US Army Corps
of Engineers
Omaha District

MISSOURI RIVER SHALLOW WATER HABITAT CREATION

Dan Pridal

Omaha District Corps of Engineers


Missouri River Region
Omaha District
Kansas City District
Location Map
SCALE 1:9,000,000
Kilometers
Statute Miles
Projection: Albers Equal Area Conic
National Rec. River
Omaha District Navigation Channel – RM 752 to 498
Omaha Federal Levee Reach
Corps Projects
USBR Authorized Flood Control Projects
Other Non-Federal Projects
Montana
North Dakota
South Dakota
Minnesota
Wyoming
Iowa
Nebraska
Colorado
Kansas
Missouri
Army Corps of Engineers
Northwest Division
Missouri River Region
Reservoir Control Center
Missouri River Basin

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Mitigation History

- WRDA 1986 (Section 1135, Missouri River Mitigation)
- WRDA 1999 – Expanded Mitigation
- Biologic Opinion 2000
- Amended BiOp 2003

LEAST TERN

PIPING PLOVER

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PALLID STURGEON

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BiOp

Reasonable and Prudent Alternatives

1) Flow Enhancement
2) **Habitat Restoration / Creation / Acquisition**
3) Unbalance System Regulation
4) Adaptive Management / Monitoring
5) Propagation / Augmentation

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BiOp Shallow Water Habitat Creation

- Create 20-30 acres of shallow water per mile
- Criteria for shallow water habitat at August 50% flow:
  - <5 feet deep
  - < 2.5 feet/second velocity
- Existing Acres Estimate ~ 3,000 Acres
- Construction
  - With max. Flow Mod. – 10,380 to 17,820
  - Without Flow Modification – 11,680 to 19,020

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Habitat Creation Goals

Project near term goals:

- 10% (2000 acres) of shallow-water habitat by year 2005 (Achieved)
- 40% (7300 acres) of shallow-water habitat by year 2010

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Past Major Activities

- Construction 6 main stem dams (system filled in 1967)
- Navigation and Bank Stabilization to Sioux City
  - 9x300 foot minimum navigation channel
  - Declared Operational Complete in 1981
- Extensive river modifications
  - Systematic design to set alignment and width
  - Extensive side channel cut-offs and shortening
- Intermittent federal levees - Omaha to St. Louis

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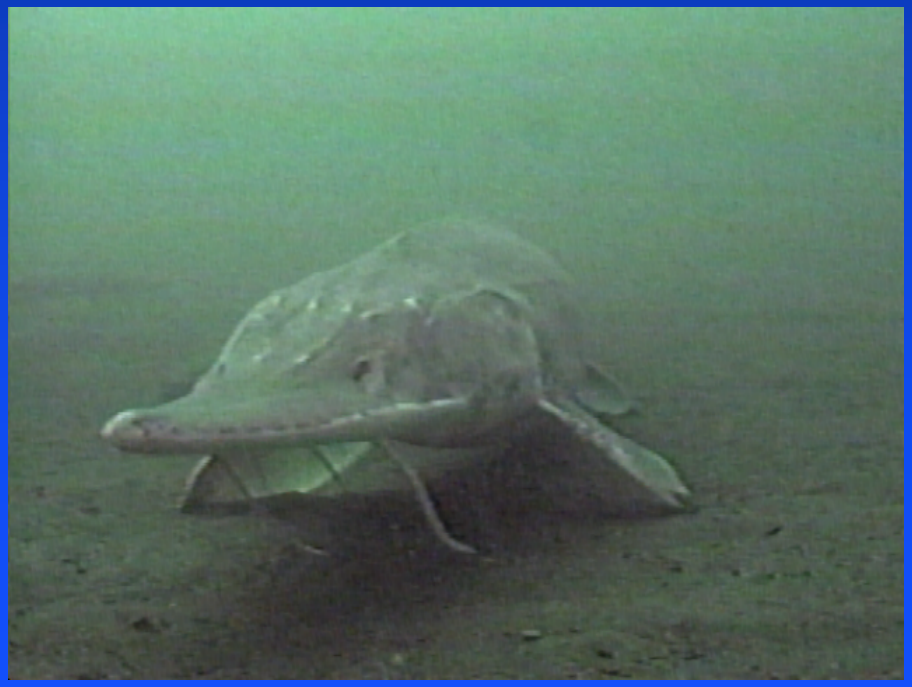
Why Create Habitat?

- Loss of physical habitat
- Loss of alluvial dynamics



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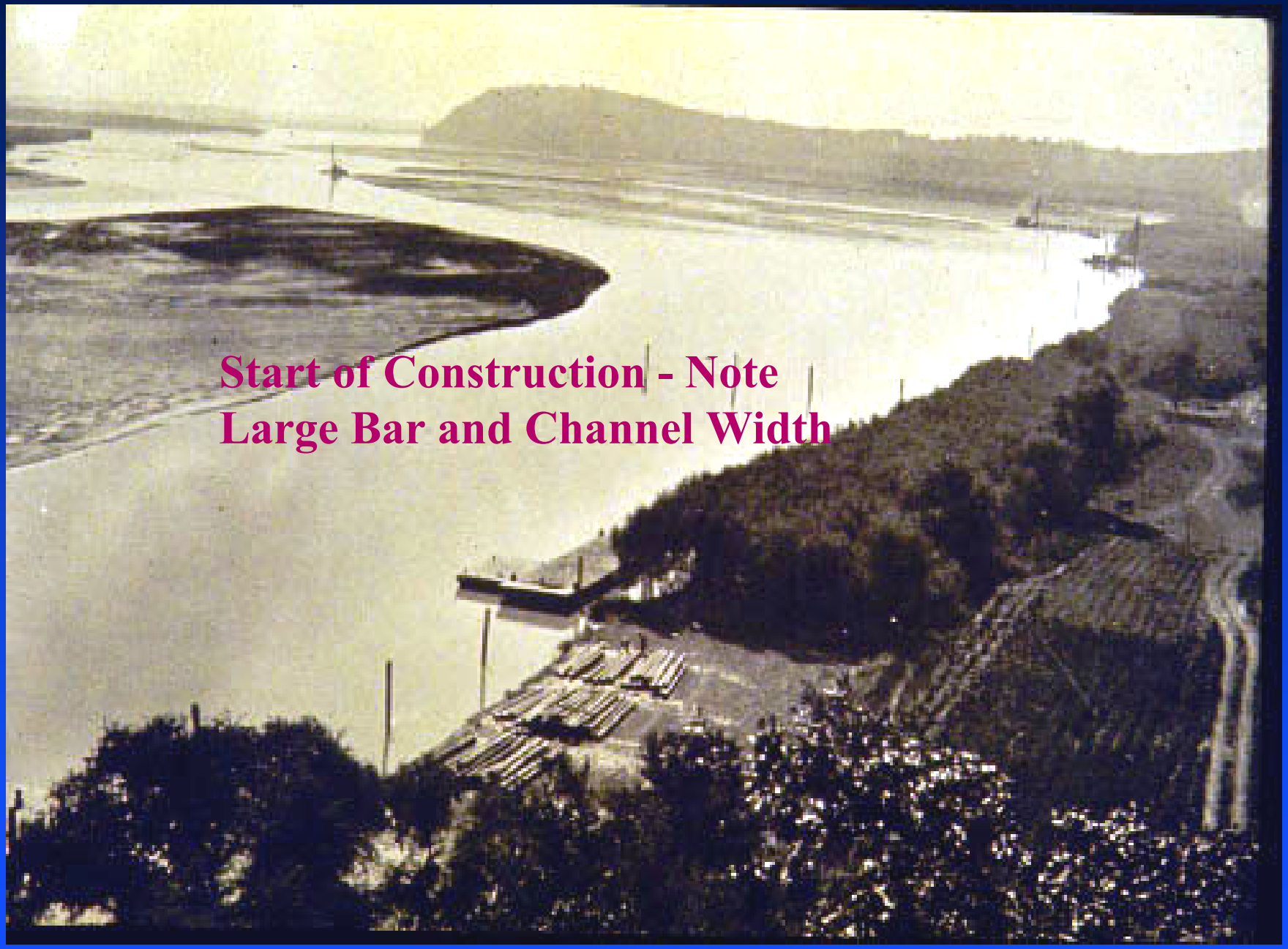
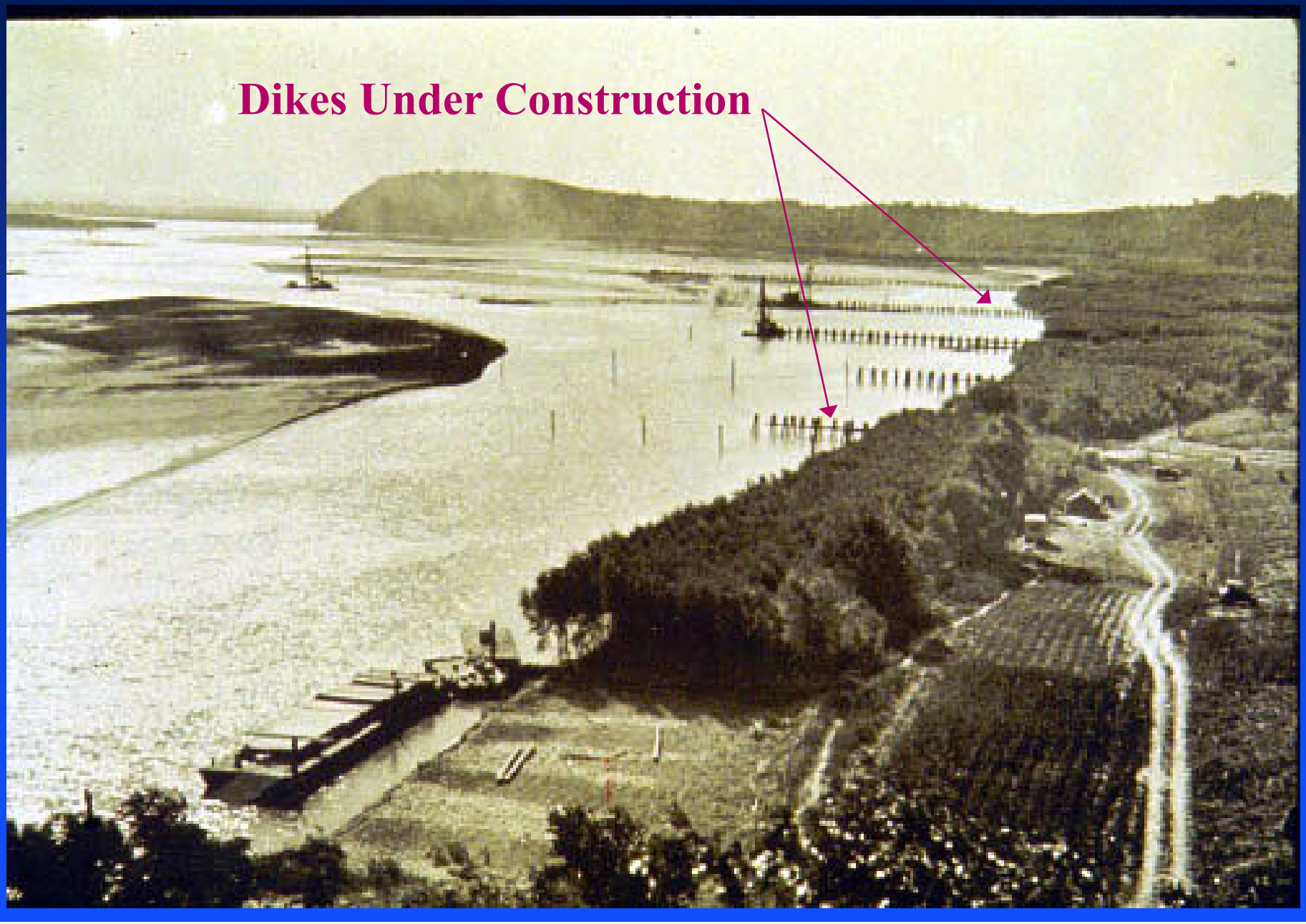
Channel Impacts

- Decreased depth diversity
- Channel meander stopped
- Aggradation on flood plain
- Limited dynamic interaction of channel and floodplain
- Channel degradation downstream of dams – lower floodplain connectivity
- Removed nearly 500,000 acres of habitat

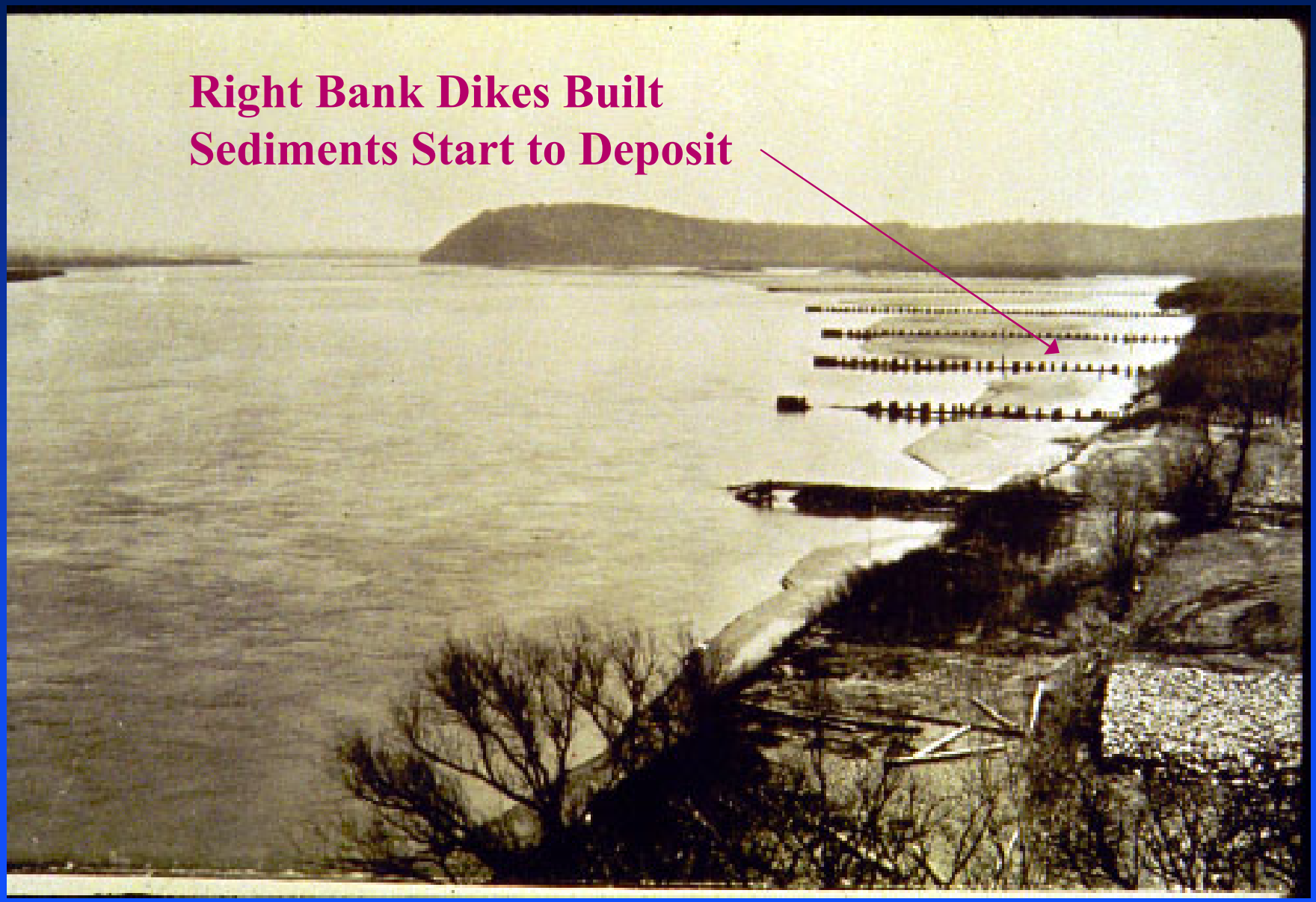
Rock Bluff Bend (RM 583 – 584) - Sep 1934



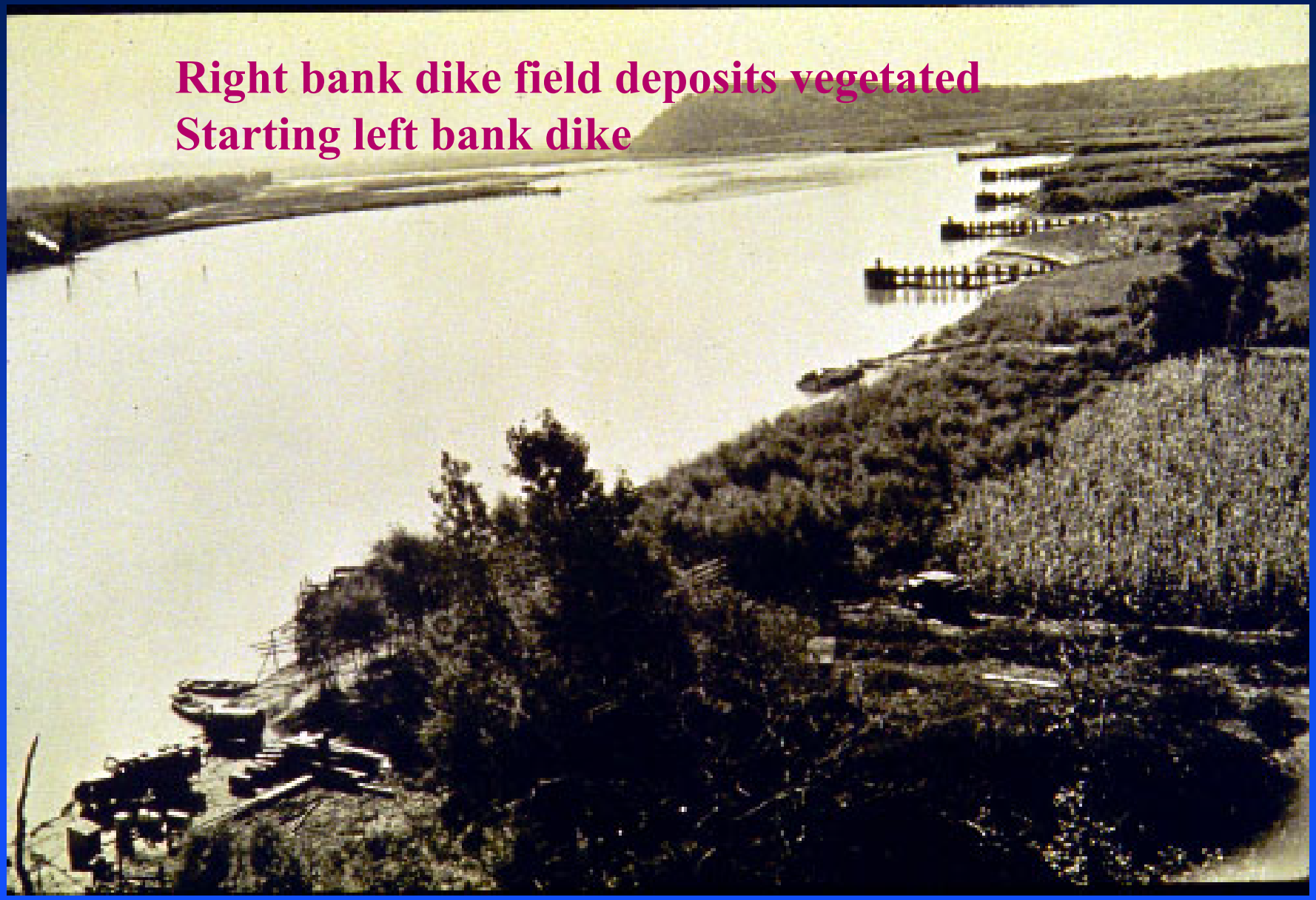
Rock Bluff Bend - Oct 1934



Rock Bluff Bend - Mar 1936

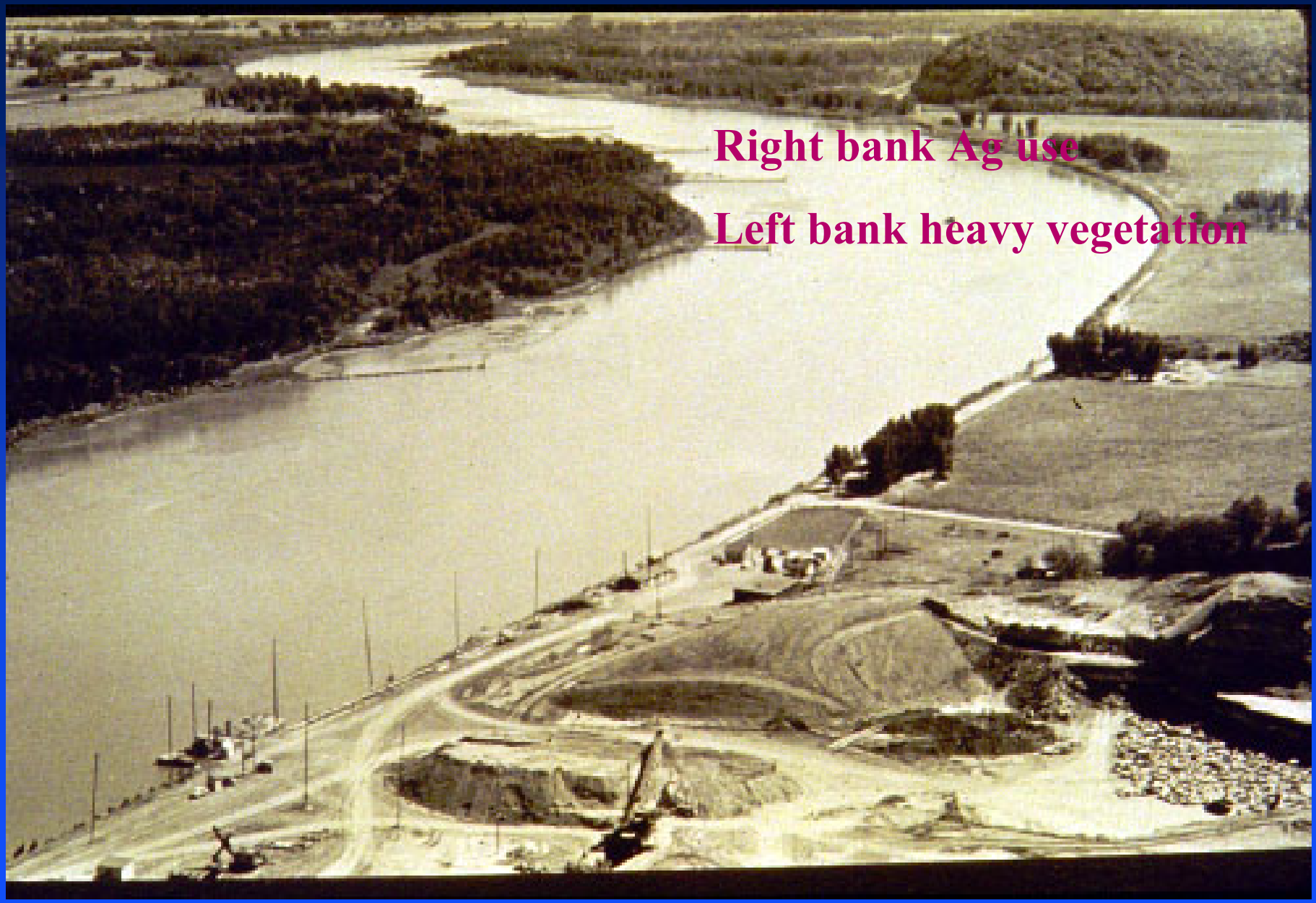


Rock Bluff Bend - Oct 1939 (5 years)



Rock Bluff Bend - 1942 (8 years)

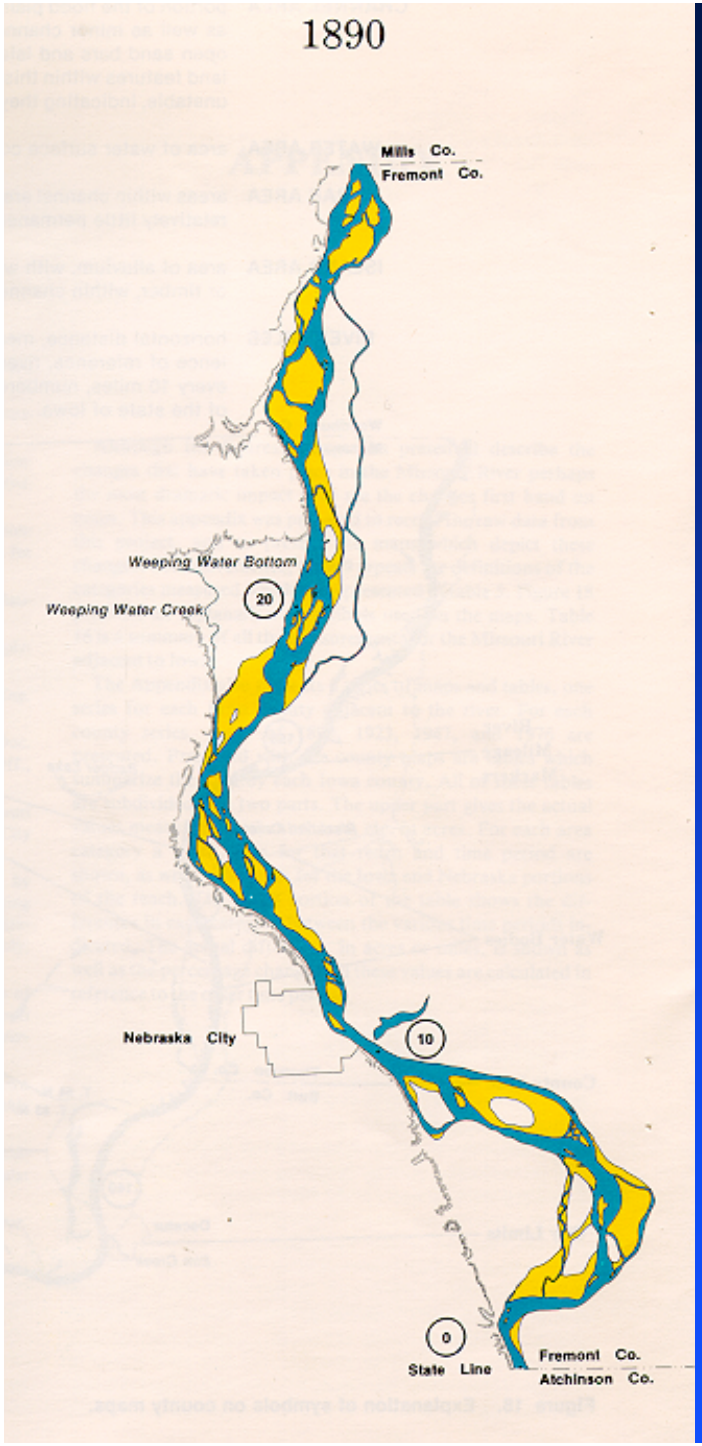
Rock Bluff Bend - May 1956 (22 years)

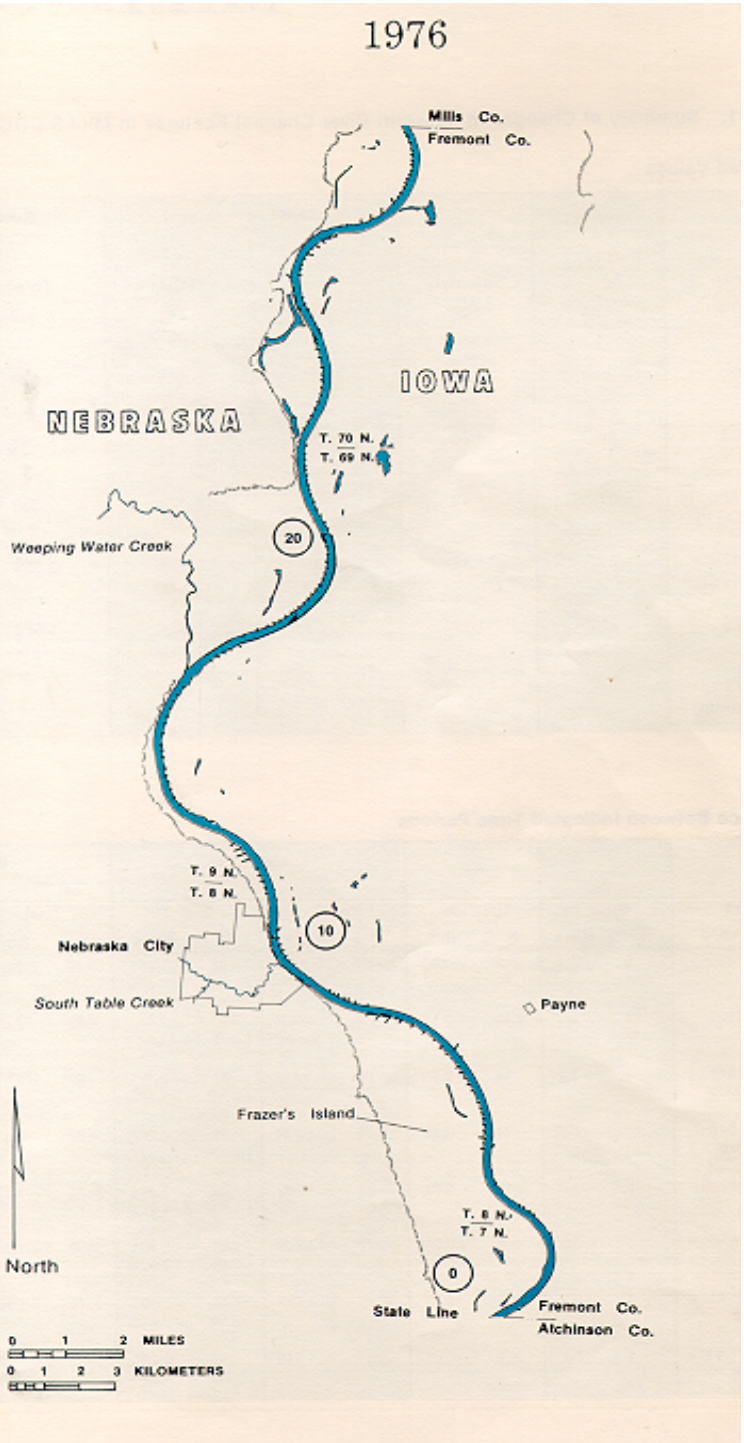


Rock Bluff Bend - Mar 1983 (50 years)

Both banks vegetation cleared with agricultural use

Plan View Channel Changes





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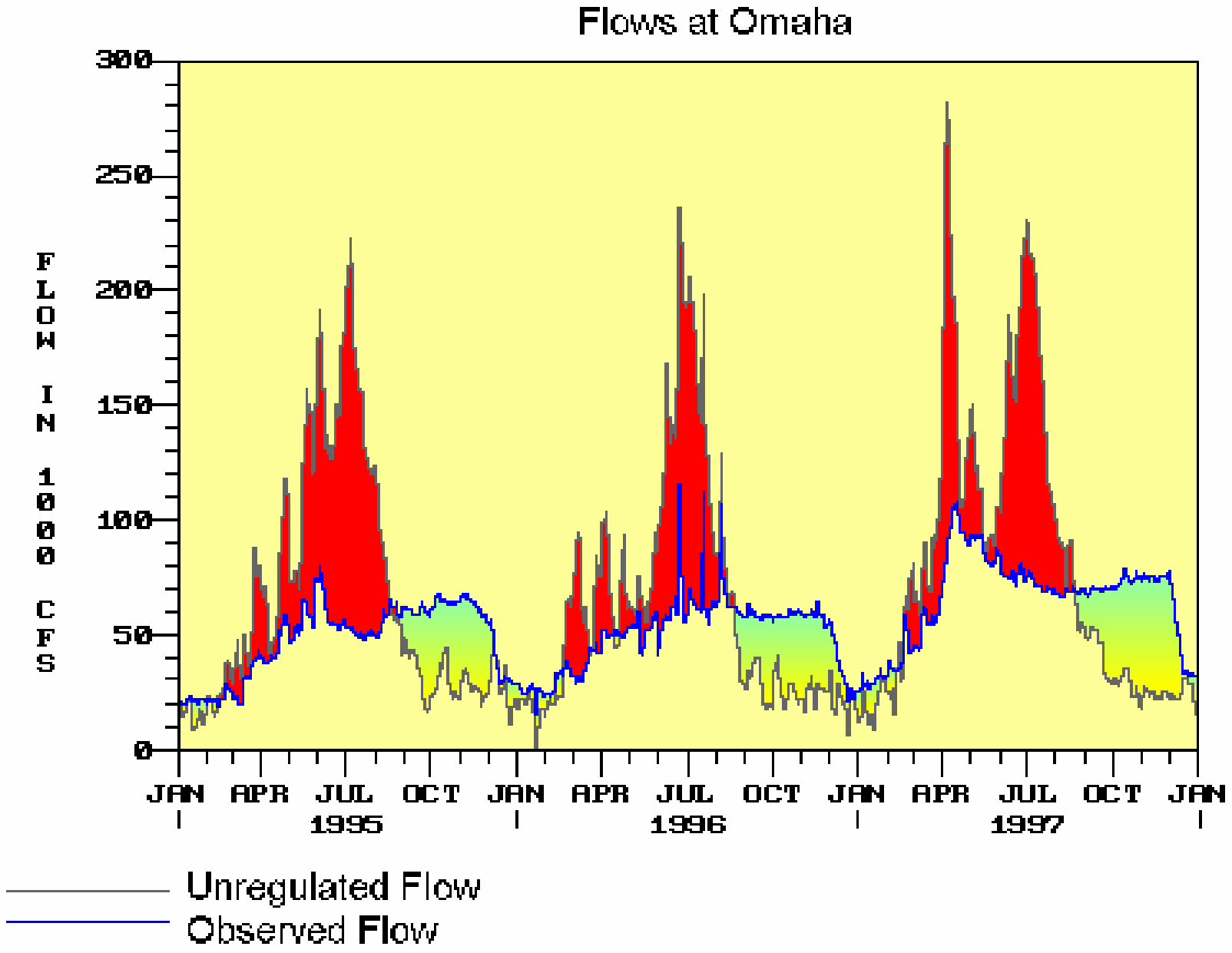
Reservoir Impacts

- Decreased peak flows (Flood Control)
- Increased base flows (Water Supply, Navigation, Hydropower)
- Operation Constraints – Hydropower and Recreation
- Trapped sediments
- Consumptive use reduces annual volume (about 20-30%)


Flows at Omaha
FLOW IN 10000 CFS
300
250
200
150
100
50
0
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT
JAN
1995
1996
1997
Unregulated Flow
Observed Flow

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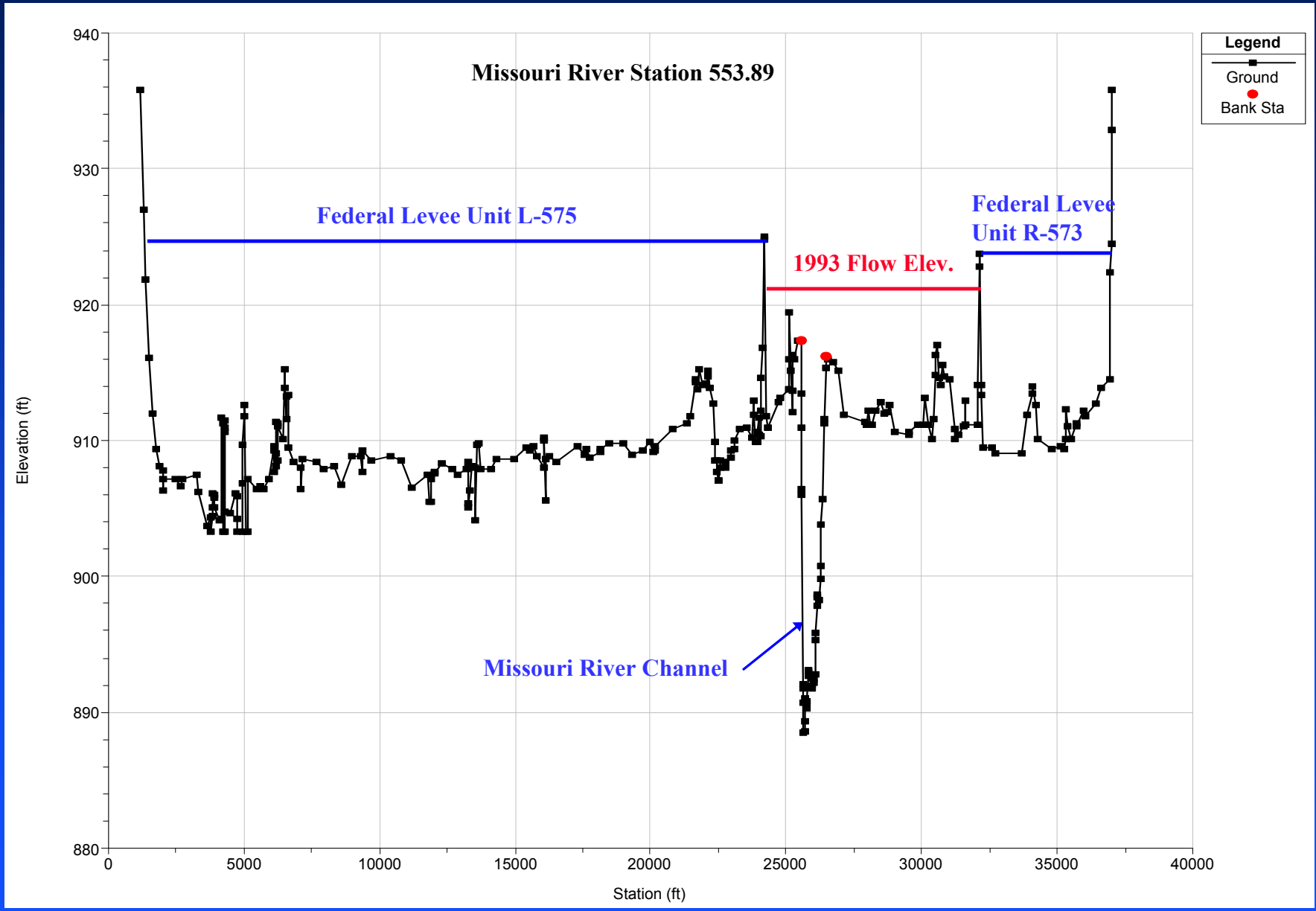
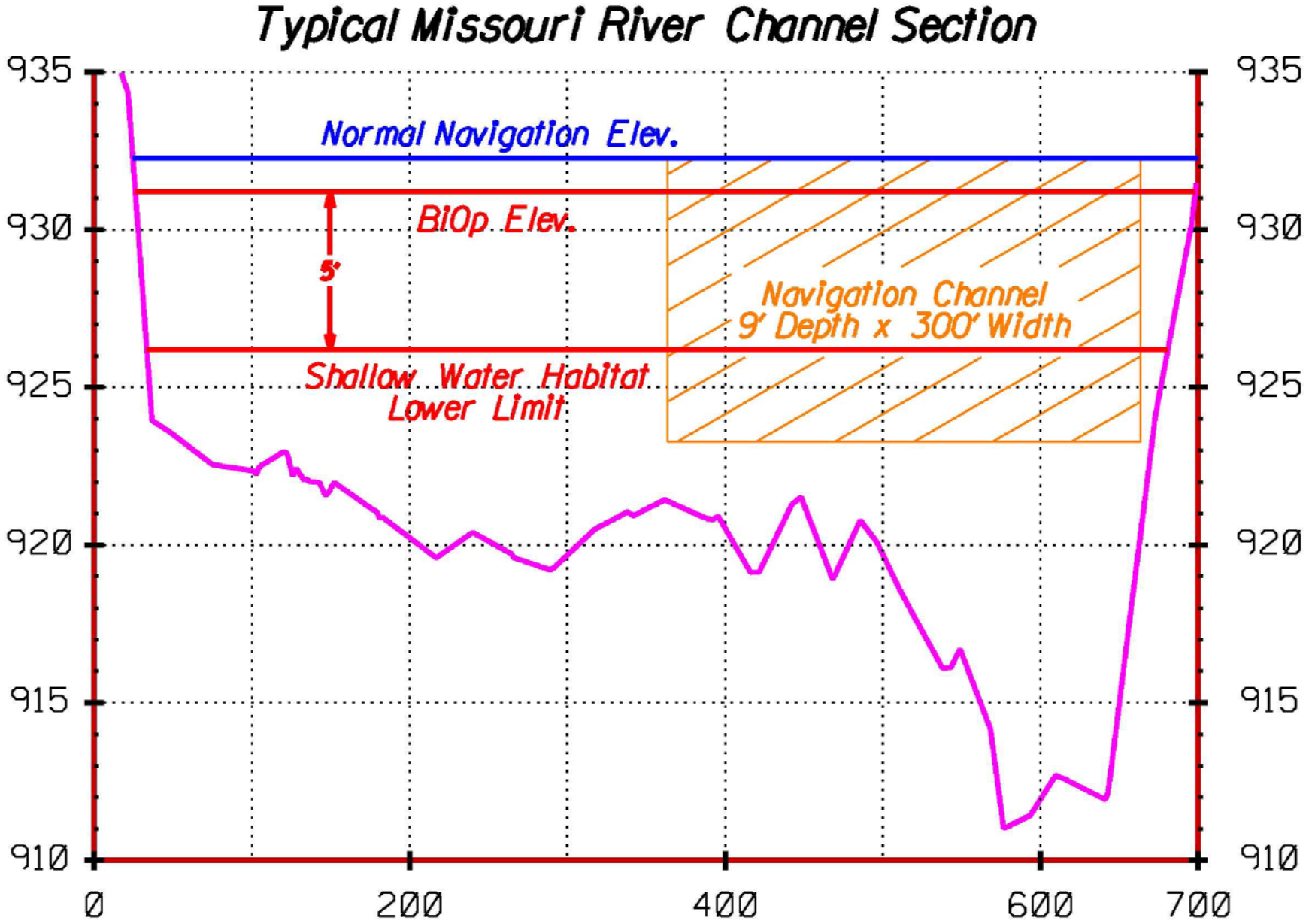
SWH Challenge

Construct SWH while maintaining existing project purposes:

- Navigation channel
- Streambank stabilization
- Flood control channel capacity
- Water supply water quality
- Recreation and public safety
- Irrigation

Typical Cross Section




Typical Missouri River Channel Section
935
930
925
920
915
910
0
200
400
600
700
Normal Navigation Elev.
BlOp Elev.
5'
Navigation Channel
9' Depth x 300' Width
Shallow Water Habitat
Lower Limit

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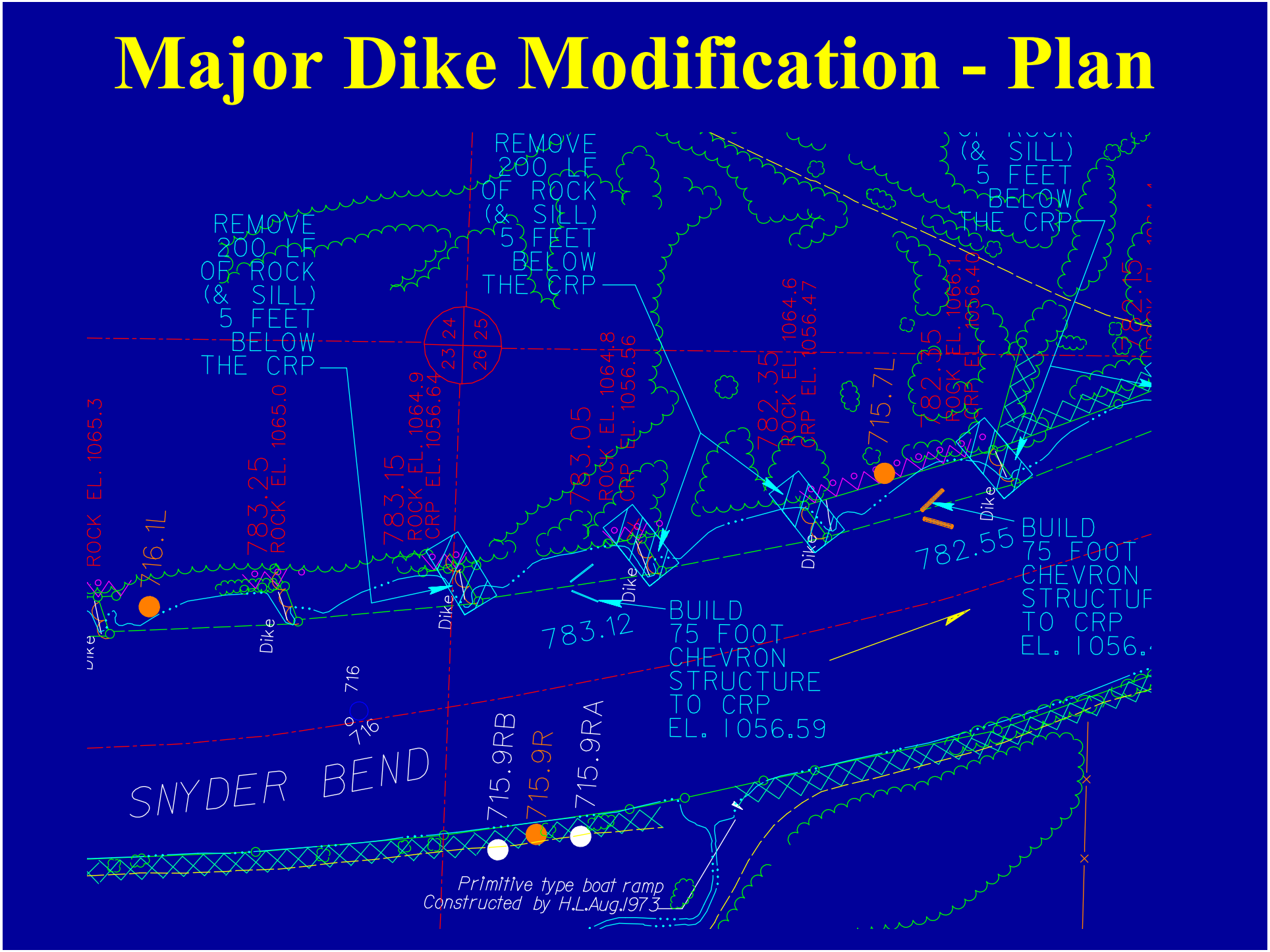
Methods to Create SWH

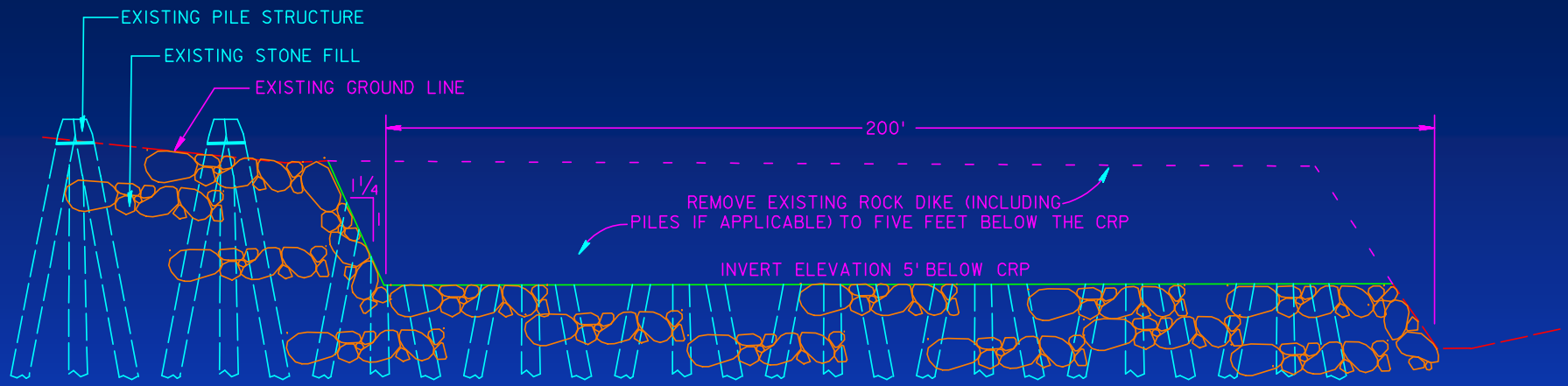
- Chutes and backwater areas
- Dike lowering / notching / removal
- Placement of new structures
- Combination of dike modification and new structures

Dredged Backwater – California Bend

Major Dike Modification - Plan

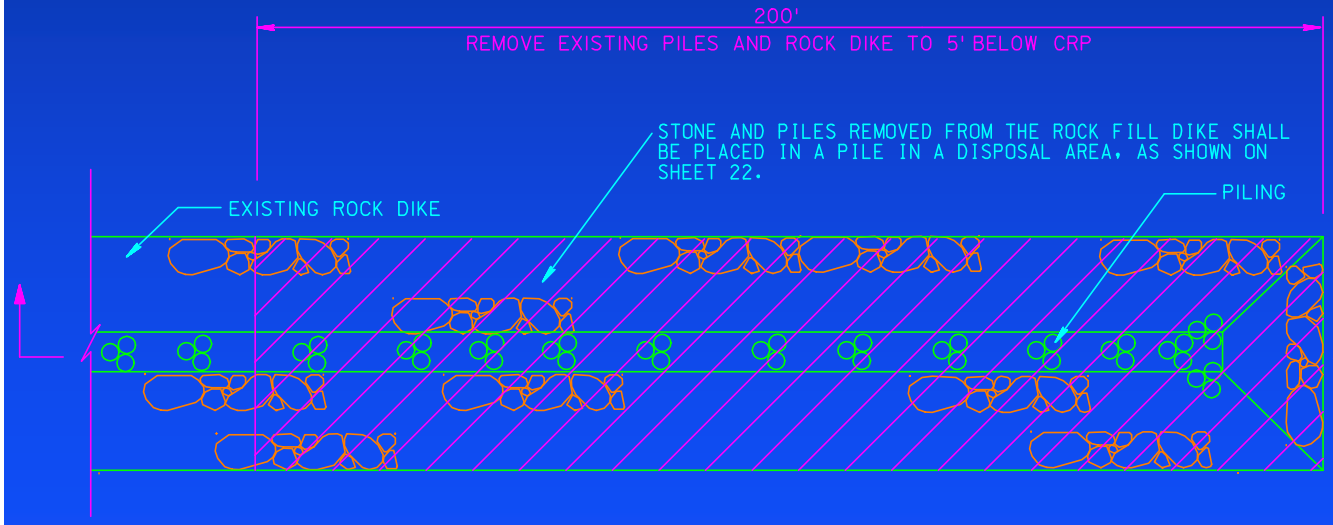


Major Dike Modification - Section



SECTION 1

NOT TO SCALE

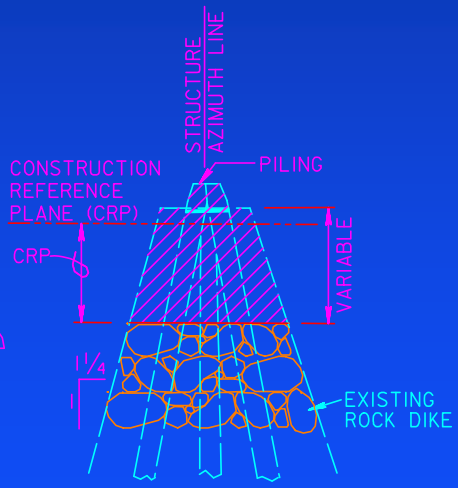


DIKE REMOVAL DETAIL

PLAN VIEW

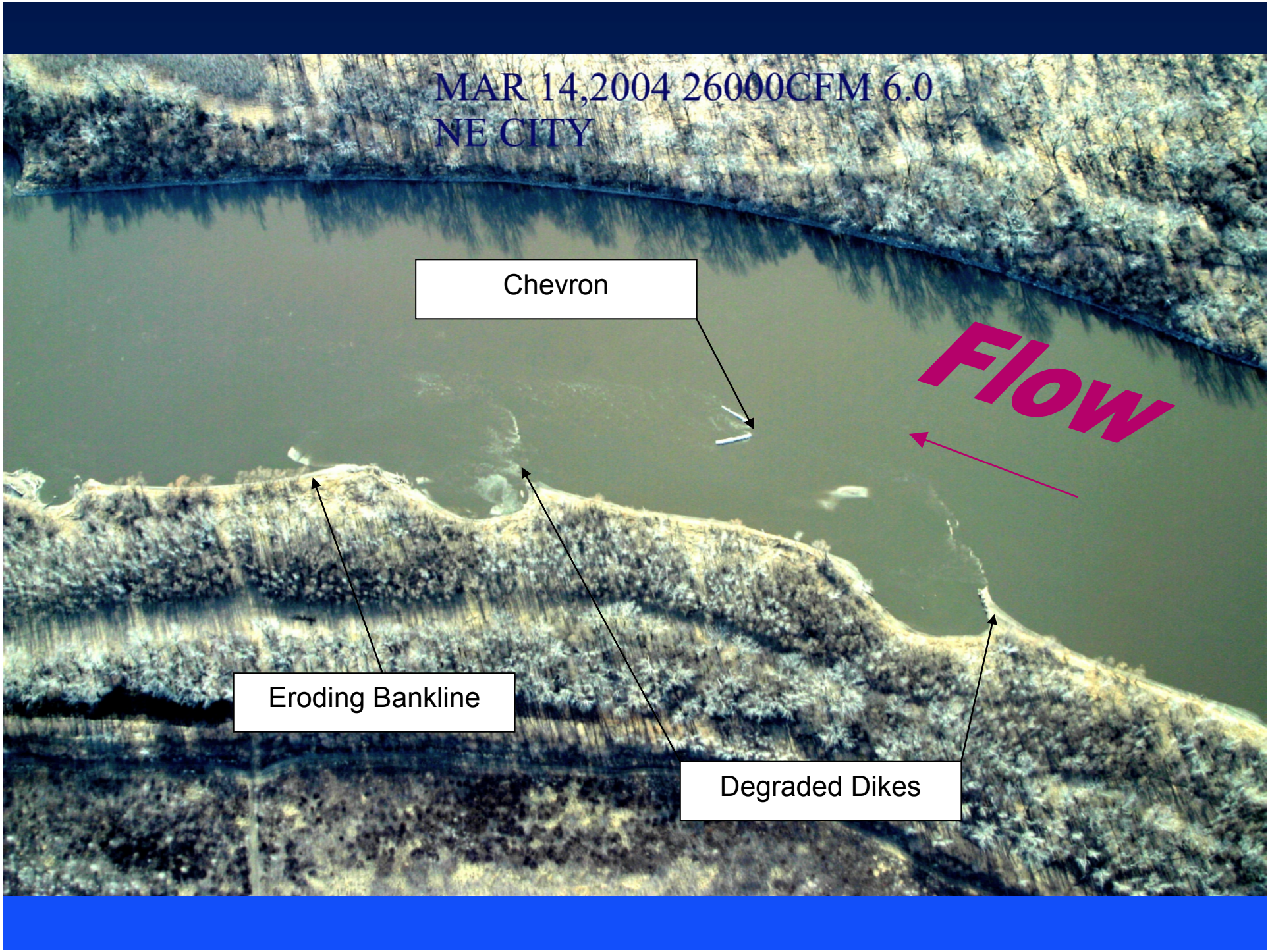
NOT TO SCALE

REMOVE EXISTING ROCK DIKE (INCLUDING PILES) TO FIVE FEET BELOW THE CRP

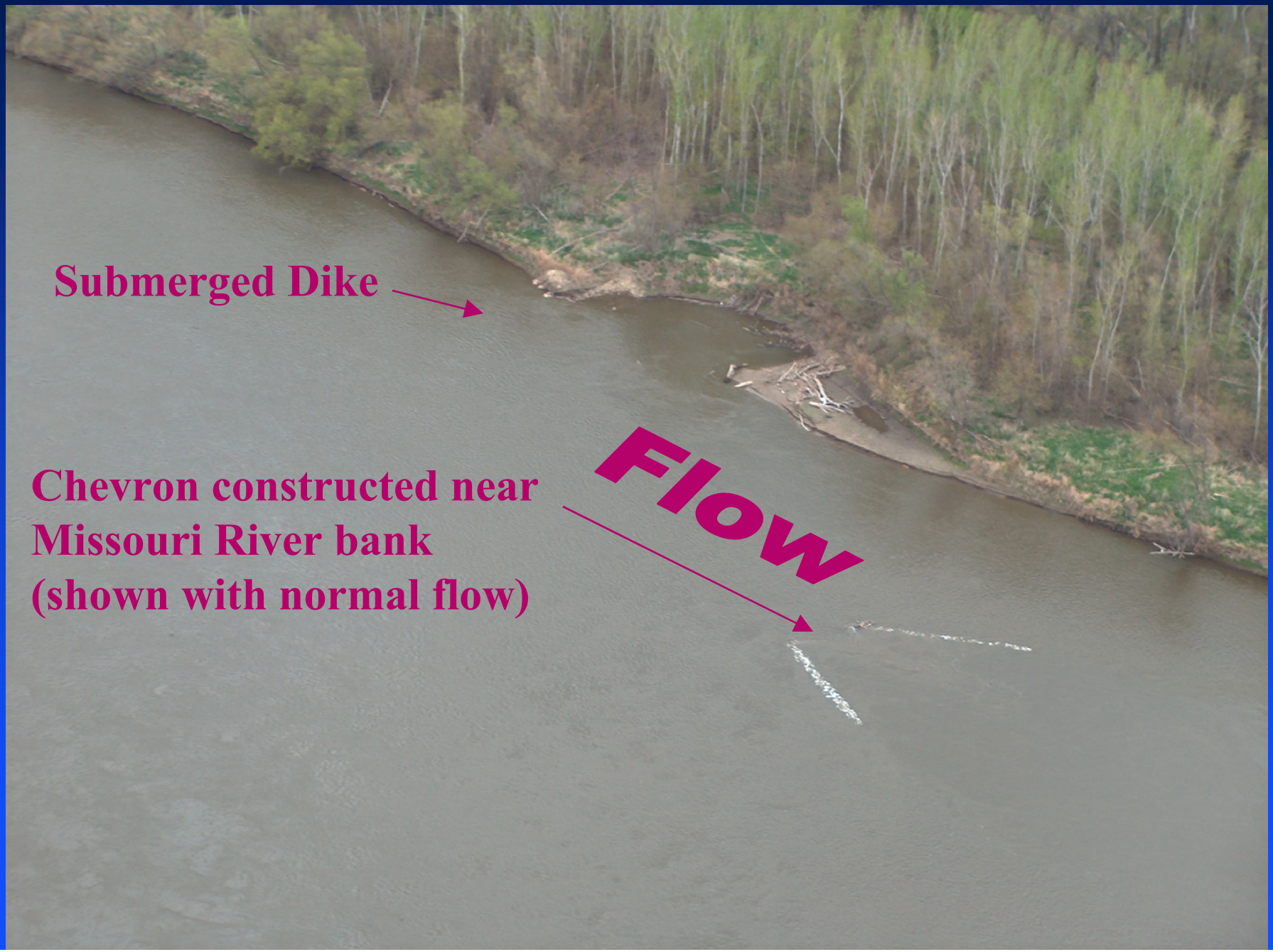


SECTION 2

NOT TO SCALE


MAR 14,2004 26000CFM 6.0
NE CITY
Chevron
Flow
Eroding Bankline
Degraded Dikes

Chevron Aerial View



Chevron with Sandbar Deposit

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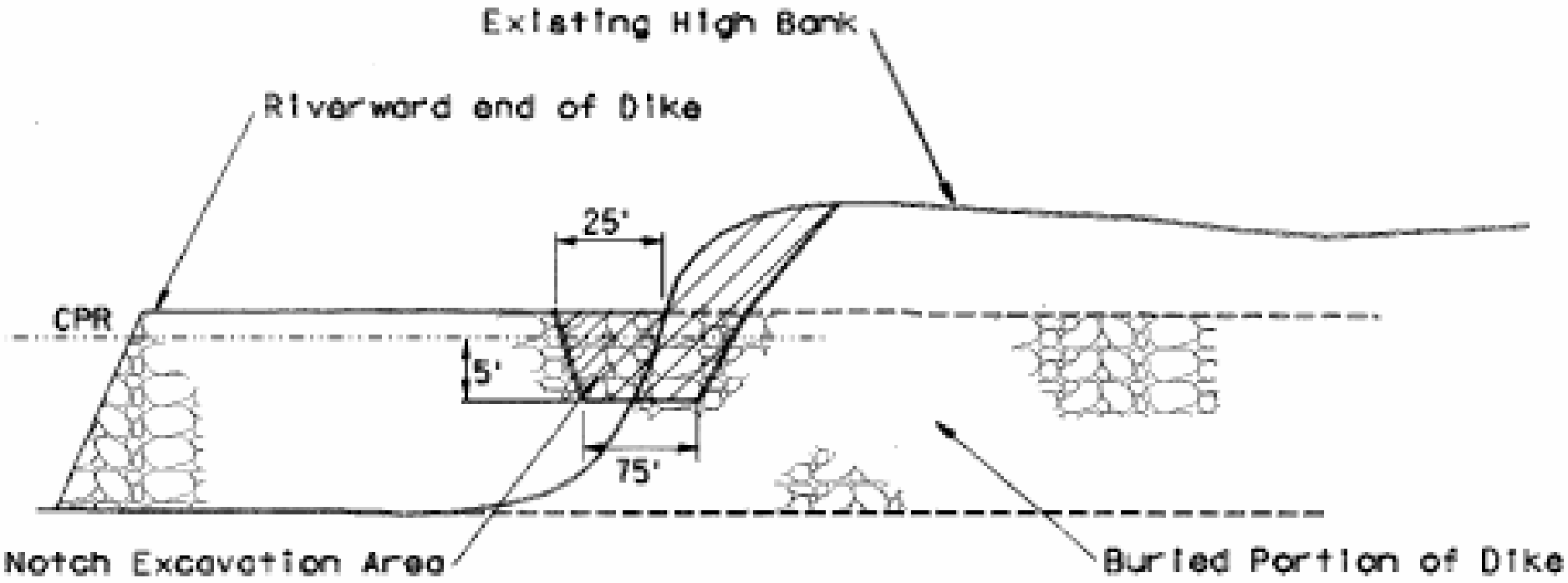
Type B Dike Notch



Notch Typical Profile - Type B

Dike Field with Type B Notches

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After Construction Field Observations

- **Increase in Measurable SWH per site**
- Increase in top width and depth diversity
- Erosion of high bank (slight to extensive)
- Ongoing erosion processes, sandbars are dynamic
- Spoil placement critical, some debris accumulation in notches

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Design and Monitoring Data Tools

- Numerous orthophotos
- 1999 4 foot contour interval DTM with 1995 hydrographic sections
- Site specific survey data
- ADCP velocity data
- Measured water surface profiles
- Rated USGS gages and COE stage gages
- CRP flow profile
- Calibrated RAS and UNET models

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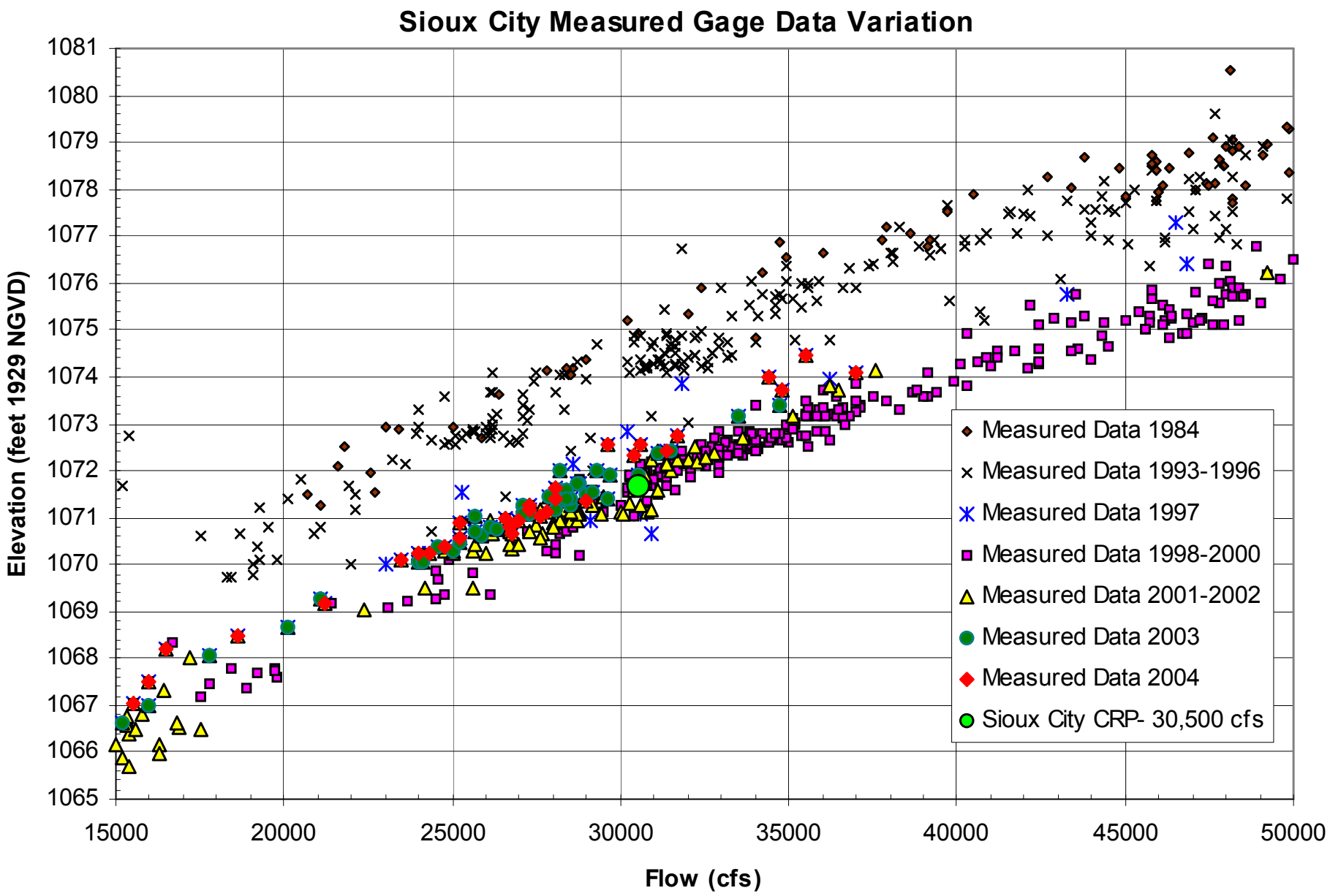
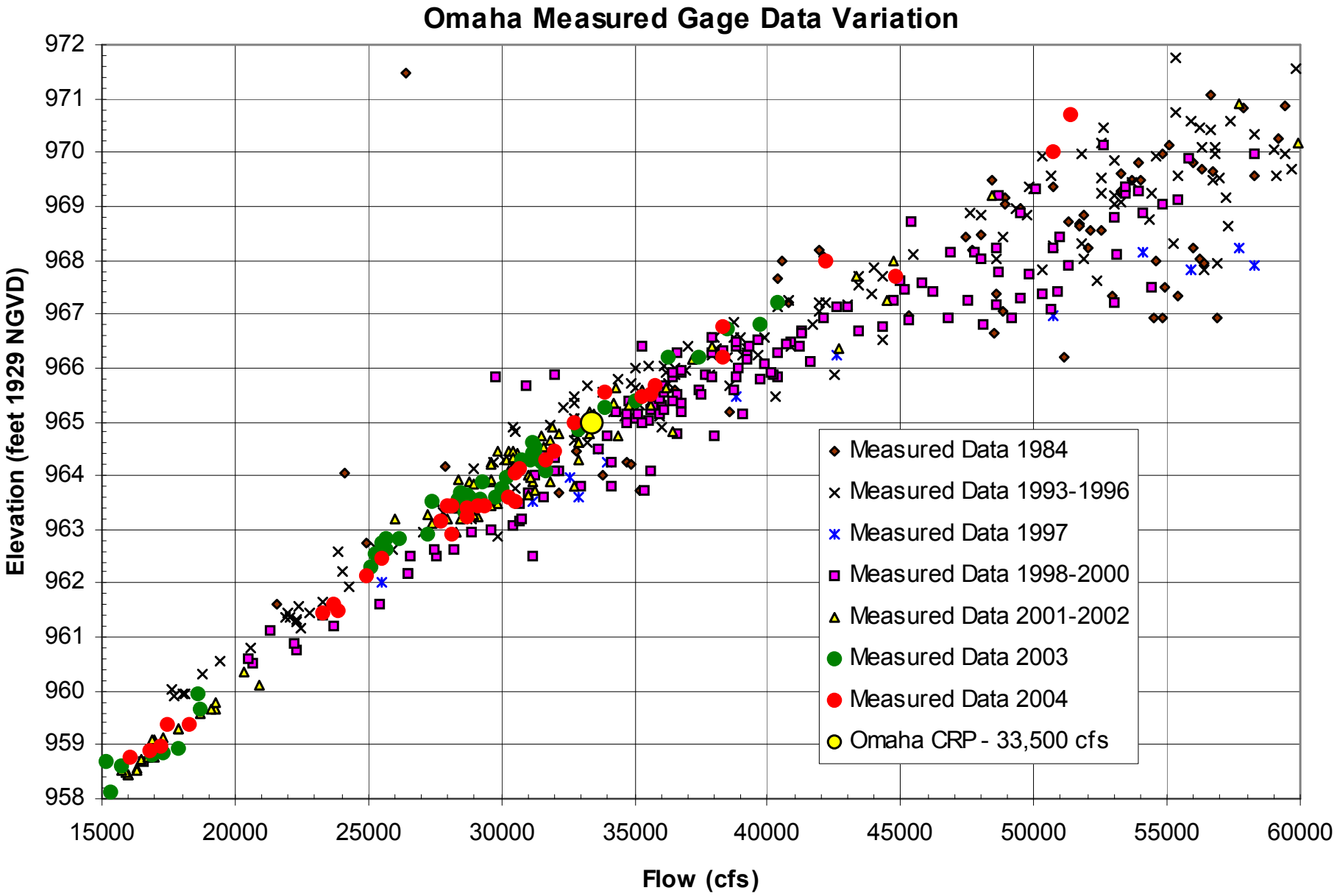
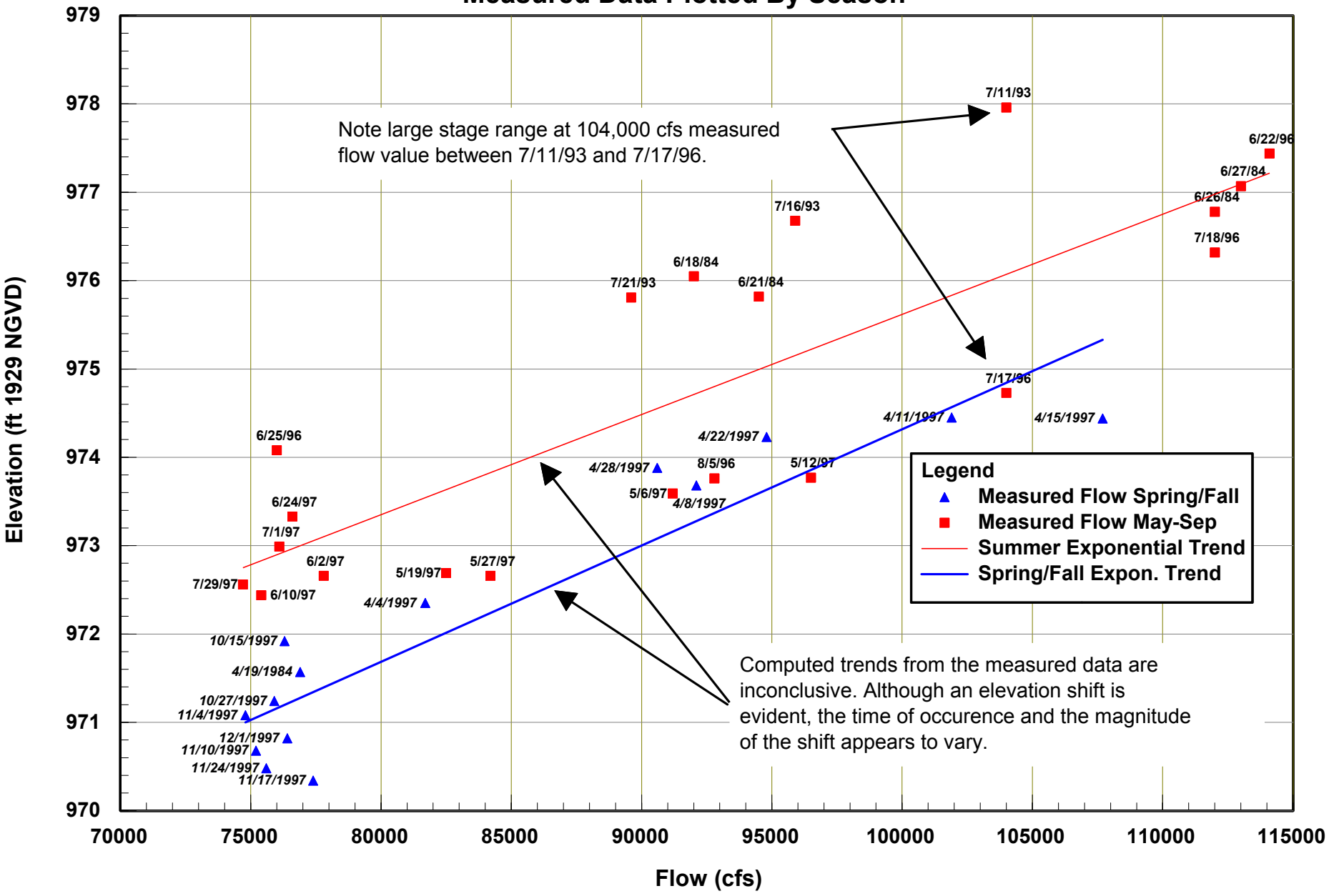
Design Challenges

- Variable flow – stage rating (re-calibrate)
- Maintain flood capacity
- Maintain sediment transport
- Monitoring to demonstrate compliance
- Coordinate with numerous federal, state, local agencies
- Changing criteria and operating plan
- Real estate acquisition, easements

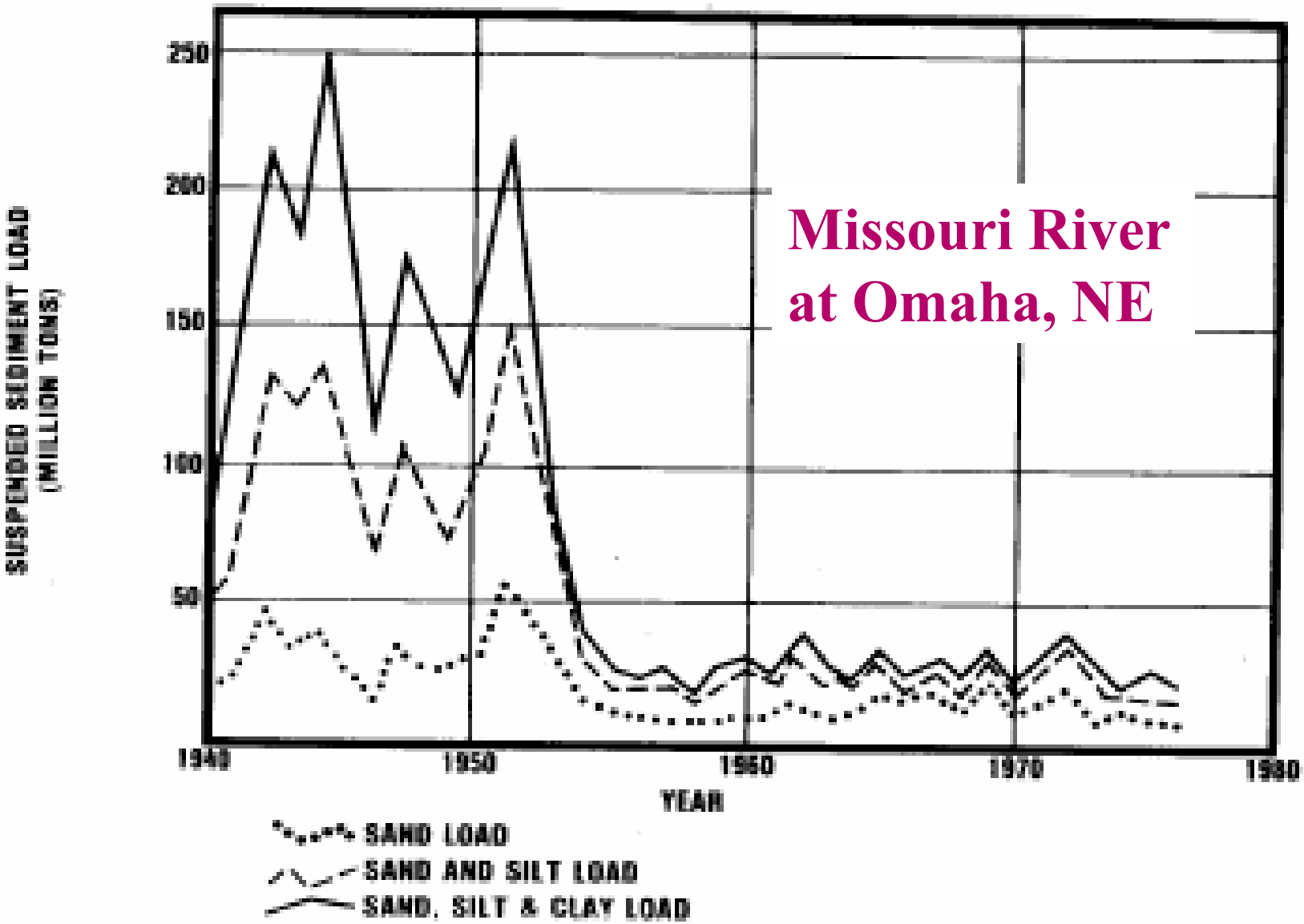

Sioux City Measured Gage Data Variation
Elevation (feet 1929 NGVD)
1081
1080
1079
1078
1077
1076
1075
1074
1073
1072
1071
1070
1069
1068
1067
1066
1065
15000
20000
25000
30000
35000
40000
45000
50000
Flow (cfs)
Measured Data 1984
Measured Data 1993-1996
Measured Data 1997
Measured Data 1998-2000
Measured Data 2001-2002
Measured Data 2003
Measured Data 2004
Sioux City CRP- 30,500 cfs


Omaha Measured Gage Data Variation
Elevation (feet 1929 NGVD)
Flow (cfs)
972
971
970
969
968
967
966
965
964
963
962
961
960
959
958
15000
20000
25000
30000
35000
40000
45000
50000
55000
60000
Measured Data 1984
Measured Data 1993-1996
Measured Data 1997
Measured Data 1998-2000
Measured Data 2001-2002
Measured Data 2003
Measured Data 2004
Omaha CRP - 33,500 cfs

Missouri River at Omaha, NE
Measured Data Plotted By Season



Sediment Load Change



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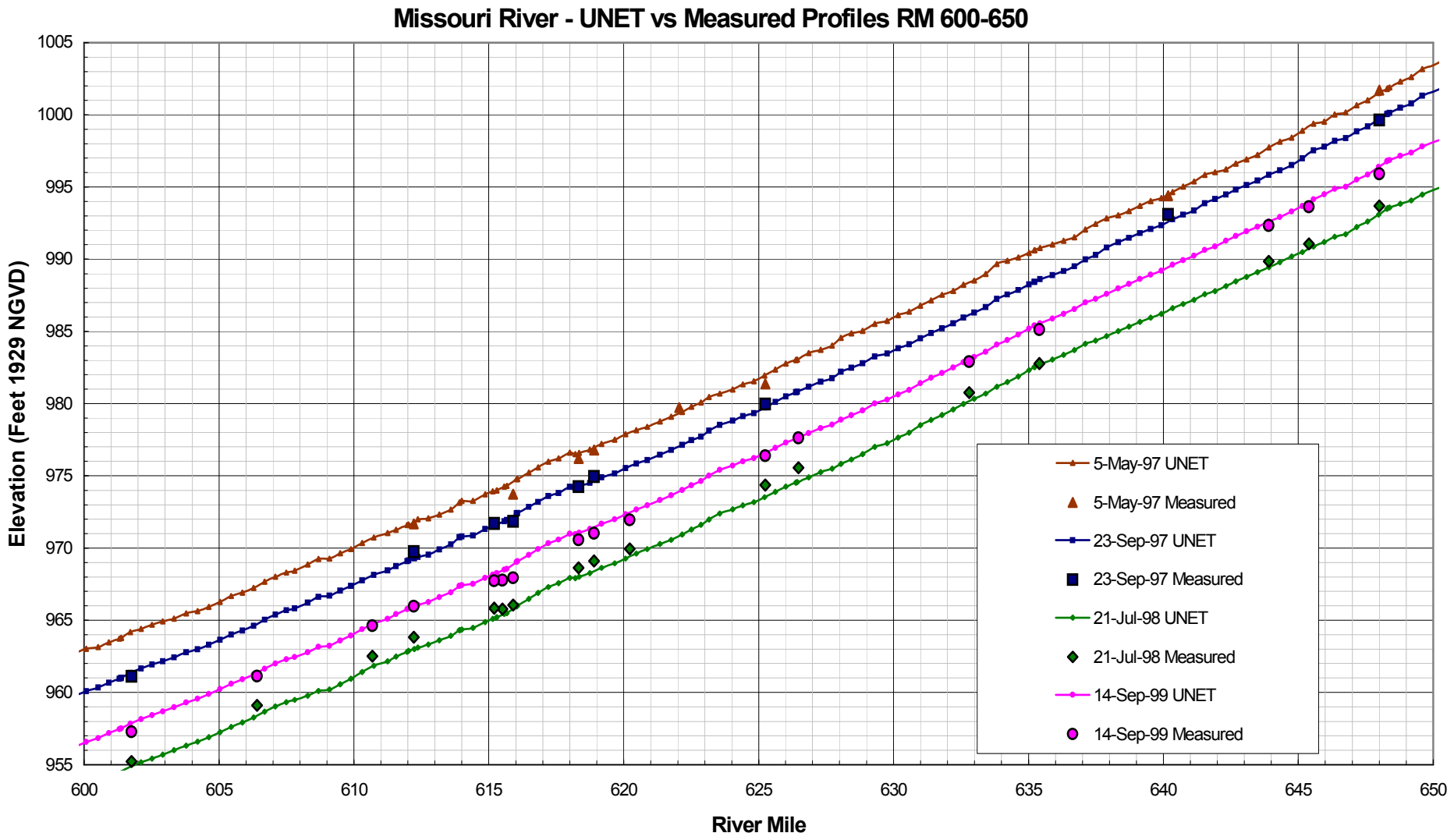
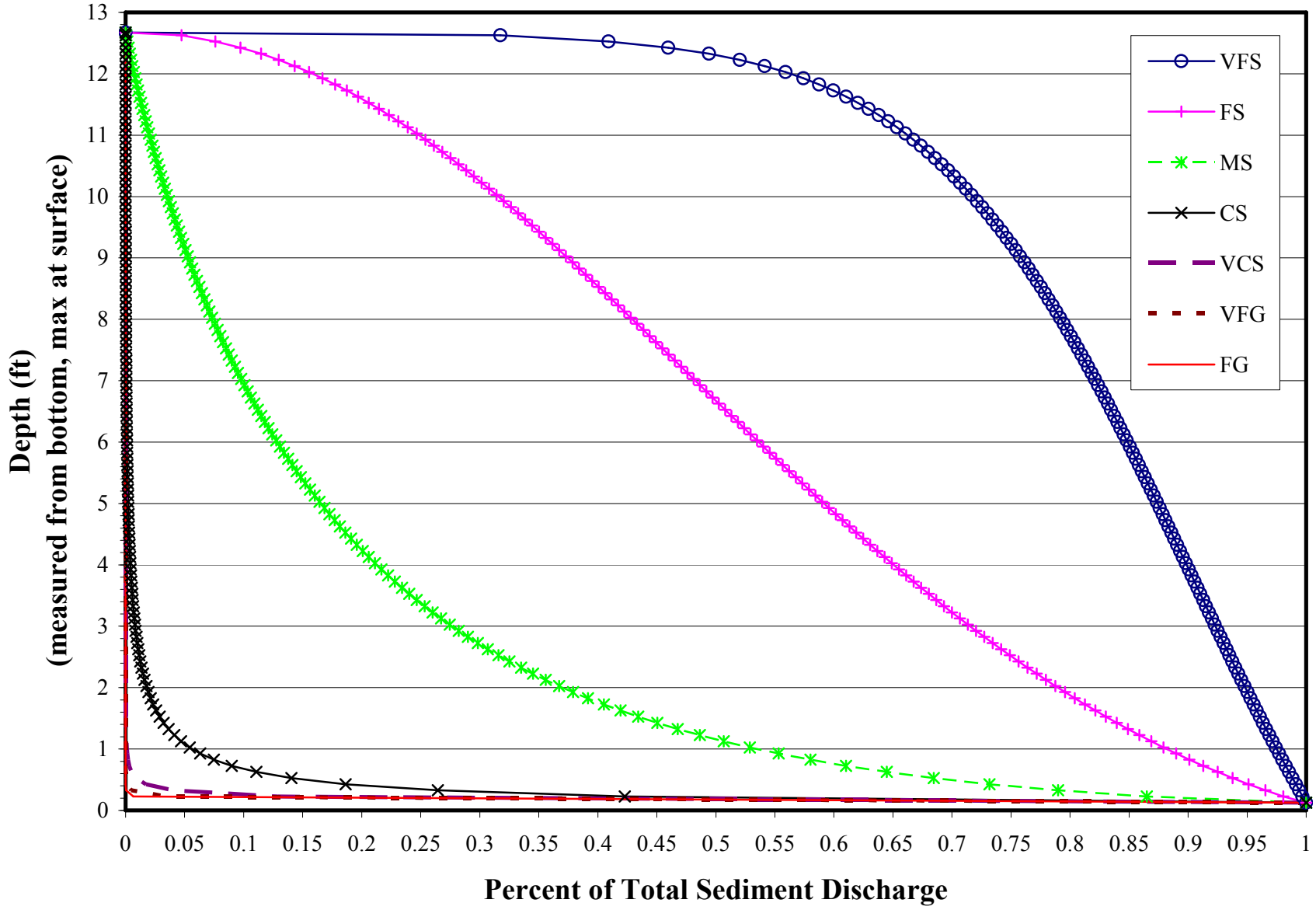
Chute Analysis

- Typically HEC-RAS split flow analysis
- Set invert using CRP to limit sediment intake
- Calibrate to measured profiles
- Provide upstream and downstream control, additional site specific
- Generally 5-10% of channel flow with velocity above 2 ft/sec at CRP flow
- SAM (used on Platte River chute)
- HEC-6 for Missouri River sediment transport

Calibration to Measured Profiles



Sediment Distribution



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Dike Modification

- 2 Dimensional (SMS and RMA-2)
- 3 Dimensional (Iowa IHR)
  - Limited applicability due to run time, sediment modeling, and result interpretation
- Micro Model
  - Modeled various widths to widen the channel, results set thresholds of channel widths
- HEC-6 Model
  - System model lacking detail to evaluate depth diversity and velocity changes
- Movable Bed Physical Model
  - Limited experience, scale, dike flow too shallow

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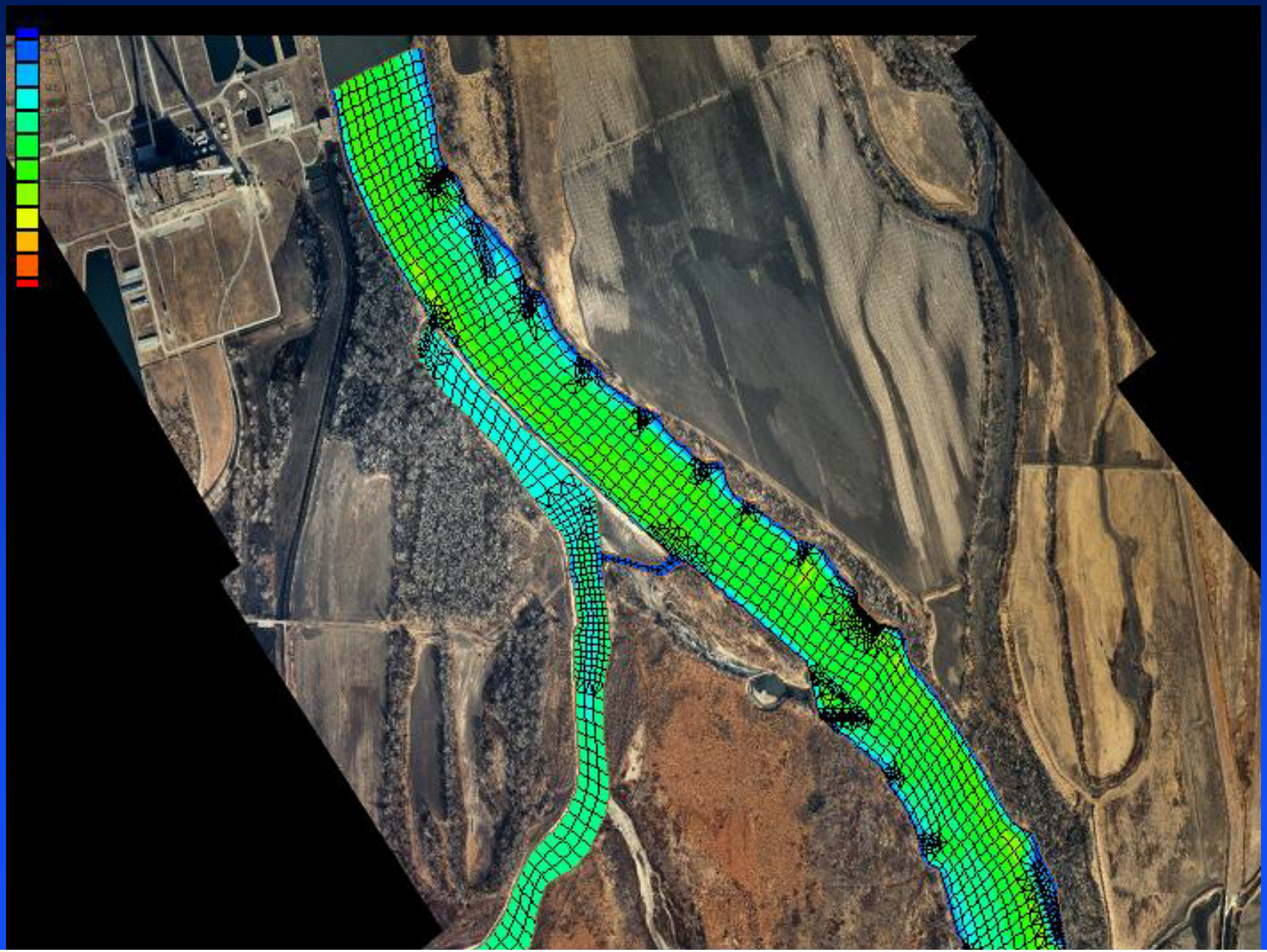
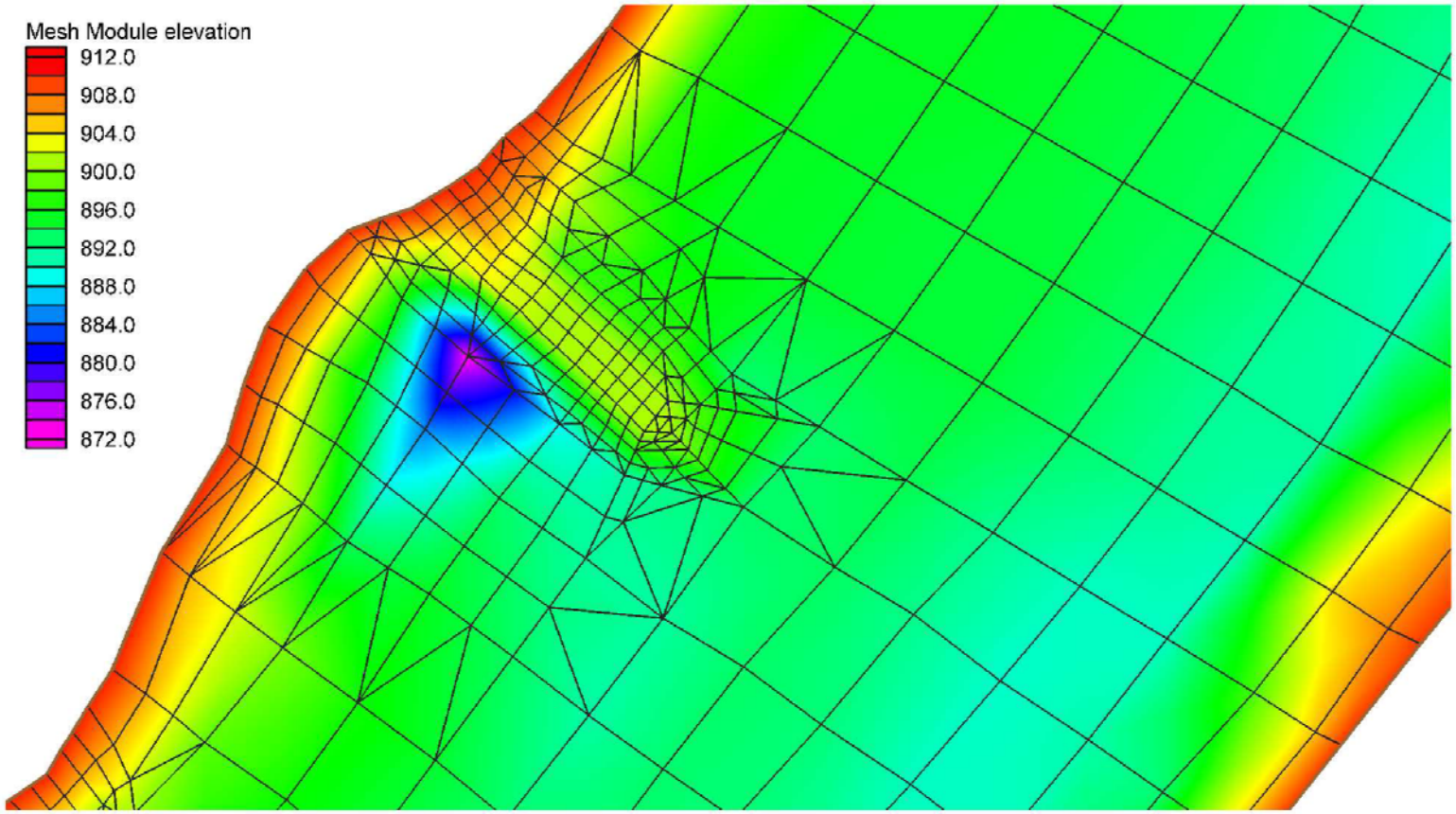
2D Modeling

- Model analysis performed through dike fields
- Calibrated to stage and ADCP velocity data
- Grid density increased for dike areas
- Sediment analysis limited by SED2D and not accurate in dike fields
- Next generation is to model a navigation season hydrograph with sediment to evaluate pre and post channel response

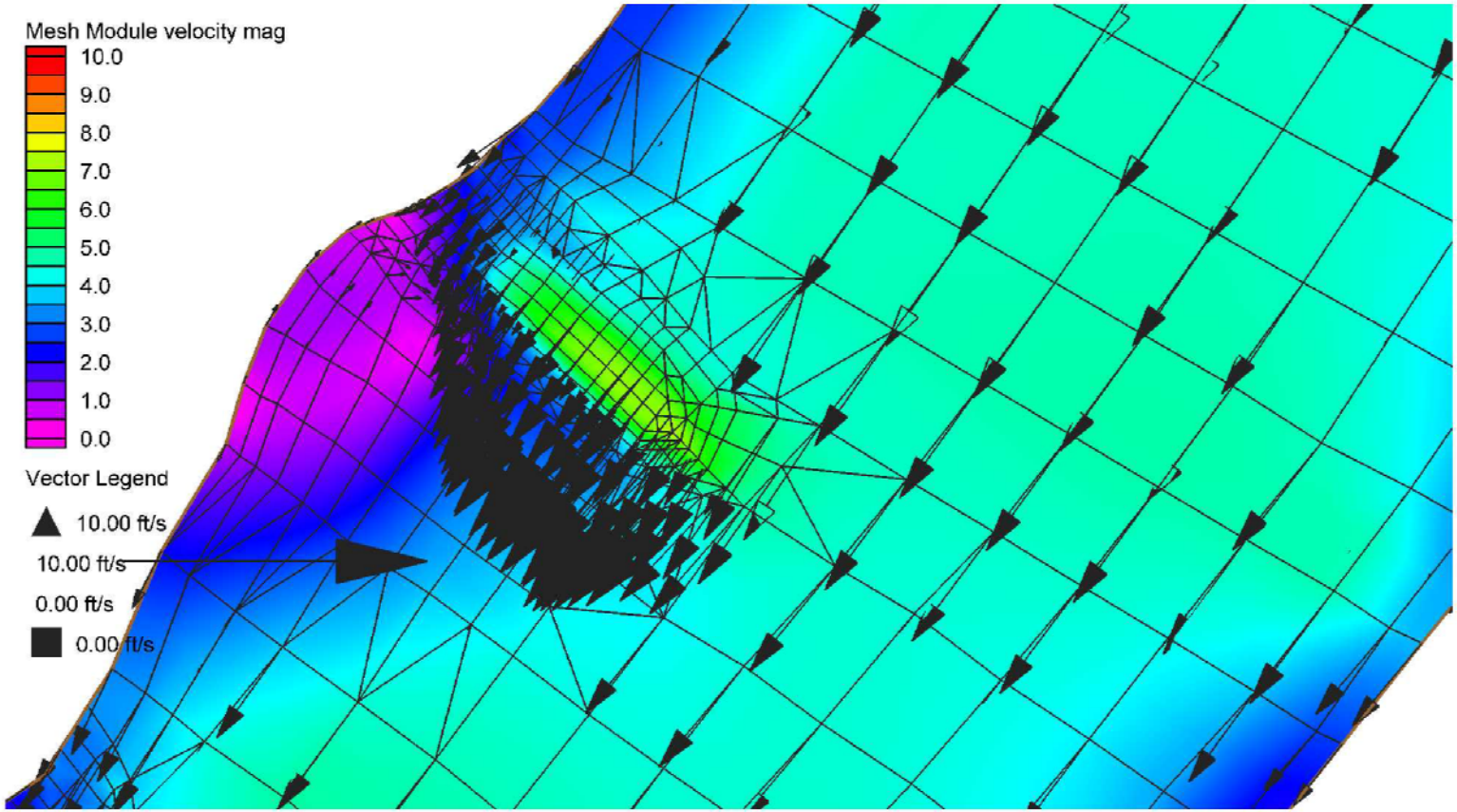
Hamburg Bend 2D Mesh

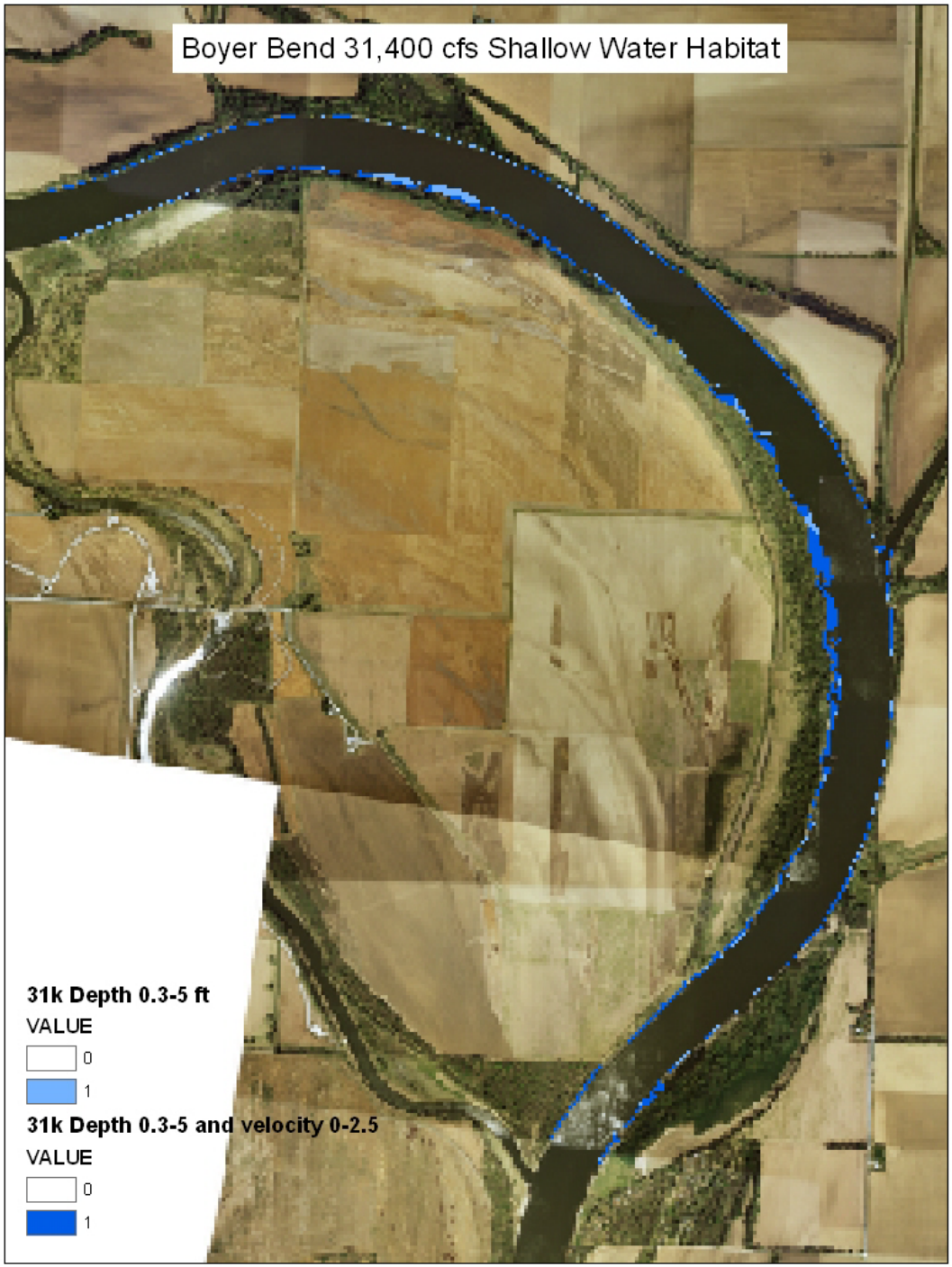


Typical Mesh Topography



Computed Velocity




Boyer Bend 31,400 cfs Shallow Water Habitat
31k Depth 0.3-5 ft
VALUE
0
1
31k Depth 0.3-5 and velocity 0-2.5
VALUE
0
1

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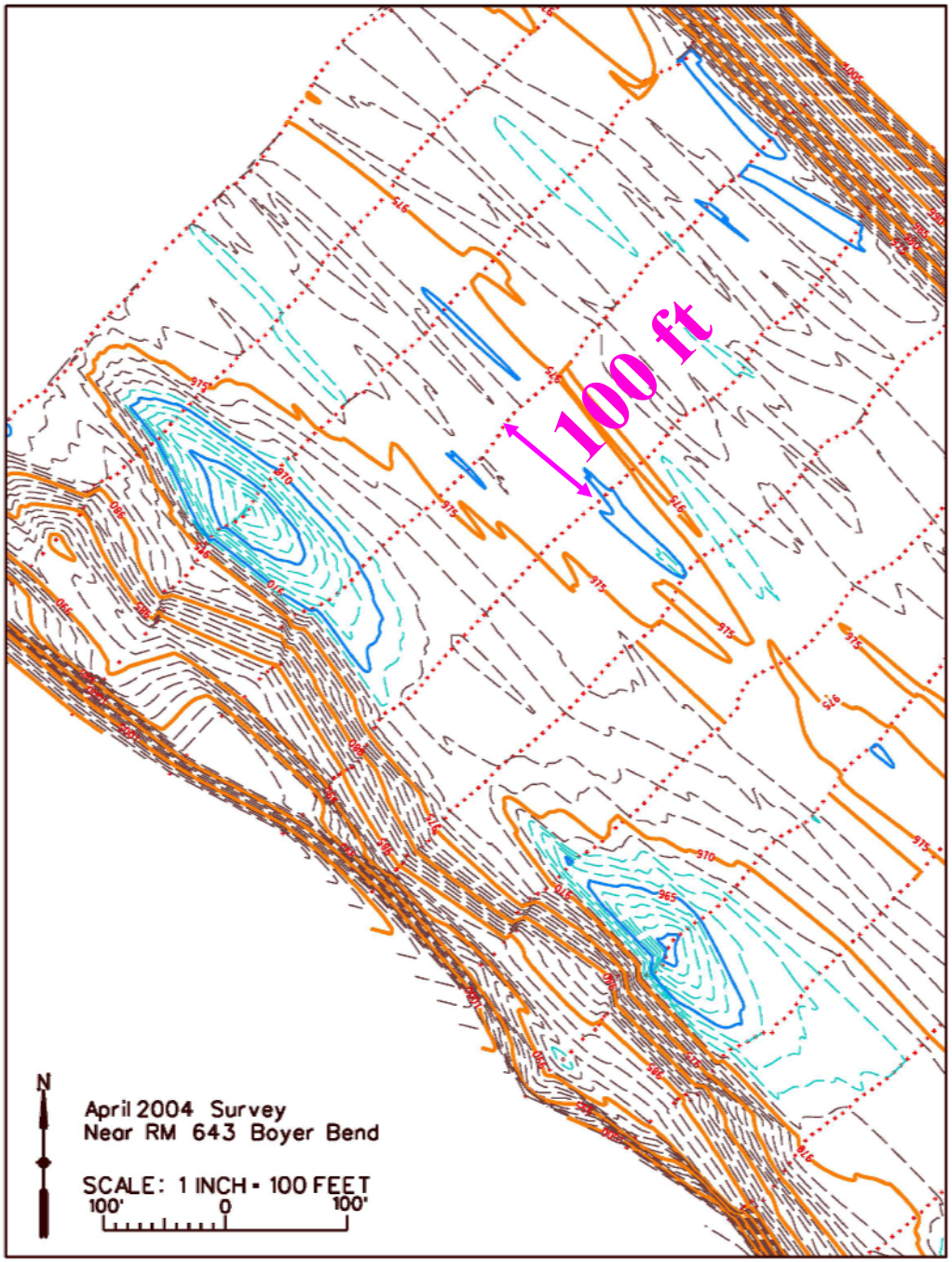
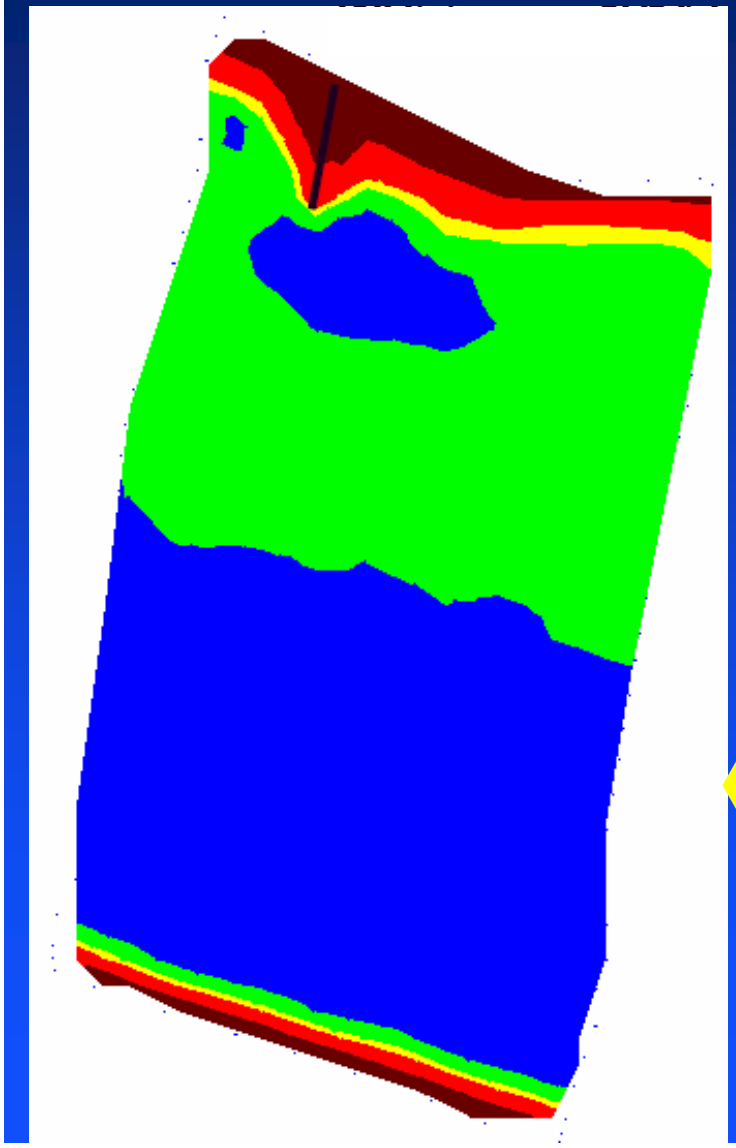
Physical Monitoring

- Data collection and analysis to define SWH quantity and quality, track changes
- Analyze impacts on project purposes
- Develop SOP's for data collection, data analysis, data storage
- Impacts outside the project reach

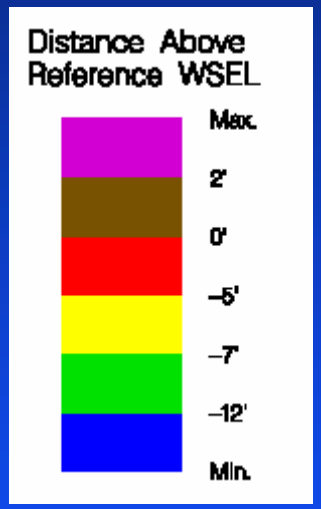
Evaluation of survey data collected using 100 feet spacing



Dike Notching

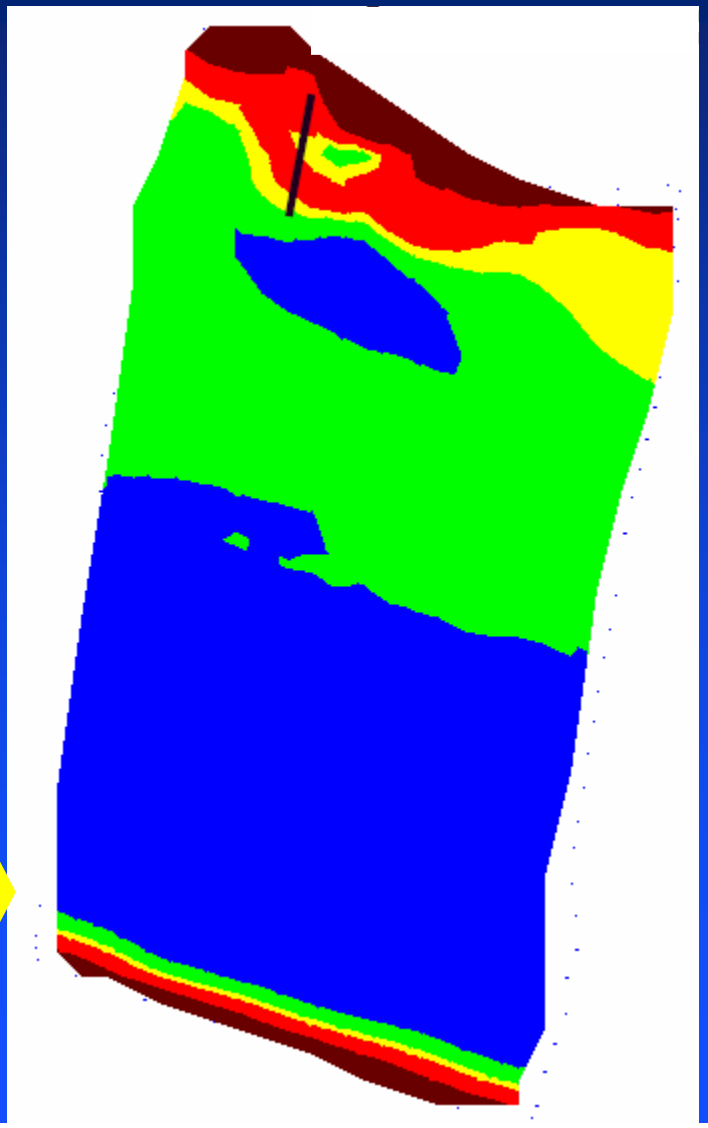


Dike 723.8



Pre Const.

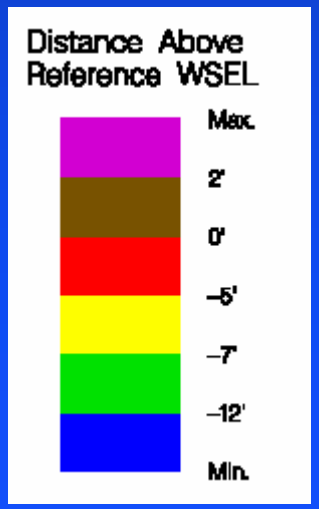
May 2004

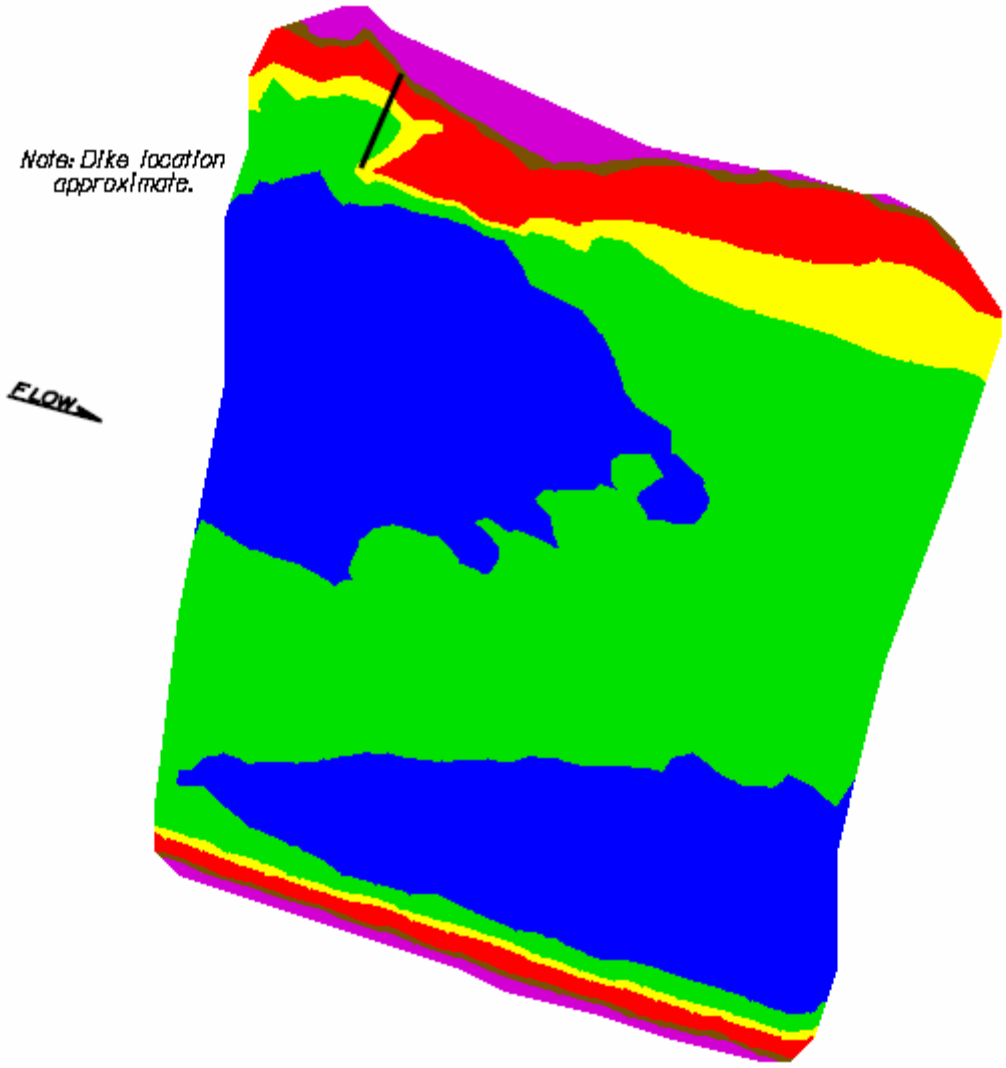


Dike Notching – After 3+ Months

Dike 723.8

August 2004





Major Dike Mod.
Tobacco Bend

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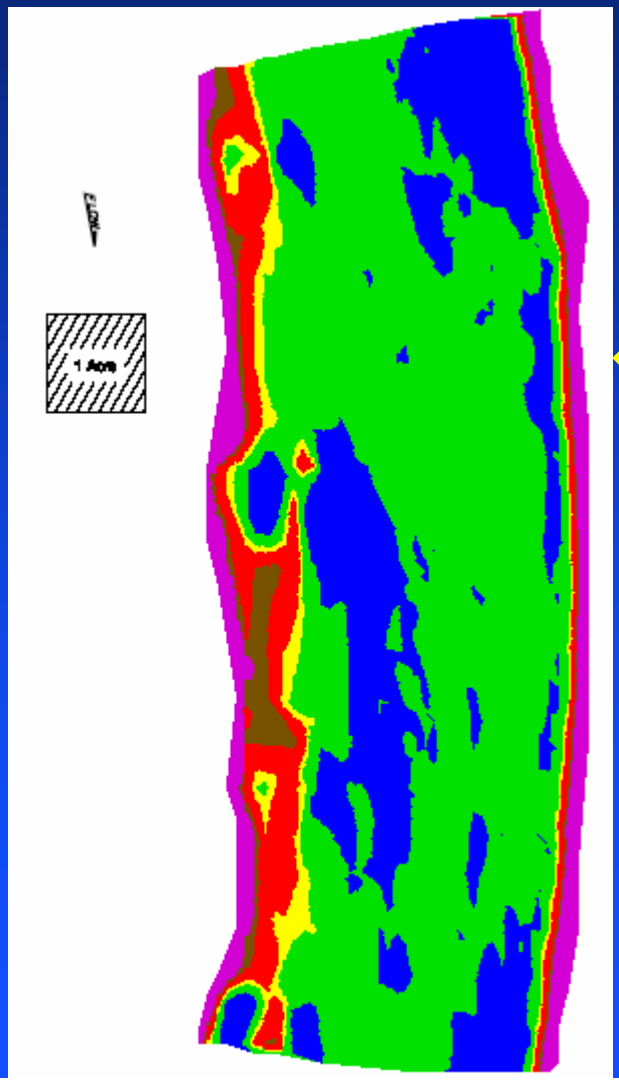
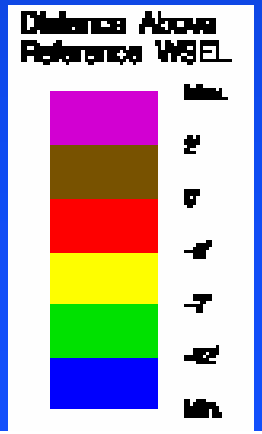
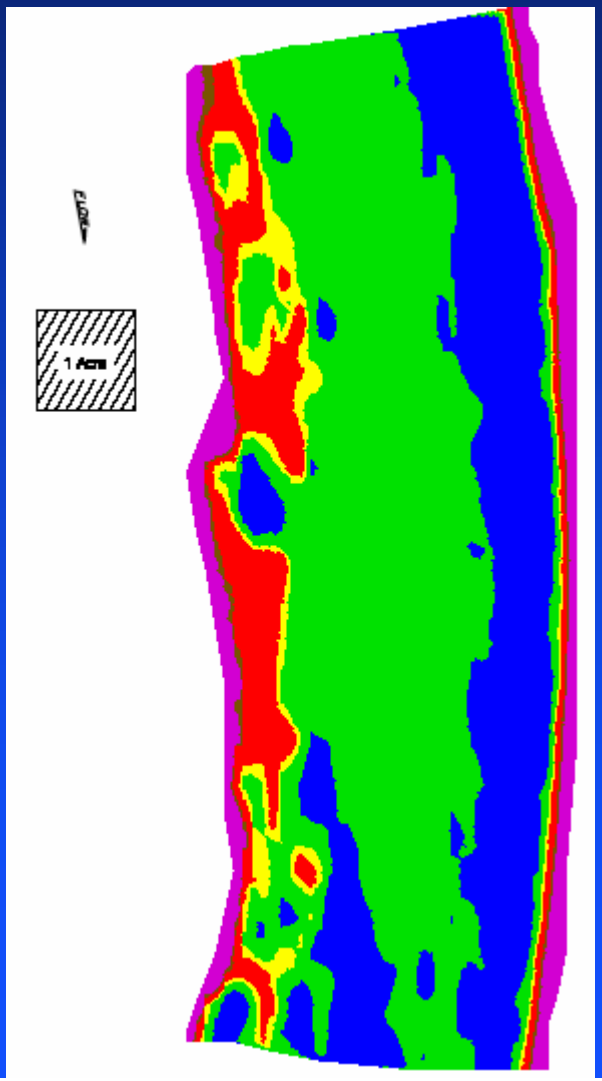


16 Dikes
8 Chevrons

Pre Const.

August 2004





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Monitoring and Assessment

- Multi-disciplinary team developed scientific study design to gather pertinent information
- Beginning implementation 2005
- Design is Before/After/Control/Impact
- Sample unit is the Bend
- Design includes 16 treatments and 28 controls between Ponca and the mouth
- Physical and Biological data collection

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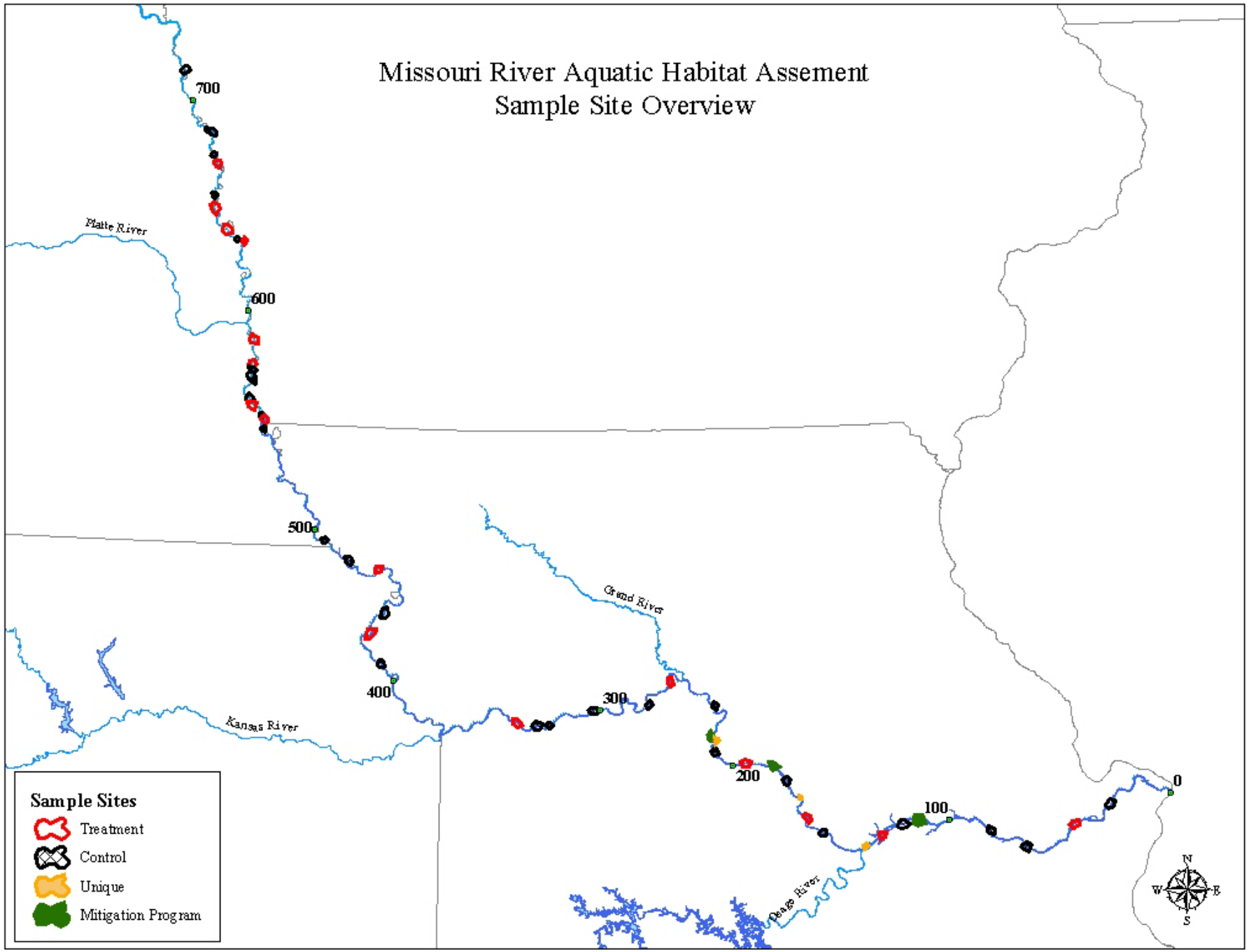
Bend Selection

- Divided Missouri into 5 representative reaches
- Bend selection based on 75/25 percentile radius
- Each treatment (dike mod., dike notch, etc.) has 2 controls – one for before and after construction, one for no modification


Missouri River Aquatic Habitat Assement
Sample Site Overview
700
600
500
400
300
200
100
0
Platte River
Grand River
Kansas River
Osage River
Sample Sites
Treatment
Control
Unique
Mitigation Program
N
W
E
S

Bend Selection Table

Major Dike Modification Projects

Bend Index	Bend Name	Bend Location	Upstream River Mile (1960)	Downstr. River Mile (1960)	Bend Length (miles)	Upstream Dike #	Downstr. Dike #	Avg. Dike Spacing (ft)	Avg. River Width (ft)	Bend Radius (ft)	Arc Length (ft)	Approx. River Energy Slope (ft/ft)
	Snyder Bend, RM 715.2 to 714.7, Left Bank, Located in IA/NE, 5 Structures Modified, 3 Chevrons Constructed											
S-1	Snyder		716.4	714.3	2.1	783.3	779.1	500	650	9300	11000	0.0002234
	Winnebago Bend, RM 710.0 to 708.7, Left Bank, Located in NE, 12 Structures Modified, 5 Chevrons Constructed											
S-2	Winnebago		710.4	708	2.4	770.65	767.7	500	650	5800	12638	0.0001488
	Desoto Bend, RM 644.0 to 642.0, Right Bank, Located in NE, 12 Structures Modified, 6 Chevrons Constructed											
S-3	**DeSoto Cut-off**		**644.8**	**641.8**	**3**	**691.41**	**684.05**	**500**	**650**	**10500**	**15578**	**0.0001559**
	Boyer Bend, RM 637.0 to 634.0, Right Bank, Located in Nebraska, 20 Structures Modified, 8 Chevrons Constructed											
S-4	Boyer	Upper	637.3	636	1.3	680	679.5	750	650	6700	6717	0.0001773
S-4	**Boyer**	**Lower**	**636**	**634.1**	**1.9**	**679.37**	**678.24**	**750**	**650**	**5400**	**9629**	**0.0001964**
	Tobacco Island, RM 589.0 to 586.2, Right Bank, Located in Nebraska, 16 Structures Modified, 8 Chevrons Constructed											
S-5	**Tobacco**		**589.4**	**586.3**	**3.1**	**632.48**	**629.62**	**550**	**650**	**7700**	**16145**	**0.0002125**
	Upper/Lower Hamburg Bend, RM 555 to 551											
S-6A	**Hamburg**	**Upper**	**555.5**	**552.9**	**2.6**	**601**	**597.55**	**600**	**650**	**5400**	**13510**	**0.000191**
S-6B	Hamburg	Lower	552.9	550.9	2	597.5	595.3	600	650	5500	10877	0.0002167
	Langdon Bend, RM 531.7 to 529.0, Right Bank, Located in Nebraska, 20 Structures Modified, 10 Chevrons Constructed											
S-7	Langdon	0	532	529.2	2.8	574.2	570.85	500	650	5800	15254	0.0001918

Proposed Major Dike Modification monitoring sites noted by red shade (25% bend radius representative sites) and blue shade (75% radius representative sites)

Dike Notching Projects

Bend Index	Bend Name	Bend Location	Upstream River Mile (1960)	Downstr. River Mile (1960)	Bend Length (miles)	Upstream Dike #	Downstr. Dike #	Avg. Dike Spacing (ft)	Avg. River Width (ft)	Bend Radius (ft)	Arc Length (ft)	Approx. River Energy Slope (ft/ft)
	Lower Dakota Bend, RM 722.5 to 722.1, Right Bank, Located in Iowa, 5 Dikes Notched											
D-1	Dakota	Lower	723.6	722.3	1.3	799	797.5	600	650	7200	6732	0.000170
	Lower Monona Bend, RM 700.8 to 699.6, Right Bank, Located in Iowa, 10 Dikes Notched											
D-2	Monona	Lower B	700	697.7	2.3	758.2	751.98	600	650	10300	12336	0.000200
	Middle Blenco Bend. RM 679.6 to 678.9, Left Bank, Located in Iowa, 6 Dikes Notched											
D-3	Blencoe	Middle	679.7	678	1.7	732	730.71	600	600	3800	8794	0.000212
	Lower Little Sioux Reach Bend, RM 672.4 to 670.5, Left Bank, Located in Iowa, 14 Dikes Notched											
D-4	**Little Sioux Reach**	**Lower**	**672.8**	**670.5**	**2.3**	**725.4**	**723.6**	**750**	**650**	**6300**	**12106**	**0.000171**
	Sandy Point Bend, RM 657.4 to 656.5, Right Bank, Located in Iowa, 7 Dikes Notched											
D-5	Sandy Point		657.8	655	2.8	707	704.5	650	650	8000	14797	0.000162
	Tyson Bend, RM 655.4 to RM 653.0, Left Bank, Located in Iowa, 7 Dikes Notched											
D-6	**Tysons**		**655**	**651.6**	**3.4**	**704.4**	**701.55**	**550**	**650**	**8700**	**17507**	**0.000166**
	Rock Bluff Bend - Nottleman Island, RM 585.8 to 582.8, Left Bank, Located in Iowa, 15 Dikes Notched											
D-7	Rock Bluff		586.3	582.7	3.6	629.6	626.33	550	650	13500	18626	0.000172
	Pin Hook Bend - Aulden Bar, RM 578.7 to 576.8, Left Bank, located in Iowa, 13 Dikes Notched											
D-8	**Pin Hook**		**579.2**	**576.8**	**2.4**	**623.6**	**622.05**	**550**	**650**	**5300**	**12685**	**0.000211**
	Copeland Bend, RM 569.2 to 565.4, Left Bank, Located in Iowa, 21 Dikes Notched											
D-9A	Copeland	Upper A	569.8	567	2.8	615.45	613	600	650	12000	14390	0.000207
D-9B	Copeland	Upper B	567	565.1	1.9	612.9	610.9	600	650	7500	10072	0.000187
	Nebraska Bend, RM 562.7 to 561.5, Left Bank, Located in Iowa, 8 Dikes Notched											
D-10	**Nebraska**		**562.9**	**560.4**	**2.5**	**608.75**	**606.4**	**550**	**650**	**9200**	**13182**	**0.000276**
	U/L Deroin and Indian Cave Bend, RM 519.7 to 516.3, 17 Dikes Notched											
D-11A	Deroin	Upper	520.1	518.4	1.7	561.3	560.1	550	650	4500	9020	0.000213
D-11B	Deroin	Lower	518.4	517.7	0.7	559.9	559.5	500	650	7300	3616	0.000240
D-11C	Indian Cave		517.7	516.4	1.3	559.45	558.31	650	650	7300	6872	0.000189
	Cottier Bend, RM 509.2 to 508.5, Left Bank, Located in Missouri, 1 Dike Notched											
D-12	Cottier	Upper	512.1	508.2	3.9	553.75	548.4	550	650	11100	20622	0.000189

Proposed Dike Notching monitoring sites noted by red font (25% bend radius representative sites) and blue font (75% radius representative sites)

US Army Corps
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Omaha District

Technical Focus

- Sediment evaluation and system wide impact analysis
- Prototype experience - refinements
- Limited experience with high flow events – what is expected?
- Dynamic river with constant change – look for predictor variables
- Monitoring may lead to adaptive management and changing criteria based on biologic response

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QUESTIONS?