

# VOLUME 3 TABLE OF CONTENTS—CONTINUED

## RIVER GEOMORPHOLOGY CD, PART 2

### *River Geomorphology Appendix*

#### A. Geomorphology Study Reports:

Holburn, E.R., L.M. Fotherby, T.J. Randle, and D.E. Carlson. 2006. "Trends of Aggradation and Degradation Along the Central Platte River: 1985 – 2005." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 180 p.

Murphy, P.J., T.J. Randle, L.M. Fotherby, and J.A. Daraio. 2004. "Platte River Channel: History and Restoration." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 167 p.

Murphy, P.J., L.M. Fotherby, T.J. Randle, and R.K. Simons. 2006. "Platte River Sediment Transport and Riparian Vegetation Model." Technical Report. Bureau of Reclamation, Technical Service Center, Denver, Colorado, 136 p.

Randle, T.J. and M.A. Samad. 2003. "Platte River Flow and Sediment Transport Between North Platte and Grand Island, Nebraska (1895-1999)." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 60 p.

Simons and Associates, Inc. and URS Greiner Woodward Clyde. 2000. Physical History of the Platte River in Nebraska: Focusing Upon Flow, Sediment Transport, Geomorphology, and Vegetation. Prepared for Bureau of Reclamation and U.S. Fish and Wildlife Service. Platte River EIS Office, Dated August 2000.

## ***River Geomorphology Appendix***

### **A. Geomorphology Study Reports:**

**Holburn, E.R., L.M. Fotherby, T.J. Randle, and D.E. Carlson. 2006. "Trends of Aggradation and Degradation Along the Central Platte River: 1985 – 2005." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 180 p.**

I. Executive Summary .....	v
1.0 Brief History of The Central Platte River .....	1
2.0 Study Background and Objectives .....	5
3.0 Surveys .....	6
4.0 Vertical Transformations of Data .....	40
5.0 Development of Plots of Repeat Cross Sections and Habitat Transects .....	43
6.0 Calculations of Aggradation and Degradation .....	46
7.0 Trends of Aggradation and Degradation .....	51
8.0 Limitations of Study Findings and Future Directions.....	58
9.0 References .....	62
Appendix A: Plots of Repeat Cross Sections .....	68
Appendix B: Control Points Summary Table .....	159
Appendix C: Flow on Date of Survey Table .....	169
Appendix D: Electronic Form of 1989 USBR Survey Data and Photographs .....	178
Appendix E: Electronic Form of All Other Survey Data Used .....	179
Appendix F: Electronic Form of 1989 USBR Sediment Sample Data .....	180

**Murphy, P.J., T.J. Randle, L.M. Fotherby, and J.A. Daraio. 2004. "Platte River Channel: History and Restoration." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 167 p.**

Dedication .....	ii
List of Figures .....	ix
List of Tables .....	xiii
Glossary .....	xiv
1.0 Introduction .....	1
1.1 Location .....	2
1.2 The Concern .....	3
1.3 Objective of the Paper .....	3
1.4 Study Approach .....	4
1.5 Factors Considered .....	5
1.6 Organization of the Paper .....	5
1.7 Principal Findings .....	6
2.0 Historic Setting of the Platte River .....	9
2.1 The Pre-Development River .....	9
2.2 The Nineteenth Century .....	17
2.3 The Twentieth Century.....	45
3.0 Changes to Primary Elements of River Morphology in the Twentieth Century .....	55
3.1 Changes to Flow .....	55
3.2 Changes to the Temporal Distribution of Flows .....	73
3.3 Changes to Sediment Transport and Sediment Size .....	76
3.4 Changes to the Basin Structure .....	85

**Murphy, P.J., T.J. Randle, L.M. Fotherby, and J.A. Daraio. 2004. "Platte River Channel: History and Restoration." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 167 p.—Continued**

4.0 Channel Response to Changed Conditions .....	89
4.1 Reductions in Unvegetated Channel Widths .....	90
4.2 Flow Reductions .....	92
4.3 Vegetation and Vegetation Expansion.....	95
4.4 Reductions in Sediment Supply and Channel Incision .....	100
4.5 Coarsening Sediment and Channel Changes.....	115
4.6 Changes in Plan Form .....	121
4.7 Channel Changes From Bridges, Diversion Dams, and Bank Protection .....	126
4.8 Time Scales of Channel Processes in the Platte River.....	128
5.0 Options for Restoring Channel Habitat .....	131
5.1 Mechanical Widening of the Channel and Augmentation of Medium Sand.....	132
5.2 Increased Annual High Flows.....	133
6.0 Summary and Conclusions.....	137
6.1 The Historic River.....	137
6.2 The Processes of Habitat Reduction and River Narrowing.....	139
6.3 Option for Restoring Habitat .....	143
6.4 Future Directions .....	144
7.0 References.....	145
Geology Appendix .....	159
A. Geology of South-Central Nebraska.....	159
B. Geomorphic History .....	163

**Murphy, P.J., L.M. Fotherby, T.J. Randle, and R.K. Simons. 2006. "Platte River Sediment Transport and Riparian Vegetation Model." Technical Report. Bureau of Reclamation, Technical Service Center, Denver, Colorado, 136 p.**

Acknowledgements .....	i
Executive Summary .....	iii
1.0 Introduction .....	1
1.1 Background.....	2
1.2 Approach .....	3
1.3 Objectives.....	3
2.0 General Methods and Assumptions .....	5
2.1 Input Data.....	5
2.1.1 Flow Data .....	5
2.1.2 Cross Section Data .....	6
2.1.3 Sediment Data.....	6
2.1.4 Mechanical Actions.....	7
2.1.5 Vegetation Inputs .....	7
2.2 General Description of Model Computations .....	7
2.2.1 Hydraulic Computations.....	7
2.2.2 Sediment Transport and Grain Size Computations.....	8
2.3 Vegetation Computations .....	10
2.3.1 Vegetation Accounting.....	12
2.3.2 Vegetation Subroutines.....	12
2.3.3 Germination/Growth.....	13
2.3.4 Inundation .....	13
2.3.5 Desiccation .....	14
2.3.6 Ice Scour .....	14
2.3.7 Flow Scour.....	15

**Murphy, P.J., L.M. Fotherby, T.J. Randle, and R.K. Simons. 2006. "Platte River Sediment Transport and Riparian Vegetation Model." Technical Report. Bureau of Reclamation, Technical Service Center, Denver, Colorado, 136 p.—Continued**

2.4 Active Layer Scour .....	15
2.5 Stream Power Scour .....	15
2.6 Model Run and Output .....	16
2.6.1 SEDVEG Model Run .....	16
2.6.2 SEDVEG Output Files .....	16
3.0 Governing Equations .....	19
3.1 Hydraulics .....	19
3.2 Uniform Flow Equations for Water Surface Elevation .....	19
3.2.1 Manning's Equation .....	19
3.2.2 Transverse Distribution for Velocity and Depth .....	20
3.3 Sediment Transport .....	20
3.3.1 Transport Capacity Equations .....	21
3.3.2 Transverse Distribution of Transport Capacity .....	21
3.3.3 Transverse Distribution of Mass Balance .....	22
3.3.4 Changes in Bed Elevation .....	22
4.0 Development of Earlier Versions of SEDVEG .....	25
4.1 SEDVEG Gen1 .....	26
4.1.1 Development of SEDVEG Gen1 Platte River Model and Historic Platte River Model .....	26
4.1.2 Calibration of SEDVEG Gen1 .....	27
4.1.3 Verification of SEDVEG Gen1 .....	27
4.1.4 Sensitivity Testing of SEDVEG Gen1 .....	28
4.1.5 External Reviews of SEDVEG Gen1 .....	35
4.2 SEDVEG Gen2 Platte River Model .....	37
4.2.1 Revisions to SEDVEG Gen1 Platte River Model .....	37
4.2.2 Description of SEDVEG Gen2 Platte River Model .....	38
4.2.3 Calibration and Sensitivity Studies for the SEDVEG Gen2 Platte River Model .....	43
4.2.4 External Reviews of SEDVEG Gen2 Platte River Model .....	44
5.0 SEDVEG Gen3 Platte River Model .....	47
5.1 Revisions to the SEDVEG Gen2 Platte River Model .....	47
5.1.1 Revisions to the Code .....	47
5.1.2 Revisions to the Platte River Model .....	49
5.2 Description of the SEDVEG Gen3 Platte River Model .....	51
5.2.1 Cross Section Information .....	51
5.2.2 Flow Information .....	54
5.2.3 Sediment and Vegetation Coefficients and Parameters .....	61
5.2.4 Mechanical Actions and Sediment Augmentation Plan .....	61
5.3 Calibration and Sensitivity Studies .....	63
5.3.1 Calibration Studies .....	63
5.3.2 Sensitivity Studies .....	65
5.4 Results and Verification .....	68
5.4.1 Calibration and Sediment Transport (Absolute Values) .....	68
5.4.2 Verification of Sediment Transport (Relative Values) .....	70
5.4.3 Description of Sediment Transport in the Central Platte River .....	73
5.4.4 Sediment Transport Budget .....	76
6.0 Assessment of the SEDVEG Gen3 and Recommendations for Future Studies .....	77
6.1 Assessment of the SEDVEG Gen3 Platte River Model .....	77
6.2 Benefits From the SEDVEG Model Studies .....	77
6.3 Recommendations for Future Directions .....	78
6.3.1 Recommendations for the SEDVEG Gen3 Platte River Model .....	78
6.3.2 Recommended Areas for Future Sediment Studies .....	80
References .....	81

**Murphy, P.J., L.M. Fotherby, T.J. Randle, and R.K. Simons. 2006. "Platte River Sediment Transport and Riparian Vegetation Model." Technical Report. Bureau of Reclamation, Technical Service Center, Denver, Colorado, 136 p.—Continued**

Appendix A: SEDVEG Gen3 Platte River Model.....	87
Appendix B: Comments and Responses on SEDVEG Gen1 and SEDVEG Gen2 Platte River Models .....	89
Appendix C: Basis of River Flows.....	121
Appendix D: Basis of Vegetation Subroutines.....	123
Appendix E: Calibration and Verification of SEDVEG Gen1, Including the Historic Platte River Model.....	127

**Randle, T.J. and M.A. Samad. 2003. "Platte River Flow and Sediment transport Between North Platte and Grand Island, Nebraska (1895-1999)." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 60 p.**

1.0 Introduction .....	11
2.0 Stream Flow Analysis .....	13
2.1 Mean Platte River Flows .....	16
2.2 Median Platte River Flows .....	18
2.3 1.5-Year Flood Peak Flows .....	19
2.4 Streamflow Trends.....	22
3.0 Sediment Transport Analysis .....	25
3.1 Sediment-Discharge Equations .....	26
3.1.1 Sediment-Discharge Equations by Simons and Associates, Inc. (August 2000).....	27
3.1.2 Sediment-Discharge Equations by Kircher (1983).....	29
3.1.3 Sediment-Discharge Equations by Lyons and Randle (1988).....	31
3.2 Sediment Transport Model .....	33
3.3 Comparison of Sediment Transport Functions.....	34
3.4 Sediment Load Trends.....	36
4.0 Effective Discharge Analysis .....	38
4.1 Effective Discharge by Equal Discharge Interval Method.....	40
4.2 Effective Discharge by Probability Method.....	49
4.3 Median Sediment Transporting Discharge Method.....	52
4.4 Comparison of Effective Discharge Methods .....	53
4.5 Effective Discharge Trends .....	56
5.0 Conclusions.....	57
6.0 References.....	59

[Figures are in a separate file (Randle and Samad 2003 figure.pdf)]

- Figure 1: Platte River Basin location map.
- Figure 2: Platte River reach location map.
- Figure 3: Annual flow volume and annual peak flow for North Platte River at North Platte, Nebraska.
- Figure 4: Platte River mean flows.
- Figure 5: Platte River median flows.
- Figure 6: Platte River 1.5-year flood peak flows.
- Figure 7: North Platte River at North Platte, Nebraska, flow-durations curves.
- Figure 8: South Platte River at North Platte, Nebraska, flow-durations curve.
- Figure 9: Platte River near Cozad, Nebraska, flow-durations curves.
- Figure 10: Platte River near Overton, Nebraska, flow-durations curves.
- Figure 11: Platte River near Grand Island, Nebraska, flow-durations curves.
- Figure 12: Platte River mean annual sediment load based on sediment-discharge equations by Simons and Associates, Inc. (2000).
- Figure 13: Platte River mean annual sediment load based on sediment-discharge equations by Kircher (1983).
- Figure 14: Platte River mean annual sediment load based on sediment-discharge equations by Lyons and Randle (1988).

**Randle, T.J. and M.A. Samad. 2003. "Platte River Flow and Sediment transport Between North Platte and Grand Island, Nebraska (1895-1999)." Bureau of Reclamation, Technical Service Center, Sedimentation and River Hydraulics Group, Denver, Colorado, 60 p.—Continued**

- Figure 15: Platte River mean annual sediment load based on the sediment transport model by Murphy and Randle (2001).
- Figure 16: Platte River effective discharges for the Platte River near Overton, Nebraska, based on the equal discharge increment method.
- Figure 17: Comparison of effective discharge results for the North Platte River at North Platte, Nebraska.
- Figure 18: Comparison of effective discharge results for the South Platte River at North Platte, Nebraska.
- Figure 19: Comparison of effective discharge results for the North Platte River near Cozad, Nebraska.
- Figure 20: Comparison of effective discharge results for the Platte River near Overton, Nebraska.
- Figure 21: Comparison of effective discharge results for the Platte River near Grand Island, Nebraska.
- Figure 22: Platte River effective discharges for the Platte River near Overton, Nebraska, based on the probability increment method.
- Figure 23: Quartiles of cumulative sediment load for various gauging stations along the Platte River.

**Simons and Associates, Inc. and URS Greiner Woodward Clyde. 2000. Physical History of the Platte River in Nebraska: Focusing Upon Flow, Sediment Transport, Geomorphology, and Vegetation. Prepared for Bureau of Reclamation and U.S. Fish and Wildlife Service. Platte River EIS Office, Dated August 2000.**

1. Introduction.....	1
2. Description of the Platte River Basin .....	2
2.1 Water Resources Development History .....	5
2.2 Flow History .....	15
2.3 Groundwater History.....	18
2.4 Sediment Supply and Transport History .....	19
2.5 Channel Geometry .....	22
2.6 Woody Vegetation .....	24
3. Current Baseline Conditions .....	30
3.1 Current Level of Water Resource Development .....	30
3.2 Flow Characteristics .....	30
3.3 Groundwater and Surface Water Interactions .....	33
3.4 Sediment Transport and Supply .....	34
3.5 Channel Geometry .....	43
3.6 Woody Vegetation .....	43
3.7 Summary of Current Conditions .....	43
3.8 Discussion of Current Trends of Channel .....	44
3.9 Morphology and Vegetation .....	45
4. Channel Processes and Causes of Change .....	46
4.1 Resource Linkages .....	46
4.2 Analysis of Factors that May Affect Channel Morphology and Vegetation .....	49
4.3 Potential Effect of Mitigation Measures .....	70
References .....	80

- Appendix A: Sediment Data
- Appendix B: Bed Elevation Change
- Appendix C: Hydraulic Analysis of Woodland Expansion
- Appendix D: Timing of Woodland Expansion
- Appendix E: Computer Modeling of Woodland Expansion
- Appendix F: Structures