Chapter 5
Introduction to Environmental Consequences

TABLE OF CONTENTS
CHAPTER 5

5.1 Introduction 5-1
5.1.1 Impact Analysis Process and Resource Evaluation Categories 5-2
5.1.2 Features and Components 5-3
5.1.3 Study Features Impact Analysis Process 5-3
5.1.3.1 Flow Management Feature 5-3
5.1.3.1.1 River Conditions 5-3
5.1.3.1.2 Reservoir Conditions 5-7
5.1.3.2 Navigation Channel Deepening Feature 5-10
5.1.3.2.1 Dredging 5-11
5.1.3.2.2 Disposal 5-13
5.1.3.2.3 River Training Structures 5-15
5.1.3.2.4 Navigation Traffic 5-16
5.1.3.3 Navigation Channel Depth Maintenance Feature 5-16
5.1.3.3.1 Dredging 5-16
5.1.3.3.2 Disposal 5-21
5.1.3.3.3 River Training Structures 5-21
5.1.4 Study Alternatives Impact Analysis Process 5-22
5.1.5 Definition of Key Terms 5-23
5.1.5.1 Direct Versus Indirect Impacts 5-23
5.1.5.2 Impact Characterization 5-23
5.1.5.3 Short-Term Versus Long-Term Impacts 5-24
5.1.5.4 Significance 5-24
5.1.5.5 Mitigation 5-25
5.1.6 Impact Analysis Performed 5-25
5.2 Air Quality 5-26
5.2.1 Flow Management Feature 5-27
5.2.1.1 No Action Component (FM-NA) 5-27
5.2.1.2 175,000 cfs Plan Component (FM-175) 5-27
5.2.1.3 200,000 cfs Plan Component (FM-200) 5-27
5.2.1.4 Operations Only Plan Component (FM-OPS) 5-27
5.2.2 Navigation Channel Deepening Feature 5-28
5.2.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-28
5.2.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-28
5.2.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-28
5.2.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-28
5.2.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-28
5.2.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-28
5.2.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-28
5.2.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-29
5.2.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-29
5.2.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-29
5.2.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-29

5.2.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) ... 5-29
5.2.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) ... 5-29
5.2.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) ... 5-29
5.2.2.3 Navigation Channel Deepening 11-Foot Channel Component ... 5-29
5.2.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) ... 5-30
5.2.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) ... 5-30
5.2.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) ... 5-30
5.2.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) ... 5-30
5.2.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) ... 5-30
5.2.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) ... 5-30
5.2.2.4 Navigation Channel Deepening 12-Foot Channel Component ... 5-30
5.2.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) ... 5-30
5.2.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) ... 5-31
5.2.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) ... 5-31
5.2.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) ... 5-31
5.2.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) ... 5-31
5.2.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) ... 5-31
5.2.3 Navigation Channel Depth Maintenance Feature ... 5-31
5.2.3.1 No Action Component (NCDM-NA) ... 5-31
5.2.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) ... 5-31
5.2.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) ... 5-31
5.3 Noise ... 5-32
5.3.1 Flow Management Feature ... 5-32
5.3.1.1 No Action Component (FM-NA) ... 5-32
5.3.1.2 175,000 cfs Plan Component (FM-175) ... 5-32
5.3.1.3 200,000 cfs Plan Component (FM-200) ... 5-33
5.3.1.4 Operations Only Plan Component (FM-OPS) ... 5-33
5.3.2 Navigation Channel Deepening Feature ... 5-33
5.3.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) ... 5-33
5.3.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) ... 5-33
5.3.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) ... 5-33
5.3.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) ... 5-33
5.3.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) ... 5-34
5.3.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) ... 5-34
5.3.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) ... 5-34
5.3.2.2 Navigation Channel Deepening 10-Foot Channel Component ... 5-34
5.3.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) ... 5-34
5.3.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) ... 5-34
5.3.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) ... 5-35
5.3.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) ... 5-35
5.3.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) ... 5-35
5.3.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) ... 5-35
5.3.2.3 Navigation Channel Deepening 11-Foot Channel Component ... 5-35
5.3.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) ... 5-35
5.3.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) ... 5-35

5.3.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-36
5.3.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-36
5.3.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-36
5.3.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-36
5.3.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-36
5.3.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-36
5.3.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-36
5.3.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-37
5.3.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-37
5.3.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-37
5.3.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-37
5.3.3 Navigation Channel Depth Maintenance Feature 5-37
5.3.3.1 No Action Component (NCDM-NA) 5-37
5.3.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) 5-37
5.3.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) 5-37
5.4 Geology and Soils 5-38
5.4.1 Flow Management Feature 5-38
5.4.1.1 No Action Component (FM-NA) 5-38
5.4.1.2 175,000 cfs Plan Component (FM-175) 5-38
5.4.1.3 200,000 cfs Plan Component (FM-200) 5-39
5.4.1.4 Operations Only Plan Component (FM-OPS) 5-39
5.4.2 Navigation Channel Deepening Feature 5-39
5.4.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-39
5.4.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-40
5.4.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-40
5.4.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-40
5.4.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-40
5.4.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-40
5.4.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-40
5.4.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-40
5.4.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-40
5.4.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-41
5.4.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-41
5.4.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-41
5.4.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-41
5.4.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-41
5.4.2.3 Navigation Channel Deepening 11-Foot Channel Component 5-41
5.4.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-42
5.4.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-42
5.4.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-42
5.4.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-42
5.4.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-42
5.4.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-42
5.4.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-43
5.4.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-43

5.4.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-43
5.4.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-43
5.4.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-43
5.4.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-43
5.4.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-44
5.4.3 Navigation Channel Depth Maintenance Feature 5-44
5.4.3.1 No Action Component (NCDM-NA) 5-44
5.4.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) 5-44
5.4.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) 5-44
5.5 Surface Waters 5-45
5.5.1 Flow Management Feature 5-45
5.5.1.1 No Action Component (FM-NA) 5-45
5.5.1.2 175,000 cfs Plan Component (FM-175) 5-45
5.5.1.3 200,000 cfs Plan Component (FM-200) 5-46
5.5.1.4 Operations Only Plan Component (FM-OPS) 5-46
5.5.2 Navigation Channel Deepening Feature 5-47
5.5.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-48
5.5.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-48
5.5.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-48
5.5.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-48
5.5.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-48
5.5.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-48
5.5.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-49
5.5.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-49
5.5.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-50
5.5.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-50
5.5.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-50
5.5.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-50
5.5.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-50
5.5.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-51
5.5.2.3 Navigation Channel Deepening 11-Foot Channel Component 5-51
5.5.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-51
5.5.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-51
5.5.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-51
5.5.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-51
5.5.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-51
5.5.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-52
5.5.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-52
5.5.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-52
5.5.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-52
5.5.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-52
5.5.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-52
5.5.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-52
5.5.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-53
5.5.3 Navigation Channel Depth Maintenance Feature 5-53

5.5.3.1 No Action Component (NCDM-NA) ... 5-53
5.5.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) ... 5-53
5.5.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) ... 5-53
5.6 Land Cover and Land Use ... 5-53
5.6.1 Flow Management Feature ... 5-54
5.6.1.1 No Action Component (FM-NA) ... 5-54
5.6.1.2 175,000 cfs Plan Component (FM-175) ... 5-54
5.6.1.3 200,000 cfs Plan Component (FM-200) ... 5-54
5.6.1.4 Operations Only Plan Component (FM-OPS) ... 5-55
5.6.2 Navigation Channel Deepening Feature ... 5-55
5.6.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) ... 5-55
5.6.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) ... 5-55
5.6.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) ... 5-55
5.6.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) ... 5-55
5.6.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) ... 5-55
5.6.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) ... 5-55
5.6.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) ... 5-56
5.6.2.2 Navigation Channel Deepening 10-Foot Channel Component ... 5-56
5.6.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) ... 5-56
5.6.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) ... 5-56
5.6.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) ... 5-56
5.6.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) ... 5-56
5.6.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) ... 5-56
5.6.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) ... 5-57
5.6.2.3 Navigation Channel Deepening 11-Foot Channel Component ... 5-57
5.6.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) ... 5-57
5.6.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) ... 5-57
5.6.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) ... 5-57
5.6.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) ... 5-57
5.6.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) ... 5-57
5.6.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) ... 5-58
5.6.2.4 Navigation Channel Deepening 12-Foot Channel Component ... 5-58
5.6.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) ... 5-58
5.6.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) ... 5-58
5.6.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) ... 5-58
5.6.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) ... 5-58
5.6.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) ... 5-58
5.6.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) ... 5-59
5.6.3 Navigation Channel Depth Maintenance Feature ... 5-59
5.6.3.1 No Action Component (NCDM-NA) ... 5-59
5.6.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) ... 5-59
5.6.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) ... 5-59
5.7 Infrastructure ... 5-60
5.7.1 Flow Management Feature ... 5-60

5.7.1.1 No Action Component (FM-NA) 5-60
5.7.1.2 175,000 cfs Plan Component (FM-175) 5-60
5.7.1.3 200,000 cfs Plan Component (FM-200) 5-61
5.7.1.4 Operations Only Plan Component (FM-OPS) 5-62
5.7.2 Navigation Channel Deepening Feature 5-63
5.7.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-63
5.7.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-63
5.7.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-63
5.7.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-63
5.7.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-64
5.7.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-64
5.7.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-64
5.7.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-64
5.7.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-65
5.7.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-65
5.7.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-65
5.7.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-65
5.7.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-65
5.7.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-65
5.7.2.3 Navigation Channel Deepening 11-Foot Channel Component 5-65
5.7.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-66
5.7.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-66
5.7.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-67
5.7.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-67
5.7.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-67
5.7.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-67
5.7.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-67
5.7.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-68
5.7.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-68
5.7.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-68
5.7.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-68
5.7.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-68
5.7.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-68
5.7.3 Navigation Channel Depth Maintenance Feature 5-69
5.7.3.1 No Action Component (NCDM-NA) 5-69
5.7.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) 5-69
5.7.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) 5-70
5.8 Biological Resources 5-70
5.8.1 Introduction to Biological Resources Impact Analysis 5-70
5.8.2 Flow Management Feature 5-71
5.8.2.1 No Action Component (FM-NA) 5-71
5.8.2.1.1 Threatened and Endangered Species 5-71
5.8.2.1.2 Wetlands 5-71
5.8.2.1.3 Aquatic Resources 5-71
5.8.2.1.4 Terrestrial Resources 5-71

5.8.2.2 175,000 cfs Plan Component (FM-175) 5-72
5.8.2.2.1 Threatened and Endangered Species 5-72
5.8.2.2.2 Wetlands 5-73
5.8.2.2.3 Aquatic Resources 5-73
5.8.2.2.4 Terrestrial Resources 5-75
5.8.2.3 200,000 cfs Plan Component (FM-200) 5-76
5.8.2.3.1 Threatened and Endangered Species 5-76
5.8.2.3.2 Wetlands 5-76
5.8.2.3.3 Aquatic Resources 5-76
5.8.2.3.4 Terrestrial Resources 5-77
5.8.2.4 Operations Only Plan Component (FM-OPS) 5-77
5.8.2.4.1 Threatened and Endangered Species 5-77
5.8.2.4.2 Wetlands 5-78
5.8.2.4.3 Aquatic Resources 5-78
5.8.2.4.4 Terrestrial Resources 5-78
5.8.3 Navigation Channel Deepening Feature 5-78
5.8.3.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-78
5.8.3.1.1 Threatened and Endangered Species 5-78
5.8.3.1.2 Wetlands 5-79
5.8.3.1.3 Aquatic Resources 5-79
5.8.3.1.4 Terrestrial Resources 5-79
5.8.3.1.5 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-79
5.8.3.1.6 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-79
5.8.3.1.7 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-79
5.8.3.1.8 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-79
5.8.3.1.9 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-80
5.8.3.1.10 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-80
5.8.3.2 Navigation Channel Deepening 10-Foot Channel Component 5-80
5.8.3.2.1 Threatened and Endangered Species 5-80
5.8.3.2.2 Wetlands 5-81
5.8.3.2.3 Aquatic Resources 5-81
5.8.3.2.4 Terrestrial Resources 5-83
5.8.3.2.5 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-83
5.8.3.2.6 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-83
5.8.3.2.7 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-83
5.8.3.2.8 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-83
5.8.3.2.9 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-84
5.8.3.2.10 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-84
5.8.3.3 Navigation Channel Deepening 11-Foot Channel Component 5-84
5.8.3.3.1 Threatened and Endangered Species 5-84
5.8.3.3.2 Wetlands 5-84
5.8.3.3.3 Aquatic Resources 5-84
5.8.3.3.4 Terrestrial Resources 5-85
5.8.3.3.5 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-85
5.8.3.3.6 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-86
5.8.3.3.7 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-86

5.8.3.3.8 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-86
5.8.3.3.9 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-86
5.8.3.3.10 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-86
5.8.3.4 Navigation Channel Deepening 12-Foot Channel Component 5-86
5.8.3.4.1 Threatened and Endangered Species 5-86
5.8.3.4.2 Wetlands 5-87
5.8.3.4.3 Aquatic Resources 5-87
5.8.3.4.4 Terrestrial Resources 5-88
5.8.3.4.5 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-88
5.8.3.4.6 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-88
5.8.3.4.7 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-88
5.8.3.4.8 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-88
5.8.3.4.9 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-88
5.8.3.4.10 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-89
5.8.4 Navigation Channel Depth Maintenance Feature 5-89
5.8.4.1 No Action Component (NCDM-NA) 5-89
5.8.4.1.1 Threatened and Endangered Species 5-89
5.8.4.1.2 Wetlands 5-89
5.8.4.1.3 Aquatic Resources 5-89
5.8.4.1.4 Terrestrial Resources 5-89
5.8.4.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) 5-89
5.8.4.2.1 Threatened and Endangered Species 5-89
5.8.4.2.2 Wetlands 5-91
5.8.4.2.3 Aquatic Resources 5-91
5.8.4.2.4 Terrestrial Resources 5-91
5.8.4.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) 5-91
5.8.4.3.1 Threatened and Endangered Species 5-91
5.8.4.3.2 Wetlands 5-92
5.8.4.3.3 Aquatic Resources 5-92
5.8.4.3.4 Terrestrial Resources 5-92
5.9 Recreation and Aesthetic Values 5-93
5.9.1 Flow Management Feature 5-93
5.9.1.1 No Action Component (FM-NA) 5-93
5.9.1.2 175,000 cfs Plan Component (FM-175) 5-93
5.9.1.3 200,000 cfs Plan Component (FM-200) 5-94
5.9.1.4 Operations Only Plan Component (FM-OPS) 5-94
5.9.2 Navigation Channel Deepening Feature 5-95
5.9.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-95
5.9.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-95
5.9.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-95
5.9.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-95
5.9.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-95
5.9.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-95
5.9.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-95
5.9.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-95

5.9.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-96
5.9.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-96
5.9.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-96
5.9.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-96
5.9.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-96
5.9.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-96
5.9.2.3 Navigation Channel Deepening 11-Foot Channel Component 5-96
5.9.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-97
5.9.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-97
5.9.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-97
5.9.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-97
5.9.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-97
5.9.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-97
5.9.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-97
5.9.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-97
5.9.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-98
5.9.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-98
5.9.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-98
5.9.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-98
5.9.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-98
5.9.3 Navigation Channel Depth Maintenance Feature 5-98
5.9.3.1 No Action Component (NCDM-NA) 5-98
5.9.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) 5-99
5.9.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) 5-99
5.10 Cultural Resources 5-99
5.10.1 Flow Management Feature 5-100
5.10.1.1 No Action Component (FM-NA) 5-100
5.10.1.2 175,000 cfs Plan Component (FM-175) 5-100
5.10.1.3 200,000 cfs Plan Component (FM-200) 5-101
5.10.1.4 Operations Only Plan Component (FM-OPS) 5-102
5.10.2 Navigation Channel Deepening Feature 5-102
5.10.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel) 5-103
5.10.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1) 5-103
5.10.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-103
5.10.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-103
5.10.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-103
5.10.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-103
5.10.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6) 5-103
5.10.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-103
5.10.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-104
5.10.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-104
5.10.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-104
5.10.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-104
5.10.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-105
5.10.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-105

5.10.2.3 Navigation Channel Deepening 11-Foot Channel Component 5-105
5.10.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-105
5.10.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-105
5.10.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-106
5.10.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-106
5.10.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-106
5.10.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-106
5.10.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-106
5.10.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-107
5.10.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-107
5.10.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-107
5.10.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-107
5.10.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-107
5.10.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-108
5.10.3 Navigation Channel Depth Maintenance Feature 5-108
5.10.3.1 No Action Component (NCDM-NA) 5-108
5.10.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)... 5-109
5.10.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) . 5-109
5.11 Sociological Environment 5-110
5.11.1 Flow Management Feature 5-110
5.11.1.1 No Action Component (FM-NA)... 5-110
5.11.1.2 175,000 cfs Plan Component (FM-175) 5-111
5.11.1.3 200,000 cfs Plan Component (FM-200) 5-112
5.11.1.4 Operations Only Plan Component (FM-OPS) 5-112
5.11.2 Navigation Channel Deepening Feature 5-113
5.11.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)..... 5-113
5.11.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)..................................... 5-113
5.11.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-113
5.11.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-114
5.11.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-114
5.11.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-114
5.11.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6).................................. 5-114
5.11.2.2 Navigation Channel Deepening 10-Foot Channel Component 5-114
5.11.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-114
5.11.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-114
5.11.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-114
5.11.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-114
5.11.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-114
5.11.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-115
5.11.2.3 Navigation Channel Deepening 11-Foot Channel Component 5-115
5.11.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-115
5.11.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-115
5.11.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-115
5.11.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-115
5.11.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-115

5.11.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-115
5.11.2.4 Navigation Channel Deepening 12-Foot Channel Component 5-115
5.11.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-115
5.11.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-115
5.11.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-116
5.11.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-116
5.11.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5) 5-116
5.11.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-116
5.11.3 Maintenance Dredging and Disposal Feature 5-116
5.11.3.1 No Action Component (MDDA-NA) 5-116
5.11.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1).. 5-116
5.11.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) . 5-116
5.12 Economic Environment 5-116
5.12.1 Flow Management Components 5-117
5.12.1.1 No Action Component (FM-NA).. 5-118
5.12.1.2 175,000 cfs Plan Component (FM-175) 5-121
5.12.1.3 200,000 cfs Plan Component (FM-200) 5-130
5.12.1.4 Operations Only Plan Component (FM-OPS) 5-131
5.12.2 Channel Deepening Components.. 5-133
5.12.2.1 Channel Deepening No Action Component (9-Foot Channel)........................ 5-136
5.12.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)...................................... 5-139
5.12.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2) 5-140
5.12.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3) 5-141
5.12.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4) 5-142
5.12.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5) 5-143
5.12.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6).................................. 5-144
5.12.2.2 Channel Deepening 10-Foot Channel Component 5-145
5.12.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1) 5-149
5.12.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2) 5-152
5.12.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3) 5-155
5.12.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4) 5-158
5.12.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5) 5-161
5.12.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6) 5-164
5.12.2.3 Channel Deepening 11-Foot Channel Component 5-167
5.12.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1) 5-171
5.12.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2) 5-174
5.12.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3) 5-177
5.12.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4) 5-180
5.12.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5) 5-183
5.12.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6) 5-186
5.12.2.4 Channel Deepening 12-Foot Channel Component 5-189
5.12.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1) 5-193
5.12.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2) 5-196
5.12.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3) 5-199
5.12.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4) 5-202

5.12.2.4.5 Segment 5 Fort Smith to Muskogee (NCD 12-5) 5-205
5.12.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6) 5-208
5.12.3 Maintenance Dredging and Disposal Components 5-211
5.12.3.1 No Action Component (NCDM-NA) 5-211
5.12.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1) 5-212
5.12.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2) 5-212

List of Tables

Table 5-1 Components Evaluated in Detail. 5-2
Table 5-2 Annual Average Change in Number of Days At or Above a Given Flow at Van Buren, Arkansas Compared With No Action Component (FM-NA). 5-5
Table 5-3 Seasonal Change in Annual Average Number of Days at or Above a Given Flow (Van Buren, Arkansas) Compared with No Action Component (FM-NA). 5-6
Table 5-4 Annual Average Change in the Number of Days Reservoirs are Expected to be Above Conservation Pool Compared to Existing Conditions (No Action Component). 5-8
Table 5-5 Change in the Annual Average Number of Days Reservoirs are Expected to be Less Than 8 Feet Above Conservation Pool and Greater Than 8 Feet Above Conservation Pool Compared to Existing Conditions (No Action Component) 5-9
Table 5-6 Dredged Material Volumes and Area of Dredging for Channel Deepening by River Segment and Navigation Depth.* 5-12
Table 5-7 River Training Structures (Dikes and Weirs) Required for Navigation Channel Deepening Feature on the MKARNS. 5-15
Table 5-8 Additional Revetments Required for the Navigation Channel Deepening Feature on the MKARNS. 5-16
Table 5-9 Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003. 5-18
Table 5-10 Additional River Training Structures (Dikes and Weirs) Required for 9-Foot Navigation Channel Depth Maintenance on the MKARNS. 5-22
Table 5-11 Additional Revetments Required for 9-Foot Navigation Channel Depth Maintenance on the MKARNS. 5-22
Table 5-12 Known Cultural Resources Potentially Affected in MKARNS by Project Segment. 5-101
Table 5-13 Known Cultural Resources Potentially Affected at Proposed Dredged Material Disposal Locations. 5-109
Table 5-14 Summary of Incremental Net Economic Benefits and Costs, Average Annual Values (Thousands of Dollars), 5.375% Discount Rate, 50-year Economic Life. 5-117
Table 5-15 Base Year Commodity Traffic, MKARNS. 5-118
Table 5-16 Projected Growth Rates through 2020, MKARNS 5-119
Table 5-17 Estimated Commodity Traffic Growth. 5-120
Table 5-18 Annual Generation Computation For Flow Management Components. 5-123
Table 5-19 Dependable Capacity For Components. 5-124

Table 5-20 Annual Energy Benefits For Flow Management Components. 5-125
Table 5-21 Annual Capacity Benefits For Flow Management Components. 5-126
Table 5-22 Annual Hydropower Benefits For Flow Management Components. (FY2001 Dollars). 5-127
Table 5-23 Changes in Benefits Compared to Baseline Conditions. 5-128
Table 5-24 Visitation and Benefits. 5-128
Table 5-25 No Action Component: High, Middle and Low Traffic Projections, 9′ Channel (000's tons)[1] 5-137
Table 5-26 No Action Component: Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts, 9′ Channel (000's Dollars except for savings/ton). 5-138
Table 5-27 No Action Component: High, Middle and Low Annual Tow Trip Projections, 9′ Channel. 5-138
Table 5-28 No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 1, (000's tons). 5-139
Table 5-29 No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 1. 5-139
Table 5-30 No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 2 (000's tons). 5-140
Table 5-31 No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 2. 5-140
Table 5-32 No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 3 (000's tons). 5-141
Table 5-33 No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 3. 5-141
Table 5-34 No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 4 (000's tons). 5-142
Table 5-35 No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 4. 5-143
Table 5-36 No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 5 (000's tons). 5-143
Table 5-37 No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 5. 5-144
Table 5-38 No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 6 (000's tons). 5-144
Table 5-39 No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 6. 5-145
Table 5-40 Existing Traffic, Tonnage and Transportation Costs - Middle Forecast, 10′ Channel Deepening Component (000s except for savings/ton). 5-145
Table 5-41 High, Middle and Low Induced Traffic Projections – 10′ Channel Deepening Component (000s tons). 5-146
Table 5-42 High, Middle and Low Tow Trip Projections, 10′ Channel Deepening Component. 5-147
Table 5-43 High, Middle and Low Induced Tow Trip Projections, 10′ Channel Deepening Component[1]. 5-147
Table 5-44 High, Middle and Low Projected Average Annual Navigation Benefits, 10′ Channel Deepening Component (000s Dollars)[1]. 5-148

Table 5-45 Summary of Annualized Navigation Benefits, Middle Forecast, 10′ Channel Deepening Component (000s Dollars)[1]. 5-148
Table 5-46 Summary of Total Costs and Navigation Benefits – 10′ Channel Deepening Component[1]. 5-149
Table 5-47 No Action Component: High, Middle and Low Traffic Projections -Segment 1[1] (000s tons). 5-149
Table 5-48 High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 1 (000s tons). 5-150
Table 5-49 High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 1. 5-151
Table 5-50 High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 1. 5-151
Table 5-51 Middle Annual Incremental Navigation Benefits Forecast - 10’ Channel Deepening Component, Segment 1 (000s Dollars)[1]. 5-152
Table 5-52 Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 1[1]. 5-152
Table 5-53 No Action Component: High, Middle and Low Traffic Projections, Segment 2 (000s tons). 5-153
Table 5-54 High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 2 (000s tons). 5-153
Table 5-55 High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 2. 5-154
Table 5-56 High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 2. 5-154
Table 5-57 Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Alternative, Segment 2 (000s Dollars)[1]. 5-154
Table 5-58 Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 2[1]. 5-155
Table 5-59 No Action Component: High, Middle and Low Traffic Projections, Segment 3 (000s tons). 5-155
Table 5-60 High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 3 (000s tons). 5-156
Table 5-61 High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 3. 5-156
Table 5-62 High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 3. 5-157
Table 5-63 Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 3 (000s Dollars)[1]. 5-157
Table 5-64 Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 3[1]. 5-158
Table 5-65 No Action Component: High, Middle and Low Traffic Projections - Segment 4 (000s tons). 5-158
Table 5-66 High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 4 (000s tons). 5-159
Table 5-67 High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 4. 5-159

Table 5-68 High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 4. 5-160
Table 5-69 Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 4 (000s Dollars)[1]. 5-160
Table 5-70 Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 4 (000s Dollars)[1]. 5-161
Table 5-71 No Action Component: High, Middle and Low Traffic Projections - Segment 5 (000s tons). 5-161
Table 5-72 High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 5 (000s tons). 5-162
Table 5-73 High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 5. 5-162
Table 5-74 High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 5. 5-163
Table 5-75 Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 5 (000s Dollars)[1]. 5-163
Table 5-76 Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 5[1]. 5-164
Table 5-77 No Action Component: High, Middle and Low Traffic Projections – Segment 6 (000s tons). 5-164
Table 5-78 High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 6 (000s tons). 5-165
Table 5-79 High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 6. 5-165
Table 5-80 High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 6. 5-166
Table 5-81 Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 6 (000s Dollars)[1]. 5-166
Table 5-82 Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 6[1]. 5-167
Table 5-83 Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts, 11′ Channel Deepening Component (000s except for savings/ton). 5-168
Table 5-84 High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component (000s tons). 5-168
Table 5-85 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component. 5-169
Table 5-86 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component. 5-169
Table 5-87 High, Middle and Low Projected Average Annual Navigation Benefits - 11′ Channel Deepening Component (000s Dollars)[1]. 5-170
Table 5-88 Summary of Annualized Navigation Benefits, Middle Forecast - 11′ Channel Deepening Component (000s Dollars)[1]. 5-170
Table 5-89 Summary of Total Costs and Navigation Benefits – 11′ Channel Deepening Component[1]. 5-171
Table 5-90 No Action Component: High, Middle and Low Traffic Projections – Segment 1, (000s tons). 5-172

Table 5-91 High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 1 (000s tons). 5-172
Table 5-92 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 1. 5-173
Table 5-93 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 1. 5-173
Table 5-94 Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 1 (000s Dollars)[1]. 5-173
Table 5-95 Summary of Incremental Net Economic Benefits and Costs -11-foot Channel Deepening Component, Segment 1[1]. 5-174
Table 5-96 No Action Component: High, Middle and Low Traffic Projections – Segment 2 (000s tons). 5-174
Table 5-97 High, Middle and Low Induced Traffic Projections - 11-foot Channel Deepening Component, Segment 2 (000s tons). 5-175
Table 5-98 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 2. 5-175
Table 5-99 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 2. 5-176
Table 5-100 Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 2 (000s Dollars)[1]. 5-176
Table 5-101 Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 2[1]. 5-177
Table 5-102 No Action Component: High, Middle and Low Traffic Projections – Segment 3 (000s tons). 5-177
Table 5-103 High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 3 (000s tons). 5-178
Table 5-104 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 3. 5-178
Table 5-105 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 3. 5-179
Table 5-106 Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 3 (000s Dollars)[1]. 5-179
Table 5-107 Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 3[1]. 5-180
Table 5-108 No Action Component: High, Middle and Low Traffic Projections – Segment 4 (000s tons). 5-180
Table 5-109 High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 4 (000s tons). 5-181
Table 5-110 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 4. 5-181
Table 5-111 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 4. 5-182
Table 5-112 Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 4 (000s Dollars)[1]. 5-182
Table 5-113 Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 4 (000s Dollars)[1]. 5-183

Table 5-114 No Action Component: High, Middle and Low Traffic Projections – Segment 5 (000s tons). 5-183
Table 5-115 High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 5 (000s tons). 5-184
Table 5-116 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 5. 5-184
Table 5-117 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 5. 5-185
Table 5-118 Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 5 (000s Dollars)[1]. 5-185
Table 5-119 Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 5 (000s Dollars)[1]. 5-186
Table 5-120 No Action Component: High, Middle and Low Traffic Projections – Segment 6 (000s tons). 5-186
Table 5-121 High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 6 (000s tons). 5-187
Table 5-122 High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 6. 5-187
Table 5-123 High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 6. 5-188
Table 5-124 Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 6 (000s Dollars)[1]. 5-188
Table 5-125 Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 6 (000s Dollars)[1]. 5-189
Table 5-126 Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts - 12′ Channel Deepening Component (000s except for savings/ton). 5-190
Table 5-127 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component (000s tons). 5-190
Table 5-128 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component. 5-191
Table 5-129 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component. 5-191
Table 5-130 High, Middle and Low Projected Average Annual Navigation Benefits - 12′ Channel Deepening Component (000s Dollars)[1]. 5-192
Table 5-131 Summary of Annualized Navigation Benefits, Middle Forecast - 12′ Channel Deepening Component (000s Dollars)[1]. 5-192
Table 5-132 Summary of Total Costs and Benefits – 12′ Channel Deepening Component[1]. 5-193
Table 5-133 No Action Component: High, Middle and Low Traffic Projections – 12′ Channel Component, Segment 1 (000s tons). 5-194
Table 5-134 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 1 (000s tons). 5-194
Table 5-135 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 1. 5-195
Table 5-136 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 1. 5-195

Table 5-137 Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 1 (000s Dollars)[1]. 5-196
Table 5-138 Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 1[1]. 5-196
Table 5-139 No Action Component: High, Middle and Low Traffic Projections – Segment 2 (000s tons). 5-197
Table 5-140 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 2 (000s tons). 5-197
Table 5-141 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 2. 5-198
Table 5-142 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 2. 5-198
Table 5-143 Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 2 (000s Dollars) [1]. 5-199
Table 5-144 Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 2 (000s Dollars)[1]. 5-199
Table 5-145 No Action Component: High, Middle and Low Traffic Projections – Segment 3 (000s tons). 5-200
Table 5-146 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 3 (000s tons). 5-200
Table 5-147 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 3. 5-201
Table 5-148 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 3. 5-201
Table 5-149 Middle Incremental Benefits Forecast - 12′ Channel Deepening Component, Segment 3 (000s Dollars)[1]. 5-202
Table 5-150 Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 3[1]. 5-202
Table 5-151 No Action Component: High, Middle and Low Traffic Projections – Segment 4 (000s tons). 5-203
Table 5-152 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 4 (000s tons). 5-203
Table 5-153 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 4. 5-204
Table 5-154 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 4. 5-204
Table 5-155 Middle Incremental Benefits Forecast - 12′ Channel Deepening Component, Segment 4 (000s Dollars)[1]. 5-205
Table 5-156 Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 4[1]. 5-205
Table 5-157 No Action Component: High, Middle and Low Traffic Projections – Segment 5 (000s tons). 5-206
Table 5-158 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 5 (000s tons). 5-206
Table 5-159 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 5. 5-207

Table 5-160 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 5. 5-207
Table 5-161 Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 5 (000s Dollars)[1]. 5-208
Table 5-162 Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 5[1]. 5-208
Table 5-163 No Action Component: High, Middle and Low Traffic Projections – Segment 6 (000s tons). 5-209
Table 5-164 High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 6 (000s tons). 5-209
Table 5-165 High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 6. 5-210
Table 5-166 High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 6. 5-210
Table 5-167 Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 6 (000s Dollars)[1]. 5-211
Table 5-168 Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 6[1]. 5-211

CHAPTER 5:

INTRODUCTION TO ENVIRONMENTAL CONSEQUENCES

5.1 Introduction

The following discussion describes the potential environmental consequences of the implementation features and components described in detail in Chapter 3. Implementation features and components are those shown in Table 5-1.

The following discussion concentrates on aspects of the environment that could potentially be affected by implementation of new activities on the McClellan Kerr Arkansas River Navigation System (MKARNS), construction projects on the MKARNS, or changes in utilization rates of the MKARNS associated with each of the features and components.

Table 5-1. Components Evaluated in Detail.							
FLOW MANAGEMENT COMPONENTS							
No Action Component							
175,000 cfs Component							
200,000 cfs Component							
Operations Only Component							
NAVIGATION CHANNEL DEEPENING COMPONENTS							
NAVIGATION DEPTH		**RIVER SEGMENT**					
		Mouth to Pine Bluff	**Pine Bluff to Little Rock**	**Little Rock to Dardanelle**	**Dardanelle to Fort Smith**	**Ft Smith to Muskogee**	**Muskogee to Catoosa**
		N.M. 0.0 To N.M. 75.2	**N.M. 75.2 To N.M. 119.5**	**N.M. 119.5 To N.M. 220.3**	**N.M. 220.3 To N.M. 308.7**	**N.M. 308.7 To N.M. 394.0**	**N.M. 394.0 To N.M. 445.2**
CHANGE	**NAV DEPTH**	**75.2 Miles**	**44.3 Miles**	**100.8 Miles**	**88.4 Miles**	**85.3 Miles**	**51.2 Miles**
No Action (Depth)	**9 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
1-Foot	**10 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
2-Foot	**11 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
3-Foot	**12 Feet**	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate	Evaluate
NAVIGATION CHANNEL DEPTH MAINTENANCE COMPONENTS							
No Action Component (Maintenance Dredging)							
Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan							
Maintenance Dredged Material Disposal in New Disposal Sites							

5.1.1 Impact Analysis Process and Resource Evaluation Categories

The discussion is structured using various environmental resource categories. These environmental resource categories are:

- Air Quality;
- Noise;
- Geology and Soils;
- Surface Waters;
- Land Use;
- Infrastructure;
- Biological Resources, including Fish and Wildlife, Vegetative Community Types and Diversity, Wetlands, and Threatened and Endangered Species;

- Recreation and Aesthetic Values;
- Cultural Resources;
- Sociological Environment; and
- Economic Environment.

An environmental consequence (hereafter referred to in this document as an impact) is defined as a change in a resource from the existing environmental baseline conditions caused by the proposed action.

5.1.2 Features and Components

The impact analysis in Chapter 5 is limited to the evaluation of impacts associated with project features and components.

- Features. Features are broad actions that influence the attainment of the proposed action; and
- Components. Components are one or more specific actions within a feature that address the attainment of the proposed action within a feature.

5.1.3 Study Features Impact Analysis Process

5.1.3.1 Flow Management Feature

Environmental impacts of the flow management feature components, including potential changes to the authorized System Operation Plan, would occur primarily as a function of changes in the frequency and duration of reservoir elevations and river stage water levels. Using 61 years of rainfall data (Southwestern Division Modeling System for the Simulation of the Regulation of a Multipurpose Reservoir System (SUPER) Model Report), reservoir elevations and river stages under the No Action; 175,000 cubic feet per second (cfs); 200,000 cfs; and Operations Only Components were modeled by Little Rock District and Tulsa District, U.S. Army Corps of Engineers (USACE). None of the flow management components would result in higher reservoir elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.1.3.1.1 River Conditions

Because the Van Buren gauging station is used as the control point for river stages, the river flow stage at that station was used as the basis of the analysis. For the purposes of this document, certain critical flow rates were defined in order to provide a frame of reference for analysis. Flow rates have been designated as “optimum”, “moderate”, “high”, and “very high” based on the flow rate’s effect on commercial navigation and farming.

- Optimum Flows. Optimum river flows are defined as less than 61,000 cfs. This definition correlates to optimum conditions for commercial navigation on the MKARNS;
- Moderate Flows. Moderate river flows are defined as those between 61,000 cfs and 100,000 cfs. Flooding of some fields along the main stem of the Arkansas River in western Arkansas begins at flows greater than 61,000 cfs;
- High Flows. High river flows are defined as those between 100,000 cfs and 175,000 cfs. The 100,000 cfs level is considered critical because any flow above 100,000 cfs renders the

navigation system non-navigable for commercial barge traffic. A flow of 137,000 cfs represents bank full at Van Buren; and

- Very High Flows. Very high river flows are defined as those greater than 175,000 cfs. This flow level is notable because the modeled condition data (Table 5-2) shows that there is no appreciable difference from the baseline or between components in the annual average number of days above a flow of 175,000 cfs.

Modeling results were used to compare river stages and reservoir elevations at the critical river flow rates of 61,000 cfs and 100,000 cfs at Van Buren. The following paragraphs summarize the potential effects resulting from implementation of the flow management components.

- Greater than 61,000 cfs, Effect on Agriculture. Agricultural damages have historically occurred in the Van Buren area when river flows exceed 61,000 cfs. Under all three flow management action components, the annual average number of days when the river is anticipated to be at or above 61,000 cfs is decreased;
- Greater than 70,000 cfs Flows, Effect on Recreational Navigation. Small craft warnings are issued when flows reach 70,000 cfs or greater; and
- Greater than 100,000 cfs Flows, Effect on Commercial Navigation. Commercial navigation on the MKARNS is not possible when flows are above 100,000 cfs and commercial barge traffic is suspended until flows decrease. For shippers and vessel operators, three specific problems exist. First, the closure of the river to navigation during and after storm events reduces reliability of shipping on the system. Second, the extended higher flow conditions require vessel operators to utilize higher horsepower towboats and smaller tow size. Third shipping charged during high flows, such as barge demurrage and "hot water" charges for special services, make the land mode of transport the least cost mode.

Tables 5-2 and 5-3 summarize the differences in the annual average number of days the Arkansas River is expected to be at or above certain river flows at Van Buren for each component compared to the existing, baseline condition (represented by the No Action Component). In an average year, the expected differences in anticipated river flows for the study components compared to existing conditions are the following:

- No Action Component (FM-NA). No change from existing conditions;
- 175,000 cfs Plan Component (FM-175). This component provides approximately 9 fewer days per year at or above 61,000 cfs. In addition, this component provides approximately 16 fewer days per year at or above 100,000 cfs;
- 200,000 cfs Plan Component (FM-200). This component provides approximately 9 fewer days per year at or above 61,000 cfs. In addition, this component provides approximately 17 fewer days per year at or above 100,000 cfs; and
- Operations Only Plan Component (FM-OPS). This component provides approximately 14 fewer days per year at or above 61,000 cfs. This component results in slightly less than two additional days per year at or above 100,000 cfs.

The impact of these changes on the environment is discussed in the appropriate resource categories in subsequent chapters of this EIS.

Table 5-2. Annual Average Change in Number of Days At or Above a Given Flow at Van Buren, Arkansas Compared With No Action Component (FM-NA).				
Flow (cfs)	**No Action Component (FM-NA)**	**175,000 cfs Plan Component (FM-175)**	**200,000 cfs Plan Component (FM-200)**	**Operations Only Plan Component (FM-OPS)**
20,000	Baseline (0)	1.3	0.9	0.6
40,000	Baseline (0)	5.9	5.4	2.5
61,000*	Baseline (0)	-8.6	-8.9	-13.6
75,000	Baseline (0)	3.9	3.4	-1.8
90,000	Baseline (0)	5.3	4.6	2.1
100,000	Baseline (0)	-15.6	-16.5	1.7
137,000	Baseline (0)	-3.6	-4.7	0.0
150,000	Baseline (0)	4.4	3.3	0.0
175,000	Baseline (0)	4.3	7.1	0.0
200,000	Baseline (0)	0.1	1.3	0.0
250,000	Baseline (0)	0.1	0.1	0.0
300,000	Baseline (0)	0.0	-0.1	0.0

Positive numbers represent more days; negative numbers represent fewer days than No Action Component (FM-NA), i.e. the existing plan.

* Since flows greater than 61,000 cfs begin to have effects on commercial navigation and agriculture, a flow of 61,000 cfs was used for the purposes of modeling.

Source: USACE, Tulsa District and Parsons, 2003

Table 5-3. Seasonal Change in Annual Average Number of Days at or Above a Given Flow (Van Buren, Arkansas) Compared with No Action Component (FM-NA).

Flow (cfs)	175,000 cfs Component (FM-175)						200,000 cfs Component (FM-200)						Operations Only Plan Component (FM-OPS)					
	Jan/ Feb	Mar/ Apr	May/ June	Jul/ Aug	Sept/ Oct	Nov/ Dec	Jan/ Feb	Mar/ Apr	May/ June	Jul/ Aug	Sept/ Oct	Nov/ Dec	Jan/ Feb	Mar/ Apr	May/ June	Jul/ Aug	Sept/ Oct	Nov/ Dec
20000	0.2	0.1	0.4	0.4	0.0	-0.1	0.2	0.1	0.4	0.2	0.0	0.1	0.0	0.0	0.2	0.2	0.1	0.1
40000	0.9	0.9	1.1	1.5	0.5	1.0	0.7	1.0	1.0	1.4	0.4	0.8	0.6	0.0	-0.2	1.1	0.4	0.6
61000	-1.9	-0.5	-0.2	-2.0	-1.2	-2.8	-2.0	-0.6	-0.2	-2.3	-1.1	-2.8	-2.4	-2.0	-1.9	-2.6	-1.4	-3.1
75000	0.2	3.0	1.1	-0.2	0.0	-0.2	0.0	3.0	1.2	-0.5	0.0	-0.2	-0.3	0.7	-0.4	-0.9	-0.2	-0.8
90000	0.8	1.8	0.8	0.6	0.4	0.9	0.6	1.7	0.8	0.3	0.3	0.8	0.4	0.4	0.3	0.2	0.3	0.5
100000	-1.2	-5.3	-5.2	-1.3	-0.8	-1.7	-1.2	-5.4	-5.5	-1.5	-0.9	-1.9	0.3	0.2	0.2	0.3	0.3	0.5
137000	-0.3	-0.9	-1.5	-0.3	0.1	-0.7	-0.3	-1.1	-2.0	-0.4	0.1	-0.9	0.1	0.1	-0.1	0.1	0.0	-0.1
150000	0.2	1.1	1.7	0.4	0.5	0.5	0.1	1.0	1.2	0.3	0.5	0.2	0.1	0.1	0.0	0.0	0.0	-0.2
175000	0.1	1.1	1.8	0.3	0.4	0.6	0.2	1.8	3.0	0.4	0.7	1.0	0.0	0.0	0.0	0.0	0.0	0.0
200000	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.2	0.6	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
250000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
300000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Positive numbers represent more days; negative numbers represent fewer days than No Action Component (FM-NA), i.e. the existing plan.
*Since flows greater than 61,000 cfs begin to have effects on commercial navigation and agriculture, a flow of 61,000 cfs was used for the purposes of modeling.

Source: USACE, Tulsa District and Parsons, 2003

5.1.3.1.2 Reservoir Conditions

The flow management components are based on changes in the operational flows of the river. Changes in river flows would be associated with changes in the storage of water in the reservoirs linked with the MKARNS, since flows on the MKARNS are influenced by the storage and release of water in the reservoirs.

Tables 5-4 and 5-5 summarize the differences in the annual average number of days the major reservoirs that influence flows on the Arkansas River are expected to be above conservation pool for each flow management component compared to the existing conditions (No Action Component) within the reservoirs. In an average year, the expected differences in anticipated reservoir levels under each of the flow management components compared to existing conditions are the following:

- FM-175 (175,000 cfs Plan). Under this plan it is anticipated that reservoir levels would be between 0 and 10 feet above conservation pool more frequently than under existing conditions, and reservoir levels would be greater than 10 feet above conservation pool less frequently than under existing conditions;
- FM-200 (200,000 cfs Plan). Under this plan it is anticipated that reservoir levels would be between 0 and 8 feet above conservation pool more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above conservation pool less frequently than under existing conditions; and
- FM-OPS (Operations Only Plan). This component would have reservoir levels very similar to existing conditions. However, under this plan it is anticipated that reservoir levels would be between 0 and 8 feet above conservation pool slightly more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above conservation pool slightly less frequently than under existing conditions.

The impact of these changes on the environment is discussed in the appropriate resource categories in subsequent chapters of this Environmental Impact Statement (EIS).

Table 5-4. Annual Average Change in the Number of Days Reservoirs are Expected to be Above Conservation Pool Compared to Existing Conditions (No Action Component).

175,000 cfs Component (FM-175)							
Storage	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Copan	1	1	1	0	0	0	0
Eufaula	4	9	0	0	-1	0	0
Gibson	1	2	6	6	2	-1	-2
Grand	3	1	-2	-1	0	0	0
Hudson	0	-1	-2	-2	-2	-2	-1
Hulah	0	0	0	0	0	0	0
Kaw	-2	0	1	2	2	1	0
Keystone	3	10	12	13	11	2	-1
Oologah	5	11	14	9	0	-1	-2
Tenkiller	4	9	13	11	7	2	-2
Wister	3	3	2	1	0	0	-1
200,000 cfs Component (FM-200)							
Storage	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Copan	1	1	0	0	0	0	0
Eufaula	4	6	-1	-1	-1	-1	0
Gibson	1	2	5	4	1	-2	-3
Grand	2	0	-3	-2	-1	0	0
Hudson	0	-1	-3	-2	-2	-2	-1
Hulah	1	1	1	1	1	1	1
Kaw	-1	1	2	2	2	1	0
Keystone	3	10	11	11	8	0	-2
Oologah	5	11	12	7	-1	-2	-2
Tenkiller	4	8	8	3	-1	-4	-5
Wister	2	3	1	-1	-1	-1	-1
Operations Only Plan Component (FM-OPS)							
Storage	0 feet	2 feet	4 feet	6 feet	8 feet	10 feet	12 feet
Copan	0	0	0	0	0	0	0
Eufaula	1	0	0	0	0	0	0
Gibson	0	0	1	1	1	-2	-2
Grand	1	1	0	0	-1	0	0
Hudson	0	1	0	0	0	0	0
Hulah	0	0	0	0	0	0	0
Kaw	0	0	0	0	0	0	0
Keystone	1	2	3	2	2	0	0
Oologah	2	1	3	2	0	0	0
Tenkiller	2	4	2	1	1	0	0
Wister	1	1	0	0	0	0	0

Columns Represent Feet Above Reservoir Conservation Pool.

Source: SUPER Model Report 2002, USACE, Tulsa District, and Parsons, 2003.

Table 5-5. Change in the Annual Average Number of Days Reservoirs are Expected to be Less Than 8 Feet Above Conservation Pool and Greater Than 8 Feet Above Conservation Pool Compared to Existing Conditions (No Action Component).

175,000 cfs Component (FM-175)	Jan-Feb		Mar-Apr		May-Jun		Jul-Aug		Sep-Oct		Nov-Dec	
	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +
Keystone	-8.7	0.7	-3.3	3.3	-2.4	2.7	-2.0	2.5	-0.4	0.5	-0.6	1.0
Oologah	5.1	0.0	1.7	0.0	1.8	-0.4	-0.9	1.3	0.3	0.1	0.3	-0.1
Grand	0.4	0.0	2.1	-0.1	0.4	0.0	-0.9	0.0	0.2	0.0	0.0	-0.1
Hudson	0.0	0.0	0.1	-0.3	0.9	-0.9	0.2	-0.2	0.1	-0.1	0.2	-0.2
Fort Gibson	-0.2	0.4	-1.5	1.6	0.6	0.0	0.1	0.2	0.2	-0.1	-0.1	0.0
Tenkiller Ferry	-0.6	0.9	-1.8	2.6	-1.0	2.3	0.3	0.9	0.4	0.0	-0.1	0.0
Eufaula	0.2	0.0	0.5	-0.1	0.6	-0.1	0.5	-0.1	0.4	-0.3	0.6	-0.2
Kaw	-0.7	0.0	-1.2	0.4	-0.8	0.8	-0.4	0.2	-0.2	0.0	0.0	0.1
Hulah	-0.2	0.2	0.0	0.0	0.0	0.1	0.0	0.1	-1.6	0.0	0.0	0.1
Copan	0.0	0.0	0.0	0.0	-0.4	0.4	0.2	0.0	0.1	-0.1	-0.1	0.1
Wister	0.2	-0.1	-0.4	0.4	-0.1	0.4	1.6	-0.1	0.5	0.0	0.2	-0.2
200,000 cfs Component (FM-200)	**Jan-Feb**		**Mar-Apr**		**May-Jun**		**Jul-Aug**		**Sep-Oct**		**Nov-Dec**	
	< 8 feet	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**	**< 8 feet**	**8 feet +**
Keystone	-8.3	0.3	-2.8	2.7	-1.2	1.5	-2.0	2.4	-0.4	0.5	-0.4	0.7
Oologah	5.2	0.0	1.7	-0.1	2.2	-0.9	-1.0	1.4	0.3	0.0	0.5	-0.3
Grand	0.3	0.0	1.8	-0.1	0.3	0.0	-0.1	0.0	0.2	0.0	0.0	-0.1
Hudson	0.0	0.0	0.4	-0.4	1.2	-1.2	0.3	-0.2	0.2	-0.1	0.4	-0.4
Fort Gibson	0.0	0.1	-0.9	1.0	0.7	-0.3	0.1	0.1	0.1	0.0	-8.2	0.0
Tenkiller Ferry	-0.3	0.6	0.2	0.5	1.6	-0.4	1.4	-0.4	0.6	-0.4	0.6	-0.5
Eufaula	0.2	-0.1	0.5	-0.1	-0.5	-0.1	0.3	-0.1	0.6	-0.4	0.6	-0.1
Kaw	-0.6	0.0	-0.8	0.5	-1.0	1.0	-0.2	0.2	0.0	0.0	-0.2	0.2
Hulah	-0.1	0.1	0.0	0.0	-0.1	0.2	-0.1	0.2	-1.5	0.0	0.0	0.0
Copan	0.0	0.0	0.1	-0.1	-0.4	0.5	0.1	0.0	0.0	0.0	-0.1	0.1
Wister	0.4	-0.4	-0.2	0.2	0.6	-0.2	1.3	-0.3	0.5	0.0	0.2	-0.3

Table 5-5. Change in the Annual Average Number of Days Reservoirs are Expected to be Less Than 8 Feet Above Conservation Pool and Greater Than 8 Feet Above Conservation Pool Compared to Existing Conditions (No Action Component).

Operations Only Component (FM-OPS)	Jan-Feb		Mar-Apr		May-Jun		Jul-Aug		Sep-Oct		Nov-Dec	
	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +	< 8 feet	8 feet +
Keystone	0.4	-0.1	-0.1	0.1	-0.7	0.6	-1.3	1.7	0.0	0.1	0.2	0.1
Oologah	5.0	0.0	-12.8	0.0	0.2	0.1	-1.2	1.2	0.5	-0.1	0.1	0.1
Grand	0.2	0.0	0.4	0.0	-0.3	0.0	0.1	0.0	0.1	0.0	0.3	-0.1
Hudson	0.0	0.0	0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fort Gibson	0.0	0.0	-0.1	0.1	-0.3	0.2	-0.2	0.4	0.2	0.0	-0.1	0.1
Tenkiller Ferry	0.3	-0.1	0.5	0.0	0.2	0.2	-0.2	0.7	0.1	0.1	0.4	-0.3
Eufaula	0.1	0.0	0.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.0
Kaw	-0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0
Hulah	-0.1	0.2	0.0	0.0	0.1	0.0	0.0	0.1	-1.5	0.0	0.0	0.1
Copan	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	-0.1	0.1	-0.1	0.1
Wister	0.3	-0.2	-0.3	0.2	0.0	0.0	0.9	0.0	0.3	0.0	0.0	0.0

Source: USACE, Tulsa District and Parsons, 2003

5.1.3.2 Navigation Channel Deepening Feature

Direct and indirect environmental impacts of the components of the navigation channel deepening feature would occur primarily as a function of dredging operations, aquatic and terrestrial disposal of dredged material, and an increase or modification of in-river training structures such as dikes and revetments. Additionally, direct and indirect environmental impacts may occur due to changes in commercial, industrial, and recreational river traffic resulting from channel deepening.

Following the dredging operations it is unknown how scouring and sediment loads may impact specific locations within the study area. In addition, if any of the deepening components are implemented, maintenance dredging would occur consistent with historic maintenance dredging activities. In some areas this may include overdredging deeper than 12 feet for the maintenance of the navigation channel.

5.1.3.2.1 Dredging

Under the components of the navigation channel deepening feature, the MKARNS would be dredged at previously dredged and new locations in order to achieve a 10, 11, or 12-foot deep navigation channel. Table 5-6 shows the dredged material quantities and area required for these components by river segment. Locations of current and future dredging on the MKARNS are illustrated in Appendix A. The impact of the proposed dredging on the environment is discussed in the appropriate resource categories in subsequent chapters of this EIS.

For the deepening dredging operations a pipeline dredge would be used. A pipeline dredge sucks dredged material through the intake pipe at one end, and then pushes it out the discharge pipeline directly into the disposal site. Because pipeline dredges pump directly to the disposal site, they can operate continuously. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device that has rotating blades or teeth to break up or loosen the bottom material so that it can be sucked through the dredge. Some cutterheads are rugged enough to break up rock for removal. Pipeline dredges are mounted (fastened) to barges and are not usually self-powered, but are towed to the dredging site and secured in place by special anchor piling, called spuds.

Table 5-6. Dredged Material Volumes and Area of Dredging for Channel Deepening by River Segment and Navigation Depth.*

River Segment		Navigation Depth							
		No Action (9-Ft Channel)		10-Ft Channel		11-Ft Channel		12-Ft Channel	
		Area (acres)	Volume (cy**)	Area (acres)	Volume (cy)	Area (acres)	Volume (cy)	Area (acres)	Volume (cy)
Mouth to Pine Bluff	N.M. 0.0 To N.M. 75.2	Maintenance	Maintenance	836	790,615	836	1,299,276	836	2,066,867
Pine Bluff to Little Rock	N.M. 75.2 To N.M. 119.5	Maintenance	Maintenance	266	98,929	266	225,517	266	445,995
Little Rock to Dardanelle	N.M. 119.5 To N.M. 220.3	Maintenance	Maintenance	389	196,478	715	387,227	883	925,439
Dardanelle to Fort Smith	N.M. 220.3 To N.M. 308.7	Maintenance	Maintenance	619	378,400	835	643,500	1036	1,226,500
Ft Smith to Muskogee	N.M. 308.7 To N.M. 394.0	Maintenance	Maintenance	1152	1,319,910	1660	2,255,323	1794	3,256,749
Muskogee to Catoosa	N.M. 394.0 To N.M. 445.2	Maintenance	Maintenance	470	1,241,554	497	2,026,333	830	3,063,790
Total Deepening Dredging		Maintenance	Maintenance	3,732	4,025,886	4,809	6,837,176	5,645	10,985,340

* In addition to maintenance dredging volumes and areas.
** Cubic yards.

5.1.3.2.2 Disposal

Congressionally-authorized projects for dredging and dredged material disposal conducted by the USACE do not receive permits but must comply with the Rivers and Harbors Act and the Clean Water Act (CWA). Under the CWA, the U.S. Environmental Protection Agency (EPA) is responsible for developing the environmental criteria used by the USACE to evaluate proposed discharges of dredged material and for environmental oversight. The Section 404(b)(1) Guidelines are the substantive criteria by which proposed dredged material discharge actions are evaluated. Under Section 401, proposed discharges of dredged or fill material must comply with applicable State water quality standards.

In accordance with the USACE operations and maintenance (O&M) regulations published in 33 Code of Federal Regulations Parts 335-338, and Section 401 of the CWA, the USACE, Tulsa District has prepared a Long Term Dredged Material Disposal Plan (DMDP) for the operation and maintenance of the MKARNS with the 9-foot navigation channel. Although the USACE does not issue itself a CWA permit to authorize Corps discharges of dredged or fill material into waters of the United States, 404(b)(1) guidelines and other substantive requirements of the CWA and other environmental laws are applied. To this end, the USACE is seeking State water quality certification for the discharge of dredged or fill material into waters of the United States.

Many of the Oklahoma sites approved in the former (1974) and current (2003) DMDP will be utilized for disposal of dredged material resulting from deepening the channel. In addition to the DMDP sites, additional sites have been selected to accommodate the increased quantity of dredged material for maintenance operations.

Along the MKARNS, there are 142 existing aquatic and terrestrial dredged material disposal sites encompassing 8,148 acres. Twenty-six new sites encompassing 734 acres would be used for maintenance dredged material disposal. Thirty-four new sites encompassing 1,272 acres (see Appendix A and Table 6-2) have been selected as potential additional disposal areas for the deepening feature. Twelve of the new maintenance dredged material disposal sites would be used jointly for maintenance and deepening dredged material disposal.

As part of the dredging process, a determination of the potential for contaminant-related impacts associated with the discharge of dredged material in waters regulated under Section 404 of the CWA must be performed. The USACE utilizes the technical guidance presented in the EPA and USACE *Evaluation of Dredged Material proposed for Discharge in waters of the U.S.-Testing Manual* commonly referred to as the Inland Testing Manual (EPA/USACE 1998), and EPA regulation 40 Code of Federal Regulations (CFR) Part 230, (*Guidelines for Specification of Disposal Sites for Dredged or Fill Material*) and the USACE operation and maintenance regulations 33 CFR Parts 335-338 when determining the need for sediment analysis. The Inland Testing Manual contains technical guidance for determining the potential for contaminant-related impacts associated with the discharge of dredged material in to waters regulated under Section 404 of the CWA through chemical, physical, and biological evaluations. The manual utilizes a tiered process for analysis of a dredge site. Subpart G of the Section 404(b)(1) guideline, known as the "reason to believe principle" requires the use of available information to make a preliminary determination concerning the need for testing of the material proposed for dredging.

The reason to believe that no testing is required is based on the type of material to be dredged and/or its potential to be contaminated. This general evaluation describes the procedures found in Tier I of the Inland Testing Manual's tiered-testing process. If the available information is sufficient to make a positive factual determination, no further testing is required. Evaluation at successive tiers is based on more extensive and specific information about the potential impact of the dredged material. It is necessary to proceed through the tiers until information sufficient to make factual determinations has been obtained.

Site-specific habitat analyses were conducted to evaluate potential impacts of the construction and use of proposed dredged material disposal areas. Refer to Appendix C for detailed descriptions of analyses of dredged material disposal sites. The primary purpose was to assist the study team in formulating a recommended plan by providing quantitative measure or qualitative evaluation of environmental impacts and estimated habitat replacement costs. Detailed analysis of site-specific impacts, based on engineering site plans, will not be possible until those plans are available. Should future construction activities be recommended, detailed site-specific evaluations would be completed for each incremental step towards completion of the action. Site surveys would be conducted to determine the potential for environmental impacts and environmental assessments (EAs) would be prepared for site specific activities. These detailed evaluations would be documented in tiered EAs.

A habitat assessment study team included representatives from the Little Rock and Tulsa Districts of the USACE; the U.S. Fish and Wildlife Service – Tulsa Field Office; the U.S Fish and Wildlife Service – Conway Field Office; Arkansas Game & Fish Commission; Oklahoma Department of Wildlife Conservation; Arkansas Department of Environmental Quality; U.S. Army Engineer Research and Development Center - Environmental Laboratory; and Parsons Corporation. The study team regularly coordinated with State and Federal resource agencies and other interested agencies.

Quantitative evaluations of representative terrestrial and aquatic disposal sites were accomplished using the Habitat Evaluation Procedures (HEP), as developed by the U.S. Army Engineer Research and Development Center (ERDC), and the results extrapolated to the remaining potential dredged material disposal sites. HEP is a nationally recognized evaluation method developed to quantify the impacts of habitat changes made by land and water development projects. Included in that process are creation of a study team, formation of objectives and selection of evaluation species, followed by inventory design and data gathering. HEP provides a formula and information to compare the relative habitat value of different areas at the same point in time and the relative habitat value of the same area in the future. Documented Habitat Suitability Index (HSI) models are used in HEP to determine the quality portion of the formula. The HSI values are multiplied by area to calculate Habitat Units (HUs). The changes in HUs for species and their habitats are reported as the results in a HEP evaluation.

For the terrestrial HEP analysis, a group of 21 sites, 10 reference sites and 11 potential dredged material disposal sites was chosen to represent those terrestrial habitats that may be impacted by the project. The study team coordinated each step of the process, including habitat model selection and data gathering, with interested parties including State and Federal biologists. Detailed descriptions of the site-specific terrestrial habitat assessment can be found in Appendix C.

A HEP evaluation of the potential aquatic disposal areas was conducted through field studies to establish baseline conditions of fish and aquatic habitat. In addition, primary impacts of the project identified by an interagency team of biologists and engineers were evaluated including dike filling rates and associated effects on habitat quality, and the potential of degrading or removing gravel during dredging activities (see Appendix C).

5.1.3.2.3 River Training Structures

Many in-stream structures have been created for stream bank stability and maintenance of the navigation channel along the MKARNS. These structures include wing dikes (Table 5-7) and revetments (Table 5-8). Wing dikes force the water flow away from the bank from which they are built. Typically then, revetments, which strengthen and hold unstable banks from erosional forces, must be placed on opposite shores of wing dams. As part of the deepening feature, modifications and/or additions to dikes and revetments would occur. These modifications are shown in Tables 5-7 and 5-8. The impacts of these proposed structures and/or modifications on the environment are discussed in the appropriate resource categories in subsequent chapters of this EIS.

Table 5-7. Additional River Training Structures (Dikes and Weirs) Required for Navigation Channel Deepening Feature on the MKARNS.

Reach	Number Existing Structures	Number New Structures*	Total Length (ft) of New Structures for 12′ Channel Component**	Number Modified (Raised or Extended) Structures*	Change in Length (ft) of Modified Structures for 12′Channel Component**
Mouth To Pine Bluff	278	4	2,040	21	3,615
Pine Bluff to Little Rock	201	30	9,700	4	0
Little Rock to Dardanelle	392	5	2,050	34	4,600
Dardanelle to Fort Smith	236	6	1,850	28	2,300
Fort Smith to Muskogee	195	44	48,729	0	0
Muskogee to Catoosa	12	0	0	0	0

* Structures required for 10-foot, 11-foot, and 12-foot navigation channel deepening components.
** It is assumed that structures required for 11-foot navigation channel deepening component would be approximately 2/3 the length of those required for 12-foot navigation channel deepening component. Structures required for 10-foot navigation channel deepening component would be approximately 1/3 the length of those required for 12-foot navigation channel deepening component.
Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

Table 5-8. Additional Revetments Required for the Navigation Channel Deepening Feature on the MKARNS.

Reach	Total Number of Existing Structures	Total Length (mi) of Existing Structures	Number New Structures*	Total Length (mi) of New Structures for 12′ Channel Component**	Number Modified (Raised or Extended) Structures*	Change in Length (ft) of Modified Structures for 12′ Channel Component**
Mouth To Pine Bluff	57	56.7	0	0	9	0.06
Pine Bluff to Little Rock	49	44.5	1	2.3	0	0
Little Rock to Dardanelle	64	75.3	0	1.5	1	0
Dardanelle to Fort Smith	49	58.3	0	2.5	6	0.09
Fort Smith to Muskogee	34	58.5	0	0	0	0
Muskogee to Catoosa	42	35.6	0	0	0	0

* Structures required for 10-foot, 11-foot, and 12-foot navigation channel deepening components.
** Length of new and modified revetments will be comparable for the 10-foot, 11-foot, and 12-foot navigation channel deepening components.
Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

5.1.3.2.4 Navigation Traffic

Implementation of the proposed action would improve navigation efficiencies which in combination with economic factors could interact with changes in demand and transportation in the following three ways:

- Demand for goods stays the same and due to increased efficiencies there are fewer trips necessary to transport the same amount of goods, producing a decrease in waterway traffic;
- Demand for goods increases, and there is an increase in waterway traffic; and
- Due to increased efficiencies and more competitive prices there is an increase in waterway transportation and a reduction in other forms of transportation, such as railways and highways.

5.1.3.3 Navigation Channel Depth Maintenance Feature

5.1.3.3.1 Dredging

Regular maintenance dredging, in combination with a series of river training structures, is conducted on the MKARNS to maintain the current 9-foot channel depth for navigation purposes. Table 5-9 lists dredging quantities along the MKARNS for the USACE, Little Rock and Tulsa Districts from 1995 to 2003. For the maintenance dredging operations a pipeline dredge is used.

Since the USACE is authorized to continue to maintain a 9-foot channel in the MKARNS, the environmental impacts of maintenance dredging and disposal are addressed in this EIS.

Table 5-9. Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003.											
Navigation Mile	**Pool**	**Quantity Dredged (CY[1])**									**Average Amount Dredged**
		1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	
0.1-1.3	WREC[2]	0	116,277.00	0	0	90,088.03	0	59,049.05	292,304.00	175,537.00	146,651.02
2.0-2.6	WREC	68,021.80	93,835.00	0	0	93,234.22	0	0	0	0	85,030.34
3.24-3.48	WREC	0	0	0	0	0	34,535.28	0	0	0	34,535.28
3.9-4.3	WREC	0	0	0	46,558.06	0	0	0	0	0	46,558.06
4.6-5.59	WREC	0	0	0	0	48,564.43	0	40,665.74	0	0	44,615.09
6.3-10.44	WREC	181,561.50	95,554.00	489566.54	207,129.19	509,838.17	280,754.63	225,640.08	339,207.00	365,355.00	299,400.68
Total WREC		**249,583.30**	**305,666.00**	**489,566.54**	**253,687.25**	**741,724.85**	**315,289.91**	**325,354.87**	**631,511.00**	**540,892.00**	**428,141.75**
18.8-18.9	2	6,248.60	0	0	0	0	0	0	0	0	6,248.60
23.1-23.7	2	0	73,509.00	0	0	0	0	0	0	0	73,509.00
43.0-44.8	2	216,507.50	0	18,960.31	0	105,555.48	55,335.56	37,936.39	96,615.00	119,562.00	92,924.61
46.2-46.6	2	0	0	0	0	0	0	0	0	26,536.00	26,536.00
48.3-48.9	2	0	0	0	0	0	0	0	0	48,319.00	48,319.00
49.5-50.0	2	78,485.80	54,561.00	44,977.13	36,948.10	21,019.36	0	10,092.96	0	11,813.00	36,842.48
Total Pool 2		**301,241.90**	**128,070.00**	**63,937.44**	**36,948.10**	**126,574.84**	**55,335.56**	**48,029.35**	**96,615.00**	**206,230.00**	**118,109.13**
65.1-65.83	3	0	24,434.00	5,688.61	19,772.41	16,260.77	0	4,424.81	0	10,243.00	13,470.60
Total Pool 3		**0**	**24,434.00**	**5,688.61**	**19,772.41**	**16,260.77**	**0**	**4,424.81**	**0**	**10,243.00**	**13,470.60**
85.8-86.2	4	0	5,305.00	3,263.43	8,060.93	10,178.72	0	3,754.54	0	19,721.00	8,380.60
Total Pool 4		**0**	**5,305.00**	**3,263.43**	**8,060.93**	**10,178.72**	**0**	**3,754.54**	**0**	**19,721.00**	**8,380.60**
94.8-95.2	5	0	0	0	40,568.09	0	0	0	0	0	40,568.09

Table 5-9. Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003.											
Navigation Mile	Pool	Quantity Dredged (CY[1])									Average Amount Dredged
		1995	1996	1997	1998	1999	2000	2001	2002	2003	
96.2-97.0	5	0	0	0	0	0	0	0	0	116,428.00	116,428.00
107.6-107.94	5	0	0	0	0	0	0	6,990.05	0	7,085.00	7,037.53
Total Pool 5		**0**	**0**	**0**	**40,568.09**	**0**	**0**	**6,990.05**	**0**	**123,513.00**	**57,023.71**
124.8-125.1	7	0	0	0	0	0	0	0	0	18,395.00	18,395.00
146.0-146.63	7	0	0	0	0	0	0	19,046.30	26,233.00	0	22,639.65
Total Pool 7		**0**	**0**	**0**	**0**	**0**	**0**	**19,046.30**	**26,233.00**	**18,395.00**	**21,224.77**
175.2-175.5	8	37,703.40	0	0	0	0	0	0	0	0	37,703.40
Total Pool 8		**37,703.40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**37,703.40**
205.0-205.3	9	0	0	0	29,385.19	0	0	0	0	0	29,385.19
Total Pool 9		**0**	**0**	**0**	**29,385.19**	**0**	**0**	**0**	**0**	**0**	**29,385.19**
222.0-222.3	10	0	0	0	17,651.00	0	0	0	41,811.00	0	29,731.00
225.5-225.7	10	122,300.00	0	0	0	0	0	0	0	0	122,300.00
239.0-239.19	10	0	0	0	0	0	0	0	23,425.19	0	23,425.19
240.6-241.2	10	0	0	0	17,986.00	0	8,096.11	0	0	0	13,041.06
Total Pool 10		**122,300.00**	**0**	**0**	**35,637.00**	**0**	**8,096.11**	**0**	**65,236.19**	**0**	**57,817.33**
275.0-275.55	12	0	0	0	0	0	0	61,604.95	51,804.00	0	56,704.48
279.5-280.2	12	95,343.00	0	0	0	0	0	0	0	0	95,343.00
280.57-280.91	12	0	0	0	0	0	0	0	30,667.87	0	30,667.87
Total Pool 12		**95,343.00**	**0**	**0**	**0**	**0**	**0**	**61,604.95**	**82,471.87**	**0**	**79,806.61**

Table 5-9. Maintenance Dredging Conducted by the USACE along the MKARNS, 1995-2003.

Navigation Mile	Pool	Quantity Dredged (CY[1]) 1995	1996	1997	1998	1999	2000	2001	2002	2003	Average Amount Dredged
Poteau River 0.0-0.3	13	45,098.20	0	0	0	0	0	0	0	0	45,098.20
319.0	13	0	0	0	0	19,445.37	0	0	0	0	19,445.37
Total Pool 13		**45,098.20**	**0**	**0**	**0**	**19,445.37**	**0**	**0**	**0**	**0**	**32,271.79**
311.5-312.0	14	62,214.40	0	0	0	0	0	0	0	0	62,214.40
Total Pool 14		**62,214.40**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**62,214.40**
393.0	16	0	0	0	0	64,892.41	0	0	0	0	64,892.41
394.0-395.0	16	0	143,894.00	102,893.52	0	0	0	0	151,606.00	0	132,797.84
400.0-400.6	16	75,486.00	4,094.00	0	0	17,637.41	0	0	0	0	32,405.80
Total Pool 16		**75,486.00**	**147,988.00**	**102,893.52**	**0**	**82,529.82**	**0**	**0**	**151,606.00**	**0**	**112,100.67**
402.7-403.0	17	0	3,328.00	0	0	0	0	0	0	0	3,328.00
421.0-421.6	17	50,171.02	0	0	0	91,862.41	0	0	91,403.61	0	77,812.35
Total Pool 17		**50,171.02**	**3,328.00**	**0**	**0**	**91,862.41**	**0**	**0**	**91,403.61**	**0**	**59,191.26**
444.6-445.1	18	42,777.30	0	0	0	0	0	0	0	0	42,777.30
Total Pool 18		**42,777.30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**42,777.30**
Total for Year		**1,081,918.52**	**614,791.00**	**665,349.54**	**424,058.97**	**1,088,576.78**	**378,721.58**	**469,204.87**	**1,145,076.67**	**918,994.00**	

[1]Cubic yards
[2]White River entrance channel

Source: USACE, Little Rock District, C.N. Mitchell, email correspondence dated June 9, 2004.

5.1.3.3.2 Disposal

The USACE published a Final Environmental Impact Statement for the O&M Program of the MKARNS in Oklahoma, in September 1974 (USACE 1974). O&M activities have been conducted under this document since that time. Dredged material disposal has taken place in designated disposal areas such as on-shore unconfined disposal areas; or behind bank stabilization and channel alignment structures; or in confined upland disposal areas. The USACE has avoided open water disposal in the past, however, the current Long Term DMDP (2003) for Oklahoma calls for 23 new dredged material disposal areas including the expansion of five islands created by dredged material from the original San Bois Creek Navigation Channel construction when the Robert S. Kerr Reservoir was built. As part of the Navigation Channel Depth Maintenance Feature of the Proposed Action, the USACE is evaluating both open-water and confined upland disposal sites to complement the dredged material disposal areas identified in 1974.

Along the Arkansas portion of the MKARNS, there are 138 pre-approved aquatic and terrestrial dredged material disposal sites encompassing 12,709 acres within dike fields.

Dredged material disposal for both the channel maintenance and channel deepening features would be limited to 6,120 acres of open water sites in Oklahoma and Arkansas.

5.1.3.3.3 River Training Structures

Along with dredging, development of river training structures such as dikes and revetments, is an important tool in maintaining navigation channel depth. River training structures have several functions including to:

- direct the flow either toward or away from a bank;
- constrict the channel to increase velocity and thus deepen it (navigation);
- prevent erosion on susceptible banks; and
- create slack water for marinas and boat launches.

The existing river training structure system on the MKARNS serves to reduce the need for maintenance dredging. However, new structures may be warranted, primarily in Arkansas, to facilitate the maintenance of the 9-foot navigation channel. Nine-foot channel maintenance would require two new river training structures, modifications to 50 existing river training structures, two new revetments, and modifications to four existing revetments along the MKARNS (Tables 5-10 and 5-11).

Table 5-10. Additional River Training Structures (Dikes and Weirs) Required for 9-Foot Navigation Channel Depth Maintenance on the MKARNS.

Reach	Number of Existing Structures	Number of New Structures*	Total Length (ft) of New Structures	Number of Modified (Raised) Structures*
Mouth To Pine Bluff	278	2	800	18
Pine Bluff to Little Rock	201	0	0	0
Little Rock to Dardanelle	392	0	0	24
Dardanelle to Fort Smith	236	0	0	8
Fort Smith to Muskogee	195	0	0	0
Muskogee to Catoosa	12	0	0	0

* Structures required to maintain a 9-foot navigation channel.

Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

Table 5-11. Additional Revetments Required for 9-Foot Navigation Channel Depth Maintenance on the MKARNS.

Reach	Number of Existing Structures	Total Length (mi) of Existing Structures	Number of New Structures*	Total Length (mi) of New Structures*	Number of Modified (Raised) Structures*
Mouth To Pine Bluff	57	56.7	0	0.00	0
Pine Bluff to Little Rock	49	44.5	1	0.80	0
Little Rock to Dardanelle	64	75.3	0	0.00	3
Dardanelle to Fort Smith	49	58.3	1	0.83	1
Fort Smith to Muskogee	34	58.5	0	0.00	0
Muskogee to Catoosa	42	35.6	0	0.00	0

* Structures required to maintain a 9-foot navigation channel.

Source: MKARNS Navigation Charts, 1997 and USACE, 2004.

5.1.4 Study Alternatives Impact Analysis Process

The impact analysis as a whole for this study includes the evaluation of impacts associated with project features, components, and alternatives.

- Features. Features are broad actions that influence the attainment of the proposed action;

- Components. Components are one or more specific actions within a feature that address the attainment of the proposed action within a feature; and
- Alternatives. Alternatives are combinations of components, among one or more features, that specifically address the attainment of the proposed action. Selection of the preferred alternative to implement the proposed action is the "Decision to be Made" by the USACE.

Impact analysis is included in the following chapters of the document:

- **Chapter 5 – Introduction to Environmental Consequences**. This chapter provides details associated with the environmental consequences of implementing features and components of the study.
- **Chapter 6 – Environmental Consequences Associated with Study Alternatives**. This chapter provides details associated with the environmental consequences of implementing each of the study alternatives.
- **Chapter 7 – Cumulative Impacts.** This chapter provides impact analysis associated with the cumulative environmental consequences of implementing each of the study alternatives.
- **Chapter 8 – Impacts Summary and Mitigation.** This chapter provides a summary of environmental impacts associated with each alternative as well as mitigation for adverse environmental impacts.

5.1.5 Definition of Key Terms

The analysis of impacts associated with each course of action has been further divided into direct, indirect, and cumulative impacts.

5.1.5.1 Direct Versus Indirect Impacts

- **Direct Impacts.** A direct impact is caused by the proposed action and occurs at the same time and place;
- **Indirect Impacts.** An indirect impact is caused by the proposed action and occurs later in time or is farther removed in distance, but is still reasonably foreseeable; and
- **Application of Direct versus Indirect Impacts.** For direct impacts to occur, a resource must be present in a particular area. For example, if highly erodible soils were exposed during the project, there would be a direct impact to soils from erosion at the dredged material disposal site. Sediment laden runoff might indirectly affect water quality in adjacent areas downstream from the site.

5.1.5.2 Impact Characterization

Impacts are characterized by their relative magnitude. Adverse or beneficial impacts that are significant (see 5.1.5.4) are the highest level of impacts. Conversely, minor adverse or beneficial impacts are the lowest level of impacts. In this document, four descriptors are used to characterize the level of impacts. In order of degree of impact, the descriptors are:

- No Impact
- Minor Impact
- Major Impact
- Significant Impact

The following figure graphically represents this hierarchy of impacts.

< IMPACT SCALE >

Significant Adverse Impact	Major Adverse Impact	Minor Adverse Impact	No Impact	Minor Beneficial Impact	Major Beneficial Impact	Significant Beneficial Impact

5.1.5.3 Short-Term Versus Long-Term Impacts

In addition to indicating whether impacts are direct or indirect, the environmental consequences analysis also distinguishes between short- and long-term impacts. Short-term and long-term do not refer to any rigid time period and are determined on a case-by-case basis in terms of the environmentally significant consequences of the proposed action. The clearing of trees on a new construction site would be classified as a long term impact, while erosion and siltation in nearby streams during the construction period would be classified as a short term impact.

5.1.5.4 Significance

The term “significant”, as defined in 40 CFR 1508.27 of the Regulations for Implementing the National Environmental Protection Act (NEPA), requires consideration of both the context and intensity of the impact evaluated. Significance can vary in relation to the context of the proposed action, and thus the significance of an action must be evaluated in several contexts and this varies with the setting of the proposed action. For example, context may include consideration of effects on a national, regional, and/or local basis depending upon the action proposed. Both short–term and long–term effects may be relevant.

In accordance with the Council on Environmental Quality (CEQ) implementing guidance, impacts are also evaluated in terms of their intensity or severity. Factors contributing to the evaluation of the intensity of an impact include, but are not limited to:

- Because an impact may be both beneficial and adverse, a significant impact may exist even if, on balance, the impact is considered beneficial;
- The degree to which the action affects public health or safety;
- Unique characteristics of the geographic area where the action is proposed such as proximity to parklands, historic or cultural resources, wetlands, prime farmlands, wild and scenic rivers or ecologically critical areas;
- The degree to which the effects on the quality of the human environment are likely to be controversial;
- The degree to which the effects of the action on the quality of the human environment are likely to be highly uncertain or involve unique or unknown risks;
- The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration;
- Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts;

- The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources;
- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act (ESA) of 1973; and
- Whether the action threatens a violation of Federal, State, or local law or requirements imposed for the protection of the environment.

5.1.5.5 Mitigation

Mitigation measures will be implemented by the USACE to eliminate or reduce the impact of adverse impacts. As defined in 40 CFR 1508.20: "Mitigation" includes:

1) Avoiding the impact altogether by not taking a certain action or parts of an action;
2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation;
3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; or
5) Compensating for the impact by replacing or providing substitute resources or environments.

Only those mitigation measures that are practicable (i.e., can be accomplished using existing technology with a reasonable commitment of resources) have been identified. In addition to the mitigation commitments identified in this EIS, the USACE will continue to use a wide range of ongoing environmental management programs, Best Management Practices (BMPs), Standard Operating Procedures (SOPs), monitoring programs, and permit compliance procedures to minimize the type and magnitude of adverse impacts identified in this EIS. The USACE will adhere to all permit conditions in effect at the time the action occurs, under any circumstance.

5.1.6 Impact Analysis Performed

The proposed action is to maintain and improve the navigation channel in order to enhance commercial navigation on the MKARNS, while maintaining the other MKARNS project purposes of flood control, recreation, hydropower, water supply, and fish and wildlife. The proposed action involves implementing actions associated with three features that influence navigation on the MKARNS. These three features are:

- River Flow Management;
- Navigation Channel Deepening and Modification; and
- Navigation Channel Depth Maintenance.

Individually, the three features have a range of proposed action components. These components will initially be analyzed separately for each feature.

The discussion of the No Action Alternative focuses on identifying the anticipated impacts of not implementing any of the action alternatives. It is this No Action scenario against which potential impacts associated with implementing any of the action alternatives can be compared.

Based on the analyses presented in Chapter 5, study alternatives were developed including the No Action Alternative, by combining components of the three features to achieve, in varying degrees, the proposed action. Chapter 6 describes the environmental consequences for the alternatives selected for evaluation. The discussion of impacts associated with features and components presented in the following pages of Chapter 5 provides the basis for the evaluation of environmental impacts associated with alternatives in Chapter 6

5.2 Air Quality

The assessment of impacts on air quality addresses three major elements of air quality concerns. These three major elements include:

- Source of pollutants;
- Means of transport for pollutants; and
- The pollutant receptor.

Sources can be classified as emitting particulate and/or gases and vapors. The degree of pollutant transport is controlled by meteorological and topographic factors. Receptors may be living or non-living, ranging from plants and animals to exterior finishes on vehicles and buildings. Air quality issues considered as part of the air quality analysis include:

- Potential for increased emissions during dredging;
- Potential for increased industrial and/or recreational development (additional ports and/or marinas) and the creation of new point sources;
- National Ambient Air Quality Standards (NAAQS) attainment status; and
- Potential for modified highway, rail, and river traffic volumes and modified traffic patterns.

The purpose of the air quality impact analysis is to determine if the air emission sources associated with the Proposed Action Components will cause an exceedance of the NAAQS. A significant adverse impact would occur if an action results in an exceedance of the NAAQS for a criteria pollutant.

As described in Chapter 4, the study area of the MKARNS contains six Air Quality Control Regions (AQCRs), all of which are in attainment of applicable air quality standards. No change to the AQCRs attainment status is anticipated with the implementation of any of the components. Although there would be slight increases in emissions due to construction, rock placement, and additional dredging, these increases would be short-term and minimal. No other changes in stationary emission sources would occur with the implementation of any of the components.

Mobile emissions from the transportation of goods along the MKARNS are the main factor determining the proposed action's air quality impacts. According to predicted changes in transportation based on economic forecasting contained in the Feasibility Report, very minimal changes in transportation would occur with the implementation of any of the proposed actions.

Implementation of the proposed action would improve navigation efficiencies that in combination with economic factors could interact with changes in demand and transportation in the following three ways:

- Demand for goods stays the same and due to increased efficiencies there are fewer trips necessary to transport the same amount of goods producing a decrease in waterway traffic;
- Demand for goods increases, and there is an increase in waterway traffic; and

- Due to increased efficiencies and more competitive prices there is an increase in waterway transportation and a reduction in other forms of transportation, such as railways or trucks.

The Economics Analysis (USACE 2005) predicted that no large increase in demand would occur, but that some small levels of increased demand in steel, dry fertilizers, and specialty stone would occur. In addition the forecast said that a 1% increase in waterway traffic could occur due to a shift from railway to waterway transport. However, this predicted change is too small to distinguish from the standard level of anticipated error in a quantitative analysis.

5.2.1 Flow Management Feature

Adjusting flows to increase the predictability of water levels on the MKARNS would increase navigation efficiencies of towboats. No notable change in the number of towboat trips is anticipated.

5.2.1.1 No Action Component (FM-NA)

Under the No Action Component, river levels on the MKARNS would continue to fluctuate at current levels and barge traffic would be restricted during high flows. The annual average number of high flow days (>100,000 cfs) would not be reduced and, therefore, the amount of barge traffic would not increase. Air emissions from barges, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.2.1.2 175,000 cfs Plan Component (FM-175)

Under FM-175 river levels on the MKARNS would continue to fluctuate and barge traffic would be restricted during high flows. The annual average number of high flow days would be reduced by approximately 16 days and, therefore, the number of days barges can operate at maximum tow size on the river may increase. Air emissions from barges would increase very slightly due to the additional days of use, but this is not expected to affect air quality along the MKARNS. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component.

5.2.1.3 200,000 cfs Plan Component (FM-200)

Under FM-200 river levels on the MKARNS would continue to fluctuate and barge traffic would be restricted during high flows. The annual average number of high flow days would be reduced by approximately 17 days and, therefore, the number of days barges can operate at maximum tow size on the river may increase. Air emissions from barges would increase very slightly due to the additional days of use, but this is not expected to affect air quality along the MKARNS. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component.

5.2.1.4 Operations Only Plan Component (FM-OPS)

FM-OPS would result in an annual average of 2 additional days per year above 100,000 cfs, a level at which barge traffic would not be able to operate at maximum tow size. Conversely commercial navigation would benefit from the efficiency associated with an annual average of

14 fewer days per year with river flows above 61,000 cfs. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component. This minor change would not impact air quality along the MKARNS.

5.2.2 Navigation Channel Deepening Feature

5.2.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the No Action Component, transportation would not change because navigation channel deepening would not occur. Without the channel deepening, the amount of barge traffic would not change. Air emissions from towboats and other transportation sources would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.2.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Air emissions from towboats, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 1.

5.2.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Air emissions from towboats, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated Segment 2.

5.2.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Air emissions from towboats, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 3..

5.2.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Air emissions from towboats, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated. within Segment 4.

5.2.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Air emissions from towboats, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 5.

5.2.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Air emissions from towboats, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated. within Segment 6.

5.2.2.2 Navigation Channel Deepening 10-Foot Channel Component

Deepening the channel to 10 feet would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase that in combination with the increased barge efficiencies would result in no net change in air quality. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component. Therefore, implementation of this component would not impact air quality in the region.

5.2.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Deepening the channel to 10 feet in Segment 1 would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase that in combination with the increased efficiencies would result in no net change in air quality. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component. Therefore, implementation of this component would not impact air quality in Segment 1.

5.2.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

As in Segment 1, implementation of this component would not impact air quality in Segment 2.

5.2.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

As in Segment 1, implementation of this component would not impact air quality in Segment 3.

5.2.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

As in Segment 1, implementation of this component would not impact air quality in Segment 4.

5.2.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

As in Segment 1, implementation of this component would not impact air quality in Segment 5.

5.2.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

As in Segment 1, implementation of this component would not impact air quality in Segment 6.

5.2.2.3 Navigation Channel Deepening 11-Foot Channel Component

Deepening the channel to 11 feet would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase that in combination with the increased efficiencies would result in no net change in air quality. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component. Therefore, implementation of this component would not impact air quality in the region.

5.2.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Deepening the channel to 11 feet in Segment 1 would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase that in combination with the increased efficiencies would result in no net change in air quality. Therefore, implementation of this component would not impact air quality in Segment 1.

5.2.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

As in Segment 1, implementation of this component would not impact air quality in Segment 2.

5.2.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

As in Segment 1, implementation of this component would not impact air quality in Segment 3.

5.2.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

As in Segment 1, implementation of this component would not impact air quality in Segment 4.

5.2.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

As in Segment 1, implementation of this component would not impact air quality in Segment 5.

5.2.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

As in Segment 1, implementation of this component would not impact air quality in Segment 6.

5.2.2.4 Navigation Channel Deepening 12-Foot Channel Component

Deepening the channel to 12 feet would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase that in combination with the increased efficiencies would result in no net change in air quality. Also, emissions associated with other forms of transportation would not measurably change as a result of the implementation of this component. Therefore, implementation of this component would not impact air quality in the region.

5.2.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Deepening the channel to 12 feet in Segment 1 would allow towboats to push heavier barges carrying more goods. However, the increased weight and draft of the barge would require towboats to use more horsepower producing an increase in emissions. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase that in combination with the increased efficiencies would result in no net change in air quality. Therefore, implementation of this component would not impact air quality in Segment 1.

5.2.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

As in Segment 1, implementation of this component would not impact air quality in Segment 2.

5.2.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

As in Segment 1, implementation of this component would not impact air quality in Segment 3.

5.2.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

As in Segment 1, implementation of this component would not impact air quality in Segment 4.

5.2.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

As in Segment 1, implementation of this component would not impact air quality in Segment 5.

5.2.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

As in Segment 1, implementation of this component would not impact air quality in Segment 6.

5.2.3 Navigation Channel Depth Maintenance Feature

5.2.3.1 No Action Component (NCDM-NA)

Under the No Action Component, once disposal site capacity has been reached, maintenance dredging and disposal conditions on the MKARNS would be maintained in the short-term but in the long-term dredged material would be pumped further to active disposal sites or currently inactive disposal sites would be used.

5.2.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, once capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected regardless of habitat type. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. The current conditions for navigation would therefore be maintained and there would be no changes in transportation levels. Air emissions from towboats, and other transportation sources, would remain at current levels and would not have an adverse or beneficial impact on air quality.

5.2.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Under the Maintenance Dredged Material Disposal in New Disposal Sites Component, once capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected. However, when selecting disposal sites, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. The current conditions for navigation would therefore be maintained and there would be no changes in transportation levels. Air emissions from towboats, and other transportation sources, would remain at current levels and would not have an adverse or beneficial impact on air quality.

5.3 Noise

As described in Chapter 4, noise impacts in the MKARNS study area include both stationary and mobile sources. Noise is created by vehicle engines, as well as by frictional contact of an object with the water, ground, and/or air. In general, land vehicles cause greater noise effects than waterway transportation. Horns and whistles of transportation vehicles generate the highest noise levels.

Smaller waterway vehicles actually produce more noise than larger vessels such as barge tows. Small, recreational vehicles such as powerboats often accelerate and decelerate rapidly which produces higher noise levels than the slower barge tows. In addition, smaller recreational vehicles travel higher in the water than barge tows, which results in higher levels of engine noise relative to barge tows whose engine noise is dampened by the water.

5.3.1 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the flow management components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

Adjusting flows to increase the predictability of water levels on the MKARNS would increase navigation efficiencies of towboats. However, this increase in efficiency would not result in a reduction in noise and would not have an adverse or beneficial impact on noise levels in the region.

5.3.1.1 No Action Component (FM-NA)

Under the No Action Component, river levels on the MKARNS would continue to fluctuate at current levels and restrict barge traffic during high flows. The annual average number of high flow days would not be reduced and, therefore, the amount of barge traffic would not increase. Barge traffic would remain at current levels, and therefore no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.3.1.2 175,000 cfs Plan Component (FM-175)

FM-175 would result in an annual average of approximately 16 more days per year when barge traffic could operate at maximum tow size. This slight increase in barge transport on the MKARNS would not result in impacts to noise levels in the region.

5.3.1.3 200,000 cfs Plan Component (FM-200)

FM-200 would result in an annual average of approximately 17 more days per year when barge traffic could operate at maximum tow size. This slight increase in barge transport on the MKARNS would not result in impacts to noise levels in the region.

5.3.1.4 Operations Only Plan Component (FM-OPS)

FM-OPS would result in an annual average of 2 additional days per year when barge traffic could not operate at maximum tow size. Conversely commercial navigation would benefit from the efficiency associated with an annual average of 14 fewer days per year with river flows above 61,000 cfs. Therefore, barge traffic would essentially remain at current levels and would not have an impact on noise levels in the region.

5.3.2 Navigation Channel Deepening Feature

5.3.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the No Action Component, transportation would not change because navigation channel deepening would not occur. Without the channel deepening the amount of barge traffic would not change. Noise from towboats, recreational vehicles, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.3.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Under the No Action Component, transportation would not change in Segment 1 because navigation channel deepening would not occur. Without the channel deepening the amount of barge traffic would not change. Noise from towboats, recreational vehicles, and other transportation sources, would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 1.

5.3.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Noise from towboats, recreational vehicles, and other transportation sources would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 2.

5.3.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Noise from towboats, recreational vehicles, and other transportation sources would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 3.

5.3.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Noise from towboats, recreational vehicles, and other transportation sources would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 4.

5.3.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Noise from towboats, recreational vehicles, and other transportation sources would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 5.

5.3.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Noise from towboats, recreational vehicles, and other transportation sources would remain at current levels. Therefore, no changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 6.

5.3.2.2 Navigation Channel Deepening 10-Foot Channel Component

Deepening the channel to 10 feet would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, but this would not produce an appreciable difference in noise. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report (USACE 2005), demand for goods may increase slightly that in combination with the increased efficiencies would result in no net change in noise levels. Additionally, there would be a short-term minor increase in noise levels from deepening dredging operations on the MKARNS. Therefore, implementation of this component would result in a short-term minor adverse impact to noise levels in the region.

5.3.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Deepening the channel to 10 feet in Segment 1 would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, but this would not produce an appreciable difference in noise. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase slightly that in combination with the increased efficiencies would result in no net change in noise levels. Additionally, there would be a short-term minor increase in noise levels in Segment 1 from deepening dredging operations on the MKARNS. Therefore, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 1.

5.3.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 2.

5.3.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 3.

5.3.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 4.

5.3.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 5.

5.3.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 6.

5.3.2.3 Navigation Channel Deepening 11-Foot Channel Component

Deepening the channel to 11 feet would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, but this would not produce an appreciable difference in noise. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report (USACE 2005), demand for goods may increase slightly that in combination with the increased efficiencies would result in no net change in noise levels. Additionally, there would be a short-term minor increase in noise levels from deepening dredging operations on the MKARNS. Therefore, implementation of this component would result in a short-term minor adverse impact to noise levels in the region.

5.3.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Deepening the channel to 11 feet in Segment 1 would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, but this would not produce an appreciable difference in noise. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase slightly that in combination with the increased efficiencies would result in no net change in noise levels. Additionally, there would be a short-term minor increase in noise levels from deepening dredging operations on the MKARNS. Therefore, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 1.

5.3.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 2.

5.3.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 3.

5.3.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 4.

5.3.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 5.

5.3.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 6.

5.3.2.4 Navigation Channel Deepening 12-Foot Channel Component

Deepening the channel to 12 feet would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, but this would not produce an appreciable difference in noise. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase slightly that in combination with the increased efficiencies would result in no net change in noise levels. Additionally, there would be a short-term minor increase in noise levels from deepening dredging operations on the MKARNS. Therefore, implementation of this component would result in a short-term minor adverse impact to noise levels in the region.

5.3.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Deepening the channel to 12 feet in Segment 1 would allow towboats to push heavier barges carrying more goods. The increased weight and draft of the barge would require towboats to use more horsepower, but this would not produce an appreciable difference in noise. If the demand for goods remains the same then the greater barge towing capacity may allow for fewer trips and slightly less traffic and noise on the MKARNS. According to the economic forecasting provided in the Feasibility Report, demand for goods may increase slightly that in combination with the increased efficiencies would result in no net change in noise levels. Additionally, there would be a short-term minor increase in noise levels from deepening dredging operations on the MKARNS. Therefore, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 1.

5.3.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 2.

5.3.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 3.

5.3.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 4.

5.3.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 5.

5.3.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Similar to Segment 1, implementation of this component would result in a short-term minor adverse impact to noise levels in Segment 6.

5.3.3 <u>Navigation Channel Depth Maintenance Feature</u>

5.3.3.1 No Action Component (NCDM-NA)

Under the No Action Component, once disposal site capacity has been reached, maintenance dredging and disposal conditions on the MKARNS would be maintained in the short-term but in the long-term dredged material would be pumped further to active disposal sites or currently inactive disposal sites would be used.

5.3.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, once capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected regardless of habitat type. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. The current conditions for navigation would therefore be maintained and there would be no changes in transportation levels. Noise from towboats, recreational vehicles, and other transportation sources would remain at current levels and there would be no impacts to noise levels in the region.

5.3.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Under the Maintenance Dredged Material Disposal in New Disposal Sites Component, once disposal capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected. However, when selecting disposal sites, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. The current conditions for navigation would therefore be maintained and there would be no changes in transportation levels. Noise from towboats, recreational vehicles, and other transportation sources, would remain at current levels, and there would be no impacts to noise levels in the region.

5.4 Geology and Soils

The hydrogeology of the MKARNS study area is strongly influenced by various alluvial and other aquifers. Most natural recharge to the aquifers occurs as precipitation that falls directly on the alluvial deposits, infiltration of runoff from adjacent slopes, and infiltration from the streams that cross the deposits, especially during higher flows. The shallow depth to ground-water and permeable materials result in alluvial aquifers being potentially vulnerable to contamination by pesticides used to control vegetation and insects in agricultural and urban areas.

On the Verdigris River, the alluvial sediment contains more silt, while the material dredged from the Arkansas River is primarily sand. Dredged material is most likely to be free of contaminants if the material is composed primarily of sand, gravel, or similar materials and is found in areas of high current or wave action.

Evaluation criteria for consideration of impacts to geologic features and soils are based on chemical constituent concentrations in the soil (relative to applicable laws and regulations) and on physical damage to soil and geologic features. Among the more important geological processes are stream and wind erosion, deposition, mass wasting (the down-slope movement of soil and rock by the force of gravity), and soil formation.

Geology and soil issues considered in the analysis include:

- Changes in the rate of erosion and deposition within the river channel or banks due to a change in river levels and/or flows;
- Soil types within the dredge sites and dredged material disposal areas; and
- Potential contaminants present in river-bed sediments at dredge sites.

5.4.1 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the flow management components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.4.1.1 No Action Component (FM-NA)

No impacts differing from the baseline conditions are expected under the No Action Component. Under the No Action Component, the existing flow management policies and procedures for the Arkansas River system would remain in place. These management policies and procedures have contributed to the establishment of the existing conditions. Under the No Action Component, erosion and deposition would continue as they have historically and would continue to be influenced by the existence of river flow management procedures.

5.4.1.2 175,000 cfs Plan Component (FM-175)

No impacts to geology, soils, or topography are expected with implementation of this component.

Adverse impacts to soils are realized through the increase in the rate of erosion. Denuding or removing natural vegetation increases the rate of soil erosion (FHWA, 1978; Smoot et al., 1992; Wang and Grubbs, 1992; and Thompson and Green, 1994). Vegetation modification may occur with an increase of days the river is out-of-bank. Under FM-175, an annual decrease of an average of 4 days out-of-bank would occur above 137,000 cfs. However, very high flows of greater than 175,000 cfs at Van Buren would occur an average of 4 more days annually. Thus, lower flow out-of-bank events would occur less often, but higher flow out-of-bank events would occur more often. Thus, any change in erosion potential would be minor and would not result in impacts to soils.

A decrease in moderate (>61,000 cfs) flow days and high (>100,000 cfs) flow days may introduce variation in the groundwater tables in the alluvial aquifers associated with the MKARNS. These potential water level variations would be minor and would not result in impacts to groundwater.

5.4.1.3 200,000 cfs Plan Component (FM-200)

No impacts to geology, soils, or topography are expected with implementation of this component. Potential adverse impacts to soils are discussed under the FM-175 Component. The FM-200 Component would decrease the annual average number of days out-of-bank (above 137,000 cfs) by 5 days. However, higher flows of ≥150,000 and of ≥175,000 cfs at Van Buren would occur an average of 3 and 7 more days, respectively, per year. Flows of ≥200,000 cfs would occur an average of 1 more day annually. Thus, lower flow out-of-bank events would occur less often, but higher flow out-of-bank events would occur more often. Thus, an increase in erosion potential would be minor and would not result in impacts to soils.

Impacts to hydrogeology and groundwater would be similar to those of FM-175.

5.4.1.4 Operations Only Plan Component (FM-OPS)

No impacts to geology or topography are expected with implementation of this component.

Potential adverse impacts to soils are discussed under the FM-175 Component. Under FM-OPS, annual out-of-bank flows (≥ 137,000 cfs) at Van Buren would continue with the same frequency as the No Action Component. Thus, there would be no increase in erosion potential and no impacts to soils.

Under FM-OPS, the average 14-day decrease in flow days per year above 61,000 cfs may slightly increase agricultural production in the Arkansas River floodplain. This increase in cultivation may result in increased pesticide use that would cause minor indirect adverse impacts to the quality of groundwater in the study area.

5.4.2 Navigation Channel Deepening Feature

5.4.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the No Action Component, maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel.

5.4.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Since maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel, no additional impacts to geology and soils would be expected within Segment 1 of the MKARNS.

5.4.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Since maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel, no additional impacts to geology and soils would be expected within Segment 2 of the MKARNS.

5.4.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Since maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel, no additional impacts to geology and soils would be expected within Segment 3 of the MKARNS.

5.4.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Since maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel, no additional impacts to geology and soils would be expected within Segment 4.

5.4.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Under the No Action Component, maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel. No additional impacts to geology and soils would be expected within Segment 5 of the MKARNS.

5.4.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Since maintenance dredging and disposal would continue at the current rates to maintain a 9-foot navigation channel, no additional impacts to geology and soils would be expected within Segment 6 of the MKARNS.

5.4.2.2 Navigation Channel Deepening 10-Foot Channel Component

Under the 10-Foot Channel Component a total of approximately 4,025,886 cy of additional dredged material would be removed from the MKARNS. The amount removed would vary from segment to segment.

5.4.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Under the 10-foot Channel Component approximately 790,615 cy of additional dredged material would be removed from the MKARNS within Segment 1. This would result in minor short-term adverse impacts to soils from sediment suspension, movement, and resettlement caused by dredging, and minor long-term impacts to soils due to a small increase in barge traffic on the MKARNS after completion of dredging.

Upland dredged material disposal is anticipated to have a major direct, long-term impact on the soils and topography of many of the sites. Erosion and compaction would occur from construction and dredged material disposal activities. Runoff and erosion would be minimized during disposal by use of BMPs. For any potentially contaminated sediments the USACE would comply with the requirements of the Inland Testing Manual (USEPA/USACE 1998). Disposal material would be contained within a diked area at most of the upland disposal sites. The addition of dredged material to the disposal sites would serve to raise the elevation of the sites with respect to the surrounding area.

5.4.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Under the 10-foot Channel Component approximately 98,929 cy of additional dredged material would be removed from the MKARNS within Segment 2. The impacts to Segment 2 would be similar to those of Segment 1. However, since much less dredging would be required in this segment, the potential for adverse impacts is less than in Segment 1.

5.4.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Under the 10-foot Channel Component approximately 196,478 cy of additional dredged material would be removed from the MKARNS within Segment 3. Although the nature of impacts to Segment 3 would be similar to those of Segment 1, they would be of lesser intensity than those to Segment 1 and of greater intensity than those to Segment 2.

5.4.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Under the 10-foot Channel Component approximately 378,400 cy of additional dredged material would be removed from the MKARNS within Segment 4. Although the nature of impacts to Segment 4 would be similar to those of Segment 1, they would be of lesser intensity than those to Segment 1 and of greater intensity than those to Segments 2 and 3.

5.4.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Under the 10-foot Channel Component approximately 1,319,910 cy of additional dredged material would be removed from the MKARNS within Segment 5. Although the nature of impacts to Segment 5 would be similar to those of Segment 1, they would be of greater intensity than those to the other segments of the MKARNS.

5.4.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Under the 10-foot Channel Component approximately 1,241,554 cy of additional dredged material would be removed from the MKARNS within Segment 6. The nature of impacts to Geology and Soils along Segment 6 would be similar to those of Segment 1. However, the impacts to Segment 6 would be of lesser intensity than those of Segment 5 and of greater intensity than those to all the other segments of the MKARNS.

5.4.2.3 Navigation Channel Deepening 11-Foot Channel Component

Under the 11-Foot Channel Component a total of approximately 6,837,176 cy of additional dredged material would be removed from the MKARNS. The amount would vary from segment to segment.

5.4.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Under the 11-foot Channel Component approximately 1,299,276 cy of additional dredged material would be removed from the MKARNS within Segment 1. This would result in minor short-term adverse impacts to soils from sediment suspension, movement, and resettlement caused by dredging, and minor long term impacts to soils due to a small increase in barge traffic on the MKARNS after completion of dredging.

Upland dredged material disposal is anticipated to have a major direct, long-term impact on the soils and topography of many of the sites. Erosion and compaction would occur from construction and dredged material disposal activities. Runoff and erosion would be minimized during disposal by use of BMPs. For any potentially contaminated sediments the USACE would comply with the requirements of the Inland Testing Manual (USEPA/USACE 1998). Disposal material would be contained within a diked area at most of the upland disposal sites. The addition of dredged material to the disposal sites would serve to raise the elevation of the sites with respect to the surrounding area.

5.4.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Under the 11-foot Channel Component approximately 225,517 cy of additional dredged material would be removed from the MKARNS within Segment 2. The impacts to Segment 2 would be similar to those of Segment 1. However, since much less dredging would be required in this segment, the potential for adverse impacts is less than in Segment 1.

5.4.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Under the 11-foot Channel Component approximately 387,227 cy of additional dredged material would be removed from the MKARNS within Segment 3. Although the nature of the impacts to Segment 3 would be similar to those of Segment 1, they would be of lesser intensity than those to Segment 1 and of greater intensity than those to Segment 2.

5.4.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Under the 11-foot Channel Component approximately 643,500 cy of additional dredged material would be removed from the MKARNS within Segment 4. Although the nature of the impacts to Segment 4 would be similar to those of Segment 1, they would be of lesser intensity than those to Segment 1 and of greater intensity than those to Segments 2 and 3.

5.4.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Under the 11-foot Channel Component approximately 2,255,323 cy of additional dredged material would be removed from the MKARNS within Segment 5. Although the nature of impacts to Segment 5 would be similar to those of Segment 1, they would be of greater intensity than those to the other segments because of the large amount of dredged material removed.

5.4.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Under the 11-foot Channel Component approximately 2,026,333 cy of additional dredged material would be removed from the MKARNS within Segment 6. The nature of impacts to Geology and Soils along Segment 6 would be similar to those of Segment 1. However, the impacts to Segment 6 would be of lesser intensity than those of Segment 5 and of greater intensity than those to all the other segments of the MKARNS.

5.4.2.4 Navigation Channel Deepening 12-Foot Channel Component

Under the 12-Foot Channel Component a total of approximately 10,985,340 cy of additional dredged material would be removed from the MKARNS. The amount would vary from segment to segment.

5.4.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Under the 12-foot Channel Component approximately 2,066,867 cy of additional dredged material would be removed from the MKARNS within Segment 1. This would result in minor short-term adverse impacts to soils from sediment suspension, movement, and resettlement caused by dredging, and minor long term impacts to soils from a slight increase in barge traffic on the MKARNS after completion of dredging.

Upland dredged material disposal is anticipated to have a major direct, long-term effect on the soils and topography of many of the sites. Erosion and compaction would occur from construction and dredged material disposal activities. Runoff and erosion would be minimized during disposal by use of BMPs. For any potentially contaminated sediments the USACE would comply with the requirements of the Inland Testing Manual (USEPA/USACE 1998). Disposal material would be contained within a diked area at most of the upland disposal sites. The addition of dredged material to the disposal sites would serve to raise the elevation of the sites with respect to the surrounding area.

5.4.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Under the 12-foot Channel Component approximately 445,995 cy of additional dredged material would be removed from the MKARNS within Segment 2. The impacts to Segment 2 would be similar to those of Segment 1. However, since much less dredging would be required in this segment, the potential for adverse impacts is less than in Segment 1.

5.4.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Under the 12-foot Channel Component approximately 925,439 cy of additional dredged material would be removed from the MKARNS within Segment 3. Although the nature of the impacts to Segment 3 would be similar to those of Segment 1, they would be of lesser intensity than those to Segment 1 and of greater intensity than those to Segment 2.

5.4.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Under the 12-foot Channel Component approximately 1,226,500 cy of additional dredged material would be removed from the MKARNS within Segment 4. Although the nature of the impacts to Segment 4 would be similar to those of Segment 1, they would be of lesser intensity than those to Segment 1 and of greater intensity than those to Segments 2 and 3.

5.4.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

Under the 12-foot Channel Component approximately 3,256,749 cy of additional dredged material would be removed from the MKARNS within Segment 5. Although the nature of impacts to Segment 5 would be similar to those of Segment 1, they would be of greater intensity than those to the other segments because of the large amount of dredged material removed.

5.4.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Under the 12-foot Channel Component approximately 3,063,790 cy of additional dredged material would be removed from the MKARNS within Segment 6. The nature of impacts to Geology and Soils along Segment 6 would be similar to those of Segment 1. However, the impacts to Segment 6 would be of lesser intensity than those of Segment 5 and of greater intensity than those to all the other segments of the MKARNS.

5.4.3 Navigation Channel Depth Maintenance Feature

5.4.3.1 No Action Component (NCDM-NA)

Under the No Action Component maintenance dredging and disposal would continue at the current rate until all current disposal areas have reached their capacity. In Oklahoma, this is estimated to be in approximately 10 years. In Arkansas, capacity exists for many years of disposal. Upland dredged material disposal is anticipated to have a major direct, long-term impact on the soils and topography of the disposal sites. Erosion and compaction would occur from construction and dredged material disposal activities. Runoff and erosion would be minimized during disposal by use of BMPs. Disposal material would be contained within a diked area at most of the upland disposal sites. The addition of dredged material to the disposal sites would serve to raise the elevation of the sites with respect to the surrounding area.

5.4.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, impacts would be similar to the No Action Component. The potential exists for some high quality habitats to be adversely impacted since these habitats are avoided for disposal under the current plan. Dredged material would be disposed of at unused sections within areas approved in the 1974 O&M Plan and EIS, regardless of the quality or type of habitat present.

5.4.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Under the Maintenance Dredged Material Disposal in New Disposal Sites Component, impacts would be similar to the No Action Component. In addition to the impacts of the No Action Component, major adverse impacts would occur once currently utilized dredged material disposal sites reach their holding capacity. Dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. However, no high quality habitats would be adversely impacted since these habitats would be avoided where practical. Most of the impacts would be to agricultural lands, rather than to higher quality habitats such as wetlands, prairie, and bottomland forest. Quantitative evaluations of representative terrestrial and aquatic disposal sites were accomplished using the HEP, as developed by the ERDC, and the results extrapolated to the remaining potential dredged material disposal sites (see Section 5.1.3.2.2).

5.5 Surface Waters

Potential environmental impacts of the proposed actions would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels, changes in water quality and/or designated water body uses, and/or changes in the quantity or quality of aquatic and shoreline habitat.

Additional dredging to deepen the channel along the MKARNS would have the potential to negatively affect water quality if contaminants exist within riverbed sediments. Increased sediment suspension (turbidity) during dredging and/or disposal of dredged material in aquatic areas also may cause short term impacts to surface waters. Maintenance dredging volumes would remain similar to historic patterns and will vary according to river flow conditions. Unexpected high flows may dictate when actual dredging is required for any given site. Changes to geomorphology, e.g. headcutting, would not occur because reservoir pool levels would be maintained and stream gradients would be unaffected. Therefore, the channel bottom would remain geomorphologically stable at tributary confluences.

5.5.1 Flow Management Feature

Potential environmental impacts of the flow management action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

Eight reservoirs in Oklahoma are on Oklahoma's 2002 303(d) list of waters impaired or threatened by a pollutant(s), including Oolagah Lake, Hudson Lake, Fort Gibson Lake, Tenkiller Ferry Lake, Robert S. Kerr Lake, Keystone Lake, Kaw Lake, and Wister Lake. Oolagah, Robert S. Kerr, Keystone, Kaw, and Fort Gibson Lakes did not reach attainment for warm water aquatic community because of turbidity. Hudson Lake did not reach attainment for warm water aquatic community due to low Dissolved Oxygen (DO) levels. Fort Gibson Lake did not reach attainment for Tenkiller Ferry Lake did not reach attainment for aesthetics or warm water aquatic community due to low DO and high phosphorus levels. Wister Lake did not reach attainment for aesthetics due to phosphorus. All of the causes of impairment are derived from unknown sources.

5.5.1.1 No Action Component (FM-NA)

Under the No Action Component, river, associated tributary, and reservoir levels would continue to fluctuate under the existing operation plan. Therefore, no changes in impacts to surface waters and floodplains of the MKARNS, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.5.1.2 175,000 cfs Plan Component (FM-175)

Because the total number of flow days above 100,000 cfs would decrease by an average of 16 per year under FM-175, inundation frequency and elevation of the Arkansas River channel, floodplain, and tributary streams would be reduced. This would reduce impacts to aquatic systems caused by fluctuations in river levels. Conversely, more low-flow days may slightly increase the concentration of dissolved solids, including pollutants, in the Arkansas River.

This potential increase is expected to be neglible and would not affect the National Pollutant Discharge and Elimination System permits of regulated facilities. There will be no alteration of 7Q10 flows.

Under FM-175 annual average flow levels would exceed 175,000 cfs at Van Buren for 4 days above the current plan. Tributaries of the Arkansas River System would be flooded at slightly higher elevations during these few additional very high-flow events, but impacts would be inconsequential. In addition, there may be a slight increase in erosion and sedimentation to the Arkansas River System under FM-175. See Section 5.4 Geology and Soils for a discussion of erosion impacts.

Because floodwaters would reach higher elevations slightly more frequently under FM-175, oxbow lakes, sloughs, and other backwater areas may be both adversely and beneficially impacted. Habitat quality in oxbow lakes declines when floodwaters deposit sediment that fills in aquatic habitat, increases turbidity levels, and smothers fish eggs and benthic organisms. Floodwaters also cause channel cutting in the lower end of the lake that lowers the lake's average water depth. Conversely, periods of high water benefit the exchange of fishes between backwaters and the main river. Backwaters serve as useful spawning and nursery areas for some riverine fish species and high water periods facilitate movement between habitat types. Impacts would be minor due to the minimal change in days of flow above 175,000 cfs.

Under FM-175, all Oklahoma reservoir pool elevations would not exceed 12 feet above conservation pool levels for additional days above the existing plan (Table 5-4). However, an increase in water storage in the reservoirs (below 12 feet above conservation pool) may cause increased inundation of adjacent vegetated areas, which would provide additional habitat for larval fish and organic material for primary consumers.

According to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than 3 additional days over 8 feet above conservation pool occurring in any two-month period (Table 5-5). Other minor impacts of this water level fluctuation may include altering the littoral or shoreline zone of the reservoirs that provide important aquatic habitat. The USACE's modifications of flow rates would continue to remain compatible with the authorized operational plan of each reservoir.

5.5.1.3 200,000 cfs Plan Component (FM-200)

Because the total number of flow days above 100,000 cfs would decrease by an average of 17 per year under FM-200, inundation frequency and elevation of the Arkansas River channel, floodplain, and tributary streams would be reduced. This would reduce impacts to aquatic systems caused by fluctuations in river levels. Impacts to surface waters, floodplains, and reservoirs would be similar to those of FM-175. These minor impacts would be slightly greater for FM-200 due to higher variability in target flows along the MKARNS.

5.5.1.4 Operations Only Plan Component (FM-OPS)

Under FM-OPS, flow above 61,000 cfs would be reduced from the No Action Component by an average of 14 days per year, while changes in flow above 175,000 cfs would be negligible. A decrease in annual average flow days above 61,000 cfs would reduce the duration of floodplain inundation. No change in flow days above 175,000 would avert the increase in erosion associated with FM-175 and FM-200.

Under FM-OPS, all Oklahoma reservoir pool elevations would not exceed 10 feet above conservation pool levels for additional days over FM-NA. However, an annual average increase in water storage in the reservoirs (below 10 feet above conservation pool) may cause increased inundation of adjacent vegetated areas, which would provide additional habitat for larval fish and organic material for primary consumers

According to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than 2 additional days over 8 feet above conservation pool occurring in any two-month period (Table 5-5). Other minor impacts of this water level fluctuation may include altering the littoral or shoreline zone of the reservoirs that provide important aquatic habitat. The USACE's modifications of flow rates would continue to remain compatible with the authorized operational plan of each reservoir.

5.5.2 Navigation Channel Deepening Feature

Potential environmental impacts of the proposed Navigation Channel Deepening action would occur primarily as a result of changes in the water quality and/or designated beneficial uses of the MKARNS. Additional dredging to deepen the channel along the MKARNS would have the potential to adversely impact water quality if contaminants exist within riverbed sediments. Increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also may cause minor short-term impacts to surface waters. Changes to geomorphology, e.g. headcutting, would not occur, because reservoir pool levels would be maintained and stream gradients would be unaffected. Therefore, the channel bottom would remain geomorphologically stable at tributary confluences.

According to the Arkansas Department of Environmental Quality (ADEQ) 2002 Integrated Water Quality Monitoring and Assessment Report a portion of the Arkansas River and Upper White River were reported on the state's proposed 303(d) list that notes limitations for use of certain waterbodies, however, only the portion on the Arkansas River is within the scope of work for this project. Section 303(d) of the Clean Water Act requires that States identify waters that do not meet or are not expected to meet applicable water quality standards. These water bodies are compiled into a list known as the 303(d) list. The regulation (40 CFR 130.7) requires that each 303(d) list be prioritized and identify waters targeted for Total Maximum Daily Load (TMDL) development in the next two years.

An approximate 2-mile segment of the Arkansas River below Dardanelle Reservoir (pool #10) occasionally had DO values below the State's standard (<5 mg/L) during the summer period. This is related to hydropower releases from the upstream reservoir when very low DO concentrations exist in the deeper levels of the reservoir. These low concentrations seem to recover quickly downstream of the reservoir under low to moderate generation flows and in the presence of photosynthetic activity from planktonic algae (ADEQ 2002). The reporting period for Arkansas' 2002 report is from October 1998 to January 2002.

According to the Oklahoma Department of Environmental Quality (ODEQ) 2002 Water Quality Assessment Integrated Report there are several segments of the MKARNS within Oklahoma with impaired water. Segments along the Arkansas River within the study area that are on the State's 303(d) list include a 15-mile segment in Muskogee County that did not reach attainment for primary contact recreation due to pathogens (disease-carrying fecal indicator bacteria such as fecal coliform, E. coli, or Enterococci) and a segment 29 miles long within Wagoner County that did not reach attainment for secondary contact (recreation) and agriculture due to pathogens and total dissolved solids (TDS). Segments along the Verdigris River within the study area that are on the 303(d) list include a 6-mile segment in Wagoner County that did not reach attainment for primary contact recreation and warm water aquatic community due to lead, pathogens, and turbidity and an 18-mile segment in Wagoner County that did not reach attainment for warm water aquatic community due to lead concentrations. All causes for impairment came from unknown sources (ODEQ 2002).

5.5.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.5.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

5.5.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

5.5.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

5.5.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

5.5.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

5.5.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Under the No Action Component, no additional dredging would be completed and therefore, water quality and/or designated beneficial uses of the MKARNS, and quantity or quality of aquatic and shoreline habitat would remain at current levels.

5.5.2.2 Navigation Channel Deepening 10-Foot Channel Component

Additional dredging completed for the 10-Foot Channel Component, totaling approximately 4,025,886 cubic yards (cy) above the maintenance dredging volume, would have the potential to adversely impact water quality within the MKARNS if contaminants occurring within riverbed sediments are exposed. Short-term increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also would have the potential to adversely impact water quality. In addition, navigation traffic may increase along the MKARNS due to a reduction in water transportation costs that result from navigation channel deepening (see Section 5.12.2.2). This also would cause a potential increase in sediment suspension. Adverse impacts would be minor.

The USACE has performed a "screening" level analysis of MKARNS sediment quality in support of both future O&M dredging needs (maintenance of 9-ft channel) as well as impact assessment for channel deepening proposals. Similar methodology was used for sampling site selection for both Oklahoma and Arkansas portions of the MKARNS. Sampling sites in Oklahoma and Arkansas were selected by Tulsa and Little Rock District personnel, respectively. Detailed results from the USACE sediment sampling and testing can be found in Appendix E and represents the most recent sediment quality data available.

Twenty-four surface sediment and 12 subsurface sediment samples were collected by USACE, Tulsa District along the Oklahoma portion of the MKARNS in September, 2004. Samples were analyzed in accordance with current guidelines established by the environmental protection agency and routinely referenced in USEPA SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (3rd Edition). To date (1/14/05), results have been obtained for all Oklahoma sampling locations with the exception of three sites in Pool 13, which crosses the Oklahoma-Arkansas state line. Three Oklahoma locations at river miles 312.3 and 317 and Poteau River mile 1.3 will be sampled in conjunction with data collection in the Arkansas portion of the MKARNS.

In general, constituents were reported at low detection frequencies and concentrations throughout the sampled Oklahoma portion of the MKARNS:

- bis(2-ethylhexyl)phthalate, a phthalate ester, was detected in low concentrations in several samples. This compound is recognized by the USEPA as a common laboratory contaminant and may be introduced into a sample through laboratory cross-contamination (USEPA 1989);
- The only other detected semivolatile compounds included several detected at low concentrations in the depth-composited sample at river mile 421.0. For those with established Threshold Effects Concentration (TEC) values, "below which adverse effects are not expected to occur," detected concentrations were well-below TEC criteria;
- For chlorinated pesticides, detected constituents occurred in only three samples (7SBC B, 421.0 B, and 422.0 B). In all cases, concentrations were low and below TECs for specific pesticides;

- Detected concentrations of Polychlorinated Biphenyls (PCBs) were reported for only one sample (a surface sample at 9 San Bois Creek). Total PCBs at this location were 26.2 parts-per-billion or ppb, below the total PCB TEC of 59.8 ppb;
- With the one exception noted below, concentrations of all metals were below TEC values in all samples at all locations; and
- In the surface sample from river mile 421.0 (near Newt Graham Lock and Dam), cadmium was detected at 3.45 ppm. This concentration exceeds the cadmium TEC of 0.99 but is less than the Probable Effects Concentration (PEC), values "above which adverse effects are expected to occur more often than not," of 4.98 ppb. A much lower concentration was reported in the depth-composited sample at this location.

The result of the analysis of sediments collected in Arkansas is pending. It will be summarized in this section when the information is received. Detailed results will be included in Appendix E.

For any potentially contaminated sediments encountered during dredging, the USACE would comply with the requirements of the Inland Testing Manual (USEPA/USACE 1998). Disturbing contaminated sediments would adversely impact water quality within the MKARNS during dredging.

5.5.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Additional dredging completed for the 10-Foot Channel Component in Segment 1 would total approximately 790,615 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Additional dredging completed for the 10-Foot Channel Component in Segment 2 would total approximately 98,929 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Additional dredging completed for the 10-Foot Channel Component in Segment 3 would total approximately 196,478 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Additional dredging completed for the 10-Foot Channel Component in Segment 4 would total approximately 378,400 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Additional dredging completed for the 10-Foot Channel Component in Segment 5 would total approximately 1,319,910 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Additional dredging completed for the 10-Foot Channel Component in Segment 6 would total approximately 1,241,554 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.3 Navigation Channel Deepening 11-Foot Channel Component

Additional dredging completed for the 11-Foot Channel Component, totaling approximately 6,837,176 cy above the maintenance dredging volume, would have the potential to adversely impact water quality within the MKARNS if any contaminants occurring within riverbed sediments are exposed. As stated in Section 5.5.2.2, an Inland Testing Manual Tier I evaluation would be performed along watercourses before dredging is conducted. Short-term increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also would have the potential to adversely impact water quality. In addition, navigation traffic may increase along the MKARNS due to a reduction in water transportation costs that result from channel deepening (see Section 5.12.2.3). This also would cause a potential increase in sediment suspension. Although still minor, impacts would be greater than those of the 10-Foot Channel Component but less than those of the 12-Foot Channel Component.

5.5.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Additional dredging completed for the 11-Foot Channel Component in Segment 1 would total approximately 1,299,276 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Additional dredging completed for the 11-Foot Channel Component in Segment 2 would total approximately 225,517 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Additional dredging completed for the 11-Foot Channel Component in Segment 3 would total approximately 387,227 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Additional dredging completed for the 11-Foot Channel Component in Segment 4 would total approximately 643,500 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Additional dredging completed for the 11-Foot Channel Component in Segment 5 would total approximately 2,255,323 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Additional dredging completed for the 11-Foot Channel Component in Segment 6 would total approximately 2,026,333 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.4 Navigation Channel Deepening 12-Foot Channel Component

Additional dredging completed for the 12-Foot Channel Component, totaling approximately 10,985,340 cy above the maintenance dredging volume, would have the potential to adversely impact water quality within the MKARNS if any contaminants occurring within riverbed sediments are exposed. As stated in Section 5.5.2.2, an Inland Testing Manual Tier I evaluation would be performed along watercourses before dredging is conducted. Short-term increased sediment suspension (turbidity) during dredging and/or during disposal of dredged material in aquatic areas also would have the potential to negatively affect water quality. In addition, navigation traffic may increase along the MKARNS due to a reduction in water transportation costs that result from navigation channel deepening (see Section 5.12.2.4). This also would cause a potential increase in sediment suspension. Although still minor, impacts would be greater than those of the 10-Foot Channel Component and the 11-Foot Channel Component.

5.5.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Additional dredging completed for the 12-Foot Channel Component in Segment 1 would total approximately 2,066,867 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Additional dredging completed for the 12-Foot Channel Component in Segment 2 would total approximately 445,995 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Additional dredging completed for the 12-Foot Channel Component in Segment 3 would total approximately 925,439 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Additional dredging completed for the 12-Foot Channel Component in Segment 4 would total approximately 1,226,500 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

Additional dredging completed for the 12-Foot Channel Component in Segment 5 would total approximately 3,256,749 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Additional dredging completed for the 12-Foot Channel Component in Segment 6 would total approximately 3,063,790 cy above the maintenance dredging volume. Impacts would be as discussed in Section 5.5.2.2.

5.5.3 Navigation Channel Depth Maintenance Feature

The amount of maintenance dredging that would occur under the Navigation Channel Depth Maintenance Components would be approximately the same as historic maintenance dredging volumes. Quantities and locations dredged would continue to vary annually based on river flows and sediment deposition patterns in the navigation channel. Table 5-9 shows the volumes dredged for maintenance from 1995 to 2003 for each pool. Maintenance dredging volumes for the entire MKARNS ranged from approximately 379,000 cy to 1,145,000 cy per year during this period.

Sediment sampling conducted in 2004 (see Appendix E) by USACE, Tulsa District along the Oklahoma portion of the MKARNS found that constituents were reported at low detection frequencies and concentrations throughout the sampled Oklahoma portion of the MKARNS and were generally below established TEC values. According to the protocol outlined in the Inland Testing Manual, Tier II Analysis would be required for continued or new disposal of material dredged from contaminated sites. Disturbing contaminated sediments would adversely impact water quality within the MKARNS during dredging.

5.5.3.1 No Action Component (NCDM-NA)

Under the No Action Component no additional dredging would be completed and therefore water quality and/or designated beneficial uses of the MKARNS and quality of surface water would remain at current levels. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.5.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

There would be no impacts to surface waters under the NCDM-1 Component as compared to current conditions. Maintenance dredging would continue at historic levels.

5.5.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

There would be no impacts to surface waters under the NCDM-2 Component as compared to current conditions. Maintenance dredging would continue at historic levels.

5.6 Land Cover and Land Use

Potential direct and indirect adverse impacts to land cover and land use, if any, would occur primarily as a result of changes in the type and/or relative proportions of land use within the study area due to implementation of any of the components.

5.6.1 Flow Management Feature

Potential environmental consequences of the proposed flow management components would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.6.1.1 No Action Component (FM-NA)

There would continue to be adverse impacts to agricultural cropland as a result of maintaining the current plan. Farmland soils would continue to be saturated and ponded at times during the growing season. However, these impacts are not expected to bring about a change in land cover and use.

5.6.1.2 175,000 cfs Plan Component (FM-175)

Annual crop damages under FM-175 would be approximately $264,000 more than the No Action Component. There would be increased soil saturation and ponding of farmland during the growing season under this component. Although impacts would vary over time and by location, they most likely would not produce a shift from cropland to other land use types. Similarly, annual structural damages under FM-175 would be approximately $263,000 more than the No Action Component. These impacts also would not likely produce a change in land cover and land use.

Almost 10,000 acres of private land, residences, and farms would be inundated more frequently in Oklahoma with the implementation of FM-175 according to Appendix B: Economics Analysis of the Feasibility Report (USACE 2005). This would not likely induce changes in land cover or use.

5.6.1.3 200,000 cfs Plan Component (FM-200)

Agricultural crop damages are greatest under FM-200 with an estimated $545,000 in additional annual damages over the No Action Component. The majority of these damages would occur in the Arkansas portion of the study area. There would be increased soil saturation and ponding of farmland during the growing season under this Component. Although impacts would vary over time and by location, they most likely would not produce a shift from cropland to other land cover or land use types.

Similarly, non-agricultural property or structure damages are greatest under FM-200 with an estimated $453,000 in additional annual damages over the No Action Component. The majority of these damages would occur in the Arkansas portion of the study area. These additional costs would not likely produce a change in land cover and land use.

Almost 15,000 acres of private land, residences, and farms would be inundated more frequently in Oklahoma with the implementation of FM-200 according to Appendix B: Economics Analysis of the Feasibility Report (USACE 2005). This would not likely induce changes in land cover and land use.

5.6.1.4 Operations Only Plan Component (FM-OPS)

There would be an average of 14 fewer days per year with flows at or above 61,000 cfs under FM-OPS. Therefore, minor beneficial impacts to agricultural cropland are expected as a result of implementing FM-OPS. There would be less soil saturation and ponding of farmland during the growing season. Although impacts would vary over time and by location, these changes may encourage the cropping of additional land, thus potentially displacing native vegetation within the floodplain.

5.6.2 Navigation Channel Deepening Feature

5.6.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns within the study area from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.6.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns in Segment 1 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.6.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns in Segment 2 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.6.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns in Segment 3 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.6.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns in Segment 4 from the existing, baseline conditions, as described in Chapter 4, are anticipated..

5.6.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns in Segment 5 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.6.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Because no additional dredging would occur under the No Action Component, no changes in impacts to land cover and land use patterns in Segment 6 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.6.2.2 Navigation Channel Deepening 10-Foot Channel Component

Under the Navigation Channel Deepening 10-Foot Component, additional dredged material disposal sites would be selected, developed, and used. Potential impacts to land cover and land use in these areas, in addition to current maintenance dredged material disposal, include a loss of 4,398 acres of bottomland, upland, and aquatic habitat along the entire length of the MKARNS according to Geographic Information Systems (GIS) data compiled by USACE, Tulsa and Little Rock Districts. Additionally, improved navigation may spur increased development of ports and marinas along the MKARNS, resulting in a minor loss of farmland, open areas, or a conversion of one developed land use to another.

5.6.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Impacts to land cover and land use along Segment 1 of the MKARNS due to improved navigation would be the same as above. There would be a conversion of 308 acres of agricultural land and 330 acres of aquatic habitat to dredged material disposal.

5.6.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Impacts to land cover and land use along Segment 2 of the MKARNS due to improved navigation would be the same as above. There would be a conversion of 181 acres of aquatic habitat to dredged material disposal.

5.6.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Impacts to land cover and land use along Segment 3 of the MKARNS due to improved navigation would be the same as above. There would be a conversion of 2,023 acres of aquatic habitat to dredged material disposal.

5.6.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Impacts to land cover and land use along Segment 4 of the MKARNS due to improved navigation would be the same as above. There would be a conversion of 667 acres of aquatic habitat to dredged material disposal.

5.6.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Impacts to land cover and land use along Segment 5 of the MKARNS due to improved navigation would be the same as above. There would be a conversion of 8 acres of bottomland hardwood, 44 acres of upland forest, 137 acres of open field, 48 acres of old field, 86 acres of agricultural land, 40 acres of barren/sand, and 270 acres of aquatic habitat to dredged material disposal.

5.6.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Impacts to land cover and land use along Segment 6 of the MKARNS due to improved navigation would be the same as above. There would be a conversion of 2 acres of upland forest, 99 acres of open field, 50 acres of old field, and 105 acres of agricultural land to dredged material disposal.

5.6.2.3 Navigation Channel Deepening 11-Foot Channel Component

Under the Navigation Channel Deepening 11-Foot Component, additional dredged material disposal sites would be selected, developed, and used. Potential impacts to land cover and land use would be similar to those of the Navigation Channel Deepening 10-Foot Channel Component. It was assumed that changes would occur approximately in proportion to the depth of dredging. Therefore, there may be slightly more land cover and land use changes under this component.

5.6.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Impacts to Segment 1 of the Navigation Channel Deepening 11-Foot Channel Component would be similar to those of Segment 1 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Impacts to Segment 2 of the Navigation Channel Deepening 11-Foot Channel Component would be similar to those of Segment 2 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Impacts to Segment 3 of the Navigation Channel Deepening 11-Foot Channel Component would be similar to those of Segment 3 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Impacts to Segment 4 of the Navigation Channel Deepening 11-Foot Channel Component would be similar to those of Segment 4 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Impacts to Segment 5 of the Navigation Channel Deepening 11-Foot Channel Component would be similar to those of Segment 5 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Impacts to Segment 6 of the Navigation Channel Deepening 11-Foot Channel Component would be similar to those of Segment 6 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.4 Navigation Channel Deepening 12-Foot Channel Component

Under the Navigation Channel Deepening 12-Foot Component, additional dredged material disposal sites would be selected, developed, and used. Potential impacts to land cover and land use would be similar to those of the Channel Deepening 10-Foot and 11-foot Channel Components. It was assumed that changes would occur approximately in proportion to the depth of dredging. Therefore, there may be slightly more land cover and land use changes under this component.

5.6.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Impacts to Segment 1 of the Navigation Channel Deepening 12-Foot Channel Component would be similar to those of Segment 1 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Impacts to Segment 2 of the Navigation Channel Deepening 12-Foot Channel Component would be similar to those of Segment 2 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Impacts to Segment 3 of the Navigation Channel Deepening 12-Foot Channel Component would be similar to those of Segment 3 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Impacts to Segment 4 of the Navigation Channel Deepening 12-Foot Channel Component would be similar to those of Segment 4 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

Impacts to Segment 5 of the Navigation Channel Deepening 12-Foot Channel Component would be similar to those of Segment 5 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth.

5.6.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Impacts to Segment 6 of the Navigation Channel Deepening 12-Foot Channel Component would be similar to those of Segment 6 of the Channel Deepening 10-Foot Channel Component. The amount of minor land cover and land use changes may be slightly more, due to the increase in depth of dredging.

5.6.3 Navigation Channel Depth Maintenance Feature

The amount of maintenance dredging that would occur under the Navigation Channel Depth Components would be the same as historic maintenance dredging volumes while dredged material disposal sites are available. Common elements of the two implementation components include new disposal sites to accommodate continuing 9-foot channel maintenance dredging (primarily in Oklahoma) and construction of additional river training structures to facilitate the maintenance of the 9-foot channel (primarily in Arkansas).

5.6.3.1 No Action Component (NCDM-NA)

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. Dredged material would continue to be disposed of at existing sites until they reached their holding capacity. The USACE would utilize existing approved disposal sites, and no new dredged material disposal sites would be developed. Therefore, no changes in land cover and land use patterns are expected within the study area under the No Action Component.

5.6.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. After currently utilized disposal sites reach their holding capacity, dredged material would be disposed of at unused sections within areas approved in the 1974 O&M Plan and EIS, regardless of the quality or type of habitat present. Therefore, high quality habitat such as bottomland hardwoods, grasslands, or wetlands would potentially be converted to dredged material disposal areas under this component, resulting in major impacts to land cover and land use.

5.6.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this component, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided wherever practical. Potential impacts to land cover and land use in these areas, in addition to current maintenance dredged material disposal, include a conversion of approximately 7 acres of bottomland hardwood, 73 acres of upland forest, 140 acres of open field, 234 acres of old field, 115 acres of agriculture, and 165 acres of aquatic habitat to dredged material disposal along the MKARNS, according to GIS data compiled by USACE, Tulsa and Little Rock Districts. This would result in minor impacts to land cover and land use in the study area.

5.7 Infrastructure

The MKARNS is a 445-mile long navigation system consisting of a series of navigation pools that are connected by locks in order to overcome a 420-foot change in elevation. The MKARNS connects Oklahoma and Arkansas to the Mississippi River and the nation's inland waterway system and via the Gulf Intracoastal Waterway to international ports as well. There are five major publicly developed ports along the MKARNS including the Port of Catoosa, Port of Muskogee, Port of Fort Smith, Port of Little Rock, and Port of Pine Bluff. In addition, there are numerous privately developed ports as well.

The different components of infrastructure examined in this impact analysis are:

- Commercial Navigation;
- MKARNS Operations and Maintenance;
- Locks and Dams;
- Other In-River Structures;
- Levees;
- Reservoirs;
- Hydroelectric Power and Energy; and
- Roadways and Railways.

5.7.1 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.7.1.1 No Action Component (FM-NA)

Under the No Action Component flows on the MKARNS would continue to fluctuate at current levels. This component averages 34 days per year above 100,000 cfs. Flows above this level result in the navigation system being non-navigable for commercial barge traffic, thus increasing costs for barge transport of commodities in the region. FM-NA would not impact levees, locks and dams, or other in-river structures along the MKARNS. It also would not impact water supply or wastewater discharge issues.

The No Action Component would not affect the function of the eleven upstream reservoirs or reservoir hydroelectric energy production. Hydropower on locks and dams is limited by FM-NA. High peak releases (greater than 100,000 cfs) exceed powerhouse capacity, resulting in restricted power generation at these locations.

Since the No Action Component would continue to restrict barge traffic on the MKARNS during high flows, the amount of barge traffic would not change.

5.7.1.2 175,000 cfs Plan Component (FM-175)

Under FM-175 flows above 100,000 cfs would be reduced by an annual average of 16 days (47%) from the current plan and flow days below 61,000 cfs would increase, providing for an average of approximately nine additional days of navigation at maximum tow size per year (see

Table 5-2). This increase in navigation efficiency would benefit the navigation industry by allowing commercial navigation to become more reliable throughout the system and would reduce river transportation costs for the region.

Implementation of FM-175 would increase annual average flow over 175,000 cfs by 4 days above the current plan. This may create minor added stress and wear and tear on levees, locks and dams, and wing dikes and revetments. An increase in very high flow days (above 175,000 cfs) may cause slightly increased erosion. Thus, sediment load in the water supply may also increase. These actions may result in a minor decline in water quality, which would adversely impact water supply functions of the navigation pools, although these pools are rarely used as a potable water supply source. FM-175 would not impact wastewater treatment issues on the MKARNS.

Under FM-175, duration in the extreme upper limits (>12 feet above conservation pool) of the Oklahoma reservoir pools would decrease, compared with the existing plan. Conversely, annual average duration of storage between 0 and 12 feet above conservation pool would increase slightly at some reservoirs (Table 5-4) under this component. An increase in reservoir flood pool duration would diminish the flood control capabilities of the reservoirs by reducing their available flood storage capacity. Since this component would increase annual average days of duration above conservation pool level in the reservoirs, reservoir water supply would not be impacted. Because reservoir storage would increase due to reduced average daily flow under FM-175, losses to reservoir hydropower energy production would increase. On the contrary, losses to hydropower on the locks and dams would decrease. With lower peak releases, less flow exceeds the powerhouse capacity resulting in slightly higher power generation for run-of-river projects. According to the Economics Analysis, included in the Feasibility Report (USACE 2005), total monetary hydropower benefits under FM-175 would increase by $1,340,000 per year over the No Action Component.

With a higher target flow than the No Action Component, water levels may reach higher elevations more frequently under FM-175. Roads and railways throughout the floodplain that are rarely inundated under the current plan may be adversely impacted by an average of 4 additional days above 175,000 cfs (approximate 1-year flood level) per year. The precise number of days per year that infrastructure would flood and remain inundated would vary according to elevation, soil type, topography, and other variables. Expanded flooding times may cause temporary disruptions in various forms of ground transportation, emergency services, and utility services.

5.7.1.3 200,000 cfs Plan Component (FM-200)

Under FM-200 flows above 100,000 cfs would be reduced by an annual average of 17 days (50%) from the current plan and flow days below 61,000 cfs would increase, providing for an average of approximately nine additional days of navigation at maximum tow size per year. This increase in navigation efficiency would benefit the navigation industry by allowing commercial navigation to become more reliable throughout the system and would reduce river transportation costs for the region.

Implementation of FM-200 would increase average annual flow over 175,000 cfs by 7 days above the current plan. This may create minor added stress and wear and tear on levees, locks and dams, and wing dikes and revetments. An increase in very high flow days (above 175,000 cfs) may cause slightly increased erosion. Thus, sediment load in the water supply may also increase. These actions may result in a minor decline in water quality, which would adversely impact water supply functions of the navigation pools, although these pools are rarely used as a potable water supply source. FM-200 would not affect wastewater treatment issues on the MKARNS.

Under FM-200, duration in the extreme upper limits (>10 feet above conservation pool) of the reservoir pools would generally decrease. Conversely, annual average duration of storage between 0 and 10 feet above conservation pool would increase slightly at some reservoirs (Table 5-4) under this component. An increase in reservoir flood pool duration would diminish the flood control capabilities of the reservoirs by reducing their available flood storage capacity. Since this component would increase the annual average days of duration above conservation pool level in the reservoirs, reservoir water supply would not be impacted. Because reservoir storage would increase due to reduced average daily flow under FM-200, losses to reservoir hydropower energy production would increase. On the contrary, losses to hydropower on the locks and dams would decrease. With lower peak releases, less flow exceeds the powerhouse capacity resulting in slightly higher power generation for run-of-river projects. According to the Economics Analysis, included in the Feasibility Report (USACE 2005), total monetary hydropower benefits under FM-200 would increase by $1,056,000 per year over the No Action Component.

With a higher target flow than the No Action Component, water levels may reach higher elevations more frequently under FM-200. Roads and railways throughout the floodplain that are rarely inundated under the current plan may be adversely impacted by an average of 7 additional days above 175,000 cfs (approximate 1-year flood level) per year. The precise number of days per year that infrastructure would flood and remain inundated would vary according to elevation, soil type, topography, and other variables. Expanded flooding times may cause temporary disruptions in various forms of ground transportation, emergency services, and utility services.

5.7.1.4 Operations Only Plan Component (FM-OPS)

Under FM-OPS, flows above 61,000 cfs would decrease by an average of 14 days per year compared to the current plan. Flows above 61,000 cfs restrict navigation at maximum tow size along the MKARNS. This increase in navigation efficiency would benefit the navigation industry by allowing commercial navigation to become more reliable throughout the system and would reduce river transportation costs for the region.

FM-OPS may slightly reduce the impact on levees, locks and dams, and other in-river structures along the MKARNS because flow above 61,000 cfs would be reduced by an annual average of 14 days, while there would be no changes in flow above 175,000 cfs. Under FM-OPS, duration in the extreme upper limits (>10 feet above conservation pool) of the reservoir pools would decrease. Conversely, annual average duration of storage between 0 and 10 feet above conservation pool would increase slightly at some reservoirs (Table 5-4) under this component, but these minor increases would not impact reservoir functions. Since FM-OPS would increase annual average days of duration above conservation pool level in the reservoirs, reservoir water supply would not be impacted. FM-OPS would not affect wastewater treatment on the MKARNS.

Because reservoir storage would increase due to reduced average daily flow under FM-OPS, losses to reservoir hydropower energy production would increase slightly. On the contrary, losses to hydropower on the locks and dams would decrease. With lower peak releases, less flow exceeds the powerhouse capacity resulting in slightly higher power generation for run-of-river projects. According to the Economics Analysis, included in the Feasibility Report (USACE 2005), total monetary hydropower benefits under FM-OPS would increase by $466,000 per year over the No Action Component.

FM-OPS would result in an average of 14 fewer days of flow above 61,000 cfs per year along the MKARNS than the current plan. Local rural economies may be stimulated by this increase, as production in agricultural fields may slightly improve. Economic growth would result in higher traffic levels, which would require more roadway maintenance, repair, and may result in additional road construction.

5.7.2 Navigation Channel Deepening Feature

5.7.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the No Action Component there would be no navigation channel deepening and the MKARNS would remain at its current depth. Under this component there would be no improvements to navigation efficiencies or other benefits to the navigation industry.

Implementation of the No Action Component would not impact levees, locks and dams, or other in-river structures along the MKARNS. Under this component there would also be no changes to reservoirs or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality. In addition, dredging maintenance and disposal would continue according to current procedures, and there are no anticipated changes to railway or roadway transportation.

5.7.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Under the No Action Component there would be no channel deepening and the MKARNS would remain at its current depth. Therefore, no changes in impacts to infrastructure within Segment 1 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.7.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Under the No Action Component there would be no channel deepening and the MKARNS would remain at its current depth. Therefore, no changes in impacts to infrastructure within Segment 2 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.7.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Under the No Action Component there would be no channel deepening and the MKARNS would remain at its current depth. Therefore, no changes in impacts to infrastructure within Segment 3 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.7.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Under the No Action Component there would be no channel deepening and the MKARNS would remain at its current depth. Therefore, no changes in impacts to infrastructure within Segment 4 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.7.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Under the No Action Component there would be no channel deepening and the MKARNS would remain at its current depth. Therefore, no changes in impacts to infrastructure within Segment 5 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.7.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Under the No Action Component there would be no channel deepening and the MKARNS would remain at its current depth. Therefore, no changes in impacts to infrastructure within Segment 6 from the existing, baseline conditions, as described in Chapter 4, are anticipated.

5.7.2.2 Navigation Channel Deepening 10-Foot Channel Component

Deepening the channel to 10 feet would create greater efficiencies in commercial navigation by allowing barge tows to carry larger loads. Larger towing capacities help reduce transportation costs for the region and provide benefits to the navigation industry.

Implementation of this component would require minor engineering changes to locks and dams in order to accommodate deeper draft vessels. Also, new river training structures or modifications to existing structures would be necessary to allow for the passage of deeper draft vessels. Levees, however, would not need to be altered because there would be no change in river elevation. There would also be no change to reservoirs or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality.

Dredging and disposal would initially be required to establish the 10-foot channel. Subsequently, continued maintenance dredging and disposal would also be necessary.

Under this component, traffic may be induced to shift onto the river system considering the reduction in water routing transportation costs that result from navigation channel deepening. A long-term impact would be a minor reduction in utilization of railways and roads.

Dredging to a depth of 10 feet would require the following approximate number of new and modified river training structures and revetments. There are 1,314 existing river training structures and 295 revetments on the MKARNS (Tables 5-7 and 5-8). Under this component there would be an approximate 7% increase in the number of new river training structures and an approximate 2% increase in the number of new revetments along the MKARNS.

- Mouth to Pine Bluff 4 new and 21 modified river training structures
- Pine Bluff to Little Rock 30 new and 4 modified river training structures
- Little Rock to Dardanelle 5 new and 34 modified river training structures
- Dardanelle to Fort Smith 6 new and 28 modified river training structures
- Ft Smith to Muskogee 44 new and 0 modified river training structures
- Muskogee to Catoosa 0 new or modified river training structures

- **Total MKARNS (10 Ft)** 89 new and 87 modified river training structures

- Mouth to Pine Bluff 0 new and 9 modified revetments
- Pine Bluff to Little Rock 1 new and 0 modified revetments
- Little Rock to Dardanelle 0 new and 1 modified revetment
- Dardanelle to Fort Smith 0 new and 6 modified revetments
- Ft Smith to Muskogee 0 new or modified revetments
- Muskogee to Catoosa 0 new or modified revetments
- **Total MKARNS (10 Ft)** 1 new and 16 modified revetments

5.7.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

In Segment 1, there would be 4 new river training structures totaling 680 feet in length, 21 modified river training structures totaling 1,205 feet in additional length, and no new revetments under this component. There would be nine modified revetments totaling 0.02 miles in additional length.

5.7.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

In Segment 2, there would be 30 new river training structures totaling 3,233 feet in length, 4 modified river training structures totaling 0 feet in additional length, one new revetment totaling 0.8 mi, and no modified revetments under this component.

5.7.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

In Segment 3, there would be 5 new river training structures totaling 683 feet in length, 34 modified river training structures totaling 1,533 feet in additional length, no new revetments, and 1 modified revetment totaling 0 mi in additional length under this component.

5.7.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

In Segment 4, there would be 6 new river training structures totaling 617 feet in length, 28 modified river training structures totaling 767 feet in additional length, no new revetments, and 6 modified revetments totaling 0.03 mi in additional length under this component.

5.7.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

In Segment 5, there would be 44 new river training structures totaling 16,243 feet in length, 0 modified river training structures totaling 0 feet in additional length, 0 new revetments totaling 0 mi, and 0 modified revetments totaling 0 mi in additional length under this component.

5.7.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

In Segment 6, there would be no new or modified river training structures and no new or modified revetments under this component.

5.7.2.3 Navigation Channel Deepening 11-Foot Channel Component

Deepening the channel to 11 feet would create greater efficiencies in commercial navigation by allowing barge tows to carry larger loads. Larger towing capacities help reduce transportation costs for the region and provide benefits to the navigation industry.

Implementation of this component would require minor engineering changes to locks and dams in order to accommodate deeper draft vessels. Also, new river structures or modifications to existing structures would be necessary to allow for the passage of deeper draft vessels. Levees, however, would not need to be altered because there would be no change in river elevation. There would also be no change to reservoirs or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality.

Dredging and disposal would be initially required to establish the 11-foot channel. Subsequently, continued maintenance dredging and disposal would also be necessary.

Under this component, traffic may be induced to shift onto the river system considering the reduction in water routing transportation costs that result from navigation channel deepening. A long-term impact would be a minor reduction in utilization of railways and roads.

Dredging to a depth of 11 feet would require the following approximate number of new river training structures and revetments. There are 1,314 existing river training structures and 295 revetments on the MKARNS (Tables 5-7 and 5-8). Under this component there would be an approximate 7% increase in the number of river training structures and an approximate 2% increase in the number of revetments along the MKARNS.

- Mouth to Pine Bluff 4 new and 21 modified river training structures
- Pine Bluff to Little Rock 30 new and 4 modified river training structures
- Little Rock to Dardanelle 5 new and 34 modified river training structures
- Dardanelle to Fort Smith 6 new and 28 modified river training structures
- Ft Smith to Muskogee 44 new and 0 modified river training structures
- Muskogee to Catoosa 0 new or modified river training structures
- **Total MKARNS (11 Ft)** 89 new and 87 modified river training structures

- Mouth to Pine Bluff 0 new and 9 modified revetments
- Pine Bluff to Little Rock 1 new and 0 modified revetments
- Little Rock to Dardanelle 0 new and 1 modified revetment
- Dardanelle to Fort Smith 0 new and 6 modified revetments
- Ft Smith to Muskogee 0 new or modified revetments
- Muskogee to Catoosa 0 new or modified revetments
- **Total MKARNS (11 Ft)** 1 new and 16 modified revetments

5.7.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

In Segment 1, there would be 4 new river training structures totaling 1,360 feet in length, 21 modified river training structures totaling 2,410 feet in additional length, and no new revetments under this component. There would be nine modified revetments totaling 0.04 miles in additional length.

5.7.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

In Segment 2, there would be 30 new river training structures totaling 6,467 feet in length, 4 modified river training structures totaling 0 feet in additional length, one new revetment totaling 1.5 mi, and no modified revetments under this component.

5.7.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

In Segment 3, there would be 5 new river training structures totaling 1,367 feet in length, 34 modified river training structures totaling 3,067 feet in additional length, no new revetments, and 1 modified revetment totaling 0 mi in additional length under this component.

5.7.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

In Segment 4, there would be 6 new river training structures totaling 1,233 feet in length, 28 modified river training structures totaling 1,533 feet in additional length, no new revetments, and 6 modified revetments totaling 0.06 mi in additional length under this component.

5.7.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

In Segment 5, there would be 44 new river training structures totaling 32,486 feet in length, 0 modified river training structures totaling 0 feet in additional length, 0 new revetments totaling 0 mi, and 0 modified revetments totaling 0 mi in additional length under this component.

5.7.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

In Segment 6, there would be no new or modified river training structures and no new or modified revetments under this component.

5.7.2.4 Navigation Channel Deepening 12-Foot Channel Component

Deepening the channel to 12 feet would create greater efficiencies in commercial navigation by allowing barge tows to carry larger loads. Larger towing capacities help reduce transportation costs for the region and provide benefits to the navigation industry.

Implementation of this component would require minor engineering changes to locks and dams in order to accommodate deeper draft vessels. Also, new river structures or modifications to existing structures would be necessary to allow for the passage of deeper draft vessels. Levees, however, would not need to be altered because there would be no change in river elevation. There would also be no change to reservoirs or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality.

Dredging and disposal would be initially required to establish the 12-foot channel. Subsequently, continued maintenance dredging and disposal would also be necessary.

Under this component, traffic may be induced to shift onto the river system considering the reduction in water routing transportation costs that result from navigation channel deepening. A long-term impact would be a minor reduction in utilization of railways and roads.

Dredging to a depth of 12 feet would require the following approximate number of new river training structures and revetments. There are 1,314 existing river training structures and 295 revetments on the MKARNS (Tables 5-7 and 5-8). Under this component there would be an approximate 7% increase in the number of river training structures and an approximate 2% increase in the number of revetments along the MKARNS.

- Mouth to Pine Bluff 4 new and 21 modified river training structures
- Pine Bluff to Little Rock 30 new and 4 modified river training structures

- Little Rock to Dardanelle 5 new and 34 modified river training structures
- Dardanelle to Fort Smith 6 new and 28 modified river training structures
- Ft Smith to Muskogee 44 new and 0 modified river training structures
- Muskogee to Catoosa 0 new or modified river training structures
- **Total MKARNS (12 Ft)** 89 new and 87 modified river training structures

- Mouth to Pine Bluff 0 new and 9 modified revetments
- Pine Bluff to Little Rock 1 new and 0 modified revetments
- Little Rock to Dardanelle 0 new and 1 modified revetment
- Dardanelle to Fort Smith 0 new and 6 modified revetments
- Ft Smith to Muskogee 0 new or modified revetments
- Muskogee to Catoosa 0 new or modified revetments
- **Total MKARNS (12 Ft)** 1 new and 16 modified revetments

5.7.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

In Segment 1, there would be 4 new river training structures totaling 2,040 feet in length, 21 modified river training structures totaling 3,615 feet in additional length, and no new revetments under this component. There would be nine modified revetments totaling 0.06 miles in additional length.

5.7.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

In Segment 2, there would be 30 new river training structures totaling 9,700 feet in length, 4 modified river training structures totaling 0 feet in additional length, one new revetment totaling 2.3 mi, and no modified revetments under this component.

5.7.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

In Segment 3, there would be 5 new river training structures totaling 2,050 feet in length, 34 modified river training structures totaling 4,600 feet in additional length, no new revetments, and 1 modified revetment totaling 0 mi in additional length under this component.

5.7.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

In Segment 4, there would be 6 new river training structures totaling 1,850 feet in length, 28 modified river training structures totaling 2,300 feet in additional length, no new revetments, and 6 modified revetments totaling 0.09 mi in additional length under this component.

5.7.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

In Segment 5, there would be 44 new river training structures totaling 48,729 feet in length, 0 modified river training structures totaling 0 feet in additional length, 0 new revetments totaling 0 mi, and 0 modified revetments totaling 0 mi in additional length under this component.

5.7.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

In Segment 6, there would be no new or modified river training structures and no new or modified revetments under this component.

5.7.3 Navigation Channel Depth Maintenance Feature

5.7.3.1 No Action Component (NCDM-NA)

Under the No Action Component, once disposal site capacity has been reached, maintenance dredging and disposal conditions on the MKARNS would be maintained in the short-term but in the long-term dredged material would be pumped further to active disposal sites or currently inactive disposal sites would be used.

Implementation of the No Action Component would not impact levees, locks and dams, or other in-river structures along the MKARNS. Under this component there would also be no changes to reservoirs, or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality. In addition, there are no anticipated changes to railway or roadway transportation.

5.7.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, once disposal capacity has been reached at the existing disposal sites on the MKARNS then new disposal sites would be selected (from within pre-approved areas) regardless of habitat type. The new sites would allow for continued maintenance dredging and disposal on the MKARNS.

Implementation of the Maintenance Dredged Material Disposal in Approved Areas Component would not impact levees or locks and dams along the MKARNS. Construction of additional river training structures to facilitate the maintenance of the 9-foot channel (primarily in Arkansas) would include:

- Mouth to Pine Bluff 2 new and 18 modified river training structures
- Pine Bluff to Little Rock 0 new and 0 modified river training structures
- Little Rock to Dardanelle 0 new and 24 modified river training structures
- Dardanelle to Fort Smith 0 new and 8 modified river training structures
- Ft Smith to Muskogee 0 new and 0 modified river training structures
- Muskogee to Catoosa 0 new and 0 modified river training structures
- **Total NCDM-1** 2 new and 50 modified river training structures

- Mouth to Pine Bluff 0 new and 0 modified revetments
- Pine Bluff to Little Rock 1 new and 0 modified revetments
- Little Rock to Dardanelle 0 new and 3 modified revetments
- Dardanelle to Fort Smith 1 new and 1 modified revetments
- Ft Smith to Muskogee 0 new and 0 modified revetments
- Muskogee to Catoosa 0 new and 0 modified revetments
- **Total NCDM-1** 2 new and 4 modified revetments

Under this component there would also be no changes to reservoirs, or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality. In addition, there are no anticipated changes to railway or roadway transportation.

5.7.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Under the Maintenance Dredged Material Disposal in New Disposal Sites Component, once capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected. However, when selecting disposal sites, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided. The new sites would allow for continued maintenance dredging and disposal on the MKARNS.

Implementation of the New Disposal Sites Component would not impact levees or locks and dams along the MKARNS. Construction of additional river training structures to facilitate the maintenance of the 9-foot channel (primarily in Arkansas) would include:

- Mouth to Pine Bluff — 2 new and 18 modified river training structures
- Pine Bluff to Little Rock — 0 new and 0 modified river training structures
- Little Rock to Dardanelle — 0 new and 24 modified river training structures
- Dardanelle to Fort Smith — 0 new and 8 modified river training structures
- Ft Smith to Muskogee — 0 new and 0 modified river training structures
- Muskogee to Catoosa — 0 new and 0 modified river training structures
- **Total NCDM-2** — 2 new and 50 modified river training structures

- Mouth to Pine Bluff — 0 new and 0 modified revetments
- Pine Bluff to Little Rock — 1 new and 0 modified revetments
- Little Rock to Dardanelle — 0 new and 3 modified revetment
- Dardanelle to Fort Smith — 1 new and 1 modified revetments
- Ft Smith to Muskogee — 0 new and 0 modified revetments
- Muskogee to Catoosa — 0 new and 0 modified revetments
- **Total NCDM-2** — 2 new and 4 modified revetments

Under this component there would also be no changes to reservoirs, or hydroelectric power from their current operating conditions. Reservoir storage would remain the same and there would also be no changes to water supply, wastewater discharge, or water quality. In addition, there are no anticipated changes to railway or roadway transportation

5.8 Biological Resources

5.8.1 <u>Introduction to Biological Resources Impact Analysis</u>

The MKARNS and its associated upstream reservoirs are hosts to a variety of biological resources including federally threatened and endangered species, wetland habitat and biota, aquatic habitats and biota, and terrestrial habitats and biota. The principal direct and indirect adverse impacts to biological resources result from 1) direct contact between construction activities and biota; 2) direct degradation of biological habitats; and 3) indirect degradation of biological habitats.

5.8.2 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.8.2.1 No Action Component (FM-NA)

5.8.2.1.1 Threatened and Endangered Species

Under FM-NA, river levels on the MKARNS would continue to fluctuate at current levels.

The USACE coordinated with the U.S. Fish and Wildlife Service (USFWS) to prepare a Biological Assessment (BA) for the Arkansas River Navigation Study and related activities associated with the operation of the MKARNS and the upstream reservoirs that influence water flow on the MKARNS. The BA was prepared pursuant to the requirements of the ESA, and it considered potential impacts to threatened and endangered species throughout the study area. While the BA addressed anticipated impacts to all federally listed threatened and endangered species potentially influenced by the USACE study and activities, it focused on species such as the interior least tern which are known to be present in multiple locations in the study area and have potentially been influenced by USACE activities along the MKARNS.

The BA was submitted to the USFWS in October 2003. In response to the preparation of the BA, the USFWS issued a Biological Opinion (BO) (June 28, 2005). The findings of the BA and BO are included in Section 4.8 of the EIS. The BO suggested BMPs as well as Reasonable and Prudent Measures (RPMs) for the protection of threatened and endangered species and their habitat in the study area. These BMPs and RPMs will be incorporated into the design features of the selected component for the proposed action. As a result of implementing the BMPs and RMPs, no impacts to threatened or endangered species would occur. The ivory-billed woodpecker was not included in the BA because it was not discovered until recently. However, the USFWS included consideration of the ivory-billed woodpecker in its June 28, 2005 BO. The USFWS determined that the proposed action would not adversely affect the endangered ivory-billed woodpecker.

5.8.2.1.2 Wetlands

FM-NA has an average of only 1 day per year of flow above 175,000 cfs. Because floodwaters rarely reach this level under this component, wetland habitats that fall beyond the reach of this flow are influenced less frequently. Continued operation under this plan would maintain the existing conditions, including the hydrology and species composition of these areas.

5.8.2.1.3 Aquatic Resources

No direct or indirect impacts to aquatic resources are expected if FM-NA is implemented. River and associated reservoir levels would continue to fluctuate under current flow rates.

5.8.2.1.4 Terrestrial Resources

No direct or indirect impacts to terrestrial resources are expected if FM-NA is implemented. River and associated reservoir levels would continue to fluctuate under current flow rates.

5.8.2.2 175,000 cfs Plan Component (FM-175)

5.8.2.2.1 Threatened and Endangered Species

Refer to Section 5.8.2.1.1 for a discussion of the BA submitted by the USACE and the subsequent BO prepared by the USFWS. Sixteen federally listed species occur in or near the Action Area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action. The least tern and American burying beetle are the only species addressed in the BO (USFWS 2005). Although the USFWS does anticipate that the American burying beetle would be affected by the proposed action as well, the BO emphasized anticipated impacts of the proposed action on the least tern.

The BO suggested BMPs as well as RPMs for the protection of threatened and endangered species and their habitat in the study area. These BMPs and RPMs will be incorporated into the design features of the selected component for the proposed action. As a result of implementing the BMPs and RPMs, no impacts to threatened or endangered species would occur.

Interior Least Tern

The federally endangered interior least tern (*Sterna antillarum*) nests on exposed river sandbars and sandy islands of major rivers and sandy shorelines of reservoirs from May through August in the study area. Least tern nesting habitat can be impacted by any action that changes river hydrology and morphology. A major hydrologic effect of large reservoirs on nesting habitat is the reduction in the magnitude, frequency, and duration of peak flows that are necessary to move sediments for new sandbars, maintain channel widths, and scour existing sandbars. These reservoirs also retain large volumes of sediment (sand), the basic building block for least tern habitat, that normally would be distributed throughout an unregulated river.

According to hydrological modeling data provided by the USACE, Tulsa District, minor benefits to the interior least tern include an average of two fewer days above 61,000 cfs and seven fewer high flow days (above 100,000 cfs) during May through August (Table 5-3), and thus less frequent flooding of lower elevation nesting areas during their breeding season.

Reduced scouring of sandy nesting areas can impact the interior least tern. Frequent flooding controls vegetation encroachment that may hamper nesting attempts on these areas. Because the average number of days of flow above 61,000 cfs (potential scouring flow) only decreases by six days over the No Action Component during the entire non-breeding season, impacts to least tern nesting habitat would be negligible under FM-175. In addition, the average number of days of flow above 75,000 cfs increases by three days during the non-nesting season with FM-175, which would increase scouring flow frequency above this flow level.

If reduced flow rates are such that sandy islands used for nesting become connected to the shore during the nesting season, nest predation may increase and adversely impact the tern population. These circumstances would not occur under FM-175 because changes in flow durations below 20,000 cfs would be negligible.

According to the USACE, Tulsa District Management Guidelines and Strategies for Interior Least Terns, water levels and water releases at key Oklahoma reservoirs (Kaw, Keystone, and Eufaula) would be manipulated within a predetermined safe range of operation to provide protection to least tern nesting areas below these reservoirs and to provide scouring flows needed for vegetation management at nesting areas. USACE would continue to consult with the USFWS on this issue and to follow these guidelines under FM-175.

American Burying Beetle

Adverse impacts to American burying beetles (*Nicrophorus americanus*) would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented.

Other Federally Listed Species

No impacts would be expected for the piping plover (*Charadrius melodius*), whooping crane (*Grus americana*), ivory-billed woodpecker (*Campephilus principalis*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Ozark big-eared bat (*Plecotus townsendii ingens*), bald eagle (*Haliaeetus leucocephalus*), Arkansas River shiner (*Notropis girardi*), pink mucket pearlymussel (*Lampsilis abrupta*), scaleshell mussel (*Leptodea leptodon*), American alligator (*Alligator mississippiensis*), pallid sturgeon (*Scaphirhynchus albus*), Geocarpon (*Geocarpon minimum*), western prairie fringed orchid (*Platanthera praeclara*), or harperella (*Ptilimnium nodosum*). Although these species may occur in the vicinity of the MKARNS, they are either unlikely to occur in the study area or their habitat would not be affected by FM-175.

5.8.2.2.2 Wetlands

Under FM-175 the hydrology of wetlands associated with the MKARNS may experience minor variations. The changes in river flow associated with the component are minor and are documented in Tables 5-2 and 5-3. Inundation of lower elevation wetlands and bottomland hardwoods may decrease in frequency, which may have a minor adverse impact on these ecosystems. Higher elevation wetlands may have an average four-day increase in inundation each year. This may produce minor beneficial impacts to these wetlands. Specific impacts would depend on rainfall, soil characteristics, topography, vegetation at each wetland area, and other variables.

Arkansas State-listed wetlands species that may be affected by fluctuations in wetland hydrology include Strecker's chorus frog (*Pseudacris streckeri*), swamp darter (*Etheostoma fusiforme*), California bulrush (*Scirpus californicus*), hairy water-fern (*Marsilea vestita*), lax hornpod (*Cynoctonum mitreola*), soapwort gentian (*Gentiana saponaria*), Texas bergia (*Bergia texana*), and tissue sedge (*Carex hyalina*). Oklahoma State-listed wetlands species that may be affected include marsh rice rat (*Oryzomys palustris*), alligator gar (*Lepisosteus spatula*), alligator snapping turtle (*Macroclemys temminckii*), and hammock sedge (*Carex fissa*). Specific impacts to each of these species are expected to be insignificant.

5.8.2.2.3 Aquatic Resources

Rivers

The overall area of aquatic habitat within the MKARNS study area is not expected to change. Adverse impacts to aquatic systems are realized through the increase in the rate of erosion and turbidity. Denuding or removing natural vegetation increases the rate of soil erosion (FHWA 1978; Smoot et al. 1992; Wang and Grubbs 1992; and Thompson and Green 1994). Vegetation modification may occur with an increase of days the river is out-of-bank. Under FM-175, an annual average 4-day decrease of out-of-bank flow (>137,000 cfs) from the current plan would occur at Van Buren. Thus, a reduction in erosion potential would occur, resulting in minor beneficial impacts to the Arkansas River.

Because the annual average number of high flow days (between 100,000 cfs and 175,000 cfs) would decrease by 16 under FM-175, inundation frequency and elevation of the Arkansas River channel and tributary streams would be reduced. Flooding reduces the stability of the tributary habitat that is used by many species of stream and large river fish species for reproduction. Thus, the reduction in high flow days under this component would produce minor beneficial impacts to tributary stream fishery habitat.

Direct minor impacts to aquatic species would include fluctuations in river levels that may adversely affect fish reproduction. Fluctuations would be similar to those under the current plan and they would continue to be heavily influenced by rainfall events. Adverse impacts would be compensated for by the continuation of the habitat enhancement program that was recently instituted by USACE. Habitat enhancement projects include: notched dikes to create backwater areas for spawning fish, as well as for fish, angler, and hunter access; notches in closure structures so that flow is allowed to re-enter side channels; development of moist soil areas for waterfowl; and establishment of water level management plans for fish spawning seasons.

Inundation of sloughs and other connected backwater areas may decrease in frequency by an average of 16 days per year with a decrease in flow days above 100,000 cfs, which could both beneficially and adversely impact these ecosystems. Also, out-of-bank flows (above 137,000 cfs) that can affect oxbow lakes and other unconnected wetland areas would decrease by an average of four days per year over the current plan. Habitat quality in backwater areas can decline when floodwaters deposit sediment that fills in aquatic habitat, increase turbidity levels, and smother fish eggs and benthic organisms. Floodwaters can cause channel cutting in the lower end of an oxbow lake that decreases the lake's average water depth. Therefore, a decrease in inundation days could produce minor beneficial impacts to both connected and unconnected backwater habitats.

Conversely, periods of high water benefit the exchange of fishes between unconnected backwaters and the main river, and may increase the amount of habitat available in connected backwater areas. These areas serve as useful spawning and nursery areas for some riverine fish species and high water periods facilitate movement between habitat types. In addition, oxbow lakes can be replenished with water and nutrients from a nearby river during seasonal flood periods. In this manner, a reduction in the inundation period of backwaters may result in minor adverse impacts to these biological communities.

Higher elevation oxbows and other unconnected backwaters may have an average four-day increase in inundation days (river flows above 175,000 cfs) each year. Because of this minimal change in duration, the beneficial and adverse impacts to these areas along the MKARNS would be negligible.

Arkansas State-listed large river species that may be affected by FM-175 include the flathead chub (*Platygobio gracilis*), goldeye (*Hiodon alosoides*), lake sturgeon (*Acipenser fulvescens*), paddlefish (*Polydon spathula*), shorthead darter (*Percina phoxocephala*), suckermouth minnow (*Phenacobius mirabilis*), and six-angle spurge (*Euphorbia hexagona*). Oklahoma State-listed species that may be affected include Alabama shad (*Alosa alabame*), alligator gar (*Lepisosteus spatula*), Arkansas River speckled chub (*Macrhybopsis aestivalis tetranemus*), black buffalo

(*Ictiobus niger*), blackside darter (*Percina maculata*), shovelnose sturgeon (*Scaphirhyncus platorynchus*), and Ouachita indigo bush (*Amorpha ouachitensis*). Specific impacts to each of these species are expected to be insignificant.

Reservoirs

Drawdowns in reservoirs can result in a loss of habitat for various fish species that inhabit littoral zones and use these shoreline areas for spawning and nursery areas. Loss of this habitat could force fish into open water where predation rates may increase and spawning is less successful. Fairly stable rising reservoir levels in the spring and summer can be highly conducive to fish reproduction and recruitment within the reservoirs. Highly variable water levels can be disruptive to reproduction and recruitment.

An increase in reservoir water storage may cause slightly increased inundation of adjacent vegetated areas. If shoreline vegetation is flooded too long during the growing season, it could be adversely impacted. The rates of deoxygenation through the decomposition of vegetation would increase, adversely affecting aquatic organisms. If increases in reservoir storage were short-term, shoreline vegetation would provide additional habitat for larval fish, which would be a beneficial impact. According to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than three additional days over eight feet above conservation pool occurring in any two-month period (Table 5-5). Increasing storage in the reservoirs also may result in indirect variations in the physical characteristics of the river downstream of the dam such as depth, velocity, turbidity, and temperature. These changes can adversely impact organisms that are dependant on aquatic systems. Because storage in the reservoirs would not increase beyond current flood control pool elevations, impacts are expected to be insignificant.

The USACE's modifications of flow rates and associated Oklahoma reservoir pools' levels (e.g. flood control pools, conservation pools, etc.) would continue to remain compatible with the authorized operational plan of each reservoir. USACE would maintain cooperation with State and Federal fish and wildlife agencies to develop plans for lakes and to provide seasonal pool fluctuations conducive to the management of the aquatic resources. Appropriate seasonal pool variations help to improve fish spawn by maintaining or increasing water levels during spring months, improve water recreation by maintaining levels sufficient for recreation during summer months, and improve waterfowl food and hunting by fluctuating water levels to maximize waterfowl habitat and hunting opportunities during fall months. Flow change will not affect fish passage given the relatively minor nature of the proposed changes

5.8.2.2.4 Terrestrial Resources

Under FM-175, increased storage in existing reservoirs and an increase in flow above 175,000 cfs may result in more frequent flooding of higher elevation terrestrial habitat types along the MKARNS. Many of the MKARNS Oklahoma reservoir pools would rise above their conservation pool elevations for additional days each year, compared with the No Action Component (Table 5-4). Elevations would not reach 12 feet above the conservation pool for any of the lakes under this component. Therefore, flood control pool elevations would not be reached and impacts to adjacent terrestrial (e.g. upland and riparian) habitat would be minimal. In addition, according to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than three additional days over eight feet above conservation pool occurring in any two-month period (Table 5-5).

Riparian forests and other terrestrial habitats along the Arkansas River that are rarely (averaging one day per year) inundated under the current plan would be flooded for an average of four additional days each year. Conversely, lower elevation terrestrial habitats along the navigation channel that are more frequently (averaging 18 days per year) flooded at 137,000 cfs or higher flow under the current plan would experience a reduced inundation period by an average of four days per year under FM-175. These changes should have minimal impacts on the health and survival of bottomland hardwood trees and associated flora and fauna in these areas. Species composition may experience minor alterations according to frequency and period of inundation.

5.8.2.3 200,000 cfs Plan Component (FM-200)

5.8.2.3.1 Threatened and Endangered Species

Refer to Section 5.8.2.1.1 for a discussion of the BA submitted by the USACE and the subsequent BO prepared by the USFWS (2005). Sixteen federally listed species occur in or near the Action Area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action. Refer to Section 5.8.2.2.1 for impacts to endangered species associated with the flow management components.

Interior Least Tern

Similar to FM-175, there would be no significant impacts to the federally endangered interior least tern under FM-200. USACE, Tulsa District would continue to consult with the U.S. Fish and Wildlife Service on least tern management and would continue to follow the Management Guidelines and Strategies for Interior Least Terns in Oklahoma under FM-200.

American Burying Beetle

Similar to FM-175, adverse impacts to American burying beetles would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented.

Other Federally Listed Species

Similar to FM-175, no impacts would be expected for other federally listed species.

5.8.2.3.2 Wetlands

Under FM-200 the hydrology of wetlands associated with the MKARNS may experience minor fluctuations. Although similar to those of FM-175, the variations would be slightly greater for FM-200 due to higher variability in target flows along the MKARNS.

5.8.2.3.3 Aquatic Resources

Refer to the Aquatic Resources Section under the FM-175 for a discussion of flow management component impacts to aquatic resources. Under FM-200, an annual average increase of only seven days out-of-bank would occur at 175,000 cfs at Van Buren. Thus, an increase in erosion potential would be minor and would not result in impacts to aquatic systems. Impacts to aquatic resources, i.e. Arkansas River and its associated backwater areas and reservoirs, in the study area are expected to be similar to those of FM-175. These impacts would be slightly greater for FM-200 due to higher variability in target flows along the MKARNS.

5.8.2.3.4 Terrestrial Resources

Impacts to terrestrial resources would be similar to those of the FM-175 component. MKARNS Oklahoma pool elevations would reach only 12 feet above the conservation pool for any of the lakes under FM-200. Therefore, flood control pool elevations would not be reached and impacts to adjacent terrestrial (e.g. upland and riparian) habitat would be minimal. In addition, according to hydrologic modeling data, increases in pool elevation at all lakes are spread throughout the year, with no more than three additional days over eight feet above conservation pool occurring in any two-month period (Table 5-5).

Riparian forests and other terrestrial habitats along the Arkansas River that are rarely (averaging one day per year) inundated under the current plan would be flooded for an average of seven additional days each year. Conversely, lower elevation terrestrial habitats along the navigation channel that are more frequently (averaging 18 days per year) flooded at 137,000 cfs or higher flow under the current plan would experience a reduced inundation period by an average of five days per year under FM-200. These changes should have minimal impacts on the health and survival of bottomland hardwood trees and associated flora and fauna in these areas. Species composition may experience minor alterations according to frequency and period of inundation.

5.8.2.4 Operations Only Plan Component (FM-OPS)

5.8.2.4.1 Threatened and Endangered Species

Refer to Section 5.8.2.1.1 for a discussion of the BA submitted by the USACE and the subsequent BO prepared by the USFWS (2005). Sixteen federally listed species occur in or near the Action Area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be impacted by the proposed action. Refer to Section 5.8.2.2.1 for impacts to endangered species associated with the flow management components.

Interior Least Tern

Since a reduction in days of flow above 61,000 cfs (five fewer days) occurs during the federally endangered interior least tern nesting season under FM-OPS, nesting success would have the potential to improve due to decreased flooding of sand bars and islands used for nesting. Frequent flooding, or scouring flow, controls vegetation encroachment that may hamper tern nesting attempts. An annual average nine-day reduction in number of days of flow above 61,000 cfs during the non-nesting period would not impact the tern since there would still be 30 days per year of flow above 61,000 cfs during this period.

Impacts to the interior least tern would be similar to those associated with FM-175 and FM-200.

American Burying Beetle

Adverse impacts to American burying beetles would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented.

Other Federally Listed Species

FM-OPS would result in an average annual increase of two days in flow above 100,000 cfs and no change in flow above 175,000 cfs along the MKARNS compared with the current plan. Because the average number of high flow days per year would not change appreciably, the amount of barge traffic would not increase. Such limitations on barge transport on the MKARNS may indirectly result in an increase in goods transported by trucks. An increase in truck traffic could result in increased development and expansion of local roads and highways. This could result in the loss of habitat used by local flora and fauna. Habitat losses would be expected to be minor. Therefore, other federally threatened or endangered species would not be impacted by FM-OPS.

5.8.2.4.2 Wetlands

FM-OPS would have an average of only one day per year of flow above 175,000 cfs. Because floodwaters would rarely reach this level under this component, wetland habitats that fall beyond the reach of this flow would be influenced less frequently. Continued operation under this plan would maintain the existing conditions, including the hydrology and species composition of these areas.

5.8.2.4.3 Aquatic Resources

No direct or indirect impacts to aquatic resources are expected if FM-OPS is implemented. River and associated reservoir levels would fluctuate similarly to current flow rates.

5.8.2.4.4 Terrestrial Resources

No direct or indirect impacts to terrestrial resources are expected if FM-OPS is implemented. River and associated reservoir levels would fluctuate similarly to current flow rates.

5.8.3 Navigation Channel Deepening Feature

5.8.3.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.1 Threatened and Endangered Species

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.2 Wetlands

The Navigation Channel Deepening No Action Component would maintain the existing conditions, including the hydrology and species composition of wetlands. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated..

5.8.3.1.3 Aquatic Resources

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.4 Terrestrial Resources

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.5 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained in Segment 1 and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.6 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained in Segment 2 and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.7 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained in Segment 3 and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.8 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained in Segment 4 and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.9 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained in Segment 5 and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.1.10 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained in Segment 6 and no additional dredging locations or new river training structures would be required. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.3.2 Navigation Channel Deepening 10-Foot Channel Component

5.8.3.2.1 Threatened and Endangered Species

The USACE coordinated with the USFWS to prepare a BA for the Arkansas River Navigation Study and related activities associated with the operation of the MKARNS and the upstream reservoirs that influence water flow on the MKARNS. The BA was prepared pursuant to the requirements of the ESA, and it considered potential impacts to threatened and endangered species throughout the study area. While the BA addressed anticipated impacts to all federally listed threatened and endangered species potentially influenced by the USACE study and activities, it focused on species such as the interior least tern which are known to be present in multiple locations in the study area and have potentially been influenced by USACE activities along the MKARNS.

The BA was submitted to the USFWS in October, 2003. In response to the preparation of the BA, the USFWS issued a BO (June 28, 2005). The findings of the BA and BO are included in Section 4.8 of the EIS. Sixteen federally listed species occur in or near the study area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action. The least tern and American burying beetle are the only species addressed in the BO (USFWS 2005). Although the USFWS does anticipate that the American burying beetle would be affected by the proposed action as well, the BO emphasized anticipated effects of the proposed action on the least tern.

The BO suggested BMPs as well as RPMs for the protection of threatened and endangered species and their habitat in the study area. These BMPs and RPMs will be incorporated into the design features of the selected component for the proposed action. As a result of implementing the BMPs and RPMs, no impacts to threatened or endangered species would occur. The ivory-billed woodpecker was not included in the BA or BO because it was not discovered until recently. However, the USFWS included consideration of the ivory-billed woodpecker in its June 28, 2005 BO. The USFWS determined that the propsed action would not adversely affect the endangered ivory-billed woodpecker.

Interior Least Tern

There would be no adverse impacts to the federally endangered interior least tern under the Navigation Channel Deepening 10-Foot Channel Component. USACE, Tulsa District would continue to consult with the USFWS on least tern management and protective measures recommended by the USFWS would be incorporated into the proposed action and implemented. Minor beneficial impacts to the least tern would include increased habitat due to the creation of least tern islands from dredged material.

American Burying Beetle

Adverse impacts to American burying beetles would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented. Approximately 1,065 acres of terrestrial habitat disturbance due to dredged material disposal is anticipated with the proposed action, in addition to maintenance dredging. Despite the protective measures, some American burying beetles may be disturbed or killed during dredged material disposal pit construction, dredged material disposal, or other ground disturbance activities, but most of the effects are expected to be infrequent and of short duration.

Other Federally Listed Species

No impacts would be expected for the piping plover (*Charadrius melodius*), whooping crane (*Grus americana*), ivory-billed woodpecker (*Campephilus principalis*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Ozark big-eared bat (*Plecotus townsendii ingens*), bald eagle (*Haliaeetus leucocephalus*), Arkansas River shiner (*Notropis girardi*), pink mucket pearlymussel (*Lampsilis abrupta*), scaleshell mussel (*Leptodea leptodon*), American alligator (*Alligator mississippiensis*), pallid sturgeon (*Scaphirhynchus albus*), Geocarpon (*Geocarpon minimum*), western prairie fringed orchid (*Platanthera praeclara*), or harperella (*Ptilimnium nodosum*). Although these species may occur in the vicinity of the MKARNS, they are either unlikely to occur in the study area or their habitat would not be affected by the Navigation Channel Deepening 10-Foot Channel Component.

5.8.3.2.2 Wetlands

No impacts to wetlands are expected with implementation of the Navigation Channel Deepening 10-Foot Channel Component. National Wetland Inventory maps were used to avoid wetland areas when choosing dredged material disposal sites.

5.8.3.2.3 Aquatic Resources

According to GIS data compiled by USACE, Tulsa and Little Rock Districts, dredged material would be disposed of on approximately 2,484 acres of shallow water dike field habitat in Arkansas (see Appendix A) under all of the components. Under the NCD 10 Component, an additional 3,126 acres of aquatic habitat in Arkansas and 345 acres of aquatic habitat in Arkansas and Oklahoma would be impacted by dredged material disposal, for a total of 3,471 acres. Results from the aquatic habitat impacts analysis (Appendix C) illustrates a positive relationship between fish abundance and the depth of dike pools and the amount of gravel and sand-and-gravel mixture available. It implies that reducing water depth in a dike field through dredged material disposal and reducing the amount of gravel in the channel through dredging will have a major adverse impact to those fishes.

Approximately 3,732 acres and 4,025,886 cy of navigation channel substrate would be dredged along the MKARNS, in addition to maintenance dredging, for the Navigation Channel Deepening 10-Foot Channel Component (Table 5-6). Because the main channel of the

MKARNS has been degraded from the dredging and deepening activities associated with establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to deepening the channel to 10 feet and adding river training structures would be minor.

Gravel substrate is important habitat to aquatic life for spawning, food production, shelter, and hydrologic diversity. Pursuant with the concern about gravel bars, a gravel survey for this project was conducted during the summer of 2005 (Appendix C). A total of 28 potential gravel sites were initially identified in the project area ranging from river miles 6.5-421.0. The preliminary estimate of total available acres of gravel along the project length was 6,984 acres. However, 96.5 miles of gravel bars, or 23% of the project length, were identified as potential sites that could be impacted by dredging. Estimated total acres of gravel that could be impacted from dredging activities within these 96.5 miles were 967 acres, or 13.8% of the available gravel. These locations, encompassing the 96.5 miles, were provided to the survey boat, and over a 3-week period, the aerial extent and composition of the substrates were measured. These surveys subsequently identified 628 acres of sand/gravel mix, and 165 acres of pure gravel.

The goal of the mitigation is to have no-net loss of pure gravel bars either by relocating gravel that is dredged to a nearby, suitable area or transporting dredged gravel to other sites within the project area. Therefore, adverse impacts to gravel substrate would be short term and minor.

A 2004 Freshwater Mussel (Unionid) Survey conducted by Ecological Specialists, Inc. collected a total of 5,467 live unionids of 27 species at 43 sample sites encompassing dredging areas, disposal areas, and areas reported to harbor mussel beds along the MKARNS, and two additional species were found only as weathered shells. No threatened or endangered species were found in the mussel survey (see Appendix C). Of the 5,467 unionids collected in the study, 3,053 live unionids of 25 species were collected from Segment 1 of the MKARNS. Mussel populations would incur major adverse impacts at scattered areas throughout the MKARNS with more impacts occurring at higher density mussel areas that would be heavily dredged such as the Arkansas Post Canal in Segment 1. Adverse impacts to mussels would be reduced if mitigation measures are incorporated into the proposed action and implemented.

Adverse impacts to fish species as a result of dredging and in-water disposal associated with the Navigation Channel Deepening 10-foot Channel Component would be short-term and minor, primarily as a result of displacement during the dredging and disposal activities. Benthic macroinvertebrates in the dredged areas could be removed with the material and redistributed or buried during the disposal process. Those invertebrates at the disposal site could be buried. These two actions could also cause a temporary and short-lived reduction in prey items for fish and crayfish at these locations. Recolonization by invertebrate species would follow completion of dredging at both the dredging and disposal areas. Macroinvertebrate production would occur at both the dredge site location and on the disposed material during the following growing season. These species would be available as food organisms to resident and anadromous fish in the following spring.

Both resident and anadromous fish could use the area upstream and downstream of the sites where dredging and disposal activities would occur. The dredging and disposal activities would not be a continuous activity confined to a single location and fish would return to the activity areas shortly after completion of the project. Turbidity and water quality problems are expected to be minimal.

5.8.3.2.4 Terrestrial Resources

According to GIS data compiled by USACE, Tulsa and Little Rock Districts, approximately 5,664 acres of terrestrial habitat would be impacted by disposal of dredged material under all of the components. Under the NCD 10 Component, an additional 927 acres of terrestrial habitat would be impacted by dredged material disposal (see Appendix A). These additional disposal acreages for channel deepening occur in the following habitat categories:

- 8 acres of bottomland hardwoods;
- 46 acres of upland forest;
- 236 acres of open field;
- 98 acres of old field;
- 499 acres of agricultural land; and
- 40 acres of barren/sand habitat.

Since the majority of area impacted for deepening dredged material disposal would not be high quality habitat, such as agricultural lands open fields, and old fields, direct impacts to quality terrestrial habitats would be minor.

5.8.3.2.5 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Approximately 836 acres and 790,615 cy of sediment would be dredged in Segment 1, in addition to maintenance dredging, under the Navigation Channel Deepening 10-foot Channel Component. Channel deepening dredged material disposal would impact approximately 308 acres of terrestrial habitat (agricultural land only) and 330 acres of aquatic habitat. The majority of adverse impacts to mussels would be incurred along this segment.

5.8.3.2.6 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Approximately 266 acres and 98,929 cy of sediment would be dredged in Segment 2, in addition to maintenance dredging, under the Navigation Channel Deepening 10-foot Channel Component. Channel deepening dredged material disposal would impact approximately 181 acres of aquatic habitat.

5.8.3.2.7 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Approximately 389 acres and 196,478 cy of sediment would be dredged in Segment 3, in addition to maintenance dredging, under the Navigation Channel Deepening 10-foot Channel Component. Channel deepening dredged material disposal would impact approximately 2,023 acres of aquatic habitat.

5.8.3.2.8 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Approximately 619 acres and 378,400 cy of sediment would be dredged in Segment 4, in addition to maintenance dredging, under the Navigation Channel Deepening 10-foot Channel Component. Channel deepening dredged material disposal would impact approximately 667 acres of aquatic habitat.

5.8.3.2.9 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Approximately 1152 acres and 1,319,910 cy of sediment would be dredged in Segment 5, in addition to maintenance dredging, under the Navigation Channel Deepening 10-foot Channel Component. Channel deepening dredged material disposal would impact approximately 363 acres of terrestrial habitat and 270 acres of aquatic habitat. Most of the impacts to sensitive habitats would occur within this segment. Also, this segment contains all of the dredged material disposal impacts to aquatic habitat in Oklahoma.

5.8.3.2.10 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Approximately 470 acres and 1,241,554 cy of sediment would be dredged in Segment 6, in addition to maintenance dredging, under the Navigation Channel Deepening 10-foot Channel Component. Channel deepening dredged material disposal would impact approximately 256 acres of terrestrial habitat (mostly agricultural, open field, and old field).

5.8.3.3 Navigation Channel Deepening 11-Foot Channel Component

5.8.3.3.1 Threatened and Endangered Species

Refer to Section 5.8.3.2.1 for a discussion of the BA submitted by the USACE, the subsequent BO prepared by the USFWS (2005), and impacts to threatened and endangered species associated with the channel deepening components.

Interior Least Tern

Impacts to the federally endangered interior least tern would be similar to those for the Navigation Channel Deepening 10-Foot Channel Component.

American Burying Beetle

Impacts to the federally endangered American burying beetle would be similar to those for the Navigation Channel Deepening 10-Foot Channel Component.

Other Federally Listed Species

Similar to the Navigation Channel Deepening 10-Foot Channel Component, no impacts would be expected for other federally listed species.

5.8.3.3.2 Wetlands

Similar to the Navigation Channel Deepening 10-foot Channel Component, no impacts to wetlands are expected with implementation of the Channel Deepening 11-Foot Channel Component. National Wetland Inventory maps were used to avoid wetland areas when choosing dredged material disposal sites.

5.8.3.3.3 Aquatic Resources

Impacts to aquatic resources associated with the Navigation Channel Deepening 11-foot Channel Component would be similar to those for the 10-foot Channel Component (Section 5.8.3.2.3). According to GIS data compiled by USACE, Tulsa and Little Rock Districts, dredged material would be disposed of on approximately 2,484 acres of shallow water dike field habitat in

Arkansas (see Appendix A) under all of the components. Under the NCD 11 Component, an additional 3,126 acres of aquatic habitat in Arkansas and 345 acres of aquatic habitat in Arkansas and Oklahoma would be impacted by dredged material disposal, for a total of 3,471 acres. Results from the aquatic habitat impacts analysis (Appendix C) illustrates a positive relationship between fish abundance and the depth of dike pools and the amount of gravel and sand-and-gravel mixture available. It implies that reducing water depth in a dike field through dredged material disposal and reducing the amount of gravel in the channel through dredging will have a major adverse impact to those fishes.

Approximately 4,809 acres and 6,837,176 cy of navigation channel substrate would be dredged along the MKARNS, in addition to maintenance dredging, for the Channel Deepening 11-Foot Channel Component (Table 5-6). Because the main channel of the MKARNS has been degraded from the dredging and deepening activities associated with establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to deepening the channel to 11 feet and adding river training structures would be minor.

A total of 28 potential gravel sites were initially identified in the project area ranging from river miles 6.5-421.0. The preliminary estimate of total available acres of gravel along the project length was 6,984 acres. However, 96.5 miles of gravel bars, or 23% of the project length, were identified as potential sites that could be impacted by dredging. Estimated total acres of gravel that could be impacted from dredging activities within these 96.5 miles were 967 acres, or 13.8% of the available gravel. These locations, encompassing the 96.5 miles, were provided to the survey boat, and over a 3-week period, the aerial extent and composition of the substrates were measured. These surveys subsequently identified 628 acres of sand/gravel mix, and 165 acres of pure gravel. Similar to the NCD 10 Component, impacts to gravel substrate would be short term and minor.

A 2004 Freshwater Mussel (Unionid) Survey conducted by Ecological Specialists, Inc. collected a total of 5,467 live unionids of 27 species at 43 sample sites encompassing dredging areas, disposal areas, and areas reported to harbor mussel beds along the MKARNS, and two additional species were found only as weathered shells. No threatened or endangered species were found in the mussel survey (see Appendix C). Of the 5,467 unionids collected in the study, 3,053 live unionids of 25 species were collected from Segment 1 of the MKARNS. Mussel populations would incur major adverse impacts at scattered areas throughout the MKARNS with more impacts occurring at higher density mussel areas that would be heavily dredged such as the Arkansas Post Canal in Segment 1. Adverse impacts to mussels would be reduced if mitigation measures are incorporated into the proposed action and implemented.

5.8.3.3.4 Terrestrial Resources

Impacts to terrestrial resources under the Navigation Channel Deepening 11-foot Channel Component would be similar to those for the 10-foot Channel Component.

5.8.3.3.5 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Approximately 836 acres and 1,299,276 cy of sediment would be dredged in Segment 1, in addition to maintenance dredging, under the Navigation Channel Deepening 11-foot Channel Component. Channel deepening dredged material disposal would impact approximately 308 acres of terrestrial habitat (agricultural land only) and 330 acres of aquatic habitat. The majority of adverse impacts to mussels would be incurred along this segment.

5.8.3.3.6 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Approximately 266 acres and 225,517 cy of sediment would be dredged in Segment 2, in addition to maintenance dredging, under the Navigation Channel Deepening 11-foot Channel Component. Channel deepening dredged material disposal would impact approximately 181 acres of aquatic habitat.

5.8.3.3.7 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Approximately 715 acres and 387,227 cy of sediment would be dredged in Segment 3, in addition to maintenance dredging, under the Navigation Channel Deepening 11-foot Channel Component. Channel deepening dredged material disposal would impact approximately 2,023 acres of aquatic habitat.

5.8.3.3.8 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Approximately 835 acres and 643,500 cy of sediment would be dredged in Segment 4, in addition to maintenance dredging, under the Navigation Channel Deepening 11-foot Channel Component. Channel deepening dredged material disposal would impact approximately 667 acres of aquatic habitat.

5.8.3.3.9 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Approximately 1660 acres and 2,255,323 cy of sediment would be dredged in Segment 5, in addition to maintenance dredging, under the Navigation Channel Deepening 11-foot Channel Component. Channel deepening dredged material disposal would impact approximately 363 acres of terrestrial habitat and 270 acres of aquatic habitat. Most of the impacts to sensitive habitats would occur within this segment. Also, this segment contains all of the dredged material disposal impacts to aquatic habitat in Oklahoma.

5.8.3.3.10 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Approximately 497 acres and 2,026,333 cy of sediment would be dredged in Segment 6, in addition to maintenance dredging, under the Navigation Channel Deepening 11-foot Channel Component. Channel deepening dredged material disposal would impact approximately 256 acres of terrestrial habitat (mostly agricultural, open field, and old field).

5.8.3.4 Navigation Channel Deepening 12-Foot Channel Component

5.8.3.4.1 Threatened and Endangered Species

Refer to Section 5.8.3.2.1 for a discussion of the BA submitted by the USACE, the subsequent BO prepared by the USFWS (2005), and impacts to threatened and endangered species associated with the channel deepening components.

Interior Least Tern

Impacts to the federally endangered interior least tern would be similar to those for the Navigation Channel Deepening 10-Foot Channel Component.

American Burying Beetle

Impacts to the federally endangered American burying beetle would be similar to those for the Navigation Channel Deepening 10-Foot Channel Component.

Other Federally Listed Species

Similar to the Navigation Channel Deepening 10-Foot Channel Component, no impacts would be expected for other federally listed species.

5.8.3.4.2 Wetlands

Similar to the Navigation Channel Deepening 10-Foot Channel Component, no impacts to wetlands are expected with implementation of the Channel Deepening 12-Foot Channel Component. National Wetland Inventory maps were used to avoid wetland areas when choosing dredged material disposal sites.

5.8.3.4.3 Aquatic Resources

Impacts to aquatic resources associated with the Navigation Channel Deepening 12-foot Channel Component would be similar to those for the 10-foot Channel Component. According to GIS data compiled by USACE, Tulsa and Little Rock Districts, approximately 2,484 acres of shallow water dike field habitat in Arkansas (see Appendix A) under all of the components. Under the NCD 12 Component, an additional 3,126 acres of aquatic habitat in Arkansas and 345 acres of aquatic habitat in Arkansas and Oklahoma would be impacted by dredged material disposal, for a total of 3,471 acres. Results from the aquatic habitat impacts analysis (Appendix C) illustrates a positive relationship between fish abundance and the depth of dike pools and the amount of gravel and sand-and-gravel mixture available. It implies that reducing water depth in a dike field through dredged material disposal and reducing the amount of gravel in the channel through dredging will have a major adverse impact to those fishes.

Approximately 5645 acres and 10,985,340 cy of navigation channel substrate would be dredged along the MKARNS, in addition to maintenance dredging, for the Channel Deepening 12-foot Channel Component (Table 5-6). Because the main channel of the MKARNS has been degraded from the dredging and deepening activities associated with establishing and maintaining the navigation channel, prime aquatic substrate habitat loss due to deepening the channel to 12 feet and adding river training structures would be minor.

A total of 28 potential gravel sites were initially identified in the project area ranging from river miles 6.5 - 421.0. The preliminary estimate of total available acres of gravel along the project length was 6,984 acres. However, 96.5 miles of gravel bars, or 23% of the project length, were identified as potential sites that could be impacted by dredging. Estimated total acres of gravel that could be impacted from dredging activities within these 96.5 miles were 967 acres, or 13.8% of the available gravel. These locations, encompassing the 96.5 miles, were provided to the survey boat, and over a 3-week period, the aerial extent and composition of the substrates were measured. These surveys subsequently identified 628 acres of sand/gravel mix, and 165 acres of pure gravel. Similar to the NCD 10 Component, adverse impacts to gravel substrate would be short term and minor.

Impacts to mussels associated with the Navigation Channel Deepening 12-foot Channel Component would be similar to those for the 11-foot Channel Component. Mussels would incur major adverse impacts at scattered high-density mussel bed areas along the MKARNS. Impacts may be slightly higher due to the increased amount of dredging under this component.

5.8.3.4.4 Terrestrial Resources

Impacts to terrestrial resources under the Navigation Channel Deepening 12-foot Channel Component would be similar to those for the 10-foot Channel Component.

5.8.3.4.5 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Approximately 836 acres and 2,066,867 cy of sediment would be dredged in Segment 1, in addition to maintenance dredging, under the Navigation Channel Deepening 12-foot Channel Component. Channel deepening dredged material disposal would impact approximately 308 acres of terrestrial habitat (agricultural land only) and 330 acres of aquatic habitat. The majority of adverse impacts to mussels would be incurred along this segment.

5.8.3.4.6 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Approximately 266 acres and 445,995 cy of sediment would be dredged in Segment 2, in addition to maintenance dredging, under the Navigation Channel Deepening 12-foot Channel Component. Channel deepening dredged material disposal would impact approximately 181 acres of aquatic habitat.

5.8.3.4.7 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Approximately 883 acres and 925,439 cy of sediment would be dredged in Segment 3, in addition to maintenance dredging, under the Navigation Channel Deepening 12-foot Channel Component. Channel deepening dredged material disposal would impact approximately 2,023 acres of aquatic habitat.

5.8.3.4.8 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Approximately 1036 acres and 1,226,500 cy of sediment would be dredged in Segment 4, in addition to maintenance dredging, under the Navigation Channel Deepening 12-foot Channel Component. Channel deepening dredged material disposal would impact approximately 667 acres of aquatic habitat.

5.8.3.4.9 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

Approximately 1794 acres and 3,256,749 cy of sediment would be dredged in Segment 5, in addition to maintenance dredging, under the Navigation Channel Deepening 12-foot Channel Component. Channel deepening dredged material disposal would impact approximately 363 acres of terrestrial habitat and 270 acres of aquatic habitat. Most of the impacts to sensitive habitats would occur within this segment. Also, this segment contains all of the dredged material disposal impacts to aquatic habitat in Oklahoma.

5.8.3.4.10 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Approximately 830 acres and 3,063,790 cy of sediment would be dredged in Segment 6, in addition to maintenance dredging, under the Navigation Channel Deepening 12-foot Channel Component. Channel deepening dredged material disposal would impact approximately 256 acres of terrestrial habitat (mostly agricultural, open field, and old field).

5.8.4 Navigation Channel Depth Maintenance Feature

5.8.4.1 No Action Component (NCDM-NA)

Under the Navigation Channel Depth Maintenance No Action Component, current 9-foot navigation channel maintenance would continue under the existing plan. No changes in impacts to biological resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.4.1.1 Threatened and Endangered Species

Under the Navigation Channel Depth Maintenance No Action Component, current 9-foot navigation channel maintenance would continue under the existing plan. No changes in impacts to threatened and endangered species, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.4.1.2 Wetlands

Under the Navigation Channel Depth Maintenance No Action Component, current 9-foot navigation channel maintenance would continue under the existing plan. No changes in impacts to wetlands, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.4.1.3 Aquatic Resources

Under the Navigation Channel Depth Maintenance No Action Component, current 9-foot navigation channel maintenance would continue under the existing plan. No changes in impacts to aquatic resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.4.1.4 Terrestrial Resources

Under the Navigation Channel Depth Maintenance No Action Component, current 9-foot navigation channel maintenance would continue under the existing plan. No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.8.4.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

5.8.4.2.1 Threatened and Endangered Species

The USACE coordinated with the USFWS to prepare a BA for the Arkansas River Navigation Study and related activities associated with the operation of the MKARNS and the upstream reservoirs that influence water flow on the MKARNS. The BA was prepared pursuant to the requirements of the ESA, and it considered potential impacts to threatened and endangered species throughout the study area. While the BA addressed anticipated impacts to all federally listed threatened and endangered species potentially influenced by the USACE study and activities, it focused on species such as the interior least tern which are known to be present in multiple locations in the study area and have potentially been influenced by USACE activities along the MKARNS.

The BA was submitted to the USFWS in October, 2003. In response to the preparation of the BA, the USFWS issued a BO (June 28, 2005). The findings of the BA and BO are included in Section 4.8 of the EIS. Sixteen federally listed species occur in or near the study area; however, existing information indicates that only the endangered interior least tern and American burying beetle are likely to be affected by the proposed action. The least tern and American burying beetle are the only species addressed in the BO (USFWS 2005). Although the USFWS does anticipate that the American burying beetle would be affected by the proposed action as well, the BO emphasized anticipated effects of the proposed action on the least tern.

The BO suggested BMPs as well as RPMs for the protection of threatened and endangered species and their habitat in the study area. These BMPs and RPMs will be incorporated into the design features of the selected component for the proposed action. As a result of implementing the BMPs and RPMs, no impacts to threatened or endangered species would occur. The ivory-billed woodpecker was not included in the BA or BO because it was not discovered until recently. However, the USFWS included consideration of the ivory-billed woodpecker in its June 28, 2005 BO. The USFWS determined that the propsed action would not adversely affect the endangered ivory-billed woodpecker.

Interior Least Tern

There would be no adverse impacts to the federally endangered interior least tern under the NCDM-1 Component. USACE, Tulsa District would continue to consult with the USFWS on least tern management and protective measures recommended by the USFWS would be incorporated into the proposed action and implemented.

American Burying Beetle

Adverse impacts to American burying beetles would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented.

Other Federally Listed Species

No impacts would be expected for the piping plover (*Charadrius melodius*), whooping crane (*Grus americana*), ivory-billed woodpecker (*Campephilus principalis*), gray bat (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), Ozark big-eared bat (*Plecotus townsendii ingens*), bald eagle (*Haliaeetus leucocephalus*), Arkansas River shiner (*Notropis girardi*), pink mucket pearlymussel (*Lampsilis abrupta*), scaleshell mussel (*Leptodea leptodon*), American alligator (*Alligator mississippiensis*), pallid sturgeon (*Scaphirhynchus albus*), Geocarpon (*Geocarpon minimum*), western prairie fringed orchid (*Platanthera praeclara*), or harperella (*Ptilimnium nodosum*). Although these species may occur in the vicinity of the MKARNS, they are either unlikely to occur in the study area or their habitat would not be affected by the NCDM-1 Component.

5.8.4.2.2 Wetlands

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, once disposal capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected regardless of habitat type. Therefore, high quality habitat such as bottomland hardwoods, wet prairie, or wetlands could potentially be converted to dredged material disposal areas under this component, resulting in major long-term adverse impacts.

5.8.4.2.3 Aquatic Resources

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. Therefore, no changes to aquatic resources from current conditions are expected under the NCDM-1 Component.

5.8.4.2.4 Terrestrial Resources

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, once disposal capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected regardless of habitat type. Therefore, high quality habitat such as bottomland hardwoods, upland forest, and prairie could potentially be converted to dredged material disposal areas under this component, resulting in major long-term adverse impacts.

5.8.4.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

5.8.4.3.1 Threatened and Endangered Species

Refer to Section 5.8.4.2.1 for a discussion of the BA submitted by the USACE, the subsequent BO prepared by the USFWS, and impacts to threatened and endangered species associated with the maintenance dredged material disposal components.

Interior Least Tern

Impacts to the federally endangered interior least tern would be similar to those for the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component (Section 5.8.4.2.1).

American Burying Beetle

Similar to the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, adverse impacts to American burying beetles would be minor if protective measures recommended by the USFWS are incorporated into the proposed action and implemented.

Other Federally Listed Species

Similar to the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, no impacts would be expected for other federally listed species.

5.8.4.3.2 Wetlands

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this component, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided for dredged material disposal wherever practical. Therefore, impacts would be similar to existing conditions under the NCDM-2 Component.

5.8.4.3.3 Aquatic Resources

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long Term DMDP. Under this component, aquatic areas would be avoided for dredged material disposal wherever practical. Potential impacts to aquatic resources in these areas include, in addition to current maintenance dredged material disposal, a conversion of approximately 165 acres of aquatic habitat to dredged material disposal along the MKARNS, according to GIS data compiled by USACE, Tulsa and Little Rock Districts. This represents 0.14 percent of aquatic habitat within the study area. When considered within the geographical scope of the MKARNS, these aquatic impacts would be minor.

5.8.4.3.4 Terrestrial Resources

Existing dredging and disposal to maintain a 9-foot navigation channel would continue under this component. After currently utilized dredged material disposal sites reach their holding capacity, dredged material would be disposed of in new disposal sites designated in the 2003 Long-Term DMDP. Under this component, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided wherever practical. Potential impacts to terrestrial resources in these areas include dredged material disposal on a total of 537 acres of terrestrial habitat. These additional disposal acreages for the NCDM-2 Component occur in the following habitat categories:

- 7 acres of bottomland hardwoods;
- 73 acres of upland forest;
- 140 acres of open field;
- 234 acres of old field; and
- 115 acres of agricultural land.

The majority of area impacted would already not be high quality habitat, such as agricultural lands and old fields, and therefore, direct impacts to quality terrestrial habitats would be minor.

5.9 Recreation and Aesthetic Values

MKARNS and its associated upstream reservoirs offer numerous recreational and aesthetic opportunities to millions of people each year. Boating, fishing, wildlife viewing, hunting, and camping are just some of the recreational activities available. There are 26 recreational lakes and reservoirs found along the MKARNS that in 2002 had approximately 18.5 million visitors. These visitors have a very positive economic impact on the local communities in these areas. Therefore impacts to these recreational resources would affect not only those who would like to visit these areas, but also those who benefit from the economic effects of these areas.

5.9.1 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.9.1.1 No Action Component (FM-NA)

Under the No Action Component, river levels on the MKARNS would continue to fluctuate at current levels. The number of days greater than 75,000 cfs (small craft warnings are issued when flows reach 70,000 cfs or greater) would remain at an average of 47 days per year.

The USACE's modifications of flow rates are compatible with the authorized operational plan of each reservoir along the MKARNS. USACE would continue to cooperate with State and Federal fish and wildlife agencies to develop plans for some lakes and to provide regular seasonal pool fluctuations. Appropriate seasonal pool variations help to improve fish spawn by maintaining or increasing water levels during spring months, improve water recreation by maintaining levels sufficient for recreation during summer months, and improve waterfowl food and hunting by fluctuating water levels to maximize waterfowl habitat and hunting opportunities during fall months.

5.9.1.2 175,000 cfs Plan Component (FM-175)

This component produces an annual average of four additional days of flow above 175,000 cfs (approximate one-year flood level) at Van Buren. Also, the annual average number of days that reservoirs are expected to be above conservation pool level would increase (Table 5-4). Such flood events would produce minor impacts to recreation by inundating public use areas adjacent to the MKARNS more frequently. These areas include national wildlife refuges (NWRs), wildlife management areas (WMAs), State, Federal, and local parks, and natural heritage areas used for boat ramps, campgrounds, picnic areas, hunting, fishing, hiking, and/or nature observation. Costs related to lost camping days and recreational facility damage/cleanup is estimated at approximately $1,437,000 annually for FM-175. Slightly higher reservoir levels would lead to beneficial impacts to recreation activities such as boating, water sports, fishing, and swimming.

FM-175 would result in minor adverse impacts to recreation opportunities for pleasure boaters and fishermen that use the navigation channel. There would be an average of 2.6 additional days of flow above 75,000 cfs from April through September with this component. Small craft warnings are issued when flows reach 70,000 cfs or greater. Therefore, although the MKARNS would remain open for commercial navigation for an average of 16 more days each year, conditions would be less safe for small craft for a few additional days per year.

The USACE's modifications of flow rates would continue to remain compatible with the authorized operational plan of each reservoir along the MKARNS. USACE would cooperate with State and Federal fish and wildlife agencies to develop plans for some lakes and to provide regular seasonal pool fluctuations. Appropriate seasonal pool variations help to improve fish spawn by maintaining or increasing water levels during spring months, improve water recreation by maintaining levels sufficient for recreation during summer months, and improve waterfowl food and hunting by fluctuating water levels to maximize waterfowl habitat and hunting opportunities during fall months.

5.9.1.3 200,000 cfs Plan Component (FM-200)

This component produces an annual average of seven additional days of flow above 175,000 cfs (approximate one-year flood level) at Van Buren. Additionally, the annual average number of days that reservoirs are expected to be above conservation pool level would increase (Table 5-4). Costs related to lost camping days and recreational facility damage/cleanup is estimated at approximately $790,000 annually for FM-200.

There would be an average of 2.3 additional days of flow above 75,000 cfs from April through September with this component. Small craft warnings are issued when flows reach 70,000 cfs or greater. Therefore, although the MKARNS would remain open for commercial navigation for an average of 17 more days each year, conditions would be less safe for small craft for a few additional days per year.

Impacts to recreation under the 200,000 cfs Plan Component would be similar to those of the 175,000 cfs Plan Component.

5.9.1.4 Operations Only Plan Component (FM-OPS)

This component produces no additional days on an annual average of flow above 175,000 cfs (approximate 1-year flood level) at Van Buren compared with the No Action Component. In addition, alterations in average flow above 137,000 cfs (channel capacity) are negligible compared with the No Action Component. The number of days that reservoirs are expected to be above conservation pool level would be negligible (Table 5-4). Therefore, flow changes as a result of FM-OPS would not impact public use areas along the MKARNS and minimal additional annual costs would occur under FM-OPS as compared to the No Action Component.

FM-OPS would have minor beneficial impacts to recreation opportunities for pleasure boaters and fishermen that use the navigation channel. There would be an annual average of two fewer days of flow above 75,000 cfs at Van Buren with this component. Therefore, compared with the current plan the MKARNS would be safer for navigation and boating for approximately two additional days each year.

The USACE's seasonal pool fluctuation plans for the reservoirs under the Operations Only Plan Component would be similar to those for the other flow management components.

5.9.2 Navigation Channel Deepening Feature

5.9.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the No Action Component, there would be no short-term or long-term impacts to recreation and aesthetic values because channel deepening would not occur. The MKARNS channel would remain at its current depth, and there would be no negative or positive effects on recreation or aesthetic values in the region.

5.9.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Because channel deepening would not occur, no impacts to recreation or aesthetic values would be associated with implementing the No Action Component in this segment.

5.9.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Because channel deepening would not occur, no impacts to recreation or aesthetic values would be associated with implementing the No Action Component in this segment.

5.9.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Because channel deepening would not occur, no impacts to recreation or aesthetic values would be associated with implementing the No Action Component in this segment.

5.9.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Because channel deepening would not occur, no impacts to recreation or aesthetic values would be associated with implementing the No Action Component in this segment.

5.9.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Because channel deepening would not occur, no impacts to recreation or aesthetic values would be associated with implementing the No Action Component in this segment.

5.9.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Because channel deepening would not occur, no impacts to recreation or aesthetic values would be associated with implementing the No Action Component in this segment.

5.9.2.2 Navigation Channel Deepening 10-Foot Channel Component

The Navigation Channel Deepening 10-foot Channel Component would produce minor short-term impacts to recreation and aesthetic values. Actions proposed as part of this component would impact recreation activities and facilities located near proposed dredging and disposal locations. Dredging scenarios proposed under this component may temporarily close boat ramps and boat basins and affect public recreation areas (swimming beaches) on a short-term, temporary basis during deepening dredging. In addition, the dredging process and construction of or modification of river training structures would provide a minor, short-term decrease in aesthetics along the MKARNS. Minor long-term adverse impacts would be associated with dredged material disposal on areas used for hunting, fishing, or other recreational activities.

Beneficial uses of dredged material that would create wildlife habitat would have indirect beneficial impacts on recreation if they enhanced hunting, fishing, or wildlife viewing opportunities.

5.9.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 790,615 cy of material, creation of 2 new dredged material disposal sites, 9 modified revetments, and 4 new and 21 modified river training structures.

5.9.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 98,929 cy of material, creation of 2 new dredged material disposal sites, 1 new revetment, and 30 new and 4 modified river training structures.

5.9.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 196,478 cy of material, creation of 2 new dredged material disposal sites, 1 modified revetment, and 5 new and 34 modified river training structures.

5.9.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 378,400 cy of material, creation of 0 new dredged material disposal sites, 6 modified revetments, and 6 new and 28 modified river training structures.

5.9.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 1,319,910 cy of material, creation of 19 new dredged material disposal sites, 0 new or modified revetments, and 44 new and 0 modified river training structures.

5.9.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 1,241,554 cy of material, creation of 15 new dredged material disposal sites, 0 new or modified revetments, and 0 new or modified river training structures.

5.9.2.3 Navigation Channel Deepening 11-Foot Channel Component

Impacts to recreation and aesthetic values under the Navigation Channel Deepening 11-Foot Channel Component would be similar to those under the 10-Foot Channel Component. However, there would be slightly more impacts due to increased dredging area and volumes.

5.9.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 1,299,276 cy of material, creation of 2 new dredged material disposal sites, 0 new and 9 modified revetments, and 4 new and 21 modified river training structures.

5.9.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 225,517 cy of material, creation of 2 new dredged material disposal sites, 1 new revetment, and 30 new and 4 modified river training structures.

5.9.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 387,227 cy of material, creation of 2 new dredged material disposal sites, 1 modified revetments, and 5 new and 34 modified river training structures.

5.9.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 643,500 cy of material, creation of 0 new dredged material disposal sites, 6 modified revetments, and 6 new and 28 modified river training structures.

5.9.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 2,255,323 cy of material, creation of 19 new dredged material disposal sites, 0 new or modified revetments, and 44 new and 0 modified river training structures.

5.9.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 2,026,233 cy of material, creation of 15 new dredged material disposal sites, 0 new or modified revetments, and 0 new or modified river training structures.

5.9.2.4 Navigation Channel Deepening 12-Foot Channel Component

Impacts to recreation and aesthetic values under the Navigation Channel Deepening 12-Foot Channel Component would be similar to those under the 10-Foot Channel Component. However, there would be slightly more impacts due to increased dredging area and volumes.

5.9.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 2,066,867 cy of material, creation of 2 new dredged material disposal sites, 0 new and 9 modified revetments, and 4 new and 21 modified river training structures.

5.9.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 445,995 cy of material, creation of 2 new dredged material disposal sites, 1 new revetment, and 30 new and 4 modified river training structures.

5.9.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 925,439 cy of material, creation of 2 new dredged material disposal sites, 1 modified revetments, and 5 new and 34 modified river training structures.

5.9.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 1,226,500 cy of material, creation of 0 new dredged material disposal sites, 6 modified revetments, and 6 new and 34 modified river training structures.

5.9.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 3,256,749 cy of material, creation of 19 new dredged material disposal sites, 0 new or modified revetments, and 44 new and 0 modified river training structures.

5.9.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Channel deepening activities within this section and depth that could produce short-term impacts to recreation and aesthetic values include dredging and disposal of approximately 3,063,790 cy of material, creation of 15 new dredged material disposal sites, 0 new or modified revetments, and 0 new or modified river training structures.

5.9.3 Navigation Channel Depth Maintenance Feature

5.9.3.1 No Action Component (NCDM-NA)

Under the No Action Component, once disposal site capacity has been reached, maintenance dredging and disposal conditions on the MKARNS would be maintained in the short-term but in the long-term dredged material would be pumped further to active disposal sites or currently inactive disposal sites would be used.

No changes in impacts, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.9.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Under the Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan Component, once capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas would be selected regardless of habitat type. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. However, unlike large commercial vessels, recreational vehicles can still operate on the river without maintenance dredging and disposal occurring. Implementation of this component would have no beneficial or adverse impact on recreation and aesthetic values in the region.

5.9.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Under the Maintenance Dredged Material Disposal in New Disposal Sites Component, once capacity has been reached at the existing disposal sites on the MKARNS then new disposal areas (2 to 7 new disposal sites) would be selected. However, when selecting disposal sites, areas with high quality habitat such as forest, wetlands, and high quality grassland would be avoided. The new sites would allow for continued maintenance dredging and disposal on the MKARNS. Unlike large commercial vessels, recreational vehicles can still operate on the river without maintenance dredging and disposal occurring. Implementation of this component would have no beneficial or adverse impact on recreation and aesthetic values in the region.

5.10 Cultural Resources

An integral part of the impact analysis process is to determine the area within which archaeological resources would be affected or likely to be affected (36 CFR 800.16(d)). The Area of Potential Effect (APE) for archaeological resources is dependent on the project component under consideration. For the Flow Management Components, the APE on the MKARNS encompasses lands within the existing operating levels. In the 11 lakes, the APE encompasses all lands within the existing operating level for each lake. For the Channel Deepening Components, the APE on the MKARNS encompasses the existing channel and the areas identified for construction and/or modification of dikes and revetments. For the Maintenance Dredging and Disposal Components, the APE on the MKARNS encompasses the existing channel and the areas identified for construction and/or modification of dikes and revetments. The APE for the dredge disposal sites for this component are the limits of each proposed disposal location including any access roads and staging.

An undertaking is considered to have an effect on a historic property when the undertaking may alter characteristics of the property that may qualify the property for inclusion in the National Register of Historic Places (NRHP). An effect is considered adverse when it diminishes the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Adverse effects on historic properties (i.e., NRHP-listed or eligible resources) would include, but not be limited to:

- physical destruction, damage, or alteration of all or part of the property;

- isolation of the property from or alteration of the character of the property's setting when that character contributes to the property's qualification for the National Register of Historic Places;
- introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;
- neglect of a property resulting in its deterioration or destruction; and
- transfer, lease, or sale of the property (36 CFR 800.9[b]).

Any ground-disturbing action in the area of an NRHP-eligible or potentially eligible archaeological site, or modification to such a site, can affect the integrity of that cultural resource, resulting in alteration or destruction of those characteristics or qualities which make it potentially eligible for inclusion in the NRHP.

For the purposes of this document, a significant impact under NEPA will be defined as an 'adverse effect' under Section 106 of the National Historic Preservation Act.

5.10.1 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data. It is expected that reservoir and lake elevations and river stages will not fluctuate beyond existing operating levels.

Impacts to archaeological sites may include physical disturbance through wave action erosion of archaeological sites located along the shoreline, undercutting, slumping, and subsequent erosion of shoreline archaeological sites, and vandalism of archaeological materials from temporarily increased access to sites during periods of lower water levels. These types of physical disturbance would disturb or destroy the integrity of the archaeological sites and subsequently, their eligibility for the NRHP. Impacts to architectural resources include damage or destruction by erosion and flooding, and audio or visual intrusions to associated historic settings or cultural landscapes or alterations to viewsheds that form the cultural landscapes at these resources.

5.10.1.1 No Action Component (FM-NA)

Under the No Action Component, the Existing Operations Plan would continue. Existing conditions including ongoing erosion of archaeological sites or architectural resources, and vandalism of shoreline archaeological sites would continue. No additional cultural resources on the MKARNS or the lakes would be adversely impacted as a result of implementing the No Action Component. Cultural resources would continue to be managed in accordance with Federal laws, regulations, and USACE policies and procedures, and under the scope of the existing MKARNS management plan.

5.10.1.2 175,000 cfs Plan Component (FM-175)

Implementation of the FM-175 Component could result in changes to historic river flows and reservoir elevations. River flows under this component would provide an average of 9 fewer days per year at or above 61,000 cfs and an average of 16 fewer days per year at or above 100,000 cfs (note that changes in river flows are typically associated with changes in river stage elevations). The duration that reservoirs remain at flood level would increase under this plan since it is anticipated that reservoir levels would be between 0 and 10 feet above conservation pool more frequently than under existing conditions, and reservoir levels would be greater than 10 feet above conservation pool less frequently than under existing conditions. As a result, this change in river flows and reservoir levels would create additional opportunity for shoreline erosion exposing archaeological deposits, undercutting, slumping, and subsequent erosion of shoreline archaeological sites, and increasing the potential for vandalism of these exposed sites when the water levels decrease. This exposure of archaeological sites and potential subsequent vandalism may result in the disturbance and/or destruction of potentially NRHP-eligible cultural resources.

Known shoreline cultural resources and unidentified cultural resources occurring in unsurveyed areas may be located in the APEs. Some of these cultural resources may be considered NRHP-eligible and may also be disturbed or destroyed during fluctuations in lake flood pools and river levels. This component may result in an adverse effect to cultural resources.

Extended periods of flooding could cause erosion or damage to architectural resources and may also affect the historic setting or viewshed associated with these resources. No audio intrusion would occur.

Table 5-12. Known Cultural Resources Potentially Affected in MKARNS by Project Segment.

River Segment	Archaeological Sites	Architectural Resources	Known Shipwrecks
Mouth to Pine Bluff	Yes	1	25
Pine Bluff to Little Rock	Yes	1	34
Little Rock to Dardanelle	Yes	0	32
Dardanelle to Fort Smith	Yes	0	22
Fort Smith to Muskogee	Yes	0	7
Muskogee to Catoosa	Yes	0	32

5.10.1.3 200,000 cfs Plan Component (FM-200)

Impacts associated with the FM-200 Component would be similar to those associated with the FM-175 Component. Implementation of the FM-200 Component could result in changes to historic river flows and reservoir elevations. River flows under this component would provide an average of 9 fewer days per year at or above 61,000 cfs. In addition, this component provides an average of 17 fewer days per year at or above 100,000 cfs. (Note - changes in river flows are typically associated with changes in river stage elevations). The duration that reservoirs remain at flood level would increase under this plan since it is anticipated that reservoir levels would be between 0 and 8 feet above conservation pool more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above conservation pool less frequently than under existing conditions. As a result, this change in river flows and reservoir levels would create additional opportunity for shoreline erosion exposing archaeological deposits, undercutting, slumping, and subsequent erosion of shoreline archaeological sites, and increasing the potential for vandalism of these exposed sites when the water levels decrease. This exposure of archaeological sites and potential subsequent vandalism may result in the disturbance and/or destruction of potentially NRHP-eligible cultural resources.

5.10.1.4 Operations Only Plan Component (FM-OPS)

Impacts associated with the FM-OPS Component would be similar to those associated with the FM-175 and FM-200 Component, although changes in river and reservoir stages would be less under the FM-OPS Component. Implementation of the FM-OPS Component could result in changes to historic river flows and reservoir elevations. River flows under this component would provide an average of 14 fewer days per year at or above 61,000 cfs. This component results in an average of slightly less than two additional days per year at or above 100,000 cfs (note that changes in river flows are typically associated with changes in river stage elevations). The duration that reservoirs remain at flood level would be similar to existing conditions. It is anticipated that reservoir levels would be between 0 and 8 feet above conservation pool slightly more frequently than under existing conditions, and reservoir levels would be greater than 8 feet above conservation pool slightly less frequently than under existing conditions. As a result, this change in river flows and reservoir levels would create additional opportunity for shoreline erosion exposing archaeological deposits, undercutting, slumping, and subsequent erosion of shoreline archaeological sites, and increasing the potential for vandalism of these exposed sites when the water levels decrease. This exposure of archaeological sites and potential subsequent vandalism may result in the disturbance and/or destruction of potentially NRHP-eligible cultural resources.

5.10.2 Navigation Channel Deepening Feature

Potential environmental consequences of the proposed action could occur as a result of deepening the river channel through riverbottom dredging at selected locations and the construction and/or modification of dikes and revetments. None of the components would result in changes to reservoir water elevations or changes to the width of the navigation channel.

Potential impacts to cultural resources may include physical disturbance through channel deepening and dredging operations, and activities related to the construction and/or modification of dikes and revetments within the river channel and on adjacent shorelines. These types of physical disturbance would disturb or destroy the integrity of the archaeological sites and subsequently, their eligibility for the NRHP. Intact cultural resources within the existing channel are unlikely to occur. However, shipwrecks and submerged cultural resources, including submerged terrestrial sites, may occur in the areas identified for construction and/or modification of dikes and revetments

Impacts to architectural resources include audio or visual intrusions to associated historic settings or alterations to viewsheds that form the cultural landscapes at these resources as a result of activities related to the construction and/or modification of dikes and revetments.

5.10.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the Navigation Channel Deepening No Action Component, the current 9-foot navigation channel would be maintained and no additional dredging locations or new river training structures (i.e., dikes and revetments) would be required. Areas of the riverbottom that have been previously dredged as part of regular maintenance would not contain intact cultural resources. No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.10.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 1.

5.10.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 2.

5.10.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 3.

5.10.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 4.

5.10.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 5.

5.10.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated in Segment 6.

5.10.2.2 Navigation Channel Deepening 10-Foot Channel Component

River bottom dredging is unlikely to encounter intact cultural resources. Construction and/or modification of dikes may adversely impact submerged archaeological sites. Construction and/or modification of revetments and increased access to shoreline areas may adversely impact both submerged and terrestrial archaeological sites. Shipwrecks and submerged cultural resources, including submerged terrestrial sites, may occur in the APE and would be identified during subsequent cultural resources investigations if this component is selected. Some of these archaeological sites may be considered NRHP-eligible and may be disturbed or destroyed during activities relating to the construction and/or modification of dikes and revetments.

This component would cause temporary audio intrusion of architectural resources during construction activities. Impacts to the visual landscape or viewshed of resources caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

NRHP-eligible resources may be adversely impacted in this segment with this component. The construction of four new dikes measuring 680 linear feet and the modification of 36 existing dikes (an additional 1,205 linear feet) may impact submerged cultural resources. The modification of two existing revetments (an additional approximate 317 feet) may impact shoreline cultural resources. Twenty-five known shipwrecks occur in this segment of MKARNS.

The Arkansas Post National Memorial, an NRHP-listed cultural resource is partially within the APE of Segment 1 of the MKARNS, and may be subject to temporary audio intrusions during construction activities. Impacts to the visual landscape or viewshed of this resource caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 30 new dikes measuring 3,233 linear feet and the modification of four existing dikes may impact submerged cultural resources. The construction of one new revetment measuring 2.3 miles may impact shoreline cultural resources. Thirty-four known shipwrecks occur in this segment of the MKARNS.

The Plum Bayou Homesteads Historic District, in Wright, Arkansas, a 5,307 acre NRHP-listed cultural resource, extends to the Arkansas River at several locations and is assumed to be within the APE of the MKARNS. This resource may be subject to temporary audio intrusions during construction activities. Impacts to the visual landscape or viewshed of this resource caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of five new dikes measuring 683 linear feet, and the modification of 30 existing dikes of an additional 1,533 linear feet may impact submerged cultural resources. The construction of one new revetment measuring 1.5 miles and the modification of one existing revetment may impact shoreline cultural resources. Thirty-two known shipwrecks occur in this segment of MKARNS.

5.10.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of six new dikes measuring 616 linear feet, and the modification of 22 existing dikes of an additional 766 linear feet may impact submerged cultural resources. The construction of three new revetments measuring 2.5 miles and the modification of six existing revetments of an additional 475 feet may impact shoreline cultural resources. Twenty-two known shipwrecks occur in this segment of MKARNS.

5.10.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 44 new dikes measuring 16,243 linear feet may impact submerged cultural resources. No new revetments would be constructed. Riverbottom dredging may adversely impact submerged cultural resources, including site 34SQ026, an unevaluated, submerged terrestrial archaeological site located in the river bottom. Seven known shipwrecks occur in this segment of the MKARNS.

5.10.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

No new dikes or revetments would be constructed. No NRHP-eligible resources will be adversely affected in this segment with this component.

5.10.2.3 Navigation Channel Deepening 11-Foot Channel Component

Riverbottom dredging is unlikely to encounter intact cultural resources. Construction and/or modification of revetments and increased access to shoreline areas may adversely impact both submerged and terrestrial archaeological sites. Shipwrecks and submerged cultural resources, including submerged terrestrial sites, may occur within the APE and would be identified during subsequent cultural resources investigations if this component is selected. Some of these archaeological sites may be considered NRHP-eligible and may be disturbed or destroyed during activities relating to the construction and/or modification of dikes and revetments.

This component may cause temporary audio intrusion of architectural resources during construction activities. Impacts to the visual landscape or viewshed of resources caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of four new dikes measuring 1,360 linear feet and the modification of 36 existing dikes of an additional 2,410 linear feet may impact submerged cultural resources. No new revetments would be constructed. The modification of two existing revetments of an additional 317 feet may impact shoreline cultural resources. Twenty-five known shipwrecks occur in this segment of the MKARNS. The Arkansas Post National Memorial, an NRHP-listed cultural resource is partially within the APE of Segment 1 of the MKARNS, and may be subject to temporary audio intrusions during construction activities. Impacts to the visual landscape or viewshed of this resource caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 30 new dikes measuring 6,466 linear feet, and the modification of four existing dikes may impact submerged cultural resources. The construction of one new revetment measuring 2.3 miles may impact shoreline cultural resources. Thirty-four known shipwrecks occur in this segment of the MKARNS. The Plum Bayou Homesteads Historic District, in Wright, Arkansas, a 5,307 acre NRHP-listed cultural resource, extends to the Arkansas River at several locations and is assumed to be within the APE of the MKARNS. This resource may be subject to temporary audio intrusions during construction activities. Impacts to the visual landscape or viewshed of this resource caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of five new dikes measuring 1,366 linear feet, and the modification of 30 existing dikes of an additional 3,066 linear feet may impact submerged cultural resources. The construction of one new revetment measuring 1.5 miles and the modification of one existing revetment may impact shoreline cultural resources. Thirty-two known shipwrecks occur in this segment of MKARNS.

5.10.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 6 new dikes measuring 1,233 linear feet, and the modification of 22 existing dikes (an additional 1,533 linear feet) may impact submerged cultural resources. The construction of three new revetments measuring 2.5 miles and the modification of 6 existing revetments (an additional 0.09 miles) may impact shoreline cultural resources. Twenty-two known shipwrecks occur in this segment of MKARNS.

5.10.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 44 new dikes measuring 32,486 linear feet may impact submerged cultural resources. No new revetments will be constructed. Riverbottom dredging may adversely impact submerged cultural resources, including site 34SQ026, an unevaluated, submerged terrestrial archaeological site located in the river bottom. Seven known shipwrecks occur in this segment of MKARNS.

5.10.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

No new dikes or revetments would be constructed. No NRHP-eligible resources would be adversely impacted in this segment with this component.

5.10.2.4 Navigation Channel Deepening 12-Foot Channel Component

Riverbottom dredging is unlikely to encounter intact cultural resources. Construction and/or modification of dikes may adversely impact submerged archaeological sites. Construction and/or modification of revetments and increased access to shoreline areas may adversely impact both submerged and terrestrial archaeological sites. Shipwrecks and submerged cultural resources, including submerged terrestrial sites, may occur in the APE. Some of these archaeological sites may be considered NRHP-eligible and may be disturbed or destroyed during activities relating to the construction and/or modification of dikes and revetments.

This component may cause temporary audio intrusion of architectural resources during construction activities. Impacts to the visual landscape or viewshed of resources caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of four new dikes measuring 2,040 linear feet and the modification of 36 existing dikes of an additional 3,615 linear feet may impact submerged cultural resources. No new revetments would be constructed. The modification of 2 existing revetments of an additional 317 feet may impact shoreline cultural resources. Twenty-five known shipwrecks occur in this segment of the MKARNS. The Arkansas Post National Memorial, an NRHP-listed cultural resource is partially within the APE of Segment 1 of the MKARNS, and may be subject to temporary audio intrusions during construction activities. Impacts to the visual landscape or viewshed of this resource caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 30 new dikes measuring 9,700 linear feet and the modification of four existing dikes may impact submerged cultural resources. The construction of one new revetment measuring 2.3 miles may impact shoreline cultural resources. Thirty-four known shipwrecks occur in this segment of MKARNS. The Plum Bayou Homesteads Historic District, in Wright, Arkansas, a 5,307 acre NRHP-listed cultural resource, extends to the Arkansas River at several locations and is assumed to be within the APE of the MKARNS. This resource may be subject to temporary audio intrusions during construction activities. Impacts to the visual landscape or viewshed of this resource caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

5.10.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of five new dikes measuring 2,050 linear feet, and the modification of 30 existing dikes of an additional 4,600 linear feet may impact submerged cultural resources. The construction of one new revetment measuring 1.5 miles and the modification of one existing revetment may impact shoreline cultural resources. Thirty-two known shipwrecks occur in this segment of MKARNS.

5.10.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of six new dikes measuring 1,850 linear feet, and the modification of 22 existing dikes of an additional 2,300 linear feet may impact submerged cultural resources. The construction of three new revetments measuring 2.5 miles and the modification of six existing revetments of an additional 475 feet may impact shoreline cultural resources. Twenty-two known shipwrecks occur in this segment of MKARNS.

5.10.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

NRHP-eligible resources may be adversely impacted in this segment with this component. Construction of 44 new dikes measuring 48,729 linear feet may impact submerged cultural resources. No new revetments would be constructed. Riverbottom dredging may adversely affect submerged cultural resources, including site 34SQ026, an unevaluated, submerged terrestrial archaeological site located in the riverbottom. Seven known shipwrecks occur in this segment of MKARNS.

5.10.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

No new dikes or revetments would be constructed. No NRHP-eligible resources may be adversely impacted in this segment with this component.

5.10.3 Navigation Channel Depth Maintenance Feature

Potential adverse consequences of the proposed action on cultural resources would occur as a result of changes in the location of maintenance dredging disposal sites.

Potential adverse impacts to cultural resources include physical disturbance through construction and/or modification of dikes and revetments within the river channel and adjacent shorelines, use of new disposal locations, and vandalism from temporarily increased access during construction of shoreline revetments. Construction-related ground disturbance through the creation of access roads, staging areas, surface grading, or the use of heavy equipment may occur during the construction and/or modification of shoreline revetments. No disturbance of cultural resources at existing disposal locations would occur. Surface disturbance and ground preparation at areas designated as new disposal locations may damage cultural resources. Burial of cultural resources by dredged material may also occur. Such archaeological resources would essentially be sealed intact beneath the dredged materials; however, deeply buried sites would likely be unavailable for future research. Compaction of sites might result from burial, and contaminants in the dredged material have the potential to render some types of archaeological analysis ineffective if buried sites were excavated at some future time (e.g., fuel oil would hinder accurate radiocarbon dating of organic remains and make soil-phosphate analysis impossible). These types of physical disturbance would disturb or destroy the integrity of the archaeological sites and subsequently, their eligibility for the NRHP.

A total of 3 known NRHP-listed, eligible, potentially eligible, or unevaluated archaeological sites occur within the APE of the proposed dredged material disposal locations.

Potential impacts to architectural resources include audio or visual intrusions on associated historic settings or alterations to viewsheds that form the cultural landscapes at these resources.

5.10.3.1 No Action Component (NCDM-NA)

Under the No Action Component, current riverbottom dredging practices and use of existing disposal locations would continue. Areas where the riverbottom has been previously dredged as part of regular maintenance would not contain intact cultural resources. Intact cultural resources would not occur at existing disposal locations. No additional cultural resources would be adversely impacted as a result of implementing the No Action Component. No changes in impacts to NRHP-eligible cultural resources, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated.

5.10.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

The current 9-foot navigation channel would be maintained, resulting in no impacts to submerged cultural resources from dredging activities. NRHP-eligible resources may be adversely impacted in this segment with this component (Table 5-13). Construction of two new dikes measuring 800 feet (in Segment 1) and modification of 50 dikes may adversely impact submerged archaeological sites. Ninety documented shipwrecks occur in the MKARNS system. Some of these may be impacted by the construction and/or modification of dikes. Construction of two new revetments measuring 1.63 miles and modification of four existing revetments may adversely impact shoreline cultural resources. Use of existing disposal locations would not result in damage to cultural resources.

This component may cause temporary audio intrusions of architectural resources during construction activities. Impacts to the visual landscape or viewshed of resources caused by changes in the appearance of the shoreline through addition of revetments would be minimal.

Table 5-13. Known Cultural Resources Potentially Affected at Proposed Dredged Material Disposal Locations.

Segment	Number of Disposal Locations	Archaeological Sites in APE	Architectural Resources in APE	Total Cultural Resources in APE
Segment 1	2	0	0	0
Segment 2	0	0	0	0
Segment 3	0	0	0	0
Segment 4	0	0	0	0
Segment 5	37	2	0	2
Segment 6	22	1	0	1
Total	**61**	**3**	**0**	**3**

5.10.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

The current 9-foot navigation channel would be maintained resulting in no impacts to submerged cultural resources from dredging activities. NRHP-eligible resources may be adversely impacted in this segment with this component (Table 5-14). Construction of two new dikes measuring 800 feet (in Segment 1) and modification of 50 dikes may adversely impact submerged archaeological sites. Ninety documented shipwrecks occur in the MKARNS system. Some of these may be impacted by the construction and/or modification of dikes and revetments. Construction of two new revetments measuring 1.63 miles and modification of four existing revetments may adversely impact shoreline cultural resources. Use of new disposal locations would result in little disturbance to cultural resources provided disposal activities do not penetrate the ground surface; however, the disposal would cover or cap any cultural resources at the locations and curtail accessibility to site deposits for future archaeological research, and may compact or contaminate archaeological sites. There are three archeological sites, potentially eligible or recommended eligible or with unevaluated NRHP status identified in the APE at proposed disposal locations, one in Segment 5, and two in Segment 6.

There are no NRHP-listed architectural resources within the APE of any proposed dredged material disposal location within the project area.

5.11 Sociological Environment

Direct and indirect adverse impacts to the sociological environment result from those activities that affect the regional or local community fabric, including population, housing, community facilities and services, and infrastructure. These sociological changes can generally be directly or indirectly linked to new or expanded economic impacts.

5.11.1 Flow Management Feature

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

5.11.1.1 No Action Component (FM-NA)

Under the No Action Component river levels on the MKARNS would continue to fluctuate at current levels and restrict barge traffic during high flows. The average number of high flow days would not change and, therefore, the amount of barge traffic would not increase.

Because the number of high flow days would not be reduced, flooding of farm fields would continue at the same rate. This may cause farmers to lose production in some fields, and thus may adversely impact the local economy.

FM-NA would have little or no impact on local housing, schools, and public or social services.

Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-Income Populations. For environmental justice considerations, these populations are defined as individuals or groups of individuals that are subject to an actual or potential health, economic or environmental threat arising from existing or proposed Federal actions and policies. Low income is defined as an aggregate annual mean income of $17,050 for a family of four in 2000. Low income and minority population data were compared for counties located proximate to the Arkansas River, the study area, and the States of Oklahoma and Arkansas.

The 2000 U.S. Census indicates that over 13 percent of the population in counties proximate to the Arkansas River, versus 14 percent of the population within the State of Oklahoma and 15 percent of the population within the State of Arkansas falls within the definition of low-income.

Likewise the 2000 U.S. Census indicates that over 26 percent of the population in counties proximate to the Arkansas River, versus 24 percent of the population within the State of Oklahoma and 20 percent of the population within the State of Arkansas are identified as minority.

FM-NA would not have a disproportionate impact on minority or low-income populations in the study area.

Native American and Other Ethnic Concerns

On May 14, 1998, the President issued Executive Order 13084, *Consultation and Coordination with Indian Tribal Governments.* This Executive Order recognizes the unique legal relationship the U.S. government has with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, Executive Orders, and court decisions.

Although no impacts are expected under FM-NA, it is the USACE's policy to fully comply with Executive Order 13084.

Protection of Children

On April 21, 1997, the President issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. This Executive Order recognizes that a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks.

FM-NA would not have a disproportionate impact on children in the study area.

5.11.1.2 175,000 cfs Plan Component (FM-175)

A 16-day increase in navigation at maximum tow size per year produced by FM-175 could result in more goods transported by barge. Navigation on the MKARNS provides the least expensive form of transportation for dozens of local industries that produce chemical fertilizer, sand, gravel and rock, wheat, soybeans, and other commodities. Based upon analysis of the potential river operations projected under this component, there would be a minor long-term increase in employment within the study area.

With a higher target flow than the No Action Component, water levels may reach higher elevations slightly more frequently under FM-175 than under the No Action Component. Structures, roads, agricultural fields, and local industry such as gravel pits and quarries throughout the floodplain that are rarely inundated under the current plan have a higher chance of flooding under FM-175, causing economic impacts to local residents. Average annual agricultural property damages of $264,000 and non-agricultural property damages of $263,000 would produce minor adverse impacts to the local economies.

Several recreational public use areas, boat ramps, and campgrounds that provide for quality of life and stimulate the economy also may be impacted by FM-175. The number of days per year that these areas would flood and remain inundated would vary according to soil type, topography, and other variables. Flooding may cause temporary disruptions in ground transportation (roadways), emergency services, and utility services.

FM-175 would have little or no impact on local housing, schools, and public or social services.

Environmental Justice

As with FM-NA, FM-175 also would not have a disproportionate impact on minority or low-income populations in the study area.

Native American and Other Ethnic Concerns

Slightly increased flooding caused by FM-175 may affect tribal lands or resources on the Osage Indian Reservation or on off-reservation American Indian trust lands. It is the USACE's policy to fully comply with Executive Order 13084 and it would respond to any impacts to minorities within the affected area. Where differences occur regarding the preferred alternative or mitigation measures that would affect tribal lands or resources, the affected Indian Tribe may request that a dispute resolution process be initiated to resolve the conflict between the tribe and Agency.

Protection of Children

FM-175 would not have a disproportionate impact on children in the study area.

5.11.1.3 200,000 cfs Plan Component (FM-200)

With a higher target flow than the No Action Component, water levels may reach higher elevations slightly more frequently under FM-200. Additional impacts of FM-200 are slightly higher than those of FM-175, including flood agricultural and property damage, employment, quality of life, and other sociological issues. Average annual agricultural property damages of $545,000 and non-agricultural property damages of $453,000 would produce minor adverse impacts to the local economies.

FM-200 would have little or no impact on local housing, schools, and public or social services.

Environmental Justice

As with FM-NA, FM-200 also would not have a disproportionate impact on minority or low-income populations in the study area.

Native American and Other Ethnic Concerns

Slightly increased flooding caused by FM-200 may impact tribal lands or resources on the Osage Indian Reservation or on off-reservation American Indian trust lands. It is the USACE's policy to fully comply with Executive Order 13084 and it would respond to any impacts to minorities within the study area. Where differences occur regarding the preferred alternative or mitigation measures that would impact tribal lands or resources, the affected Indian Tribe may request that a dispute resolution process be initiated to resolve the conflict between the tribe and Agency.

Protection of Children

FM-200 would not have a disproportionate impact on children in the study area.

5.11.1.4 Operations Only Plan Component (FM-OPS)

An annual average 14-day decrease in flow days above 61,000 cfs produced by FM-OPS could result in more efficient barge transport. Navigation on the MKARNS provides the least expensive form of transportation for dozens of local industries that produce chemical fertilizer, sand, gravel and rock, wheat, soybeans, and other commodities. Based upon analysis of the potential river operations projected under this component, there would be a minor long-term increase in employment within the study area.

The decrease in number of days of flows above 61,000 cfs would slightly improve farming operations along the MKARNS, while there would be no significant increases in agricultural/structural or recreational damages within the system. Less frequent flooding of farm fields may stimulate agricultural production and thus the local economy and quality of life.

FM-OPS would have little or no impact on local housing, schools, and public or social services.

Environmental Justice

As with FM-NA, FM-OPS also would not have a disproportionate impact on minority or low-income populations in the study area.

Native American and Other Ethnic Concerns

Similar to the No Action Component, although no impacts are expected under FM-OPS it is the USACE's policy to fully comply with Executive Order 13084.

Protection of Children

FM-OPS would not have a disproportionate impact on children in the study area.

5.11.2 Navigation Channel Deepening Feature

5.11.2.1 Navigation Channel Deepening No Action Component (9-Foot Channel)

Under the Navigation Channel Deepening No Action Component, the MKARNS channel would remain at its current depth. Therefore, this component is anticipated to have no impacts on regional population, employment, or income. Since navigational clearances and water surface profiles would be maintained and no changes in overall reservoir operations are proposed, this component is also expected to have little to no impact on MKARNS uses or users.

No additional impacts on environmental justice issues would be expected under the Channel Deepening No Action Component. No changes in demographics, employment, housing, or public services would be expected relative to baseline conditions.

5.11.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Since the MKARNS channel would remain at its current depth, no changes in impacts to the sociological environment, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 1.

5.11.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Since the MKARNS channel would remain at its current depth, no changes in impacts to the sociological environment, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 2.

5.11.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Since the MKARNS channel would remain at its current depth, no changes in impacts to the sociological environment, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 3.

5.11.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Since the MKARNS channel would remain at its current depth, no changes in impacts to the sociological environment, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 4.

5.11.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Since the MKARNS channel would remain at its current depth, no changes in impacts to the sociological environment, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 5.

5.11.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Since the MKARNS channel would remain at its current depth, no changes in impacts to the sociological environment, either in frequency or magnitude, from the existing, baseline conditions as described in Chapter 4, are anticipated within Segment 6.

5.11.2.2 Navigation Channel Deepening 10-Foot Channel Component

5.11.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

There would be one residential displacement and relocation in this segment as a result of dredging material operations and disposal. There would be no adverse disproportionate impacts on low-income or minority populations.

5.11.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

There would be no short or long-term adverse or beneficial impacts on the sociological environment within Segment 2 as a result of channel deepening to 10 feet.

5.11.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

There would be no short or long-term adverse or beneficial impacts on the sociological environment within Segment 3 as a result of channel deepening to 10 feet.

5.11.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

There would be no short or long-term adverse or beneficial impacts on the sociological environment within Segment 4 as a result of channel deepening to 10 feet.

5.11.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

There would be no short or long-term adverse or beneficial impacts on the sociological environment within Segment 5 as a result of channel deepening to 10 feet.

5.11.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

There would be no short or long-term adverse or beneficial impacts on the sociological environment within Segment 6 as a result of channel deepening to 10 feet.

5.11.2.3 Navigation Channel Deepening 11-Foot Channel Component

5.11.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

There would be one residential displacement and relocation in this segment as a result of dredging material operations and disposal. There would be no adverse disproportionate impacts on low-income or minority populations

5.11.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

There would be no short or long-term impacts on the sociological environment within Segment 2 as a result of channel deepening to 11 feet.

5.11.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

There would be no short or long-term impacts on the sociological environment within Segment 3 as a result of channel deepening to 11 feet.

5.11.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

There would be no short or long-term impacts on the sociological environment within Segment 4 as a result of channel deepening to 11 feet.

5.11.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

There would be no short or long-term impacts on the sociological environment within Segment 5 as a result of channel deepening to 11 feet.

5.11.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

There would be no short or long-term impacts on the sociological environment within Segment 6 as a result of channel deepening to 11 feet.

5.11.2.4 Navigation Channel Deepening 12-Foot Channel Component

5.11.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

There would be one displacement and relocation of a land owner or tenant as a result of dredging and disposal operations in this segment. There would be no adverse disproportionate impacts on low-income or minority populations.

5.11.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

There would be no short or long-term impacts on the sociological environment within Segment 2 as a result of channel deepening to 12 feet.

5.11.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

There would be no short or long-term impacts on the sociological environment within Segment 3 as a result of channel deepening to 12 feet.

5.11.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

There would be no short or long-term impacts on the sociological environment within Segment 4 as a result of channel deepening to 12 feet.

5.11.2.4.5 Segment 5 – Fort Smith to Muskogee (NCD 12-5)

There would be no short or long-term impacts on the sociological environment within Segment 5 as a result of channel deepening to 12 feet.

5.11.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

There would be no short or long-term impacts on the sociological environment within Segment 1 as a result of channel deepening to 12 feet.

5.11.3 <u>Maintenance Dredging and Disposal Feature</u>

5.11.3.1 No Action Component (MDDA-NA)

There would be no additional short or long-term adverse or beneficial impacts on the sociological environment under the No Action Component as existing dredging and disposal operations would continue as under current conditions.

5.11.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

There would be no short or long-term adverse or beneficial impacts on the sociological environment under this Component. In addition, there would be no adverse disproportionate impacts on low-income or minority populations.

5.11.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

There would be no short or long-term adverse or beneficial impacts on the sociological environment under this Component. In addition, there would be no adverse disproportionate impacts on low-income or minority populations.

5.12 Economic Environment

Direct and indirect impacts to the economic environment of the study area would result from the economic costs or benefits of each component to operations and maintenance of the navigation system, commercial navigation, agricultural and non-agricultural lands, hydropower facilities, and tourism/recreation. Analysis of the economic consequences includes the comparison of economic benefits and project costs under each component. Indirect benefits would include a potential increase in employment, labor force, income and business volume, and expansion of new business and industry. Other potential indirect impacts include impacts on community and regional growth, property values and tax revenues, and public facilities and services.

5.12.1 Flow Management Components

Potential environmental consequences of the proposed action would occur primarily as a result of changes in the frequency and duration of reservoir elevation and river stage water levels. None of the Flow Management Components would result in higher reservoir water elevations or river stages than have been previously recorded in the 61 years of rainfall data.

Table 5-14 provides a summary of the incremental net economic benefits and costs associated with each of the components.

Table 5-14. Summary of Incremental Net Economic Benefits and Costs, Average Annual Values (Thousands of Dollars), 5.375% Discount Rate, 50-year Economic Life.

	Increment Over Baseline			
	No Action Component (FM-NA)	**175,000 cfs Component (FM-175)**	**200,000 cfs Component (FMA-200)**	**Operations Only Plan Component (FM-OPS)**
Incremental Costs				
Construction	-	-	-	-
O&M	-	-	-	-
Real Estate (Potential)	-	719.00	955.90	0
Non-Agricultural Property Damage (Includes Recreational Facilities)				
Oklahoma	-	78.30	37.00	(5.50)
Arkansas	-	185.00	415.90	(13.10)
Agricultural Property Damages				
Oklahoma	-	119.50	245.50	0
Arkansas	-	144.80	299.60	(18.80)
Subtotal		**1,246.60**	**1,953.9 0**	**(37.40)**
Incremental Benefits				
Navigation	-	9,220.70	9,176.10	8,372.10
Recreation	-	(1,436.90)	(790.20)	0

Hydropower	-	1,340.00	1,056.00	466.00
Subtotal		**9,123.80**	**9,441.90**	**8,838.10**
Incremental Net Benefits	**-**	**7,877.20**	**7,488.12**	**8,800.70**
Source: USACE, Tulsa and Little Rock Districts, NWD, Parsons, 2005.				

5.12.1.1 No Action Component (FM-NA)

Operations and Maintenance

Under FM-NA, existing operations and maintenance activities accomplished by the USACE to maintain the existing MKARNS would continue at their current rate and frequency. These activities include the maintenance and repair of the existing locks, dams, levees, recreational structures, as well as the dredging of the river to maintain safe navigation depths. Implementation of this component would result in the continuation of existing beneficial and adverse direct and indirect impacts associated with operation and maintenance of the system. Consequently, no changes in the conditions contributing to the affected environment are anticipated.

Commercial Navigation

The MKARNS was completed in 1971. From the establishment of the project, river traffic has steadily grown to more than ten million tons annually. Future growth of traffic on the waterway is dependent upon the operating scenarios employed by the USACE, regional economic growth and the existing navigation traffic base.

For the purpose of this analysis, current navigation traffic on the river has been estimated to be equal to the five-year average of traffic reported by the Waterborne Commerce Statistical Center (WCSC) for the period 1996-2000. The observed movements provided by the WCSC data were sorted into groups representing the type of barge service each of eight commodity groups would utilize. Table 5-15 portrays the base year traffic by commodity group, as well as the observations for each of the five years that make up the average.

Table 5-15. Base Year Commodity Traffic, MKARNS.

Commodity Group	1996	1997	1998	1999	2000	Five Year Average
Grain & Grain Products	1,710,492	2,186,214	2,250,890	2,223,384	2,023,648	2,078,926
Chemicals	1,111,730	1,252,057	1,380,276	1,438,195	1,298,542	1,296,160
Iron & Steel	733,582	911,361	1,024,751	826,322	929,897	885,183
Manufactured Products	1,272,074	1,473,379	1,705,475	1,396,290	1,092,175	1,387,879
Aggregates	1,299,011	1,390,901	1,690,175	2,037,920	2,021,256	1,687,853

Table 5-15. Base Year Commodity Traffic, MKARNS.						
Petroleum Products	724,588	520,912	637,325	583,886	476,360	588,614
Liquid Fertilizer	667,345	568,027	572,674	420,938	481,974	542,192
Dredged Sand & Gravel	2,435,775	2,454,359	2,300,430	2,322,770	2,167,888	2,336,244
Total	**9,954,597**	**10,757,210**	**11,561,996**	**11,249,705**	**10,491,740**	**10,803,050**
Source: USACE, Little Rock District, 2002						

The growth in barge traffic on the inland waterway system is a function of the infrastructure development along the waterways and the economic development in the region adjacent to the waterways. In 1999, the USACE Institute for Water Resources (IWR) published traffic growth rates by river segment and by commodity group, based on low, median and high growth rates. SCI and Wharton Econometric Forecasting Associates (WEFA) prepared the commodity group growth rates, and IWR prepared the waterway growth segment analysis.

The specific MKARNS waterway segment low growth rate, by commodity group, was constrained to be a positive 0.1%. This reflects national differences in the methods of grouping the commodities between a type of service or a statistical category. Since the White River traffic is outside the scope of this analysis, navigation traffic on the river was not included in the forecast.

Table 5-16 displays the commodity growth rates through 2020 used for the MKARNS analysis. After 2020, the low growth rate was employed to expand the traffic for the 50-year length of the project. It should be noted that the growth rates are compounded and the use of the range of growth rates facilitated the sensitivity analysis.

Table 5-16. Projected Growth Rates through 2020, MKARNS

Commodity Group	% Low	% Mean	% High
Grain & Grain Products	0.9%	1.6%	2.2%
Chemicals	0.6%	1.5%	2.1%
Iron & Steel	0.6%	1.7%	2.6%
Manufactured Products	0.8%	1.5%	2.1%
Aggregates	0.1%	0.7%	1.5%
Petroleum Products	0.3%	1.0%	1.5%
Liquid Fertilizer	0.1%	0.9%	1.6%
Dredged Sand & Gravel	0.1%	0.7%	1.5%
Source: USACE, Little Rock District, 2002			

Based upon the estimated growth rates anticipated under FM-NA, Table 5-17 reflects the growth in estimated navigation activity that would occur if the current flow management operations and maintenance policies were continued into the future.

Table 5-17. Estimated Commodity Traffic Growth.			
Commodity Group	**Five Year Average (Tons)**	**Percent Growth (Mean)**	**Average Annual Increase**
Grain & Grain Products	2,078,926	1.6	33,263
Chemicals	1,296,160	1.5	19,442
Iron & Steel	885,183	1.7	15,048
Manufactured Products	1,387,879	1.5	20,818
Aggregates	1,687,853	0.7	11,815
Petroleum Products	588,614	1.0	5,886
Liquid Fertilizer	542,192	0.9	4,880
Dredged Sand & Gravel	2,336,244	0.7	16,354
Total	**10,803,050**		**127,506**
Source: USACE, Little Rock District, 2002			

Based on this analysis, commodity traffic growth on the MKARNS would be expected to increase by approximately $127,506 per year or approximately 1.18% per year under FM-NA. This would not significantly impact navigation in the region.

Increased commodity traffic along the MKARNS would likely result in some increased employment with the shipping industry. Minor amounts of secondary employment could also be anticipated as personnel employed in the shipping industry purchase goods and services in the surrounding community.

Non-Agricultural Structures

An inventory of structures and application of the HEC-FDA Model was used to determine structure damages under each flow management component. In the Economics Analysis Appendix within the Feasibility Report (USACE 2005), the study titled “Flood Control Economic Analysis: Oklahoma” and a description and analysis of the methodologies employed for the Arkansas portion of the study area, prepared by the economics analysis team, provide a detailed description and analysis of structure damages in the study area.

Under FM-NA, river levels on the MKARNS would continue to fluctuate at current levels. No additional positive or negative economic impacts are anticipated to occur under this component, since existing impacts would continue as under current conditions. No damage estimates were developed for roads, railroads, utility systems, or other infrastructure in Oklahoma since losses to non-agricultural property for the flow management components was not high relative to the baseline condition. Generally, losses to infrastructure, such as utilities, are estimated to be relatively small and based on updated historical losses of about $150 to $200 per structure. Road losses are not high and would be relatively minor based on a change in operating plans.

Agricultural

A description and analysis of the methodologies employed by the economics analysis team for the Arkansas portion of the study area in respect to crop inventory, crop damage assessment, and application of the HEC-AGDAM Model can be found in the Economics Analysis Appendix of the Feasibility Report (USACE 2005).

The study entitled "*Flood Control Economic Analysis: Oklahoma*", of the Economics Analysis Appendix in the Feasibility Report (USACE 2005), provides a more detailed description and analysis of crop damages in the Oklahoma portion of the study area. The Oklahoma study also contains a description of the procedure and methodologies for determining crop damages.

Under FM-NA, river levels on the MKARNS would continue to fluctuate at current levels. No additional positive or negative economic impacts are anticipated to occur under this component, since existing impacts would continue as under current conditions.

Hydroelectric

FM-NA represents the current operating condition of the hydropower facilities on the MKARNS. A basic assumption of FM-NA is that there would be no change in reliability at the hydropower projects. The powerhouse equipment is expected to be unchanged. Future flows available for hydropower generation are based on years' 1940–2000 historical flows modeled with the SUPER Model using the current system operating plan. The No Action project condition also assumes that within the Southwest Power Pool (SPP), plant retirements would occur, that load demand would increase, and new generation would be brought on-line to meet this demand. Consequently, implementation of FM-NA is not anticipated to result in either direct or indirect effects to the existing, baseline conditions.

Tourism/Recreation

Under FM-NA, river levels on the MKARNS would continue to fluctuate at current levels. No additional positive or negative economic impacts are anticipated to occur with this component, since existing impacts would continue as under current conditions.

5.12.1.2 175,000 cfs Plan Component (FM-175)

Operations and Maintenance

Implementation of FM-175 is anticipated to result in a minor reduction in the amount of maintenance dredging that would be required to maintain safe navigation depth. However, it is not possible to quantify this reduction. Consequently, for the purpose of analysis, it was assumed that the average annual cost of maintenance dredging on the MKARNS would remain at approximately $1.3 million per year. In addition, the USACE does not anticipate that any of the flow management components would result in the requirement of additional bank stabilization, revetments, or dike work. Other existing beneficial and adverse direct and indirect impacts associated with the implementation of FM-175 are anticipated to be similar to those present under FM-NA.

Commercial Navigation

Implementation of FM-175 would result in commercial navigation gaining an average of 16 additional days per year in which river flow rates would be below 100,000 cfs. This change in flow would result in commercial navigation cost savings. Implementation of this component would also increase the annual average number of days in which river flow would be less than

61,000 cfs. Below 61,000 cfs, towboat operators could change their towboat configuration, allowing them to run more favorable configurations.

If this component were implemented, approximately $9.2 million per year in costs currently incurred by commercial shipping companies would be avoided. These cost savings would allow them to decrease charges to customers and increase company profits. The decrease in shipping charges is anticipated to result in increased demand for shipping on the MKARNS, increasing surface water transportation usage at a rate faster then would be experienced under FM-NA.

Decreased shipping costs and the resulting increase in shipping demand would result in increased employment as use of this shipping method increased. Minor amounts of secondary employment could also be anticipated as personnel employed in the shipping industry purchase goods and services in the surrounding community.

No modal shift in the use of alternative modes of transportation (e.g. highway or rail) is anticipated as a result of implementing this component.

Non-Agricultural Structures

Non-agricultural property or structure damages under FM-175 are approximately $263,000, as shown in Table 5-14.

Agricultural

Additional annual agricultural property damages under FM-175 are approximately $264,000 compared to FM-NA, as shown in Table 5-14.

Hydroelectric

The determination of power benefits for the flow management components included the following steps:

For Energy Benefits:

1) Obtain period-of-record daily head, total discharge, and generation for hydropower projects modeled in SUPER. For projects where generation was not estimated in SUPER, daily total discharge for the period-of-record was obtained. These data represent project operation under current operating assumptions.
2) Obtain plant performance data (output and efficiency as a function of head) for each plant not modeled in SUPER.
3) Make a period-of-record daily determination of project generation and peaking capability for each flow management alternative.
4) Utilizing the previous results, estimate the project average annual generation for each flow management alternative.
5) Determine the levelized energy value using energy value output from the PROSYM production cost model.
6) Using the average annual generation and levelized energy value, determine life-cycle energy benefits for each flow management alternative.

For Capacity Benefits:

1) Obtain period-of-record daily head, total discharge, and generation for hydropower projects modeled in SUPER. For projects where generation was not estimated in SUPER, daily total discharge period-of-record was obtained. These data represent project operation under current operating assumptions.

2) Obtain plant performance data (output and unit efficiency as a function of head) for each plant not modeled in SUPER.

3) Make a period-of-record daily determination of project generation and peaking capability for each flow management alternative.

4) Utilizing the previous results and the average availability method, estimate the project dependable capacity for each flow management alternative.

5) Establish values for thermal plant availability and operational flexibility.

6) Utilize MKARNS projects historical hourly generation data to develop annual generation-duration curves.

7) Utilize Federal Energy Regulatory Commission procedures to develop the capacity value for each thermal alternative.

8) Perform a screening curve analysis to determine the unit capacity value for the most likely, least-cost thermal alternative.

9) Using dependable capacity and the capacity value, determine life-cycle capacity benefits for each flow management alternative.

By utilizing the steps summarized in the previous section on a day-by-day basis, the analysis determined the period-of-record daily energy and capacity output for each run-of-river project under each flow management study alternative. For the storage projects on the MKARNS, daily energy and capacity output was used directly from the SUPER model. For each flow management component, the period-of-record daily energy output results were used to develop the corresponding estimate of project average annual energy. Table 5-18 summarizes the average annual energy estimates obtained for the flow management components as well as the corresponding annual energy gain relative to baseline conditions.

Table 5-18. Annual Generation Computation For Flow Management Components.

	Plant Capacity (mega watt (MW))	Average Annual Energy (GWh)			
Flow Management Component	**All Projects**	**Storage Projects**	**Run of River Projects**	**All Projects**	**Annual Energy Gain Relative to the Baseline**
FM-NA	1,095	1,503	2,683	4,186	-
FM-175	1,095	1,494	2,726	4,219	33
FM-200	1,095	1,491	2,720	4,211	25
FM-OPS	1,095	1,504	2,691	4,196	10

Source: USACE, Northwestern Division, Hydropower Analysis Center, 2002

For each flow management component, the usable capacity results over the period of record were averaged in order to compute the dependable capacity for that component. Table 5-19 summarizes the dependable capacity estimates obtained for the components as well as the corresponding dependable capacity gain relative to the existing condition.

Table 5-19. Dependable Capacity For Components.

Component	Plant Capacity (MW)	Run-of-River Dependable Capacity (MW)	Storage Dependable Capacity (MW)	Total Dependable Capacity (MW)	Dependable Capacity Gain Relative to the Baseline (MW)
FM-NA	1,095	584.9	463.9	1,049	-
FM-175	1,095	587.1	463.9	1,051	2
FM-200	1,095	587.0	463.9	1,051	2
FM-OPS	1,095	585.7	464.5	1,050	1

Source: USACE, Northwestern Division, Hydropower Analysis Center, 2002

The energy benefits attributable to the hydropower projects are based on the system cost of producing the same amount of energy as the hydropower project. To obtain a unit energy value for the project, a system analysis is performed in which the area power system is modeled under two different conditions: one that includes the hydropower project in the power system, and one that excludes the hydropower project from the power system. The unit energy value is then determined by dividing the difference in system operating costs for the two conditions by the hydropower project's annual energy output.

Discussions with the Southwestern Power Administration indicated that the power generated at projects on the MKARNS would be marketed to preferred customers located throughout the SPP region. This region includes the States of Oklahoma, Kansas, parts of Arkansas and Missouri, eastern and northern Texas, and Louisiana. Therefore, the output of the MKARNS projects was modeled with PROSYM within the SPP system.

Plant and annual load projections for the SPP system were based on the *Southwest Power Pool EIA-411 Report*, dated April 1, 1999, and on Henwood Energy Services' North American Electric Reliability Council database. These annual peak loads and energy demands were then converted into hourly loads for a typical load year, using historical 1993-2000 loads for the SPP utilities.

The flow management components being considered would result in relatively minor changes in energy and capacity benefits for hydropower projects on the MKARNS. The basis for any changes in hydropower benefits are related to:

- Reduced spill – with lower peak releases, less flow exceeds the powerhouse capacity, resulting in slightly higher power generation generally for run-of-river projects; and
- Reduced average daily flow at storage projects, resulting in slightly less generation at most storage projects.

Energy benefits for the Arkansas River Navigation Study were computed for each flow management component as shown in Table 5-20.

Table 5-20. Annual Energy Benefits For Flow Management Components.				
Flow Management Component	**Average Annual Energy (GWh)**	**Levelized Energy Value ($/MWh)**	**Annual Energy Benefits ($1,000)**	**Energy Benefit Gain Relative to Base Condition ($1,000)**
No Action Component (FM-NA)				
Run-of-River Projects	2,683.2	30.77	82,562	-----
Storage Projects	1,503.0	30.77	46,247	-----
Total			**128,809**	
175,000 Component (FM-175)				
Run-of-River Projects	2,725.8	30.77	83,873	1,311
Storage Projects	1,493.7	30.77	45,961	(286)
Total			**129,834**	**1,025**
200,000 Component (FM-200)				
Run-of-River Projects	2,720.1	30.77	83,697	1,135
Storage Projects	1,490.7	30.77	45,869	(378)
Total			**121,058**	**702**
Operations Only Component (FM-OPS)				
Run-of-River Projects	2,691.3	30.77	82,811	249
Storage Projects	1,504.3	30.77	46,287	40
Total			**129,098**	**289**
Source: USACE, Northwestern Division, Hydropower Analysis Center, 2002				

A model was used that applied the levelized energy value to the average annual generation values, in order to compute project energy benefits for each year of the project life. Computing the present value of the annual project benefits, adding up the results for the period of analysis, and then applying the appropriate amortization factor resulted in average annual energy benefits for the project. The net gain in energy benefits attributable to a particular flow management component was then determined by subtracting the baseline condition energy benefits from the component energy benefits.

Table 5-21 illustrates the magnitude of the annual capacity benefits that were calculated within the model. The last column of the table shows the annual gain in capacity benefits relative to the baseline. The values shown in the table were obtained by applying the composite unit capacity value to the dependable capacity values summarized.

Table 5-21. Annual Capacity Benefits For Flow Management Components.

Flow Management Component	Dependable Capacity (MW)	Composite Capacity Value ($/kW-yr)	Annual Capacity Benefits ($1,000)	Capacity Benefit Gain Relative to the Base Case ($1,000)
No Action Component (FM-NA)				
Peaking Projects	463.9	89.25	41,403	-----
Intermediate Load Projects	584.9	111.82	65,404	-----
Total			**106,807**	
175,000 cfs Component (FM-175)				
Peaking Projects	463.9	89.25	41,403	0
Intermediate Load Projects	587.1	111.82	65,650	246
Total			**107,053**	**246**
200,000 cfs Component (FM-200)				
Peaking Projects	463.9	89.25	51,858	0
Intermediate Load Projects	587.0	111.82	65,638	235
Total			**117,496**	**235**
Operations Only Component (FM-OPS)				
Peaking Projects	464.5	89.25	41,457	54
Intermediate Load Projects	585.7	111.82	65,493	89
Total			**106,950**	**143**

Source: USACE, Northwestern Division, Hydropower Analysis Center, 2002

Table 5-22 illustrates the magnitude of the annual hydropower benefits that are obtained when the annual energy benefits from Table 5-20 and the annual capacity benefits from Table 5-21 are combined. The last column of the table shows the annual gain in hydropower benefits relative to the baseline. The Gross National Product Implicit Price Deflator was used to adjust the hydropower benefits to January 2001 prices.

Table 5-22. Annual Hydropower Benefits For Flow Management Components. (FY2001 Dollars).

Flow Management Component	Annual Energy Benefits ($1,000)	Annual Capacity Benefits ($1,000)	Total Annual Hydropower Benefits ($1,000)	Hydropower Benefit Gain Relative to FM-NA ($1,000)
No Action Component (FM-NA)	121,879	101,061	222,940	-
175,000 cfs Component (FM-175)	122,849	101,294	224,142	1,203
200,000 cfs Component (FM-200)	122,586	101,282	223,868	928
Operations Only Component (FM-OPS)	122,153	101,196	223,349	409

Source: USACE, Northwestern Division, Hydropower Analysis Center, 2002

Consequently, implementation of FM-175 would result in a net economic impact of approximately $1.3 million in hydroelectric power benefits per year. These savings represent approximately 0.53 percent of the current value of the current benefits provided by FM-NA. These relatively minor benefits would result in a minor increase in economic activity for the power company and for the regional economy.

Increasing the amount of hydroelectric power by approximately $1.3 million per year, or 0.53 percent, would result in a negligible reduction in the dependence of the local economy on power produced by other sources.

Tourism/Recreation

A description and analysis of the methodologies employed by the economics analysis team for the evaluation of changes in recreation use and NED benefits that would occur as a result of implementing different flow management components can be found in of the Economics Analysis Appendix in the Feasibility Report (USACE 2005).

The changes in recreation use and benefits at the eight affected reservoir projects are summarized in Table 5-23, with detailed project-by-project calculations shown in Table 5-24. For Baseline Conditions, total discounted project benefits over the 50-year analysis period are $391.7 million for 2.51 million annual visits (Table 5-24). Water management conditions under FM-175 produce benefits of $368.3 million for 2.37 million annual visits (Table 5-24). The net change in benefits (Table 5-23) is -$23.4 million for FM-175, with the average annual incremental recreation benefit (Table 5-23) being -$1.38 million for FM-175. Therefore, minor negative impacts to tourism and recreation would result with implementation of FM-175.

Table 5-23. Changes in Benefits Compared to Baseline Conditions.						
	Discounted 50-Yr. NED Benefit Changes 175,000 cfs Component (FM-175)			Discounted 50-Yr. NED Benefit Changes 200,000 cfs Component (FM-200)		
Project	**Camping**	**Day-Use**	**Total**	**Camping**	**Day-Use**	**Total**
Copan	-$1,649	-$22,446	-$24,095	-$825	-$11,223	-$12,047
Eufaula	-$105,135	-$333,477	-$438,613	-$26,284	-$83,369	-$109,653
Fort Gibson	-$1,448,331	-$4,884,591	-$6,332,922	-$779,871	-$2,630,164	-$3,410,035
Hulah	$0	$0	$0	-$17,102	-$101,643	-$118,746
Keystone	-$561,574	-$6,432,643	-$6,994,217	-$454,038	-$5,200,860	-$5,654,899
Oologah	-$669,591	-$1,719,515	-$2,389,106	-$539,992	-$1,386,706	-$1,926,698
Tenkiller Ferry	-$1,526,285	-$5,280,908	-$6,807,193	-$371,258	-$1,284,545	-$1,655,803
Wister	-$58,733	-$389,580	-$448,313	$0	$0	$0
Total	**-$4,371,298**	**-$19,063,159**	**-$23,434,457**	**-$2,189,370**	**-$10,698,510**	**-$12,887,881**
5-7/8 % amortization			0.058945			0.058945
Average annual incremental recreation benefit			**-$1,381,355**			**-$759,682**

Table 5-24. Visitation and Benefits.								
	Per-Visit Benefits		**FM-NA Visitation**		**FM-NA Annual Benefits**		**FM-NA 50-Yr. Benefits**	
Project	**Camping**	**Day-Use**	**Camping**	**Day-Use**	**Camping**	**Day-Use**	**Camping**	**Day-Use**
Copan	$13.17	$9.93	1,347	24,315	$17,743	$241,460	$311,585	$4,240,218
Eufaula	$12.43	$8.75	22,752	102,527	$282,750	$896,850	$4,965,295	$15,749,335
Fort Gibson	$11.48	$7.59	208,810	1,065,330	$2,396,999	$8,084,036	$40,093,050	$141,961,563
Hulah	$12.81	$9.58	4,787	38,030	$61,327	$364,478	$1,076,955	$6,400,495
Keystone	$12.87	$10.11	19,978	291,269	$257,071	$2,944,659	$4,514,348	$51,710,355
Oologah	$13.32	$8.03	34,891	148,610	$464,720	$1,193,404	$8,160,816	$20,957,052
Tenkiller Ferry	$13.62	$11.20	65,144	274,246	$887,518	$3,070,791	$15,585,468	$53,925,327

Table 5-24. Visitation and Benefits.

Wister	$12.33	$9.11	20,504	184,096	$252,730	$1,676,369	$4,438,123	$29,438,265
Total			**378,213**	**2,128,423**	**$4,620,858**	**$18,472,047**	**$81,145,640**	**$324,382,611**
	FM-175		**FM-175 Annual Visits**		**FM-175 Annual Benefits**		**FM-175 50-Yr. Benefits**	
Project	**Days above Rec. Pool**	**Portion of Days above Rec. Pool**	**Camping**	**Day-Use**	**Camping**	**Day-Use**	**Camping**	**Day-Use**
Copan	2	0.005	1,340	24,182	$17,646	$240,137	$309,878	$4,216,984
Eufaula	8	0.022	22,253	100,280	$276,553	$877,193	$4,856,467	$15,404,144
Fort Gibson	13	0.036	201,373	1,027,387	$2,311,626	$7,796,111	$40,593,846	$136,905,398
Hulah	0	0.000	4,787	38,030	$61,327	$364,478	$1,076,955	$6,400,495
Keystone	47	0.129	17,405	253,763	$223,968	$2,565,484	$3,933,048	$45,051,761
Oologah	31	0.085	31,928	135,988	$425,250	$1,092,047	$7,467,705	$19,177,138
Tenkiller Ferry	37	0.101	58,540	246,446	$797,551	$2,759,505	$14,005,571	$48,458,924
Wister	5	0.014	20,223	181,574	$249,268	$1,653,405	$4,377,327	$29,035,001
Total			**357,850**	**2,007,650**	**$4,363,190**	**$17,348,360**	**$76,620,797**	**$304,649,846**
	FM-200		**FM-200 Annual Visits**		**FM-200 Annual Benefits**		**FM-200 50-Year Benefits**	
Project	**Days above Rec. Pool**	**Portion of Days above Rec. Pool**	**Camping**	**Day-Use**	**Camping**	**Day-Use**	**Camping**	**Day-Use**
Copan	1	0.003	1,343	24,248	$17,695	$240,799	$310,731	$4,228,601
Eufaula	2	0.005	22,627	101,965	$281,201	$891,935	$4,938,088	$15,663,037
Fort Gibson	7	0.019	204,805	1,044,899	$2,351,029	$7,929,000	$41,285,786	$139,239,013
Hulah	6	0.016	4,708	37,405	$60,319	$358,486	$1,059,251	$6,295,282
Keystone	38	0.104	17,898	260,945	$230,307	$2,638,092	$4,044,361	$46,326,811
Oologah	25	0.068	32,501	138,431	$432,890	$1,111,664	$7,601,856	$19,521,638

Table 5-24. Visitation and Benefits.

Tenkiller Ferry	9	0.025	63,538	267,484	$865,634	$2,995,073	$15,201,169	$52,595,661
Wister	0	0.000	20,504	184,096	$252,730	$1,676,369	$4,438,123	$29,438,265
Total			**367,925**	**2,059,474**	**$4,491,805**	**$17,841,418**	**$78,879,365**	**$313,308,308**

5.12.1.3 200,000 cfs Plan Component (FM-200)

Operations and Maintenance

Similar to FM-175 above, implementation of the 200,000 cfs Plan Component is anticipated to result in a minor reduction in the amount of dredging that would be required to maintain safe navigation depth; however it is not possible to quantify this reduction. Other existing beneficial and adverse direct and indirect impacts associated with the implementation of FM-200 are anticipated to be similar to those present under FM-NA.

Commercial Navigation

Implementation of FM-200 would result in commercial navigation gaining an average of 17 additional days per year in which river flow rates would be below 100,000 cfs. Implementation of this component would also increase the annual average number of days in which river flow would be less than 61,000 cfs, meaning that towboat operators could optimize their towboat configuration. This change in flow would result in additional commercial navigation cost avoidance of approximately $45,000 per year compared to the 175,000 cfs Plan Component. Together, implementation of this component would allow commercial navigation cost avoidances of approximately $9.2 million per year.

These cost avoidances would allow the commercial navigation industry to decrease charges to customers and increase company profits. The decrease in shipping charges would be anticipated to result in increased demand for commercial navigation shipping, thereby increasing surface water transportation usage at a rate faster then would be experienced under FM-NA.

Decreased shipping costs and the resulting increase in shipping demand would result in increased employment, since more companies would use this shipping method. Minor amounts of secondary employment could also be anticipated as personnel employed in the shipping industry purchase goods and services in the surrounding community.

No modal shift in the use of alternative modes of transportation (e.g. highway or rail) is anticipated as a result of implementing FM-200.

Non-Agricultural Structures

The previously described methodology and assessment of structures and application of the HEC-FDA Model was used to determine structure damages under the FM-200. Non-agricultural property or structure damages are greatest under FM-200 with an estimated $453,000 in additional annual damages compared to the No Action Component (FM-NA) (see Table 5-14).

Agricultural

Agricultural crop damages are greatest under FM-200 with an estimated $545,000 in annual damages compared to the No Action Component (FM-NA), as shown in Table 5-14.

Hydroelectric

As summarized in the discussion of FM-175, implementation of FM-200 would result in a net economic impact of approximately $1 million in hydroelectric power benefits per year when compared to the No Action Component (see Table 5-14). These savings represent approximately 0.42 percent of the current value of the current benefits provided by FM-NA, and are slightly smaller than the benefits offered by the 175,000 cfs Plan Component. These relatively minor benefits would result in a minor increase in economic activity for the power company and for the regional economy.

Increasing the amount of hydroelectric power by approximately $1 million per year, or 0.42 percent, would result in a negligible reduction in the dependence of the local economy on power produced by other sources. These indirect impacts would be slightly smaller than the beneficial impacts that would be offered by FM-175. Additionally, this slight increase in available electrical power might result in a proportional reduction in the amount of emissions produced at other energy sources in the region.

Tourism/Recreation

A description and analysis of the methodologies employed by the economics analysis team for the evaluation of changes in recreation use and NED benefits that would occur as a result of implementing different flow management components can be found in the Economics Analysis Appendix in the Feasibility Report (USACE 2005). The changes in recreation use and benefits at the eight affected reservoir projects are summarized in Table 5-23, with detailed project-by-project calculations shown in Table 5-24. For baseline conditions, total discounted project benefits over the 50-year analysis period are $391.7 million for 2.51 million annual visits (Table 5-24). The 200,000 cfs Component has total benefits of $378.9 million for 2.43 million annual visits (Table 5-24). The net change in benefits (Table 5-23) is -$12.9 million for the 200,000 cfs Component and the average annual incremental recreation benefit (Table 5-23) is -$0.76 million for the 200,000 cfs Component. Therefore, minor negative impacts to tourism and recreation would result with implementation of FM-200.

5.12.1.4 Operations Only Plan Component (FM-OPS)

Operations and Maintenance

As noted for the 175,000 cfs and the 200,000 cfs Components above, implementation of the Operations Only Component (FM-OPS) is anticipated to result in a minor reduction in the amount of dredging that would be required to maintain safe navigation depth; however it is not possible to quantify this reduction. Other beneficial and adverse direct and indirect impacts associated with the implementation of the Operations Only Component are anticipated to be similar to those that would occur under FM-NA.

Commercial Navigation

Implementation of FM-OPS would result in commercial navigation losing an average of two days per year in which river flow rates would be below 100,000 cfs. This loss in navigation days would increase the number days lost due to high flow conditions. However, implementation of this component would increase the annual average number of days in which river flow would be at less than 61,000 cfs, meaning that towboat operators could optimize their towboat configuration. Implementation of FM-OPS would allow navigation cost savings of approximately $8.4 million per year compared to the costs incurred under FM-NA. This total cost avoidance represents approximately $848,000 less per year in savings compared to FM-175, and $804,000 less per year in savings compared to the FM-200.

These cost avoidances would allow the navigation industry to decrease charges to customers and increase company profits. The decrease in shipping charges would be anticipated to result in increased demand for MKARNS shipping, thereby increasing surface water transportation usage at a rate faster then would be experienced under FM-NA.

Decreased shipping costs and the resulting increase in shipping demand would result in increased employment since more companies would use this shipping method. Minor amounts of secondary employment could also be anticipated as personnel employed in the shipping industry purchase goods and services in the surrounding community.

No modal shift in the use of alternative modes of transportation (e.g. highway or rail) is anticipated as a result of implementing FM-OPS.

Non-Agricultural Structures

The previously described methodology for an inventory of structures and application of the HEC-FDA Model was also used to determine structure damages under FM-OPS. Annual non-agricultural property or structure damages under FM-OPS would be minimal at approximately $18,000 compared to FM-NA (see Table 5-14).

Agricultural

Annual agricultural property damages under FM-OPS would be minimal compared to FM-NA.

Hydroelectric

As summarized in the discussion of FM-175, implementation of FM-OPS would result in a net economic impact of approximately $466,000 in hydroelectric power benefits per year when compared to FM-NA. These savings represent approximately 0.05 percent of the current value of the current benefits provided by the No Action Component, and are much smaller than the benefits offered by either the 175,000 cfs Plan Component ($1,340,000) or the 200,000 cfs Plan Component ($1,056,000). These minor benefits would result in a minor increase in economic activity for the power company and for the regional economy.

Increasing the amount of hydroelectric power by approximately $466,000 per year, or 0.05 percent, would result in a minor reduction in the dependence of the local economy on power produced by other sources. These indirect impacts would be much smaller than the beneficial impacts that would be offered by FM-175 ($1,340,000) or FM-200 ($1,056,000).

Tourism/Recreation

Additional annual costs of $1,200 would occur under FM-OPS when compared to FM-NA. The results of the recreation analysis indicate that FM-OPS contributes the least overall negative incremental net impacts to recreational facilities of any plan that changes the existing river flow operation. A very slight improvement in recreation impacts along the facilities in Arkansas is offset by relatively low negative incremental net impacts in the Oklahoma area facilities.

5.12.2 Channel Deepening Components

Introduction

The purpose of this economic impact analysis is to compare the potential economic benefits of each channel deepening component. Thus, this analysis of the economic consequences of channel deepening includes the comparison of economic benefits and project costs under each component. The selection of the NED Plan is based on net economic benefits.

The primary economic benefit of a navigation project is the reduction in the amount of resources that are required to transport commodities. These navigation benefits include:

- cost reduction benefits, for the same origin-destination/same mode;
- shift in mode benefits from overland to waterway transportation;
- shift of origin and/or destination benefits as a result of navigation improvements; and
- new movement, including induced traffic that is credited to reduced transportation costs.

Induced traffic is traffic inclined to move onto the waterway from land transportation due to the reduction in waterborne transportation costs resulting from navigation improvements.

Cost reduction benefits associated with the same origin-destination/same mode include reduction in costs resulting from trip delays occurring as a result of congestion or non-navigable waters; reduction in costs as a result of the use of larger or longer tows; and reduction in costs by permitting more fully loaded barges and reduced lightering (conveying cargo with another vessel known as a lighter from ship to shore, or vice versa). Other potential direct benefits result from a change in mode of transport or shift in origin of a commodity to water transportation as a result of project implementation because of the associated cost advantages.

The direct navigation-related benefits in turn create indirect economic benefits. These indirect benefits include a potential increase in employment, labor force, income and business volume, and expansion of new business and industry. Other potential impacts include impacts on community and regional growth, property values and tax revenues, and public facilities and services.

Costs associated with implementation of each component include an array of related costs that include:

- dredging costs associated with channel and port deepening;
- dredged material disposal costs, including land acquisition;
- other in-stream structural costs, such as dikes and revetments;
- annual operation and maintenance costs;
- interest during construction;
- project mitigation costs; and

- other associated costs.

Procedure

Navigation benefits are evaluated based on the procedure outlined in Engineer Regulation 1105-2-100, Appendix E, Section E-9, "NED Benefit Evaluation Procedures: Transportation Inland Navigation". This evaluation procedure includes an identification of types and volumes of commodity flow; projection of waterborne commerce for a selected time period; determination of vessel fleet composition and cost; determination of current cost of commodity movements; determination of current cost of alternative movements; determination of future cost of commodity movements; determination of use of ports/harbors with and without the project; and computation of total cost benefit reductions under each component. Annual NED benefits are measured as the difference in vessel transportation costs between the No Action and action components. The basic benefit for improvements is a reduction in the amount of resources required to transport commodities.

Incremental analysis is also a part of the economic impact evaluation. The incremental analysis consists of an assessment of the costs and benefits of project implementation for each of the six segments of the waterway under each component. NED benefits were estimated using the baseline fiscal year 2004 discount rate of 5 3/8 percent, a base year of 2006 for completion of construction, with benefits first being realized in 2007 and over a 50-year economic life. All benefits are expressed at July, 2004 price levels.

The final step in the economic analysis is the computation of net navigation benefits after deducting project costs from NED benefits under each component. The NED Plan is determined by a comparison of average annual NED benefits and average annual costs under each component. The NED Plan represents the component plan that reasonably maximizes net economic benefits consistent with protecting the nation's environment.

The project was evaluated for the components of deepening the entire MKARNS to depths of 10, 11, and 12 feet, and for six individual segments of the river beginning at the mouth and ending at the navigation headwaters. The evaluation under each component was performed using three different future traffic forecasts – high, middle and low growth.

Projected Traffic Demands

Existing Traffic

Traffic demand projections were developed for existing traffic shipments and for shipments that could potentially shift transportation modes, or be "induced" on to the waterway as a result of navigation improvements. The identification and development of "induced" traffic was based on surveys and on assumptions regarding the price elasticity of demand.

Historic commodity traffic levels (measured in tons) for the 1950-2002 period for the eight commodity groups were used for traffic projections in this study. The overall annual rate of growth between 1975 and 2002 was 3.1 percent, with annual rates of change for the more significant commodity groups ranging from -2.2 percent for forest products to +7.1 percent for agricultural chemicals. The directional and regional flows of traffic for each commodity group for the year 2002 were also documented. Base year traffic was used as a basis for projecting future commodity shipments. The base year for this study is 2003 and the base year tonnage is approximately 11.9 million tons. The base year traffic is based on two sources of traffic data - the Waterborne Commerce Statistics, and lock performance monitoring system statistics.

Future traffic forecasts were based on the same general procedures used in the on-going comprehensive studies of the Upper Mississippi and Ohio River Navigation Systems. Traffic demand projections were developed for existing traffic shipments and for shipments that could potentially shift transportation modes (traffic that could be induced on to the waterway) as a result of navigation improvements. The identification and development of induced traffic was based on surveys and on assumptions regarding the price elasticity of demand. The traffic forecasts were based on existing shipments and include high, middle and low growth projections with and without induced traffic. The high forecasts are equal to traffic volumes on similar river systems that operate closer to their capacity than does the MKARNS, while the middle forecast is keyed to economic and demographic projections by the U.S. Census Bureau, the U.S. Department of Agriculture, and NPA Data Services, Inc. The overall annual growth rate through 2060 for the middle forecast is 1.1 percent. The low forecast reflects no future growth of existing traffic levels on the system.

Induced Traffic

The determination of the quantity of traffic that would be induced on to the MKARNS due to lower waterway transportation costs is highly subjective. Responses obtained during a survey conducted by the Tennessee Valley Authority (TVA) indicated a potential volume of 3.0 million tons of induced traffic. However, because of the myriad of other influencing factors, it is impossible to determine how much is actually due to lower transportation costs. It is assumed, however, that lower transportation costs would increase the competitiveness of waterway transportation. Thus, given the uncertainties about the extent of the impact, a range of tonnage for induced traffic was developed based on different assumptions regarding the price elasticity of demand. Deepening the channel would lower the overall water-routing costs by 3.2 percent to 5.6 percent depending upon the depth (10′, 11′, 12′). Assuming unitary elasticity between water-routing costs and traffic volumes, the reductions would result in the inducement of 358,000 to 627,000 tons based on the volume of traffic in the year 2001. These percentages were applied to future traffic levels to obtain future volumes of induced traffic for each deepening component.

Vessel Fleet

The existing vessel fleet, consisting of barges and towboats that are used to transport commodities on the river system, was also analyzed for this study. The number, size, loading, and type of vessel fleet were documented. The No Action Component fleet, as it relates to the channel deepening components, is expected to be the same as the existing fleet, with one minor change in the “averages”. Currently, the average loading per tow is 7,000 tons. The minor change is due to different growth rates projected for the different commodities. The future fleet will change in terms of average “tons per tow” as the barges are more heavily loaded to take advantage of the deeper channel depths.

The transportation costs of the No Action Component are used in the calculation of the NED benefits for channel deepening.

The channel deepening components considered in this study are to deepen the channel beyond its currently maintained 9-foot channel to 10-foot, 11-foot, and 12-foot depths. Deepening to these depths was evaluated for six segments of the river beginning at the mouth and extending upriver to the head of navigation near Tulsa. Deepening of the channel would allow barges to carry more cargo. The greater loads of cargo per barge decrease transportation costs per ton, decreases the number of tows required to move a given amount of goods, and increases the cost competitiveness of waterway shipments versus overland modes.

Over 95 percent of the total benefits under each channel deepening component consist of cost reduction benefits. The only other benefit category is "shift of mode". The impacts in this category are minor due to the relatively small amount of induced traffic and the marginal savings realized in these shipments.

Benefits were divided by river segment based on navigation traffic. The procedure used in this analysis was to begin at the upper segment near Tulsa and compute the transportation costs for traffic with an origin and/or destination in this reach without and with channel deepening. The differences in costs are the benefits for deepening the next segment (increment) of the river given that previous reaches were also deepened. The next step was to repeat the process for each next downstream segment with the added increment of benefits reflecting the traffic that had an origin or destination within this segment plus any upstream traffic moving into or through this second segment. This process was continued for all six segments to the mouth of the river. The incremental benefits were then computed by deducting the benefits of the upstream segment from the adjacent downstream segment. For example, if the benefits for the uppermost segment were $100 and the benefits for the second most upper each were $150, then the incremental benefits of deepening the second most upper segment were $50.

5.12.2.1 Channel Deepening No Action Component (9-Foot Channel)

Since the MKARNS channel would remain at its current depth under the No Action Component, there would be no direct or indirect positive or negative benefits to hydroelectric power, tourism/recreation, and agricultural and non-agricultural properties. Since no channel deepening would occur under this component, the reservoir head and level of surface water relative to the adjacent land would remain at current levels. There would be no increase or decrease in operations and maintenance since existing dredging and other operations would remain at their current levels.

However, under the No Action Component, potential long-term adverse impacts could affect the navigation industry. Under the No Action Component, the navigation benefits would remain at the current levels. The following discussion summarizes the No Action Component condition.

Table 5-25 provides a summary of the high, middle and low traffic forecasts under the No Action Component for shipments that currently move on the MKARNS. The high forecast is based on the assumption that tonnage volume could eventually approximate tonnage volumes currently shipped on the Illinois and Tennessee Rivers navigation systems, both of which operate closer to their capacity than does the MKARNS. It is assumed that the MKARNS would reach the use level of these rivers by the year 2060. The low forecast reflects the current 2003 traffic level, which was held constant throughout the future. No traffic is expected to be induced on to the waterway system in the absence of channel deepening. Under the No Action Component, future traffic forecasts range from a high of 43.55 million tons to a low of 11.88 million tons in the year

2060. The middle forecast of 21.77 million tons for the year 2060, which represents an approximate doubling of the current traffic, was used throughout this study as the most logical forecast.

Table 5-26 displays the existing traffic tonnage and transportation costs under the No Action Component for the middle forecast. The costs for the water-routing and the least cost all-overland routing are compared in the following table. Lock processing costs, that include delay and lockage time, are indicated separately in Table 5-26. These latter costs generally comprise approximately one percent of the total water-routed costs. The current benefits of the MKARNS system are approximately $116 million annually, or $9.75 per ton. There would be no additional induced traffic associated with the No Action Component since no structural improvements resulting in water-route cost reductions versus overland transportation would be made under this component.

Table 5-25. No Action Component: High, Middle and Low Traffic Projections, 9′ Channel (000's tons)[1]

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	11,884.3	21,558.2	31,993.6	34,711.9	37,415.1	40,353.4	43,550.7	2.3%
Middle	11,884.3	14,372.1	15,996.8	17,355.9	18,707.6	20,176.7	21,775.3	1.0%
Low	11,884.3	11,884.3	11,884.3	11,884.3	11,884.3	11,884.3	11,884.3	0.0%

[1] Does not include induced traffic.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-26. No Action Component: Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts, 9′ Channel (000's Dollars except for savings/ton).							
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Tons (000's)[1]	11,884	14,372	15,997	17,356	18,708	20,177	21,775
Water-Routed Transportation Costs for Existing Shipments[2]							
9′	150,344.6	177,979.5	196,781.4	213,242.4	229,292.3	246,738.0	265,728.8
Lock Processing Costs for Existing Traffic							
9′	325.6	390.1	425.2	436.7	523.1	609.7	759.6
Overland Transportation Costs for Existing Shipments							
9′	266,230.2	277,660.1	315,212.6	348,329.8	377,392.3	405,865.8	436,843.6
Savings	115,885.6	137,233.1	151,548.4	164,149.9	176,573.5	190,105.6	204,871.6
Savings/Ton	$9.75	$9.55	$9.47	$9.46	$9.44	$9.42	$9.41

[1] Does not include induced traffic.
[2] Does not include lock processing costs.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-27 portrays the high, middle and low tow trip projections for the 9-foot channel for the No Action Component. The number of tows was estimated based on tonnage levels, number of barges per tow, and the number of tons per barge. Annual forecasted tow trips range from a low of 1,805 to a high of 6,615 in 2060. The low forecast reflects the current 2003 tow trip level that was held constant throughout the future. Currently, the average MKARNS tow has 6.9 barges with an average of nearly 7,000 tons per tow.

Table 5-27. No Action Component: High, Middle and Low Annual Tow Trip Projections, 9′ Channel.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High 9′	1,805	3,274	4,859	5,272	5,683	6,129	6,615	2.3%
Middle 9′	1,805	2,183	2,430	2,636	2,841	3,065	3,307	1.1%
Low 9′	1,805	1,805	1,805	1,805	1,805	1,805	1,805	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.1.1 Segment 1 - Mouth to Pine Bluff (NCD NA-1)

Since the MKARNS channel would remain at its current depth, there would be no short-term or long-term positive or negative impacts to operations and maintenance, hydroelectric power, and tourism/recreation within Segment 1. The long-term potential for future traffic growth in commercial navigation would remain the same based on current traffic movement and growth trends on the MKARNS without channel deepening.

Table 5-28 displays the high, middle and low traffic projections based on existing traffic under the No Action Component for Segment l. Under the No Action Component, there would be no additional, or induced, traffic resulting from channel deepening. Annual forecasted traffic ranges from an average annual 2.1 percent increase under the high forecast to no increase under the low forecast, with a middle annual forecasted growth of 1.0 percent.

Table 5-28. No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 1, (000's tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	11,591.6	21,049.5	31,244.5	33,900.6	36,553.8	39,439.0	42,579.0	2.1
Middle	11,591.6	14,033.0	15,622.3	16,950.3	18,276.9	19,719.5	21,290.0	1.0
Low	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-29 portrays the high, middle and low tow trip projections for Segment 1 for the No Action Component. The tons per tow by segment were computed as a weighted average based on the tons and tows at the locks located within each segment. Under continuation of existing conditions there would be no decrease in tow trips based on existing traffic.

Table 5-29. No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 1.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High 9′	1,767	3,208	4,762	5,167	5,571	6,011	6,490	2.3
Middle 9′	1,767	2,139	2,381	2,584	2,786	3,006	3,245	1.1
Low 9′	1,767	1,767	1,767	1,767	1,767	1,767	1,767	0.0
Tons per Tow, 9′	6,561							

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.1.2 Segment 2 - Pine Bluff to Little Rock (NCD NA-2)

Since the MKARNS channel would remain at its current depth, there would be no short-term or long-term positive or negative impacts to operations and maintenance, hydroelectric power, and tourism/recreation within Segment 2. The long-term potential for future traffic growth in commercial navigation would remain the same based on current traffic movement and growth trends on the MKARNS without channel deepening.

Table 5-30 displays the high, middle and low traffic projections based on existing traffic under the No Action Component for Segment 2. Under the No Action Component, there would be no additional, or induced, traffic resulting from channel deepening. Annual forecasted traffic ranges from an average annual 2.1 percent increase under the high forecast to no increase under the low forecast, with a middle annual forecasted growth of 1.0 percent.

Table 5-30. No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 2 (000's tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	10,447.3	19,063.7	28,307.9	30,674.7	33,052.6	35,632.1	38,432.8	2.1
Middle	10,447.3	12,709.1	14,154.0	15,337.4	16,526.3	17,816.1	19,216.4	1.0
Low	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-31 portrays the high, middle and low tow trip projections for Segment 2 for both the No Action Component. The tons per tow by segment were computed as a weighted average based on the tons and tows at the locks located within each segment. Under continuation of existing conditions there would be no decrease in tow trips based on existing traffic.

Table 5-31. No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 2.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High 9′	1,516	2,767	4,109	4,452	4,797	5,172	5,578	2.3
Middle 9′	1,516	1,845	2,054	2,226	2,399	2,586	2,789	1.1
Low 9′	1,516	1,516	1,516	1,516	1,516	1,516	1,516	0.0
Tons per Tow, 9′	6,890							

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.1.3 Segment 3 - Little Rock to Dardanelle (NCD NA-3)

Since the MKARNS channel would remain at its current depth, there would be no short-term or long-term positive or negative impacts to operations and maintenance, hydroelectric power, and tourism/recreation within Segment 3. The long-term potential for future traffic growth in commercial navigation would remain the same based on current traffic movement and growth trends on the MKARNS without channel deepening.

Table 5-32 displays the high, middle and low traffic projections based on existing traffic under the No Action Component for Segment 3. Under the No Action Component, there would be no additional, or induced, traffic resulting from channel deepening. Annual forecasted traffic ranges from an average annual 2.1 percent increase under the high forecast to no increase under the low forecast, with a middle annual forecasted growth rate of 1.0 percent.

Table 5-32. No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 3 (000's tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	8,672.5	15,773.7	23,405.9	25,364.8	27,328.6	29,460.4	31,776.8	2.1
Middle	8,672.5	10,515.8	11,702.9	12,682.4	13,664.3	14,730.2	15,888.4	1.0
Low	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-33 portrays the high, middle and low tow trip projections for Segment 3 for the No Action Component. The tons per tow by segment were computed as a weighted average based on the tons and tows at the locks located within each segment. Under continuation of existing conditions there would be no decrease in tow trips based on existing traffic.

Table 5-33. No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 3.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High 9′	1,174	2,135	3,168	3,433	3,699	3,988	4,301	2.3
Middle 9′	1,174	1,423	1,584	1,717	1,850	1,994	2,151	1.1
Low 9′	1,174	1,174	1,174	1,174	1,174	1,174	1,174	0.0
Tons per Tow, 9′	7,388							

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.1.4 Segment 4 – Dardanelle to Fort Smith (NCD NA-4)

Since the MKARNS channel would remain at its current depth, there would be no short-term or long-term positive or negative impacts to operations and maintenance, hydroelectric power, and tourism/recreation within Segment 4. The long-term potential for future traffic growth in commercial navigation would remain the same based on current traffic movement and growth trends on the MKARNS without channel deepening.

Table 5-34 displays the high, middle and low traffic projections based on existing traffic under the No Action Component for Segment 4. Under the No Action Component there would be no additional, or induced, traffic resulting from channel deepening. Annual forecasted traffic ranges from an average annual 2.0 percent increase under the high forecast to no increase under the low forecast, with a middle forecasted annual growth rate of 1.0 percent.

Table 5-34. No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 4 (000's tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	6,183.4	11,017.6	16,234.6	17,587.0	18,910.6	20,349.2	21,915.3	2.0
Middle	6,183,4	7,345.0	8,117.3	8,793.5	9,455.3	10,174.6	10,957.6	1.0
Low	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-35 portrays the high, middle and low tow trip projections for Segment 4 for both the No Action Component. The tons per tow by segment were computed as a weighted average based on the tons and tows at the locks located within each segment. Under continuation of existing conditions there would be no decrease in tow trips based on existing traffic.

Table 5-35. No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 4.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High 9′	863	1,538	2,266	2,454	2,639	2,840	3,058	2.2
Middle 9′	863	1,025	1,133	1,227	1,320	1,420	1,529	1.0
Low 9′	863	863	863	863	863	863	863	0.0
Tons per Tow, 9′	7,166							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

5.12.2.1.5 Segment 5 – Fort Smith to Muskogee (NCD NA-5)

Since the MKARNS channel would remain at its current depth, there would be no short-term or long-term positive or negative impacts to operations and maintenance, hydroelectric power, and tourism/recreation within Segment 5. The long-term potential for future traffic growth in commercial navigation would remain the same based on current traffic movement and growth trends on the MKARNS without channel deepening.

Table 5-36 displays the high, middle and low traffic projections based on existing traffic under the No Action Component for Segment 5. Under the No Action Component there would be no additional, or induced, traffic resulting from channel deepening. Annual forecasted traffic ranges from an average annual 2.0 percent increase under the high forecast to no increase under the low forecast, with a middle annual forecasted annual growth of 1.0 percent.

Table 5-36. No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 5 (000’s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	4,894.9	8,564.7	12,543.5	13,572.6	14,567.9	15,651.2	16,832.5	2.0
Middle	4,894.9	5,709.8	6,271.7	6,786.3	7,284.0	7,825.6	8,416.3	1.0
Low	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	0.0
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-37 portrays the high, middle and low tow trip projections for Segment 5 for both the No Action Component. The tons per tow by segment were computed as a weighted average based on the tons and tows at the locks located within each segment. Under continuation of existing conditions there would be no decrease in tow trips based on existing traffic.

Table 5-37. No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 5.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High 9′	679	1,189	1,741	1,884	2,022	2,172	2,336	2.2
Middle 9′	679	793	871	942	1,011	1,086	1,168	1.0
Low 9′	679	679	679	679	679	679	679	0.0
Tons per Tow, 9′	7,205							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

5.12.2.1.6 Segment 6 – Muskogee to Catoosa (NCD NA-6)

Since the MKARNS channel would remain at its current depth, there would be no short-term or long-term positive or negative impacts to operations and maintenance, hydroelectric power, and tourism/recreation within Segment 6. The long-term potential for future traffic growth in commercial navigation would remain the same based on current traffic movement and growth trends on the MKARNS without channel deepening.

Table 5-38 displays the high, middle and low traffic projections based on existing traffic under the No Action Component for Segment 6. Under the No Action Component, there would be no additional, or induced, traffic resulting from channel deepening. Annual forecasted traffic ranges from an average annual 2.1 percent increase under the high forecast to no increase under the low forecast, with a middle annual forecasted growth rate of 1.0 percent.

Table 5-38. No Action Component: High, Middle and Low Traffic Projections – 9′ Channel, Segment 6 (000's tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	4,258.6	7,473.3	10,956.8	11,866.9	12,746.1	13,704.7	14,751.8	2.0
Middle	4,258.6	4,982.2	5,478.4	5,933.4	6,373.0	6,852.3	7,375.9	1.0
Low	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	0.0
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-39 portrays the high, middle and low tow trip projections for Segment 6 for both the No Action Component. The tons per tow by segment were computed as a weighted average based on the tons and tows at the locks located within each segment. Under continuation of existing conditions there would be no decrease in tow trips based on existing traffic.

Table 5-39. No Action Component: High, Middle and Low Tow Trip Projections – 9′ Channel, Segment 6.								
	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High 9′	639	1,121	1,643	1,780	1,912	2,056	2,213	2.2
Middle 9′	639	747	822	890	956	1,028	1,106	1.0
Low 9′	639	639	639	639	639	639	639	0.0
Tons per Tow, 9′	6,667							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

5.12.2.2 Channel Deepening 10-Foot Channel Component

Channel deepening to 10 feet will result in both direct and indirect positive impacts on commercial navigation, and impacts on operations and maintenance in all segments. However, these impacts vary among the individual segments. There will be no impacts within any of the segments of this Component on hydroelectric power and tourism/recreation since the reservoir head and level of surface water relative to the adjacent land would remain at or near current levels. There also will be no flooding impacts on agricultural and non-agricultural properties.

Deepening the channel would allow a substantial portion of barges to be more fully loaded than is currently possible on the 9-foot deep existing channel. The TVA made the identification of shipments that could take advantage of a deeper channel considering their commodity type and origin/destination. Following identification of these shipments, TVA developed new waterway transportation costs for each shipment assuming they could load up to 10, 11, and 11.5 feet. The latter depth of 11.5 feet is less than the 12-foot component because 12 feet is assumed to be the maximum depth to which the waterway would be dredged and maintained.

The shipping costs for existing traffic as well as under the middle forecast for the 10-foot Channel Deepening Component are portrayed in Table 5-40. At the year 2003 base level, the cost savings between the existing 9-foot channel and the 10-foot Channel Deepening Component is approximately $3 million, while the differential costs savings per ton under the 10-foot Channel Deepening Component is approximately $.26. The savings per ton represent the savings per ton on water transportation compared to overland transportation costs. Lock processing costs are expected to increase as a result of channel deepening. This increase is due to the need to enter and exit the lock chambers at slower speeds and with greater caution due to reduced clearances between the bottom of the barges and the top of the gate sills.

Table 5-40. Existing Traffic, Tonnage and Transportation Costs - Middle Forecast, 10′ Channel Deepening Component (000s except for savings/ton).							
	2003	2010	2020	2030	2040	2050	2060
Tons (000s)	11,884	14,372	15,997	17,356	18,708	20,177	21,775
Water-Routed Transportation Costs for Existing Shipments[1]							
9′	150,344.6	177,979.5	196,781.4	213,242.4	229,292.3	246,739.0	265,728.8
10′	147,297.1	174,377.2	192,798.7	208,922.2	224,647.2	241,739.9	260,345.9
Net Savings	3,047.5	3,602.3	3,982.7	4,320.2	4,645.1	4,999.1	5,382.9
Savings per Ton for Existing Shipments							

9′	$9.75	$9.55	$9.47	$9.46	$9.44	$9.42	$9.41
10′	$10.01	$9.80	$9.72	$9.71	$9.69	$9.67	$9.66
Net Savings	$.26	$.25	$.25	$.25	$.25	$.25	$.25

[1]Does not include lock processing costs, that are typically approximately one percent of transportation costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-41 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component. Traffic may be induced to shift on to the river system considering the reduction in water routing transportation costs that result from channel deepening. The amounts induced vary with the forecast scenario and with the potential depth of deepening. Thus, the amount of induced traffic was calculated based on the percentage reduction in water-routing shipping costs attributable to a deeper channel.

It is anticipated that there would be a time lag between the completion of the channel deepening and the shift of tonnage onto the waterway system. Based on the expected project completion date of 2006, it was assumed that 50 percent of the maximum induced traffic would shift by the year 2010 and 100 percent by 2020.

Under the middle forecast, induced traffic is forecast to account for a 1.6 percent increase in total MKARNS traffic in 2010, and for an increase of 3.2 percent in the year 2060. It is projected that induced traffic will increase annually by 2.2 percent under the middle forecast during the 2010-2060 period under the 10-foot Channel Deepening Component.

Table 5-41. High, Middle and Low Induced Traffic Projections – 10′ Channel Deepening Component (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0.0	344.9	1,023.8	1,110.8	1,197.3	1,291.3	1,393.6	2.8%
Middle	0.0	230.0	511.9	555.4	598.6	645.7	696.8	2.2%
Low	0.0	190.1	380.2	380.2	380.2	380.2	380.2	1.4%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-42 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component. The deepening components are expected to result in increased barge loadings. This in turn would decrease the number of tows required to move the traffic since each tow could haul more cargo. The effect of deepening on the number of tows was estimated using pro-rating techniques keyed to the percent reduction in barge line-haul costs. For example, if deepening from 9-foot to 10-foot resulted in a 7 percent decrease in barge line-haul costs, then the number of tows required to move the goods was also reduced by 7 percent.

Under the 10-foot Channel Deepening Component, 1,762 tow trips are projected annually for existing traffic under the middle forecast for the year 2010. This compares to 2,183 tow trips under the existing 9-foot No Action Component. This represents a 19 percent decrease in annual tow trips, with these rates continuing through the year 2060.

Table 5-42. High, Middle and Low Tow Trip Projections, 10′ Channel Deepening Component.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	1,457	2,642	3,921	4,254	4,586	4,946	5,338	2.3
Middle	1,457	1,762	1,961	2,127	2,293	2,473	2,669	1.1
Low	1,457	1,457	1,457	1,457	1,457	1,457	1,457	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-43 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component. Induced tow trips may result from a shift from overland to water transportation as a result of more favorable water transportation costs. These tow trips represent an addition to the tow trip projections based on existing traffic. The induced tow trips represent an additional 1.5 percent increase in tow trips in 2010 and a 3.2 percent increase in tow trips in the year 2060. Induced tow trips are projected to increase at an annual rate of 2.4 percent under the middle forecast and would comprise approximately 3 percent of the total tow trips in the year 2060.

Table 5-43. High, Middle and Low Induced Tow Trip Projections, 10′ Channel Deepening Component[1].

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	n.a	42	126	136	147	158	171	3.0%
Middle	n.a	28	63	68	73	79	85	2.4%
Low	n.a	23	47	47	47	47	47	1.5%

[1] Assumes proposed flow management changes will occur.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-44 reflects the high, middle and low projected average annual navigation benefits for the 10-foot Channel Deepening Component with and without induced traffic. These benefits reflect the annual average savings in water transportation costs versus overland transportation costs for the same volume and group of commodities. The results indicate that induced traffic has little effect on the overall benefits since the annual benefits from induced traffic are only $139,000 under the middle projected forecast. This is true regardless of the channel depth or traffic forecasts. However, the benefits are sensitive to channel depth and to future traffic projections.

Table 5-44. High, Middle and Low Projected Average Annual Navigation Benefits, 10′ Channel Deepening Component (000s Dollars)[1].		
	Without Induced Traffic	**With Induced Traffic**
High	(3,722.73)	(8,546.36)
Middle	3,983.92	4,022.23
Low	3,056.50	3,066.73

[1] Reflects July,2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year time period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-45 provides a more detailed summary of the annualized navigation benefits under the middle forecast for the 10-foot Channel Deepening Component. The annualized benefits reflect a reduction in transportation costs as a result of more efficient use of existing equipment, reductions in transit time, and in the use of water transportation rather than alternative overland transit modes. The benefits are expressed as average annual equivalent values. Over 98 percent of the benefits are cost reduction benefits, with the induced traffic providing the remaining benefits. The small benefit is due to the relatively small amount of induced traffic and the marginal savings realized from these shipments.

Table 5-45. Summary of Annualized Navigation Benefits, Middle Forecast, 10′ Channel Deepening Component (000s Dollars)[1].	
Benefits With Induced Traffic	
Cost Reduction	3,964.92,
Existing	4,126.20
Processing	(161.29)
Shift of Mode	57.31
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**4,022.23**
Benefits Without Induced Traffic	
Cost Reduction	3,983.81
Existing	4,126.20
Processing	(142.39)
Shift of Mode	0.0
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**3.983.81**

[1] Reflects July, 2004 dollars, and an annual discount rate of 5 3/8 percent over a 50-year period.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-46 provides a summary of the total project costs, annual costs and benefits, net benefits, and benefit-to-cost ratio for the 10-foot Channel Deepening Component. The annual negative net benefits of approximately $3.8 million results in a benefit-to-cost ratio of 0.51. The following discussion provides a similar summary of costs and benefits, and benefit-to-cost ratio for each segment of the 10-foot Channel Deepening Component. See Appendix B for more detailed information on total project costs and annual costs for each segment under each component.

Table 5-46. Summary of Total Costs and Navigation Benefits – 10′ Channel Deepening Component[1].

Middle Forecast	
Total Project Cost[2]	$ 106,404,800
Total Annual Costs[3]	$ 7,837,700
Annual Navigation Benefits	$ 4,022,200
Annual Net Benefits	($3,815,500)
Benefit-to-Cost Ratio	0.51

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.2.1 Segment 1 - Mouth to Pine Bluff (NCD 10-1)

Table 5-47 displays the high, middle and low traffic projections for Segment 1 based on river traffic for shipments that currently move on the system. In this and subsequent discussions on the individual segments or segments of the MKARNS under each component, note that the forecasts per segment are not additive since one ton can move on several segments. In addition, it is noted that the dividing line in terms of traffic under each component is the Ozark to Fort Smith segment where approximately one-half of the traffic moves on the upstream segments. In 2003 approximately 98 percent of the total MCKARS traffic moved within or through Segment 1.

Table 5-47. No Action Component: High, Middle and Low Traffic Projections - Segment 1[1] (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	11,591.6	21,049.5	31,244.5	33,900.6	36,553.8	39,439.0	42,579.0	2.1%
Middle	11,591.6	14,033.0	15,622.3	16,950.3	18,276.9	19,719.5	21,290.0	1.0%
Low	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	0.0%

[1] Does not include induced traffic.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-48 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component, Segment 1. Induced tonnage is forecast to increase at an annual rate of 2.2 percent under the middle forecast, 1.4 percent under the low forecast, and 2.8 percent under the high forecast universally within all segments under each Component. Approximately 98 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 1.

Table 5-48. High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 1 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0.0	336.8	999.8	1,084.8	1,169.7	1,262.0	1,362.6	2.8%
Middle	0.0	224.5	499.9	542.4	584.9	631.0	681.3	2.2%
Low	0.0	185.5	370.9	370.9	370.9	370.9	370.9	1.4%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005..

Table 5-49 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component, Segment 1. The deepening components are expected to result in increased barge loadings. This in turn would decrease the number of tows required to move the traffic since each tow could haul more cargo. This increase in barge loadings and decrease in tow trips applies to all segments under each action component, but varies depending upon the segment and channel depth.

Under the 10-foot Channel Deepening Component, 1,727 tow trips are projected annually for existing traffic for Segment 1under the middle forecast for the year 2010. This compares to 2,139 tow trips under the 9-foot No Action Component. This represents a 19 percent decrease in annual tow trips. These rates would continue through the year 2060. Approximately 98 percent of the total tow trips would move through Segment 1.

Also reflected in Table 5-49 are the tons per tow for the 10-foot Channel Component. The projected 7,071 tons per tow forecast for the 10-foot Channel Component, Segment 1, represents an approximate 8 percent increase over the 6,561 tons per tow under the existing 9-foot Channel, Segment 1.

Table 5-49. High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 1.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	1,426	2,590	3,845	4,171	4,498	4,853	5,239	2.3%
Medium	1,426	1,727	1,922	2,086	2,249	2,426	2,620	1.1%
Low	1,426	1,426	1,426	1,426	1,426	1,426	1,426	0.0%
Tons per Tow, 10′	7,071							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-50 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component, Segment 1. Induced tow trips may result from a shift from overland to water transportation as a result of more favorable water transportation costs as a result of channel deepening. These tow trips represent an addition to the tow trip projections based on existing traffic in Table 5-49. As with the projected tow trips, the induced tow trips for each segment represent increments from the previous segment or segments. Thus, the 28 induced tow trips projected for Segment 1 for the year 2010 represents the incremental total of induced tow trips for all six segments that would pass through Segment 1. Throughout each segment of each component, the induced tow trips represent an additional 1.5 percent increase in tow trips in 2010 and a 3.2 percent increase in tow trips in the year 2060. Induced tow trips are projected to increase at an annual rate of 2.4 percent under the middle forecast universally within each segment under each component and would comprise approximately 3 percent of the total tow trips in the year 2060. All of the induced tow trips would move through Segment 1.

Table 5-50. High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 1.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	41	123	134	144	155	168	3.0%
Middle	0	28	62	67	72	78	84	2.4%
Low	0	23	46	46	46	46	46	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-51 portrays the middle forecasted navigation benefits for the 10-foot Channel Component, Segment 1. The middle forecast of navigation benefits, including induced traffic, for Segment 1 represents approximately 8 percent of the total navigation benefits for the six segments of the waterway under the 10-foot Channel Component. The benefits from induced traffic account for less than 4 percent of the total navigation benefits.

Table 5-51. Middle Annual Incremental Navigation Benefits Forecast – 10' Channel Deepening Component, Segment 1 (000s Dollars)[1].		
Forecast Scenario	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	339.20	339.20

[1] Reflects July, 2004 dollars, an annual discount rate of 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-52 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 1 under the middle forecast. Construction generally comprises the majority of the total project costs for all river segments under each component. The major construction cost for Segment 1 is for dredged material disposal areas and dikes. As indicated in Table 5-52, the total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.151, and negative annual net benefits exceeding $1.9 million.

Table 5-52. Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 1[1].		
Middle Forecast Scenario	**Segment 1**	**Cumulative Incremental**
Total Project Cost[2]	$33,403,200	$33,403,200
Total Annual Costs[3]	$ 2,246,700	$ 2,246,700
Annual Navigation Benefits	$ 339,200	$ 339,200
Annual Net Benefits	($ 1,907,500)	($ 1,907,500)
Benefit-to-Cost Ratio	0.151	0.151

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.2.2 Segment 2 - Pine Bluff to Little Rock (NCD 10-2)

Table 5-53 displays the high, middle and low traffic projections for Segment 2 based on river traffic for shipments that currently move on the system. In 2003 approximately 88 percent of the total MKARNS traffic moved within or through Segment 2.

Table 5-53. No Action Component: High, Middle and Low Traffic Projections, Segment 2 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	10,447.3	19,063.7	28,307.9	30,674.7	33,052.6	35,632.1	38,432.8	2.1%
Middle	10,447.3	12,709.1	14,154.0	15,337.4	16,526.3	17,816.1	19,216.4	1.0%
Low	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-54 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component, Segment 2. Approximately 88 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 2.

Table 5-54. High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 2 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	305.0	905.9	981.6	1,057.7	1,140.2	1,229.9	2.8%
Middle	0.0	203.3	452.9	490.8	528.8	570.1	614.9	2.2%
Low	0.0	167.2	334.3	334.3	334.3	334.3	334.3	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-55 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component, Segment 2. Under the 10-foot Channel Deepening Component, 1,501 tow trips are projected annually for existing traffic for Segment 2 under the middle forecast for the year 2010. This compares to 1,845 tow trips under the 9-foot No Action Component. This represents a 19 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 85 percent of the total tow trips on the MKARNS would move through segment 2.

Also reflected in Table 5-55 are the tons per tow for the 10-foot Channel Component. The projected 7,428 tons per tow forecast for the 10-foot Channel Component, Segment 2, represents an approximate 8 percent increase over the 6,890 tons per tow under the existing 9-foot Channel, Segment 1.

Table 5-55. High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 2.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	1,233	2,251	3,342	3,622	3,902	4,207	4,538	2.3%
Medium	1,233	1,501	1,671	1,811	1,951	2,103	2,269	1.1%
Low	1,233	1,233	1,233	1,233	1,233	1,233	1,233	0.0%
Tons per Tow, 10′	7,428							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-56 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component, Segment 2. It is projected that approximately 85 percent of the induced tow trips will move through Segment 2.

Table 5-56. High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 2.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	36	107	116	125	135	145	3.0%
Middle	0	24	54	58	62	67	73	2.4%
Low	0	20	40	40	40	40	40	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-57 portrays the middle forecasted navigation benefits for the 10-foot Channel Component, Segment 2. The navigation benefits have been calculated incrementally by segment with an overall cumulative incremental benefit for each segment for the component. Thus, the cumulative increment for Segment 2 represents the incremental total for Segments 1 and 2. The middle forecast of navigation benefits, including induced traffic, for Segment 2 represents approximately 4 percent of the total navigation benefits for the six segments of the waterway under the 10-foot Channel Component. The benefits from induced traffic account for less than 2 percent of the total navigation benefits for Segment 2.

Table 5-57. Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 2 (000s Dollars)[1].		
Forecast Scenario	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	175.40	514.60
[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period. *Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.*		

Table 5-58 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 2 under the middle forecast. Approximately one-half of the total project costs for Segment 2 consist of mitigation costs. The major construction cost for Segment 2 is for dikes. The total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.26 and annual net costs of approximately $499,000. The cumulative benefit-to-cost ratio for Segments 1-2 is 0.176.

Table 5-58. Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 2[1].

Middle Forecast	Segment 2	Cumulative Incremental Segments 1-2
Total Project Cost[2]	$9,249,200	$42,652,400
Total Annual Costs[3]	$ 675,000	$ 2,921,700
Annual Navigation Benefits	$ 175,400	$ 514, 600
Annual Net Benefits	($ 499,600)	($2,407,100)
Benefit-to-Cost Ratio	0.26	0.176

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not included escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, U. S. Army Corps of Engineers, Little Rock and Tulsa Districts, 2005.

5.12.2.2.3 Segment 3 - Little Rock to Dardanelle (NCD 10-3)

Table 5-59 displays the high, middle and low traffic projections for Segment 3 based on river traffic for shipments that currently move on the system. In 2003 approximately 73 percent of the total MKARNS traffic moved within or through Segment 3.

Table 5-59. No Action Component: High, Middle and Low Traffic Projections, Segment 3 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	8,672.5	15,773.7	23,405.9	25,364.8	27,328.6	29,460.4	31,776.8	2.1
Middle	8,672.5	10,515.8	11,702.9	12,682.4	13,664.3	14,730.2	15,888.4	1.0
Low	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-60 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component, Segment 3. Approximately 73 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 3 under the 10-foot Channel Component.

Table 5-60. High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 3 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0.0	252.4	749.0	811.7	874.5	942.7	1,016.9	2.8%
Middle	0.0	168.3	374.5	405.8	437.3	471.4	508.4	2.2%
Low	0.0	138.8	277.5	277.5	277.5	277.5	277.5	1.4%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-61 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component, Segment 3. Under the 10-foot Channel Deepening Component, 1,167 tow trips are projected annually for existing traffic for Segment 3 under the middle forecast for the year 2010. This compares to 1,423 tow trips under the 9-foot No Action Component. This represents a 19 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 66 percent of the total tow trips on the MKARNS would move within or through Segment 3.

Also reflected in Table 5-61 are the tons per tow for the 10-foot Channel Component. The projected 7,966 tons per tow forecast for the 10-foot Channel Component, Segment 3, represents an approximate 8 percent increase over the 7,388 tons per tow under the existing 9-foot channel, Segment 3.

Table 5-61. High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 3.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	962	1,751	2,598	2,815	3,033	3,269	3,526	2.3%
Medium	962	1,167	1,299	1,407	1,516	1,635	1,763	1.1%
Low	962	962	962	962	962	962	962	0.0%
Tons per Tow, 10′	7,966							

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-62 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component, Segment 3. It is projected that approximately 68 percent of the induced tow trips will move within or through Segment3.

Table 5-62. High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 3.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	28	83	90	97	105	113	3.0%
Middle	0	19	42	45	49	52	56	2.4%
Low	0	15	31	31	31	31	31	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-63 portrays the middle forecasted navigation benefits for the 10-foot Channel Component, Segment 3. The annual incremental navigation benefit of the 10-foot Channel Deepening Component for Segment 3 range has a middle annual forecasted benefit of $489,000 with induced traffic**.** The benefits from induced traffic account for approximately 12 percent of the total navigation benefits for Segment 3. The middle forecast of benefits, including induced traffic, for Segment 3 represents approximately 1 percent of the total navigation benefits for the six segments of the waterway under the 10-foot Channel Component.

Table 5-63. Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 3 (000s Dollars)[1].

Forecast Scenario	Incremental	Cumulative Incremental
Middle with Induced Traffic	488.9	1,003.5

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-64 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 3 under the middle forecast. Over one-half of the total project costs for Segment 3 consist of mitigation costs. The major construction cost for Segment 3 is for dikes. As indicated in Table 5-64, the total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.686 and negative annual net benefits of approximately $223,000. The cumulative benefit-to-cost ratio for Segments 1-3 is 0.276.

Table 5-64. Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 3[1].		
Middle Forecast	**Segment 3**	**Cumulative Incremental Segments 1-3**
Total Project Cost[2]	$9,937,000	$52,589,400
Total Annual Costs[3]	$ 711,700	$ 3,633,400
Annual Navigation Benefits	$ 488,900	$ 1,003,500
Annual Net Benefits	$ (222,800)	($ 2,629,900)
Benefit-to-Cost Ratio	0.686	0.276

[1] Reflects Jul, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.2.4 Segment 4 – Dardanelle to Fort Smith (NCD 10-4)

Table 5-65 displays the high, middle and low traffic projections for Segment 4 based on river traffic for shipments that currently move on the system. In 2003 approximately 52 percent of the total MKARNS traffic moved within or through Segment 4.

Table 5-65. No Action Component: High, Middle and Low Traffic Projections - Segment 4 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	6,183.4	11,017.6	16,234.6	17,587.0	18,910.6	20,349.2	21,915.3	2.0%
Middle	6,183,4	7,345.0	8,117.3	8,793.5	9,455.3	10,174.6	10,957.6	1.0%
Low	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-66 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component, Segment 4. Approximately 51 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 4 under the 10-foot Channel Component.

Table 5-66. High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 4 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	176.3	519.5	562.8	605.1	651.2	701.3	2.8%
Middle	0.0	117.5	259.8	281.4	302.6	325.6	350.6	2.2%
Low	0.0	98.9	197.9	197.9	197.9	197.9	197.9	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-67 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component, Segment 4. Under the 10-foot Channel Deepening Component, 841 tow trips are projected annually for existing traffic for Segment 4 under the middle forecast for the year 2010. This compares to 1,025 tow trips under the 9-foot No Action Component. This represents an 18 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 48 percent of the total tow trips on the MKARNS would move within or through Segment 4.

Also reflected in Table 5-67 are the tons per tow for the 10-foot Channel Component. The projected 7,728 tons per tow forecast for the 10-foot Channel Component, Segment 4, represents an approximate 8 percent increase over the 7,166 tons per tow under the existing 9-foot channel, Segment 4.

Table 5-67. High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 4.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	708	1,261	1,858	2,013	2,165	2,329	2,509	2.2%
Medium	708	841	929	1,007	1,082	1,165	1,254	1.0%
Low	708	708	708	708	708	708	708	0.0%
Tons per Tow, 10′	7,728							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-68 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component, Segment 4. It is projected that approximately 50 percent of the induced tow trips will move within or through Segment 4.

Table 5-68. High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 4.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	20	60	64	69	75	80	3.0%
Middle	0	14	30	32	35	37	40	2.4%
Low	0	11	23	23	23	23	23	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts2005.								

Table 5-69 portrays the middle forecasted navigation benefits for the 10-foot Channel Component, Segment 4. The annual incremental navigation benefit of the 10-foot Channel Deepening Component for Segment 4 is approximately $66,000. The benefits from induced traffic account for approximately 6 percent of the total navigation benefits for Segment 4. The middle forecast of benefits, including induced traffic, for Segment 4 represents approximately 2 percent of the total navigation benefits for the six segments of the waterway under the 10-foot Channel Component.

Table 5-69. Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 4 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	65.8	1,069.3
[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period. *Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.*		

Table 5-70 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 4 under the middle forecast. Almost one-half of the total project costs for Segment 4 consist of mitigation costs. The major construction cost for Segment 4 is for dikes. As indicated in Table 5-70, the total annual costs greatly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of almost 0.07 and negative annual net benefits of approximately $902,200. The cumulative benefit-to-cost ratio for Segments 1-4 is 0.23, with cumulative negative net annual benefits of $3.53 million.

Table 5-70. Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 4 (000s Dollars)[1].		
Middle Forecast	**Segment 4**	**Cumulative Incremental Segments 1-4**
Total Project Cost[2]	$10,857,700	$63,447,100
Total Annual Costs[3]	$ 968,000	$ 4,601,400
Annual Navigation Benefits	$ 65,800	$ 1,069,300
Annual Net Benefits	($ 902,200)	($ 3,532,100)
Benefit-to-Cost Ratio	0.067	0.232

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.2.5 Segment 5 – Fort Smith to Muskogee (NCD 10-5)

Table 5-71 displays the high, middle and low traffic projections for Segment 5 based on river traffic for shipments that currently move on the system. In 2003 approximately 41 percent of the total MKARNS traffic moved within or through Segment 5.

Table 5-71. No Action Component: High, Middle and Low Traffic Projections - Segment 5 (000s tons).

	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	4,894.9	8,564.7	12,543.5	13,572.6	14,567.9	15,651.2	16,832.5	2.0%
Middle	4,894.9	5,709.8	6,271.7	6,786.3	7,284.0	7,825.6	8,416.3	1.0%
Low	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-72 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component, Segment 5. Approximately 40 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 5 under the 10-foot Channel Component.

Table 5-72. High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 5 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	137.0	401.4	434.3	466.2	500.8	538.6	2.8%
Middle	0.0	91.4	200.7	217.2	233.1	250.4	269.3	2.2%
Low	0.0	78.3	156.6	156.6	156.6	156.6	156.6	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-73 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component, Segment 5. Under the 10-foot Channel Deepening Component, 634 tow trips are projected annually for existing traffic for Segment 5 under the middle forecast for the year 2010. This compares to 793 tow trips under the 9-foot No Action Component. This represents a 20 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 36 percent of the total tow trips on the MKARNS would move within or through Segment 5.

Also reflected in Table 5-73 are the tons per tow for the 10-foot Channel Component. The projected 7,768 tons per tow forecast for the 10-foot Channel Component, Segment 5, represents an approximate 8 percent increase over the 7,205 tons per tow under the existing 9-foot Channel, Segment 5.

Table 5-73. High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 5.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	544	952	1,394	1,508	1,619	1,739	1,870	2.2%
Medium	544	634	697	754	809	869	935	1.0%
Low	544	544	544	544	544	544	544	0.0%
Tons per Tow, 10′	7,768							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-74 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component, Segment 5. It is projected that approximately 35 percent of the induced tow trips will move within or through Segment 5.

Table 5-74. High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 5.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	15	45	48	52	56	60	3.0%
Middle	0	10	22	24	26	28	30	2.4%
Low	0	9	17	17	17	17	17	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-75 portrays the middle forecasted navigation benefits for the 10-foot Channel Component, Segment 5. The annual incremental navigation benefit of the 10-foot Channel Deepening Component for Segment 5 is $234,000 with induced traffic. The benefits from induced traffic account for approximately 2 percent of the total navigation benefits for Segment 5. The middle forecast of benefits, including induced traffic, for Segment 5 represents approximately 6 percent of the total navigation benefits for the six segments of the waterway under the 10-foot Channel Component.

Table 5-75. Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 5 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	234.4	1,303.7
[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period. *Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.*		

Table 5-76 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 5 under the middle forecast. Construction costs comprise two-thirds of the total project costs, with dikes accounting for almost one-half of the construction costs. Mitigation comprises the majority of the non-construction costs for Segment 5. As indicated in Table 5-76, the total annual costs greatly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of almost 0.12 and negative annual net benefits of approximately $1.79 million. The cumulative benefit-to-cost ratio for Segments 1-5 is 0.196, with cumulative negative net annual benefits of over $5.3 million.

Table 5-76. Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 5[1].		
Middle Forecast	**Segment 5**	**Cumulative Incremental Segments 1-5**
Total Project Cost[2]	$26,961,300	$90,408,400
Total Annual Costs[3]	$ 2,028,800	$ 6,630,200
Annual Navigation Benefits	$ 234,400	$ 1,303,700
Annual Net Benefits	($1,794,400)	($5,326,500)
Benefit-to-Cost Ratio	0.115	0.196

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.2.6 Segment 6 – Muskogee to Catoosa (NCD 10-6)

Table 5-77 displays the high, middle and low traffic projections for Segment 6 based on river traffic for shipments that currently move on the system. In 2003 approximately 36 percent of the total MKARNS traffic moved within or through Segment 6.

Table 5-77. No Action Component: High, Middle and Low Traffic Projections – Segment 6 (000s tons).

	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	4,258.6	7,473.3	10,956.8	11,866.9	12,746.1	13,704.7	14,751.8	2.0
Middle	4,258.6	4,982.2	5,478.4	5,933.4	6,373.0	6,852.3	7,375.9	1.0
Low	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	0.0

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-78 displays high, middle and low induced traffic tonnage projections for the 10-foot Channel Deepening Component, Segment 6. Approximately 35 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 6 under the 10-foot Channel Component.

Table 5-78. High, Middle and Low Induced Traffic Projections - 10′ Channel Deepening Component, Segment 6 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	119.6	350.6	379.7	407.9	438.5	472.1	2.8%
Middle	0.0	79.7	175.3	189.9	203.9	219.3	236.0	2.2%
Low	0.0	68.1	136.3	136.3	136.3	136.3	136.3	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-79 portrays the projected tow trips under the high, middle and low forecasts for the 10-foot Channel Deepening Component, Segment 6. Under the 10-foot Channel Deepening Component, 589 tow trips are projected annually for existing traffic for Segment 6 under the middle forecast for the year 2010. This compares to 747 tow trips under the 9-foot No Action Component. This represents a 21 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 36 percent of the total tow trips on the MKARNS would move within or through Segment 6.

Also reflected in Table 5-79 are the tons per tow for the 10-foot Channel Component. The projected 7,190 tons per tow forecast for the 10-foot Channel Component, Segment 6, represents an approximate 8 percent increase over the 6,667 tons per tow under the existing 9-foot Channel, Segment 6.

Table 5-79. High, Middle and Low Tow Trip Projections - 10′ Channel Deepening Component, Segment 6.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	504	884	1,296	1,403	1,507	1,621	1,744	2.2%
Medium	504	589	648	702	754	810	872	1.0%
Low	504	504	504	504	504	504	504	0.0%
Tons per Tow, 10′	7,190							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-80 displays the projected high, middle and low induced tow trips for the 10-foot Channel Deepening Component, Segment 6. It is projected that approximately 32 percent of the induced tow trips will move within or through Segment 6.

Table 5-80. High, Middle and Low Induced Tow Trip Projections - 10′ Channel Deepening Component, Segment 6.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	14	42	45	48	52	56	3.0%
Middle	0	9	21	23	24	26	28	2.4%
Low	0	8	16	16	16	16	16	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-81 portrays the middle forecasted navigation benefits for the 10-foot Channel Component, Segment 6. The annual incremental navigation benefit of the 10-foot Channel Deepening Component for Segment 6 is $2.7 with induced traffic. The benefits from induced traffic account for less than 2 percent of the total navigation benefits for Segment 6. The middle forecast of benefits, including induced traffic, for Segment 6 represents almost 68 percent of the total navigation benefits for the six segments of the waterway under the 10-foot Channel Component.

Table 5-81. Middle Incremental Navigation Benefits Forecast - 10′ Channel Deepening Component, Segment 6 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	2,718.5	4,022.2
1 Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year horizon. *Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.*		

Table 5-82 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 6 under the middle forecast. Construction costs comprise two-thirds of the total project costs, with dredged material disposal areas, and dredging and rock removal comprising almost all of the construction costs. Mitigation comprises the majority of the non-construction costs for Segment 6. As indicated in Table 5-82, the total annual navigation benefits greatly exceed the annual costs with a resulting benefit-to-cost ratio of 2.25 and positive annual net benefits of approximately $1.5 million for Segment 6. However, the cumulative benefit-to-cost ratio for Segments 1-6 is 0.513, with cumulative negative net annual benefits of almost $3.8 million.

Table 5-82. Summary of Incremental Net Economic Benefits and Costs -10′ Channel Deepening Component, Segment 6[1].

Middle Forecast	Segment 6	Cumulative Incremental Segments 1-6
Total Project Cost[2]	$15,996,400	$106,404,800
Total Annual Costs[3]	$ 1,207,500	$ 7,837,700
Annual Navigation Benefits	$2,718,500	$ 4,022,200
Annual Net Benefits	$1,511,000	($3,815,500)
Benefit-to-Cost Ratio	2.25	0.513

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3 Channel Deepening 11-Foot Channel Component

The 11-foot Channel Deepening Component would result in both direct and indirect positive impacts on commercial navigation and impacts on operations and maintenance in all segments. However, these impacts vary among the individual segments as is discussed under segment. There will be no impacts within any of the segments of this component on hydroelectric power and tourism/recreation since the reservoir head and level of surface water relative to the adjacent land would remain at or near current levels. There also will be no flooding impacts on agricultural or non-agricultural properties.

Deepening the channel would allow a substantial portion of barges to be more fully loaded than is currently possible on the 9-foot deep existing channel and on a 10-foot deep channel.

The shipping costs for existing traffic for the existing 9-foot channel depth and for the 11-foot Channel Deepening Component are portrayed in Table 5-83. At the year 2003 base-level the differential cost savings between the existing 9-foot channel and the 11-foot Channel Deepening Component is approximately $7.5 million, while the differential cost savings per ton under the 11-foot Channel Deepening Component would be approximately $.64 In the ensuing years the differential cost savings per ton would be approximately $.61 per ton. The savings per ton represents water transportation costs compared to overland transportation costs.

Table 5-83. Existing Traffic, Tonnage and Transportation Costs - Middle Forecasts, 11′ Channel Deepening Component (000s except for savings/ton).

	2003	2010	2020	2030	2040	2050	2060
Tons (000s)	11,884	14,372	15,997	17,356	18,708	20,177	21,775
Water-Routed Transportation Costs for Existing Shipments							
9′	150,344.6	177,979.5	196,781.4	213,242.4	229,292.3	246,738.0	265,728.8
11′	142,798.0	169,065.2	186,930.2	202,562.0	217,814.0	234,394.8	252,443.0
Net Cost Savings	7,546.6	8,914.3	9,851.2	10,680.4	11,478.3	12,343.2	13,285.8
Savings per Ton for Existing Shipments							
9′	$ 9.75	$ 9.55	$ 9.47	$ 9.46	$ 9.44	$ 9.42	$ 9.41
11′	$ 10.39	$10.17	$10.09	$10.07	$10.05	$10.03	$10.02
Net Savings	$ .64	$ .62	$ .62	$ .61	$ .61	$ .61	$ .61

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-84 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Deepening Component, and the transportation savings per ton under the middle forecast. The methodology and assumptions regarding induced traffic discussed under the 10-foot Channel Deepening Component also apply to the 11-foot Channel Deepening Component. The induced traffic under the 11-foot Channel Component is projected to be over 50 percent greater than under the 10-foot Channel Component. Likewise, the transportation savings per ton for induced traffic is projected to be approximately 50 percent greater under the 11-foot Channel Component.

Table 5-84. High, Middle and Low Induced Traffic Projections – 11′ Channel Deepening Component (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0.0	528.2	1,567.7	1,700.9	1,833.3	1,977.3	2,134.0	2.8%
Middle	0.0	352.1	783.8	850.4	916.7	988.7	1,067.0	2.2%
Low	0.0	291.2	582.4	582.4	582.4	582.4	582.4	1.4%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-85 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Deepening Component. Further deepening is expected to result in increased barge loadings that in turn would further decrease the number of tows required to move the traffic. The effect of channel deepening on the number of tows was estimated using pro-rationing techniques keyed to the percent reduction in barge line-haul costs as discussed under the 10-foot Channel Deepening Component. Under the 11-foot Channel Component, the "middle' forecast for annual tow trips is approximately 4 percent less than under the 10-foot Channel Component.

Table 5-85. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	1,402	2,543	3,773	4,094	4,413	4,759	5,136	2.3%
Middle	1,402	1,695	1,887	2,047	2,206	2,380	2,568	1.1%
Low	1,402	1,402	1,402	1,402	1,402	1,402	1,402	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-86 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component. These tow trips represent an addition to the tow trip projections based on existing traffic. The induced tow trips represent approximately 3 percent of the total tow trips. The middle forecast of induced tow trips under the 11-foot Channel Deepening Component is approximately 50 percent higher than under the 10-foot Channel Deepening Component.

Table 5-86. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	62	185	201	216	233	252	3.0%
Middle	0	42	92	100	108	117	126	2.4%
Low	0	34	69	69	69	69	69	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-87 reflects the high, middle and low projected average annual navigation benefits for the 11-foot Channel Deepening Component with and without induced traffic. These benefits reflect the annual average savings in water transportation costs versus overland transportation costs for the same volume and group of commodities. The results indicate that induced traffic has little effect on the overall benefits. This is true regardless of the channel depth or traffic forecasts. However, the benefits are sensitive to channel depth and to future traffic projections. For example, the benefits of induced traffic under the high forecast are almost 80 percent greater than the benefits under the middle forecast for the 11-foot Channel Component. The middle forecast of navigation benefits with induced traffic under the 11-foot Channel Component exceed by 250 percent the navigation benefits under the 10-foot Channel Component.

Table 5-87. High, Middle and Low Projected Average Annual Navigation Benefits - 11′ Channel Deepening Component (000s Dollars)[1].		
	Without Induced Traffic	**With Induced Traffic**
High	16,684.26	8,158,14
Middle	10,013.92	10,173.53
Low	7,638.37	7,755.08

1 Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year time period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-88 provides a more detailed summary of the annualized navigation benefits under the middle forecast for the 11-foot Channel Deepening Component. The annualized benefits reflect a reduction in transportation costs as a result of more efficient use of existing equipment, reductions in transit time, and in the use of water transportation rather than alternative overland transit modes. The benefits are expressed as average annual equivalent values. Over 95 percent of the benefits are cost reduction benefits, with the induced traffic providing the remaining benefits. The small benefits are due to the relatively small amount of induced traffic and the marginal savings realized by these shipments.

Table 5-88. Summary of Annualized Navigation Benefits, Middle Forecast - 11′ Channel Deepening Component (000s Dollars)[1].	
Benefits With Induced Traffic	
Cost Reduction	9,959.53
Existing	10,066.64
Processing	(107.11)
Shift of Mode	214.00
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**10,173.53**
Benefits Without Induced Traffic	
Cost Reduction	10,013.92
Existing	10,066.64
Processing	(52.72)
Shift of Mode	0.0

Table 5-88. Summary of Annualized Navigation Benefits, Middle Forecast - 11′ Channel Deepening Component (000s Dollars)[1].	
Benefits With Induced Traffic	
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**10,013.92**

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-89 provides a summary of the total project costs, annual costs and benefits, net benefits, and benefit-to-cost ratio for the 11-foot Channel Deepening Component. The annual negative net benefits of approximately $34 thousand results in a benefit-to-cost ratio of 0.99. The following discussion provides a similar summary of costs and benefits and benefit-to-cost ratio for each segment of the 11-foot Channel Deepening Component.

Table 5-89. Summary of Total Costs and Navigation Benefits – 11′ Channel Deepening Component[1].	
Middle Forecast	
Total Project Cost[2]	$137,512,900
Total Annual Costs[3]	$ 10,207,200
Annual Navigation Benefits	$ 10,173,500
Annual Net Benefits	$ (33,700)
Benefit-to-Cost Ratio	0.99

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3.1 Segment 1 - Mouth to Pine Bluff (NCD 11-1)

Table 5-90 displays the high, middle and low traffic projections for Segment 1 based on river traffic for shipments that currently move on the system. In 2003 approximately 98 percent of the total MKARNS traffic moved within or through Segment 1.

Table 5-90. No Action Component: High, Middle and Low Traffic Projections – Segment 1, (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	11,591.6	21,049.5	31,244.5	33,900.6	36,553.8	39,439.0	42,579.0	2.1%
Middle	11,591.6	14,033.0	15,622.3	16,950.3	18,276.9	19,719.5	21,290.0	1.0%
Low	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-91 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Component, Segment 1. Approximately 98 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 1 under the 11-foot Channel Component.

Table 5-91. High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 1 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	515.7	1,531.0	1,661.1	1,791.1	1,932.5	2,086.4	2.8%
Middle	0.0	343.8	765.5	830.6	895.6	966.3	1,043.2	2.2%
Low	0.0	284.0	568.0	568.0	568.0	568.0	568.0	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-92 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Component, Segment 1. Under the 11-foot Channel Deepening Component, 1,662 tow trips are projected annually for existing traffic for Segment 1 under the middle forecast for the year 2010 compared to 1,727 under the 10-foot Channel Component. This compares to 2,139 tow trips under the No Action Component. This represents a 22 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 98 percent of the total tow trips on the MKARNS would move within or through Segment 1.

Also reflected in Table 5-92 are the tons per tow for the 11-foot Channel Component. The projected 7,351 tons per tow forecast for the 11-foot Channel Component, Segment 1, represents an approximate 12 percent increase over the 6,561 tons per tow under the existing 9-foot Channel, Segment 1, and a 4 percent increase over the 7,071 tons under the 10-foot Channel Component, Segment 1.

Table 5-92. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 1.								
	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	1,372	2,492	3,699	4,014	4,328	4,670	5,041	2.3%
Medium	1,372	1,662	1,850	2,007	2,164	2,335	2,521	1.1%
Low	1,372	1,372	1,372	1,372	1,372	1,372	1,372	0.0%
Tons per Tow, 11′	7,351							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-93 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component, Segment 1. It is projected that approximately 98 percent of the induced tow trips will move within or through Segment 1.

Table 5-93. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 1.								
	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	61	181	197	212	229	247	3.0%
Middle	0	41	91	98	106	114	124	2.4%
Low	0	34	67	67	67	67	67	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-94 portrays the middle forecasted navigation benefits for the 11-foot Channel Component, Segment 1. The annual navigation benefit of the 11-foot Channel Deepening Component for Segment 1 is $933,000 with induced traffic. The benefits from induced traffic account for approximately 5 percent of the total navigation benefits for Segment 1 of the 11-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 1 represents approximately 9 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component.

Table 5-94. Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 1 (000s Dollars)[1].		
Forecast	Incremental	Cumulative Incremental
Middle with Induced Traffic	933.2	933.2
[1] Reflects July 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period. *Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.*		

Table 5-95 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 1 under the middle forecast. Construction costs comprise the majority of the total project costs, with dredged material disposal areas, and dikes comprising almost all of the construction costs. Mitigation comprises the majority of the non-construction costs for Segment 1. The total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.39, and negative annual net benefits of approximately $1.47 million.

Table 5-95. Summary of Incremental Net Economic Benefits and Costs -11-foot Channel Deepening Component, Segment 1[1].

Middle Forecast	Segment 1	Cumulative Incremental
Total Project Cost[2]	$34,577,500	$34,577,500
Total Annual Costs[3]	$ 2,409,100	$ 2,409,100
Annual Navigation Benefits	$ 933,200	$ 933,200
Annual Net Benefits	($1,475,900)	($1,407,900)
Benefit-to-Cost Ratio	0.39	0.39

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3.2 Segment 2 - Pine Bluff to Little Rock (NCD 11-2)

Table 5-96 displays the high, middle and low traffic projections for Segment 2 based on river traffic for shipments that currently move on the system. In 2003 approximately 88 percent of the total MKARNS traffic moved within or through Segment 2.

Table 5-96. No Action Component: High, Middle and Low Traffic Projections – Segment 2 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	10,447.3	19,063.7	28,307.9	30,674.7	33,052.6	35,632.1	38,432.8	2.1%
Middle	10,447.3	12,709.1	14,154.0	15,337.4	16,526.3	17,816.1	19,216.4	1.0%
Low	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-97 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Component, Segment 2. Approximately 98 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 2 under the 11-foot Channel Component.

Table 5-97. High, Middle and Low Induced Traffic Projections - 11-foot Channel Deepening Component, Segment 2 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0.0	467.1	1,387.1	1,503.1	1,619.6	1,746.0	1,883.2	2.8%
Middle	0.0	311.4	693.5	751.5	809.8	873.0	941.6	2.2%
Low	0.0	256.0	511.9	511.9	511.9	511.9	511.9	1.4%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-98 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Component, Segment 2. Under the 11-foot Channel Deepening Component, 1,444 tow trips are projected annually for existing traffic for Segment 2 under the middle forecast for the year 2010 compared to 1,501 under the 10-foot Channel Component. This compares to 1,845 tow trips under the 9-foot No Action Component. This represents a 22 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 85 percent of the total tow trips on the MKARNS would move within or through Segment 2.

Also reflected in Table 5-98 are the tons per tow for the 11-foot Channel Component, Segment 2. The projected 7,718 tons per tow forecast for the 11-foot Channel Component, Segment 1, represents an approximate 12 percent increase over the 6,890 tons per tow under the existing 9-foot channel, Segment 1, and a 4 percent increase over the 7,428 tons under the 10-foot Channel Component, Segment 1.

Table 5-98. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 2.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	1,187	2,166	3,216	3,485	3,755	4,048	4,366	2.3%
Medium	1,187	1,444	1,608	1,742	1,877	2,024	2,183	1.1%
Low	1,187	1,187	1,187	1,187	1,187	1,187	1,187	0.0%
Tons per Tow, 11′	7,718							

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-99 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component, Segment 2. It is projected that approximately 83 percent of the induced tow trips will move within or through Segment 2.

Table 5-99. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 2.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	53	158	171	184	198	214	3.0%
Middle	0	35	79	85	92	99	107	2.4%
Low	0	29	58	58	58	58	58	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-100 portrays the middle forecasted navigation benefits for the 11-foot Channel Component, Segment 2. The annual navigation benefit of the 11-foot Channel Deepening Component for Segment 2 is $561,000 with induced traffic. The latter forecasted navigation benefit under the 11-foot Channel Component compares to $175,000 under the 10-foot Channel Component for Segment 2. The benefits from induced traffic account for approximately 4 percent of the total navigation benefits for Segment 2 of the 11-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 2 represents approximately 6 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component.

Table 5-100. Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 2 (000s Dollars)[1].

Forecast	Incremental	Cumulative Incremental
Middle with Induced Traffic	560.7	1,493.9

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-101 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 2 under the middle forecast. Mitigation comprises almost one-half of the total project costs, with dikes and jetties accounting for the majority of the construction costs. As indicated in Table 5-101, the total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.72 for Segment 2, and negative annual net benefits of approximately $217,000. The cumulative benefit-to-cost ratio for Segments 1-2 is 0.47, with cumulative negative net annual benefits of approximately $1.69 million for Segments 1-2.

Table 5-101. Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 2[1].		
Middle Forecast	**Segment 2**	**Cumulative Incremental Segments 1-2**
Total Project Cost[2]	$10,094,700	$44,672,200
Total Annual Costs[3]	$ 777,900	$ 3,187,000
Annual Navigation Benefits	$ 560,700	$1,493,900
Annual Net Benefits	($ 217,200)	($1,693,100)
Benefit-to-Cost Ratio	0.72	0.47

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3.3 Segment 3 - Little Rock to Dardanelle (NCD 11-3)

Table 5-102 displays the high, middle and low traffic projections for Segment 3 based on river traffic for shipments that currently move on the system. In 2003 approximately 73 percent of the total MKARNS traffic moved within or through Segment 3.

Table 5-102. No Action Component: High, Middle and Low Traffic Projections – Segment 3 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	8,672.5	15,773.7	23,405.9	25,364.8	27,328.6	29,460.4	31,776.8	2.1%
Middle	8,672.5	10,515.8	11,702.9	12,682.4	13,664.3	14,730.2	15,888.4	1.0%
Low	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-103 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Component, Segment 3. Approximately 73 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 3 under the 11-foot Channel Component.

Table 5-103. High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 3 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	386.5	1,146.9	1,242.9	1,339.1	1,443.6	1,557.1	2.8%
Middle	0.0	257.6	573.4	621.4	669.6	721.8	778.5	2.2%
Low	0.0	212.5	425.0	425.0	425.0	425.0	425.0	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-104 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Component, Segment 3. Under the 11-foot Channel Deepening Component, 1,123 tow trips are projected annually for existing traffic for Segment 3 under the middle forecast for the year 2010 compared to 1,167 under the 10-foot Channel Component. This compares to 1,423 tow trips under the 9-foot No Action Component. This represents a 22 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 69 percent of the total tow trips on the MKARNS would move within or through Segment 3.

Also reflected in Table 5-104 are the tons per tow for the 11-foot Channel Component, Segment 3. The projected 8,278 tons per tow forecast for the 11-foot Channel Component, Segment 3, represents an approximate 12 percent increase over the 7,388 tons per tow under the existing 9-foot channel, Segment 1, and a 4 increase over the 7,966 tons under the 10-foot Channel Component, Segment 1.

Table 5-104. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 3.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	926	1,685	2,500	2,709	2,919	3,147	3,394	2.3%
Medium	926	1,123	1,250	1,355	1,459	1,573	1,697	1.1%
Low	926	926	926	926	926	926	926	0.0%
Tons per Tow, 11’	8,278							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-105 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component, Segment 3. It is projected that approximately 67 percent of the induced tow trips will move within or through Segment 3.

Table 5-105. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 3.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	41	123	133	143	154	166	3.0%
Middle	0	28	61	66	72	77	83	2.4%
Low	0	23	45	45	45	45	45	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-106 portrays the middle forecasted navigation benefits for the 11-foot Channel Component, Segment 3. The annual navigation benefit of the 11-foot Channel Deepening Component for Segment 3 is $1.16 million with induced traffic. The latter forecasted navigation benefit under the 11-foot Channel Component compares to $489,000 under the 10-foot Channel Component for Segment 3. The benefits from induced traffic account for approximately 4 percent of the total navigation benefits for Segment 3 of the 11-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 3 represents approximately 11 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component. The cumulative benefits with induced traffic for Segments 1-3 total $2.66 million, or 26 percent of the total navigation benefits for the six segments under the 11-foot Channel Component.

Table 5-106. Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 3 (000s Dollars)[1].

Forecast Scenario	Incremental	Cumulative Incremental
Middle with Induced Traffic	1,166.6	2,660.5

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-107 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 3 under the middle forecast. Mitigation comprises the majority of the non-construction costs, with dikes being the primary construction cost. As indicated in Table 5-107, the total annual benefits exceed the annual navigation costs with a resulting benefit-to-cost ratio of 1.07 for Segment 3, and positive annual net benefits of approximately $80,000. The cumulative benefit-to-cost ratio for Segments 1-3 is 0.62, with cumulative negative net annual benefits of approximately $1.6 million for Segments 1-3.

Table 5-107. Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 3[1].		
Middle Forecast	**Segment 3**	**Cumulative Incremental Segments 1-3**
Total Project Cost[2]	$14,397,700	$59,069,900
Total Annual Costs[3]	$ 1,086,800	$ 4,273,800
Annual Navigation Benefits	$ 1,166,600	$ 2,660,500
Annual Net Benefits	$ 79,800	($ 1,613,300)
Benefit-to-Cost Ratio	1.07	0.62

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3.4 Segment 4 – Dardanelle to Fort Smith (NCD 11-4)

Table 5-108 displays the high, middle and low traffic projections for Segment 4 based on river traffic for shipments that currently move on the system. In 2003 approximately 52 percent of the total MKARNS traffic moved within or through Segment 4.

Table 5-108. No Action Component: High, Middle and Low Traffic Projections – Segment 4 (000s tons).

	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	6,183.4	11,017.6	16,234.6	17,587.0	18,910.6	20,349.2	21,915.3	2.0%
Middle	6,183,4	7,345.0	8,117.3	8,793.5	9,455.3	10,174.6	10,957.6	1.0%
Low	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-109 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Component, Segment 4. Approximately 51 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 4 under the 11-foot Channel Component.

Table 5-109. High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 4 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	269.9	795.5	861.8	926.6	997.1	1,073.8	2.8%
Middle	0.0	180.0	397.7	430.9	463.3	498.6	536.9	2.2%
Low	0.0	151.5	303.0	303.0	303.0	303.0	303.0	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-110 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Component, Segment 4. Under the 11-foot Channel Deepening Component, 809 tow trips are projected annually for existing traffic for Segment 4 under the middle forecast for the year 2010 compared to 841 under the 10-foot Channel Component. This compares to 1,025 tow trips under the "existing" 9-foot No Action Component. This represents an approximate 22 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 48 percent of the total tow trips on the MKARNS would move within or through Segment 4.

Also reflected in Table 5-110 are the tons per tow for the 11-foot Channel Component, Segment 4. The projected 8,030 tons per tow forecast for the 11-foot Channel Component, Segment 4, represents an approximate 12 percent increase over the 7,166 tons per tow under the existing 9-foot Channel, Segment 4, and a 4 increase over the 7,728 tons under the 10-foot Channel Component, Segment 4.

Table 5-110. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 4.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	681	1,214	1,789	1,938	2,084	2,242	2,415	2.3%
Medium	681	809	894	969	1,042	1,121	1,207	1.0%
Low	681	681	681	681	681	681	681	0.0%
Tons per Tow, 11′	8,030							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-111 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component, Segment 4. It is projected that approximately 48 percent of the induced tow trips will move within or through Segment 4.

Table 5-111. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 4.								
	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	30	88	95	102	110	118	3.0%
Middle	0	20	44	48	51	55	59	2.4%
Low	0	17	33	33	33	33	33	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-112 portrays the middle forecasted navigation benefits for the 11-foot Channel Component, Segment 4. The annual navigation benefit of the 11-foot Channel Deepening Component for Segment 4 is $171,000 with induced traffic. The middle forecasted benefit under the 11-foot Channel Component compares to $66,000 under the 10-foot Channel Component for Segment 4. The benefits from induced traffic account for approximately 7 percent of the total navigation benefits for Segment 4 of the 11-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 4 represents approximately 4 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component. The cumulative benefits with induced traffic for Segments 1-4 total $2.831 million, or 28 percent of the total navigation benefits for the six segments under the 11-foot Channel Component.

Table 5-112. Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 4 (000s Dollars)[1].

Forecast	Incremental	Cumulative Incremental
Middle with Induced Traffic	171.3	2,831.8

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-113 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 4 under the middle forecast. Mitigation comprises the majority of the non-construction costs, with dikes being the primary construction cost. As indicated in Table 5-113, the total annual costs greatly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.14 for Segment 4 and negative annual net benefits of approximately $1 million. The cumulative benefit-to-cost ratio for Segments 1-4 is 0.52, with cumulative negative net annual benefits of approximately $2.65 million for Segments 1-4.

Table 5-113. Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 4 (000s Dollars)[1].		
Middle Forecast	**Segment 4**	**Cumulative Incremental Segments 1-4**
Total Project Cost[2]	$12,155,800	$71,225,700
Total Annual Costs[3]	$ 1, 207,800	$ 5,481,600
Annual Navigation Benefits	$ 171,300	$ 2,831,800
Annual Net Benefits	($ 1,036,500)	($2,649,800)
Benefit-to-Cost Ratio	0.14	0.52

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3.5 Segment 5 – Fort Smith to Muskogee (NCD 11-5)

Table 5-114 displays the high, middle and low traffic projections for Segment 5 based on river traffic for shipments that currently move on the system. In 2003 approximately 41 percent of the total MKARNS traffic moved within or through Segment 5.

Table 5-114. No Action Component: High, Middle and Low Traffic Projections – Segment 5 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	4,894.9	8,564.7	12,543.5	13,572.6	14,567.9	15,651.2	16,832.5	2.0%
Middle	4,894.9	5,709.8	6,271.7	6,786.3	7,284.0	7,825.6	8,416.3	1.0%
Low	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-115 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Component, Segment 5. Approximately 40 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 5 under the 11-foot Channel Component.

Table 5-115. High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 5 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	209.8	614.6	665.1	713.8	766.9	824.8	2.8%
Middle	0.0	139.9	307.3	332.5	356.9	383.5	412.4	2.2%
Low	0.0	119.9	239.9	239.9	239.9	239.9	239.9	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-116 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Component, Segment 5. Under the 11-foot Channel Deepening Component, 610 tow trips are projected annually for existing traffic for Segment 5 under the middle forecast for the year 2010 compared to 634 under the 10-foot Channel Component. This compares to 793 tow trips under the 9-foot No Action Component. This represents an approximate 22 percent decrease in annual tow trips, rates that would continue through the year 2060. Thirty-six percent of the total tow trips on the MKARNS would move within or through Segment 5.

Also reflected in Table 5-116 are the tons per tow for the 11-foot Channel Component, Segment 5. The projected 8,081 tons per tow forecast for the 11-foot Channel Component, Segment 5, represents an approximate 12 percent increase over the 7,205 tons per tow under the 9-foot channel, Segment 5, and a four percent increase over the 7,768 tons under the 10-foot Channel Component, Segment 5.

Table 5-116. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 5.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	523	915	1,340	1,450	1,556	1,672	1,798	2.2%
Medium	523	610	670	725	778	836	899	1.0%
Low	523	523	523	523	523	523	523	0.0%
Tons per Tow, 11′	8,081							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-117 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component, Segment 5. It is projected that approximately 36 percent of the induced tow trips will move within or through Segment 5.

Table 5-117. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 5.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	22	66	71	76	82	88	3.0%
Middle	0	15	33	36	38	41	44	2.4%
Low	0	13	26	26	26	26	26	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-118 portrays the middle forecasted navigation benefits for the 11-foot Channel Component, Segment 5. The annual navigation benefit of the 11-foot Channel Deepening Component for Segment 5 is $607,000 with induced traffic. The middle forecasted benefit under the 11-foot Channel Component compares to $234,000 under the 10-foot Channel Component for Segment 5. The benefits from induced traffic account for approximately 3 percent of the total navigation benefits for Segment 5 of the 11-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 5 represents approximately 6 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component. The cumulative benefits with induced traffic for Segments 1-5 total $3.439 million, or 34 percent of the total navigation benefits for the six segments under the 11-foot Channel Component.

Table 5-118. Middle Incremental Navigation Benefits Forecast - 11′ Channel Deepening Component, Segment 5 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	606.98	3,438.78
[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period. *Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.*		

Table 5-119 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 5 under the middle forecast. Total project costs for Segment 5 are approximately $47.5 million, or over one-third of the total project costs for Segments 1-6. Mitigation comprises the majority of the non-construction costs. As indicated in Table 5-119, the total annual costs greatly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.185 for Segment 5, and negative annual net benefits of approximately $2.66 million. The cumulative benefit-to-cost ratio for Segments 1-5 is 0.39, with cumulative negative net annual benefits of approximately $5.3 million for Segments 1-5.

Table 5-119. Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 5 (000s Dollars)[1].		
Middle Forecast	**Segment 5**	**Cumulative Incremental Segments 1-5**
Total Project Cost[2]	$47,535,500	$118,761,200
Total Annual Costs[3]	$ 3,276,200	$ 8,757,900
Annual Navigation Benefits	$ 606,980	$ 3,438,780
Annual Net Benefits	($2,669,300)	($ 5,319,100)
Benefit-to-Cost Ratio	0.185	0.39

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.3.6 Segment 6 – Muskogee to Catoosa (NCD 11-6)

Table 5-120 displays the high, middle and low traffic projections for Segment 6 based on river traffic for shipments that currently move on the system. In 2003 approximately 36 percent of the total MKARNS traffic moved within or through Segment 6.

Table 5-120. No Action Component: High, Middle and Low Traffic Projections – Segment 6 (000s tons).

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	4,258.6	7,473.3	10,956.8	11,866.9	12,746.1	13,704.7	14,751.8	2.0%
Middle	4,258.6	4,982.2	5,478.4	5,933.4	6,373.0	6,852.3	7,375.9	1.0%
Low	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-121 displays high, middle and low induced traffic tonnage projections for the 11-foot Channel Component, Segment 6. Approximately 35 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 6 under the 11-foot Channel Component.

Table 5-121. High, Middle and Low Induced Traffic Projections - 11′ Channel Deepening Component, Segment 6 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	183.1	536.9	581.5	624.6	671.5	722.8	2.8%
Middle	0.0	122.1	268.4	290.7	312.3	335.8	361.4	2.2%
Low	0.0	104.3	208.7	208.7	208.7	208.7	208.7	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-122 portrays the projected tow trips under the high, middle and low forecasts for the 11-foot Channel Component, Segment 6. Under the 11-foot Channel Deepening Component, 567 tow trips are projected annually for existing traffic for Segment 6 under the middle forecast for the year 2010 compared to 589 under the 10-foot Channel Component. This compares to 747 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 33 percent of the total tow trips on the MKARNS would move within or through Segment 6.

Also reflected in Table 5-122 are the tons per tow for the 11-foot Channel Component, Segment 6. The projected 7,473 tons per tow forecast for the 11-foot Channel Component, Segment 6, represents an approximate 12 percent increase over the 6,667 tons per tow under the existing 9-foot Channel, Segment 6, and a 4 increase over the 7,190 tons under the 10-foot Channel Component, Segment 6.

Table 5-122. High, Middle and Low Tow Trip Projections - 11′ Channel Deepening Component, Segment 6.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	484	850	1,246	1,349	1,449	1,558	1,678	2.2%
Medium	484	567	623	675	725	779	839	1.0%
Low	484	484	484	484	484	484	484	0.0%
Tons per Tow, 11′	7,473							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-123 displays the projected high, middle and low induced tow trips for the 11-foot Channel Deepening Component, Segment 6. It is projected that approximately 29 percent of the induced tow trips will move within or through Segment 6.

Table 5-123. High, Middle and Low Induced Tow Trip Projections - 11′ Channel Deepening Component, Segment 6.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	21	61	66	71	76	82	3.0%
Middle	0	14	31	33	36	38	41	2.4%
Low	0	12	24	24	24	24	24	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-124 portrays the middle forecasted navigation benefits for the 11-foot Channel Component, Segment 6. The annual navigation benefit of the 11-foot Channel Deepening Component for Segment 6 is $6.7 million with induced traffic. The middle forecasted benefit under the 11-foot Channel Component compares to $2.7 million under the 10-foot Channel Component for Segment 6. The benefits from induced traffic account for approximately 2 percent of the total navigation benefits for Segment 6 of the 11-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 6 represents approximately 66 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component. The cumulative annual navigation benefits with induced traffic for Segments 1-6 total $10.173 million under the 11-foot Channel Component, compared to $4.022 million under the 10-foot Channel Component.

Table 5-124. Middle Incremental Navigation Benefits Forecast – 11′ Channel Deepening Component, Segment 6 (000s Dollars)[1].

Forecast	Incremental	Cumulative Incremental
Middle with Induced Traffic	6,734.72	10,173.50

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-125 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 6 under the middle forecast. Total project costs for Segment 6 are approximately $18.7 million, or fourteen percent of the total project costs for Segments 1-6. As indicated in Table 5-125, the total annual navigation benefits greatly exceed the annual costs with a resulting benefit-to-cost ratio of 4.64 for Segment 6, and positive annual net benefits of approximately $5.3 million. The cumulative benefit-to-cost ratio for Segments 1-6 is 0.99, with cumulative negative net annual benefits of $33,700 for Segments 1-6.

Table 5-125. Summary of Incremental Net Economic Benefits and Costs -11′ Channel Deepening Component, Segment 6 (000s Dollars)[1].		
Middle Forecast	**Segment 6**	**Cumulative Incremental Segments 1-6**
Total Project Cost[2]	$18,751,700	$137,512,900
Total Annual Costs[3]	$ 1,449,400	$ 10,207,300
Annual Navigation Benefits	$ 6,734,720	$ 10,173,500
Annual Net Benefits	$ 5,285,400	$ (33,700)
Benefit-to-Cost Ratio	4.64	0.99

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4 Channel Deepening 12-Foot Channel Component

Channel deepening to 12 feet will result in both direct and indirect positive impacts on commercial navigation, and impacts on operations and maintenance in all segments under the 12-foot Channel Deepening Component. However, these impacts vary among the various segments as is discussed under each segment. There would be no impacts within any of the segments of this Component on hydroelectric power and tourism/recreation since the reservoir head and level of surface water relative to the adjacent land would remain at or near current levels. There also would be no flooding impacts on agricultural and non-agricultural properties.

Further deepening of the channel would allow a substantial portion of barges to be more fully loaded than is currently possible on the 9-foot deep existing channel. The shipping costs for existing traffic for the existing 9-foot channel depth and the 12-foot channel depth are portrayed in Table 5-126. At the year 2003 base level, the cost savings between the existing 9-foot channel and the 12-foot channel deepening component is approximately $10.1 million, while the differential costs savings per ton under the 12-foot channel depth component is approximately $.85. The savings per ton represent the savings on water transportation compared to overland transportation costs.

Table 5-126. Existing Traffic, Tonnage and Transportation Costs – Middle Forecasts - 12′ Channel Deepening Component (000s except for savings/ton).							
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Tons (000s)	11,884	14,372	15,997	17,356	18,708	20,177	21,775
Water-Routed Transportation Costs for Existing Shipments							
9′	150,344.6	177,979.5	196,781.4	213,242.4	229,292.3	246,738.0	265,728.8
12′	140,224.9	166,032.8	183,585.7	198,942.2	213,933.8	230,231.0	247,972.8
Net Savings	10,119.7	11,946.7	13,195.7	14.300.2	15.358.5	16,507.0	17,756.0
Savings per Ton for Existing Shipments							
9′	$ 9.75	$ 9.55	$ 9.47	$ 9.46	$ 9.44	$ 9.42	$ 9.41
12′	$10.60	$10.38	$10.30	$10.28	$10.26	$10.24	$10.22
Net Savings	$ .85	$ .83	$ .83	$ .82	$ .82	$ .82	$ .81
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.							

Table 5-127 displays high, middle and low induced traffic tonnage projections for the 12-foot channel deepening component, and the transportation savings per ton under the mid-level forecast. The methodology and assumptions regarding induced traffic discussed under the 10-foot and 11-foot Channel Deepening Components also apply to the 12-foot Channel Deepening Component. The induced traffic under the 12-foot Channel Component is projected to be approximately 14 percent greater than under the 11-foot Channel Component. The transportation savings per ton for induced traffic is projected to be approximately 12 percent greater than under the 11-foot Channel Component.

Table 5-127. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	603.6	1,791.6	1,943.9	2,095.2	2,259.8	2,438.8	2.8%
Middle	0.0	402.4	895.8	971.9	1,047.6	1,129.9	1,219.4	2.2%
Low	0.0	332.8	665.6	665.6	665.6	665.6	665.6	1.4%
Overland Transportation Costs of Potentially Induced Traffic (000s Dollars)								
12′ Middle	n.a.	9,270.8	20,513.9	22,224.8	23,909.8	25,742.6	25,742.6	n.a.
Transportation Costs per Ton for All Overland Transportation Mode								
12′ Middle	n.a.	$23.04	$22.90	$22.87	$22.82	$22.78	$22.75	n.a.
Transportation Savings per Ton for Induced Traffic (Oct. 2003 Dollars)								
12′ Middle	n.a.	$.38	$.37	$.37	$.37	$.37	$.37	n.a.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-128 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot deepening component. The methodology for estimating the effect of deepening on the number of tows was discussed under the previous Components. Under the 12-foot Channel Component, the middle forecast for annual tow trips is less than 2 percent less than under the 11-foot Channel Component.

Table 5-128. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	1,380	2,504	3,716	4,032	4,346	4,687	5,058	2.3%
Middle	1,380	1,669	1,858	2,016	2,173	2,343	2,529	1.1%
Low	1,380	1,380	1,380	1,380	1,380	1,380	1,380	0.0%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts2005.

Table 5-129 displays the projected high, middle and low induced tow trips for the 12-foot channel deepening component. The induced tow trips represent approximately 3 percent of the total tow trips. The middle forecast of induced tow trips under the 12-foot Channel Component is approximately 12 percent higher than under the 11-foot Channel Component.

Table 5-129. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	n.a	70	208	226	243	263	283	3.0%
Middle	n.a	47	104	113	122	131	142	2.4%
Low	n.a	39	77	77	77	77	77	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-130 reflects the high, middle and low projected average annual navigation benefits for the 12-foot channel depth with and without induced traffic. These benefits reflect the annual average savings in water transportation costs versus overland transportation costs for the same volume and group of commodities. The results indicate that induced traffic has little effect on the overall benefits. This is true regardless of the channel depth or traffic forecasts. However, the benefits are sensitive to channel depth and to future traffic projections. For example, the benefits of induced traffic under the high forecast are almost 80 percent greater than the benefits under the middle forecasts for the 12-foot channel deepening component. The middle forecast of annual navigation benefits with induced traffic under the 12-foot Channel Component exceed by approximately 32 percent the annual navigation benefits under the 11-foot Channel Component.

Table 5-130. High, Middle and Low Projected Average Annual Navigation Benefits - 12′ Channel Deepening Component (000s Dollars)[1].

Forecast	Without Induced Traffic	With Induced Traffic
High	22,370.29	21,033.13
Middle	13,252.68	13,482.55
Low	10,114.86	10,321.35

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-131 provides a more detailed summary of the annualized navigation benefits under the middle forecast for the 12-foot Channel Component. The annualized benefits reflect a reduction in transportation costs as a result of more efficient use of existing equipment, reductions in transit time, and in the use of water transportation rather than alternative overland transit modes. The benefits are expressed as average annual equivalent values. Over 95 percent of the benefits are cost reduction benefits, with the induced traffic providing the remaining benefits. The small benefit from induced traffic is due to the relatively small amount of traffic induced and the marginal savings realized from these shipments.

Table 5-131. Summary of Annualized Navigation Benefits, Middle Forecast - 12′ Channel Deepening Component (000s Dollars)[1].

Benefits With Induced Traffic	
Cost Reduction	13,211.13
Existing	13,297.68
Processing	(86.54)
Shift of Mode	271.32
Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**13,482.45**
Benefits Without Induced Traffic	
Cost Reduction	13,252.68
Existing	13,297.68
Processing	(44.99)
Shift of Mode	0.0

Shift in Origin/Destination	0.0
New Movement	0.0
TOTAL	**13,252.68**

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-132 provides a summary of the total project costs, annual costs and benefits, net benefits, and benefit-to-cost ratio for the 12-foot Channel Deepening Component. The annual positive benefits of approximately $1.0 million results in a benefit-to-cost ratio of 1.08. The following discussion provides a summary of costs and benefits and benefit-to-cost ratio for each segment of the 12-foot Channel Deepening Component.

Table 5-132. Summary of Total Costs and Benefits – 12′ Channel Deepening Component[1].

Middle Forecast Scenario	
Total Project Cost[2]	$166,418,500
Total Annual Costs[3]	$ 12,472,800
Annual Navigation Benefits	$ 13,482,600
Annual Net Benefits	$ 1,009,800
Benefit-to-Cost Ratio	1.08

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4.1 Segment 1 - Mouth to Pine Bluff (NCD 12-1)

Table 5-133 displays the high, middle and low traffic projections for Segment 1 based on river traffic for shipments that currently move on the system. In 2003 approximately 98 percent of the total MKARNS traffic moved within or through Segment 1.

Table 5-133. No Action Component: High, Middle and Low Traffic Projections – 12′ Channel Component, Segment 1 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	11,591.6	21,049.5	31,244.5	33,900.6	36,553.8	39,439.0	42,579.0	2.1%
Middle	11,591.6	14,033.0	15,622.3	16,950.3	18,276.9	19,719.5	21,290.0	1.0%
Low	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	11,591.6	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-134 displays high, middle and low induced traffic tonnage projections for the 12-foot Channel Component, Segment 1. Approximately 98 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 1 under the 12-foot Channel Component.

Table 5-134. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 1 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	589.4	1,749.7	1,898.4	2,047.0	2,208.6	2,384.5	2.8%
Middle	0.0	392.9	874.8	949.2	1,023.5	1,104.3	1,192.2	2.2%
Low	0.0	324.6	649.1	649.1	649.1	649.1	649.1	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-135 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot Channel Component, Segment 1. Under the 12-foot Channel Deepening Component, 1,636 tow trips are projected annually for existing traffic for Segment 1 under the middle forecast for the year 2010 compared to 1,662 under the 11-foot Channel Component. This compares to 2,139 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 98 percent of the total tow trips on the MKARNS would move within or through Segment 1.

Also reflected in Table 5-135 are the tons per tow for the 12-foot Channel Component, Segment 1. The projected 7,461 tons per tow forecast for the 12-foot Channel Component, Segment 1, represents an approximate 14 percent increase over the 6,561 tons per tow under the existing 9-foot channel, Segment 1, and a 1 percent increase over the 7,351 tons under the 10-foot Channel Component, Segment 1.

Table 5-135. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 1.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	1,352	2,455	3,643	3,953	4,262	4,599	4,965	2.3%
Medium	1,352	1,636	1,822	1,977	2,131	2,299	2,483	1.1%
Low	1,352	1,352	1,352	1,352	1,352	1,352	1,352	0.0%
Tons per Tow, 12′	7,461							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-136 displays the projected high, middle and low induced tow trips for the 12-foot Channel Deepening Component, Segment 1. It is projected that approximately 98 percent of the induced tow trips will move within or through Segment 1.

Table 5-136. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 1.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	69	204	221	239	258	278	3.0%
Middle	0	46	102	111	119	129	139	2.4%
Low	0	38	76	76	76	76	76	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-137 portrays the middle forecasted navigation benefits for the 12-foot Channel Component, Segment 1. The annual navigation benefit of the 12-foot Channel Deepening Component for Segment 1 is $1.25 million with induced traffic. The middle forecasted benefit under the 12-foot Channel Component compares to $933,000 under the 11-foot Channel Component for Segment 1. The benefits from induced traffic account for approximately 5 percent of the total navigation benefits for Segment 1 of the 12-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 1 represents approximately 10 percent of the total navigation benefits for the six segments of the waterway under the 11-foot Channel Component.

Table 5-137. Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 1 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	1,250.2	1,250.2

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-138 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 1 under the middle forecast. The majority of the construction costs consist of dredged material disposal areas and dikes. Mitigation comprises the majority of the non-construction costs. As indicated in Table 5-138, the total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.46 for Segment 1, and negative annual net benefits of approximately $1.49 million.

Table 5-138. Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 1[1].		
Middle Forecast	**Segment 1**	**Cumulative Incremental**
Total Project Cost[2]	$38,453,800	$38,453,800
Total Annual Costs[3]	$ 2,745,500	$2,745,500
Annual Navigation Benefits	$ 1,250,200	$1,250,200
Annual Net Benefits	($1,495,300)	($1,495,300)
Benefit-to-Cost Ratio	0.46	0.46

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4.2 Segment 2 - Pine Bluff to Little Rock (NCD 12-2)

Table 5-139 displays the high, middle and low traffic projections for Segment 2 based on river traffic for shipments that currently move on the system. In 2003 approximately 88 percent of the total MKARNS traffic moved within or through Segment 2.

Table 5-139. No Action Component: High, Middle and Low Traffic Projections – Segment 2 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	10,447.3	19,063.7	28,307.9	30,674.7	33,052.6	35,632.1	38,432.8	2.1%
Middle	10,447.3	12,709.1	14,154.0	15,337.4	16,526.3	17,816.1	19,216.4	1.0%
Low	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	10,447.3	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-140 displays high, middle and low induced traffic tonnage projections for the 12-foot Channel Component, Segment 2. Approximately 89 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 2 under the 12-foot Channel Component.

Table 5-140. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 2 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	533.8	1,585.2	1,717.8	1,850.9	1,995.4	2,152.2	2.8%
Middle	0.0	355.9	792.6	858.9	925.5	997.7	1,076.1	2.2%
Low	0.0	292.5	585.0	585.0	585.0	585.0	585.0	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-141 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot Channel Component, Segment 2. Under the 12-foot Channel Deepening Component, 1,422 tow trips are projected annually for existing traffic for Segment 2 under the middle forecast for the year 2010 compared to 1,444 under the 11-foot Channel Component. This compares to 1,845 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 85 percent of the total tow trips on the MKARNS would move within or through Segment 2.

Also reflected in Table 5-141 are the tons per tow for the 12-foot Channel Component, Segment 2. The projected 7,839 tons per tow forecast for the 12-foot Channel Component, Segment 2, represents an approximate 14 percent increase over the 6,890 tons per tow under the existing 9-foot Channel, Segment 2, and a 1 percent increase over the 7,718 tons under the 11-foot Channel Component, Segment 2.

Table 5-141. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 2.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	1,169	2,132	3,166	3,431	3,697	3,986	4,299	2.3%
Medium	1,169	1,422	1,583	1,716	1,849	1,993	2,150	1.1%
Low	1,169	1,169	1,169	1,169	1,169	1,169	1,169	0.0%
Tons per Tow, 12′	7,839							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-142 displays the projected high, middle and low induced tow trips for the 12-foot Channel Deepening Component, Segment 1. It is projected that approximately 85 percent of the induced tow trips will move within or through Segment 2.

Table 5-142. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 2.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	60	177	192	207	223	241	3.0%
Middle	0	40	89	96	104	112	120	2.4%
Low	0	33	65	65	65	65	65	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-143 portrays the middle forecasted navigation benefits for the 12-foot Channel Component, Segment 2. The annual navigation benefits of the 12-foot Channel Deepening Component for Segment 2 is $803,000 with induced traffic. The latter middle forecasted benefit under the 12-foot Channel Component compares to $561,000 under the 11-foot Channel Component for Segment 2. The benefits from induced traffic account for approximately 3 percent of the total navigation benefits for Segment 2 of the 12-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 2 represents approximately 6 percent of the total navigation benefits for the six segments of the waterway under the 12-foot Channel Component. The cumulative annual navigation benefits with induced traffic for Segments 1-2 total $2.05 million under the 12-foot Channel Component, compared to $1.49 million under the 11-foot Channel Component.

Table 5-143. Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 2 (000s Dollars) [1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	803.4	2,053.6

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-144 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 2 under the middle forecast. The majority of the construction costs consist of dikes, with mitigation comprising the majority of the non-construction costs. As indicated in Table 5-144, the total annual costs slightly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.86 for Segment 2, and negative annual net benefits of approximately $126,600. The cumulative benefit-to-cost ratio for Segments 1-2 is 0.56, with cumulative negative net annual benefits of approximately $1.62 million for Segments 1-2.

Table 5-144. Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 2 (000s Dollars)[1].		
Middle Forecast	**Segment 2**	**Cumulative Incremental Segments 1-2**
Total Project Cost[2]	$11,487,600	$49,941,400
Total Annual Costs[3]	$ 930,000	$ 3,675,500
Annual Navigation Benefits	$ 803,400	$ 2,053,600
Annual Net Benefits	($ 126,600)	($1,621,900)
Benefit-to-Cost Ratio	0.86	0.56

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4.3 Segment 3 - Little Rock to Dardanelle (NCD 12-3)

Table 5-145 displays the high, middle and low traffic projections for Segment 3 based on river traffic for shipments that currently move on the system. In 2003 approximately 88 percent of the total MKARNS traffic moved within or through Segment 3.

Table 5-145. No Action Component: High, Middle and Low Traffic Projections – Segment 3 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	8,672.5	15,773.7	23,405.9	25,364.8	27,328.6	29,460.4	31,776.8	2.1%
Middle	8,672.5	10,515.8	11,702.9	12,682.4	13,664.3	14,730.2	15,888.4	1.0%
Low	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	8,672.5	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-146 displays high, middle and low induced traffic tonnage projections for the 12-foot Channel Component, Segment 2. Approximately 73 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 3 under the 12-foot Channel Component.

Table 5-146. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 3 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	441.7	1,310.7	1,420.4	1,530.4	1,649.8	1,779.5	2.8%
Middle	0.0	294.4	655.4	710.2	765.2	824.9	889.8	2.2%
Low	0.0	242.8	485.7	485.7	485.7	485.7	485.7	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-147 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot Channel Component, Segment 3. Under the 12-foot Channel Deepening Component, 1,107 tow trips are projected annually for existing traffic for Segment 3 under the middle forecast for the year 2010 compared to 1,123 under the 11-foot Channel Component. This compares to 1,423 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 66 percent of the total tow trips on the MKARNS would move within or through Segment 3.

Also reflected in Table 5-147 are the tons per tow for the 12-foot Channel Component, Segment 3. The projected 8,403 tons per tow forecast for the 12-foot Channel Component, Segment 3, represents an approximate 14 percent increase over the 7,388 tons per tow under the existing 9-foot channel, Segment 3, and a 1 increase over the 8,278 tons under the 11-foot Channel Component, Segment 3.

Table 5-147. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 3.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	913	1,660	2,464	2,670	2,876	3,101	3,345	2.3%
Medium	913	1,107	1,232	1,335	1,438	1,550	1,672	1.1%
Low	913	913	913	913	913	913	913	0.0%
Tons per Tow, 12′	8,403							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-148 displays the projected high, middle and low induced tow trips for the 12-foot Channel Deepening Component, Segment 3. It is projected that approximately 66 percent of the induced tow trips will move within or through Segment 3.

Table 5-148. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 3.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	47	138	150	161	174	187	3.0%
Middle	0	31	69	75	81	87	94	2.4%
Low	0	26	51	51	51	51	51	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-149 portrays the middle forecasted navigation benefits for the 12-foot Channel Component, Segment 3, for the high, middle and low forecasts. The annual navigation benefit of the 12-foot Channel Deepening Component for Segment 3 is $1.434 million with induced traffic. The middle forecasted benefit under the 12-foot Channel Component compares to $1.166 million under the 11-foot Channel Component for Segment 3. The benefits from induced traffic account for approximately 1 percent of the total navigation benefits for Segment 3 of the 12-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 3 represents approximately 10 percent of the total navigation benefits for the six segments of the waterway under the 12-foot Channel Component. The cumulative annual navigation benefits with induced traffic for Segments 1-3 total $3.488 million under the 12-foot Channel Component, compared to $2.660 million under the 11-foot Channel Component.

Table 5-149. Middle Incremental Benefits Forecast - 12′ Channel Deepening Component, Segment 3 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	1,434.7	3,488.3

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-150 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 3 under the middle forecast. The majority of the construction costs consist of dikes, with mitigation comprising the majority of the non-construction costs. As indicated in Table 5-150, the total annual costs exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.88 for Segment 3, and negative annual net benefits of approximately $185,000. The cumulative benefit-to-cost ratio for Segments 1-3 is 0.66, with cumulative negative net annual benefits of approximately $1.8 million for Segments 1-3.

Table 5-150. Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 3[1].		
Middle Forecast	**Segment 3**	**Cumulative Incremental Segments 1-3**
Total Project Cost[2]	$20,478,000	$70,419,400
Total Annual Costs[3]	$ 1,619,900	$ 5,295,400
Annual Navigation Benefits	$ 1,434,700	$ 3,488,300
Annual Net Benefits	$ (185,200)	($1,807,100)
Benefit-to-Cost Ratio	0.885	0.66

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4.4 Segment 4 – Dardanelle to Fort Smith (NCD 12-4)

Table 5-151 displays the high, middle and low traffic projections for Segment 4 based on river traffic for shipments that currently move on the system. In 2003 approximately 52 percent of the total MKARNS traffic moved within or through Segment 4.

Table 5-151. No Action Component: High, Middle and Low Traffic Projections – Segment 4 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	6,183.4	11,017.6	16,234.6	17,587.0	18,910.6	20,349.2	21,915.3	2.0%
Middle	6,183,4	7,345.0	8,117.3	8,793.5	9,455.3	10,174.6	10,957.6	1.0%
Low	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	6,183,4	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-152 displays high, middle and low induced traffic tonnage projections for the 12-foot Channel Component, Segment 4. Approximately 51 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 4 under the 12-foot Channel Component.

Table 5-152. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 4 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	308.5	909.1	984.9	1,059.0	1,139.6	1,227.3	2.8%
Middle	0.0	205.7	454.6	492.4	529.5	569.8	613.6	2.2%
Low	0.0	173.1	346.3	346.3	346.3	346.3	346.3	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-153 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot Channel Component, Segment 4. Under the 12-foot Channel Deepening Component, 797 tow trips are projected annually for existing traffic for Segment 4 under the middle forecast for the year 2010 compared to 809 under the 11-foot Channel Component. This compares to 1,025 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 48 percent of the total tow trips on the MKARNS would move within or through Segment 4.

Also reflected in Table 5-153 are the tons per tow for the 12-foot Channel Component, Segment 4, with and without the implementation of the proposed flow management changes. The projected 8,153 tons per tow forecast for the 12-foot Channel Component, Segment 4, represents an approximate 14 percent increase over the 7,166 tons per tow under the existing 9-foot channel, Segment 4, and a 1 percent increase over the 8,030 tons under the 11-foot Channel Component, Segment 4.

Table 5-153. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 4.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	671	1,195	1,761	1,908	2,051	2,207	2,377	2.3%
Medium	671	797	881	954	1,026	1,104	1,189	1.1%
Low	671	671	671	671	671	671	671	0.0%
Tons per Tow, 12’	8,153							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-154 displays the projected high, middle and low induced tow trips for the 12-foot Channel Deepening Component, Segment 4. It is projected that approximately 47 percent of the induced tow trips will move within or through Segment 4.

Table 5-154. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 4.								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0	34	99	107	115	124	133	3.0%
Middle	0	22	49	53	57	62	67	2.4%
Low	0	19	38	38	38	38	38	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-155 portrays the middle forecasted navigation benefits for the 12-foot Channel Component, Segment 4. The annual navigation benefit of the 12-foot Channel Deepening Component for Segment 4 is $226,000 with induced traffic. The middle forecasted navigation benefit under the 12-foot Channel Component compares to $171,000 under the 11-foot Channel Component for Segment 4. The benefits from induced traffic account for approximately 6 percent of the total navigation benefits for Segment 4 of the 12-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 4 represents approximately 2 percent of the total navigation benefits for the six segments of the waterway under the 12-foot Channel Component. The cumulative annual navigation benefits with induced traffic for Segments 1-4 total $3.7 million under the 12-foot Channel Component, compared to $2.8 million under the 11-foot Channel Component.

Table 5-155. Middle Incremental Benefits Forecast - 12′ Channel Deepening Component, Segment 4 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	226.22	3,714.50

[1] Reflects October, 2003 dollars, an annual discount rate of 5 5/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-156 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 4 under the middle forecast. The majority of the construction costs consist of dikes, with mitigation comprising the majority of the non-construction costs. As indicated in Table 5-156, the total annual costs greatly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.134 for Segment 4, and negative annual net benefits of approximately $1.46 million. The cumulative benefit-to-cost ratio for Segments 1-4 is 0.53, with cumulative negative net annual benefits of approximately $3.267 million for Segments 1-4.

Table 5-156. Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 4[1].		
Middle Forecast	**Segment 4**	**Cumulative Incremental Segments 1-4**
Total Project Cost[2]	$17,880,500	$88,299,900
Total Annual Costs[3]	$ 1,686,000	$ 6,981,400
Annual Navigation Benefits	$ 226,200	$ 3,714,500
Annual Net Benefits	($ 1,459,800)	($ 3,266,900)
Benefit-to-Cost Ratio	0.134	0.53

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4.5 Segment 5 Fort Smith to Muskogee (NCD 12-5)

Table 5-157 displays the high, middle and low traffic projections for Segment 5 based on river traffic for shipments that currently move on the system. In 2003 approximately 41 percent of the total MKARNS traffic moved within or through Segment 5.

Table 5-157. No Action Component: High, Middle and Low Traffic Projections – Segment 5 (000s tons).							
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	4,894.9	8,564.7	12,543.5	13,572.6	14,567.9	15,651.2	16,832.5	2.0%
Middle	4,894.9	5,709.8	6,271.7	6,786.3	7,284.0	7,825.6	8,416.3	1.0%
Low	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	4,894.9	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-158 displays high, middle and low induced traffic tonnage projections for the 12-foot Channel Component, Segment 5. Approximately 40 percent of the total induced tonnage on the MKARNS is forecasted to move through or within Segment 5 under the 12-foot Channel Component.

Table 5-158. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 5 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	239.8	702.4	760.1	815.8	876.5	942.6	2.8%
Middle	0.0	159.9	351.2	380.0	407.9	438.2	471.3	2.2%
Low	0.0	137.1	274.1	274.1	274.1	274.1	274.1	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-159 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot Channel Component, Segment 5. Under the 12-foot Channel Deepening Component, 601 tow trips are projected annually for existing traffic for Segment 5 under the middle forecast for the year 2010 compared to 610 under the 11-foot Channel Component. This compares to 793 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 36 percent of the total tow trips on the MKARNS would move within or through Segment 5.

Also reflected in Table 5-159 are the tons per tow for the 12-foot Channel Component, Segment 5. The projected 8,200 tons per tow forecast for the 12-foot Channel Component, Segment 5, represents an approximate 14 percent increase over the 7,205 tons per tow under the existing 9-foot channel, Segment 5, and a 1 increase over the 8,081 tons under the 11-foot Channel Component, Segment 5.

Table 5-159. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 5.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	515	901	1,320	1,428	1,533	1,647	1,771	2.2%
Medium	515	601	660	714	766	823	886	1.1%
Low	515	515	515	515	515	515	515	0.0%
Tons per Tow, 12’	8,200							

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-160 displays the projected high, middle and low induced tow trips for the 12-foot Channel Deepening Component, Segment 4. It is projected that approximately 36 percent of the induced tow trips will move within or through Segment 5.

Table 5-160. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 5.

	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	25	74	80	86	92	99	3.0%
Middle	0	17	37	40	43	46	50	2.4%
Low	0	14	29	29	29	29	29	1.5%

Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-161 portrays the middle forecasted navigation benefits for the 12-foot Channel Component, Segment 5. The annual navigation benefit of the 12-foot Channel Deepening Component for Segment 5 is approximately $838,000 with induced traffic. The middle forecasted navigation benefit under the 12-foot Channel Component compares to $606,940 under the 11-foot Channel Component for Segment 5. The benefits from induced traffic account for approximately 3 percent of the total navigation benefits for Segment 5 of the 12-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 5 represents approximately 6 percent of the total navigation benefits for the six segments of the waterway under the 12-foot Channel Component. The cumulative annual navigation benefits with induced traffic for Segments 1-5 total $4.552 million under the 12-foot Channel Component, compared to $3.438 million under the 11-foot Channel Component.

Table 5-161. Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 5 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	838.3	4,552.8

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-162 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 5 under the middle forecast. Project costs for Segment 5 account for almost one-third of the total project costs for Segments 1-6. As indicated in Table 5-162, the total annual costs greatly exceed the annual navigation benefits with a resulting benefit-to-cost ratio of 0.228 for Segment 5 and negative annual net benefits of approximately $2.8 million. The cumulative benefit-to-cost ratio for Segments 1-5 is 0.43, with cumulative negative net annual benefits of approximately $6.1 million for Segments 1-5.

Table 5-162. Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 5[1].		
Middle Forecast	**Segment 5**	**Cumulative Incremental Segments 1-5**
Total Project Cost[2]	$53,666,200	$141,966,100
Total Annual Costs[3]	$ 3,669,000	$ 10,650,400
Annual Navigation Benefits	$ 838,300	$ 4,552,800
Annual Net Benefits	($2,830,700)	($ 6,097,600)
Benefit-to-Cost Ratio	0.228	0.43

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.2.4.6 Segment 6 – Muskogee to Catoosa (NCD 12-6)

Table 5-163 displays the high, middle and low traffic projections for Segment 6 based on river traffic for shipments that currently move on the system. In 2003 approximately 36 percent of the total MKARNS traffic moved within or through Segment 6.

Table 5-163. No Action Component: High, Middle and Low Traffic Projections – Segment 6 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	4,258.6	7,473.3	10,956.8	11,866.9	12,746.1	13,704.7	14,751.8	2.0%
Middle	4,258.6	4,982.2	5,478.4	5,933.4	6,373.0	6,852.3	7,375.9	1.0%
Low	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	4,258.6	0.0%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-164 displays high, middle and low induced traffic tonnage projections for the 12-foot Channel Component, Segment 6. Approximately 35 percent of the total induced tonnage on the MKARNS is forecast to move through or within Segment 6 under the 12-foot Channel Component.

Table 5-164. High, Middle and Low Induced Traffic Projections - 12′ Channel Deepening Component, Segment 6 (000s tons).								
	2003	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**	**Annual Increase**
High	0.0	209.3	613.6	664.5	713.8	767.5	826.1	2.8%
Middle	0.0	139.5	306.8	332.3	356.9	383.7	413.1	2.2%
Low	0.0	119.2	238.5	238.5	238.5	238.5	238.5	1.4%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-165 portrays the projected tow trips under the high, middle and low forecasts for the 12-foot Channel Component, Segment 6. Under the 12-foot Channel Deepening Component, 558 tow trips are projected annually for existing traffic for Segment 6 under the middle forecast for the year 2010 compared to 567 under the 11-foot Channel Component. This compares to 747 tow trips under the 9-foot No Action Component. This represents an approximate 24 percent decrease in annual tow trips, rates that would continue through the year 2060. Approximately 33 percent of the total tow trips on the MKARNS would move within or through Segment 5.

Also reflected in Table 5-165 are the tons per tow for the 12-foot Channel Component, Segment 6. The projected 7,587 tons per tow forecast for the 12-foot Channel Component, Segment 6, represents an approximate 14 percent increase over the 6,667 tons per tow under the existing 9-foot channel, Segment 6, and a 1 percent increase over the 7,473 tons under the 11-foot Channel Component, Segment 5.

Table 5-165. High, Middle and Low Tow Trip Projections - 12′ Channel Deepening Component, Segment 6.								
	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	477	837	1,227	1,329	1,428	1,535	1,653	2.2%
Medium	477	558	614	665	714	768	826	1.0%
Low	477	477	477	477	477	477	477	0.0%
Tons per Tow, 12'	7,587							
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-166 displays the projected high, middle and low induced tow trips for the 12-foot Channel Deepening Component, Segment 6. It is projected that approximately 34 percent of the induced tow trips will move within or through Segment 6.

Table 5-166. High, Middle and Low Induced Tow Trip Projections - 12′ Channel Deepening Component, Segment 6.								
	2003	2010	2020	2030	2040	2050	2060	Annual Increase
High	0	23	69	74	80	86	93	3.0%
Middle	0	16	34	37	40	43	46	2.4%
Low	0	13	27	27	27	27	27	1.5%
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.								

Table 5-167 portrays the middle forecasted navigation benefits for the 12-foot Channel Component, Segment 6. The annual navigation benefit of the 12-foot Channel Deepening Component for Segment 6 is $8.929 million with induced traffic. The middle forecasted benefit under the 12-foot Channel Component compares to $6.734 million under the 11-foot Channel Component for Segment 6. The benefits from induced traffic account for approximately 3 percent of the total navigation benefits for Segment 6 of the 12-foot Channel Component. The middle forecast of benefits, including induced traffic, for Segment 6 represents approximately 66 percent of the total navigation benefits for the six segments of the waterway under the 12-foot Channel Component. The cumulative annual navigation benefits with induced traffic for Segments 1-6 total $13.482 million under the 12-foot Channel Component, compared to $10.173 million under the 11-foot Channel Component.

Table 5-167. Middle Incremental Navigation Benefits Forecast - 12′ Channel Deepening Component, Segment 6 (000s Dollars)[1].		
Forecast	**Incremental**	**Cumulative Incremental**
Middle with Induced Traffic	8,929.8	13,482.6

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

Table 5-168 provides a summary of the total project costs, annual costs and benefits, and the benefit-to-cost ratio for Segment 6 under the middle forecast. Total project costs for Segment 6 approximate only $24.4 million, or approximately 15 percent of the total project costs for Segments 1-6. As indicated in Table 5-168, the total annual navigation benefits greatly exceed the annual costs with a resulting benefit-to-cost ratio of 4.90 for Segment 6, and positive annual net benefits of approximately $7.1 million. The cumulative benefit-to-cost ratio for Segments 1-6 is 1.08, with cumulative positive net annual benefits of approximately $1.0 million for Segments 1-6.

Table 5-168. Summary of Incremental Costs and Net Incremental Benefits -12′ Channel Deepening Component, Segment 6[1].		
Middle Forecast	**Segment 6**	**Cumulative Incremental Segments 1-6**
Total Project Cost[2]	$24,452,400	$166,418,500
Total Annual Costs[3]	$ 1,822,400	$ 12,472,800
Annual Navigation Benefits	$ 8,929,800	$ 13,482,600
Annual Net Benefits	$ 7,107,400	$ 1,009,800
Benefit-to-Cost Ratio	4.90	1.08

[1] Reflects July, 2004 dollars, an annual discount rate of 5 3/8 percent over a 50-year period.
[2] Includes construction, interest during construction, real estate, planning/engineering/design, mitigation, contract administration, and contingency costs. Does not include escalation and investment by ports costs.
[3] Includes interest, amortization, and operations and maintenance costs.
Source: Appendix B: Economic Analysis. Arkansas River Navigation Study, USACE, Little Rock and Tulsa Districts, 2005.

5.12.3 Maintenance Dredging and Disposal Components

5.12.3.1 No Action Component (NCDM-NA)

Periodic dredging will continue to be required in some locations within the river as part of the ongoing operation and maintenance of the designated 9-foot navigation channel. Under the No Action Component, once disposal site capacity has been reached, maintenance dredging and disposal conditions on the MKARNS would be maintained in the short-term but in the long-term dredged material would be pumped further to active disposal sites or currently inactive disposal sites would be used.

5.12.3.2 Maintenance Dredged Material Disposal in Approved Areas in 1974 O&M Plan (NCDM-1)

Under this component dredging and disposal will continue at existing sites. After existing disposal sites have reached their capacity, dredged material will be disposed of at new sites within the areas approved in the original O & M Plan and EIS, regardless of habitat type. Thus, continuous maintenance dredging and disposal would occur with the current navigation conditions maintained. Therefore, there would be no additional beneficial or adverse economic impacts under this component.

5.12.3.3 Maintenance Dredged Material Disposal in New Disposal Sites (NCDM-2)

Based on the assumption that 3 feet of advance maintenance dredging is assumed over the length of the MKARNS, 54 new or expanded dredged material disposal sites will be required within the Tulsa District to accommodate the existing and 10, 11, and 12-foot channel dredging requirements. The dredged material disposal sites range in size from 5 acres to 100 acres.

A total of 285 acres of privately owned land, involving 37 land owners and an unknown number of tenants, would be required for dredged material disposal sites and rights-of-way access. In addition, approximately 230 acres of privately owned land have been identified for environmental mitigation. The estimated total value of private land required for this project is $694,800, with an estimated value of $496,800 for additional private land required for mitigation. Total real estate acquisition cost estimates, including administrative and other related costs, approximate $2,768,100, or $162,000 annually over the 50-year time period.

The new dredged material disposal sites will not require the relocation of any known facilities or utilities, and will not require the displacements of homeowners, farm operations, or businesses. However, there would be some adverse impacts on farm operations on affected cropland fields. In some instances the establishment of new dredged material disposal sites will adversely impact the functional use of the remaining land with a subsequent loss of economic utility. Thus, there will be an annual loss of some former cropland production in addition to the affected land value being adversely impacted in respect to annual real property tax revenues generated.

Within the Little Rock District, three sites totaling 428 acres of privately owned land would be required for the dredged material disposal sites. The estimated total value of private land required for dredged material disposal is $727,600, with total real estate acquisition cost estimates, including administrative and other related costs, of approximately $1,197,000, or approximately $70,000 annually over the 50-year time period.

All three proposed dredged material disposal sites are part of active farm operations and of larger ownerships in Arkansas County. The construction and use of these new dredged material disposal sites will adversely impact all three owners. Project implementation will require the relocation of one mobile home, two irrigation wellheads, and the removal of a machine shed from two of the properties. In addition, there will the displacement and relocation of one homeowner or tenant within Segment 1 between Pine Bluff and the mouth of the Arkansas River.

Thus, there will be an annual loss of some former cropland production to disposal sites in addition to land value being adversely impacted in respect to annual real property tax revenues generated

Certain economic benefits will accrue from the dredging and disposal operations. Dredged material can have economic value and benefits as the material can be used for a variety of purposes, including construction and industrial uses, material transfer (e.g. fill material, levees, roads, recreation). Thus, indirect benefits could occur as a result of these operations in respect to employment and income, and the value added to those projects that benefit from the use of dredged materials.