

TABLE OF CONTENTS

	<u>Page No.</u>
Chapter 1 - EXECUTIVE SUMMARY.....	1-1
1.1 BACKGROUND.....	1-1
1.2 PLANNING GOALS AND OBJECTIVES.....	1-1
1.3 STUDY AREA BOUNDARIES.....	1-1
1.4 POPULATION PROJECTIONS.....	1-2
1.5 COLLECTION SYSTEM MODELING.....	1-4
1.6 COLLECTION SYSTEM IMPROVEMENTS.....	1-8
1.7 THERESA STREET WWTF IMPROVEMENTS	1-17
1.7.1 Projected Flows	1-17
1.7.2 Summary of Theresa Street WWTF Tier I and II Improvements	1-17
1.7.3 Summary of Theresa Street WWTF Tier III Improvements	1-17
1.8 NE WWTF IMPROVEMENTS	1-20
1.8.1 Summary of NE WWTF Tier I, II, and III Improvements	1-21
1.9 EMERGING WWTF TECHNOLOGIES AND OTHER CONSIDERATION	1-21
1.10 ADDITIONAL RECOMMENDATIONS.....	1-24
1.10.1 Collection System Operation and Maintenance.....	1-24
1.10.2 Peak Flow Reduction.....	1-26
1.10.3 Collection System Flow Monitoring Program.....	1-26
1.10.4 Hydraulic Modeling	1-26
1.10.5 Industrial Pre-Treatment Program	1-27
1.10.6 Wastewater Lift Stations.....	1-27
1.11 CIP - PLANNING LEVEL COSTS	1-27
1.11.1 Collection System.....	1-27
1.11.2 Wastewater Treatment Facilities	1-27
1.11.3 Combined Total Costs	1-27
Chapter 2 - INTRODUCTION.....	2-1
2.1 BACKGROUND.....	2-1
2.1.1 History.....	2-1
2.1.2 Reason for Updating the Wastewater Facilities Master Plan.....	2-1
2.1.3 2030 Comprehensive Plan	2-1
2.2 FACTORS THAT AFFECT FACILITIES PLANNING	2-2
2.2.1 Population Increases	2-2
2.2.2 Regulatory Changes.....	2-2
2.2.3 Condition and Age of Facilities	2-2
2.3 PLANNING GOALS AND OBJECTIVES.....	2-3
2.4 IDENTIFIED IMPROVEMENTS	2-3

2.5	RELATED STUDIES, REPORTS, AND DOCUMENTS	2-3
2.6	GENERAL TERMINOLOGY	2-5
	2.6.1 Facilities	2-5
	2.6.2 Wastewater Flow	2-5
	2.6.3 Wastewater Constituents	2-6
2.7	WASTEWATER AND SOLID WASTE ORGANIZATION	2-6
2.8	ACKNOWLEDGMENTS	2-7
Chapter 3 - PLANNING CONSIDERATIONS.....		3-1
3.1	GENERAL	3-1
3.2	STUDY LIMITS.....	3-1
	3.2.1 Geographical Boundaries	3-1
	3.2.2 Wastewater Drainage Basins	3-1
	3.2.3 Planning Areas	3-1
	3.2.4 100 Year Floodplain Areas	3-6
3.3	PLANNING AGENCIES.....	3-6
3.4	EXISTING LAND USAGE	3-6
3.5	FUTURE LAND USE	3-8
3.6	POPULATION	3-8
	3.6.1 Historical Population	3-8
	3.6.2 Projected Population.....	3-9
	3.6.3 Comparison of Land Inventory to Projected Population	3-10
Chapter 4 - EXISTING COLLECTION SYSTEM.....		4-1
4.1	BACKGROUND.....	4-1
	4.1.1 Existing Collection System	4-1
	4.1.2 Collection System Operation and Maintenance.....	4-5
4.2	WASTEWATER COLLECTION SYSTEM BASINS TRIBUTARY TO THE THERESA STREET WWTF	4-7
	4.2.1 Salt Valley (Salt Creek).....	4-7
	4.2.2 Antelope Creek	4-8
	4.2.3 West 'O' Street.....	4-8
	4.2.4 Middle Creek.....	4-8
	4.2.5 Haines Branch	4-9
	4.2.6 Beal Slough	4-9
	4.2.7 Oak Creek.....	4-9
	4.2.8 Lynn Creek	4-10
	4.2.9 Little Salt Creek	4-10
	4.2.10 East Campus	4-10
4.3	WASTEWATER COLLECTION SYSTEM BASINS TRIBUTARY TO THE NORTHEAST WWTF	4-11
	4.3.1 Deadmans Run.....	4-11
	4.3.2 Havelock.....	4-11
	4.3.3 Stevens Creek	4-11
4.4	WASTEWATER LIFT STATIONS	4-12
	4.4.1 General Summary.....	4-12
	4.4.2 Wastewater Lift Station Telemetry.....	4-13
	4.4.3 Lift Station Operation and Maintenance	4-13

Chapter 5 - EXISTING WASTEWATER TREATMENT FACILITIES.....	5-1
5.1 THERESA STREET WWTF	5-1
5.1.1 Overview.....	5-1
5.1.2 Liquid Treatment.....	5-10
5.1.3 Biosolids Treatment.....	5-10
5.1.4 Odor Control	5-12
5.1.5 Recently Completed Improvements.....	5-12
5.1.6 Historical Influent Flows.....	5-13
5.1.7 Historical Influent Quality	5-16
5.1.8 Treatment Facility Performance.....	5-17
5.1.9 Discharge Permit	5-20
5.1.10 Future Capacity	5-20
5.2 NORTHEAST WWTF	5-24
5.2.1 Overview.....	5-24
5.2.2 Liquid Treatment.....	5-31
5.2.3 Odor Control	5-31
5.2.4 Biosolids Treatment.....	5-33
5.2.5 Recently Completed Improvements.....	5-33
5.2.6 Historical Influent Flows.....	5-34
5.2.7 Historical Influent Quality	5-37
5.2.8 Treatment Facility Performance.....	5-41
5.2.9 Discharge Permit	5-42
5.2.10 Future Capacity	5-43
5.3 COMPARISON OF WATER USAGE TO WASTEWATER FLOW	5-45
5.4 HISTORICAL PER CAPITA WASTEWATER FLOW	5-46
5.5 INDUSTRIAL CONTRIBUTIONS	5-46
Chapter 6 - REGULATORY REQUIREMENTS.....	6-1
6.1 CURRENT REGULATORY REQUIREMENTS	6-1
6.1.1 Surface Water Quality Standards	6-1
6.1.2 Effluent Discharge Permitting System	6-2
6.1.3 Residuals Disposal Regulations	6-5
6.1.4 Air Permits	6-8
6.1.5 Stormwater Permits	6-9
6.2 EVOLVING REGULATIONS	6-9
6.2.1 Effluent Limits	6-9
6.2.2 Biosolids Use and Disposal Regulations	6-11
Chapter 7 - BASIS FOR ALTERNATIVE EVALUATIONS.....	7-1
7.1 GENERAL	7-1
7.2 ECONOMIC EVALUATION	7-1
7.2.1 Probable Opinion of Estimated Costs.....	7-1
7.2.2 Future Costs	7-1
7.2.3 Assigning Costs	7-2
7.2.4 Contingencies	7-2
7.2.5 Collection System Costs.....	7-2
7.2.6 Wastewater Treatment Facility Costs.....	7-2
7.2.7 Summary or Recommendation	7-2

Chapter 8 - DEVELOPMENT OF THE COLLECTION SYSTEM HYDRAULIC MODEL...8-1

8.1	INTRODUCTION	8-1
8.2	DYNAMIC HYDRAULIC MODEL DEVELOPMENT	8-1
	8.2.1 Data Collection	8-1
	8.2.2 Establishment of Network Connectivity	8-5
8.3	HYDRAULIC MODEL FLOW INPUTS	8-5
	8.3.1 Manning's Equation	8-5
	8.3.2 Peak Flow Equation.....	8-6
	8.3.3 Comparison of Peak Flow Equations.....	8-6
	8.3.4 Flow Inputs	8-10
	8.3.5 Development of Peak Flow Diurnal Curve.....	8-10
8.4	MODEL CALIBRATION.....	8-10
	8.4.1 Wet Weather Flow Calibration	8-11

Chapter 9 - COLLECTION SYSTEM MODELING EVALUATION CRITERIA..... 9-1

9.1	INTRODUCTION	9-1
9.2	DESIGN CRITERIA AND CONSTRAINTS.....	9-1
	9.2.1 Existing and Future System Evaluation Criteria	9-1
	9.2.2 Recommended Improvements Criteria	9-2
9.3	MODEL SCENARIOS	9-2

Chapter 10 - SALT CREEK BASIN..... 10-1

10.1	SALT VALLEY TRUNK SEWER SYSTEM.....	10-1
10.2	EXISTING CONDITIONS	10-1
	10.2.1 Model Results	10-1
	10.2.2 Improvements	10-1
10.3	TIER I CONDITIONS.....	10-4
	10.3.1 Modeling Results	10-4
	10.3.2 Identification of Alternatives.....	10-5
10.4	TIER II CONDITIONS.....	10-18
	10.4.1 Modeling Results	10-18
	10.4.2 Improvements/Recommendations.....	10-24
10.5	TIER III CONDITIONS.....	10-28
	10.5.1 Model Results	10-28
	10.5.2 Improvements	10-28
10.6	SUMMARY OF RECOMMENDED IMPROVEMENTS	10-28

Chapter 11 - ANTELOPE CREEK BASIN..... 11-1

11.1	ANTELOPE CREEK TRUNK SEWER SYSTEM.....	11-1
11.2	EXISTING CONDITIONS	11-1
	11.2.1 Model Results	11-1
	11.2.2 Improvement Alternatives	11-6
11.3	TIER I CONDITIONS.....	11-6
	11.3.1 Model Results	11-6
	11.3.2 Identified Alternatives	11-6
11.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	11-10

Chapter 12 - BEAL SLOUGH BASIN.....	12-1
12.1 BEAL SLOUGH TRUNK SEWER SYSTEM.....	12-1
12.2 EXISTING CONDITIONS	12-3
12.2.1 Model Results.....	12-3
12.2.2 Improvements	12-3
12.3 TIER I CONDITIONS.....	12-3
12.3.1 Model Results.....	12-3
12.3.2 Alternative Identification.....	12-3
12.4 SUMMARY OF RECOMMENDED IMPROVEMENTS	12-7
Chapter 13 - UPPER SOUTHEAST SALT CREEK BASIN.....	13-1
13.1 UPPER SOUTHEAST TRUNK SEWER SYSTEM.....	13-1
13.2 MODELING RESULTS.....	13-1
13.2.1 Tier I Conditions.....	13-1
13.2.2 Tier II Conditions.....	13-3
13.3 IMPROVEMENTS	13-3
13.3.1 Tier I Improvements.....	13-4
13.3.2 Tier II Improvements.....	13-4
13.4 SUMMARY OF RECOMMENDED IMPROVEMENTS	13-6
Chapter 14 - UPPER SOUTHWEST SALT CREEK BASIN.....	14-1
14.1 UPPER SOUTHWEST TRUNK SEWER SYSTEM.....	14-1
14.2 MODELING RESULTS.....	14-1
14.2.1 Tier I Conditions.....	14-1
14.2.2 Tier II Conditions.....	14-1
14.2.3 Tier III Conditions.....	14-1
14.3 IMPROVEMENTS	14-3
14.3.1 Tier I Improvements.....	14-3
14.3.2 Tier II Improvements.....	14-3
14.3.3 Tier III Improvements.....	14-5
14.4 SUMMARY OF RECOMMENDED IMPROVEMENTS	14-7
Chapter 15 - HAINES BRANCH BASIN.....	15-1
15.1 HAINES BRANCH TRUNK SEWER SYSTEM.....	15-1
15.2 MODELING RESULTS.....	15-1
15.2.1 Existing Conditions	15-1
15.2.2 Tier I Conditions.....	15-3
15.2.3 Tier II Conditions.....	15-3
15.2.4 Tier III Conditions.....	15-3
15.3 IMPROVEMENTS	15-3
15.3.1 Tier I Improvements.....	15-3
15.3.2 Tier II Improvements.....	15-7
15.3.3 Tier III Improvements.....	15-7
15.4 SUMMARY OF RECOMMENDED IMPROVEMENTS	15-7
Chapter 16 - MIDDLE CREEK AND WEST 'O' STREET BASINS.....	16-1

16.1	MIDDLE CREEK AND WEST 'O' STREET TRUNK SEWER SYSTEMS	16-1
16.2	MODELING RESULTS	16-1
	16.2.1 Existing Conditions	16-1
	16.2.2 Tier I Conditions.....	16-5
	16.2.3 Tier II Conditions.....	16-6
	16.2.4 Tier III Conditions.....	16-6
16.3	IMPROVEMENTS	16-7
	16.3.1 Existing Conditions	16-7
	16.3.2 Tier I Improvements.....	16-9
	16.3.3 Tier II Improvements.....	16-10
	16.3.4 Tier III Improvements.....	16-10
16.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	16-17

Chapter 17 - OAK CREEK AND LYNN CREEK BASINS..... 17-1

17.1	TRUNK SEWER SYSTEM	17-1
17.2	MODELING RESULTS	17-1
	17.2.1 Existing Conditions	17-1
	17.2.2 TIER I CONDITIONS	17-12
	17.2.3 Tier II Conditions.....	17-12
	17.2.4 Tier III Conditions.....	17-12
17.3	IMPROVEMENTS	17-13
	17.3.1 Existing Improvements	17-13
	17.3.2 Tier I Improvements.....	17-13
	17.3.3 Tier II Improvements.....	17-14
	17.3.4 Tier III Improvements.....	17-14
17.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	17-18

Chapter 18 - LITTLE SALT CREEK BASIN..... 18-1

18.1	LITTLE SALT CREEK TRUNK SEWER SYSTEM	18-1
18.2	MODELING RESULTS	18-1
	18.2.1 Existing Conditions	18-1
	18.2.2 Tier I Conditions.....	18-3
	18.2.3 Tier II Conditions.....	18-3
	18.2.4 Tier III Conditions.....	18-3
18.3	IMPROVEMENTS	18-3
	18.3.1 Existing Conditions	18-4
	18.3.2 Tier I Improvements.....	18-4
	18.3.3 Tier II Improvements.....	18-4
	18.3.4 Tier III Improvements.....	18-4
18.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	18-9

Chapter 19 - DEADMANS RUN, EAST CAMPUS, AND HAVELOCK BASINS..... 19-1

19.1	TRUNK SEWER SYSTEMS.....	19-1
19.2	MODELING RESULTS	19-1
	19.2.1 Existing Conditions	19-1
	19.2.2 Tier I Conditions.....	19-8
19.3	IMPROVEMENTS	19-8
	19.3.1 Existing Conditions	19-8

19.3.2	Tier I Conditions.....	19-10
19.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	19-12
19.4.1	Sewer Monitoring.....	19-12
19.4.2	84th Street Sewer.....	19-12
Chapter 20 - NORTHEAST SALT CREEK BASIN.....		20-1
20.1	NORTHEAST SALT CREEK TRUNK SEWER SYSTEM.....	20-1
20.1.1	Modeling Results	20-3
20.1.2	Existing Conditions	20-3
20.1.3	Tier I Conditions.....	20-3
20.1.4	Tier II and III Conditions.....	20-5
20.2	IMPROVEMENTS	20-5
20.2.1	Tier I.....	20-5
20.2.2	Tier II	20-5
20.2.3	Tier III.....	20-5
20.3	SUMMARY OF RECOMMENDED IMPROVEMENTS	20-6
Chapter 21 - STEVENS CREEK BASIN.....		21-1
21.1	STEVENS CREEK TRUNK SEWER SYSTEM.....	21-1
21.2	MODELING RESULTS.....	21-1
21.2.1	Existing Conditions	21-1
21.2.2	Tier I Conditions.....	21-4
21.2.3	Tier II Conditions.....	21-4
21.2.4	Tier III Conditions.....	21-4
21.3	IMPROVEMENTS	21-4
21.3.1	Tier I Improvements.....	21-4
21.3.2	Tier II Improvements.....	21-6
21.3.3	Tier III Improvements.....	21-6
21.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	21-14
Chapter 22 - SOUTHEAST BASIN.....		22-1
22.1	SOUTHEAST DRAINAGE BASIN	22-1
22.2	MODELING RESULTS.....	22-1
22.2.1	Existing, Tier I and Tier II Conditions.....	22-1
22.2.2	Tier III.....	22-3
22.3	TIER III IMPROVEMENTS	22-3
22.4	SUMMARY OF RECOMMENDED IMPROVEMENTS	22-6
Chapter 23 - COLLECTION SYSTEM SUMMARY.....		23-1
23.1	SUMMARY OF IMPROVEMENTS	23-1
23.2	LIFT STATION IMPROVEMENTS	23-10
23.2.1	Summary	23-10
23.2.2	Recommended Improvements to Existing Lift Stations	23-10
23.2.3	Anticipated New Lift Stations	23-12
23.3	SUMMARY OF COLLECTION SYSTEM MODELING	23-12
23.3.1	Theresa Street WWTF Drainage Areas.....	23-13
23.3.2	NE WWTF Drainage Areas.....	23-13

Chapter 24 - WASTEWATER TREATMENT FACILITIES FUTURE IMPROVEMENTS 24-1

24.1	INTRODUCTION	24-1
24.2	THERESA STREET WWTF - FUTURE IMPROVEMENTS	24-1
	24.2.1 Current Through Tier II Improvements	24-1
	24.2.2 Recent and Current Improvements.....	24-1
	24.2.3 Tier I Improvements - Current and Recommended	24-5
	24.2.4 Tier II Improvements.....	24-6
	24.2.5 Tier III Improvements.....	24-6
	24.2.6 Summary of Tier III Improvements	24-17
	24.2.7 Summary of Theresa Street WWTF Improvements.....	24-19
24.3	NORTHEAST STREET WWTF	24-20
	24.3.1 Overview.....	24-20
	24.3.2 Tier I Improvements.....	24-20
	24.3.3 Tier II Improvements.....	24-23
	24.3.4 Tier III Improvements.....	24-23
	24.3.5 Summary of NE WWTF Improvements	24-24
24.4	EMERGING WASTEWATER TREATMENT TECHNOLOGIES AND OTHER CONSIDERATIONS	24-24
24.5	SUMMARY OF IDENTIFIED WWTF IMPROVEMENTS.....	24-25

Chapter 25 - ADDITIONAL RECOMMENDATIONS..... 25-1

25.1	GENERAL	25-1
25.2	COLLECTION SYSTEM OPERATION AND MAINTENANCE.....	25-1
25.3	PEAK FLOW REDUCTION	25-4
	25.3.1 I/I Flow Reduction	25-4
	25.3.2 Foundation Drains - Sump Pumps.....	25-6
	25.3.3 Service Lateral Repairs	25-6
	25.3.4 Low Flow Plumbing Devices.....	25-6
25.4	COLLECTION SYSTEM FLOW MONITORING PROGRAM	25-7
	25.4.1 Components of Wastewater Flows	25-7
	25.4.2 Need for Flow Monitoring Program.....	25-7
25.5	INDUSTRIAL PRE-TREATMENT PROGRAM.....	25-11

Chapter 26 - SUMMARY OF PLANNING COSTS AND PHASING..... 26-1

26.1	GENERAL	26-1
26.2	SUMMARY OF ESTIMATED IMPROVEMENT COSTS	26-1
	26.2.1 Collection System	26-1
	26.2.2 Wastewater Treatment Facilities	26-1
26.3	OVERVIEW	26-1

APPENDIX A - History of Wastewater Collection and Treatment in Lincoln

APPENDIX B - Abbreviations

APPENDIX C - Wastewater Lift Stations

APPENDIX D - Hydraulic Model Results

APPENDIX E - WWTF Process and Equipment Identification

APPENDIX F - Theresa Street and Northeast WWTF's Discharge Permits

APPENDIX G - Industrial Audit (FY 2005/2006)

APPENDIX H - Air Permit for Theresa Street WWTF

APPENDIX I - Stormwater Permits for Both WWTF's
 APPENDIX J - Biosolids Agreement and 2006 Reports
 APPENDIX K - NE WWTF Biosolids Land Application Yearly Summaries (1996-2006)
 APPENDIX L - Theresa Street WWTF Odor Abatement Study
 APPENDIX M - Theresa Street WWTF Hydraulic Profile Calculations

LIST OF TABLES

Table 1.1	Population Projections from 2005 to 2060 ⁽¹⁾	1-4
Table 1.2	Modeled Theresa Street WWTF Drainage Areas ^(1,2)	1-5
Table 1.3	Modeled NE WWTF Drainage Areas ^(1,2)	1-8
Table 1.4	Summary of Collection System Pipeline Improvements ⁽¹⁾	1-9
Table 1.5	Summary of Collection System Storage Improvements ⁽¹⁾	1-10
Table 1.6	Summary of Tier III Planning Level Costs	1-20
Table 1.7	Summary of Collection System Improvement Costs ⁽¹⁾	1-28
Table 1.8	Summary of Wastewater Treatment Facility Improvement Costs ^(1,2)	1-29
Table 1.9	Total of Collection and WWTF Improvements Costs ^(1,2)	1-29
Table 3.1	Historical Population From 1880 to 1980 ⁽¹⁾	3-9
Table 3.2	Population Projections from 2005 to 2060 ⁽¹⁾	3-10
Table 3.3	Acreage Calculations Based on Population	3-11
Table 4.1	Historical Length of Sanitary Sewer Pipe Installed	4-2
Table 4.2	Increase in Existing Wastewater Drainage Basin Areas.....	4-3
Table 4.3	Existing Collection System Operations and Maintenance Requirements.....	4-5
Table 4.4	Summary of Wastewater Lift Stations.....	4-12
Table 5.1	Rated Capacity of the Theresa Street WWTF	5-8
Table 5.2	Theresa Street WWTF Secondary Treatment Summary.....	5-10
Table 5.3	Theresa Street WWTF Annual Biosolids Land Application Volumes.....	5-12
Table 5.4	Theresa Street WWTF Historical Influent Flows.....	5-13
Table 5.5	Theresa Street WWTF Average Influent Loading Concentrations.....	5-16

Table 5.6	Theresa Street WWTF Average Influent Mass Loading	5-17
Table 5.7	Theresa Street WWTF Average Effluent Concentrations	5-21
Table 5.8	Theresa Street WWTF Average Influent Removal ⁽¹⁾	5-21
Table 5.9	Theresa Street WWTF Effluent Fecal Coliform Concentrations ⁽¹⁾	5-22
Table 5.10	Rated Capacity of the Northeast WWTF	5-32
Table 5.11	Northeast WWTF Secondary Treatment Summary	5-32
Table 5.12	Northeast WWTF Annual Average Flows	5-34
Table 5.13	Northeast WWTF Average Influent Loading Concentrations.....	5-37
Table 5.14	Northeast WWTF Average Influent Mass Loading	5-38
Table 5.15	Northeast WWTF Average Effluent Concentrations	5-41
Table 5.16	Northeast WWTF Average Influent Removal ⁽¹⁾	5-42
Table 5.17	Northeast WWTF Effluent Fecal Coliform Concentrations ⁽¹⁾	5-43
Table 5.18	Comparison of Water Usage and Wastewater Treatment Facility Flows ...	5-45
Table 5.20	Industrial Flow and Loading Contributions	5-46
Table 6.1	Salt Creek Segment LP2-20000 Stream Classification	6-2
Table 6.2	Theresa Street WWTF NPDES Permit Monitoring Requirements.....	6-3
Table 6.3	Theresa Street WWTF Effluent NPDES Permit Limitations.....	6-4
Table 6.4	Northeast WWTF Effluent NPDES Permit Limitations.....	6-5
Table 6.5	Theresa Street WWTF - Air Permit Requirements (1).....	6-9
Table 7.1	Collection System Planning Costs.....	7-3
Table 7.2	Wastewater Treatment Facility Planning Costs	7-3
Table 8.1	Key Hydraulic Model Data	8-2
Table 8.2	Collection System Lift Stations included in the Hydraulic Model	8-4
Table 8.3	Peak Wastewater Design Flow Equation Comparison	8-10
Table 8.3	Wet Weather Calibration Results.....	8-11
Table 9.1	Existing System Model Scenarios	9-3

Table 10.1	Salt Valley Trunk Sewer System Existing and Future Tributary Areas.....	10-4
Table 10.2	Surcharged Pipes Salt Valley System - Tier I Conditions.....	10-6
Table 10.3	Results of Flow Maximization of Existing System.....	10-9
Table 10.4	Simulation Results of Storage with Flow Maximization	10-11
Table 10.5	Comparison of d/D Ratios for various I/I Flow Reduction Target Levels ..	10-16
Table 10.6	Manholes with Modeled SSO's Under Tier II Conditions.....	10-18
Table 10.7A	Surcharged Pipes Salt Valley System - Tier II Conditions.....	10-19
Table 10.7B	Surcharged Pipes Salt Valley System - Tier II Conditions.....	10-20
Table 10.7C	Surcharged Pipes Salt Valley System - Tier II Conditions.....	10-21
Table 10.8	Recommended Improvements - Salt Valley Trunk Sewer System	10-29
Table 11.1	Antelope Creek Trunk Sewer System Modeling Areas (ac) ^(1,2)	11-1
Table 11.2	Surcharged Pipes - Existing Conditions - Antelope Creek Trunk Sewer....	11-3
Table 11.3	Surcharged Pipes - Tier I Conditions - Antelope Creek Trunk Sewer	11-10
Table 11.4	Recommended Improvements - Antelope Creek Trunk Sewer	11-12
Table 12.1	Beal Slough Trunk Sewer Tributary Areas (ac) ^(1,2) Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska.....	12-1
Table 12.2	Surcharged Pipes - Tier I Conditions.....	12-4
Table 12.3	Recommended Improvements - Beal Slough Trunk Sewer System.....	12-8
Table 13.1	Service Area and Flows - Upper Southeast Basin ^(1,2)	13-1
Table 13.2	Upper Southeast Basin Tier I Modeling Results	13-3
Table 13.3	Design Characteristics of Proposed Sewers - Upper SE Basin.....	13-6
Table 13.4	Modeling Results of Proposed Sewers - Upper Southeast Basin.....	13-6
Table 13.5	Recommended Improvements - Upper Southeast Basin	13-8
Table 14.1	Service Areas and Flows - Upper Southwest Basin	14-1
Table 14.2	Design Characteristics of Proposed Sewers - Upper SW Basin.....	14-4
Table 14.3	Modeling Results of Proposed Sewers - Upper Southwest Basin.....	14-5

Table 14.7	Recommended Improvements - Upper Southwest Salt Valley Basin.....	14-8
Table 14.7	Recommended Improvements - Upper Southwest Salt Valley Basin	14-9
Table 15.1	Service Areas and Flows - Haines Branch Basin ^(1, 2)	15-1
Table 15.2	Design Characteristics of Proposed Sewers - Haines Branch Basin.....	15-5
Table 15.3	Modeling Results of Proposed Sewers - Haines Branch Basin	15-6
Table 15.4	Recommended Improvements - Haines Branch Basin.....	15-9
Table 15.4	Recommended Improvements - Haines Branch Basin.....	15-10
Table 16.1	Service Areas and Flows - West O St & Middle Creek Basins	16-1
Table 16.2	Manholes with Modeled SSO's - Tier I Conditions - West 'O' St and Middle Creek Basins	16-5
Table 16.3	Design Characteristics of Proposed Sewers - Middle Creek Basin.....	16-12
Table 16.4	Design Characteristics of Proposed Sewers - West O St Basin.....	16-13
Table 16.5	Modeling Results of Proposed Sewers - Middle Creek Basin	16-15
Table 16.6	Modeling Results of Proposed Sewers - West O St Basin	16-16
Table 16.7	Recommended Improvements - West 'O' Street and Middle Creek Basins.....	16-19
Table 16.7	Recommended Improvements - West 'O' Street and Middle Creek Basins.....	16-20
Table 16.7	Recommended Improvements - West 'O' Street and Middle Creek Basins.....	16-21
Table 17.1	Service Areas and Flows - Oak Creek and Lynn Creek Basins	17-1
Table 17.2	Oak Creek Manholes with Modeled SSO's - Existing Conditions.....	17-4
Table 17.3	Surcharged Pipes - Oak Creek Basin - Existing Conditions	17-6
Table 17.4	Surcharged Pipes - Lynn Creek Basin - Existing Conditions.....	17-10
Table 17.5	Design Characteristics of Proposed Sewers - Oak Creek Basin.....	17-16
Table 17.6	Modeling Results of Proposed Sewers - Oak Creek Basin	17-17
Table 17.7	Recommended Improvements - Oak Creek and Lynn Creek Basins	17-20
Table 17.7	Recommended Improvements - Oak and Lynn Creek Basins	17-21

Table 17.7	Recommended Improvements - Oak and Lynn Creek Basins	17-22
Table 18.1	Service Areas and Flows - Little Salt Creek Basin ^(1, 2)	18-1
Table 18.2	Design Characteristics of Proposed Sewers - Little Salt Basin	18-5
Table 18.3	Modeling Results of Proposed Sewers - Little Salt Basin.....	18-6
Table 18.4	Recommended Improvements – Little Salt Creek Basin	18-10
Table 19.1	Service Area and Flows - Deadmans Run, East Campus, & Havelock Basins ^{1,2}	19-1
Table 19.2	Surcharged Pipes - Existing Conditions- Deadmans Run Basin Wastewater Facilities Master Plan Update - 2007 City of Lincoln, Nebraska.....	19-5
Table 19.3	Comparison of d/D Ratios for I/I Flow Reduction Target Levels - Deadmans Run Basin.....	19-9
Table 20.1	Service Areas and Flows - Northeast Salt Creek Basin ^(1, 2)	20-1
Table 20.2	Un-Developable Areas in Northeast Salt Creek Basin	20-1
Table 20.3	Northeast Salt Creek Tier I Phased Basin Development Plan.....	20-3
Table 20.5	Design Characteristics of Proposed Sewers - Northeast Salt Creek Basin	20-8
Table 20.6	Modeling Results of Proposed Sewers - Northeast Salt Creek Basin	20-9
Table 20.7	Recommended Improvements – Northeast Salt Creek Basin	20-11
Table 20.7	Recommended Improvements – Northeast Salt Creek Basin	20-12
Table 21.1	Service Areas and Flows - Stevens Creek Basin ^(1, 2)	21-1
Table 21.2	Design Characteristics of Proposed Sewers - Stevens Creek Basin.....	21-7
Table 21.3	Modeling Results of Proposed Sewers - Stevens Creek Basin.....	21-10
Table 21.4	Recommended Improvements – Stevens Creek Basin	21-15
Table 21.4	Recommended Improvements – Stevens Creek Basin.....	21-16
Table 21.4	Recommended Improvements – Stevens Creek Basin.....	21-17
Table 21.4	Recommended Improvements – Stevens Creek Basin.....	21-18
Table 22.1	Service Areas and Flows - Southeast Basin ^(1, 2)	22-1

Table 22.2	Design Characteristics of Proposed Sewers - Southeast Basin	22-4
Table 22.3	Modeling Results of Proposed Sewers - Southeast Basin	22-4
Table 22.4	Recommended Improvements – Southeast Basin	22-7
Table 23.1	Summary of Collection System Pipeline Improvements ⁽¹⁾	23-1
Table 23.2	Summary of Collection System Storage Improvements ⁽¹⁾	23-7
Table 23.3	Modeled Theresa Street WWTF Drainage Areas ^(1,2)	23-14
Table 23.4	Modeled NE WWTF Drainage Areas ^(1,2)	23-16
Table 24.1	Modeled Tier III Theresa Street and SW WWTF Drainage Areas ^(1,2)	24-8
Table 24.2	New SW WWTF - Tier III Alternative 1	24-9
Table 24.3	New West Side Salt Creek Trunk Sewer - Tier III Alternative 2.....	24-12
Table 24.4	Parallel East Side Salt Creek Trunk Sewer - Tier III Alternative 3.....	24-13
Table 24.5	Increased Storage - Tier III Alternative 4	24-14
Table 24.6	Summary of Tier III Planning Level Costs	24-17
Table 24.7	Recommended Improvements – Theresa Street Wastewater Treatment Facility	24-27
Table 24.8	Recommended Improvements – Northeast Wastewater Treatment Facility	24-28
Table 25.1	Collection System Projected Cleaning and Videoing Crew Needs.....	25-2
Table 26.1	Summary of Collection System Improvement Costs ⁽¹⁾	26-2
Table 26.2	Summary of Wastewater Treatment Facility Improvement Costs ^(1,2)	26-2
Table 26.3	Comparison of City CIP and Master Plan Update Costs for Tier I Period ^(1,2)	26-3

LIST OF FIGURES

Figure 1.1 - Study Area Boundaries.....	1-3
Figure 1.2 - Modeled Peak Collection System Flows at Theresa Street WWTF.....	1-6

Figure 1.3 - Modeled Peak Collection System Flows at NE WWTF.....	1-7
Figure 1.4 - Planning Area Tier I Improvements	1-11
Figure 1.5 - Planning Area Tier II Improvements	1-12
Figure 1.6 - Planning Area tier III Improvements	1-13
Figure 1.7 - Planning Area Storage Improvements.....	1-14
Figure 1.8 - Schematic Drawing of Storage Facilities	1-15
Figure 1.9 - General Layout of Storage Facilities.....	1-16
Figure 1.10 - Theresa Street WWTF Projected MMAD Flows.	1-18
Figure 1.11 - Theresa Street WWTF Aerial Photo with Tier I and II Future Improvements..	1-19
Figure 1.12 - Northeast WWTF Projected MMAD Flows.....	1-22
Figure 1.13 - Northeast WWTF Future Improvements	1-23
Figure 1.14 - General Layout of WWTF Site	1-25
Figure 1.15 - Annual Cost of Collection System Improvements.....	1-30
Figure 1.16 - Annual Cost of Theresa Street and Northeast WWTF Improvements	1-31
Figure 1.17 - Summary of Annual Cost of Improvements	1-32
Figure 2.1 - City of Lincoln Wastewater and Solid Waste System Organization Chart	2-8
Figure 3.1 - Project Study Area	3-2
Figure 3.2 - Drainage Basins	3-3
Figure 3.3 - Utility Planning Zones	3-4
Figure 3.4 - Planning Growth Tiers	3-5
Figure 3.5 - 100 Year Floodplain.....	3-7
Figure 3.6 - Historical and Projected Population Trends for City of Lincoln and Lancaster County	3-12
Figure 3.7 - Comparison of Historic and Projected Population to Projected Tier Growth	3-13
Figure 4.1 - Existing Wastewater Trunk Sewer System.....	4-4
Figure 4.2 - Historical Collection System Stoppages	4-6

Figure 5.1 - Theresa Street WWTF Liquid Process Schematic.....	5-2
Figure 5.2A - Theresa Street WWTF Hydraulic Profile - Central Train	5-3
Figure 5.2B - Theresa Street WWTF Hydraulic Profile - East and West Train.....	5-4
Figure 5.3 - Theresa Street WWTF Solids Process Schematic	5-5
Figure 5.4 - Theresa Street WWTF Aerial Photo (April 2005).....	5-6
Figure 5.5 - Theresa Street WWTF Aerial Photo (Oct. 12, 2006)	5-7
Figure 5.6 - Treatment Facilities SCADA System Diagram.....	5-9
Figure 5.7 - Theresa Street WWTF Historical Influent Flows	5-14
Figure 5.8 - Theresa Street WWTF Influent Flow Comparison	5-15
Figure 5.9 - Theresa Street WWTF Influent Loading Concentrations	5-18
Figure 5.10 - Theresa Street WWTF Influent Mass Loading.....	5-19
Figure 5.11 - Theresa Street WWTF Effluent Concentrations.....	5-23
Figure 5.12 - Northeast WWTF Liquid Process Schematic.....	5-25
Figure 5.13 - Northeast WWTF Hydraulic Profile.....	5-26
Figure 5.14 - Northeast WWTF Biosolids Injection Sites	5-27
Figure 5.15 - Northeast WWTF Solids Process Schematic.....	5-28
Figure 5.16 - Northeast WWTF Aerial Photo (April 2005).....	5-29
Figure 5.17 - Northeast WWTF Aerial Photo (Oct. 12, 2006).....	5-30
Figure 5.18 - Northeast WWTF Historical Influent Flows	5-35
Figure 5.19 - Northeast WWTF Influent Flow Comparison	5-36
Figure 5.20 - Northeast WWTF Influent Loading Concentrations	5-39
Figure 5.21 - Northeast WWTF Influent Mass Loading.....	5-40
Figure 5.22 - Northeast WWTF Effluent Concentrations.....	5-44
Figure 5.23 - Historical Per Capita Wastewater Flow.....	5-47
Figure 8.1 - Peak Flow Curve Based on Flow Equation.....	8-8
Figure 8.2 - Peak Wastewater Design Flow Equation Comparison	8-9

Figure 8.3 - Theresa Street WWTF Ratio of Instantaneous Flow and Peak Wet Weather Flow	8-12
Figure 8.4 - Beal Slough Ratio of Instantaneous Flow and Peak Wet Weather Flow	8-13
Figure 10.1 - Salt Valley Basin Trunk Sewer System.....	10-2
Figure 10.2 - Locations of Pipes with Velocities ≤ 2.0 ft/sec - Existing Conditions	10-3
Figure 10.3 - Location of Surcharged Pipes - Tier I Conditions	10-7
Figure 10.4 - Hydraulic Profile of Surcharged Pipes - Tier I Conditions.....	10-8
Figure 10.5 - Modeled Water Surface Levels With and Without Flow Maximization - Tier I Conditions.....	10-10
Figure 10.6 - Location of Modeled Storage - Tier I Conditions.....	10-12
Figure 10.7 - Comparison of Water Surface Elevations - Tier I Conditions.....	10-14
Figure 10.8 - Comparison of Water Surface Elevation for Various I/I Flow Reduction Target Levels - Tier I Conditions	10-17
Figure 10.9 - Locations of Surcharged Pipes - Tier II Conditions.....	10-22
Figure 10.10 - Hydraulic Profile of Surcharged Pipes - Tier II Conditions.....	10-23
Figure 10.11 - Comparison of Water Surface Elevations for Various I/I Flow Reduction Target Levels - Tier II Conditions.....	10-25
Figure 10.12 - Location of Storage with 20% I/I Flow Reduction - Tier II Conditions	10-26
Figure 10.13 - Hydraulic Profile - Tier II Conditions with Storage Improvements.....	10-27
Figure 11.1 - Antelope Basin Trunk Sewer System	11-2
Figure 11.2 - Location of Surcharged Pipes - Antelope Creek Trunk Sewer - Existing Conditions.....	11-4
Figure 11.3 - Hydraulic Profile of Surcharged Pipes - Antelope Creek Trunk Sewer - Existing Conditions.	11-5
Figure 11.4 - Locations of Pipes with Velocities ≤ 2.0 ft/sec - Antelope Creek Trunk Sewer - Existing Conditions	11-7
Figure 11.5 - Location of Surcharged Pipes - Antelope Creek Trunk Sewer - Tier I Conditions.....	11-8

Figure 11.6 - Hydraulic Profile of Surcharged Pipes - Antelope Creek Trunk Sewer - Tier I Conditions.....	11-9
Figure12.1 - Beal Slough Trunk Sewer System	12-2
Figure12.2 - Location of Pipes with Velocities ≤ 2.0 ft/sec - Existing Conditions	12-5
Figure12.3 - Location of Surcharged Pipes - Tier I Conditions	12-6
Figure13.1 - Upper Southeast Salt Creek Basin Map	13-2
Figure13.2 - Proposed Tier I and II Sewer Improvements - Upper Southeast Basin	13-5
Figure 14.1 - Upper Southwest Basin Map	14-2
Figure 14.2 - Proposed Sewer Improvements - Upper Southwest Basin.....	14-6
Figure 15.1 - Haines Branch Basin Map	15-2
Figure 15.2 - Proposed Sewer Improvements - Haines Branch Trunk Sewer System	15-4
Figure 16.1 - Middle Creek and West 'O' Street Trunk Sewer System	16-2
Figure 16.2 - Location of Surcharged Pipes - Existing Conditions	16-4
Figure 16.3 - Proposed Sewer Improvements - West 'O' St and Middle Creek Basins ...	16-8
Figure 17.1 - Oak Creek Basin Schematic.....	17-2
Figure 17.2 - Lynn Creek Basin Schematic.....	17-3
Figure 17.3 - Surcharged Pipes - Oak and Lynn Creek Basins - Existing Conditions.....	17-5
Figure 17.4A - Hydraulic Profile Surcharged Pipes - Oak Creek Basin - Existing Conditions	17-8
Figure 17.4B - Hydraulic Profile Surcharged Pipes - Oak Creek Basin - Existing Conditions	17-9
Figure 17.5 - Hydraulic Profile of Surcharged Pipes- Existing Conditions - Lynn Creek	17-11
Figure 17.6 - Proposed Sewer Improvements - Oak Creek Basin	17-15
Figure 18.1 - Little Salt Creek Basin Map	18-2
Figure 18.2 - Proposed Sewer Improvements - Little Salt Creek Basin	18-7
Figure 18.3 - Proposed Sewer Improvements with Storage Alternative - Little Salt Creek Basin.....	18-8

Figure 19.1 - Deadmans Run Trunk Sewer System	19-2
Figure 19.2 - East Campus Trunk Sewer System	19-3
Figure 19.3 - Havelock Basin Trunk Sewer System.....	19-4
Figure 19.4 - Surcharged Pipes - Existing Conditions - Deadmans Run, East Campus, and Havelock Basins	19-6
Figure 19.5 - Hydraulic Profile of Surcharged Pipes - Existing Conditions - Deadmans Run Trunk Sewer	19-7
Figure 19.6 - Locations of Pipes with Velocities ≤ 2.0 ft/sec - Existing Conditions - Deadmans Run, East Campus, and Havelock Basins.....	19-11
Figure 20.1 - Basin Map - Northeast Salt Creek	20-2
Figure 20.2 - Hydraulic Profile of Surcharged Pipes -Northeast Basin - Deadmans Run	20-4
Figure 20.3 - Proposed Sewer Improvements - Northeast Salt Creek	20-7
Figure 21.1 - Stevens Creek Basin Map	21-2
Figure 21.2 - Hydraulic Profile - Stevens Creek Trunk Sewer - Existing Conditions.....	21-3
Figure 21.3 - Proposed Sewer Improvements - Stevens Creek Trunk Sewer System	21-5
Figure 22.1 - Southeast Basin Map.....	22-2
Figure 22.2 - Proposed Sewer Improvements – Southeast Basin	22-5
Figure 23.1 - Planning Area Tier I Improvements	23-3
Figure 23.2 - Planning Area Tier II Improvements	23-4
Figure 23.3 - Planning Area Tier III Improvements	23-5
Figure 23.4 - Planning Area Storage Improvements.....	23-6
Figure 23.5 - Schematic Drawing of Storage Facilities	23-8
Figure 23.6 - General Layout of Storage Facilities.....	23-9
Figure 23.7- Planning Level O&M Costs for Storage Facilities	23-11
Figure 23.8 - Modeled Peak Flows at Theresa Street WWTF.....	23-15
Figure 23.9 - Modeled Peak Flows at NE WWTF	23-17
Figure 24.1 - Existing WWTF Service Areas.....	24-2

Figure 24.2 - Theresa Street WWTF Projected MMAD Flows.	24-3
Figure 24.3 - Theresa Street WWTF Aerial Photo with Future Tier I and II Improvements.....	24-4
Figure 24.4 - Proposed Southwest WWTF Service Area - Alternative 1.....	24-10
Figure 24.5 - West Side Salt Creek Trunk Sewer - Alternative 2	24-11
Figure 24.6 - Parallel East Side Salt Creek Trunk Sewer - Alternative 3	24-15
Figure 24.7 - Increased Storage - Alternative 4	24-16
Figure 24.8 - Theresa Street WWTF Tier III Improvements Area	24-18
Figure 24.9 - Northeast WWTF Projected MMAD Flows.....	24-21
Figure 24.10 - Northeast WWTF Future Improvements	24-22
Figure 24.11 - General Layout of WWTF Facilities	24-26
Figure 25.1 - Collection System Projected Maintenance Crew Requirements.....	25-3
Figure 25.2 - Proposed Locations for Flow Monitoring Facilities.....	25-10
Figure 26.1 - Annual Cost of Collection System Improvements.....	26-4
Figure 26.2 - Annual Cost of Theresa Street & Northeast WWTF Improvements.....	26-5
Figure 26.3 - Summary of Annual Improvements	26-6