## **Volume I: Text Contents**

Abstract	vi
Acknowledgements	vii
List of abbreviations	viii
Introduction	1
Research aims and parameters	1
Thesis structure	5
Nature of the evidence	6
Chapter 1: Water resources in the East	12
1.1 Climate and rainfall patterns	12
1.2 Geology and runoff patterns	16
1.3 Aquifers	18
1.4 Springs	19
1.5 Wadis and rivers	20
Chapter 2: Water technology in the Near East before 63 BC	23
2.1 Water-lifting devices	23
2.2 Dams	26
2.3 Irrigation	27
2.4 Long distance water transport	31
2.5 Urban water supply, storage and drainage	33
2.6 Water storage and use in domestic contexts (including baths, latrines and <i>miqva'ot</i> )	36
2.7 Watermills	39
2.8 Conclusions	40
Chapter 3: Water-lifting devices	44
3.1 Introduction	44
3.2 Shaduf and čerd	44
3.3 Water screw	45
3.4 Force pump	46
3.5 Water-lifting wheel	46
3.6 Bucket chains and pot garlands (including <i>saqiya</i> gear)	48
3.7 Conclusions	53

Chapter 4: Dams	54
4.1 Introduction	54
4.2 Purpose and function	55
4.3 Design and location	58
4.4 Dating	66
4.5 The cultural importance of damming	71
4.6 Innovations in dam construction	72
Chapter 5: Irrigation techniques and installations	75
5.1 Introduction	75
5.2 River-fed irrigation	75
5.3 Aquifer-fed irrigation	79
5.4 Floodwater farming	85
5.4.1 Terrace farming and wadi farming	86
5.4.2 Chronology	89
5.5 Well-fed and cistern-fed garden cultivation	90
5.6 Spring-fed irrigation	91
5.7 Teleilat al-anab	93
5.8 Discussion and conclusions	95
Chapter 6: Aqueducts in the rural landscape	99
6.1 Introduction	99
6.2 Technological aspects of aqueducts in the rural landscape	101
6.2.1 Sources	101
6.2.2 Channel <i>specus</i> and course	103
6.2.3 Tunnels	105
6.2.4 Bridges and arcades	107
6.2.5 Pipelines and siphons	109
6.2.6 Settling tanks and other installations	113
6.3 Sociological aspects of aqueducts in the rural landscape	115
6.3.1 Status and power: the building and maintenance of aqueducts	115
6.3.2 The rural-urban divide	124
6.4 Conclusions	130

Chapter 7: Water management in cities and towns	132
7.1 Introduction	132
7.2 Destination and uses of aqueduct water in urban contexts	133
7.2.1 The <i>castellum divisorium</i> and other distribution devices	133
7.2.2 <i>Nymphaea</i> and fountains	136
7.2.3 Water storage	142
7.3 Non-aqueduct urban water supplies	147
7.3.1 Reservoirs and cisterns	147
7.3.2 Wells	150
7.4 The distribution network: channels and pipelines	151
7.5 Drainage	154
7.6 Urban case studies	158
7.6.1 Apamea	158
7.6.2 Jerash	161
7.6.3 Caesarea	164
7.7 Construction and maintenance	167
7.8 Urban water supply and storage and the constant-offtake principle	169
7.8.1 Complementary water sources in urban contexts	170
7.8.2 Urban water management and storage in the late Roman period	174
7.9 Conclusions	177
Chapter 8: Water supply in public bathhouses and latrines	179
8.1 Introduction	179
8.2 Latrines	179
8.3 Attitudes towards latrines in the East	182
8.4 Bathhouses	184
8.4.1 Period 1: Herodian and early Roman (late 1 <sup>st</sup> century BC and 1 <sup>st</sup> century AD)	185
8.4.2 Period 2: 2 <sup>nd</sup> century AD	188
8.4.3 Period 3: 3 <sup>rd</sup> century AD	191
8.4.4 Period 4: 4 <sup>th</sup> to 7 <sup>th</sup> centuries AD	196
8.4.5 Bathhouses in the East: an overview	199
8.5 Attitudes towards bathing in the East	201
8.6 Discussion and conclusions	208

Chapter 9: Water supply and management in the domestic sphere	
9.1 Introduction	215
9.2 Water supply and management in the domestic sphere in urban contexts	215
9.2.1 1 <sup>st</sup> century BC 9.2.2 1 <sup>st</sup> century AD 9.2.3 2 <sup>nd</sup> century AD	216
	216
	217
9.2.4 3 <sup>rd</sup> century AD	217
9.2.5 1 <sup>st</sup> -century BC – 3 <sup>rd</sup> -century AD houses 9.2.6 4 <sup>th</sup> century AD	218
	219
9.2.7 5 <sup>th</sup> century AD	219
9.2.8 4 <sup>th</sup> -century AD – 7 <sup>th</sup> century AD houses	220
9.2.9 Houses with a non-specific 'Roman' date	221
9.2.10 Water supply of urban domestic houses: an overview	221
9.3 Water supply and management in the domestic sphere in rural contexts	223
9.4 The use of water in domestic contexts: status and display 9.5 Discussion and conclusions	224
	229
Chapter 10: The role of water in industrial processes	
10.1 Introduction	231 231
10.2 Watermills and water-powered installations	
10.3 Tanning, dyeing and fulling	237
10.4 Fishponds ( <i>vivaria</i> )	240
10.5 Conclusions	242
Chapter 11: Conclusions	244

## **Volume II: Figures**

## Volume III: Gazetteers and Bibliography