From Lamanai to Ka’kabish: Human and environment interaction, settlement change, and urbanism in Northern Belize

Alec McLellan

A dissertation submitted in partial fulfilment of the requirements for the degree of

Doctor of Philosophy

of

University College London.

Institute of Archaeology
University College London

November 8, 2019
I, Alec McLellan, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the work.
Abstract

At Lamanai and Ka’kabish, two Pre Columbian Maya centres in north-western Belize, archaeologists have focused their research on the environment, architecture, and long-term occupation of the civic-ceremonial centres. The sites’ rural or hinterland populations, however, which were presumably critical to the support of the centres, have not been studied. These populations are key to an understanding of the sites’ long histories and especially to our understanding of urban and rural relationships and how Lamanai survived the Maya collapse (AD 600-900), flourished during the transition to the Postclassic period (AD 900-1500), and continued to be a focus of settlement in the Spanish colonial period. Only two small-scale studies have shown interest in the domestic occupation of the larger region and they have been restricted by funding and time, leaving a massive gap in an otherwise robust and important comparative dataset. By reconstructing the spatial and temporal dynamics of Ka’kabish, Lamanai, and the inter-site settlement zone, and comparing them to environmental evidence from pollen cores collected in the New River Lagoon, this study aims to shed much-needed light on the processes that promoted the continuity in evidence in this region.

The results of the analysis indicate that the historical trajectory of the civic-ceremonial centres and the inter-site settlement zone differed in many ways. The centre of Lamanai remained occupied long after the abandonment of the peripheries and Ka’kabish, which were almost completely depopulated by the end of the Late Postclassic (AD 1250-1521) period. It is possible that Lamanai was occupied longer than many other sites in the region because of a large influx of migrant populations in the Terminal Classic (AD 800-1000) and Early Postclassic (AD 900-1250) periods, as evidenced by changes in ceramic traditions and a dramatic increase in the number of single domestic structures and their distribution. It also seems likely that the inhabitants of Lamanai reacted to earlier periods of increased soil erosion and deforestation (in the Late Preclassic and Early Classic) by managing their agricultural and arboreal resources in the Terminal Classic and Early Postclassic periods, striking a balance between settlement growth and an increasing need to exploit the environment.
Impact Statement

Transect surveys are used extensively in archaeology to understand the composition and distribution of past settlements and societies (Folan et al. 2009; Healy et al. 2007; Hutson et al. 2008; Puleston 1983). The doctoral project presented here includes both re-analysis and new fieldwork results that add to a growing list of studies of ancient examples of urbanism, which researchers argue are not just of considerable importance in their own right but can also provide context for interpreting variations in urban and rural settlement in the contemporary world (Fletcher 2009; Smith 2010). Of interest is the relationship between structures and greenspace (Graham 1999b), because potential patterns can inform new models of urban and peri-urban agriculture. Archaeological understanding of agricultural and urban systems and their response to changes in climate, can inform current practices in both temperate and neotropical environments. It is widely recognized that soil erosion globally surpasses soil formation in the contemporary world, causing soil degradation, which leads to an overall decline in productive potential (Mabit et al. 2014). While current agriculture practices have increased productivity, they are often monocultural, or homogenised (Lichtfouse et al. 2009; Lithourgidis et al. 2011) and cause a loss in natural plant diversity (Vandermeer et al., 1998), habitat loss, and decreased water resources (Foley et al. 2005). The urban and agricultural systems at Lamanai and Ka’kabish supported large populations for over two millennia, providing a model for sustained human occupation in neotropical environments.
Acknowledgements

There are countless people who helped me complete this work.

First and foremost, I want to thank my supervisors, Professor Elizabeth Graham and Professor Andrew Bevan, who spent many hours with me collaborating on the direction and design of my research. Their effort and advice carried this project to its conclusion. I am also thankful for my committee and progress review members at University College London (UCL), such as Dr. Ulrike Sommer, Professor Andrew Reynolds, and Dr. Manuel Arroyo-Kalin, who offered timely instruction during many stages of my writing. Their comments and criticisms were honest and helpful.

I met numerous people throughout the course of the project at Ka’kabish and Lamanai, which spanned 5 field seasons and over 7 years. I am grateful for the tutelage of Dr. Helen Haines, the director of the Ka’kabish Archaeological Research Project (KARP), who provided leadership and education in the field and in the classroom. I am thankful for the dedicated work of Dr. Kerry Sagebiel, who catalogued and analysed the ceramic assemblage. I am also thankful for the assistance of my colleagues, Dr. Cara Tremain, Dr. Chris Carleton, Toni Gonzalez, Erik Jamik, Gwynne Carlos, Danielle Budhoo, Gabi Dziki, Ella Bekesi, and Alice Gomer, who participated in the project.

A special thanks to Jaime Yanes, who was both a friend and a confidant. There is no one who knows the archaeology between Lamanai and Ka’kabish better than he does. I am also thankful for my co-workers in Belize, Roni Yanes, Alexis Deonel Alvarez, Herman Aquilar, Greg Rodríguez, and Charlie Kenny Diaz, who worked side-by-side with me in the field, collecting artefacts and mapping the sites.

I have several friends who I want to acknowledge. I am thankful for the online lessons of Brandon McCready, who helped me with photoshop and graphic design. I am appreciative of the attentiveness of Stuart Karrow, who listened to me talk about my study and my research. I also extend thanks to Lindsey Brooks, who helped me in many ways during my project – she can tell you everything about settlement patterns.

Lastly, I want to thank my family, Michael McLellan, Rose McLellan, and Bryce McLellan, who made this journey possible. Lots of love.
# Table of Contents

ABSTRACT.........................................................................................................................3
IMPACT STATEMENT.........................................................................................................4
ACKNOWLEDGEMENTS .......................................................................................................5
TABLE OF CONTENTS ........................................................................................................6
LIST OF FIGURES ..............................................................................................................11
LIST OF TABLES ..................................................................................................................19
GLOSSARY OF TERMS .......................................................................................................20

<table>
<thead>
<tr>
<th>Civic-Ceremonial Centre</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-Site Settlement Zone</td>
<td>20</td>
</tr>
<tr>
<td>Occupation</td>
<td>20</td>
</tr>
<tr>
<td>Space-Time Systematics</td>
<td>21</td>
</tr>
<tr>
<td>Sustainability</td>
<td>21</td>
</tr>
</tbody>
</table>

INTRODUCTION ..................................................................................................................22

RESEARCH QUESTIONS ......................................................................................................24
REVIEW OF CHAPTERS ......................................................................................................25

CHAPTER 1 ..........................................................................................................................28

*Maya History and the Sites of Lamanai and Ka’kabish* .....................................................28

1.1 Overview of Maya History .............................................................................................28
1.1.1 Paleoindian Period (12,000 BC to 7000 BC) ...............................................................28
1.1.2 Archaic Period (7000 BC to 2000 BC) ........................................................................30
1.1.3 Preclassic Period (2000 BC to AD 250) .....................................................................31
1.1.4 Classic Period (AD 250 to 900) ................................................................................33
1.1.5 Postclassic Period (AD 900 to 1521) ........................................................................35
1.1.6 Spanish Colonial Period (AD 1521 to 1708) ..............................................................36

1.2 The Preclassic Maya at Lamanai ....................................................................................37
1.2.1 Archaeological History ...............................................................................................37
1.2.2 Location and Composition ..........................................................................................42

1.3 The Preclassic Maya at Ka’kabish ................................................................................49
1.3.1 Archaeological History ...............................................................................................49
1.3.2 Location and Composition ..........................................................................................54

1.4 SUMMARY ......................................................................................................................59

CHAPTER 2 ..........................................................................................................................60

*Settlement Patterns and Maya Urbanism* ........................................................................60

2.1 Settlement Patterns .......................................................................................................60
2.1.1 A Definition of Settlement Patterns ..........................................................................60
2.1.2 Settlement Patterns and the Colonial Past ..................................................................61
2.1.3 The Advent of Archaeology in the New World .............................................................62
2.1.4 Towards a Systematic Approach ................................................................................63
2.1.5 Post-1960s and Settlement Systems .........................................................................65
CHAPTER 3
HUMAN AND ENVIRONMENT INTERACTION, LANDSCAPE MODIFICATION, AND SPATIAL ORGANISATION OF THE PRECOLUMBIAN MAYA

3.1 THE BUILT ENVIRONMENT
3.1.1 A Comparison of the Size and Scale of Two Ancient Cities
3.1.2 Spatial Organization and the “Mayacene”
3.1.3 Urban Heat Islands, Lime Production, and Green Cities

3.2 LANDSCAPE MODIFICATIONS AND THE PRECOLUMBIAN MAYA
3.2.1 Water Retention Systems and Landscape Transformation
3.2.2 Terraces and Agricultural Intensification
3.2.3 Field Conditions
3.2.4 Ceramic Assemblages
3.2.5 Lithic Assemblages

3.3 THE PRECOLUMBIAN MAYA AND THE CONTEMPORARY WORLD
3.3.1 Deforestation and Soil Erosion in the Current Era
3.3.2 Human Niche Construction

3.4 SUMMARY

CHAPTER 4
METHODS: ANALYSING AND RECORDING PRECOLUMBIAN MAYA SETTLEMENT

4.1 LAMANAI AND KA’KABISH: RE-ANALYSIS OF EXISTING DATA
4.1.1 Interpreting Temporal Dynamics at Lamanai
4.1.2 Interpreting Temporal Dynamics at Ka’Kabish

4.2 THE INTER-SITE SETTLEMENT ZONE: SURFACE SURVEY
4.2.1 Archaeological History of the Settlement Zone
4.2.1.1 The Maya Research Project Survey
4.2.1.2 The Spring Mapping Project Survey
4.2.2 Survey and Mapping Techniques
4.2.3 Field Conditions
4.2.4 Ceramic Assemblages
4.2.5 Lithic Assemblages

4.3 GEOMORPHOLOGY AND LANDSCAPE ECOLOGY

4.4 PRESENTATION AND ARRANGEMENT OF DATA
4.4.1 Designation of the Settlement Zone
4.4.2 A Heuristic Device
4.4.3 Sherd Density
4.4.4 Relative-Risk Surfaces

4.5 METHODOLOGICAL JUSTIFICATION AND LIMITATIONS
4.5.1 Methodological Justification
4.5.2 Methodological Limitations
CHAPTER 5 ............................................................................................................. 115
THE CIVIC-CEREMONIAL CENTRES OF LAMANAI AND KA’KABISH ....... 115
5.1 THE CHRONOLOGY AT LAMANAI ................................................................. 115
   5.1.1 Evidence from the Middle Preclassic to Early Classic periods .......... 116
   5.1.2 Evidence from the Late Classic to Late Postclassic periods .......... 121
5.2 THE TEMPORAL DYNAMICS AT LAMANAI ............................................ 124
5.3 THE CHRONOLOGY AT KA’KABISH ............................................................ 135
   5.3.1 Evidence from the Middle Preclassic to Late Postclassic Periods .... 135
5.4 THE TEMPORAL DYNAMICS AT KA’KABISH ......................................... 144
5.5 SUMMARY ...................................................................................................... 148

CHAPTER 6 ............................................................................................................. 150
THE INTER-SITE SETTLEMENT ZONE AND ITS ARTEFACTS .................... 150
6.1 SPATIAL DISTRIBUTION OF THE STRUCTURES ...................................... 150
   6.1.1 Settlement Zone A ................................................................................. 150
   6.1.2 Settlement Zone B ................................................................................ 154
   6.1.3 Settlement Zone C ................................................................................ 157
   6.1.4 Settlement Zone D ................................................................................ 160
   6.1.5 Settlement Zone E ................................................................................ 163
   6.1.6 Settlement Zone F ................................................................................ 166
6.2 CERAMIC ASSEMBLAGE ............................................................................. 169
   6.2.1 Type: Variety ......................................................................................... 169
   6.2.2 Density and Distribution of Sherds ......................................................... 178
      6.2.2.1 Settlement Zone A ........................................................................... 178
      6.2.2.2 Settlement Zone B ........................................................................... 180
      6.2.2.3 Settlement Zone C ........................................................................... 183
      6.2.2.4 Settlement Zone D ........................................................................... 185
      6.2.2.5 Settlement Zone E ........................................................................... 188
      6.2.2.6 Settlement Zone F ........................................................................... 191
6.3 LITHIC ASSEMBLAGE ................................................................................. 194
6.4 TEMPORAL DYNAMICS OF THE SETTLEMENT ZONE .......................... 200
   6.4.1 Settlement Zone A ................................................................................ 200
   6.4.2 Settlement Zone B ................................................................................ 202
   6.4.3 Settlement Zone C ................................................................................ 205
   6.4.4 Settlement Zone D ................................................................................ 208
   6.4.5 Settlement Zone E ................................................................................ 211
   6.4.6 Settlement Zone F ................................................................................ 214
6.5 SUMMARY ...................................................................................................... 218

CHAPTER 7 ............................................................................................................. 220
HUMAN AND ENVIRONMENTAL DYNAMICS IN THE REGION .............. 220
7.1 ENVIRONMENTAL SETTING OF THE STUDY ........................................... 220
7.2 EVIDENCE OF ENVIRONMENTAL CHANGE ........................................... 224
   7.2.1 Environmental Change and the New River Lagoon ....................... 224
   7.2.2 History of Vegetation Change ............................................................... 225
   7.2.3 Agroforestry and the Exploitation of Pine .......................................... 228
7.3 SETTLEMENT DYNAMICS AND THE CHANGING ENVIRONMENT .... 229
7.3.1 Settlement Dynamics in the Study Zone ........................................... 229
7.3.2 Human/Environment Interaction at Ka’kabish, Lamanai, and the Inter-Site Settlement Zone .................................................... 231
7.3.3 The Environment and the Maya ..................................................... 234
7.4 SUMMARY ....................................................................................... 235
CHAPTER 8............................................................................................... 236
LAMANAI, KA’KABISH, THE INTER-SITE SETTLEMENT ZONE, AND THE GREATER REGION OF NORTHERN BELIZE ..................................................... 236
8.1 MAJOR SITES WITHIN 25 KM OF LAMANAI ....................................... 239
  8.1.1 Greater Lamanai Region ............................................................ 239
    8.1.1.1 Chau Hiix ................................................................. 239
    8.1.1.2 El Pozito .................................................................. 241
  8.1.2 Dynamics of Sites within 25 km .................................................... 242
8.2 MAJOR SITES BETWEEN 25-50 KM FROM LAMANAI ......................... 243
  8.2.1 Three Rivers Region ............................................................... 243
    8.2.1.1 La Milpa .................................................................... 243
    8.2.1.2 Blue Creek .................................................................. 245
    8.2.1.3 Dos Hombres ............................................................. 247
  8.2.2 Northern Belize Region ............................................................. 248
    8.2.2.1 Nohmul ........................................................................ 248
    8.2.2.2 San Estevan ............................................................... 250
    8.2.2.3 Cuello ........................................................................ 251
  8.2.3 Eastern Coastal Region .............................................................. 253
    8.2.3.1 Altun Ha .................................................................... 253
    8.2.3.2 Colha ........................................................................ 254
  8.2.4 Southern Hondo-Nuevo Region ................................................... 256
    8.2.4.1 San Jose ..................................................................... 256
  8.2.5 Dynamics of Sites within 50 km ..................................................... 257
8.3 COMPARISON WITH THE WIDER MAYA WORLD .............................. 259
8.4 SUMMARY ....................................................................................... 261
CHAPTER 9............................................................................................... 262
THE INVISIBLE MAYA, LOW-DENSITY URBANISM, SUSTAINABILITY, AND SETTLEMENT .......................................................... 262
  9.1 THE INVISIBLE MAYA, LOW-DENSITY URBANISM, AND URBAN SCALING .......................................................... 263
  9.2 URBAN TRADITIONS, SUSTAINABILITY, CARACOL, AND CHUNCHUCMIL .......................................................... 270
  9.3 POLITICAL DISINTEGRATION, MARKET FORCES, AND MANAGED CITIES .......................................................... 274
  9.4 MIGRATION, DEVELOPMENTAL HISTORY, AND SETTLEMENT .......................................................... 276
  9.5 SUMMARY ....................................................................................... 280
CHAPTER 10............................................................................................. 281
CONCLUSION ......................................................................................... 281
10.1 RESEARCH QUESTIONS .................................................................. 281
   10.1.1 What is the character of the settled landscape between Ka’kabish and Lamanai (number of structures; patterns and distribution of settlement;
modifications to the natural environment) and how does this compare to other sites in Northern Belize? ................................................................. 281
10.1.2 How does the chronology of the inter-site settlement zone compare to the chronology of the two civic-ceremonial centres – Lamanai and Ka’kabish – as well as the core-periphery dynamics at other sites in Northern Belize? ........ 285
10.1.3 How does the distribution and density of occupation (as defined by the location and date of each structure) in the inter-site settlement zone change over time, and how does this compare to occupation of the centres, as well as other sites in Northern Belize? ......................................................... 289
10.1.4 To what extent is there consistency or variation in material culture found at structures in the region within and between these two major centres? .... 290
10.1.5 What does the environmental evidence from pollen cores collected adjacent to Lamanai suggest about the settlement patterns at Lamanai, Ka’kabish, and the inter-site settlement zone? ........................................ 291
10.2 IMPLICATIONS FOR FUTURE STUDY ........................................... 292
10.3 CONCLUDING REMARKS ................................................................. 294
REFERENCES .................................................................................. 295
APPENDIX A: CHRONOLOGY OF STRUCTURES AT LAMANAI........... 371
APPENDIX B: DESIGNATION, SIZE, LOCATION, SPATIAL DISTRIBUTION, AND CHRONOLOGY, OF THE INTER-SITE SETTLEMENT ZONE .................................................................................. 376
APPENDIX C: LITHIC DATA FROM THE INTER-SITE SETTLEMENT ZONE .................................................................................. 409
APPENDIX D: MAPS OF SITES WITHIN 50 KM OF LAMANAI, KA’KABISH, AND THE INTER-SITE SETTLEMENT ZONE ......................... 416
List of Figures

Figure 1: Map of major Maya sites
(modified from Zralka and Hermes 2012: 162) ................................................................. 29
Figure 2: Map of the civic-ceremonial centre of Lamanai
(Pendergast 1986a: 228) ......................................................................................................... 43
Figure 3: Map of structures that have been excavated at Lamanai (in red) ........... 44
Figure 4: A) Str. N10-9 at the end of the Early Classic Period, B) Str. N10-9 as modified in the Late Classic (Pendergast 1981: 35) ....................... 46
Figure 5: Plan view of Str. FA-8, with unit, altar and tomb locations
(Dziki 2017: 12) ......................................................................................................................... 53
Figure 6: Map of the civic-ceremonial centre of Ka’akabish (Haines 2007: 35) .... 56
Figure 7: Hillshade map of the civic-ceremonial centre of Ka’akabish .......... 57
Figure 8: Map of the structures that are excavated at Ka’akabish (in red) .......... 58
Figure 9: Image of the civic-ceremonial centre of Caracol
(Chase et al. 2011: 394) ........................................................................................................... 67
Figure 10: Image of a gridded system at El Mirador (Seaburn 2016) .......... 67
Figure 11: Map of the centre of Chunchucmil (ca. 10 sq. km)
(Hutson et al. 2008: 23) ........................................................................................................... 71
Figure 12: Map of a section of the site of Coba, Quintana Roo, showing the distribution of structures and their labour investment (Folan et al. 2009: 64) .... 85
Figure 13: Surface albedo in cleared and forested areas (modified from O’Brien 1996: 315; Shaw 2003: 162) .......................................................... 81
Figure 14: Elevation transect from the Northern Caribbean coast of Belize to the Mirador Basin in the Northern Petén, Guatemala (Dunning et al. 2002: 269) ..... 84
Figure 15: Extent of causeways, settlement, and agricultural terraces at Caracol, Belize (modified from Chase and Chase 2016a: 5) ...................... 85
Figure 16: Roughness length in cleared and forested areas (modified from O’Brien 1996: 317; Shaw 2003: 163) .............................................................. 87
Figure 17: Comparing the chronology and ceramic complexes at Lamanai and Ka’akabish (modified from Graham 2004:25 and Sagebiel 2015:55) (see Chapter 5 for a list of the ceramics that comprise each group at each site) ................. 93
Figure 18: Map of the location of the inter-site settlement zone, Ka’akabish, Lamanai, and Coco Chan ................................................................. 95
Figure 19: The civic-ceremonial centre of Coco Chan (Baker 1995: 114) .......... 98
Figure 20: Map of the settlement south of the major temple structures at Coco Chan and northwest of Settlement Zone E (Patterson 2007: 57) (see Figure 18 for the location of Patterson’s survey zone) ....................................................... 99
Figure 21: Ruined structures and artefact scatters surrounding the civic-ceremonial centre of Ka’akabish (Patterson 2007: 58) ........................................ 100
Figure 22: Ruined platform structure in Settlement Zone F (Str. 18)
(see Appendix A) ....................................................................................................................... 103
Figure 23: 3D Wireframe of ruined platform structure in Settlement Zone F (Str. 18) (see Appendix A) ................................................................. 103
Figure 24: Conditions of the agricultural fields in Settlement Zone D .......... 105
Figure 25: Conditions of the agricultural fields in Settlement Zone E .......... 105
Figure 26: Current land parcels and the location of Lamanai, Ka’kabish, Coco Chan, and Settlement Zone A to F ................................................................. 108
Figure 27: a) Sierra Red: Sierra Variety; b) Leguna Verde Incised: Grooved-incised Variety; c) Puletan Red-and-unslipped (Powis 2002: 103, 108) (Illustrated by Louise Belanger) ................................................................. 117
Figure 28: a) Lechugal Incised: Gouged-incised Variety; b) Sierra Red: Variety Unspecified (Red-double slip) (Powis 2002: 182) (Illustrated by Louise Belanger) ................................................................. 118
Figure 29: a) Flor Cream: Variety Unspecified; b) Alta Mira Fluted: Variety Unspecified; c) Polvero Black: Polvero Variety (Powis 2002: 131, 145) (Illustrated by Louise Belanger) ................................................................. 120
Figure 30: Pottery maskette with crocodile headdress (Pendergast 1981: 38) .... 121
Figure 31: Zalal Incised vessels, Buk phase, Early Postclassic (Pendergast 1981: 51) (Illustrated by Louise Belanger) ................................................................. 123
Figure 32: Mayapan-style censor or Chen Mul Modelled (Pendergast 1981: 51) ................................................................. 124
Figure 33: Middle Preclassic (900-400 BC) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Middle Preclassic period. Blue to yellow indicates the spatial intensity of occupation in the Middle Preclassic period, c) Comparison of the proportion of structures occupied in the Middle Preclassic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Middle Preclassic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolombian Maya history ................................................................. 125
Figure 34: Late Preclassic (400 BC-AD 250) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Late Preclassic period. Blue to yellow indicates the spatial intensity of occupation in the Late Preclassic period, c) Comparison of the proportion of structures occupied in the Late Preclassic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Late Preclassic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolombian Maya history ................................................................. 126
Figure 35: Early Classic (AD 250-450) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Early Classic period. Blue to yellow indicates the spatial intensity of occupation in the Early Classic period, c) Comparison of the proportion of structures occupied in the Early Classic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Early Classic period. White dots represent all the structures at Lamanai. Black dots represent
structures with evidence of occupation in a specific period of Precolumbian Maya history.......................................................... 127

Figure 36: Late Classic (AD 600-800) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Late Classic period. Blue to yellow indicates the spatial intensity of occupation in the Late Classic period, c) Comparison of the proportion of structures occupied in the Late Classic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Late Classic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.......................................................... 129

Figure 37: Terminal Classic (AD 800-1000) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Terminal Classic period. Blue to yellow indicates the spatial intensity of occupation in the Terminal Classic period, c) Comparison of the proportion of structures occupied in the Terminal Classic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Terminal Classic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.......................................................... 130

Figure 38: Early Postclassic (AD 1000-1250) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Early Postclassic period. Blue to yellow indicates the spatial intensity of occupation in the Early Postclassic period, c) Comparison of the proportion of structures occupied in the Early Postclassic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Early Postclassic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.......................................................... 131

Figure 39: Late Postclassic (AD 1250-1500) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Late Postclassic period. Blue to yellow indicates the spatial intensity of occupation in the Late Postclassic period, c) Comparison of the proportion of structures occupied in the Late Postclassic period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Late Postclassic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.......................................................... 133

Figure 40: Spanish Colonial (AD 1500-1700) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Spanish Colonial period. Blue to yellow indicates the spatial
intensity of occupation in the Spanish Colonial period. c) Comparison of the proportion of structures occupied in the Spanish Colonial period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the Spanish Colonial period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history. ................................................................. 134

Figure 41: British Colonial (AD 1700-) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue to yellow indicates the spatial intensity of occupation. b) Location of structures with evidence of occupation in the British Colonial period. Blue to yellow indicates the spatial intensity of occupation in the British Colonial period. c) Comparison of the proportion of structures occupied in the British Colonial period to all other chronological periods. Blue to beige implies low to high intensity of occupation in the British Colonial period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history. ................................................................. 135

Figure 42: Profile map of Str. D4 south trench, north wall (Tremain 2011: 75). 137

Figure 43: Middle Preclassic to Late Preclassic ceramic roller stamp from Str. D4, Sub-I (Tremain 2011:105) ................................................................. 138

Figure 44: Profile map of Str. D9 looter’s trench, north wall (Tremain 2011: 95) ......................................................................................... 140

Figure 45: Vasquez Ceramic Complex sherd from Str. D9, Sub-II (Tremain 2011: 121) ......................................................................................... 141

Figure 46: Profile of Str. FA-8 with the building phases of the structure (Dziki 2017: 13) ................................................................. 143

Figure 47: Evidence of occupation at structures at Ka’kabish. A) Middle Preclassic B) Late Preclassic C) Early Classic D) Late Classic E) Terminal Classic F) Early Postclassic ................................................................. 146

Figure 48: Satellite image, topography and schematic drawing of Type 6 settlement in Settlement Zone A ......................................................... 152

Figure 49: Satellite image, topography, and schematic drawing of Type 3 settlement in Settlement Zone A ......................................................... 153

Figure 50: Satellite image, topography, and schematic drawing of Settlement Zone B ......................................................................................... 155

Figure 51: Topography and schematic drawing of Settlement Zone B ......................................................................................... 156

Figure 52: Satellite image, topography, and schematic drawing of Type 7 settlement in Settlement Zone C ......................................................................................... 158

Figure 53: Satellite image, topography, and schematic drawing of Type 2, 3 and 4 settlement in Settlement Zone C ......................................................................................... 159

Figure 54: Satellite image, topography, and schematic drawing of the minor centre of Coco Chan161 in Settlement Zone D ......................................................................................... 161

Figure 55: Satellite image, topography, and schematic drawing of Type 1, 2, 3, and 4 settlement in Settlement Zone D ......................................................................................... 162

Figure 56: Satellite Image, topography, and schematic drawing of Type 6 settlement in Settlement Zone E ......................................................................................... 164
Figure 57: Satellite image, topography, and schematic drawing of Type 1, 2, and 3 settlement in Settlement Zone E ................................................................. 165
Feature 58: Satellite image, topography, and schematic drawing of Type 6 settlement in Settlement Zone F ................................................................. 167
Figure 59: Satellite imagery, topography, and schematic drawing of Type 3 settlement in Settlement Zone F ................................................................. 168
Figure 60: A) Late Classic to Terminal Classic, Cubeta Incised B) Terminal Classic to Early Postclassic, Dumbcane Striated C) Terminal Classic to Early Postclassic, Red Neck Mother D) Postclassic chalice E) Colonial jar F) Colonial Period ................................................................. 172
Figure 61: A) Terminal to Early Postclassic, Dumbcane Striated, B) Terminal to Early Postclassic, Red Neck Mother, C) Late Postclassic, Payil Red 173 (Photography by Kerry Sagebiel) ................................................................. 173
Figure 62: Terminal to Early Postclassic, Lamanai Orange (Photography by Kerry Sagebiel) ................................................................. 174
Figure 63: A) Eroded Postclassic foot, B) Late Postclassic foot, C) Late Postclassic, Payil Red foot (Photography by Kerry Sagebiel) ................................................................. 175
Figure 64: A) Late Postclassic to Spanish Colonial jar, B) Yglesias Colonial bowl, C) Yglesias Colonial jar (Photography by Kerry Sagebiel) ................................................................. 177
Figure 65: Number of sherds at structures in Settlement Zone A ..................... 178
Figure 66: Number of sherds found at each structure in Settlement Zone A .... 179
Figure 67: Number of sherds at structures in Settlement Zone B ..................... 181
Figure 68: Number of sherds at structures in Settlement Zone B ..................... 181
Figure 69: Number of sherds found at each structure in Settlement Zone B ..... 182
Figure 70: Number of sherds at structures in Settlement Zone C ..................... 183
Figure 71: Number of sherds found at each structure in Settlement Zone C ..... 184
Figure 72: Number of sherds at structures in Settlement Zone D ..................... 186
Figure 73: Number of sherds at structures in Settlement Zone D ..................... 186
Figure 74: Number of sherds found at each structure in Settlement Zone D ..... 187
Figure 75: Number of sherds at structures in Settlement Zone E ..................... 189
Figure 76: Number of sherds at structures in Settlement Zone E ..................... 189
Figure 77: Number of sherds found at each structure in Settlement Zone E ..... 190
Figure 78: Number of sherds at structures in Settlement Zone F ..................... 191
Figure 79: Number of sherds at structures in Settlement Zone F ..................... 192
Figure 80: Number of sherds at structures in Settlement Zone F ..................... 192
Figure 81: Number of sherds found at each structure in Settlement Zone F ..... 193
Figure 82: A) Mano, rectangular variety (Willey et al. 1965: 458), B) Mano, rectangular, thick variety (Willey et al. 1965: 461), C) Mano, rectangular, thick variety (Willey et al. 1965: 461) ................................................................. 195
Figure 83: Metate, large variety (Willey et al. 1965: 455) ..................................... 195
Figure 84: Rectangular B variety bark beater fragment found in the inter-site settlement zone (see Willey et al. 1965: 471) ................................................................. 196
Figure 85: A, B, C) Standard biface (Willey et al. 1965: 425), D) Fragmentary biface ................................................................. 197
Figure 86: Standard biface (Willey et al. 1965: 425) .................................................. 198
Figure 87: Laural-Leaf, unstemmed, bifacial blade (Willey et al. 1965: 421) .... 199
Figure 88: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone A. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic, e) Terminal Classic, f) Early Postclassic ..........................201

Figure 89: Chronology of structures (n=8) at Settlement Zone A .................202

Figure 90: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone B. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic .....................................................203

Figure 91: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone B. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, c) Late Postclassic ..................................................204

Figure 92: Chronology of structures (n=60) at Settlement Zone B..........................205

Figure 93: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone C. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic .....................................................206

Figure 94: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone C. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, c) Late Postclassic, d) Colonial ..................................................207

Figure 95: Chronology of structures (n=21) at Settlement Zone C..................208

Figure 96: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone A. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic .....................................................209

Figure 97: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone D. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, c) Late Postclassic, c) Colonial ..................................................210

Figure 98: Chronology of structures (n=45) at Settlement Zone D ..................211

Figure 99: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone E. Black dots represent structures with evidence of occupation in specific periods of Precolombian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic .....................................................212
Figure 100: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone E. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, c) Colonial.

Figure 101: Chronology of structures (n=33) at Settlement Zone E.

Figure 102: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone F. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Middle Preclassic, c) Late Preclassic, d) Early Classic.

Figure 103: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone F. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Late Classic, b) Terminal Classic, c) Early Postclassic.

Figure 104: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone F. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Late Postclassic, b) Colonial.

Figure 105: Chronology of structures (n=86) at Settlement Zone F.

Figure 106: Average annual rainfall in Belize (see Meerman and Sabido 2001: 16 for average precipitation by months and districts).

Figure 107: Distribution of ecosystems in the Survey Zone (Meerman and Sabido 2001).

Figure 108: Pollen percentage for the New River Lagoon core at Lamanai (Rushton et al. 2013: 488).

Figure 109: Expanded pollen percentage for the New River Lagoon core at Lamanai (Rushton et al. 2013: 489).

Figure 110: Comparison of wood use from similar contexts at three sites from the Late Classic to Postclassic periods (Lentz et al. 2016: 291).

Figure 111: Settlement dynamics of Lamanai and Ka’kabish.

Figure 112: Settlement dynamics of Settlement Zones A to F.

Figure 113: Map of Precolumbian Maya centres mentioned in this chapter.

Figure 114: Profile of a structure represented on the surface by only a slight rise in elevation (Johnston 2004: 157).

Figure 115: Chich mound in Settlement Zone B (Str. B15) (27.82 sq. m).

Figure 116: Chich mound in Settlement Zone F (Str. F32) (35.90 sq. m).

Figure 117: Distribution of elite compounds at Coba (Folan et al. 2009: 62).

Figure 118: Image of an area inferred to be unsettled in Settlement Zone C.

Figure 119: Comparison of the geographic extent of Caracol, Chunchucmil, and Lamanai.

Figure 120: Evidence of a domestic household at Coba (the right half of the household was constructed after the left half to accommodate an extended family) (Manzanilla and Barba 1990: 44).
Figure 121: Relative-risk surface of Settlement Zone B (left) and Settlement Zone F (right), showing the changes in the density of occupation (blue to beige = low to high) from the Late Classic to Terminal Classic periods .......................... 279
List of Tables

Table 1: Morphological system based on structural and locational features.............. 109
Table 2: Survey perimeter, survey area, and number of structures at Settlement Zone A................................................................. 151
Table 3: Unit types in Settlement Zone A ........................................................................ 151
Table 4: Survey perimeter, survey area, and number of structures at Settlement Zone B................................................................. 154
Table 5: Unit types in Settlement Zone B ........................................................................ 154
Table 6: Survey perimeter, survey area, and number of structures at Settlement Zone C................................................................. 157
Table 7: Unit types in Settlement Zone C ........................................................................ 157
Table 8: Survey perimeter, survey area, and number of structures at Settlement Zone D................................................................. 160
Table 9: Unit types in Settlement Zone D ........................................................................ 160
Table 10: Survey perimeter, survey area, and number of structures at Settlement Zone E............................................................... 163
Table 11: Unit types in Settlement Zone E ..................................................................... 163
Table 12: Survey perimeter, survey area, and number of structures at Settlement Zone F............................................................... 166
Table 13: Unit types in Settlement Zone F ..................................................................... 166
Table 14: List of diagnostic artefacts found in the inter-site settlement zone ......... 170
Table 15: Common types of ceramics in Settlement Zone A ......................................... 180
Table 16: Common types of ceramics in Settlement Zone B ......................................... 183
Table 17: Common types of ceramics in Settlement Zone C ......................................... 185
Table 18: Common types of ceramics in Settlement Zone D ......................................... 188
Table 19: Common types of ceramics in Settlement Zone E ......................................... 191
Table 20: Common types of ceramics in Settlement Zone F ......................................... 194
Glossary of Terms

Civic-Ceremonial Centre

The term “civic-ceremonial centre” is used in Maya studies to describe a zone of urban settlement that is governed by a monarch, or a “decentralized, unbureaucratized polity,” and organized by “religious principles” (Houston 2001: 145). It is used in many publications to refer to an area that was intensively constructed, with large multi-terraced structures, ball courts, plazas, and range structures (long multi-room buildings) (Ball and Tascheck 1991; Morten et al. 2014; Stuardo 2007: 94). As Houston (2001: 146) notes, in Mesoamerica the urban centre contains a “nucleus of civic and religious buildings,” with temples that restrict access to “ceremonial processions,” and other religious activities. In this thesis, the term “civic-ceremonial centre” is used to distinguish between the settlement in the centre of the site and the supporting settlement in the periphery.

Inter-Site Settlement Zone

The term “inter-site settlement zone” is used to refer to six areas outside the civic-ceremonial centre of Lamanai and Ka’kabish, which are known as Settlement Zones A to F. These zones were likely inhabited by mostly commoner populations in the Pre columbian past (see Lohse and Valdez 2004b), as smaller structures are sometimes, albeit it not always (Adams and Smith 1981), an indicator of commoner occupation (Lohse and Valdez 2004a: 4; Webster and Gonlin 1988). In this thesis, the term “inter-site settlement zone” is used to refer to the periphery, or hinterlands, as the settlement in these areas are outside the civic-ceremonial centres of Lamanai and Ka’kabish.

Occupation

The term “occupation” is commonly used by Mayanists to refer to the presence of Maya settlements. Evidence of Maya occupation is indicated by construction activities (domestic platform structures and monumental architecture), additions/changes to structures, and the identification of Pre-columbian ceramics. For example, the presence of Middle Preclassic Maya occupation in the Northern Lowlands is often indicated by ballcourts (see Bey 2006: 18-19), a common architectural construction in the Maya world.
Changes in the density of structures and their associated ceramics over time are indicative of changes in the intensity of Maya occupation and may indicate expanding and declining populations.

**Space-Time Systematics**

The term “space-time systematics” was used by Willey and Phillips (1958) to describe changes in material culture through time and across space (see Kelly and Thomas 2014:107-112). The goal of space-time systematics is to create “geographic and temporal boundaries,” with more accurate boundaries providing clearer reconstructions of historic events (Hermon and Niccolucci 2017: 95). In this thesis, ceramic typologies are categorized into chronological periods, which provide the “temporal boundary,” while the “geographic boundary” is defined by the spatial distribution of Precolumbian Maya structures. I also use the terms “temporal dynamics” and “settlement dynamics” to refer to changes in the composition of the settlement over time.

**Sustainability**

There are many definitions of sustainability from various disciplines, such as science, economics, politics, ethics, and engineering (Atkinson, Yates, and Wyatt 2009: 1). Brundtland (1987: 292) defined sustainability as “meeting the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs.” Contemporary approaches to environmental engineering promote three principles of sustainable practice: environmental, ecological, and economic (Glavic and Lukman 2007: 1876). These policies use terms such as renewable resources, recovery, degradation, design for environment, life cycle, and no waste (Glavic and Lukman 2007: 1876-1880). In a conference on the concept of sustainability from an archaeological perspective, sustainability was defined as “the way in which people or communities remain diverse, yet productive while maintaining an ecological balance” (Favreau and Patalano 2017: iv). In this thesis, I use sustainability as a term to refer to the longevity, or length of occupation, of Precolumbian Maya cities and especially to their ability to maintain a settlement during changing social and environmental conditions.
Introduction

“A wonderful fact to reflect upon, that every human creature is constituted to be that profound secret and mystery to every other. A solemn consideration, when I enter a great city by night, that every one of those darkly clustered houses encloses its own secret...”

— Charles Dickens, A Tale of Two Cities

Lamanai and Ka’kabish, two Precolumbian Maya centres in north-western Belize, have been sites of archaeological investigation and interpretative progress for several decades, with archaeologists exploring many different facets of their developmental history. A large amount of research has focused on the long stratigraphic sequences at Lamanai and Ka’kabish, which date from the Middle Preclassic (1000-400 BC) to Late Postclassic (AD 1250-1521), and Colonial periods (AD 1521-1708) of Maya history (Aimers 2007a; Graham 2004, 2011; Haines 2013; Howie 2012; Pendergast 1986a, Powis 2002). Existing studies have identified relatively long culture-histories for each site, but they have yet to embark on a structure-by-structure temporal reconstruction of the settlement dynamics of the civic-ceremonial centres and the structures surrounding them. Archaeologists have excavated many of the structures at Ka’kabish and Lamanai, but most of the relevant information has remained in note form or as site reports, without it being used for broad space-time reconstructions. This is the major goal of this project – to create a fine-grained model of the settlement dynamics, or changes in the density and distribution of structures through time and across space at Lamanai, Ka’kabish, and the inter-site settlement zone – an area inbetween the two centres – and compare the model to environmental evidence from pollen cores in the New River Lagoon, a body of water adjacent to Lamanai. By analysing the spatio-temporal distribution of settlement and comparing it to evidence from pollen cores, this study aims to understand the human and environmental dynamics at Ka’kabish, Lamanai, and the inter-site settlement zone. This relationship is later compared to the human and environmental dynamics at other sites in the region and across the greater Precolumbian Maya world.
At Lamanai, archaeologists have studied the material evidence of occupation from many periods of Maya history, with projects focusing on the ceramics of the Preclassic (Powis 2002, 2004) and Terminal Classic-Early Postclassic periods (Howie 2012), as well as changes in the paleoenvironment from the beginning of the Holocene to the present (Metcalfe et al. 2009; Rushton et al. 2013). The site of Lamanai was visited by archaeologists in the mid-1920s and returned to in the late-1930s and mid-1960s, however, the first excavation and systematic survey of the site was conducted in the 1970s. Excavations in the civic-ceremonial centre and evidence from pollen collected adjacent to Lamanai suggest that the site was occupied as early as 1600 BC (Hanna et al. 2016), spanned the period of the Maya collapse, and continued to be a focus of settlement after the arrival of the Spanish (Graham 2004, 2011; Metclafe et al. 2009; Pendergast 1982a; Rushton et al. 2013). These studies uncovered the length of occupation at Lamanai, but there has yet to be an analysis of settlement dynamics and changes in settlement over time. Archaeologists have speculated that the peak periods of population at Lamanai were in several different time periods, however, these speculations are based on data that is limited to the core of the site.

At Ka’kabish, a Pre Columbian Maya centre 10 km northwest of Lamanai, archaeologists have only recently begun to understand the historical trajectory of the site (Haines 2008, 2010, 2013; McLellan and Haines 2013, Tremain 2011). In the early 1980s, archaeologists surveyed several domestic structures in cleared milpa, or corn fields next to the core of the site, using ceramic materials collected from the surface to identify Early Postclassic period occupation (Haines 2008: 4). Several years later, archaeologists from the Maya Research Program mapped the civic-ceremonial centre (Guderjan 1996). These archaeologists compared ceramics at the site to existing type-variety sequences, which suggest a long history of occupation, beginning as early as the Late Preclassic (400 BC-AD 300) period and continuing until the end of the Late Classic period (AD 600-900). More recently, archaeologists have identified evidence of occupation during the Middle Preclassic (1000-400 BC) and Postclassic periods (AD 900-1521) (Haines 2013; McLellan 2013). The history of archaeological study at Ka’kabish is shorter than Lamanai, however, several lines of evidence can be used to reconstruct a structure-by-structure analysis of Ka’kabish. Unlike Lamanai, which has benefitted from the governmental protection of a natural reserve, Ka’kabish has been extensively looted, with some excavations bisecting the primary axis of monumental structures. The trenches from
these excavations have been mapped to understand the developmental history of structures in the civic-ceremonial centre (Tremain 2011). These data, and other information from excavations in the civic-ceremonial centre, are used in my research to understand the settlement dynamics of Ka’kabish, with the goal of comparing the historical trajectory of Ka’kabish to Lamanai.

To complement the chronological reconstruction of Lamanai and Ka’kabish, I surveyed several areas peripheral to the site cores, which are collectively referred to as the inter-site settlement zone and represent a hinterland. Ceramic material from each structure identified in the inter-site settlement zone was collected and analysed to recreate the settlement dynamics of the periphery, or hinterland, of Lamanai and Ka’kabish. By reconstructing the settlement dynamics of Lamanai, Ka’kabish, and the inter-site settlement zone, I intend to provide a detailed and thorough understanding of the historical trajectory of the region. This reconstruction is subsequently compared to the settlement dynamics of other sites in the Precolumbian Maya world to highlight consistency and variability in the archaeological record.

**RESEARCH QUESTIONS**

The major research question addressed by this study is: What are the settlement dynamics at Ka’kabish, Lamanai, and the inter-site settlement zone, and how do these compare to the environmental evidence of pollen cores from the New River Lagoon, as well as the core-hinterland dynamics at other Maya sites in the greater region of Northern Belize?

To answer this question, it is important to identify several key characteristics of the study zone, such as:

1) What is the character of the settled landscape between Ka’kabish and Lamanai (number of structures; patterns and distribution of settlement; modifications to the natural environment) and how does this compare to other sites in Northern Belize?

2) How does the chronology of the inter-site settlement zone compare to the chronology of the two civic-ceremonial centres – Lamanai and Ka’kabish – as well as chronology of other sites in Northern Belize?

3) How does the distribution and density of occupation (as defined by the location and date of each structure) in the inter-site settlement zone change over time, and
how does this compare to occupation of the centres, as well as other sites in Northern Belize?

4) To what extent is there consistency or variation in material culture found at structures in the region within and between these two major centres?

5) What does the environmental evidence from pollen cores collected adjacent to Lamanai suggest about the settlement patterns at Lamanai, Ka’kabish, and the inter-site settlement zone?

REVIEW OF CHAPTERS
Chapter’s 1, 2, and 3, look to: 1) provide an overview of Precolombian Maya history and the historical development of archaeological settlement pattern studies, 2) discuss the theoretical background of settlement studies and urbanism in Maya cities, 3) describe the character and composition of Maya cities, 4) analyse evidence of landscape modifications and their effect on past environments. The goal of Chapter 1 is to place my work within the broader context of Maya studies and show how the reconstruction of settlement dynamics at Lamanai, Ka’kabish, and the inter-site settlement zone, adds to the narrative of Precolombian history. Chapter 2 highlights the ways in which my work builds on the theoretical development of settlement pattern studies, especially as it relates to low-density urbanism. Chapter 3 presents some of the ambiguities in Precolombian Maya studies, with a goal of assessing the way the configuration – the plan, or layout – of the settlement affected the environment in the past.

Chapter 4 outlines the methods used to collect and analyse data from Lamanai, Ka’kabish, and the inter-site settlement zone. At Lamanai and Ka’kabish, I reviewed and reused existing data from unpublished fieldwork notebooks, site reports, and published articles, to identify the occupation date of each excavated structure in the civic-ceremonial centres. I surveyed 6 fields over the course of 7 years along a 10 km corridor between Lamanai and Ka’kabish to add to our understanding of core-periphery dynamics and to further understand the historical trajectory of the area. To visually assess and analyse the distribution and chronology of structures at Lamanai, Ka’kabish, and the inter-site settlement zone, I created kernel density maps and, in some cases, relative-risk surfaces (see pg. 110-111 for an explanation of relative-risk surfaces). I used interpolation to visualize the density of ceramics in the inter-site settlement zone and to identify changes in the density of ceramics across space. Chapter 4 presents a new
method for analysing core-periphery dynamics at Pre columbian Maya sites – a method that has yet to be used in current studies of spatial and chronological distributions of settlement.

Chapter 5 is divided into two sections: one that focuses on the Pre columbian Maya at Lamanai and the other at Ka’kabish. For each site, there is a summary of the ceramics that were identified and a discussion of their chronology. The dates from the ceramics at each structure at Lamanai and Ka’kabish are used to present maps of the changes in settlement over time. This is the first time data has been used Lamanai and Ka’kabish to recreate changes in the settlement over time and offers a unique perspective on the growth and decline of these centres.

Chapter 6 provides a structure-by-structure analysis of the architectural and ceramic evidence from the area between Ka’kabish and Lamanai, from Settlement Zones A to F. I analyse the spatial distribution and composition of structures in the settlement zone and categorise the structures in a morphological system based on structural features and relative placement location (see pg. 109 for an explanation of the typology). In the final section, I combine the spatial distribution, density, and chronology, of individual structures to recreate the settlement dynamics of the inter-site settlement zone. Chapter 6 offers a fine-grained understanding of changes in the periphery of major settlements (Lamanai and Ka’kabish) over time.

Chapter’s 7, 8, and 9, present the results of my project and places them within the larger study of Maya archaeology. The purpose of this section is to: 1) compare the settlement dynamics of Lamanai, Ka’kabish, and the inter-site settlement zone, to the environmental data from pollen cores collected adjacent to Lamanai, 2) compare the human and environment dynamics of the study area to sites in the greater region of Northern Belize, 3) assess the manner in which the results of the project address several methodological and theoretical problems in Maya archaeology. This section starts with a local perspective, moves to a regional perspective, and ends with a culture-wide perspective of Pre columbian Maya history.

Chapter 10 summarizes my major conclusions. The first part reiterates my research questions and offers responses to each question. The second part outlines the
implications for future study and discusses the direction for future research. The last part of this chapter offers concluding remarks about Precolumbian Maya studies and my experience in attempting to understand their societies. I provide a new perspective on settlement dynamics at Lamanai, Ka’kabish, and the inter-site settlement zone, as well as sites in Northern Belize, and address several current themes in Maya archaeology, such as spatial organization, low-density urbanism, human/environment interactions, and sustainability.
Chapter 1

MAYA HISTORY AND THE SITES OF LAMANAI AND KA’KABISH

The first part of this chapter reviews the historical trajectory of the early inhabitants of the Yucatan peninsula and the development of Maya culture from the end of the Archaic Period (ca. 2000 BC) to the arrival of the Spanish (ca. AD 1520). The review of the development of Precolumbian Maya societies is important to this study as the developmental trajectory of Lamanai, Ka’kabish, and the inter-site settlement zone, is later interpreted within the larger narrative of Maya history. The second part of the chapter discusses the location, composition, and archaeological history, of the civic-ceremonial centres of Lamanai and Ka’kabish. The archaeological histories of Lamanai and Ka’kabish have appeared in several publications (see Powis 2002:49-61; McLellan 2013:10-15), however, the overview provided here is the newest and most exhaustive account so far of these projects, their goals, and their outcomes. Figure 1 shows the location of the Maya sites mentioned in this chapter.

1.1 OVERVIEW OF MAYA HISTORY

1.1.1 Paleoindian Period (12,000 BC to 7000 BC)

The date of the first occupation of the New World is contested (see Jablonski 2002; Meltzer 2009), but most archaeologists agree that the earliest human inhabitants crossed the Bering Sea land bridge in one, or several migrations, from Siberia to Alaska during the last glacial advances of the Pleistocene era (Webster and Evans 2000: xii). Other migration models exist, however, such as the Pacific Coast Migration Model (Fladmark 1979), the Solutrean hypothesis (Stanford and Bradley 2004, 2012), and The Kelp Highway hypothesis (Erlandson et al. 2007). Some of these theories argue that the New World was colonized as early as 20,000 BC (Adovasaio and Page 2003), however,
Figure 1: Map of major Maya sites (modified from Zralka and Hermes 2012: 162)
Mayanists generally place the beginning of the Paleo-Indian period at about 12,000 BC (Demarest 2004; Sharer et al. 2006). Fluted points are normally considered to indicate occupation in the Paleoindian Period (Hester et al. 1981; Valdez and Aylseworth 2005). Given that fluted points have been found at several locations in Belize, including the shores of the New River Lagoon (Pearson and Bostrom 1998), the Lamanai-Ka’kabish area may well have seen Palaeoindian occupation. The problem in isolating any Palaeoindian evidence is the depth and extent of deposits from later occupations, including the urban sprawl of the Classic period. We do have evidence that the first colonists of the Yucatan Peninsula consisted of small, nomadic bands that subsisted on several now-extinct species of megafauna, as well as smaller animals and plants. Evidence from Actun Halal, a shallow cave site near the Macal River, indicates that humans may have hunted several species of Pleistocene mammals, including spectacled bear (Urisidae), peccary (Tayassuidae), and horse (Equidae) (Stemp and Awe 2013: 18; Lohse et al. 2006: 216). Fluted points have also been found on the surface in Lowe Ranch in Northern Belize and along the Rio Grande in southern Belize (Lohse et al. 2006; Hester et al. 1981; MacNeish and Nelken-Terner 1983; Valdez and Aylseworth 2005; Weintraub 1994). Although evidence from this period is scarce and mostly restricted to surface finds, the cross-dating of similar artefacts, such as fishtail points from South America (Haynes 1993; Politis 1991) and Clovis points from North America, suggests the earliest occupation in the Yucatan was sometime between 13,500 to 10,000 years ago (Lohse et al. 2006: 214).

1.1.2 Archaic Period (7000 BC to 2000 BC)

At the end of the Paleoindian period, ca. 8000 BC, Mesoamerica experienced significant climatic changes, with arid and extremely variable conditions of the Pleistocene giving way to the relatively warm, more stable temperatures of the Holocene (Richerson et al. 2001: 390). By the beginning of the Archaic period, the Pleistocene megafauna were mostly extinct in the Americas, but the cause and speed of their extinction is still a matter of debate (see Haile et al. 2009). The last recorded remains of the genus Equus (E. caballus) was sometime between 8,500 to 5,500 BC (Haile et al. 2009: 22364). One of its ancestors, the Iberian horse, returned to the continent with the Spanish in the 16th century. There are several theories for the cause of the extinction of the megafauna, such as the overkill, or blitzkrieg, hypothesis, which asserts that humans overhunted more than thirty types of now-extinct mammals in North America (Burney and Flannery 2005;
Johnson 2002; Lyons et al. 2004). Anti-overkill theorists argue in favour of climate-related causes for the extinction of the megafauna, such as shifts in vegetation (Guthrie 2003) and ecosystem instability (Sole et al. 2002) (see Grund et al. 2012: 44). Changes in climate and subsistence patterns in the Archaic period in Mesoamerica led to the major florescence of Maya culture in the Preclassic and Classic periods.

The Archaic period begins near the start of the Holocene, but as Lohse et al. (2006: 216) mention, there is little evidence in Belize of human activity until ca. 3400 BC. Evidence from other parts of Mesoamerica shows a general shift from hunting and gathering to the domestication of plants and the rise of agriculture (see Rosenswig 2015). There is also a shift from small groups of hunter-gatherers to bands and sedentary societies (MacNeish and Nelken-Terner 1983: 77). Paleoenvironmental evidence from caves in Panama indicates that human populations began using proto-domesticates as early as 6000 BC (Cooke 2005; Ranere and Cooke 1996). At Cueva de los Ladrones, in Panama, archaeologists argue that evidence of pollen and phytoliths shows the presence of domestic maize by 4000 BC (Piperno et al. 1985). Other pollen evidence from the Gulf Coast of Tabasco, Mexico, suggests human populations were cultivating maize by 5000 BC (Pope et al. 2001). In the Late Archaic period, there is evidence of several lithic production sites in Northern Belize, most notably at Colha, a site ca. 35 km north-northeast of Lamanai (Kelly 1993; Hester et al. 1996). The artefact assemblages from Colha, as well as several other smaller sites in Northern Belize, suggest that tools were used to dig soil and cut wood. This is supported by paleoecological evidence of forest disturbance by ca. 2500 BC (Rosenswig 2004: 268). Based on the presence of maize, manioc, increases in vegetation disturbance, and charcoal remains, Rosenswig (2004: 268) argues that people in the region were already organized into horticultural societies, with “specialized lithic technology to clear forests and plant crops for over a millennium” prior to the introduction of ceramics.

1.1.3 Preclassic Period (2000 BC to AD 250)

The Preclassic is divided into three temporal periods: The Early Preclassic (2000-1000 BC), the Middle Preclassic (1000-400 BC), and the Late Preclassic (400 BC-AD 300). The Preclassic period is also referred to by Mayanists as the Formative period (Willey 1956; Demarest 2004). By the beginning of the Early Preclassic period, maize was being cultivated in most of the Maya world, except in geologically unstable areas, such as the
Antigua Valley, in Guatemala (Foster 2002: 21). The development of agricultural villages allowed for increased populations and more complex, stratified societies (Sharer et al. 2006: 160). Some of the first evidence of early chiefdoms, a hierarchical political organization based on kinship, is found at the site of Chalcatzingo, in Central Mexico (Flannery and Marcus 2000). The latter half of this period witnesses the rise of the socially and politically complex societies of the Olmecs in Mexico’s southern Gulf Coast, which heavily influenced the development of Mesoamerican culture (see Pool 2007). By the end of the Early Preclassic, there is evidence in the Maya area of long-distance trade, part-time craft specialization, the advent of pottery, and a system of subsistence based on maize, beans, and squash (Sharer et al. 2006: 163-164).

In Mesoamerican studies, scholars focus their research on the cultural influence of the Olmec and the florescence of their societies at San Lorenzo and La Venta in the Early to Middle Preclassic, with the Maya lowlands viewed as a “cultural backwater,” (Lowe 1977: 198), or “passive recipient” of Olmec “influence” (Demarest 1989: 339; Rice 2015: 4). By the Middle Preclassic, there is increasing evidence of social complexity at many Maya sites, such as at Nakbe (Hanson 1998), Cival, Seibal (Estrada-Belli 2011; Inomata et al. 2013), Blackman Eddy (Brown 2003; Garber et al. 2004), and El Mirador (Hansen 1990). Evidence of public architecture, ritual caches, and trade goods, at many Maya sites suggests the emergence of an elite class that controlled resources and engaged in an exchange of goods and ideas across Mesoamerica (Sharer et al. 2006: 170-179). Some of these early signs of social complexity are viewed as a precursor of “hierarchically organized states” (Horn 2015: 3).

The Late Preclassic is a period that witnesses an apogee in the development of Maya culture, with the full emergence of complex society and the origin of states (Sharer et al. 2006: 223). As Foster (2002: 34) comments, some of the major characteristics of Maya civilization are present by the end of the Late Preclassic, such as monumental stone cities, vaulted buildings, stelae, hieroglyphic texts, altar complexes, and the earliest Long Count dates. The first occupation of El Mirador is in the Middle Preclassic period, however, the site reaches its fullest extent in the Late Preclassic, with a civic-ceremonial centre covering ca. 25 sq. km (Hansen 1990). Most of the largest and most influential sites in Maya history have evidence of occupation in the Late Preclassic, such as Tikal, Copan, Caracol, Palenque, among others. In the greater Mesoamerican world, the Late Preclassic
witnesses the rise of one of the first urban, cosmopolitan cities - Teotihuacan (see Berrin and Pasztory 1993). Teotihuacan’s influence spread throughout the Maya area, with evidence of cultural contact as far as Copan, in western Honduras (Sharer 2004). In Northern Belize, a small site, Cerros, which traces its beginnings to the Late Archaic period, reaches its cultural and demographic climax during the Late Preclassic (Robertson and Freidel 1986). It is likely that some of the first Kings also appeared during this period, as evidence of a throne-like feature was found at Xaman Susula, close to the present-day city of Merida (Stanton 2012: 275; see Peniche May et al. 2009).

1.1.4 Classic Period (AD 250 to 900)

The Classic is divided into two temporal sub-periods: The Early Classic (AD 250-600) and Late Classic (AD 600-900). There is evidence to suggest a short period of cultural recession, or hiatus, between the two epochs (Willey 1974), but as Demarest (2004: 16) notes, certain areas of the southern lowlands may have declined while other regions continued to flourish. The site of El Mirador, one of the largest and most influential centres in the Late Preclassic, is mostly abandoned by the beginning of the Early Classic (Hansen et al. 2008). The start of the Early Classic, AD 250, marks the ascension of Tikal, a site that holds “the oldest known Cycle 8 stela,” which records a Long Count date of AD 292 (Bachand 2010: 21). A major diagnostic marker of the Early Classic is the use of monochrome and polychrome pottery, known as Tzakol ceramics, which were originally identified at Waxaktun (Patino-Contreras 2016: 39-40; see Smith and Gifford 1966: 167; Willey et al. 1967: 298-299, 310). The ubiquity of Tzakol ceramics suggests an increase in the socio-political integration of sites in the Maya world. There is evidence of extensive long-distance trade, with a reorientation of important trade routes, such as the source of obsidian at Tikal, which moves from the Preclassic quarry at San Martin to the Classic source of El Chayal (Ford et al. 1997). The Early Classic centre of Chunchucmil seems to be entirely supported by commercial activity, as it is in a region with low rainfall and poor soils (Dahlin 2009: 344-346). Towards the end of Early Classic, the site of Teotihuacan, which is thought to have had a population of 120,000-150,00 people, starts to decline. Various reasons have been proposed for the cause of the decline, such as military conquest (Cowgill 1997), drought (Lachniet et al. 2011), economic challenges (Hassig 1992), and/or internal strife (Valliant 1950). The decline and eventual abandonment of Teotihuacan creates a power vacuum in greater
Mesoamerica and correlates with the florescence of lowland Maya society (Helms 1982:81).

The Late Classic period for most researchers constitutes the high point in Maya civilization, with a large networked system of sites, organized in a “tiered urban hierarchy of major and minor centres, household farms, and remote buildings” (Ford et al. 2009:496). Most of the sites in the Maya world have evidence of occupation in the Late Classic and reach their highest populations, with their densest cities (see Culbert and Rice 1990; Hutson 2016). The fullest expression of many trademark Preclassic Maya cultural traits and constructions, such as carved stelae, above-ground corbeled vaulted architecture, writing, calendrics, polychrome ceramics, and divine kingship, occurred in the Late Classic (Sabloff 1975; Schele and Freidel 1990; Willey 1987). The site of Calakmul, 38 km north of El Mirador, traces its origins to the Middle Preclassic, but by the Late Classic, it was head of a large regional state that covered ca. 8000 sq. km (Folan et al. 1995:310). Calakmul was a rival of another large regional state – Tikal – and vied for control of smaller sites in the region, such as Dos Pilas (Folan et al. 1995:327; Marcus 1973, 1988). The rivalry between these two centres culminated in several important wars, which may have triggered the political fragmentation of the entire region (Appenzeller 1994:734).

Bridging the Classic and the Postclassic periods is a span of time known to Mayanists as the Terminal Classic (AD 800-1000). This period exhibits what many have called a Maya “collapse,” a socially and politically tumultuous phase in Maya history that saw the decline and abandonment of many sites in the southern lowlands (see Aimers 2007b). Some scholars prefer to call the Terminal Classic a period of “transition” (Bey et al. 1997; Schmidt 1998), or “transformation” (Tourtellot and Gonzalez 2004), however, there is evidence for significant depopulation – sometimes rapid – of numerous, historically-established sites (Culbert and Rice 1990; Turner 1990). There are many possible explanations for the cause of the collapse, which, as Aimers (2007b:333) notes, are either socio-political or environmental. Most recently, Mayanists are attributing the abandonment of Terminal Classic sites to changes in the climate (Douglas et al. 2015; Franco-Gaviria et al. 2018; Medina-Elizalde et al. 2010). Evidence from lake sediments shows a series of severe regional droughts from 800-950 AD, a period that coincides with the decline of many Maya centres. Also, as Valdez and Scarborough (2014:268)
mention, several sites that survive into the Postclassic are located near replenishing sources of freshwater. However, like many other monicausal explanations for the demise of the large Late Classic settlements, the culture-wide effect of drought has been questioned (see Iannone 2014). Most Mayanists agree it was a mix of cultural, political, and environmental influences, that affected the historical trajectory of sites in the southern lowlands.

1.1.5 Postclassic Period (AD 900 to 1521)
The Postclassic is divided into two periods: the Early Postclassic and the Late Postclassic. As Aimers (2007b: 331) notes, the Early Postclassic is traditionally viewed as a period of “great cultural decline,” as the remnant populations of the collapse tried to re-establish themselves in the “aftermath of tyranny” (Masson 2000: 274). This view of the Postclassic is dated, as many archaeologists argue that it was an “era of innovation and vigor” (Aimers 2007b: 331; see Smith and Berdan 2003). Even after the collapse of the major Late Classic sites, there is evidence of continued settlement and agricultural activity in-and-around many of the civic-ceremonial centres (Chase and Rice 1985; Rue 1987; Willey 1987). The Terminal Classic to Early Postclassic witnesses the rise of many important sites in the Northern Yucatan, such as Chichen Itza, which may have been the capital of an “expansionistic and hegemonic tribute state” that controlled a coastal trade network into the 11th century (Kristan-Graham and Kowalski 2007: 37-38). The institution of divine kingship was replaced in the Early Postclassic with systems of shared power (multepal), which inspired a change in political systems from small dynastic states to large polities with complex state levels of organization (Andrews et al. 2003: 153; Schele and Freidel 1990). Economic exchange, which was formerly oriented in the interior, moved to more coastal regions, with more emphasis on seaborne commerce and trade goods, rather than Classic period prestige goods (McKillop and Healy 1989; Sharer et al. 2006: 627). The beginning of the Early Postclassic, which overlaps the end of the Terminal Classic, also witnesses the demise of many important Northern cities, culminating in the fall of Chichen Itza, which has its last long count dedicatory date in AD 997 (Andrews et al. 2003: 153; Ebert et al. 2011: 96).

Sometime between the Early and Late Postclassic periods, large-scale construction is witnessed in coastal cities along the Caribbean, southern Gulf Coast, and Northern Yucatan, especially at the site of Mayapán (Andrews et al. 2003: 153). Mayapán was
founded by at least the 12th century, rose to power in the 13th and 14th centuries, and collapsed in violence and conflict sometime between AD 1441 and 1461, prior to the arrival of the Spanish (Milbrath and Peraza Lope 2003; Peraza Lope et al. 2006). As Chase and Chase (1985: 7) note, militarism is a common theme in reconstructions of Late Postclassic society and may explain the appearance of walled cities on the east coast of the Yucatan, as well as the densely populated island settlements. Tulum, a Maya site on the coast of Quintana Roo, is a well-known example of a fortified city, with a wall between 3-4 m in height and 8 m wide (Webster 1976: 365). The site of Tulum, as well as the eastern region of the Yucatan peninsula, experienced “substantial population growth,” especially along the coast and the islands of Quintana Roo, with major monumental architecture (Andrews 1993: 55). In the greater Mesoamerican world, the Late Postclassic witnesses the rise of the Aztec empire, an alliance of three city states that was conquered by Hernan Cortes and fewer than a thousand Spanish troops in 1521 (Pohl and Robinson 2005).

1.1.6 Spanish Colonial Period (AD 1521 to 1708)

The Spanish Colonial period sees the arrival of the conquistadors, as well as the friars and clergy that attempted, sometimes successfully, to convert the Maya to Christianity (see Graham 2011). One of the first recorded encounters between the Maya and the Spanish was in 1502, when Christopher Columbus’s brother, Bartholomew, boarded a Maya trading vessel, looted it, and captured a guide (Clendinnen 2003: 3). In 1511, a Spanish caravel, Santa María de la Barca, capsized in the Caribbean, forcing eleven survivors to make landfall on the east coast of the Yucatan (Demarest 2004: 286). A local Maya lord captured the Spanish, sacrificed some of them, killed the others, and retained two of them - a scribe and a warrior (Demarest 2004: 286). In 1517, Francisco Hernandez de Cordoba sailed along the northeastern coast of the Yucatan Peninsula, engaging in several significant battles and suffering a major defeat to the Maya at Campeche. These early encounters, or the “chain of Indian carriers from Panama,” introduced smallpox, which ravaged the Maya world, causing massive depopulation and political instability over the next two decades (Clendinnen 2003: 19). As Demarest (2004: 286) notes, the devastation wrought by new diseases made the Maya easier to subjugate and convert, especially “by the waves of conquistadors and priests that would soon engulf them.”
1.2 THE PRECOLUMBIAN MAYA AT LAMANAI

1.2.1 Archaeological History

One of the earliest historical sources to mention Lamanai was a church list written in 1582 (Graham 2011: 135, note 189; Pendergast 1981: 31; Roys 1957: 63). This document recorded the site-name as both Lamanay and Lamayna, however, Thompson (1991) argued that “laman ai,” or “drowned insect,” was the most likely translation. Pendergast (1981: 32) later suggested the 16th-century Spaniards possibly misheard the name and failed to recognize an ‘n’ at the end of the word. This changed Laman/ai to Lama’an/ayin, with the translation switching from “drowned insect” to “submerged crocodile.” As Shelby (2000a: 10) commented, this newer translation is supported by various saurian images found at the site (see Pendergast 1981: 32, 38).

Lamanai was later mentioned, albeit fleetingly, in historical documents by Father Bartolome de Fuensalida and Juan de Orbita, who visited and described it in 1618 (Lopez de Cogolludo [1688] 1971, vol. 2, bk. 9, chap. 6, p. 213 in Graham 2011: 192, note 14). As Pendergast (1981: 31) notes, when Fuensalida returned to Lamanai in 1641, the Maya had renounced their faith, burned the Spanish church, and aligned themselves with Tipu, a centre that sometimes actively resisted the Spanish (see Graham 2011; Jones et al. 1986; Jones 1989; Jacobi 2000). Other than as a place name in 17th century and early 18th-century maps (see Graham 2011: 192), the site did not appear in publication again until the early 20th century, although by this time—and at least since the 1860s—the site was known as “Indian Church” (Castells 1904). At Indian Church, Friar Castells (1904: 34) described numerous large mounds with “a multitude of stones suggestive of ruined constructions.” The ruins were so abundant that Castells suggested they formed “one continuous chain” from Chetumal Bay, at intervals of six to twelve miles, for 150 miles of the coastline. Castells (1904: 34) also recorded the dimensions and characteristics of an “aboriginal temple” at Indian Church. This “aboriginal temple” was eventually identified as a 16-century Spanish church (Pendergast 1981: 1).

Some of the first archaeological expeditions at Lamanai were conducted in the 20th century by Gann (1926), Thompson (1939), Bullard (1965), and Thomas Lee of the New World Archaeological Foundation. In his description of an “extensive group of mounds” at Lamanai, Gann (1926: 63) commented that these material remains must represent the “last degenerate phase of the Maya civilisation.” He also noted that the “vast number of
mounds” must have housed a “very considerable population,” one that cultivated small plantations of corn, beans, tobacco, and cotton. Over a decade later, Thompson (1939: 2) referred to the site at Indian Church as a neighbour of San Jose, after he passed by it in his travels of western British Honduras (Pendergast 1981: 32). Later, Bullard (1965: 11) suggested that the ruins at Lamanai probably dated to the Classic Period, but he also found fragments of Postclassic incensarios, ceramic vessels that were used to burn incense, on the surface. He initially intended to start a project at Lamanai in 1962 but abandoned his plans because of the inaccessibility of the site and a hurricane that struck the region in 1961 (Bullard 1965: 12). In 1967, Lee made a small surface collection at Lamanai that contained Late Postclassic ceramic sherds (Pendergast 1981: 32). These early projects were exploratory and mostly confined to surface collections, yet the presence of Postclassic ceramics, and a 16th century Spanish church, inspired future research.

From 1974-1980, a team under the direction of David Pendergast for the Royal Ontario Museum in Toronto, Canada, spent approximately six months each year surveying and excavating the civic-ceremonial centre of Lamanai. The first two seasons of excavations focused on a group of structures bordering the New River Lagoon, an area with a significant Postclassic occupation (from about the 10th to 15th centuries) (Pendergast 1981: 32). To support these excavations, Stanley Loten (1985, 2006), from Carleton University, Ottawa, mapped the ceremonial centre of Lamanai. Also, Lambert and Arnason (1978) carried out a botanical study of the distribution of vegetation and its relationship to land use. Added to this, Lovisek (1978) collected ichthyological, amphibian, and reptilian fauna, for a reference collection of local material.

In 1976, the Belizean government established the Lamanai Archaeological Reserve, a 950-acre park devoted to the preservation, conservation, research, and protection of the natural and cultural environment (Powis 2002: 53). The park has been extensively studied by various academics, representing multiple disciplines (Cockrell and Simmons 2017; Davy and Fenton 2013; Gavazzi et al. 2008; Lazure and Fenton 2011). It is home to a large variety of tropical birds, howler monkeys, and a diverse range of aquatic life (Shelby 2000a: 10). The Reserve is currently administered by Parks and the Institute of Archaeology, a branch of the National Institute of Culture and History.
Although the Lamanai project was slated to end in 1984, the project continued in a limited capacity until 1986 (Pendergast 1985, 1986a, 1986c). In 1985, Pendergast (1985: 9) set out to define the physical extent and population of the community, as well as the variety of construction forms and techniques, at Lamanai during the Historic (AD 1544-1641) period of occupation, otherwise referred to as the “period of Spanish Hegemony.” Pendergast (1985: 12) discovered a large midden of 16th and 17th-century Maya ceramics associated with Spanish olive-jar sherds, which indicated the extent of European materials in the civic-ceremonial centre, roughly 100 m south of the churches. These excavations identified a Contact-period cemetery associated with the second church. The cemetery was the second to be uncovered on the site, with regularly spaced, undisturbed, burials. The final season of study in 1986 was devoted to delimiting the graveyard, as well as organizing and cataloguing the laboratory and its materials.

By the end of 1986, many sections of the site were intensively excavated, stabilized, and consolidated (Pendergast 1992a; Powis 2002: 53; Shelby 2000a: 15). Meanwhile, the Belizean Government applied for and received funds from the U.S. Agency for International Development (USAID) to make Lamanai an archaeological attraction and stimulate tourism (Glaesel-Kohler and Anzola-Betancourt 1989: 6-1). Following these efforts, archaeologists returned to Lamanai in 1996, with minor excavations in an area known as “Lamanai South,” ca. 3 km from the central precinct of the site. Herman Smith – previously one of the co-directors at the Precolumbian Maya sites of San Juan (Guderjan et al. 1988, 1989), Ek Luum, and Chac Balam (Guderjan 1995b: 149) – and Laura Howard directed several excavations of an elite residential compound at Lamanai South. However, after this brief stint as project manager, Elizabeth Graham, sponsored by the Lamanai Field Research Centre (LFRC) – which was founded by Lamanai Outpost Lodge to assist field researchers of all disciplines working on the Reserve – the Royal Ontario Museum, and York University, assumed the role of Principle Investigator.

From 1997-1999, Graham, Howard, and others (Graham and Ritscher 1997, 1998; Graham and Pendergast 1999), reorganized and renovated the laboratory space at Lamanai, while also hosting the LFRC architectural field school. Most of the artefacts recovered from 1974-1986 had been stored in a temporary field lab. In 1997, these were rehoused in one of the on-site, masonry buildings constructed by USAID. In the next season, 1998, the architectural field school cleared, excavated, stabilized, and
consolidated, portions of Str. N10-27 (see Figure 3 for the location of structures at Lamanai). In 1998 and 1999, Thomas M. Shelby and Dorie Reents-Budet conducted the Stucco Frieze Project (see Graham 2004). The goal of this project was to reconstruct the ornamentation on Str. N10-28, a structure in the Ottawa palace-courtyard group (Shelby 2000a, 2000b; Shelby and Reents-Budet 2001). Several excavations were conducted in Str. N10-28 to identify any stratigraphy associated with the stucco, to recover any diagnostic artefacts from this context, to discover more pieces of sculpture, and to expose further architectural data (Shelby 2000a: 125). Shelby’s study revealed a stucco façade of a ruler – possibly an ajaw - surrounded by lesser elites and captives, located over a central doorway. In 1999, students from the field school also examined construction characteristics and sequences of Str. N10-28 and Str. N10-15.

In 2000 and 2001, Graham and colleagues worked on Str. N10-27 (the Stela Temple) to clear a Terminal Classic to Postclassic midden that had been deposited around its base and stairs. This work was continued in 2002 and 2003 under the Tourism Development Project. From 2002 to 2004, Graham directed work in the Ottawa complex with funding from National Geographic and the Social Science and Humanities Research Council of Canada (SSHRC). The goal of the project was to understand periods of transition in the civic-ceremonial centre of the site. Archaeologists cleared the plaza of boulder fill, excavated further in Str. N10-28, Str. N10-15, in the plaza north of Str. N10-28, and cleared Str. N10-12, which overlay Str. N10-77. The team also did minor work on the south face of the Ottawa Group supporting platform (Simmons 2004). These efforts showed that the complex underwent major revision during the Classic to Postclassic transition. The boulder fill of the plaza, originally thought by Pendergast to have dated to the Postclassic, turns out to characterize the Terminal Classic period (Hanna et al. 2016).

From 1999-2008, Simmons and others simultaneously conducted the Lamanai Archaeological Project Field School and the Maya Archaeometallurgy Project (Simmons 1999, 2004, 2005, 2006; Simmons et al. 2007; Simmons and Howard 2003). The archaeometallurgical project focused on the relationship between craft specialization and socioeconomic complexity. Archaeologists were interested in the intensity of production, the constitution of the production unit, the concentration of production, and the context of production, of copper and bronze objects at Lamanai in the Postclassic and Spanish Colonial periods (Simmons and Howard 2003: 4). In the earliest stages of this project,
archaeologists opened multiple excavations in “off-platform” areas, which are known from ethnographic research to have been used by contemporary Maya populations for various domestic activities (Wilk 1997; Nash 1970). These excavations and others in the vicinity of Str. N11-18, Str. N10-2, and Str. N10-4, uncovered 168 copper artefacts (Simmons and Howard 2003: 63). Based on the concentration of copper artefacts at Structure N11-18, Pendergast (1991b, 1993) and Simmons and Howard (2003) suggested it likely served as the principle residence of Lamanai’s native ruler or cacique – a hereditary position of town governor (Clendinnen 2003) – in the Colonial period. Also, the recovery of copper prills, which are formed when molten metal drops solidify into small pellets, is strong evidence for on-site metal production, which was previously undocumented in the Maya area (Simmons and Howard 2003: 53). Lamanai has more copper and alloyed copper artefacts than any other site in the Southern Maya Lowlands and may have conducted on-site metallurgy as early as AD 1450 (Cockrell and Simmons 2017; Simmons and Shugar 2013).

By 2007, the research objectives expanded to include four specific topics: Lime plaster sampling (Villasenor et al. 2011), archaeometallurgy (Simmons and Shugar 2013), Pre-Columbian Maya ceramics (Aimers 2008, 2009), and ceramic technological studies (Howie 2012), at Lamanai (John 2008; Simmons et al. 2007). For the lime sampling, Villasenor aimed to identify changes in the technological characteristics of the plaster from the Late Preclassic to Late Postclassic periods at Lamanai. Most of the materials used in earlier periods were sourced from local quarries, while in later periods, volcanic material was used for its improved hydraulic properties (Villasenor et al. 2011; Villasenor and Graham 2010). After seven years of study, the archaeometallurgical project at Lamanai was finishing its field operations, with its final season consisting of only four days in the field. Further chemical compositional and microstructural analysis reaffirmed the case for on-site metal work and later studies showed metal recycling and reuse in the Late Postclassic to Spanish Colonial periods (Cockrell and Simmons 2017; Simmons and Shugar 2013). Aimers conducted a stylistic analysis of roughly 52,000 ceramic sherds from the Postclassic period over the course of 10 weeks of research. This work culminated in numerous publications on the classification, analysis, and interpretation, of Maya ceramics (Aimers 2008, 2009, 2010). Lastly, Howie’s (Simmons et al. 2007: 28) project focused on the continuity and change in the manufacture, origins, use, and deposition, of pottery from the Postclassic to Spanish Colonial periods. More specifically,
the main objective was to group vessels on stylistic and functional criteria and study paste variability on a macroscopic level using petrographic and chemical analysis. This study led to a major publication on pottery technology, manufacture, and consumption at Lamanai (Howie 2012).

From 2009-2013, archaeologists worked on the maintenance and restoration of the facilities and the artefact assemblage. In 2014, major work resumed in the Ottawa group, at Str. N10-15, and on the 19th-century British plantation settlement (Pierce 2014; Mayfield 2015). Added to these efforts, the team – still under the direction of Graham - continued to improve the housing and the upkeep of the on-site museum. The goal of the research in the Ottawa group was to define the construction sequence of Str. N10-15 and its relationship to other structures in the surrounding complex. Based on these excavations and previous work in the area, Pierce (2014: 15-16) identified six phases of construction, most of which date to the Late to Terminal Classic period. Research at the British Plantation at Lamanai was focused on understanding the residential, industrial, and administrative organization, or structure, of the 19th-century settlement (Mayfield 2015: 15). Mayfield concluded that similarities in the Maya and British economic structures, which relied on trade and extraction at a local level and were historically organized into extended family groups, improved British-Maya relations in the region. It is the “structural compatibility” of early British colonists and the Maya that encouraged “sociocultural congruencies” and “economic reciprocity” (Mayfield 2015: 295). This relationship was effectively ended with the introduction of the British military in 1867.

1.2.2 Location and Composition
Lamanai is in the Orange Walk district of north-central Belize, next to the New River Lagoon, the largest body of fresh water in the country. Figure 2 shows a map of the civic-ceremonial centre of Lamanai (Pendergast 1986a: 228). Figure 3 shows another version of the same map, with a newer portion added to the northern section of the site. Also, in Figure 3, the structures that have been excavated at Lamanai are labelled and highlighted in red. As Powis notes (2002: 49), Lamanai represents a human adaptation to a lacustrine environment, with settlement that spreads out in a “strip-like” pattern along the shores of the lagoon. This type of environment likely influenced the “non-standard settlement pattern” identified at Lamanai, which is different than the ceremonial grouping of structures found at many other sites in the Maya area (Pendergast 1981: 32). There are
Figure 2: Map of the civic-ceremonial centre of Lamanai (Pendergast 1986a: 228)
Figure 3: Map of structures that have been excavated at Lamanai (in red)
several sites with strip-like patterns of distribution, such as Barton Ramie, which is located along the Belize River Valley (Powis 2002: 51; Willey et al. 1965: 561). Some other sites in lacustrine and riverine environments, such as Baking Pot (Bevan et al. 2013b), on the southern bank of the Belize River Valley, Yaxchilan (Tate 2011), and Piedras Negras (Houston et al. 2000, 2003), on the banks of the Usumacinta River, have more traditional settlement patterns, with “ceremonial precinct plaza groups,” surrounded by “residential and other small structures.” (Pendergast 1981: 32). Powis (2002: 51) suggests the site may be oriented this way to maximize the centres’ access to local and nonlocal trade goods, as well as the exchange of information about markets and resources. In the post-Conquest world, Graham (1989) suggests that the Spanish did not impose a European town layout on the strip-like settlement plan because they recognized the sites’ importance as a node for trade and communication.

Like many other Precolumbian Maya sites, archaeologists did not identify any polity boundaries at Lamanai (Pendergast 1981: 32). Instead, the site was mapped along the shoreline and extended westward until archaeologists identified a noticeable drop-off in the density of structures. It is possible and likely that many smaller structures were missed, as the jungle often obscures structures less than 3 m in height (Johnston 2004) (see pg. 263 for a discussion about invisible settlement). Structures in the periphery of Maya sites are usually smaller than those encountered in or near civic-ceremonial centres. Peripheral locations are assumed by most archaeologists to have been inhabited by commoner, residential, populations (Lohse and Valdez 2004b).

The observed density drop-off that structured the mapping was probably the result of traditional ground-based survey techniques, which failed to identify smaller structures, and an environmental (heavily forested) setting that hindered identification. It is likely that many areas north, south, and west, of Lamanai were also occupied in the Precolumbian past.

In total, Lamanai has 718 structures, of which 80 have been excavated, along roughly 2 km of the New River Lagoon shoreline. The Central Precinct comprises eight major plazas, or groups of ceremonial structures, in an area that covers 4.5 sq. km (Pendergast 1981: 32; Powis 2002: 51). Several of these structures are notable for their size, design, and the ornamentation of stairside outsets. For example, at Str. N9-56, otherwise known
at the Mask Temple, stuccoed stone masks adorn each side of a central staircase. The excavated masks have facial features that are characteristic of Olmec iconography in the Gulf Coast of Mexico (Pendergast 1981: 38). Str. N10-43, the High Temple, was once considered the “largest securely dated” Preclassic building in the Maya area (Pendergast 1981: 41) – it was later eclipsed by the Tigre, Dante, and Monos, complexes at El Mirador (Hanson 1990; Howell and Copeland 1989). At Str. N10-9, known as the Jaguar Temple after the carved stone masks adorning the stairside outsets of a late-period central stair, archaeologists discovered an architectural style that was typical of the site, with a chambered building on the central stair and no building on the platform’s summit (Figure 4) (Pendergast 1981: 35).

**Figure 4:** A) Str. N10-9 at the end of the Early Classic Period, B) Str. N10-9 as modified in the Late Classic (Pendergast 1981: 35)

Pendergast (1981: 40) originally thought an area east of Str. P8-12 was a harbour, however, archaeological and geological data indicate that the topographic depression in front of the structure was a natural feature (Powis et al. 2009: 259). Pendergast argues that access to harbours at Lamanai facilitated trade (see pg. 274 for further discussion), but so far, there is no archaeological evidence to support this claim. Along the Usumacinta river, from the Precolombian site of Yaxhilan, Mexico to El Porvenir, Guatemala, archaeologists have identified stone bollards – natural limestone formations that were used by the Maya to fasten mooring lines (Canter and Pentecost 2007). Perhaps, these stone bollards can also be found along the New River, especially in the vicinity of Lamanai. It is difficult to identify harbours (because perishable structures leave little trace in the archaeological record), but the grooves left from rope wear may indicate the extent of waterborne trade at Lamanai.
The site’s ballcourt, which is notable for its small playing area, featured an offering under the ballcourt marker of two miniature ceramic vessels, jade, and shell. These objects rested atop a small pool of mercury (Pendegast 1982b). Mercury has also been found at Quirigua (Ashmore et al. 1979), Kaminaljuyu (Kidder et al. 1946), and most recently, at the Central Mexican site of Teotihuacan (Cooper-White 2015). Pendegast (1981: 40) originally thought an area east of Str. P8-12 was a harbor, but archaeological and geological data indicate that the topographic depression in front of the structure was a natural feature (Powis et al. 2009: 259).

The Precolumbian Maya at Lamanai carved stone stelae and altars (Closs 1988; Pendegast 1988; Reents-Budet 1988). Although most of these monumental stone carvings were moved from their original locations by the Precolumbian Maya in the Postclassic, eight stelae and two altars were eventually identified, one of which was found in building core (Pendegast 1988: 1). Most of the stelae and altars were heavily worn, incomplete, blank, or featured portions without any hieroglyphic text. One stone carving, Stela 9, which was found beneath about 30 cm of earth, lying face-down on the central stairs of Str. N10-27, featured an inscription (Pendegast 1983: 1-2; 1988). Based on the text, originally deciphered by Closs (1988), Stela 9 was erected sometime around AD 625. Closs argues that the inscription refers to the accession of a Lamanai lord. A new translation has been undertaken by Simon Martin, in which the depicted ruler is identified as a one-katun lord, Tzik’in Xook or “Sun Shark,” and the glyphs refer to an event associated with Tzik’in Xook that took place in AD 608. Critical parts of the inscription below the image of Tzik’in Xook are missing as the result of a burning event. These missing glyphs are thought to have described an important event that took place in AD 625. We cannot now know what the event was, but the glyphs tell us that it was supervised by K’ahk’ Yipiit Chan Yopaat, the individual named in the last eight glyphs (above Tzik’in Xook’s head). It is notable that K’ahk’ Yipiit Chan Yopaat claims the title of elk’in kaloomte’, which roughly translates as “the high ruler of the eastern quarter.” The emblem glyph following the kaloomte’ title may represent Lamanai, or possibly a larger regional power.

Based on the AD 625 event, Pendegast (1988: 6) suggests that the monument was erected in the building athwart the Str. N10-27 stair at this date and remained an “object
of importance” until the 10th or 11th century, which is the dating he gave to the start of the midden abutting the structure. Graham (2018, personal communication), however, suggests that the stela originally stood elsewhere in AD 625 and was re-erected in the Str. N10-27 building sometime in the early 8th century. In the latter part of the 8th century, a new construction phase of Str. N10-27 was begun, abandoned, and the stela deliberately toppled. Immediately afterwards began the build-up of a Terminal Classic (9th century) midden around the base of the structure, which continued into the Early Postclassic (10th and 11th centuries) (Graham 2004; Howie 2012). In Graham’s interpretation, the stela would have stood in the building for less than 50 years.

There are several Post-Conquest structures at Lamanai that attest to the site’s extended history of occupation, by both the Maya, the Spanish, and later, by the British: these include the two 16-century churches, N12-11, and N12-13 (see Figure 3), their associated settlement (Graham 2011; Pendergast 1975, 1993), and a 19th-century sugar mill (Pendergast 1982a). The first church at Lamanai, N12-11, was built over a Late Postclassic ceremonial structure sometime shortly after AD 1544 (Graham 2011; Pendergast 1993: 120-121). Pendergast (1993: 121) argues that the “defilement of the Pre-Columbian temple was a necessary precursor to Christian Church construction,” but that a jaguar effigy figure was buried by the entrance of the structure, on “Catholic consecrated ground.” For Pendergast (1993: 121), this artefact represents some of the early conflict between the Maya and their Spanish conquerors. Graham views the cache, and other rituals associated with the second church, as an investment in the new god and an appropriation of Christian sacred space (Graham 2011). The material concomitants of indigenous rituals were not meant as ‘defilement,’ which was the interpretation fostered by the Christian friars. The second church, N12-13, was likely built in the 1560s, at a time of renewed interest in the communities in the area by the Franciscans (Graham 2011). It was burned by the Maya in AD 1641 (Graham 2011: 236-237).

In the 19th century, the British settled at Lamanai, which by this time was known as Indian Church, to establish a sugar operation (Pendergast 1982a). The owners of the sugar plantation imported Jamaicans, Barbadians, and Chinese immigrants, but these labourers, particularly the Chinese, died “in astounding numbers” (Pendergast 1982a: 64). By the end of the 19th century, raids, competition with the beet sugar industry, and antiquated machinery, led to the abandonment of the mill.

48
1.3 THE PRECOLUMBIAN MAYA AT KA’KABISH

1.3.1 Archaeological History

The first known archaeologist to visit Ka’kabish (Pendergast) identified several ruined structures in some cleared milpa fields immediately adjacent to the civic-ceremonial centre. On the surface of these low-lying “mounds,” Pendergast found Early Postclassic ceramics (Haines 2008: 4). Several years later, in the mid-1990s, Ka’kabish was visited by archaeologists from the Maya Research Program, a non-profit organization that sponsors various archaeological and ethnographic projects (Beach et al. 2015a, 2015b; Guderjan 2013). The Maya Research Program produced a “rudimentary” map of the site that contained 27 individual structures (Haines 2008: 4). As part of this initial reconnaissance, five looted tombs were identified, two which were vaulted and one with a plaster dome roof. These tombs were all dated to the Late Classic Period. One of the tombs was painted red, with dark, recognizable, red glyphs. The team of archaeologists identified a ball court with a circular marker, an item that was used as evidence for elite occupation. Artefacts and architecture from these tombs, and other areas of the site, suggest that Ka’kabish was occupied from the Late Preclassic period (BC 400-AD 250) to the Late Classic period (AD 600-900) (Guderjan 1996).

Following these initial investigations, in 2006, Haines, and a couple of men from the nearby village of Indian Church, returned to the site to assess its viability for future work. They used the map by the Maya Research Program to relocate many of the original structures, while also identifying several outlying courtyard groups and low residential mounds (Haines 2008: 5). Over the next couple of years, looters excavated trenches in the civic-ceremonial centre. These illegal operations were discouraging, but Haines (2006: 17) maintained that the site still offered a “unique opportunity to simultaneously add to the limited corpus of excavated sites in north-central Belize and to investigate the dynamics of intra-polity socio-political organization.” Most pertinent to this current project, Haines (2008: 5) noted that the continued exposure of the residential settlement zone by current farmers offered an opportunity to study a range of social strata, at a “multi-scalar level.”

In 2007, Haines (2008) returned to Ka’kabish with a group of six people to remap the site. In the southern portion of the civic-ceremonial centre, they identified five architectural groups, 40 structures, three chultuns, and an aguada (see Figure 6). Also, adjacent to the
forested section of the site, in a milpa field, the team recorded another fourteen domestic residences. Based on the number, size, and complexity, of these newly identified structures, Haines (2008: 25, 2010a: 10) argued that Ka’kabish exercised more autonomy “than was originally surmised” and needed further research to re-evaluate the nature of its socio-political situation. To add to this endeavor, Haines (2010b) conducted another season of the spring mapping project. In 2009, Haines, and several men from Indian Church, surveyed and recorded the northern section of the site. In this area, they encountered more structures than initially reported – 15 of them were grouped to form an acropolis. These discoveries inspired Haines (2010b) to set out a new series of projects for the following three years with financial support from SSHRC. This project was established to understand the socio-political organization of the site and its role within the larger Precolumbian Maya world.

Prior to the initiation of the SSHRC-funded Ka’kabish Archaeological Research Project (KARP), Haines (2010a: 19) suggested that the acropolis-like architectural arrangement of the civic-ceremonial centre indicated that Ka’kabish was a small polity centre, instead of a secondary administrative centre of Lamanai. With this in mind, Haines (2010a: 19) offers four possible explanations, or models, to describe the socio-political organization of the site: 1) a centre for a “mobile” royal court from Lamanai, 2) an ideological or political seat for a “heterarchically arranged polity with the economic seat being Lamanai,” 3) a suburban settlement for elites that worked at Lamanai, 4) an autonomous polity centre. Haines applied several methods, from traditional field-based surveys to excavations in major plazas and structures, to understand the historical role of Ka’kabish.

Evidence exists from other sites in Belize to suggest the presence of mobile royal courts (Ball and Taschek 2001). At Cahal Pech, Ball and Taschek (2001: 166) identified the “wholesale transmigration” of royal courts and their activities, from one location to another in the same polity. Haines (2010a: 20) suggests that the large temples and monumental structures at Ka’kabish were unsuited to its small population size and replicated forms seen at Lamanai, possibly indicating the presence of royal migration. Based on evidence from tombs at Ka’kabish, Haines (2010a: 20) argues that the rulers at Ka’kabish were “divine elite” rather than “rich merchants,” as at Lamanai. The tombs, their associated grave goods, and Lamanai’s strategic location for trade, may have shown that Ka’kabish was an economic centre in a heterarchical system. Similar sets of material
culture discovered at both sites, which show a “close level of interaction,” indicates that Ka’kabish was an early suburban settlement (Haines 2010: 20). The sites proximity to Lamanai would have allowed its population to easily move to, and from, the site on a regular basis.

Although there is evidence to suggest close interaction between Lamanai and Ka’kabish, Haines (2010a: 21) argues that ritual monumental architecture, elite structures, and tombs, indicate that Ka’kabish was an autonomous centre. In particular, the “high labour investment,” elite ritual, and residential architecture” suggest “royal prerogatives,” as evidenced by continuous and regular additions and modifications to architecture (Haines 2010: 21). As Haines (2010a: 21) notes, other sites with “episodic construction programs” are characterized by “fluctuating periods of autonomy and subordination” (Culbert 1991; Grube 2000; Iannone 2005; Martin and Grube 2000). While each of these theories explains certain characteristics of the site, Haines (2010a: 22) favours a hegemonic city-state model, with Ka’kabish as an autonomous centre that was “dominated but not subjugated by Lamanai.”

To address the nature of the political organization of “minor centres,” and how they were integrated into the socio-political landscape, Haines (2008) developed a four-pronged research strategy. This strategy aimed to: 1) create a detailed map of the site and its settlement core, 2) define its domestic occupation history and the chronological sequence of monumental architectural development, 3) examine the cultural material from the civic-ceremonial structures and elite deposits at Ka’kabish for evidence of elite exchange patterns, 4) survey and record settlement between Ka’kabish and Lamanai. As Haines (2008) notes, previous research was limited to Lamanai, which created a distorted view of the development of complexity in the region, especially in relation to lacustrine resources and trade. By researching Ka’kabish and the inter-site settlement zone, Haines (2008) aims to gain a better understanding of the ancient populace, changes in their occupation over time, and their strategies for the management of the landscape.

The next three years of research produced several papers and publications (Gomer 2013; Haines 2011b, 2012; Heath 2011; McLellan and Haines 2013; Pitre 2012; Tremain and Haines 2013). As early as the Middle Preclassic Period, the Precolombian Maya at Ka’kabish were socially differentiated and active in both ritual and construction, as
evinced by a deposit of intact ceramic vessels in a buried platform and the escalation of building works (Haines 2013: 97). A mortuary offering in a burial dated to this period was rich in jade and shell beads, which Lockett-Harris (2013: 61) suggests was indicative of the emergence of an elite social class. In the Late Classic Period, Ka’kabish experienced an interruption in its architectural construction. As Haines (2013: 98) notes, imagery and hieroglyphic inscriptions on Stela 9 featured a *Kaloomte’*, a title used to differentiate the highest lords from their subordinates, the *K’uhul Ajaw* (Closs 1988; Demarest 2004: 209; Grube and Martin 2004; Reents-Budet 1988). The date of the monument coincides with the period of decreased architectural activity at Ka’kabish. While earlier survey and excavation efforts suggested the site was abandoned at the end of the Classic Period, residential groups adjacent to the civic-ceremonial centre were occupied in the Postclassic Period. In a chultun, a man-made subterranean chamber, Gonzalez (2013: 76) uncovered several deposits that dated to the Late Postclassic period.

Following the SSHRC-funded project at Ka’kabish, Trent University, in Peterborough, Ontario, started offering a credited course for undergraduate degrees in archaeology – referred to as the “field-school” phase of investigations (Haines 2014, 2015b; Sagebiel and Haines 2016, 2017). In 2014, the project focused its efforts in four areas: The Group F Acropolis, chultun C-2, the Group D Plaza, and Str. D-4. At the Group D Plaza, excavations revealed a “wealth of information” on the Middle Preclassic period, with many jade, greenstone, and shell bead artefacts (Haines 2015a: 8). At Str. D-4, archaeologists cleared the fallen debris from the face of the structure, exposing a staircase with large finely cut stones, like others identified at Lamanai. Excavations at the plaza of the Group F acropolis identified a platform only 15-20 cm below the surface, offcentred from the main temple, with material dated to the Terminal Classic to Early Postclassic period (Sagebiel 2015; Sinclair 2015). At chultun C-2, excavations were conducted to compare to the results of chultun B-2, excavated in previous seasons. Both yielded similar results, with a primary function of mortuary interment, each of which was dated to the Early Postclassic period.

In 2015 and 2016, excavations continued in the civic-ceremonial centre in Group D, Group F, at chultun C-2, and C-3 (Sagebiel and Haines 2016, 2017). Also, the project in the inter-site settlement zone recommenced after a two-year hiatus. These data make up a major component of this thesis (McLellan 2016, 2017). In Group D, several excavation
units were placed on Str. D-10 to understand the chronology of the structure, and a unit was placed on the south side of Str. D-9 to identify possible midden deposits (Sagebiel 2016b, 2016c: 7). The unit adjacent to Str. D-9, referred to as Operation 3, encountered a midden rich in sherds, lithics, obsidian, and faunal remains. The ceramics from this unit were all dated to the Terminal Classic and Early Postclassic periods (Sagebiel 2016a). At Str. D-10, excavations were placed at the base of the structure and on the central axis, revealing a few fill units and floors (Baker 2016). The chronology of this structure is discussed in Chapter 5. At Str. FA-8, excavations revealed multiple construction episodes, tombs, and stair blocks (Dziki 2017). Initially, Str. FA-8 was designed as a traditional pyramid temple, however, subsequent tomb construction, and other architectural adjustments, changed an extension on the front of the structure from rectangular to round (Sagebiel 2017: 8-9) (Figure 5).

Figure 5: Plan view of Str. FA-8, with unit, altar and tomb locations (Dziki 2017: 12)
Based on the composition of the structure, its location, and the tombs, Sagebiel (2017: 9) suggests that Str. FA-8 is a lineage temple. Lineage temples were continuously “occupied, enlarged, and renovated” structures, with shrines dedicated to “the residential unit’s common ancestors,” which were interred within the building (Ashmore 1981a; Gillespie 2000; Leventhal 1983; McAnany 1995; Tourtellot 1988b). In chultun C-2, Carlos (2016) identified several burials accompanied by ceramic vessels dated to the Early and Middle Postclassic periods. Similar to chultun C-2, chultun C-3 contained at least four individuals interred with ceramic vessels, clay beads, obsidian blades, a pair of copper tweezers, four projectile points, several ground celts, four balls of red pigment, four shell pendants, one copper ring, and two bone ear spools (Sagebiel 2017: 10). These objects were all dated to the Late Postclassic Period.

1.3.2 Location and Composition

Ka’kabish is near the contemporary villages of Indian Church, Indian Creek, Shipyard, and San Filipe, in north-central Belize. It is sometimes referred to as a medium-sized centre, or “second tier site,” to the larger site of Lamanai, which is 10 km southeast of the monumental core of Ka’kabish (Haines 2010: 6). Ka’kabish is on a limestone ridge, a common geographic feature in this part of the Yucatan Peninsula (Wright et al. 1959). The site rises above the surrounding landscape, standing between 100-120 m above sea level, which is the highest point between the Bravo Escarpment in northwest Belize and the coast (Guderjan 1995: 15; Tremain 2011: 32). In comparison, the terrain gradually slopes towards Lamanai, which is found between 0-10 m above sea level. This disparity in elevation, coupled with the proximity of the two sites, makes Ka’kabish visible from the High Temple at Lamanai, Str. N10-43 (Haines 2010: 6). Although it is difficult to determine the primary orientation of the site, as it has been partially demolished, it is generally aligned from north-to-south. Also, the settlement pattern is like many other Precolombian Maya sites, with a central precinct made up of plaza groups, surrounded by zones of residential and other small houses. However, it should be noted, especially for Group D, that the 10-m high structures surrounding the plaza create a “wall-like” formation. Likewise, the only noticeable “entrance” is in the southwestern portion of Group D, between Str. D-10 and Str. D-11. It is likely that there is a staircase in this location and Group D and F were a single, 2-level complex, further prohibiting movement and access to the central precinct (Haines 2018, personal communication).
Unlike Lamanai, which was declared a National Park Reserve in 1976, Ka’kabish is only protected by a private landowner. The civic-ceremonial centre is divided by a cobblestone road – an intrusive and destructive construction (built in the 20\textsuperscript{th} century) that divided the core into two constituent parts, named by Haines as the North and South Complex. This activity also altered the composition of the site, as construction workers demolished at least one structure and used two other structures for building materials (Guderjan 1996). Access to roads has encouraged looting, leaving every structure with sizable cavities and trenches, usually along the primary axis of the buildings. Added to this, the areas outside of the centre of Ka’kabish are affected by activities such as farming, quarrying, road construction, and demolition. Most of the practices are carried out by two communities, Shipyard and Indian Creek, which are encroaching on the Precolumbian Maya landscape. In some cases, farmers bulldoze Precolumbian Maya structures to increase field size and agricultural yields. Currently, the site is in a pocket of rainforest, which is surrounded by agricultural fields. In many ways, Ka’kabish is a site under siege.

The site core comprises six architectural plaza groups, labelled by Haines (2010a: 9) as Group A through Group F, and contains 57 structures, three chultuns, and an aguada. The civic-ceremonial centre is roughly 0.4 sq. km. Figure 6 shows one of the original maps of Ka’kabish (Haines 2010: 35). Figure 7 shows a topographic map of the civic-ceremonial centre and Figure 8 shows a revamped version of the same map, with excavated structures labelled and highlighted in red. Like Lamanai, several of the structures in the site core are notable for their size, design, and distribution. The largest structure on the site, Str. D4, is roughly 20 m in height and is in the centre of Group D, the largest plaza group at the site. It has evidence of multiple periods of occupation and like Str. N10-9 at Lamanai, was probably a focal point of residential and administrative life. Two other structures in Group F, Str. F1 and Str. F2, are distinguished by their proximity – they seem to be adjoining structures, which Haines suggests may indicate the presence of a range structure in the Rio Bec architectural style (Thompson 1945: 10-11). The Rio Bec architectural style is characterized by two non-functional twin-towers, with a narrow, ascending, staircase, which is constructed to give an illusion of height (see Taladoire \textit{et al.} 2013).
Figure 6: Map of the civic-ceremonial centre of Ka’kabish (Haines 2007: 35)
Figure 7: Hillshade map of the civic-ceremonial centre of Ka’kabish

Note that North refers to magnetic north and the survey was conducted in May and June of 2011. Do not use for navigation. Map Created June 29, 2011 by W. Chris Galten
Figure 8: Map of the structures that are excavated at Ka’kabish (in red)
At Str. FA-8, excavations revealed a circular, or vase-like, addition abutting a central staircase (Dziki 2017). Circular, or round, structures have been found in many parts of the greater Maya world and have been recorded in the Belize Valley as early as the Middle Preclassic period (Aimers et al. 2000). They have been interpreted as residential structures, performance platforms, alters, burial mounds, lineage houses, sweatbaths, and astronomical observatories (Aimers et al. 2000: 71; Harrison-Buck and McAnany 2013: 298). The function and chronology of this structure is described in Chapter 5 (see pg. 142-144).

At Str. FA-6, Haines discovered a vaulted tomb, painted orange red over plaster, with three recognizable glyphs in a darker brown-red pigment (Haines and Helmke 2016). The glyphs are mostly undecipherable, however, Helmke (2010: 79) suggests that it was likely a funerary text with the name of the ruler. Despite erosion and weathering, Helmke (2010: 77) notes that the tomb was probably entirely plastered over and painted with an extensive mural. Like Str. FA-8, the chronology of Str. FA-6 is discussed in Chapter 5 (see pg. 142).

1.4 SUMMARY
The developmental trajectory of Lamanai and Ka’kabish is important for the larger historical narrative of the Precolumbian Maya, especially because both sites successfully navigated the political and cultural changes of the Late Preclassic to Early Classic periods and the Terminal Classic to Early Postclassic periods. Lamanai and Ka’kabish were continuously occupied over the course of many major changes in Mesoamerica, from the fall of El Mirador, in the Late Preclassic, to the collapse of Teotihuacan, in Central Mexico, in the Late Classic. The goal of this project is to understand the reason for the continuity of evidence in this region and to place the developmental history of Lamanai and Ka’kabish within the context of the greater Maya world. To do this, I need to reconstruct the spatial and temporal dynamics of the civic-ceremonial centres and their supporting populations.
Chapter 2

SETTLEMENT PATTERNS AND MAYA URBANISM

The objective of this chapter is to review the history of settlement pattern studies in the Maya area and by doing so, understand the ways in which my project contributes to the analysis of Precolombian settlement patterns and land use. The first section traces the development of Maya archaeology and the discovery of Precolombian Maya cities in the late 19th and early 20th centuries. The second section focuses on the form of Maya cities, or more specifically, the character of urbanism found in the dense tropical setting of Mesoamerica. Researchers originally questioned the use of the term “city” to describe Maya settlements. Archaeologists now argue that Maya cities consisted of large stone civic, administrative, and ceremonial buildings, surrounded by sprawling low-density settlements in significantly human-modified environments (Fletcher 2009, 2011; Isendahl and Smith 2013; Lucero et al. 2015; Scarborough et al. 2012a).

The data from Lamanai, Ka’kabish, and the inter-site settlement zone, offers an opportunity to re-evaluate the theory of low-density urbanism and urban scaling (see Chapter 9).

2.1 SETTLEMENT PATTERNS

2.1.1 A Definition of Settlement Patterns

Archaeologists define settlement patterns as the “distribution of human activities across the landscape and the spatial relationship between these activities and features of the natural and social environment” (Kantner 2012: 108; see Drennan et al. 2015). Mayanists use the term to refer to “the total disposition of ancient Maya remains over the landscape,” including every built or modified structure or feature and their environment, at any scale of analysis (Ashmore and Willey 1981: 3).
settlement patterns in Maya archaeology (Ashmore 2007: 5; Banning 2002: 4) appears in Willey’s (1953) monograph on his research in the Viru Valley of Peru,

The term “settlement patterns” is defined here as the way in which man disposed himself over the landscape on which he lived. It refers to dwellings, to their arrangement, and to the nature and disposition of other buildings pertaining to community life. These settlements reflect the natural environment, the level of technology on which the builders operated, and various institutions of social interaction and control which the culture maintained. Because settlement patterns are, to a large extent, directly shaped by widely held cultural needs, they offer a strategic starting point for the fundamental interpretation of archaeological features (Willey 1953: 1).

Earlier definitions emphasize population sizes and settlement densities, especially as they relate to agriculture, polity boundaries, and community artefact assemblages (Willey et al. 1965: 15). Current definitions of settlement patterns refer to the spatial distribution and relationship of human activities across the landscape, the way these activities and their relationships changed over time and across space, and how these changes were both impacted and reflected by changes in the environment. As Bevan and Conolly (2006: 217) note, settlement pattern analysis attempts to “build up from the static spatial distribution of material culture and anthropogenic modifications visible in the contemporary landscape to an understanding of the dynamic cultural environmental processes of human settlement systems.” Settlement pattern studies, or “community-centric” studies, aim to document the diversity in human social systems and provide a framework for the comparative study of past peoples (Kolb and Snead 1997).

2.1.2 Settlement Patterns and the Colonial Past

Spanish colonialists provide some of first observations of the composition and organization of Maya towns and cities. During the 16th century, a Spanish missionary – one of the friars who spearheaded the ideological conquest of the New World – mentioned and recorded a Maya site in the Gulf of Mexico. Fray Pedro Lorenzo de la Nada described the ruins of Palenque (Gonzalez 1986: 3), which was referred to by the natives of the area as Otolum, “strong house land,” or “fortified place” (French and Duffy 2010: 1027). In Honduras, a government official, Diego García de Palacio, stumbled upon the ruins of Copan, writing, “on the road to the city of San Pedro, in the first town within the province of Honduras, called Copan, are certain ruins and vestiges of a great
population and of superb edifices…amongst the ruins are mounds which appear to have been made by the hand of man” (Maudsley 1889-1902: 6). A bishop of the Roman Catholic Archdiocese of Yucatan, Diego de Landa, commented,

They multiplied so that the whole land appeared to be but one town. It was then that they built temples in such numbers as are seen today on all sides and in passing through forests, there are seen in the midst of the woods the sites of houses and buildings of marvellous construction (Tozzer 1941: 40).

De Landa provided an early account of the settlement patterns of the Maya, which consisted of a town-centre with temples and plazas that was surrounded by the houses of lords and priests. He commented that the wealthiest and most important people dwelled next to these structures, followed by the poorest, or lowest class, who were relegated to the periphery of the settlement (Tozzer 1941: 62-64). This observation provided some of the earliest evidence of the social structure of the Maya and is often referred to by scholars of Precolumbian Maya society (see Arnold and Ford 1980: 714).

2.1.3 The Advent of Archaeology in the New World

Lewis Henry Morgan (1880, 1881), an American anthropologist and social theorist, argued that the New World was populated by only small towns and villages, rather than cities (see Ashmore and Willey 1981: 5-6). Morgan suggested the settlement plan at Uxmal was like many contemporary communities in North America (Ashmore and Willey 1981: 6). Thompson (1886, 1892) was the first to notice small groups of mounds surrounding several sites in the Yucatan peninsula, which demonstrated that many Precolumbian Maya centres were more densely occupied than originally assumed, with large supporting populations. This work was followed by Gordon’s (1896) study, which identified and recorded small mounds at Copan, and Hewett’s (1911) investigation of residential structures at Quirigua. Tozzer (1913) also commented on an abundance of mounds while he was travelling between several sites in the Peten (Ashmore and Willey 1981: 6). Archaeologists such as Thompson and Tozzer recorded their observations, but they were mostly concerned with the culture-history of the civic-ceremonial centres rather than the small structures that dotted the landscape.
Other archaeologists followed in the footsteps of these pioneers. Excavations were carried out in the southern Cayo District of Belize by Thompson (1931), at Cahal Pichik, Hatzcap, Tzimin Kax, Cahal Cunil, and in the Peten, at Uaxactun by Ricketson and Ricketson (1937). These archaeologists examined and described the spatial distribution and organization of domestic structures, coining the term *plazuela* to describe a group of structures built on raised platforms, a characteristic social unit. While these archaeologists started to show the analytical potential of settlement pattern studies, with Thompson (1931: 336) arguing that “small residential mounds offer much greater possibilities of a reconstruction of Maya history than do the ceremonial centers,” other developments in the study of the Maya encouraged its widespread adoption.

The early-to-mid 20th century has been referred to as the “Carnegie Period” of Maya archaeology (Ashmore and Willey 1981). At the Maya site of Uaxactun, Smith (1936a, 1936b) developed the first sequence of ceramic styles or typologies. As Ashmore and Willey (1981: 7) noted, the Mamom, Chicanel, Tzakol, and Tepeu, sequence became “the standard relative dating yardstick.” The development of type-variety analysis, as well as an ethnographic study of Maya communities in the 20th century, aided an understanding of domestic, or commoner populations. Wauchope (1938) compared Precolumbian and contemporary populations of the Maya, revealing similar house plans, construction techniques, materials, and other related behaviours. Most recent studies of Precolumbian Maya populations are based on Wauchope’s reconstruction of average person-per-households (Culbert and Rice 1990).

**2.1.4 Towards a Systematic Approach**

As Ashmore (2007: 5) notes, settlement pattern studies in the 1960s were “readily incorporated” into the theoretical trajectory of “New Archaeology,” which emphasized the processes of past human societies – the *why* and *how* of previous peoples. Before the introduction of “New Archaeology” several archaeologists started to question the prevailing patterns of archaeological inquiry, specifically its focus on reconstructions of culture-history (Steward and Setzler 1938; Strong 1936; Taylor 1948). Calls for changes in the discipline were heeded by the larger archaeological community, a group who developed a new theoretical focus on “early-functional-processual archaeology” (Trigger 2006). Willey (1953) was encouraged by Julian H. Steward, a leading advocate of a functional, or processual approach to archaeology, to use settlement patterns to
investigate the form, setting, and spatial relationships, of sites in the Viru Valley of Peru. A year later, Steward (1954: 51) praised Willey’s work on the social development of prehistoric peoples.

The first systematic settlement pattern study in the Maya area was conducted at the site of Barton Ramie, in the Belize Valley (Willey et al. 1965). Willey surveyed, excavated, and recorded, several areas of domestic occupation, mapping the spatial distribution and analysing the material culture of each residence. This dataset was applied to questions related to site location, population size, socio-political organization, and processes of urbanization. It was heralded as a “first class” contribution to Maya archaeology (Coe 1966; Thompson 1966: 110) and encouraged other archaeologists to use similar methods (Fash 1994).

Another archaeologist in the Maya area, Bullard (1960), used settlement patterns studies to define a hierarchy of sites. He used terms such as “major ceremonial center” and “household cluster” to distinguish between different scales and forms of settlement. Archaeologists carried out similar studies at Tikal (Haviland 1965, 1966) and Dzibilchaltun (Andrews IV 1965a, 1965b). At Dzibilchaltun, Andrews IV showed that areas surrounding the civic-ceremonial centre were urban-sized, with hundreds of domestic residences. The studies at Barton Ramie, Tikal, and Dzibilchaltun, reinvigorated debates over the composition and social organization of Precolombian Maya societies. However, as early as Willey’s (1956) study of Barton Ramie, archaeologists questioned the validity of the settlement pattern approach.

In a review of Willey’s (1956) *Prehistoric Settlement Patterns in the New World*, Wallis (1957: 213) commented:

> How can anyone know that a certain prehistoric group consisted of ‘small, semi-isolated, individualistic, and relatively unstable bands composed of kinsmen and congenial outsiders, under temporary chieftainship?’ How can he know that ‘the greatest elaboration of many aspects of culture, including religious ideology were reached?’

Trigger (1967) outlined several limitations of the settlement pattern approach. He argued that the function of a structure was difficult to determine, especially because of the variability in the size of structures and their material assemblages. Trigger
(1967: 153) suggested that structures may have served multiple purposes and were used by communities in different ways at different times (Trigger 1967: 153). Trigger also noted that some cultures in the tropics, such as the Maya, established markets in the “open air” and left little trace in the archaeological record.

2.1.5 Post-1960s and Settlement Systems

Archaeologists in the 1960s and 1970s started to distinguish between approaches that focused on settlement patterns and settlement systems (Flannery 1976; Winters 1969). Flannery (1976: 162) describes settlement patterns as the distribution of sites across a regional landscape. Settlement systems are defined as a set of rules that are based on general probabilistic trends in the data. For example, “no villages [are] ever found within a mile of each other” or “satellite communities [are] usually found four miles upstream from larger communities” are probabilistic statements that indirectly reflect some of the rules of the settlement system (Flannery 1976: 163). As Parsons (1972: 132) notes, investigations of settlement systems require a large collection of a variety of data, including faunal and flora remains, subsistence strategies, distributions of artifacts, and architectural features. Approaches to settlement system analysis incorporate a range of materials, requiring exhaustive surveys of occupation areas. This type of research was common in the 1980s (see Ashmore 1981b; Folan et al. 1983; Puleston 1983), because of the accessibility of earlier, traditional, settlement pattern studies (Carr and Hazard 1961; Kurjack 1974).

In the Maya area, archaeologists developed several models to explain the distribution of settlement at Precolumbian centres (Brown and Witschey 2003; Chase 1992; Folan et al. 1982; Inomata and Aoyama 1996). Folan et al. (1982: 434-435) argued that Maya centres consisted of a “concentric zonation of different architectural styles, formed of neighbourhood clusters” – which was referred to as the concentric zonation model (see Folan et al. 1979; Kurjack 1974). This model of settlement suggested that wealthy, or elite, populations generally resided nearest to the civic-ceremonial centers of Precolumbian Maya sites, with commoner populations living in the peripheries. Inomata and Aoyama (1996: 307) argued that the presence of a “central-place system,” which was hexagonally distributed with hierarchies of interrelated sites, demonstrated the influence of economic exchange on the development of Classic Maya polities. Brown and Witschey (2003) suggested that Precolumbian Maya settlements were fractal, with
buildings that formed “a pattern of repeated, complex, nested clusters of clusters” (Brown and Witschey 2003: 1619). The development of various sets of rules to define Precolumbian settlements highlighted the need to view the social organization of the Maya as “fluid instead of fixed and static” (Lecount and Yaeger 2010: 25).

2.1.6 Settlement Patterns and Contemporary Studies

In more recent years, both theoretical and methodological advances in the field of settlement archaeology have informed archaeologists’ interpretations of the past. Several technological innovations, such as Global Positioning Systems (GPS), Geographic Information Systems (GIS), and other remote sensing methods, such as Light Detection and Ranging (LiDAR), have changed the way archaeologists collect and analyse settlement data (see Bevan and Lake 2013). At Caracol, a Maya site in the Cayo District of Belize, archaeologists used LiDAR to understand the built, or modified, environment, including a network of roadways and agricultural terraces (Chase et al. 2011). Figure 9 shows a digital elevation model (DEM) of Caracol. This model is based on point cloud information from LiDAR, which uses laser pulses to penetrate the forest canopy and reveal the ground-surface. In the Peten, in Northern Guatemala, LiDAR exposed a complex system of raised ditches, which archaeologists interpreted as 17 distinct roadways (Figure 10). Scholars argue that this system was used to control the production and distribution of sustenance goods at an industrial level (Canuto et al. 2018). The use of LiDAR in the tropics created a “eureka moment” in Mesoamerican archaeology equivalent to the discovery of crop/soil marks by aerial surveys in the early 20th century. In the last five years, findings from LiDAR have increasingly prompted Maya and other regional archaeologists to remark that traditional ground-based settlement methods in tropical rainforest environments are now obsolete (Chase et al. 2011: 397). However, archaeologists at the site of Uxbenka, found that LiDAR imagery failed to detect more than 90% of the very smallest (1-3 m high) residential structures (Prufer et al. 2015). Non-detection of small mounds is problematic as these structures are a numerous and ubiquitous component of Precolumbian Maya sites. In fact, even some traditional ground-survey techniques, used in tropical rainforest environments dominated by dense jungle, fail to identify low structures (Johnston 2002, 2004).
Figure 9: Image of the civic-ceremonial centre of Caracol (Chase et al. 2011: 394)

Figure 10: Image of a gridded system at El Mirador (Seaburn 2016)
The inability to identify small structures in tropical forest environments reinforces the validity and importance of the current study at Ka’kabish, Lamanai, and the inter-site settlement zone, as recently chained fields (a technique used to remove emerging vegetation), which are cleared and ploughed, offer the most complete visibility possible for small, minimally constructed, settlement platforms (for a full discussion of the field conditions in the inter-site settlement zone see pg. 104-106).

New technological innovations have influenced the methodological approach of Maya archaeology. These technological innovations have also inspired new theoretical approaches to understanding the social organization of the past (Chase et al. 2014a; Magnoni et al. 2014). For example, Prufer et al. (2015: 3) commented that the size of domestic structures, or as others argued, their cost of labour (Arnold and Ford 1980; Haviland 1982), reflect their wealth or status, making settlement archaeology a “critical aspect of understanding social hierarchies in early complex societies.” Tourtellot (1988a: 99) suggests that the height of a structure demonstrates individuals’ prestige, the volume and floor area reflect the structure’s per capita cost, and ritual structures denote status. Wilk’s (1983) ethnographic study of the Kekchi shows that the floor area of a contemporary Maya structure bears a relationship to the number of people that lived in the unit – another term used to describe a plauzela group (Tourtellot 1988a).

These anthropological observations, as well as work by Wauchope (1938), allow archaeologists to count and date individual structures to reconstruct population demography (see Culbert and Rice 1990; Healy et al. 2007; Hutson 2016). Changes in population, or settlement dynamics, are subsequently compared to environmental conditions in order to examine the impact of human populations on the landscape – a major goal of this thesis (Metcalf et al. 2009; Rushton et al. 2013). More recently, settlement data were compared to environmental data to understand the effect of long periods of drought on Precolumbian Maya populations (Iannone 2014). Both traditional ground-survey methods and new technologies enable comparisons of the historic trajectories of multiple sites across the greater Maya world.
2.2 Maya Urbanism

2.2.1 Definitions of Urbanism

Researchers have used a variety of criteria, or traits, to define urbanism (see Childe 1950; Marcus and Sabloff 2008b; Wheatley 1972). One of the most widely cited sources in archaeology emphasizes the presence of characteristics or segments of society, such as full-time craft specialists, administrative systems, social stratification, writing, and long-distance trade, in the identification of urban communities (Childe 1950). Other scholars have stressed the importance of the heterogeneity of populations, a central precinct, or a specific form of spatial organization (see Hansen 2008: 68-70; Renfrew 2008: 46-47; Wirth 1938). In Central Mexico, archaeologists have commonly defined cities by the size and density of their residential populations (Sanders and Webster 1988). Although some archaeologists question the legitimacy of the typological approach to defining urbanism (see Butzer 2008: 77-78), Hirth (2008: 275) argues that archaeological mapping and settlement pattern analysis allows archaeologists to easily compare the density of structures at Pre Columbian Maya centres.

While the trait-complex approach to urbanism has been applied to cities in Mesoamerica, as Isendahl and Smith (2013: 132) mention, other archaeologists have used a functional or hierarchical approach to understand urban structure. For example, Ardren (2015: 34) comments that some scholars view cities as “central places that fulfil political, economic, religious, and sociocultural functions to the hinterland” (see Blanton et al. 1993; Golden and Scherer 2013; Marcus 1973). These functions are sometimes viewed as more important in defining urban communities than population size, density, or geographic extent. Other archaeologists attempt to understand the perspective of Pre Columbian people. For example, Marcus and Sabloff (2008a: 22) note that the Maya term cacab is the “meaningful [conceptual] unit” and includes “the land, people, and minor settlements controlled by one ruler,” and thus, the “link between the ruler and his territory transcended urban space.” These various definitions of urbanism, especially those related to core-periphery dynamics and structure densities, are used to understand the spatial distribution and composition of Pre Columbian settlement at Ka’kabish, Lamanai, and the inter-site settlement zone.
2.2.2 Population, Density, and Urbanism

Early scholars argued that the civic-ceremonial centres of the Maya were largely vacant, with only a small number of priests, “who maintained the calendars, observed the movements of stars, and performed rituals that would appease the gods and bring bountiful harvests” (Foster 2002: 121; see Ricketson and Ricketson 1937). The discovery of large residential populations changed the way archaeologists viewed Maya settlements (see Puleston 1973, 1974; Culbert and Rice 1990). Settlement pattern studies provided population estimates for sites such as Caracol (Chase and Chase 2007), Coba (Folan et al. 2009), Pacbitun (Healy et al. 2007), among others. For example, Chase and Chase (2007: 60) estimated that in the Late Classic period Caracol contained as many as 115,000 people. Folan et al. (2009) posited that Coba, a site in northeastern Quintana Roo, Mexico, had a population between 20,000-60,000 people during the Late Classic Period.

At one of the densest sites in the Maya area, Chunchucmil, archaeologists estimate a population of 34,000 to 43,000 people across only 20-25 sq. km of the landscape (Magnoni et al. 2012; Magnoni 2007) (Figure 11). For comparative purposes, in the Late Classic period, Caracol had a population of over 100,000 people, covering at least 200 sq. km (Chase and Chase 2007: 3)

Along with population sizes, archaeologists analysed the density of structures in Precolombian settlements, assuming a close correlation with actual population density. In some cases, even in areas outside of the civic-ceremonial centre, archaeologists found densely settled landscapes. For example, in the Xunantunich hinterlands, in the Rancho San Lorenzo survey area, Yaeger (2010) found 128 structures per sq. km. While it is likely at Xunantunich that some of these structures did not serve domestic purposes, this is still a high figure. At Chunchucmil, in the dense residential core, archaeologists have identified 950 structures per sq. km (Magnoni et al. 2014: 149). Even in areas “beyond the cities limits, in the rural hinterland” archaeologists found 39-64 structures per sq. km (Magnoni et al. 2014: 149). It should be cautioned that these estimates are potentially problematic, as it is not always clear if they include/exclude ‘blank’ areas within the settlement landscape, which may be real open zones, or areas with structures that were lost to heavier ploughing, river movement, or other site formation processes.
Figure 11: Map of the centre of Chunchucmil (ca. 10 sq. km) (Hutson et al. 2008: 23)
Archaeologists recognized that some Maya centres were densely populated cities, but others still characterized them as dispersed settlements (Barthel and Isendahl 2012: 3; Bullard 1960; Freidel 1981). As Magnoni et al. (2014: 147) note, scholars suggested that “Maya centers were not truly urban.” However, as mentioned earlier, archaeologists have identified landscape modifications, or more specifically, agricultural intensification at many Maya sites that could have sustained large urban populations. There is also evidence that some of the sites were developed with centrally-planned gridded layouts – a common feature in current cities. At Baking Pot, a Precolombian Maya site in the Cayo district of Belize, archaeologists argue that houseplots were distributed in a grid-like formation, with routes running throughout local Maya neighbourhoods (Bevan et al. 2013b). At a site in the Peten, Nixtun-Chich, archaeologists discovered a similar gridded, top-down, system of organization (Pugh 2015). It is likely that more intensive survey (both on the ground and with LiDAR) and excavation, will reveal denser, and more centrally planned Precolombian Maya cities (see Chapter 9 for further discussion).

2.2.3 Low-Density and Peri-urban Settlements in the Past
Archaeologists have recently started referring to Precolombian Maya cities as low-density, or peri-urban settlements (Isendahl and Smith 2013; Prufer et al. 2015: 2; Scarborough et al. 2012b: 12408). In contemporary contexts, peri-urban settlements are characterized by a relatively low population density, with “scattered settlements…fragmented communities, and lack of spatial governance” (Ravetz et al. 2013: 13). Most of the work on archaeological examples of low density, peri-urban settlements are inspired by Fletcher (2009), who argued that populations in lowland Mesoamerica, Sri Lanka, and South-east Asia, were organized into these types of agrarian-based cities. Fletcher (2009) suggests that low-density urbanism was socially and ecologically unstable, as many of the sites in these regions experience episodes of collapse. However, like arguments about Precolombian populations’ impact on the environment, researchers have argued that low-density, garden-based agricultural systems provided stability and resilience throughout Maya history (Isendahl and Smith 2013). As mentioned, more recent studies are uncovering grid-like settlement patterns (Bevan et al. 2013b; Pugh 2015), with high densities of structures (Hutson 2016), which make it less likely that the form of urbanism in the Precolombian Maya world affected the prosperity of their cities (see pg. 270-274 for further discussion).
Fletcher (2009) compared his historic examples of low-density urbanism to contemporary low-density urbanism. Fletcher (2011: 285) argues that low-density urbanism has a significant role in industrialization, with a “network of cities and industries enclosing patches of rural land.” More specifically, Fletcher (2011) discusses conurbations, or the processes by which cities, towns, and other urban areas, form a continuous urban and industrial developed area through population growth and physical expansion. This process is the same as urban sprawl – the migration of people from towns and cities to residential developments and suburbs. Several studies have identified evidence of this decentralizing process, and the human propensity for it, in various historical and current societies (see Bruegmann 2005; Hayden 2004). Researchers argue that some of these current examples of social organization are socially and environmentally detrimental, reducing social interaction, and contributing to a loss of productive agricultural lands (Brueckner 2000; Ewing et al. 2003; Hasse and Lathrop 2003). Fletcher (2011: 289) sees this contemporary development as particularly worrisome, as some of the historic examples of low-density urban settlement experienced periods of depopulation, or abandonment. As Fletcher (2011:290) questions, “why do we not find them as long-lasting settlements in the well-known, old primary regions of urban development?”

Perhaps, Fletcher (2009) was premature in his comparison of contemporary cities to Precolumbian Maya cities, especially considering new settlement pattern data (Hutson 2016), and the significant differences between historical and current societies.

2.2.4 The Sustainable and Resilient City

Many of the current studies are based on ideas of utopianism – the academic trend to use studies of urban development to address issues related to the environment and sustainable cities (Rapoport 2014: 137). A quick perusal of research based on urbanism and sustainability yields a corpus of contemporary studies on ways to reach a state of human and environmental equilibrium (Marans 2015; Troy 2013; Yigitcanlar et al. 2015). Rapoport notes that many current eco-city projects attempt to minimize the human impact on ecological and environmental systems to promote sustainability. Rapoport (2014: 137) argues that these ideas, whether based on the compact city (Breheny 1992; Jenks et al. 1996), or the New Urbanists’ town planning (Calthorpe 1993; Katz 1994), attempt to provide long-term ecological solutions to human settlement. Most present-day cities have high population densities surrounded by low-density urban sprawl, which, as Isendahl and Smith (2013: 131) comment, are viewed as non-sustainable for a variety of
social and economic reasons (see Hayden 2004). Many archaeologists have been inspired by research on contemporary cities, investigating sustainability and resilience amongst historic and ancient populations. The cities of the Preclassic Maya have been added to this debate, with some scholars viewing them as sustainable, because of their extensive histories, while others view them as unsustainable, due to the precipitous collapse of their populations in the 9th and 10th centuries AD (Fletcher 2009, 2011; Scarborough et al. 2012a; Smith 2010). The human and environment relationship at Lamanai, Ka’kabish, and the inter-site settlement zone, is fully explored in Chapter 7, however, Lamanai is considered an example of a sustainable city, especially in light of the social and environmental changes witnessed in the Terminal Classic period (see Douglas et al. 2015; Iannone 2014). The processes that promoted sustainability at Lamanai may indicate the causes for the abandonment of many other Preclassic Maya sites before the arrival of the Spanish, adding another perspective to the Maya collapse.

2.2.5 Current Theories and the Archaeological Record

The population density of Preclassic Maya cities is calculated by counting the number of structures and determining their period of occupation. As mentioned, by recording the number of residential buildings, archaeologists attempt to reconstruct population demographics (Culbert and Rice 1990; Healy et al. 2007). One of the issues with the theory of low-density urbanism is that it bypasses, or glosses over, several methodological issues that have been long identified in the field of Maya archaeology. Even in the earliest application of settlement pattern studies, archaeologists recognized that visibility, especially in areas of dense jungle, affected their ability to identify low-lying architecture (Bullard 1960). Scholars have referred to these areas of occupation as the ‘invisible Maya’ or ‘invisible settlement’ (Fash 1986; Pyburn 1990; Tourtellot 1993). For example, at Itzan, Guatemala, archaeologists identified several structures below the visible surface associated with artefacts indicative of domestic settlement. Johnston (2004: 146) concluded that invisible architecture and settlement could potentially be an “abundant component in the Maya lowlands.” The density of invisible structures in the inter-site settlement zone and its relation to the theory of low-density urbanism is further addressed in Chapter 9 (pg. 263).

Even if this methodological issue is ignored and Preclassic Maya populations are defined as low-density, agrarian-based settlements, there is evidence of longevity in the
archaeological record. Some of these settlements continued to be occupied long after the Maya collapse. Also, in current examples, low-density urbanism, or urban sprawl, is viewed as particularly negative because the settlements are sometimes located on prime agricultural landholdings, precluding their use for crop production (see Gurin 2003). Archaeologists argue that Precolumbian Maya settlements incorporated agricultural production at a household level, creating a rural/urban, or peri-urban, landscape with fragmented urban and rural characteristics. The densely occupied settlement at Chunchucmil (see Dahlin 2009; Hutson and Magnoni 2017) is either an exception to the common culture-history of the area, or an example of a visible settlement. The major problem is an archaeological setting with poor data-recovering conditions might produce a similar ‘dotted,’ or otherwise referred to as, low-density, settlement pattern (see pg. 263 for a discussion about low-density urbanism at Ka’kabish, Lamanai, and the inter-site settlement zone).

Added to these methodological shortcomings, there is recent theoretical evidence in mathematics to suggest that certain features of both current and ancient settlements, such as socio-economic outputs, land area, and the extent of infrastructure, “vary systematically and predictably with population size” (Ortman et al. 2014). In theoretical terms, this phenomenon is referred to as urban scaling (Bettencourt 2013; Bettencourt and Lobo 2016). Ortman et al. (2014: 1) argue that settlement data from the Precolombian Basin of Mexico shows that the “total settlement area increases with population size, on average, according to a scale.” If this is the case, it may be beneficial to apply these mathematical techniques to a well-documented, well-researched urban site, such as Chunchucmil or Lamanai. Once an appropriate scale has been established, these findings can be compared to other Precolombian Maya sites to possibly offer more accurate identification of population sizes.

2.3 SUMMARY
The interpretation of Precolombian Maya settlement has changed significantly over the course of the last several decades. From vacant ceremonial centres to civic-ceremonial centres surrounded by urban sprawl, researchers have a clearer view of the character of the urban tradition in the Maya area. This understanding has been aided by new advances in GPS, GIS, and LiDAR, which make it easier and more accurate to identify and record evidence of past activities. The fact that Maya cities can be characterized as low-density
urbanism raises the question of whether this type of social organization does or does not influence the longevity of their societies. By analysing the settlement patterns at Ka’kabish, Lamanai, and the inter-site settlement zone, I will add to our understanding of the social organization of Maya settlements and by extension, look to offer some insights into the processes that promoted the long culture-history of the area, including occupation during the time when most Mayanists record population collapse.
Chapter 3

HUMAN AND ENVIRONMENT INTERACTION, LANDSCAPE MODIFICATION, AND SPATIAL ORGANISATION OF THE PRECOLUMBIAN MAYA

The purpose of this chapter is to assess and evaluate evidence of human and environment interactions in the Precolumbian Maya world. The first section, “The Built Environment,” describes the character and composition of Maya cities, with the goal of assessing the way the configuration (aka ‘plan,’ ‘layout’) of the settlement affected the environment. The second section of this chapter analyses evidence of landscape modifications, such as water-retention and management systems and terraces, and their effect on the environment. The third and final section discusses the Precolumbian Maya and the current environment. Some of the same issues that affect human and environment interactions in contemporary society were experienced by the people of the past, albeit on a smaller scale. The reaction of the Precolumbian Maya to periods of environmental instability can potentially inform and educate us about the environmental policies and practices of the present. One of the major goals of my study is to compare the settlement dynamics of Lamanai, Ka’kabish, and the inter-site settlement zone, to environmental data from the New River Lagoon. The environmental data are based on pollen that was collected from multiple cores in the lagoon adjacent to Lamanai (Metcalfe et al. 2009; Rushton et al. 2013). By comparing these data to the settlement dynamics at Lamanai, Ka’kabish, and the inter-site settlement zone, I aim understand the relationship between changing settlement patterns and the Precolumbian environment.
3.1 THE BUILT ENVIRONMENT

3.1.1 A Comparison of the Size and Scale of Two Ancient Cities

Although the size and scale of Pre-Columbian Maya cities were briefly mentioned in the previous chapter, it is important to discuss the layout of the city and the ways in which it affected the environment. As Fletcher (2009) comments, many of the cities of the Old World were relatively small, compact urban settlements surrounded by sparsely populated rural hinterlands. For comparative purposes, from the 2nd to 5th centuries AD, the city of Rome was roughly 18-20 sq. km (Fletcher 2009: 9). In fact, this number is slightly larger than some other estimates that suggest that ancient Rome was 13.86 sq. km (Storey 1997: 966), which is based on the boundaries represented by the Aurelian Wall (Stambaugh 1988: 83). Although the population of ancient Rome has caused scholarly debate (Storey 1997: 966-967), researchers argue that the city housed over a million inhabitants (Bairoch 1989: 259; Robinson 1992: 8). Even with a conservative estimate of 450,000 people (Storey 1997: 996) and the larger size of 20 sq. km, the population density of ancient Rome was 22,500 people per sq. km, which is only somewhat smaller than the 21st-century city of Mumbai, India, with 26,000 people per sq.km (Demographia World Urban Areas 2017). At Tikal, there was an estimated population of 62,240 people over 120 sq. km (Chase and Chase 2016a: 9). At the height of its population, the city was inhabited by 517 people per sq. km – a figure significantly lower than the population density of ancient Rome. While it is possible that the figures for ancient Rome are inflated, these population densities highlight an important point – that is, the land was potentially used for more than residences and workplaces in Pre-Columbian cities.

3.1.2 Spatial Organization and the “Mayacene”

One of the major reasons for the differences between Old and New World settlement densities, especially amongst the Pre-Columbian Maya, is the spatial organization of the cities. New World neotropical cities are described as low-density (Fisher 2014; Isendahl and Smith 2013; Lucero et al. 2015; Scarborough et al. 2012a; Smith 2011). Although some of the limitations of this term were noted in the previous chapter and other authors have voiced similar concerns (Graham and Isendahl 2018), the pattern of settlement in the Pre-Columbian Maya world is different from the compact cities of similar time periods. Some Pre-Columbian Maya cities were spread out over large areas of the landscape. Urban sprawl (or low-density distributions of settlement) is visible in the north-eastern portion of the site of Coba, Quintana Roo, with regular spacing between residential units.
Archaeologists suggest that these areas formed greenspaces that were used for agriculture, arboriculture, and horticulture (Ford and Nigh 2009, 2015; Graham 1999a).

This form of spatial organization created greenspaces between residential units, but it also resulted in highly modified landscapes, with human habitation spread over a significantly larger portion of the land than is the case in high-density settlements. As Adams (1996) commented, “thirteen hundred years after their entry into the lowlands, around 750 [AD], nearly every square meter of land had been modified.” Recent advance in survey techniques, such as airborne light detection and ranging (LiDAR), have highlighted even more clearly the ability of the Maya to modify the landscape, sometimes radically, through settlement, roadways, and agricultural terraces (see Chase et al. 2011). In fact, Beach et al. (2015a) have compared the Anthropocene (Schwagerl 2014), a current period marked by humanity’s increasing control and influence on climate and the environment, to the “Mayacene,” a period from ca. 3000 to 1000 BP in which Maya cities exerted a similar level of control over their surroundings.

Figure 12: Map of a section of the site of Coba, Quintana Roo, showing the distribution of structures and their labour investment (Folan et al. 2009: 64)
3.1.3 Urban Heat Islands, Lime Production, and Green Cities

The large temples, range structures, and other forms of monumental architecture that characterize Pre-Columbian Maya sites, inspire scholars to refer to Maya settlements as stone cities (Graham 1999b; Lundell 1933: 150; Nations 2006: 3). Many of the site names, such as Naachtun, or Uaxactun, contain the Mayan word for stone, tun. Graham (1999b: 191) defines stone cities as settlements that are dominated by dense clusters of houses and features made of stone, mud brick, plaster, and/or other building materials, in which greenspace is marginalized, or “kept at bay” (see Arensberg 1980). The Maya that built these large cities altered the density and distribution of many forms of flora. They changed the forests, savannas, and wetlands, possibly more than the Pre-Columbian peoples of Amazonia (Beach et al. 2015a: 9), who some scholars have argued drastically transformed and disturbed their rainforest environment (Clement and Junqueira 2010; Heckenberger et al. 2007). Some Maya cities have also been referred to as “urban heat islands” (Beach et al. 2015a), an urban area that is significantly warmer than its surrounding rural area (Gartland 2012). The discrepancy in temperature of urban heat islands is caused by human activities that decrease the evapotranspiration, or evaporative cooling effect, of the landscape (see Taha 1997). Albedo is a measure of the reflectivity of a surface, with higher albedos reflecting more sunlight (Figure 13). Although albedo slightly increases in deforested environments, the “heated components” (the trees, branches, canopy, and soils) are larger than in clear-cut environments, resulting in lower temperatures (Shaw 2003:161). By removing vegetation from the centre of the city, the Pre-Columbian Maya, as suggested by Beach et al. (2015a), increased the temperature of their cities. However, limestone has a very high albedo and its equivalent, lime, is sometimes used in contemporary cities to reverse the effect of urban heat islands by reflecting more sunlight (see Santamouris 2006). Perhaps, even indirectly, the white washing of plazas and structures in lime in the civic-ceremonial centres helped to combat the urban heat island effect. Further study on the use of lime as a cooling agent in Pre-Columbian Maya cities (especially considering local conditions) is needed to determine its impact on urban heat islands in the past.

The investment that the Pre-Columbian Maya expended in the modification of their environment is also evident in the amount of labour that was needed to construct and maintain their monumental centres. Even some of the smaller residential units, which often included structures for sleeping, eating, storage, and religious purposes, required an
extensive labour investment (Arnold and Ford 1980). For example, Folan et al. (1982: 434) argue that the residential groups at Tikal required anywhere between 4000-6000 days of labour per person to build. Residential groups were most likely constructed by multiple individuals, but this figure captures the degree of effort, from excavating and carrying earth and limestone, to manufacturing and spreading lime, that was required to construct these structures. Archaeologists at some of the Maya sites, such as Coba, have identified 6000 structures in an area that covered almost 19.7 sq. km (Folan 1977). At Chunchucmil, in an area covering ca. 9.4 sq. km, archaeologists estimated that between 8000 to 8500 structures were occupied in the Early Classic period (Hutson et al. 2008: 30). These figures for labour investments, and the number of structures, demonstrate how intensively the Maya modified their natural setting, creating “urban anthropogenic landscapes” (Chase and Chase 2016b).

Along with excavating and moving earth, a significant portion of labour was used to produce lime for structural purposes such as floors for both pole-and-thatch and masonry residences, plazas, and monumental structures. Lime production typically required a
substantial amount of firewood, especially to apply plaster to the larger, temple pyramids found in the civic-ceremonial centres of these sites, however, there has been some disagreement about the amount of wood that was needed and how much lime was yielded (Abrams and Rue 1988; Bradley and Dahlin 2007; Morris et al. 1931; Schreiner 2002). Lime was used for various other purposes in Maya life. It was applied to Amatl paper, which was made from tree bark (Ficus tecolutensis) that was flattened and covered in lime paste. This paper was used for the folded books of the Maya, later known as codices (Coe 1998). It was used for tobacco chewing by the Maya (Thompson 1970), which, in enough quantities, is known to increase the hallucinogenic effect of the nicotine (Wilbert 1987). It was also used in several other ways, such as for maize processing, water purification, and soil stabilisation (Villasenor 2009: 43). Some scholars argue that the scale of lime production in Maya societies must have significantly contributed to deforestation (MacKinnon and May 1990; Shaw 2003). Other archaeologists have found evidence of managed systems of arboriculture, particularly in the portions of the city outside of the civic-ceremonial centre, an area sometimes referred to as the site periphery (see Chase and Chase 1983; Lentz et al. 2014; Puleston 1968).

Although Graham (1999b) refers to Precolumbian Maya centres as stone cities, Maya urban agriculture, as Barthel and Isendahl (2012: 4) note, was carried out by household compounds in the periphery of these sites, creating “green cities” (Graham 1999b), “garden cities” (Chase and Chase 1998; Folan et al. 2009), “forest gardens” (Ford and Nigh 2009, 2015), or an “agro-urban landscape” (Isendahl 2010). Graham (1999b: 187-188) argues that the absence of agro-pastoralism in Mesoamerica created a different relationship (arboriculture vs. clear cutting) between people and trees than witnessed in the Old World. As Graham (1996, 1999b: 188) notes, this relationship may explain the presence of trees and orchards in “the urban landscape of Maya cities.” Researchers (Folan et al. 1979; Ross 2011) have identified several species of trees that may have supported Maya cities and even ethnographic accounts comment on the abundance of trees surrounding Maya houses (Tozzer 1941: 62-64). In fact, instead of attributing the collapse of many Maya centres to the management of arboreal resources, scholars have argued that these gardens were sources of sustainability (Isendahl and Smith 2013). These seemingly opposing views of Maya settlements, whether they were stone cities or green cities have led Chase and Chase (2016b) to argue that two types of urbanism existed in the Maya world: one in which agricultural practices were conducted within the
cities’ boundaries, and another in which the city was too dense and compact for agriculture and instead, was reliant on agricultural fields that existed outside of the city boundaries. While it is historically difficult to define the boundaries of Precolumbian Maya cities (Rice and Culbert 1990: 20), variability in the form of urbanism may explain the apparent dichotomy in depictions of Maya cities. As Chase and Chase (2016b: 3) note, “no single site plan or scale of settlement monolithically defines the ancient Maya.” Like many other societies, it is possible that there was internal diversity in the urban form of Maya cities, albeit to varying degrees (for a discussion of urbanism at Lamanai, Ka’kabish, and the inter-site settlement zone, see Chapter 9).

3.2 LANDSCAPE MODIFICATIONS AND THE PRECOLUMBIAN MAYA

3.2.1 Water Retention Systems and Landscape Transformation

The construction of the city certainly impacted the environmental setting of the Maya. However, modifications were also needed to adjust to the scarcity of water in certain geographic locations. For example, at some inland Precolumbian Maya centres, scholars have been puzzled by the absence of permanent sources of water, such as rivers, lakes, and cenotes (Dunning et al. 1999; Scarborough and Burnside 2010). Permanent sources of water are essential in the dry season, especially in the interior Maya Lowlands, which has been referred to as a seasonal desert (Lentz et al. 2015: 282). Archaeologists have observed that some of the largest and earliest centres were located near bajos, seasonal wetlands that are generally perceived as resource-deficient (Dunning et al. 2002: 268). As Dunning et al. (2002: 269) note, many wetlands in low-lying areas are spring-fed, perennial water sources, whereas in the interior areas of the lowlands, which are between 120-300 m above sea level, bajos are flooded for several months and dry for the rest of the year. Figure 14 shows an east-west transect of the elevation of the southern Maya Lowlands (Dunning et al. 2002: 269). For the purposes of this study, it is important to note that Lamanai and Ka’kabish are in the area labelled “New River,” with wetlands that are riparian, or adjacent to rivers and streams, that are replenishing, year-round sources of water. At Tikal, a site that was seemingly founded where there is absence of perennial water sources, research has identified at least a single spring that flowed from an area underneath the Temple Reservoir (Scarborough et al. 2012b). Lentz et al. (2015: 282-283), suggest that this source of water could have sustained the first settled community. This water system was expanded in subsequent centuries to include a cofferdam in the
Figure 14: Elevation transect from the Northern Caribbean coast of Belize to the Mirador Basin in the Northern Peten, Guatemala (Dunning et al. 2002: 269)

Temple Reservoir, an enclosure built within the reservoir and constructed to distribute water out of the enclosed area (Lentz et al. 2015: 283). There was also a retention dam in the Palace Reservoir, likely to prevent flooding and manage water runoff. There were several smaller reservoirs and a sand filtration system to clean the water as it flowed to other lower-lying reservoirs (Lentz et al. 2015: 283). These systems of water retention and management again required large labour investments, but some scholars have also suggested that these landscape modifications, especially from 400 BC to AD 250, were adopted to cope with human-induced environmental change and climatic change (Dunning et al. 2002). Early agricultural efforts by the Precolumbian Maya transformed perennial wetlands and shallow lakes to seasonal swamps, or large karst depressions – the bajos that dominate the interior of the current landscape. Data from two sites, La Milpa (40 km west of Lamanai), Belize, and Yaxha, Guatemala, show that contemporary bajos were once hydrologically stable ecosystems (i.e. large perennial wetlands) (Dunning et al. 2002). It is likely that many of the water management systems at other sites in the Maya world (see Ferrand et al. 2012; Lucero et al. 2014), were constructed for similar reasons - to provide water to an ever-expanding population and as a reaction to some of the environmental transformations caused by early attempts at large-scale agriculture. At Lamanai, Ka’kabish, and the inter-site settlement zone, there is evidence of raised fields, but there is little evidence of water retention systems, other than a small aguada adjacent to Str. C1 at Ka’kabish (Figure 6). Again, this is likely due to the proximity of the New River Lagoon and other spring-fed water resources in the area (see Chapter 7).

3.2.2 Terraces and Agricultural Intensification

Several of the human and environment interactions already mentioned in this chapter, such as lime production/deforestation and agriculturalism/soil erosion, are viewed as environmentally detrimental, however, terraces are generally viewed as beneficial.
Terraces were constructed by Pre-Columbian farmers in the Maya area to cultivate slopes in areas that have fertile and well-drained soils but are prone to erosion (Kunen 2001: 326; Macrae and Iannone 2016: 372). Terraces and terrace faces are designed and constructed to reduce erosion by preventing runoff from heavy rains and conserving moisture during dry periods (Kunen 2001: 326). They are built to stabilize sediment and serve to preserve and sometimes increase the depth of the soil (Macrae and Iannone 2016: 372; Kunen 2001: 326). There are various types of terraces constructed in both ancient and contemporary societies, which are categorized based on the techniques used for their construction, their function, and their distribution over the landscape (see Donkin 1979; Morgan 2004; Frederick and Krahtopoulou 2000). Terraces are mostly found in densely settled upland landscapes with high agricultural capability (Fedick 1994: 124). They are often constructed in marginal lands, with steep slopes, for intensive cultivation, usually to provide sustenance for larger, sometimes high-density, populations. In certain circumstances, such as at the Pre-Columbian site of Tikal, intensification of sustenance strategies, of which terrace construction is a common characteristic, brought the productive potential of the land to its carrying capacity, which made it less resilient to environmental changes, such as drought (Lentz et al. 2014). Some terraces, such as at Caracol (Healy et al. 1983), covered large areas of the landscape (Figure 15).

Figure 15: Extent of causeways, settlement, and agricultural terraces at Caracol, Belize (modified from Chase and Chase 2016a: 5)
Although systems of terraces, such as those at Caracol, may have allowed cities to be self-sufficient (Graham and Isendahl 2018), the increased land modifications may also reflect increased environmental stress.

3.2.3 Land Clearance, Deforestation, and Soil Erosion

Archaeologists argue that intensive agricultural systems (terraces and raised fields) made Precolumbian Maya cities sensitive to environmental changes (Cook et al. 2012). As Erickson and Walker (2006: 233) note, agricultural landscapes are “patterned built environments” that are constructed over multiple generations of habitation, with “large-scale accumulation” of cultural and environmental changes. The alteration of natural systems can improve or degrade the landscape over time. Cook et al. (2012) use climate model simulations to demonstrate that incremental landscape modifications decreased the annual rainfall by as much as 5%-15% in southern Mexico and the Yucatan. Contemporary studies of deforestation show local climates becoming warmer and drier with decreased forest cover (Laurance 1998; Shaw 2003: 161; Walker et al. 1995). The degree of deforestation caused by Precolumbian cities, however, is a matter of scholarly debate (see Fedick 2010; Ford and Nigh 2015). In some areas, such as the Peten region in northern Guatemala, archaeologists argue that landscape modifications caused deforestation, with pollen records that indicate that by AD 900 “much of the forest was cut down” (Oglesby et al. 2010: 1). Other archaeologists suggest that the Precolumbian Maya managed their arboreal resources, creating a landscape dominated by forest gardens (Ford and Nigh 2015). This debate is intricately tied to another facet of the human and environment interaction, which is that areas with heavily reduced forests experience increased soil erosion (Anselmetti et al. 2007: 915).

Archaeologists argue that agricultural intensification and deforestation decreased soil nutrition and crop production during the Late Classic period in the Peten region of northern Guatemala (Anselmetti et al. 2007: 915). The rate of soil erosion, or more specifically, the effect of wind and land clearing on erosion, is captured by a turbulent flow theory that expresses the mixing effect of wind in a set of values – the ‘roughness length’ (Figure 16. Shaw 2003: 161). Roughness length refers to the “surface air drag on the vegetation cover” (Shaw 2003: 161). As scholars have noted, the soil surface roughness created by agricultural practices significantly affects wind erosion of cultivated soil (Fryrear and Skidmore 1985; Zhang et al. 2004: 52). At Yaxha, a Precolumbian
Maya site in the northwest of the Peten, archaeologists argue that deforestation accelerated soil erosion, which in turn, hindered population growth during the Early Classic period (Deevey et al. 1979). Likewise, at Blue Creek, a site only 20 km northwest of Ka’kabish, archaeologists identified two phases of soil erosion - during the Preclassic and Late Classic periods (Beach et al. 2006). Although the environmental impact of land modification may have been intensified by densely settled Late Classic populations, studies of soil erosion rates found that the greatest soil loss occurred at some sites during the Late Preclassic period, centuries before the population boom of the Late Classic (Anselmetti et al. 2007; Beach et al. 2002). These researchers suggest that Pre Columbian populations reacted to accelerated rates of soil depletion by developing ways to mitigate erosion by the Late Classic Period. Similarly, at the site of Copan, in Honduras, McNeil et al. (2010) suggest that large-scale deforestation was caused during the Late Preclassic, but by the 5th to 10th century AD, forest cover increased. McNeil et al. (2010) argue that Maya urban populations managed their natural resources, causing “little

Figure 16: Roughness length in cleared and forested areas (modified from O’Brien 1996: 317; Shaw 2003: 163)
environmental alteration,” an interpretation referred to as the ‘Pristine Myth’ (Beach et al. 2006: 166).

### 3.3 THE PRECOLUMBIAN MAYA AND THE CONTEMPORARY WORLD

#### 3.3.1 Deforestation and Soil Erosion in the Current Era

The environmental impact of Pre-Columbian populations is important to contemporary society, as some of the most widely discussed repercussions of Maya land-use, such as deforestation and soil erosion, currently affect 21st-century global systems. For example, researchers recognize that soil degradation, particularly soil erosion, affects 1.9 billion hectares of agricultural land worldwide (Mabit et al. 2014). The mismanagement of agriculture and livestock production has affected more than three quarters of the surface land area in developing countries, raising concerns about the impact of soil erosion on crop productivity and the environment (Mabit et al. 2014: 4). While the Pre-Columbian Maya did not have the same suite of European livestock currently available to contemporary populations, it is important to understand pre-colonial landscape modifications and their effect on the environment. Historic examples of the Maya reaction to soil erosion and deforestation during the Late to Postclassic periods can add to an understanding of current social and political practices. For example, Ford and Nigh (2015) suggest that the forest garden, or more specifically, the Maya milpa cycle, was a sustainable agroforestry technique that may be successfully employed in the current era. These forest gardens allow for a variety of complex cultivation systems and are found in both ancient and contemporary Maya contexts (Atran 1993; Graham 1996: 23; Marcus 1982; Ross 2011; Wiseman 1978). Ford and Nigh (2015: 15) argue that current agricultural techniques, based on the European plowed field or grazed pasture, are designed to be used in treeless environments. Plowed fields and pastures, where they exist in the tropics and other parts in the world, create a deforested, soil-eroded, and monoculture environment – one that is viewed as unsustainable (Lichtfouse et al. 2009; Lithourgidis et al. 2011), causing a loss in natural plant diversity (Vandermeer et al. 1998), habitat loss, and decreased water quality (Foley et al. 2005).

#### 3.3.2 Human Niche Construction

Cultural niche construction is a biological evolutionary theory (see Laland et al. 2016) that has been applied to the settlement dynamics at Tikal to understand the human and environment interactions of the Pre-Columbian Maya (Scarborough and Grazioso Sierra 2016: 24).
The concept of niche construction is based on the idea that organisms alter their environments – that is, “their metabolism, their activities, and their choices, define, partly create, and partly destroy their own niches” (Odling-Smee et al. 1996: 641). Sometimes described as a phenotype (Odling-Smee 1988), niche construction refers to an organism’s interaction with, and modification of, an environment (Odling-Smee et al. 2003). It is based on “organism-induced changes” that affect or influence “their own, or other species’ evolution” (Kendal et al. 2011: 785). From an anthropological perspective, niche construction theory is used to understand the development of hydraulic systems in southern Mesopotamia, with early Sumarian populations making small incremental changes from “crevasse splays” to overflows, forming small areas of natural irrigation, which then led to the development of the “herringbone” type of irrigation (Wilkinson et al. 2012: 157-158). In another example, O’Brien and Laland (2012) apply the concept to the evolution of dairying by Neolithic groups in Europe and Africa. At Tikal, Scarborough and Grazioso Sierra (2015: 34) use the term to describe the way landscape modifications both enhance or degrade the environment. As O’Brien and Laland (2012: 435) acknowledge, in archaeology the concept sometimes loses its biological component, with authors instead focusing on cultural selection (see O’Brien and Holland 1995), however, the theories’ emphasis on alterations to the natural environment, especially regarding urban spaces, or the urbanscape, offers insights into the human condition. Like the research at Tikal, this study of Lamanai, Ka’kabish, and the inter-site settlement zone, attempts to understand important human and environment interactions by comparing settlement dynamics and evidence of landscape modifications to existing environmental data.

3.4 SUMMARY

One of the current problems in the study of the Precolombian Maya is that there is little agreement amongst Mayanists about the complex reciprocal feedback between Maya communities and their environment. One camp argues that human degradation of the environment caused the depopulation of the some of the major Late/terminal Classic sites, whereas others argue that Precolombian populations managed their resources to provide sustainable and resilient systems of sustenance. Interpretations are either rooted in the conditions of individual sites, with some Maya cities proving more resilient than others, or environmental conditions, specifically the anthropogenic effect on these conditions, are not a major cause of the demographic changes witnessed during the period
of collapse at the end of the 9th century AD. Perhaps, this period of instability is caused by political forces, rather than environmental ones. The settlement dynamics at Lamanai, Ka’kabish, and the inter-site settlement zone, can contribute to this ongoing debate by providing an example of the human response to environmental conditions from the vantage point of an area that continued to be occupied during the Late Classic, Terminal Classic, Postclassic, and Historic periods.
Chapter 4

METHODS: ANALYSING AND RECORDING PRECOLUMBIAN MAYA SETTLEMENT

The purpose of this chapter is to describe the methods and techniques that were used to record and analyse evidence of Precolumbian Maya occupation at Lamanai, Ka’kabish, and the inter-site settlement zone. The first section of the chapter describes the methods that were used to understand the settlement dynamics at Ka’kabish and Lamanai. The chronological phases of occupation for structures in the civic-ceremonial centre of each site were determined by reviewing field notes and site reports from earlier excavations. The second section describes the methods that were used to identify, map, and chronologically assess, structures in the inter-site settlement zone, referred to as Settlement Zones A to F, which I surveyed over the course of six field seasons, from 2010 to 2016. The third section discusses the methods that were used to compare the spatial and temporal dynamics of the study zone to the environmental data from the New River Lagoon. The fourth section describes the methods used to record, categorise, and present, the spatial and chronological information, which were entered into a GIS database (QGIS). I created spatial density maps and relative-risk surface maps to both visually represent and analyse data from structures in the civic-ceremonial centres and their peripheries. The final section reviews the strengths and weaknesses of my methodological approach.

4.1 LAMANAI AND KA’KABISH: RE-ANALYSIS OF EXISTING DATA

4.1.1 Interpreting Temporal Dynamics at Lamanai

The reconstruction of settlement change at Lamanai is based on existing data from unpublished fieldwork notebooks written by Pendergast. Data were reviewed and collated to explore time-space patterning of Maya activity at the civic-ceremonial centre.
in a far more detailed way than has been tried so far for Lamanai. The occupation date of each structure was identified using stratigraphic sequences, excavation records, architectural phases, and ceramic analysis. The centre of Lamanai contains 718 individual structures, each of which has been given a designation code. Archaeologists have excavated 80 of these structures over the last 35 years of investigation (Pendergast 1975, 1981, 1982b, 1983, 1985, 1986a, 1986b) (Figure 3). By analysing the chronological history of each excavated structure, the goal is to chart changes in the settlement over time and to see whether parts of the site were more actively occupied than others in Maya history (see Chapter 5 for the results).

Most of my own assessments about relative chronology, as well as those made in the Lamanai notebooks, are based on dating from clear primary depositional contexts, such as burials and caches. However, in some instances (particularly for the very late periods of possible occupation), material found in the surface levels of mounds are used to determine the last periods of occupation. Secondary deposits such as core materials have, in contrast, not been used as Pendergast preferred contextually secure deposits, under the assumption that core material is potentially very misleading as it reflects widespread site recycling activities. This view of the relative priority of primary and secondary deposits is not universal and in the inter-site settlement zone, the civic-ceremonial centre of Ka’kabish, Graham’s excavations (e.g. 2004) in the Ottawa Group (Str. N10-3), and the Stela Temple (Str. N10-27), non-primary material was used for dating purposes. Although core material is still available at Lamanai, most of the provenance labels have disintegrated. A working chronology has been established that uses phase names (e.g. Terclep) to distinguish between stratigraphic sequences (Graham 2004; Powis 2002). These sequences have been verified using radiocarbon evidence (Hanna et al. 2016). Several archaeologists analysed ceramics at Lamanai, with many of these studies culminating in major publications (see Aimers and Graham 2013; Graham 1987, 2004; Howie 2012; Powis 2002). Figure 17 shows the name of each proposed phase at Lamanai (and Ka’kabish), its associated Maya time-period, and their dates.
Figure 17: Comparing the chronology and ceramic complexes at Lamanai and Ka’kabish (modified from Graham 2004:25 and Sagebiel 2015:55) (see Chapter 5 for a list of the ceramics that comprise each group at each site)
4.1.2 Interpreting Temporal Dynamics at Ka’Kabish

At Ka’kabish, archaeologists have excavated in plazas, in certain structures, and in chultuns (Haines 2011a, 2012, 2014, 2015; Tremain and Haines 2013), and while these efforts clearly identified the earliest and latest evidence of occupation, it remains difficult to discern the date of individual structures from single unit plaza excavations. Because of this, the time-space reconstruction of Ka’kabish is limited to 5 structures in the civic-ceremonial centre. Tremain (2011) used looters’ trenches to identify the construction histories of two structures in the Plaza A and more recent excavations focused on the primary axis of 3 more structures (Haines 2015b). Archaeologists at Ka’kabish have identified phase names, their associated dates, and the name for the time period (Sagebiel and Haines 2015; Sagebiel 2015). The chronology of Ka’kabish is like Lamanai and uses well-established timelines in Maya archaeology. Figure 17 shows the name of each proposed phase name at Ka’kabish, its associated Maya time-period, and their dates. Because excavations at Ka’kabish are in their early phases, the reconstruction of Ka’kabish is not as complete, or as representative, as the sequences identified at Lamanai, however, the chronology is fine-grained enough to offer some general comparisons.

4.2 THE INTER-SITE SETTLEMENT ZONE: SURFACE SURVEY

To complement the time-space reconstruction of the civic-ceremonial centres of Ka’kabish and Lamanai, I have reviewed the small amounts of prior survey evidence between these two sites (referred to as the inter-site settlement zone), but more importantly have also conducted a fresh survey (with colleagues) to collect further information on the location, distribution, and organization of Pre-Columbian Maya structures (McLellan 2010, 2011, 2016, 2017). While some of this research is based on earlier investigations (Baker 1995; Patterson 2007), most of it was conducted as a part of this study under the wider umbrella of KARP (see pg. 49-54 for a discussion of the goals of the Ka’kabish project). Figure 18 shows the location of Ka’kabish, Lamanai, the inter-site settlement zone, and the areas surveyed by Baker (1995) and Patterson (2007). Some of the locations of the survey zones by Baker and Patterson were lost because of inconsistent recording methods and inaccurate GPS coordinates and do not appear on the map. I surveyed Settlement Zones A, B, and C, in 2010, 2011, and 2012, and Settlement Zones D, E, and F, in 2015 and 2016.
Figure 18: Map of the location of the inter-site settlement zone, Ka’kabish, Lamanai, and Coco Chan
4.2.1 Archaeological History of the Settlement Zone

Scholars have long recognized the potential for an archaeological study of domestic occupation in the area between Ka’kabish and Lamanai, particularly owing to the size of the two main sites and their proximity (only 10 km apart). The research conducted at Lamanai focused largely on the civic-ceremonial centre (see Glossary of Terms) and not on rural or hinterland settlement, which allows for a fuller depiction of the history of the region. The project at Ka’kabish has always featured a settlement survey component, but archaeological efforts have tended to concentrate on the centre of the site. Prior to the start of my project, the inter-site settlement zone between Ka’kabish and Lamanai was surveyed as part of two small, exploratory, projects – The Maya Research Project Survey and the Spring Mapping Project Survey (Baker 1995; Patterson 2007).

4.2.1.1 The Maya Research Project Survey

In the mid-1990s, an effort was made to survey, map, and record, evidence of domestic occupation between Ka’kabish and Lamanai. Baker (1995) used cleared milpa fields on either side of the road to identify various residential groups, range buildings, and major temple structures. All areas cleared of bush, which comprised a few milpa fields and logging roads, were plotted, with random surface collections of diagnostic ceramic sherds taken from ruined structures. In total, the Maya research project identified 64 Pre-Columbian Maya structures, which Baker posited were “house mounds” – i.e., the remains of residential dwellings. As Baker notes (1995), most of the house mounds he detected are located close to Lamanai, a reflection of the fact that, at that time, land clearing for milpa farming took place near Lamanai. Most of the formerly cleared fields close to Lamanai are now abandoned and overgrown, although a few remain in the care of small-scale landowners. Abandonment by farmers of these formerly cleared fields, along with issues related to inaccurate map coordinates, made it difficult to re-locate Baker’s structures. Patterns of land clearing have also changed since the time of Baker’s work. Most of the fields 3 km northwest of Lamanai are now owned by farmers who use industrial-era technologies to clear, plant, and harvest, large tracts of land.

Surveyors and remote sensing specialists have identified problems with the accuracy of GPS systems (Piedallu and Gegout 2005), especially during the era of Baker’s archaeological project at Lamanai and Ka’kabish. While I was able to use some of his
maps to identify structures in the inter-site settlement zone (for example, the civic-ceremonial centre of Coco Chan), the GPS coordinates were mostly inaccurate, with many points appearing in random, implausible locations. Added to this, other GPS points were either missing, or incorrectly recorded. For these reasons, Baker’s report was primarily used as a guide for further study, but his data were not incorporated into the larger database.

Along with the issues of inaccuracy of older coordinate systems, the ceramic information was not reported in a way that made it usable. Baker’s random surface collection yielded 186 sherds. These were categorized based on provenance, number, classification, and functional period. Many of these sherds were labelled non-diagnostic, with uncertain time periods; 27 of these were labelled “Rim Sherd - Late Classic.” Unfortunately, Baker failed to record the type-variety designation of the diagnostic pieces. In any case, I was unable to find or restudy these sherds. They are either now lost or stored in an unknown location.

One of the most important parts of Baker’s study focuses on 5 major temple structures mid-way between Ka’kabish and Lamanai, which he surmised constituted a site on its own, and may have acted as a buffer between the larger cultural centres (Baker 1995). The site was named Coco Chan. Figure 19 shows the size and orientation of the civic-ceremonial centre. The larger structures were easily relocated and remapped, and feature in the section on Settlement Zone D, which will be discussed in Chapter 6 (see Figure 54). Baker’s original map was the first archaeological indication of a minor centre between Ka’kabish and Lamanai. Although a large portion of Baker’s data could not be used owing to the technological inaccuracies and incomplete ceramic analyses, the project revealed previously unknown settlement between these two major cultural centres (Baker 1995: 35).

4.2.1.2 The Spring Mapping Project Survey
In 2007, Patterson (2007) revisited Coco Chan, which was originally mapped by Baker (1995), and surveyed an area roughly half a kilometer south of the civic-ceremonial centre. Patterson referred to this area as Chomokeil. At Chomokeil, an area that covers
roughly 0.18 sq. km, Patterson identified 8 mounds, one multi-mound group, and 16 artefact scatters. Figure 20 shows a simple point distribution of the location of these features and their relation to the road system. Patterson (2007: 46) observed that the mounds, which he proposed were the ruins of domestic or residential structures, were severely damaged by agricultural activities. Unlike Baker’s (1995) study, Patterson recorded artefact scatters, or concentrations of ceramic and lithic materials, that were unassociated with stone platforms. The goal of this method was to identify buildings or other structures that lacked stone platforms. In hindsight, as Patterson notes (2007:46), the scatters were most often in the proximity of mounds and likely resulted from post-occupational activity such as mound destruction and spread.

Along with the area referred to as Chomokeil, Patterson surveyed several other fields adjacent to Ka’kabish. The fields had only recently been harvested for sugar cane, which significantly reduced visibility (Patterson 2007: 52). Patterson was still able to identify and map four mounds, three multi-mound groups, and seven artefact scatters.
Figure 20: Map of the settlement south of the major temple structures at Coco Chan and northwest of Settlement Zone E (Patterson 2007: 57) (see Figure 18 for the location of Patterson’s survey zone)

Figure 21 shows a point distribution of the mound groups and artefact scatters and their relation to the civic-ceremonial centre of Ka’kabish. Although Patterson suggests that the area outside the site core was densely settled in the past, it is difficult to discern the nature of habitation as the surface visibility was low and the land was heavily altered by agricultural activities (Patterson 2007: 53). The fields adjacent to Ka’kabish have been used for agriculture for many years (if not decades) and it is common for landowners to level mounds with bulldozers to increase the area of flat land and hence, increase their crop yield.
As part of my project, Patterson’s field was revisited to attempt to incorporate his data into the inter-site settlement zone study but owing to the changing landscape and mislabelled (or missing) artefact tags, his data were excluded. Patterson’s settlement survey nonetheless expanded our knowledge of both the size of Ka’kabish and Coco Chan.

Aimers (2007a) conducted the ceramic analysis of the sherds collected by Patterson from the surface of the structures in the settlement zone. Most of the rim sherds were from “large unslipped jars with outcurving necks,” with a “diagnostic encircling ridge several centimetres below the rim,” which Aimers (2007a: 66) commented are typically from “Late Classic striated jars.” As Aimers (2007a: 66) noted, these jars have several type-variety designations such as Dumbcane Striated (Fry 1987, 1989), Calderitas Heavy Plain
(Ball 1977; Sanders 1960), Sisal Unslipped (Smith 1955), and Tu-Tu Camp Striated (Valdez 1987). Similar types of pottery were also identified by Aimers (2007a: 66) at Lamanai and in the Albion Island collections at the Institute of Archaeology, in Belmopan, Belize. While these results seem to suggest that structures in the settlement zone were occupied during the Late Classic period, Aimers (2007a: 66) confessed that further research was needed to verify these designations. In 2013, Sagebiel replaced Aimers as the ceramicist for the project and reanalysed all the materials collected in previous seasons. The “large unslipped jars” were formally identified as Dumbcane Striated and reassigned to the Terminal Classic period.

As noted above, many of the structures discovered by Patterson could not be relocated because there were damaged or destroyed by subsequent agricultural activities. Patterson also failed to report the dimensions and orientation of the multi-mound groups, referring to them only by a single GPS coordinate. Although these inaccuracies prevented the incorporation of Patterson’s data, I attempted to locate and reanalyse the ceramics that were associated with the structures south of Coco Chan, at Chomokeil. The ceramics were improperly labelled, without designations or lot numbers, and subsequently discarded. Like Baker’s project, Patterson’s work was used as a guide, but the spatial distribution, density, and chronological reconstructions, were not incorporated into my study of the temporal dynamics of the inter-site settlement zone.

4.2.2 Survey and Mapping Techniques
As in many other studies in the Maya region that focus on commoner populations, I used standard survey techniques, with topographic mapping of above-ground mounds, archaeological reconnaissance via fieldwalking in lines, and surface collections to identify natural, cultural, and chronological features (see Robin et al. 2012: 39). Each field was surveyed by a group of three archaeologists, who systematically walked in 5-meter intervals, using pin-flags to identify and assess the distribution of artefacts across the landscape. The team was briefed on several factors that affect the archaeologists’ ability to locate cultural materials, such as the speed of the surveyor, the spacing of the survey, and whether the surveyor walks towards or away from the sun (Banning et al. 2011). Every structure in the inter-site settlement zone is visually shown on maps using the “schematic method of representation,” a technique used to create the maps at Lamanai and Ka’kabish (Figure 2 and 6). The schematic method of representation is used to
capture the size, height, and orientation of ruined structures, with larger shapes representing larger structures (see Carr et al. 2015: 60-61). Identifiable mounds, or ruined structures - remnants of limestone platforms - were surveyed and concentrations of artefacts were flagged and collected for analysis. Limestone platforms were commonly used by Maya populations to raise their residences off the surface of the ground.

Surveyors collected diagnostic sherds – rims and decorated/painted sherds – and complete lithic tools on the surface of the structures, using the edges of the debris field to demarcate the extent of the collection. Diagnostic sherds were collected to determine the chronology of structures and complete lithic tools were collected to determine the function of structures. Non-diagnostic artifacts were sometimes flagged, but uncollected due to the size and weight of the assemblage. We pin-flagged and collected a concentration of materials that were unaccompanied by platform structures and in such cases, this was referred to as an artefact scatter. This latter method was used to potentially identify Preclassic structures that were built directly on the surface of the ground. However, based on observations in the field, it seems that these concentrations are mostly indicative of damaged or destroyed buildings, as they were often found in proximity of ruined structures. In some cases, local farmers and contracted labourers are known to use heavy equipment to bulldoze archaeological features because ploughing is particularly difficult in the ruins of densely occupied Preclassic settlements. In these fields, limestone, ceramics, and lithic materials, are distributed across the landscape, making it difficult to identify individual structures. We did not encounter evidence of bulldozing in the inter-site settlement zone, but many of the structures were damaged from land clearing practices. In many cases, ceramic and lithic materials are found scattered inbetween ruined platform structures. We ignored these materials because they could not be attributed to specific structures.

A handheld Trimble GPS was used to record the position of concentrations of material culture that were associated with platform structures. We recorded a coordinate every second, walking an outline around the structure, and then in a rough cross shape to capture the apex of the ruin. Figure 22 shows an image of a structure recorded in Survey Zone F. Figure 23 shows a 3D wireframe of the same structure. This method was used to capture an accurate recording of the size, shape, orientation, and height of each Preclassic platform.
Figure 22: Ruined platform structure in Settlement Zone F (Str. F18) (see Appendix A)

Figure 23: 3D Wireframe of ruined platform structure in Settlement Zone F (Str. F18) (see Appendix A)
Most importantly, the 3D wireframe displays the degraded nature of the structures, which are often missing larger pieces of cut limestone, either because they have been removed by contemporary farming populations, or because they were salvaged and reused by Maya populations sometime throughout history.

**4.2.3 Field Conditions**

Our overall survey strategy in the inter-site settlement zone was to maximise good quality visibility by opportunistically surveying sections of the landscape between Ka’kabish and Lamanai that had been cleared for maize agriculture several months prior to investigation. Each season we surveyed a new section of the deforested landscape. Landowners have been considerably expanding their landholdings in the areas between Lamanai and Ka’kabish. To exploit the value of their properties, they have been clearing the tropical forest, ploughing the topsoil and planting maize. While this is potentially detrimental to local plant and animal populations, current land-clearing practices reveal Precolumbian Maya structures. Repeated seasons of intensification threaten to destroy, or obscure, domestic structures and landscape modifications. After several seasons the productive potential of the field starts to diminish, and it is used for cattle grazing. Contemporary land modifications make it difficult to identify archaeological materials. Figure 24 shows the field conditions found south of a road that connects the Belizean settlements of Indian Church, Shipyard, San Felipe, and Indian Creek – referred to as Survey Zone D. Several structures are visible in this image, which are identified by the collapsed and disturbed remains of the Precolumbian Maya platforms. The limestone core of structures is scattered over raised ‘mounds’ on the landscape. Figure 25 shows the condition of agricultural fields in Settlement Zone E. In this image, several structures are visible in the distance, surrounding the architectural centre of Coco Chan, which is still covered by forest. Coco Chan is identifiable in the image by the raised treeline on the horizon. The area was surveyed and mapped but owing to the forest setting of the civic-ceremonial centre of Coco Chan, we did not collect any ceramic, lithic, or faunal materials from the surface. Furthermore, it should be noted that owing to its proximity to several roads and villages the structures at Coco Chan are heavily damaged and looted. In the future, it may be beneficial to determine the occupation history of Coco Chan by mapping the looter’s trenches that bisect the major temple structures of the civic-ceremonial centre.
Figure 24: Conditions of the agricultural fields in Settlement Zone D

Figure 25: Conditions of the agricultural fields in Settlement Zone E
Initial reconnaissance was conducted in some of the forested areas surrounding Coco Chan to confirm the presence of Precolumbian Maya structures, but they were not systematically surveyed and recorded. These areas were only partially investigated because we wanted to keep the field conditions of the survey consistent across the inter-site settlement zone. As mentioned, the forest cover greatly reduces the visibility of archaeological remains, making it difficult to compare the settlement pattern of areas with different field conditions.

4.2.4 Ceramic Assemblages

To determine the date of individual structures, ceramics from the settlement zone were compared to existing ceramic typologies (see Chase 1982b; Gifford 1976; Masson and Mock 2004) (see Figure 17 for a list of the types identified in the settlement zone). The pottery from the inter-site settlement zone was analysed by Aimers (2007a, 2011) and Sagebeil (Sagebeil and Haines 2015). For each settlement zone, I analyzed the distribution of types of ceramics and the distribution of sherds across the landscape. This information is presented in tables, histograms, and spatial intensity maps. The ceramic data is presented in table form to highlight differences in the density of types in each settlement zone (i.e. Dumbcane Striated comprises 11% of the total number of sherds found in Settlement Zone A). The histograms are used to show a comparison of the number of sherds found at each structure. These graphs demonstrate the disparity in the number of sherds found across the settlement zone (i.e. At Str. E24 we found 184 sherds vs. at Str. E19 we found 2 sherds). Spatial intensity maps provide another way to look at the distribution of sherds across the landscape. Areas shaded in red indicate higher concentrations of sherds in Settlement Zone A to F (for a full discussion of the techniques used to create the spatial intensity maps see pg. 109-111). The composition and distribution of sherds across the landscape is important because each settlement zone is in different social and political spheres (see Figure 26).

4.2.5 Lithic Assemblages

I collected and analysed lithic materials from the inter-site settlement zone as part of this project, recording the size, weight, and shape of the materials. The assemblage includes complete and incomplete chipped and ground stone tools. I recorded the geographic location of the materials, which were always found associated with structures in Settlement Zones A to F. The lithic data appears in Appendix C. In Chapter 6, I provide
a description of the lithic materials and their relation to the function of the structures in the settlement zone (pg. 194). The lithic data is also used to identify differences in the distribution of artefacts in Settlement Zones A to F.

4.3 GEOMORPHOLOGY AND LANDSCAPE ECOLOGY
A major goal of my study is to compare the spatial and chronological reconstructions of Ka’kabish, Lamanai, and the inter-site settlement zone to existing environmental data (Howie 2012; Metcalfe 2009; Rushton et al. 2013). The objective of this research is to assess the environmental impact of Precolombian populations. The environmental data are based on diatom and stable isotope analyses of cores collected from the New River Lagoon (Metcalfe 2009). Researchers used the same cores to investigate changes in vegetation and the plant community from 1500 BC to AD 1500 (Rushton et al. 2013). These studies provide an environmental understanding of changes in the landscape over the course of Precolombian Maya occupation, but in the absence of reconstructions of settlement dynamics over the same period, these data have been assessed in an analytical vacuum. By reevaluating the environmental data and comparing the data to the settlement dynamics at Ka’kabish, Lamanai, and the inter-site settlement zone, I aim to understand the human and environmental interaction over the course of several millennia (see Chapter 7 for the results).

4.4 PRESENTATION AND ARRANGEMENT OF DATA
4.4.1 Designation of the Settlement Zone
For Settlement Zones A to F, permission was required from each property owner prior to conducting archaeological research on their land. We obtained a map of the land parcels in the study area and attempted to remain within the boundaries of the landowner’s properties. Figure 26 shows the current distribution of land parcels and the location of Lamanai, Ka’kabish, Coco Chan, and Settlement Zones A to F. The survey zones are located at different distances from the monumental centres of Lamanai, Ka’kabish, and Coco Chan. Settlement Zone A is adjacent to the major architectural structures that comprise the core of Ka’kabish. Settlement Zone B is in the periphery, or hinterland, of Ka’kabish. Settlement Zone C is in the periphery of Coco Chan and extends northward towards Ka’kabish. Settlement Zone D is next to the civic-ceremonial centre of Coco Chan. It covers the area immediately south of the architectural core and connects to
Figure 26: Current land parcels and the location of Lamanai, Ka’kabish, Coco Chan, and Settlement Zones A to F.
Settlement Zone E, which is south of the road. Settlement Zone F is mid-way between Lamanai and Coco Chan. The survey zones are analysed in Chapter 6 to highlight differences in the distribution, density, and chronology of individual structures in each location.

4.4.2 A Heuristic Device
To facilitate inter-settlement and inter-site comparisons, each settlement zone is categorized in a morphological system based on structural features and relative placement location. The criteria employed were originally developed by the Xunantunich Settlement Survey Project (Ashmore et al. 1994: 266; Yaeger and Connell 1993: 184-186), and later applied by the Social Archaeology Research Project (Longstaffe 2011), at the Precolumbian Maya site of Minanha in the north Vaca Plateau of west central Belize. The criteria used to classify settlement are the maximum height of structures, the number of structures, their arrangement in space, the presence or absence of a focal mound, and the maximum height of mounds within a group (Ashmore et al. 1994: 265). Table 1 provides the numbered types and the criteria by which they are assigned.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Isolated mound less than 2 m high</td>
</tr>
<tr>
<td>Type 2</td>
<td>2-4 mounds informally arranged; all less than 2 m high</td>
</tr>
<tr>
<td>Type 3</td>
<td>2-4 mounds orthogonally arranged; all less than 2 m high</td>
</tr>
<tr>
<td>Type 4</td>
<td>5 or more mounds informally arranged; all less than 2 m high</td>
</tr>
<tr>
<td>Type 5</td>
<td>5 or more mounds with at least 2 arranged orthogonally; all less than 2 m high</td>
</tr>
<tr>
<td>Type 6</td>
<td>1 or more mounds with at least 1 with a height between 2 m and 5 m</td>
</tr>
<tr>
<td>Type 7</td>
<td>1 or more mounds with at least 1 with a height over 5 m</td>
</tr>
</tbody>
</table>

Table 1: Morphological system based on structural and locational features

4.4.3 Sherd Density
The density of ceramics in each survey zone was visualized as a continuous density surface via interpolation of the frequency of finds over space using a geostatistical technique called kriging (Stein 1999) (for an example of a spatial intensity map, see pg. 182). This approach uses measured values to interpolate unknown values, which is a common method for spatially autocorrelated data, such as ceramic and lithic assemblages.
(Foster 2007: 82; McCoy and Johnston 2002: 221). For the settlement data, maps display the ceramic frequencies at collection points in each survey zone. As mentioned, collection points are defined by the debris field of ruined platform structures. The analytical window of each area is defined by the limits of the survey zone, except for Settlement Zone C, which has large areas without evidence of Pre-Columbian Maya occupation (for a discussion of Settlement Zone C, see pg. 157). In the case of Zone C, an arbitrary distance (75 m) was used to create an analysis mask, which limits the extent of the analytical window. The interpolated surface maps track only the number of sherds identified at each individual structure, rather than the dates of finds at each structure.

Also, the data points are from ceramic collections on top of the mounds, rather than between them. We limited the collection to the top of the structures for practical reasons (the number and weight of sherds) and analytical reasons (to collect sherds that could be attributed to specific structures). The surface maps are used to identify concentrations of ceramics and may indicate differences in the composition of the settlement. Spatial intensity maps are also used to show the distribution of settlement at Lamanai and the inter-site settlement zone. The blue-to-yellow colour scheme indicates areas with low-to-high intensity of occupation in a specific time period (without considering the chronology of other structures in the survey zone, which will be addressed by relative-risk surfaces) (see pg. 125 for an example of a spatial intensity map and a relative-risk surface map).

4.4.4 Relative-Risk Surfaces

To understand the distribution of structures both spatially and chronologically, the data are further analysed using a form of ratio-based mapping referred to as a relative-risk surface (Bevan 2012: 500; Kelsall and Diggle 1995) (for an example of a relative-risk surface, see Figure 33, c). This approach is commonly used in epidemiological studies to examine the dispersal of diseases and the spatial variation of disease risk (Bevan 2012: 500; Davies et al. 2011: 1). The mapping uses a calculation of the ratio of the kernel density estimation of “observed cases” to an at-risk population (Bevan 2012: 500; Hazelton and Davies 2009). In archaeology, similar ratio-based surfaces have been used to investigate differences in the proportion of ceramics from different historical periods, such as Middle Roman to Late and Early Roman (Bevan et al. 2013a: 324). At Lamanai, I used this technique to illustrate differences in the intensity of settlement over multiple time periods. I compared a “case” (i.e. Terminal Classic period) to a “control” (all the other time periods) (see Bevan 2015). The relative-risk surface allows me to see if
portions of Lamanai were more intensely occupied in different periods of Pre-Columbian Maya history. I also applied this technique to Settlement Zone B and F to highlight the expansion in settlement from the Late Classic to Terminal Classic and Early Postclassic periods (see pg. 279). In the relative-risk surface maps, the blue-to-beige colour scheme indicates low-to-high intensity of occupation in specific periods of Pre-Columbian Maya history (as compared to the chronology of other structures in the study zone) (see Bevan 2012 for a full discussion of the quantitative methods used to create relative-risk surfaces).

4.5 METHODOLOGICAL JUSTIFICATION AND LIMITATIONS

4.5.1 Methodological Justification

Transect surveys are extensively used in the Maya area to understand the composition of Pre-Columbian Maya societies (Folan et al. 2009; Healy et al. 2007; Hutson et al. 2008; Puleston 1983). This project adds to a growing list of studies on ancient examples of sustainability and resilience by focusing on the character of the urban environment and its supporting hinterland (Chase and Chase 2007; Scarborough et al., 2012a). One of my goals is to document the composition and distribution of sprawl surrounding an ancient city, which scholars argue can provide context for interpreting variations in urban and rural settlement in the contemporary world (Fletcher 2009; Smith 2010). Of interest is the relationship between structures and greenspace (Graham 1999b), because potential patterns can inform contemporary models of urban and peri-urban agriculture.

4.5.2 Methodological Limitations

There are several limitations to this study: the type-variety method for pottery studies, the duration of archaeologists’ temporal categories, the site formation processes of the inter-site settlement zone, the lack of prolonged and sustained excavation strategies in the civic-ceremonial centre of Ka’akibish, the number of small structures at Lamanai that cannot be dated owing to an absence of primary deposits, the typology used to define groups of structures, and problems with the full colour scale visualisation technique used to show ceramic distributions.

Archaeologists sometimes question the reliability of matching materials to published reports (Aimers 2012; Chase and Chase 2012b). This is particularly relevant to ceramicists who analyse artefacts collected from the surfaces of structures. The extensive
history of excavations at both Lamanai and Ka’kabish has refined the understanding of
the common types of ceramics and their respective dates. Populations from the inter-site
settlement zone are likely key contributors and consumers of materials found in the civic-
ceremonial centres. These materials have been validated through an analysis of
stratigraphic sequences and radio-carbon dating.

Another common problem with time-space reconstructions is that they rely on arbitrarily
distinguished periods of time. The project uses several established periods of time such as
the Terminal Classic, which covers 200 years of Precolumbian Maya history. The most
notable problem is that the periods cover multiple human generations of occupation.
Reconstructions can only provide sweeping generalizations and identify broad trends in
the data. This level of analysis does not permit fine-grained recreations of settlement
dynamics, but the trends are well-suited for human and environmental comparisons.

As mentioned, some of the survey zone has been intensively used for both crop
production and cattle ranching. In fact, it is likely in the next several years that the entire
inter-site settlement zone will be deforested. There are two encroaching communities,
Indian Creek and Shipyard, both with expanding Mennonite populations. Mennonites
have purchased many of the individual plots of land between Ka’kabish and Lamanai.
Sometimes, the Mennonites are cooperative and agree to avoid areas of occupation,
preferring to open a dialogue with the archaeologists and by extension, with the Institute
of Archaeology in Belize. In other cases, they pursue their own agendas. Processes of
agricultural intensification can sometimes destroy entire areas of Precolumbian
settlement. Individual structures, with their accompanying ceramic materials, are vital to
this study. It is not uncommon for these structures to be erased from the archaeological
record. To prevent this, I have visited many of the individual landholders to gain
permission to use their land and to demonstrate the validity of archaeological
investigation.

One of the major goals of the Ka’kabish archaeological research project was to define the
chronological sequence of monumental architectural development of the civic-ceremonial
centre (see Haines 2008, 2011b, 2014). Tremain (2011) demonstrated the importance of
identifying architectural phases in trenches in the monumental architecture, but
unfortunately, only applied this method to Str. D4 and Str. D9. There are still many
undocumented looter’s trenches at Ka’kabish. Perhaps, this work can continue in the future. Until then, the reconstruction of the settlement dynamics at the civic-ceremonial centre is limited to five structures.

A morphological system is used to define the distribution of structures at Ka’kabish, Lamanai, and the inter-site settlement zone. It is based on criteria, or characteristics, of the settlement pattern, such as the number of structures, the height of structures, and the arrangement of the structures (orthogonally or informal) (see pg. 109). The typology categorizes the settlement pattern into seven possible arrangements, which allows for intra-site comparisons. The problem with the typology is that different sites use different methods, and typologies, to record structures, which makes inter-site comparisons potentially problematic. Added to this, the areal extent, or the scale, of the analysis can introduce ambiguities, or biases, in defining the types of settlement. For example, seven structures arranged informally can potentially be defined as Type 2 or Type 5. In this case, I use other criteria, such as the distance between individual structures, or the distance between groups of structures, to define the types of settlement.

To investigate patterns in the density of ceramics in the inter-site settlement zone, I created spatial intensity maps. As mentioned, these maps use measured values (the number of ceramics at each structure) to interpolate unknown values (the number of ceramics between each structure). To accurately predict unknown values, it is vital to have a high number of known values. For the most accurate reconstruction of the spatial distribution of ceramics in the inter-site settlement zone, I should have mapped and collected each individual sherd. Because of time constraints (and physical constraints), this was impossible. In some cases, I encountered low-density artefact scatters that were unaccompanied by the debris field of ruined structures. The distribution of sherds between structures has the potential to introduce interpretive ambiguities, especially if high concentrations of sherds are found without structures. As mentioned, the highest density of sherds was found in the debris field of ruined structures, with lower densities surrounding the ruined structure. Because of the relationship between the structures and the number of sherds, the spatial intensity maps provide a reasonably accurate portrayal of the distribution of artefacts.
4.6 SUMMARY
To understand changes in the historical trajectory of Lamanai, Ka’kabish, and the inter-site settlement zone, I use several different methods: 1) reanalysis of existing notes and publications on the civic-ceremonial centres of Lamanai and Ka’kabish, 2) traditional field-based survey, mapping, and artefact collections in the inter-site settlement zone 3) reassessment of the environmental data from cores adjacent to the New River Lagoon in light of settlement dynamics, and 4) geospatial analysis, using kriging, interpolation, and relative-risk surfaces, to visualise the spatial and temporal trends in the database. By combining the various analytical techniques, the goal is to understand settlement change at Ka’kabish, Lamanai, and the inter-site settlement zone, and to explain the developmental history of the region.
Chapter 5

THE CIVIC-CEREMONIAL CENTRES OF LAMANAI AND KA’KABISH

The purpose of this chapter is twofold: 1) to discuss the ceramics that were identified at Lamanai and Ka’kabish and assess their chronology, 2) to use the spatial distribution and chronological reconstruction of the civic-ceremonial centres to understand settlement changes over time. This work takes a fresh look, particularly at the excavation archive from Lamanai, and seeks to portray the data with a focus on time-slice views of each site.

5.1 THE CHRONOLOGY AT LAMANAI

The reconstruction of the chronology of the civic-ceremonial centre of Lamanai is mostly based on the unpublished excavation notes made available to me by Pendergast. Appendix A shows a complete list of each excavated structure and the periods that have (or are lacking) evidence of occupation. Many of the dates of the structures have been mentioned in site reports and other scholarly publications (Graham 1987, 1991, 1998, 2011; Mayfield 2015; Pendergast 1981, 1982a, 1985, 1986a; Powis 2002). Pendergast (1981: 43) argues that the “progress of life [at Lamanai] continued almost unchecked and perhaps even enriched in some respects” in the Postclassic. This description has nurtured a widespread acceptance of Lamanai as a site that survived the Late Classic to Early Postclassic transition. However, little work has been done to present the chronology of individual structures and their temporal and spatial dynamics (Pendergast 1981: 43). In the following section, the individual dates of structures from Middle Preclassic (1000-400 BC) to Early Classic (AD 250-600) periods are summarized first, with Late Classic (AD 600-900) to Late Postclassic (AD 1250-1521) occupation dates described in later sections.
5.1.1 Evidence from the Middle Preclassic to Early Classic periods

Powis (2002: 63) conducted a taxonomic, modal, contextual, functional, and technological study of 140 complete vessels at Lamanai. The vessels, which were excavated by Pendergast, were found in many different contexts, including caches, hearths, middens, burials, collapse debris, and core. For this study, only primary contexts at Lamanai are considered representative of occupation. Because of this, sherds from core and collapse debris contexts are ignored. While this interpretative decision limits the amount of the data derived from Powis’ study, several Middle and Late Preclassic occupation dates can be applied to the temporal reconstruction presented in this thesis.

The following structures have evidence from primary contexts of Middle and Late Preclassic occupation: Str. N10-43, Str. P8-14, Str. P8-11, Str. P8-9, Str. P8-103, and Str. N10-27 (see Figure 3 for the location of the structures).

At Str. N10-43, archaeologists recovered four vessels from a hearth that was associated with a platform located underneath the High Temple, a structure constructed sometime during the 1st century BC (Powis 2002: 101). These vessels were assigned to several different type:varieties, including: Sierra Red: Sierra Variety, Laguna Verde Incised: Grooved-incised Variety, and Puletan Red-and-unslipped: Composite Variety (Pring 1977; Sabloff 1975; Smith and Gifford 1966). As Powis (2002: 104) noted, Sierra Red is the “principle type in the ceramic assemblages at most Late Preclassic lowland Maya sites” and has been identified at many sites, such as Chiapa de Corzo (Lowe and Agrinier 1960), Ek Balam (Bey et al. 1998), K’axob (Lopez Varela 1996), Kichpanha (McDow 1997; Meskill 1992), among others. Unlike Sierra Red varieties, which are commonly found at Late Preclassic sites, Laguna Verde Incised – specifically the Grooved-incised variety – is relatively rare and may be “somewhat unique in Northern Belize” (Powis 2002: 129). The other ceramic vessel identified from the hearth, Puletan Red-and-unslipped: Composite Variety, is mostly found in Northern Belize sites in Late Preclassic deposits with Sierra Red types (Powis 2002: 110). Figure 27 shows an example of each of these types and their specific variety.

At Str. P8-14, excavations revealed “a single-phase platform that contained five burials and one cache” (Powis 2002: 306). While the burials did not contain any grave goods, a cache contained two intact vessels dated to the Late Preclassic Period. Like Str. N10-43, both of these vessels were identified as Sierra Red: Sierra Variety (Powis 2002: 309-314).
Figure 27: a) Sierra Red: Sierra Variety; b) Leguna Verde Incised: Grooved-incised Variety; c) Puletan Red-and-unslipped (Powis 2002: 103, 108) (Illustrated by Louise Belanger)
As Powis (2002: 312) noted, these medially ridged vessels were also found at Cerros (Robertson-Freidel 1980: 17a-d) and Tikal (Culbert 1993: Figure 13b). Archaeologists uncovered several middens at Str. P8-11 associated with specific architectural phases. The first domestic midden deposit contained two ceramic vessels along with a large amount of animal bone, shell, and charcoal (Powis 2002: 180). These vessels were identified as Lechugal Incised: Gouged-incised Variety and Sierra Red: Variety Unspecified (Red-double slip). Powis (2002: 180) noted that the Lechugal Incised type is like a variety identified by Forsyth (1983) at Edzna. Figure 28 displays an illustration of both ceramic vessels.

Figure 28: a) Lechugal Incised: Gouged-incised Variety; b) Sierra Red: Variety Unspecified (Red-double slip) (Powis 2002: 182) (Illustrated by Louise Belanger)
Several other vessels were discovered associated with two other middens at Str. P8-11, but for the purposes of this study, the first midden provides a secure Late Preclassic date.

At Str. P8-9, archaeologists excavated 4 individual burials and a cache (Powis 2002: 118-158). Various ceramic vessels were interred with each burial that were indicative of the Late Preclassic period at Lamanai. Most of these types, such as Sierra Red: Sierra Variety and Lechugal Incised: Gouged-incised Variety, have already been mentioned associated with other structures, such as Str. P8-11 and Str. N10-43. For this study, it is important to note the variability in the type-variety collection of the Late Preclassic from the civic-ceremonial centre of Lamanai, as many of these types are also found in the inter-site settlement zone and at Ka’kabish.

In burials and a cache, Powis (2002: 131, 142, 155) identified several types, such as Polvero Black: Polvero Variety, Flor Cream: Variety Unspecified, and Alta Mira Fluted: Variety Unspecified (Figure 29). For Polvero Black, Powis (2002: 134) noted that this type appears at many sites in the Maya area, particularly where there is an abundance of Sierra Red. Many sites have reported this type, including Cahal Pech (Awe 1992), Colha (Adams and Valdez 1979), Holmul (Kosakowsky 2001), among others. Flor Cream is another common type:variety found in the Maya area, with related forms found at Cuello (Kosakowsky 1987), El Mirador (Forsyth 1986, 1989), Yaxchilan (Lopez Varela 1989, 1992), among others. The other type:variety identified from the burial, Alta Mira Fluted: Variety Unspecified, is again commonly found with other Sierra Red types and has been identified at Komchen (Andrews IV 1988) and Nakbe (Forsyth 1993).

At Str. P8-103, Powis (2002: 444) noted that several excavation units revealed a long architectural sequence starting as early as the Middle Preclassic and continuing until the Terminal Classic period or later. Specifically, a burial containing four pottery vessels dated the earliest structure to the Middle Preclassic (Powis 2002: 444). Another burial at Str. P8-103 was accompanied by three vessels dated to the Late Preclassic period, each of which was assigned to the Sierra Red type. A third burial was found associated with a structure that was razed for later construction and was contemporaneous with a Protoclassic midden found in a nearby chultun.
Figure 29: a) Flor Cream: Variety Unspecified; b) Alta Mira Fluted: Variety Unspecified; c) Polvero Black: Polvero Variety (Powis 2002: 131, 145) (Illustrated by Louise Belanger)
The “Protoclassic” period has caused some confusion with Maya archaeologists, but it is generally used to refer to ca. 75 BC-AD 400 (see Brady et al. 1998).

At Str. N10-27, archaeologists uncovered a cache that was indicative of the Late Preclassic period. As Powis (2002: 280) mentioned, this axial cache was sealed by a Preclassic stair and contained a single ceramic vessel and a large albite barrel-shaped bead. Like many of the other contexts, this vessel was identified as Sierra Red: Variety Unspecified, a type that was previously mentioned associated with Str. P8-11 and Str. N10-43.

5.1.2 Evidence from the Late Classic to Late Postclassic periods
As mentioned, Pendergast and others have produced publications that pertain to the dating of individual structures from the Late Classic to Late Postclassic periods. At Str. N10-9, the Jaguar Temple, in a central section of the site, an initial stair modification was dated to the Late Classic, or sometime in the 8th century, while a second stair-side outset was constructed in the Early Postclassic period (Pendergast 1981: 35). Another structure north-east of Str. N10-9, referred to as Str. N10-2, contained a few burials with Early Postclassic or Buk phase pottery (Pendergast 1981; Wrobel and Graham 2015). At Str. N10-2, a pottery maskette depicting an individual wearing a reptilian headdress was dated to the Early Postclassic (Figure 30) (Pendergast 1981: 38).

Figure 30: Pottery maskette with crocodile headdress (Pendergast 1981: 38)
The chronology of this structure and that of the Ottawa Group has been recently correlated with radiocarbon dates (Hanna et al. 2016).

At Str. N10-7, excavations yielded several dates, suggesting that major construction started in the Terminal Classic period (ca. 9th century) and continued at least until the Early Postclassic period (ca. 10th through 11th centuries) (Pendergast 1981: 43). Further evidence of burials in the upper core of Str. N10-7 also suggest the structure was in use in the Early Postclassic. Similarly, at other burials in Str. N10-1, immediately east of Str. N10-2, archaeologists identified “locally manufactured vessels with a Chichen Fine Orange Vase,” which is diagnostic of the Terminal to Early Postclassic periods (Pendergast 1981: 46). Most vessels from Str. N10-1, however, represent the Cib phase or Middle Postclassic at Lamanai. The vessels are red slipped (as opposed to the orange-red Buk vessels) and are typed as Payil Red. Figure 31 shows examples of what are now called Buk phase ceramics, from the Early Postclassic period (Aimers and Graham 2013; Graham 1987, 2004). The type names are Zakpah Orange-red and Zalal Incised, from Str. N10-2 (Aimers and Graham 2013; Walker 1990).

As Pendergast (1981: 51) notes, other than Str. N10-7, Str. N10-2, Str. N10-1, and Str. N10-9, there is no evidence of large-scale construction in the “ceremonial precinct,” but he suggests that most of the centre continued to be used in the Late Postclassic period, as evinced by scattered sherds and other Postclassic offerings. For example, in Str. N9-56, in what was a “focal point in the site for many centuries,” Pendergast found many “Mayapan-type figurine censers” smashed on the surface of the ruin, a behaviour that has sometimes been referred to as a “termination ritual” (see Lamoureux-St-Hilaire et al. 2015; Stanton et al. 2008). As Lamoureux-St-Hilaire et al. (2015: 553) note, termination rituals involve the deliberate smashing or deposition of artifacts (often ceramic vessels) on structures, usually to symbolically “kill” the buildings. Lamoureux-St-Hilaire et al. (2015) argue that termination rituals mark a moment of social transformation for the inhabitants, shifting their identity from occupiers to abandoners. Mayapan-type figurine censers are sometimes the last evidence of occupation at structures at Lamanai, however, there is still considerable evidence of settlement in the Spanish Colonial period. Figure 32 shows an example of one of these Mayapan-style figures, Chen Mul Modelled, which dates to the Late Postclassic period (Pendergast 1981: 51).
Figure 31: Zalal Incised vessels, Buk phase, Early Postclassic (Pendergast 1981: 51)  
(Illustrated by Louise Belanger)
5.2 THE TEMPORAL DYNAMICS AT LAMANAI

Like many other sites in the Precolumbian Maya world, there is limited evidence of Middle Preclassic occupation in the civic-ceremonial centre of Lamanai (see Figure 33, b) (see pg. 109-111 for a discussion about spatial intensity maps). While continued research has broadened archaeologists’ understanding of the social, economic, and political systems of Middle Preclassic communities (see Brown 2003; Powis et al. 2016; Powis and Cheetham 2007), evidence from the period is often buried under hundreds of years of architectural expansion and human settlement. At Lamanai, Middle Preclassic occupation has been identified at three structures: Str. P8-9, Str. P8-14, and Str. N9-69. The structures are small, single-phase constructions that were not altered in later periods of Maya history. Middle Preclassic structures typically consist of simple house platform constructions, built slightly above the bedrock surface (Powis 2002: 501-502). Compared to dates from other structures at Lamanai, Middle Preclassic occupation is isolated to the north-central portion of the site, especially near Str. P8-14 and Str. N9-69 (see Figure 33, c) (see pg. 110-111 for a discussion about relative-risk surface maps) (see Figure 3 for the location of the structures). In this area, a sample of wood in the same context of corn pollen was radiocarbon dated to 1600 BC (Hanna et al. 2016; Pendergast 1998: 56). Some of the earliest occupation at Lamanai may have occurred in the northern portions of the site.
Figure 33: Middle Preclassic (900-400 BC) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Middle Preclassic period. Blue to yellow indicates the spatial intensity of occupation in the Middle Preclassic period, c) Comparison of the proportion of structures occupied in the Middle Preclassic period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the Middle Preclassic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.

By the Late Preclassic period, there is evidence of occupation at 18 structures – Str. N9-53, Str. N9-56, Str. N9-69, Str. P9-24, Str. P8-2, Str. P8-9, Str. P8-11, Str. P8-12, Str. P8-14, Str. N10-2, Str. N10-4, Str. N10-15, Str. N10-27, Str. N10-43, Str. N11-18, Str. N12-11, Str. N12-13, and Str. P8-103 (Figure 34, b). Based on the increase in occupation and the density of the ceramic distribution (Powis 2002: 506), Lamanai must have undergone a rapid growth of population in the Late Preclassic. The expansion may be attributed to an increased reliance on agriculture, as isotopic analysis of skeletal material from the Late Preclassic shows that the community relied heavily on cultivated plants, such as maize, rather than marine and freshwater fish and shellfish (Coyston et al. 1999; White and
The Late Preclassic is a period of architectural intensification, with many structures constructed in a relatively short period of time; specifically, Str. N10-43, which was over 30 m in height by 100 BC (Pendergast 1981). Also, by the Late Preclassic period, there is evidence of occupation in both the northern and southern limits of the site, with a small platform in the area of the Spanish Churches. During this period, Lamanai shows its first indication of a “strip-like” settlement pattern along the lagoon, which – as mentioned earlier – shows the importance of trade and communication at the time.

Although the settlement pattern is more evenly distributed, occupation is still focused in the northern portions on the site, as there is a higher proportion of structures dated to the Late Preclassic period (compared to the chronology of other structures at Lamanai) (see Figure 34, c).
In the Early Classic period, there seems to be a slowing down in the construction activities of the site - only six structures have evidence of occupation: Str. N9-53, Str. N9-56, Str. P8-2, Str. N10-9, Str. N10-17, and Str. P7-12 (Figure 35, b). Compared to the Late Preclassic period, the site slightly contracts in size, as Str. N10-9 is the southern-most structure with evidence of occupation. In the north, there is a small platform structure that was constructed during this period and continued to be occupied until the end of the Terminal Classic period. The settlement pattern is more evenly distributed in the Late Preclassic period, however, occupation is still concentrated in the north of the site, as compared to all the other occupation dates at Lamanai (Figure 35, c).

Figure 35: Early Classic (AD 250-450) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Early Classic period. Blue to yellow indicates the spatial intensity of occupation in the Early Classic period, c) Comparison of the proportion of structures occupied in the Early Classic period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the Early Classic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.
The size and distribution of the ceramic assemblage is smaller than the previous period (Powis 2002: 518). Other archaeologists have suggested the site experienced a period of growth and prosperity in the Early Classic, with “dynamic changes” in settlement, architecture, and ceramic traditions (Powis 2002: 517). Indeed, the earliest evidence of occupation at a major monumental structure, Str. N10-9, occurs in this period and continues to show evidence through every chronological period until the end of Spanish colonization. It is likely Lamanai continued to be a focus of settlement throughout the Early Classic period, however, there is a noticeable decline in monumental construction in the centre and there is little evidence to suggest the site continued to expand (as evidenced by a decline in occupation) between the Late Preclassic and Early Classic periods (see pg. 20–21 for a definition of the term “occupation”).

By the Late Classic period, there is evidence of occupation throughout the site, with 22 structures that have primary deposits from this period – Str. N9-33, Str. N9-70, Str. N9-71, Str. P8-26, Str. P8-27, Str. N10-9, Str. N10-15, Str. N10-17, Str. N10-18, Str. N10-27, Str. N10-28, Str. N10-36, Str. N10-42, Str. N10-43, Str. N10-59, Str. N11-2, Str. N11-9, Str. N12-4, Str. P8-102, Str. N10-68, Str. N11-17, and Str. P7-12 (Figure 36, b). Most of these structures are grouped in the central portion of the site, between two major multi-terraced structures, Str. N10-9 and Str. N10-43. As mentioned earlier, both structures underwent building works during the Late Classic period, adopting a distinctive style that is characterized by a chambered structure set athwart a central stair, known as the Lamanai Building Type (Pendergast 1981: 42). It is likely that this plaza group in the Central Precinct was a focal point of civic/administrative and ceremonial activity in the Late Classic Period. Similar to the previous periods, the relative-risk surface map still shows a high intensity of occupation in the northern portions of the site, however, this is the first time in the history of Lamanai that the intensity of occupation starts to shift to the central portions of the site (Figure 36, c).

Figure 36: Late Classic (AD 600-800) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Late Classic period. Blue to yellow indicates the spatial intensity of occupation in the Late Classic period, c) Comparison of the proportion of structures occupied in the Late Classic period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the Late Classic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.

P8-102, Str. P8-104, Str. N10-66, Str. N10-75, Str. N10-67, Str. P7-12, and Str. P8-103 (Figure 37, b). By the Late Classic, access to the plaza was restricted to a passage on the south side, between Str. N10-77 and Str. N10-78, and the plaza became more of a courtyard (Graham 2004). In the latter part of the 8th century, the Classic buildings were razed and covered with boulder fill or core, as was the courtyard. Successive structures were built on low stone platforms and the superstructures (buildings) were likely built of wood, except for Str. N10-15, where masonry was still used. Although it has been suggested that by the end of the Terminal Classic occupation shifted to southern portions of the site, there is no indication of a north to south transition in the settlement pattern. The distribution of structures in the Terminal Classic period is very similar to the distribution during the Late Classic, only with added structures. The relative-risk surface
Figure 37: Terminal Classic (AD 800-1000) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Terminal Classic period. Blue to yellow indicates the spatial intensity of occupation in the Terminal Classic period, c) Comparison of the proportion of structures occupied in the Terminal Classic period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the Terminal Classic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.

map still shows a high intensity of occupation around two structures in the north – P8-14 and N9-33 – however, there is a high intensity of occupation in the central portion of the site and slightly south of the Central Precinct (Figure 37, c).

proceeding periods, with 18 of its structures concentrated in this area. Only two other small platforms roughly 150 m and 200 m south of Str. N10-9 show evidence of occupation in the Early Postclassic. The relative-risk surface map shows that settlement was clustered in the Central Plaza during the Early Postclassic period (Figure 38, c). The location of the occupation suggests a consolidation of power by the elites of Lamanai, especially considering the timing of the changes in the core of the settlement: 1) during a period of social and political upheaval in the greater Maya world, 2) during a period of settlement expansion in the peripheries of the site (see pg. 200-219 for a discussion of the inter-site settlement zone in the Early Postclassic period). The evidence from the relative-risk surface map is also interesting because the consolidation of power by the elites seems to coincide with an influx of migrant populations in the Early Postclassic period (see pg. 276-280 for a discussion of migration in the inter-site settlement zone). It seems that
settlement in the core contracted in the Early Postclassic period as a response to the growing population in the periphery. Graham (2004: 228) commented that a high quantity of Postclassic pottery was identified along the lagoon, which indicated that the shoreline was a “hub of activity,” but there is little structural evidence to support this claim. Based on the heavy occupation of the Central Precinct, and the density and distribution of ceramic material, it is likely that Lamanai was most heavily occupied in the Terminal to Early Postclassic periods.

Lamanai has significant evidence of occupation in the Late Postclassic period. There are 27 structures with evidence from primary deposits – Str. N9-56, Str. N9-59, Str. P9-35, Str. P8-26, Str. P8-35, Str. N10-2, Str. N10-4, Str. N10-9, Str. N10-10, Str. N10-12, Str. N10-17, Str. N10-27, Str. N11-3, Str. N11-4, Str. N11-18, Str. N12-4, Str. N12-6, Str. N12-11, Str. N12-12, Str. N12-26, Str. M13-3, Str. M13-4, Str. M13-12, Str. M13-14, Str. N9-76, Str. N9-77, and Str. N11-17 (Figure 39, b). Although there is occupation throughout the site, this is the first period that suggests that the southern portion was more heavily occupied than previous periods. The relative-risk surface map shows that the highest intensity of occupation in the Late Postclassic period is in the vicinity of the Spanish Churches (Figure 39, c). In the south, there are multiple small platform structures dated to the Late Postclassic. Perhaps, the Spanish constructed the churches in this area in the Spanish Colonial period because the centre of occupation at Lamanai had moved from the Central Precinct to the southern portions of the site. The Central Precinct continues to show evidence of occupation, albeit less than previous centuries. Also, like other periods, several small structures are occupied in the north. Although it seems that the site was more heavily occupied in the Late Postclassic, as opposed to the Early Postclassic, most of the structures from this period are small, single, platforms.

There are nine structures that have evidence of occupation during the Spanish Colonial period – Str. N9-53, Str. N10-9, Str. N11-7, Str. N11-18, Str. N12-11, Str. N12-12, Str. N12-13, Str. M13-3, and Str. N12-30 (Figure 40, b). The occupation is mostly located in the south, near the Spanish churches. However, there is occupation in the Ottawa Group (Graham 2004) and at a monumental multi-terraced structure, Str. N10-9. There is also evidence of Colonial period occupation in the village of Indian Church and on the grounds of the Lamanai Outpost Lodge, an ecotourist resort located south of the churches (Graham 2018, personal communication). It seems that most of the northern portions of
Figure 39: Late Postclassic (AD 1250-1500) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Late Postclassic period. Blue to yellow indicates the spatial intensity of occupation in the Late Postclassic period, c) Comparison of the proportion of structures occupied in the Late Postclassic period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the Late Postclassic period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.

the site, which were more heavily occupied in the earlier periods of Lamanai’s history, are abandoned by the Spanish Colonial period. The Ottawa Group is the northern-most extent of the Spanish colonial occupation. The relative-risk surface map shows a high intensity of occupation surrounding the Spanish churches in this period, which, perhaps, shows the successful enforcement of Spanish policies of congregacion or reduccion, which encouraged Maya populations to settle near the churches (Figure 40, c). For further reading, the Spanish Colonial period at Lamanai has been extensively covered by several publications (see Graham 2011; Graham et al. 2013; Pendergast 1986b, 1986c).

Evidence of the British Colonial period is found at six structures – Str. N12-10, Str. N12-11, Str. N12-13, Str. N12-23, Str. N12-26, and Str. N12-30 (Figure 41, b). These are
Figure 40: Spanish Colonial (AD 1500-1700) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the Spanish Colonial period. Blue to yellow indicates the spatial intensity of occupation in the Spanish Colonial period, c) Comparison of the proportion of structures occupied in the Spanish Colonial period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the Spanish Colonial period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.

...concentrated in the southern portion of the site, near the lagoon and the Spanish Churches. Like the previous period, the relative-risk surface map shows a high intensity of occupation in the vicinity of the Spanish churches (Figure 41, c). The British Colonial period is an important phase at Lamanai, but it is only beginning to be studied (Mayfield 2015). It is likely that there is more evidence of occupation west of the six British Colonial period structures – probably near the sugar mill – but this data is unpublished and is not featured in this thesis. There are two structures in the inter-site settlement zone (Settlement Zone D) near the monumental centre of Coco Chan that also have evidence of occupation in the British Colonial period. This area may have been resettled to take advantage of the trade in logwood and mahogany, which was a British export in the 18th and 19th century (Alford et al. 2019).
Figure 41: British Colonial (AD 1700-) period occupation at Lamanai, a) Location of each excavated structure at Lamanai. Blue-to-yellow indicates the spatial intensity of occupation, b) Location of structures with evidence of occupation in the British Colonial period. Blue to yellow indicates the spatial intensity of occupation in the British Colonial period, c) Comparison of the proportion of structures occupied in the British Colonial period to all other chronological periods. Blue-to-beige implies low to high intensity of occupation in the British Colonial period. White dots represent all the structures at Lamanai. Black dots represent structures with evidence of occupation in a specific period of Precolumbian Maya history.

5.3 THE CHRONOLOGY AT KA’KABISH

5.3.1 Evidence from the Middle Preclassic to Late Postclassic Periods

The chronology at Ka’kabish was determined by analyzing ceramic materials from plaza and chultun excavations. Haines (2013: 97, 2014:9) found cultural deposits dated to the Middle Preclassic period buried below the south-eastern portion of the Group D plaza. There is evidence of construction at several monumental structures in the civic-ceremonial centre in the Late Preclassic period, which may indicate an increase in the activity of elite segments of society (Haines 2013: 98; Tremain 2011).

Although the presence of a painted corbel vaulted tomb suggests the site was occupied in the Early Classic period, Sagebiel and Haines (2015) argue that Ka’kabish may have been abandoned at the end of the Early Classic, as a “scarcity of Late Classic ceramics” may
indicate a hiatus of occupation at the site. In the Terminal Classic, there is some activity at Ka’kabish – Sagebiel and Haines (2015: 364) found a burial in a chultun dated to this period – but it is difficult to determine the extent of occupation. There are Early and Late Postclassic ceramics scattered across the surface of the site and in chultuns, but archaeologists have not identified any evidence of monumental construction from these periods.

The length of occupation at Ka’kabish is based on plaza and chultun excavations, but several studies have focused on individual structures and their respective occupation histories (Haines et al. 2015; Tremain 2011; Sinclair 2015). These structures – Str. D4, Str. D9, Str. D-10, Str. FA-6, and Str. FA-8 – form the basis of the reconstruction of settlement dynamics at Ka’kabish.

At Str. D4 and Str. D9 (see Figure 8), Tremain (2011) identified phases of monumental construction by cleaning and mapping looter’s trenches. The construction sequence of Str. D4 and Str. D9 was defined by analyzing ceramics from each phase and comparing them to existing reports (Tremain 2011: 156). Other excavations at Str. D-10, Str. FA-6, and Str. FA-8, were used to determine the construction sequence of each structure.

Str. D4 is in an area referred to as the south plaza and rises 21 m above the plaza floor (see Figure 8). The structure is north of a ballcourt, with a large range structure directly across from it. It has been extensively looted, with eight trenches of different sizes and depths dug into multiple locations. As Pendergast (1991a: 89) notes, the largest trench pierced the structure from the east to the west, with a height of 5-6 m – creating a “cratered” building. An initial reconnaissance of the structure in the mid-1990s by the Maya Research Program suggested that it was occupied from the Late Preclassic to the Late Classic periods (Guderjan 1996: 117; Tremain 2011: 71). Guderjan (1996: 117) identified three distinct construction sequences, with the second earliest potentially built atop a cave system (Tremain 2011: 71). Haines (2006: 6) seems to concur with this assessment, suggesting that the original form of Str. D4 consisted of two parallel structures, “between which existed a deep hole (likely an entrance to a cavern) from which a noticeable draft emanated.” While the original form of the structure is still undetermined, Tremain (2011: 79) identified three different construction episodes, referred in the Str. D4 illustration as Sub-I, Sub-II, and Sub-III (Figure 42).
Figure 42: Profile map of Str. D4 south trench, north wall (Tremain 2011: 75)
The earliest construction of Str. D4, referred to as Sub-I, was dated to the Middle to Late Preclassic period (Tremain 2011: 105). The chronology of this architectural phase was determined by the presence of a diagnostic artefact – a ceramic roller stamp (Figure 43).

Figure 43: Middle Preclassic to Late Preclassic ceramic roller stamp from Str. D4, Sub-I (Tremain 2011:105)

As Tremain (2011: 108) notes, this form of ceramic – used to apply painted decoration – has been identified at many sites in the Maya region, including Copan (Longyear 1952), Cuello (Hammond et al. 1992), and K’axob (Bartlett 2004).

Tremain (2011: 105) argues that the roller stamp most closely resembles a variety identified at Cuello, in Northern Belize (see Figure 113 for the location of Cuello), known as the “Stacked Parallel Line variety” (Smith 2009: 59). Although this variety has been identified at Cuello, Tremain (2011: 105) argues that it is more prominent at the site of La Blanca in the Peten, Guatemala, a Middle Preclassic site that declined at the end of the Early Classic (Love 2006). This suggests that Sub-I is contemporaneous with this site.

The second sequence of construction, known at Sub-II, is dated to the Late to Terminal Classic Period (Tremain 2011: 106). This architectural phase was chronologically determined by the presence of Thin/Puuc slateware. At Nohmul, this ware is found associated with several other ceramic types, such as Achote Black (Ball 1977: 34-36), Sahcaba Peto Cream Ware (Smith and Gifford 1966: 162), and Peto Cream Ware (Ball 1977, 1979). Chase and Chase (1982: 608-609) argue that it is contemporaneous with San
Jose V (Thompson 1939) and indicates a period that is “coeval” with another Mexican ceramic complex (Sotuta) at Chichen Itza during the Terminal Classic period.

The final phase of construction, referred to as Sub-III, is also dated to the Late to Terminal Classic period. From the walls of the trench, Tremain (2011: 106) recovered two polychrome ceramic sherds – a diagnostic type that is generally agreed to mark the Classic Period in the Maya world (McKillop 2006: 246; Sharer et al. 2006: 288). This phase of construction postdated Sub-II, a context that was more securely dated to the Late/Terminal Classic Period. Because of this, Tremain (2011: 106) argues that Sub-III must date to the same period, or possibly later.

Str. D9 is in the southeast corner of the plaza adjacent to another range structure (Str. D10) (see Figure 8). It is roughly 8.5 m in height and is the second largest structure in the group. There are two looter’s trenches in the structure – one in the upper eastern corner and another mid-way up the structure on the western side (Tremain 2011: 91). Due to threat of continued looting activity in the area, a 9 m x 2 m excavation unit was placed on the stair of the structure to reveal further construction sequences. These excavations, along with the profile map of the northern wall of the trench, revealed 4 different construction episodes, referred to as Sub-I, Sub-II, Sub-III, and Sub-IV (Tremain 2011: 93). Figure 44 shows a south-facing profile of a looter’s trench in Str. D9.

The first phase of construction, Sub-I, is dated to the Late Preclassic period (Tremain 2011: 120). Several sherds collected from the building construction were identified as Chicanel phase types. As Tremain notes (2011: 120), two other sherds were identified with bichrome decoration, a trait that is sometimes diagnostic of the Late Preclassic period (Smith and Gifford 1966). Also, Tremain (2011: 120) recorded a thick plaster (60 cm) floor on the surface of Sub-I, which is indicative of the Preclassic period. Elsewhere, at Nakbe, in the Peten region of Guatemala, Hansen (1992: 67-74) identified a plaster floor from the Late Preclassic period that was 50 cm to 80 cm thick. The second sequence of construction, referred to as Sub-II, is also dated to the Late Preclassic period (Tremain 2011: 120-121). Within the construction fill, Tremain (2011: 121) identified a partial vessel that was interpreted as a ritual deposit, or cache. This interpretation is based on its location on the primary axis of the structure (Tremain 2011: 121). In a discussion of the significance of caches at Altun Ha and Lamanai, Pendergast (1998: 61) notes that it
Figure 44: Profile map of StE D9 looter’s trench, north wall (Tremain 2011: 95)
is “abundantly clear” that the primary axis was the “principal determinant of cache position in communally built structures.” Figure 45 displays an illustration of a partial vessel recovered from this primary deposit. Ceramic analysis determined it to be like the Vasquez ceramic complex from San Estevan (Bullard 1965: 29), a Late Preclassic site roughly 40 km northeast of Lamanai (see Levi 2002).

Figure 45: Vasquez Ceramic Complex sherd from Str. D9, Sub-II (Tremain 2011: 121)

The next phase of construction at Str. D9, referred to as Sub-III, is distinguished from Sub-II by a “thick layer of grey marl and small aggregate” (Tremain 2011: 96). As Tremain (2011: 158) notes, this construction episode is less securely dated, as the only chronological indicators of its occupation are from materials found as part of the construction fill. These materials are from the Early Classic period, which may indicate either an Early Classic construction episode, or a Late Classic construction using older materials for infill (Tremain 2011: 158).

The final construction episode, Sub-IV, corresponded with the excavation of the stair of structure Str. D9. Looting activities also revealed two plaster floors that were associated with this phase of construction. The initial excavations revealed evidence for a “stair block”, a type of platform or “bench-like unit,” set in or on a stair (Loten and Pendergast 1984: 13, 28). As Tremain (2011: 98) notes, these stair blocks have been identified in
Northern Belize at Altun Ha (Pendergast 1979) and at Lamanai (Loten 2006). Based on these architectural similarities, Tremain (2011: 137) suggests that this final construction episode is dated to the Late Classic Period.

The third structure, Str. FA-6, is roughly 9 m high and is in the northern plaza, amongst a group of 15 structures (Haines 2010) (see Figure 8). Other structures in this group, Str. F1 and Str. F2, were test-excavated to understand their side-by-side, north-south alignment (Guderjan 1996: 118; Pitre 2012: 49). Unfortunately, these excavations were placed too far away from the base of the ruin and only encountered collapsed debris. At Str. FA-6, multiple units were placed in various locations along the plaza, adjacent to the southern face of the structure. These excavations uncovered several plaster floors and the eastern corner of the structure (Sinclair 2015: 47-52). Sinclair (2015: 52-52) used ceramics from these units to recreate the chronological history of Str. FA-6.

As Sinclair (2015: 52) mentions, the most chronologically secure finds were discovered in the excavation unit along the central axis. The earliest evidence of occupation of Str. FA-6 is in the Middle Preclassic, with further construction in the Late Preclassic and Early Classic periods (Sagebiel 2015: 56). There is also evidence of occupation in the Terminal Classic, Early Postclassic, and Middle Postclassic periods. Like other structures in the civic-ceremonial centre of Ka’kabish, there is only trace evidence of Late Classic construction and occupation (Sagebiel 2015: 56).

Str. FA-8 is in the northern plaza of the site (see Figure 8). Initial investigations into a disturbed section of the front of Str. FA-8 revealed a looter’s trench that had exposed a large altar or capstone (Haines et al. 2015: 19). Further excavations into the looter’s trench, the top of an addition to the structure and the north façade, identified a “keyhole-shaped” platform that was attached to a larger, earlier, pyramid structure – an arrangement “previously undocumented in the literature of Maya architecture” (Haines et al. 2015: 25). These excavations revealed three tombs, the third of which was unlikely looted because of the danger posed by cracked and falling capstones (Haines et al. 2015: 19). Figure 46 shows a profile of the tombs, floor, fill, and altar at Str. FA-8. Ceramic
Figure 4.6: Profile of Str. FA-8 with the building phases of the structure (Dziki 2017: 13)
materials from these tombs provide a confident understanding of the chronological history of the structure.

From the floors associated with these tombs and collapse in the northwest corner of Tomb FA-8/1, Haines et al. (2015: 25-26) recovered Late Preclassic Sierra Red ceramics, a diagnostic type that has been identified at Lamanai and in the inter-site settlement zone. They also identified an Early Classic type from the same context – Balanza Black – which was first established by Smith and Gifford (1966: 154-155, 171) at the site of Uaxactun (Haines et al. 2015: 26). This type has been found at many Preclassic Maya sites, such as in the Holmul region, between the central Peten lowlands and the Belize River Valley (Callaghan and de Estrada 2016), and the Cochuah region, in the Northern Lowlands (Johnstone 2015: 44), among others. The plaza level materials include Late to Terminal Classic Achote Black, a type mentioned earlier and Cubeta Incised, a type found at many sites, such as Nohmul (Chase and Chase 1982) and Blue Creek (Clayton et al. 2005). The ceramic evidence suggests to Haines et al. (2015: 26) that the last construction sequence was during the Early Classic period, with later reuse, or visitation, in the Late to Terminal Classic and possibly into the Early Postclassic.

The fifth structure, Str. D-10, is in the southern portion of the Group D plaza, south-west of Str. D-9. It is a range structure, roughly 50 m long and 10 m wide. These dimensions are based on the extent of the ruins, rather than the original, undiscovered, substructure (Haines 2017: 21). As mentioned earlier, multiple units were excavated on the front and central axis of Str. D-10 to identify the front entrance and rear wall (Baker 2016; Haines 2017). These excavations failed to identify evidence for a masonry superstructure, which suggests that Str. D-10 supported a pole-and-thatch roof (Haines 2017: 21). Also, as Haines (2017: 23) argues, the east-end wall was absent from the structure, possibly indicating that the building was open on the east and west sides, like a columned range structure at Blue Creek (Driver 1996). Excavations at Str. D-10 uncovered three construction phases, two of which were attributed a specific date. The second construction phase is likely dated to the Early Classic period, as evinced by the inclusion of diagnostic ceramic types such as Balanza Black, Dos Arroyos Orange-polychrome (Smith 1955: 97), and Aguila Orange. The latest and last construction phase is dated to the Terminal and Early Postclassic periods. This construction episode contained several
diagnostic ceramic types, including Red Neck Mother Striated – one of the two specific types of the Chambel Ceramic Group (Chase 1982b: 75).

5.4 THE TEMPORAL DYNAMICS AT KA’KABISH

There is evidence of Middle Preclassic Period occupation at two structures: Str. D-4 and Str. FA-6 (Figure 47, a). At Str. D-4, analysis of construction sequences and diagnostic ceramics associated with these sequences suggest the structure was occupied sometime between 800-400 BC. At Str. FA-6, floor fill excavated above bedrock contained ritual deposits of Middle Preclassic and late Middle Preclassic ceramics. These finds suggest that as early as 800 BC the civic-ceremonial centre of Ka’kabish was occupied and some of the earliest building works were initiated on two of the major pyramidal structures of the site. In the D plaza, excavations revealed a Middle Preclassic bowl that likely belonged to the Consejo group (Sagebiel 2015: 57), another type that was also identified at Lamanai (Powis 2004: 58). It is likely that even at this early date there was interaction between the two sites. Based on architectural and ceramic evidence, it is possible that Ka’kabish and Lamanai formed an early trade network, with communication and systems of exchange between the sites.

By the Late Preclassic period, there is evidence of occupation at four structures: Str. D4, Str. D9, Str. FA-6, and Str. FA-8 (Figure 47, b). In addition to evidence of construction at Str. D4 and Str. FA-6, ceramics associated with a tomb securely dated Str. FA-8 to this period. Like many other primary deposits at Lamanai, archaeologists uncovered an abundance of Sierra Red type ceramics. At Str. D9, Chicanel phase ceramics, other bi-chrome pottery, and a thick plaster floor, indicated that the first phase of construction was in the Late Preclassic period. It is likely the site experienced a period of population growth, with architectural construction and expansion in the site core. This period of growth coincided with the continued development of Lamanai, which exhibited evidence of occupation in the northernmost and southernmost portions the site (Figure 34).

In the Early Classic period, there is construction activity in the North and South plazas, with occupation at four structures: Str. FA-6, Str. FA-8, Str. D9, and Str. D10 (Figure 47, c). The first three structures – Str. FA-6, Str. FA-8, and Str. D9 – show evidence of occupation in earlier periods. Additional architectural elements were added to these structures in the Early Classic period, as evidence of construction is found in the site core.
Figure 47: Evidence of occupation at structures at K'aabish. A) Middle Preclassic B) Late Preclassic C) Early Classic D) Late Classic E) Terminal Classic F) Early Postclassic.
Str. D-9 has evidence of occupation in the Early Classic period, however, another construction sequence was identified from an earlier phase, but it lacked any chronological indicators. Again, like the previous period, it seems the centre was continuing to experience a period of growth. Perhaps, this is the first indication of a split between the prosperity of the sites, as occupation at Lamanai during this period is only found at six structures – one of the least represented periods at the site.

Although it is generally argued that the site experienced a ‘hiatus’ during the Mid-to-Late Classic Period, there is continued evidence of occupation at structures Str. D4, Str. D9, and Str. FA-8 (Figure 47, d). At Str. D9, Tremain (2011: 98) based the dating of the third construction sequence on architectural similarities between Lamanai and Ka’kabish. Perhaps, as Tremain suggested, the date of this phase is from a later period, possibly the Terminal Classic. Also, some of the evidence from Str. D4, particularly ceramic types, such as Achote Black, are more indicative of the Terminal Classic period. Like the previous two structures, at Str. FA-8, Haines et al. (2015: 26) prefers to suggest that the structure was “reused” or “visited” in the “Late to Terminal Classic.” While it is likely that Str. D4, Str. D9, and Str. FA-8, were occupied sometime between AD 600-1000, it is difficult to chronologically distinguish between the Late and Terminal Classic at Ka’kabish, especially without secure, primary deposits. There seems to be an overwhelming lack of ceramic material between the Early and Late Classic, from roughly AD 400-600, in plaza excavations, which reinforces the assertion that there was a hiatus sometime between these periods.

The Mid-to-Late Classic period seems to indicate a lull in construction activity, but by the Terminal Classic period there is evidence of occupation at five structures: Str. D4, Str. D10, Str. FA-6, and Str. FA-8 (Figure 47, e). Compared to the Late Classic, the Terminal Classic period is more securely dated, with primary deposits and diagnostic artefacts. The settlement pattern of the site core is the same in this period as the Early Classic, with construction in the North and South complexes. Perhaps, like Lamanai, which was heavily occupied in the Terminal Classic, Ka’kabish also expanded in size during this period, as evinced by concentrations of pottery from plaza excavations in the Group F acropolis and Group D (Sagebiel 2016c: 7-9) (see Figure 8).
In the Early Postclassic period, there is evidence of occupation at three structures, Str. FA-6, Str. FA-8, and Str. D10 (Figure 47, f). Compared to the Terminal Classic, there is only a slight decline in evidence of occupation in the Early Postclassic. At Lamanai, evidence of occupation somewhat declines, with two less structures than the Terminal Classic period. Unlike many other sites in the greater Maya world, which show evidence of depopulation and abandonment between the Terminal Classic and Early Classic periods (see Turner II and Sabloff 2012), Lamanai and Ka’kabish continue to be occupied, with monumental construction in the civic-ceremonial centres.

There is no evidence of occupation, or building works, at structures in the civic-ceremonial centre of Ka’kabish in the Late Postclassic, Spanish, or British Colonial periods. The only evidence of occupation in the Late Postclassic period to date was found in chultuns scattered around the site. These were not included in this discussion because they did not represent construction episodes and may only indicate remnant populations at the site. Several of these chultuns contained copper items, such as rings, bells, and tweezers. So far, archaeologists at Ka’kabish have not discovered any evidence of metallurgy. Perhaps, like earlier periods, Ka’kabish and Lamanai continued to trade, as evinced by the metal works discovered at Lamanai and the copper at Ka’kabish, but again, these deposits may only represent pilgrimages – a common practice in the Maya world (Palka 2014). By the time of the arrival of the Spanish, it seems that the civic-ceremonial centre of Ka’kabish was completely abandoned.

5.5 SUMMARY
Lamanai is traditionally viewed as a site with continuous occupation from the Middle Preclassic to the Late Postclassic and Colonial periods, however, based on the spatial and chronological reconstruction of Lamanai, there is significant variability in the historical trajectory of the site. There are several noticeable trends that will be explored in later chapters: there is decreased construction activity in the Early Classic and Late Postclassic periods and there is significant and sustained construction from the Terminal Classic to Early Postclassic periods. The results from Ka’kabish are less conclusive because of the limited amount of excavation in most of the major structures in the civic-ceremonial centre. We can say, however, that Ka’kabish was occupied as early as the Middle Preclassic but was likely abandoned towards the end of the Late Postclassic period. In Chapter 6, I will analyse and assess the spatial and chronological history of the supporting
populations of Lamanai, Ka’kabish, and the minor centre mid-way between the two sites, Coco Chan.
Chapter 6

THE INTER-SITE SETTLEMENT ZONE AND ITS ARTEFACTS

This chapter analyses the data that were recovered from the inter-site settlement zone. Some of the raw data have already appeared in several unpublished field reports (McLellan 2010, 2011, 2016, 2017). As in the previous chapter, which looked at the two civic-ceremonial centres, a structure-by-structure analysis is presented of the architectural and ceramic evidence from the area between Ka’kabish and Lamanai. The first part of the chapter analyses the spatial distribution of the structures in the settlement zone, with sections divided into groups, from Settlement Zones A to F, depending on their location (see Figure 18). The second part of the chapter provides an analysis of the material assemblage, which is subcategorised into ceramic and lithic materials. In the final section, the spatial distribution, density, and chronological reconstruction of individual structures are used to recreate the settlement dynamics of the inter-site settlement zone. Appendix B shows the designation, size, location, and chronology of each structure in the inter-site settlement zone.

6.1 SPATIAL DISTRIBUTION OF THE STRUCTURES

6.1.1 Settlement Zone A

Settlement Zone A borders the civic-ceremonial centre of Ka’kabish. It is roughly half a km from the largest structure at Ka’kabish, which is referred to as Str. D4 (see Figure 8). Zone A is the smallest survey zone in the inter-site settlement zone and contains only seven structures (Table 2). The Zone A structures form two groups (Table 3) – Type 6 and Type 7 (see Table 1). The Type 6 group consists of five structures that share a basal platform (Figure 48). There is a noticeable depression in the centre of the arrangement, which can be seen in the satellite image. The Type 7 group consists of two structures,
arranged orthogonally, with the northern structure standing over 5 m (Figure 49). Other than the structures, the topography is flat and contains no other important features.

The average size of the structures is the highest of all the survey zones. This may be because of their proximity to the major architectural structures of Ka’kabish. As mentioned in Chapter 3 (pg. 61-62), some of the earliest observations suggested that Maya cities were organized concentrically, with wealthier households situated closer to the centre of the site. (see Folan et al. 1979; Kurjack 1974). The size of a structure is a proxy for wealth, with larger structures, which require more labour investment, indicating higher status (Folan et al. 2009; Haines 2010). Evidence from Ka’kabish, Settlement Zone A, and Settlement Zone B (see pg. 150-156), suggests the structures are concentrically organized, with larger structures located closer to the civic-ceremonial centre. This pattern of settlement is like some of the early observations of Colonial-era settlements (see Tozzer 1941: 62-64) and may indicate the importance of wealth and status in this area (see pg. 274-276 for a discussion of the importance of trade at Lamanai).

<table>
<thead>
<tr>
<th>Settlement Zone A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Perimeter</td>
</tr>
<tr>
<td>Survey Area</td>
</tr>
<tr>
<td>Number of Str.</td>
</tr>
<tr>
<td>Average Size of Str.</td>
</tr>
</tbody>
</table>

Table 2: Survey perimeter, survey area, and number of structures at Settlement Zone A

<table>
<thead>
<tr>
<th>Settlement Zone</th>
<th>Unit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Zone A</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 3: Unit types in Settlement Zone A
Figure 48: Satellite image, topography and schematic drawing of Type 6 settlement in Settlement Zone A.
Figure 49: Satellite image, topography, and schematic drawing of Type 3 settlement in Settlement Zone A
6.1.2 Settlement Zone B

Settlement Zone B is located ca. 1.5 kilometers southeast of the civic-ceremonial centre of Ka’kabish. It is the second largest of the survey zones and includes 60 structures (Figure 50, Table 4). There are several types of structures or structural groups represented in this zone (Table 5). The most common is Type 1 (n=20), which consists of a single, less-than 2 m tall, structure. The second most common is Type 3 (n=9), a standard Maya plazuela group made up of 2-4 structures arranged orthogonally. Unlike most of the other survey zones, the elevation increases in the northern portions of the Zone shown on the map (Figure 51). The topography of Settlement Zone B is characterized by this rise in elevation. Generally speaking, and probably owing to good drainage archaeologists find larger concentrations of settlement at higher elevations (Prufer et al. 2015). In the case of Zone B, settlement is more evenly distributed between higher and lower elevations. In these low areas (especially when forested) archaeologists are less likely to find smaller structures because of soil accumulation and other site formation processes. The largest structure, Str. B1, (n=941.38 sq. m) is located at the lowest elevation (50-55 m). Other than Str. B1, which is the largest encountered in all of the survey zones, most of the platforms are small in area, with an average of only 47.23 sq. m, the second lowest of the survey zones.

<table>
<thead>
<tr>
<th>Settlement Zone B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Perimeter</td>
</tr>
<tr>
<td>Survey Area</td>
</tr>
<tr>
<td>Number of Str.</td>
</tr>
<tr>
<td>Average Size of Str.</td>
</tr>
</tbody>
</table>

**Table 4: Survey perimeter, survey area, and number of structures at Settlement Zone B**

<table>
<thead>
<tr>
<th>Settlement Zone</th>
<th>Unit Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone B</td>
<td></td>
<td>20</td>
<td>5</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57%</td>
<td>14%</td>
<td>20%</td>
<td>0%</td>
<td>0%</td>
<td>9%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 5: Unit types in Settlement Zone B**
Figure 50: Satellite image, topography, and schematic drawing of Settlement Zone B
Figure 51: Topography and schematic drawing of Settlement Zone B
6.1.3 Settlement Zone C

Settlement Zone C is 4-5 km southeast of the civic-ceremonial centre of Ka’kabish in a peripheral area of the minor centre of Coco Chan. There is evidence of occupation only in the southeastern portion of the zone. Compared to the size of the survey zone (Table 6), the area that is occupied is small - 111,621.47 sq. m. Other than this limited occupation area, there is no evidence of structures or material remains in the rest of the survey zone. This stands as the largest and only area of land in the inter-site settlement zone without evidence of Maya occupation. It is possible that this uninhabited area could have also been used for agricultural purposes in the past (see pg. 268-269 for further discussion). In the southeast portion of the zone, the average surface area of the structures (n=35.2 sq. m) is the smallest in the inter-site settlement zone, with multiple platforms under 25 sq. m (Table 7). A Type 7 group on the eastern portion of the zone has the largest structures, ranging between 60-80 sq. m (Figure 52 and 53). The topography is like the other survey zones and is generally flat with a modest increase in elevation (<5 °) in the direction of Ka’kabish. There is a noticeable change in flora and soil northwest of the habitation area, with sandy soils and drier, shrub-like vegetation. It is likely that Settlement Zone C marked the extent, or occupation boundary of the minor centre of Coco Chan.

<table>
<thead>
<tr>
<th>Settlement Zone C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Perimeter</td>
</tr>
<tr>
<td>Survey Area</td>
</tr>
<tr>
<td>Number of Str.</td>
</tr>
<tr>
<td>Average Size of Str.</td>
</tr>
</tbody>
</table>

Table 6: Survey perimeter, survey area, and number of structures at Settlement Zone C

<table>
<thead>
<tr>
<th>Settlement Zone</th>
<th>Unit Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone C</td>
<td></td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22%</td>
<td>22%</td>
<td>44%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>11%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 7: Unit types in Settlement Zone C
Figure 52: Satellite image, topography, and schematic drawing of Type 7 settlement in Settlement Zone C.
Figure 53: Satellite image, topography, and schematic drawing of Type 2, 3 and 4 settlement in Settlement Zone C
6.1.4 Settlement Zone D

Settlement Zone D is located mid-way between Lamanai and Ka’kabish and covers an area adjacent to the major temple structures of Coco Chan. It is the third-smallest survey zone and includes 45 structures (Table 8). Unlike Settlement Zone B, which is dominated by small, single platforms, Settlement Zone D consists of Type 1 (n=5), Type 3 (n=6), and Type 6 groups (n=5) (Table 9). These groups surround the large architectural structures of the civic-ceremonial centre of Coco Chan, which is made up of five temples, one of which stands over 20 m tall and one range structure (Figure 54). Some of the smaller structures (30-40 sq. m) are in the southern portion of the survey zone, which also contains two Type 1 units (Figure 55). Outside of Settlement Zone A, which is next to Ka’kabish, Settlement Zone D has the largest structures (excluding Coco Chan), with an average structure size of 90.06 sq. m. Compared to the other settlement zones (except Settlement Zone A), Settlement Zone D is populated by larger groups of structures, with fewer single platforms (n=5). Also, like the relationship between Ka’kabish and Settlement Zone A, the size of structures decreases further away from the monumental architecture of Coco Chan, especially in Settlement Zone E.

### Settlement Zone D

<table>
<thead>
<tr>
<th>Survey Perimeter</th>
<th>2399.95 m</th>
<th>2.4 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Area</td>
<td>215,801.22 sq. m</td>
<td>0.22 sq. km</td>
</tr>
<tr>
<td>Number of Str.</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Average Size of Str.</td>
<td>90.06 sq. m</td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Survey perimeter, survey area, and number of structures at Settlement Zone D

<table>
<thead>
<tr>
<th>Settlement Zone</th>
<th>Unit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone D</td>
<td>1</td>
</tr>
<tr>
<td>Zone D</td>
<td>5</td>
</tr>
</tbody>
</table>

|   | 26% | 11% | 32% | 0%  | 5%  | 26% | 0%  | 100% |

Table 9: Unit types in Settlement Zone D
Figure 54: Satellite image, topography, and schematic drawing of the minor centre of Coco Chan in Settlement Zone D
Figure 55: Satellite image, topography, and schematic drawing of Type 1, 2, 3, and 4 settlement in Settlement Zone D.
6.1.5 Settlement Zone E
Like Settlement Zone C, Settlement Zone E is in the periphery of the minor centre of Coco Chan. It is roughly 4 km from the Jaguar Temple at Lamanai, which is referred to as Str. N10-9 (see Figure 3). Settlement Zone E is the second smallest survey zone and one of the least settled areas (other than Settlement Zones A and C), with only 33 structures (Table 10). Many of the structures (33%) are in the northwestern portion of the zone, closer to the civic-ceremonial centre of Coco Chan (Figure 56). Like Settlement Zone B, many of the structures (n=9) are classified as single, isolated mounds (Table 11). Although the average size of the structures (78.26 sq. m) is comparatively large, the figure is offset by a Type 6 group in the upper, middle, portion of the zone, with a range structure (287.73 sq. m) (Figure 57). The second most common group is Type 3 (n=5), like several of the other survey zones. The topography of the survey area is generally flat, with a small drop in elevation (<5 °) towards the southern portion of the zone. There is evidence of further settlement east and south of the survey zone, however, time constraints prevented its investigation.

<table>
<thead>
<tr>
<th>Settlement Zone E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Perimeter</td>
</tr>
<tr>
<td>Survey Area</td>
</tr>
<tr>
<td>Number of Str.</td>
</tr>
<tr>
<td>Average Size of Str.</td>
</tr>
</tbody>
</table>

Table 10: Survey perimeter, survey area, and number of structures at Settlement Zone E

<table>
<thead>
<tr>
<th>Settlement Zone</th>
<th>Unit Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone E</td>
<td>1 2 3 4 5 6 7 Total</td>
</tr>
<tr>
<td></td>
<td>9 3 5 0 0 1 0 18</td>
</tr>
<tr>
<td></td>
<td>50% 17% 28% 0% 0% 5% 0% 100%</td>
</tr>
</tbody>
</table>

Table 11: Unit types in Settlement Zone E
Figure 56: Satellite Image, topography, and schematic drawing of Type 6 settlement in Settlement Zone E.
Figure 57: Satellite image, topography, and schematic drawing of Type 1, 2, and 3 settlement in Settlement Zone E
6.1.6 Settlement Zone F

Settlement Zone F is between 2-3 km from the Jaguar Temple, Str. N10-9, roughly midway between the minor centre of Coco Chan and the major centre of Lamanai. It is the third largest survey zone (479,297.74 sq. m) and has the highest number of structures (n=86) (Table 12). Compared to the other survey zones, Settlement Zone F is more densely occupied, albeit with generally smaller structures. The only portion of the zone that is unoccupied is an area of low elevation in the northeastern portion of the survey zone. Like the other zones, some of the more common group Types, such as Type 3 and Type 6, are represented (Table 13). Settlement Zone F, however, is overwhelmingly characterized by small Type 1 structures (Figure 58 and 59). Like Settlement Zone E, several uncharacteristically large structures affect the average structure size, such as a temple-like (ca. 6 m tall) structure in the southeastern portion of the field (602.2 sq. m). The topography is generally flat, other than the northeast corner, which is also distinguished by a change in vegetation from forest to wetlands. It is unlikely that areas northeast of the survey zone was occupied.

<table>
<thead>
<tr>
<th>Settlement Zone F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Perimeter</td>
</tr>
<tr>
<td>Survey Area</td>
</tr>
<tr>
<td>Number of Str.</td>
</tr>
<tr>
<td>Average Size of Str.</td>
</tr>
</tbody>
</table>

Table 12: Survey perimeter, survey area, and number of structures at Settlement Zone F

<table>
<thead>
<tr>
<th>Settlement Zone</th>
<th>Unit Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone F</td>
<td></td>
<td>23</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td>74%</td>
<td>7%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>10%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 13: Unit types in Settlement Zone F
Feature 58: Satellite image, topography, and schematic drawing of Type 6 settlement in Settlement Zone F
Figure 59: Satellite imagery, topography, and schematic drawing of Type 3 settlement in Settlement Zone F
6.2 CERAMIC ASSEMBLAGE

6.2.1 Type: Variety

Table 14 shows a list of the types of diagnostic ceramics identified in the inter-site settlement zone (between Ka’kabish and Lamanai) and refers to authors who have noted the presence of these types or varieties at other sites in the Precolumbian Maya world. The ceramic evidence is used primarily to understand the chronological dynamics of the settlement zones.

Ceramics from the Middle Preclassic Period are relatively rare in the assemblage, with only two structures showing evidence of Middle Preclassic occupation – both in Settlement Zone F, close to Lamanai (see Figure 18). Sagebiel identified several sherds that indicated this period. One of these sherds, from Str. F81, is an indeterminate dichrome (red and cream) that was attributed to both the Late Middle Preclassic and the Late Preclassic, in the Mamon-Chicanel ceramic sequence at Uaxactun (see Lopez Varela 1996: 26) (see Appendix B for the location of the structures). A second sherd that was indicative of the Early Middle Preclassic period was identified at Str. F41. The date of this sherd was determined by its form, which was a double-coiled handle of a jar. Other artefacts were found in this survey zone that very likely reflect the Middle Preclassic period, such as a cream-coloured medial-angled rim from Str. F6.

Other than these few scattered finds in Settlement Zone F, some of the earliest pottery types belong to the Late Preclassic and Early Classic periods. The most commonly identified type is Sierra Red sherds, which are dated to the Late Preclassic period (Gifford 1976: 85-90). These sherds were identified in every survey zone along the transect from Lamanai to Ka’kabish. Another common type in the inter-site settlement zone is Puletan Red-and-unslipped jars, also known as Petroglyph Red-rimmed (Graham 1994; Reents 1980), manufactured from the end of the Preclassic (Terminal Preclassic) through to the early part of the Early Classic period (Tzakol 1). For the Early Classic Period, a common type in the survey zone is called Aguila Orange, a ware that postdated Aquacate Orange in the Protoclassic (Adams 1971: 142), a period from the Late Preclassic to the Early Classic that witnessed changes in ceramic styles (Brady et al. 1998). This ware is attributed to the Early Classic period.
<table>
<thead>
<tr>
<th>TYPE: VARIETY</th>
<th>REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACHOTE BLACK</td>
<td>(Ball 1977: 34-36; Masson and Rosenswig 2005: 359)</td>
</tr>
<tr>
<td>AGUILA ORANGE</td>
<td>(Ball 1977: 41-42)</td>
</tr>
<tr>
<td>ALEXANDERS</td>
<td>(Gifford 1976: 283–286)</td>
</tr>
<tr>
<td>STRIATED/UNSLIPPED</td>
<td>(Gifford 1976: 161-164)</td>
</tr>
<tr>
<td>BALANZA BLACK</td>
<td>(Ball 1977: 34-36; Masson and Rosenswig 2005: 359)</td>
</tr>
<tr>
<td>CAMBIO UNSLIPPED</td>
<td>(Masson and Rosenswig 2005: 359)</td>
</tr>
<tr>
<td>CHILAR FLUTED</td>
<td>(Sagebiel 2014: 131)</td>
</tr>
<tr>
<td>CUBETA INCISED</td>
<td>(Chase 1982b: 73 Sagebiel 2014: 125)</td>
</tr>
<tr>
<td>DAYLIGHT ORANGE</td>
<td>(Gifford 1976: Willey et al. 1965)</td>
</tr>
<tr>
<td>DOS ARROYOS GROUP</td>
<td>(Gifford 1976: 174-179)</td>
</tr>
<tr>
<td>DUMBCANE STRIATED, FRESHWATER STRIATED</td>
<td>(Fry 1989; Masson and Rosenswig 2005; Valdez 1987: Figure 47)</td>
</tr>
<tr>
<td>ENCANTO STRIATED</td>
<td>(Sagebiel 2014: 123)</td>
</tr>
<tr>
<td>FLOR CREAM</td>
<td>(Gifford 1976: 93-94)</td>
</tr>
<tr>
<td>GUITARA INCISED</td>
<td>(Pring 1977: 169-174)</td>
</tr>
<tr>
<td>KAWAY IMPRESSED</td>
<td>(Gifford 1976: 239–240)</td>
</tr>
<tr>
<td>LAGUNA VERDE INCISED</td>
<td>(Culbert 1993; Sabloff 1975: 80-81; Smith 1955: Figure 64d, 70a)</td>
</tr>
<tr>
<td>LEMONAL CREAM</td>
<td>(Sagebiel 2014: 128)</td>
</tr>
<tr>
<td>PAYIL RED</td>
<td>(Masson and Rosenswig 2005: 365; Smith 1971: 30)</td>
</tr>
<tr>
<td>PITA INCISED</td>
<td>(Sagebiel 2005: 265; Smith and Gifford 1966: 161)</td>
</tr>
<tr>
<td>PUCTE BROWN</td>
<td>(Chase and Chase 2012a: 109; Gifford 1976: 167-168)</td>
</tr>
<tr>
<td>PULETAN RED-AND-UNSLIPPED</td>
<td>(Hammond 1991a: 61)</td>
</tr>
<tr>
<td>RED NECK MOTHER</td>
<td>(Chase 1982b: 76)</td>
</tr>
<tr>
<td>ROARING CREEK RED</td>
<td>(Sagebiel 2014: 129)</td>
</tr>
<tr>
<td>RIO BRAVO RED</td>
<td>(Powis 2004)</td>
</tr>
<tr>
<td>RUBBER CAMP BROWN</td>
<td>(Kunen 2004: 72)</td>
</tr>
<tr>
<td>SAPOTE STRIATED</td>
<td>(Callaghan 2016; Smith and Gifford 1966: 162, 170)</td>
</tr>
<tr>
<td>SIERRA RED</td>
<td>(Gifford 1976: 85-90)</td>
</tr>
<tr>
<td>SOCIETY HALL RED</td>
<td>(Kosakowsky 1987: 64-67)</td>
</tr>
<tr>
<td>TINAJA RED</td>
<td>(Ball 1977: 23; Rice 1987; Sabloff 1975)</td>
</tr>
<tr>
<td>TRES MUJERES</td>
<td>(Kosakowsky and Lohse 2003: 11; Sagebiel 2005: 433-439)</td>
</tr>
<tr>
<td>TRIUNFO STRIATED</td>
<td>(Ball 1977: 14-15)</td>
</tr>
<tr>
<td>ZIBAL STRIATED</td>
<td>(Gifford 1976: 222–225)</td>
</tr>
</tbody>
</table>

Table 14: List of diagnostic artefacts found in the inter-site settlement zone
Compared to the Late Preclassic and Early Classic ceramic assemblage, there are far fewer examples of pottery that can be attributed exclusively to the Late Classic period (ca. AD 600-800) in the inter-site settlement zone. Various rims and body sherds that were attributed to specific types, such as Cambio Unslipped (Rice 1987), Cubeta Incised (Figure 60), Lemonal Cream, and Tinanja Red, are found in both Late and Terminal Classic (ca. AD 800-900/950) contexts. Another type from the inter-site settlement zone, Achote Black, shares its form with a Terminal Classic vessel found at Tiger Bay Cave (Aimers 2011), but it is cautiously considered to represent the Late to Terminal Classic period. Other types, such as Kaway Impressed and Roaring Creek Red, are more securely dated to the Terminal Classic.

The two most abundant types of sherds are Dumbcane Striated and Red Neck Mother, both of which are dated to the Terminal Classic to Early Postclassic periods (Figure 61). Dumbcane Striated is characterized by jars with arrow-head shaped rims and vertical striations. These types are like several other groups of ceramics, such as Freshwater Striated and Blue Creek Striated (see Fry 1987, 1989; Gifford 1976; Masson and Rosenswig 2005; Sanders 1960). Red Neck Mother is the most common type of ceramic in the inter-site settlement zone. It is one of two specific types of the Chambel ceramic group. Chase (1982b: 75) identified this type at the site of Nohmul, in Northern Belize (Chase 1982a), and applied the name to large, wide-necked jars, or ollas, with outflaring necks. Red Neck Mother and Dumbcane Striated are commonly used as chronological indicators of the Terminal Classic and Early Postclassic periods (9th and 10th centuries) at Lamanai, Ka’kabish, and the inter-site settlement zone.

Another type, Lamanai Orange, which is similar in form to Zakpah Orange (Sagebiel 2018, personal communication), is also used to indicate the Terminal Classic and Early Postclassic periods (Figure 62). More definitive markers of the Early Postclassic (late 10th century to 13th century) at Lamanai comprise most forms of the Zakpah ceramic group (e.g., large flanged jars with pedestal bases, “chalices,” tripod bowls [Graham 1987]). The Zakpah group includes Zakpah Orange-red and Zalal Gouged-incised types (Walker 1990), although Zalal comes to dominate the fineware assemblage at Lamanai in the Early Postclassic (Howie 2012). The Zakpah group has been named by Sagebiel at Ka’kabish as Lamanai Orange.
Figure 60: A) Late Classic to Terminal Classic, Cubeta Incised B) Terminal Classic to Early Postclassic, Dumbcane Striated C) Terminal Classic to Early Postclassic, Red Neck Mother D) Postclassic chalice E) Colonial jar F) Colonial Period
Figure 61: A) Terminal to Early Postclassic, Dumbcane Striated, B) Terminal to Early Postclassic, Red Neck Mother, C) Late Postclassic, Payil Red (Photography by Kerry Sagebiel)
Given that there are forms (e.g., pedestal-based, medial-angle bowls) and colors (the orange of Lamanai Orange and Zakpah orange-red) that are produced in the transition from the Terminal Classic to Early Postclassic periods (Graham 1987), all the types noted above, except for Zalal Gouged-incised, are considered to span the Terminal Classic and Early Postclassic periods (9th, 10th centuries) in the inter-site settlement zone, at least until future work can refine the sequence. Several eroded Zakpah group “chalices” like those known from Lamanai (Pendergast 1981: 45) were identified in the survey zone, especially in the areas close to Lamanai. The chalice types are Zakpah Orange-red: Variety unspecified and Zakpha Gouged –Incised: Variety unspecified (Aimers and Graham 2013: 99; Walker 1990).

For the Late Postclassic period, some of the key diagnostic modes are cylindrical, or conical, tripod feet, which are often perforated with round holes (Figure 63).
Figure 63: A) Eroded Postclassic foot, B) Late Postclassic foot, C) Late Postclassic, Payil Red foot (Photography by Kerry Sagebiel)
Several incised examples of Middle-to-Late Postclassic tripod vessels, Payil Red, were identified in burial contexts at Lamanai at Str. N10-2 and Str. N10-4 (Howie 2012; Pendergast 1981: 50, 1982a) (see Figure 3 for the location of the structures). What we now call “Payil Red,” which was found in several areas of the survey zone, was first described by Smith (1971) at Mayapán and placed in the Tulum Red Ware category (Sanders 1960). Subsequent projects used the name Payil Red to refer to this red-slipped pottery, a type that is distributed widely in the Late Postclassic period, particularly along coastal sites and may have been produced along the coast of Quintana Roo, in Mexico (Aimers et al. 2013: 427; Connor 1983; Masson and Rosenswig 2005: 366; Peraza Lope 1993). Another important diagnostic of the Late Postclassic period is the Chen Mul modelled effigies and censers, which have been identified at Lamanai (Pendergast 1981) (see pg. 124 for an example of Chen Mul modelled ceramic found at Lamanai). This type of effigy censer was first discovered at Mayapán by Smith (1971: 206-212) and is part of the Unslipped Panaba Group of Mayapán Unslipped Ware of the Tases ceramic complex (AD 1250/1300–1450) (Milbrath and Peraza Lope 2013: 203-204).

The Spanish Colonial period is indicated by the Maya production of thin-walled bowls and jars with collared rims and often with shallow, multiple groove-incised lines around the exterior rim (Figure 64). These are called Yglesias Unslipped at Lamanai (Graham 1987; Pendergast 1991c, 1993). In the inter-site settlement zone, Spanish Colonial sherds are generally found closer to the civic-ceremonial centre of Lamanai, with no examples identified between Coco Chan and Ka’kabish. Evidence of the Spanish Colonial period is found in Settlement Zones D, E, and F. The lack of Spanish Colonial period ceramics at Ka’kabish, Settlement Zone A, and Settlement Zone B, suggests that the area was depopulated prior to the arrival of the Spanish, especially considering the absence of Late Postclassic ceramics in these zones (see pg. 200-219 for the settlement dynamics of the inter-site settlement zone). There are also several examples of British Colonial pottery from two large platforms – Str. D37 and Str. D38 – that date to the 19th century (see pg. 133-135 for a discussion of British Colonial period occupation at Lamanai).
Figure 64: A) Late Postclassic to Spanish Colonial jar, B) Yglesias Colonial bowl, C) Yglesias Colonial jar (Photography by Kerry Sagebiel)
6.2.2 Density and Distribution of Sherds

6.2.2.1 Settlement Zone A

In total, 163 sherds were recovered from Settlement Zone A (Figure 65). The highest number of sherds (n=46) was found at a single northern structure (Str. A6) in an eastern group of mounds (Figure 66). Other than Str. A6, the number of sherds at other structures is comparatively low, especially considering the proximity of the structures to Ka’kabish (see pg. 181 for a comparison of the number of sherds in Settlement Zone B). In total, 16% of the ceramic assemblage was attributed to type categories (Table 15). Although the sample is small, the highest number of finds are from the Terminal to Early Postclassic period.

![Figure 65: Number of sherds at structures in Settlement Zone A](image-url)
Figure 66: Number of sherds found at each structure in Settlement Zone A
### Table 15: Common types of ceramics in Settlement Zone A

<table>
<thead>
<tr>
<th>Settlement Zone A</th>
<th>Diagnostic Sherds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types*</td>
<td>A</td>
</tr>
<tr>
<td>Number</td>
<td>6</td>
</tr>
<tr>
<td>Percent</td>
<td>24%</td>
</tr>
</tbody>
</table>

*A= Aguila Orange, B= Cambio Unslipped, C= Dumbcane Striated, D= Red Neck Mother, E= Sierra Red, F= Tinanja Red, G= Other

6.2.2.2 Settlement Zone B

In total, 2093 sherds were recovered from Settlement Zone B (Figure 67 and 68). The highest number is from the southeastern portion of the mapped area, surrounding the largest structure in the survey zone, Str. B1 (Figure 69). There are several other structures – Str. B2 and Str. B49 – in the central portion of the mapped area that also have high counts, between 65-75 sherds. The highest density of sherds (as well as the largest structures) are found in areas further from the civic-ceremonial centre of Ka’kabish. It is possible that the group of structures in the southeast portion of the settlement zone served as a causeway terminus of Ka’kabish. Causeway termini are groups of structures – often low range structures – surrounding a plaza and connected to the civic-ceremonial centre by a road (see Chase and Chase 2001: 276). Although I failed to identify any evidence of a Pre-Columbian road (it may have been in the same location as the current road), the group of structures is in a beneficial location (ca. 2.5 km from Ka’kabish) to facilitate local trade. Evidence of causeway termini were found between 2.7 and 3.0 km from the centre of Caracol (Chase and Chase 2001: 276).

In total, 8% of the ceramic assemblage was attributed to type categories (Table 16). The two most common types, Sierra Red and Dumbcane Striated, combine to make 65% of the total assemblage. The most notable type that is absent in Settlement Zone B is Red Neck Mother, which turned out to account for anywhere between 12-55% of the assemblage in the other settlement zones. In fact, as the distance from the civic-ceremonial centre of Lamanai decreases, the number of Red Neck Mother sherds increases. It is possible that Red Neck Mother is found more commonly in areas closer to Lamanai, because there is a larger Terminal to Early Postclassic population at Lamanai than in the inter-site settlement zone.
Figure 67: Number of sherds at structures in Settlement Zone B

Figure 68: Number of sherds at structures in Settlement Zone B
Figure 69: Number of sherds found at each structure in Settlement Zone B
<table>
<thead>
<tr>
<th>Settlement Zone B</th>
<th>Diagnostic Sherds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types*</td>
<td>A</td>
</tr>
<tr>
<td>Number</td>
<td>19</td>
</tr>
<tr>
<td>Percentage</td>
<td>12%</td>
</tr>
</tbody>
</table>

*A= Aguila Orange, B= Cambio Unslipped, C= Dumbcane Striated, D= Red Neck Mother, E= Sierra Red, F= Tinanja Red, G= Other

Table 16: Common types of ceramics in Settlement Zone B

6.2.2.3 Settlement Zone C

In total, 324 sherds were collected in Settlement Zone C (Figure 70). The highest number came from the eastern portion of the mapped zone, from the largest mound group in the survey zone, Str. C10, Str. C11, Str. C12, Str. C13, and Str. C14 (Figure 71). In total, 16% of the ceramic assemblage was attributable to types (Table 17). Of this, an overwhelming number of sherds (81%) are Dumbcane Striated, which is representative of the Terminal to Early Postclassic periods. Other than Dumbcane striated, there are several other types in the assemblage (n=10) that are attributed to specific periods. The highest number is Late Preclassic Sierra Red (n=4). There were no structures or ceramics found in any other areas in Settlement Zone C other than the southeast portion of the survey zone (see Figure 18 for an image of the entire survey zone).

Figure 70: Number of sherds at structures in Settlement Zone C
Figure 71: Number of sherds found at each structure in Settlement Zone C
<table>
<thead>
<tr>
<th>Settlement Zone C</th>
<th>Diagnostic Sherds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types*</td>
<td>A</td>
</tr>
<tr>
<td>Number</td>
<td>1</td>
</tr>
<tr>
<td>Percentage</td>
<td>2%</td>
</tr>
</tbody>
</table>

*A= Aguila Orange, B= Cambio Unslipped, C= Dumbcane Striated, D= Red Neck Mother, E= Sierra Red, F= Tinanja Red, G= Other

Table 17: Common types of ceramics in Settlement Zone C

6.2.2.4 Settlement Zone D

In total, 1839 sherds were recovered from Settlement Zone D (Figures 72 and 73). The highest number of sherds was found adjacent to the major temple structures of Coco Chan (Figure 74). The lowest number of sherds (20-25) came from the southern portion of the survey zone. The number of sherds generally decreases further from the civic-ceremonial centre of Coco Chan. In total, 16% of the ceramic assemblage was attributed to specific types (Table 18). The most common type, Red Neck Mother (n=84), comprises 29% of the assemblage. It is likely the site was most heavily occupied sometime in the Terminal to Early Postclassic period (8th and 9th centuries). The second most common type, Aguila Orange (n=66), which dates to the Early Classic period, comprises 23% of the assemblage. This is the highest number of finds for the Early Classic period in any of the settlement zones. The civic-ceremonial centre of Coco Chan was surveyed but there were no ceramic collections made at any of the monumental structures. For future study, it may be beneficial to map the looter’s trenches in the civic-ceremonial of Coco Chan, especially considering the number of Early Classic ceramics found in Settlement Zone D and the small amount of ceramics diagnostic of the Early Classic period at Lamanai and Ka’kabish (see pg. 127-128 and pg. 145-147 for a discussion of the Early Classic period at Lamanai and Ka’kabish). Perhaps, some of the monumental structures at Coco Chan were constructed in the Early Classic period.
Figure 72: Number of sherds at structures in Settlement Zone D

Figure 73: Number of sherds at structures in Settlement Zone D
Figure 74: Number of sherds found at each structure in Settlement Zone D
Table 18: Common types of ceramics in Settlement Zone D

<table>
<thead>
<tr>
<th>Settlement Zone D</th>
<th>Diagnostic Sherds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types*</td>
<td>A</td>
</tr>
<tr>
<td>Number</td>
<td>66</td>
</tr>
<tr>
<td>Percentage</td>
<td>23%</td>
</tr>
</tbody>
</table>

*A= Aguila Orange, B= Cambio Unslipped, C= Dumbcane Striated, D= Red Neck Mother, E= Sierra Red, F= Tinanja Red G= Other

6.2.2.5 Settlement Zone E

In total, 612 sherds were collected in Settlement Zone E. The highest number of sherds was found in the north-central portion of the mapped area, surrounding the largest structure in the survey zone, Str. E24 (Figure 75). Other than this structure, sherd densities (0-10) are among the lowest in all the survey zones (see Figures 76 and 77). There is a steady decline in the density of artefacts from the centre of Coco Chan towards the south. It is possible that these low counts reflect a decline in the socio-economic status of individual structures and by extension, their owners, especially in areas that are peripheral to the monumental centre of Coco Chan. Like the relationship between Ka’kabish, Settlement Zones A, and B, structures are smaller in areas further from the civic-ceremonial centres. At some of these structures (Str. E19 and Str. E20), we only found a couple of small, nondiagnostic sherds. At Str. E15, we failed to identify any ceramics at all. In these cases, occupation is indicated by the debris field of Precolumbian platforms and the arrangement of structures into plazuela groups. In total, 12% of the ceramic assemblage was attributed to specific types (Table 19). The most common type is Red Neck Mother (n=41), forming 55% of the total assemblage. The second most common (n=17) is Dumbcane Striated (23%). There is a noticeable drop-off in Aguila Orange ceramics (n=1) from Zone D to Zone E. Compared to the other surveyed zones, Settlement Zone E has the lowest number of sherds from the Early Classic period (n=2).
Figure 75: Number of sherds at structures in Settlement Zone E

Figure 76: Number of sherds at structures in Settlement Zone E
Figure 77: Number of sherds found at each structure in Settlement Zone E
### Table 19: Common types of ceramics in Settlement Zone E

<table>
<thead>
<tr>
<th>Types*</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1</td>
<td>3</td>
<td>17</td>
<td>41</td>
<td>2</td>
<td>5</td>
<td>6</td>
<td>75</td>
</tr>
<tr>
<td>Percentage</td>
<td>1%</td>
<td>4%</td>
<td>23%</td>
<td>55%</td>
<td>3%</td>
<td>6%</td>
<td>8%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*A= Aguila Orange, B= Cambio Unslipped, C= Dumbcane Striated, D= Red Neck Mother, E= Sierra Red, F= Tinanja Red, G= Other

6.2.2.6 Settlement Zone F

In total, 2267 sherds were recovered from Settlement Zone F (Figures 78, 79, and 80). High densities of ceramics were scattered throughout this settlement zone (Figure 81). In total, 12% of the ceramic assemblage was attributed to a specific type (Table 20). This area, mid-way between Coco Chan and Lamanai, has the highest number of Red Neck Mother (n=152) sherds in the inter-site settlement zone. This type accounts for 55% of the assemblage in this survey zone. The second most common type is Dumbcane Striated (n=61). For the Late Preclassic and Early Classic period, there are several types, such as Sierra Red (n=20) and Aguila Orange (n=11).
Figure 79: Number of sherds at structures in Settlement Zone F

Figure 80: Number of sherds at structures in Settlement Zone F
Figure 81: Number of sherds found at each structure in Settlement Zone F
<table>
<thead>
<tr>
<th>Settlement Zone F</th>
<th>Diagnostic Sherds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types*</td>
<td>A</td>
</tr>
<tr>
<td>Number</td>
<td>11</td>
</tr>
<tr>
<td>Percentage</td>
<td>4%</td>
</tr>
</tbody>
</table>

*A= Aguila Orange, B= Cambio Unslipped, C= Dumbcane Striated, D= Red Neck Mother, E= Sierra Red, F= Tinanja Red, G= Other

Table 20: Common types of ceramics in Settlement Zone F

6.3 LITHIC ASSEMBLAGE

Appendix C lists the type, location, and quantity of lithics found in the inter-site settlement zone. The lithic assemblage consists mostly of whole and fragmentary chipped and ground stone tools, rather than secondary flakes and debitage (see pg. 106-107 for a discussion of the methods used to collect lithic artefacts in the inter-site settlement zone). Collection strategies were time limited and I focused on collecting diagnostic lithic materials. I was interested in identifying domestic ground stone tools (manos and metates), especially from single isolated platforms, as archaeologists often debate the function of these structures (see pg. 263-270 for a discussion of the function of small single platforms). Because of the resulting small size of the lithic database, the following section focuses on summarizing the most common tools in the survey zone. I also offer a description of some of the general trends in the assemblage.

Each tool was found associated with an individual structure. The artefacts are mostly from domestic contexts and consist largely of ground stone tools such as manos and metates, which were used to process grains and seeds (Figures 82 and 83). The food processing tools recovered are mostly made of limestone, however, other types, such as basalt and granite were also identified. The rarer finds in the survey zone are bark beaters (n=2) (Figure 84). These were hafted and used to pound layers of bark from the wild fig tree into sheets of paper (Foster 2002: 318). Bark beaters are not indicative of any specific period. They have been found in some contexts along the Pacific coasts that date as early as the Middle Preclassic (Foster 2002: 318). Other rare ground stone tools in the survey zone include adzes, pestles, and hammerstones.
Figure 82: A) Mano, rectangular variety (see Willey et al. 1965: 458), B) Mano, rectangular, thick variety (see Willey et al. 1965: 461), C) Mano, rectangular, thick variety (see Willey et al. 1965: 461)

Figure 83: Metate, large variety (see Willey et al. 1965: 455)
Figure 84: Rectangular B variety bark beater fragment found in the inter-site settlement zone (see Willey et al. 1965: 471)

The most common type of chipped stone tool was a standard biface (Willey et al. 1965: 425) (Figures 85 and 86). As Whittaker et al. (2009: 140) note, standard bifaces were “all-purpose necessities of life” and were used for a range of activities, such as forest clearing, woodworking, agricultural cultivation, and limestone quarrying. These tools dominate the database, especially in the survey zones close to Lamanai (Settlement Zones D, E, and F). Other than this form of biface, there were two other types of points or knives, both of which were found in Settlement Zone B – bifacial macro-blades and laurel leaf points. There are also various types of chipped stone tools in the survey zone such as blades and scrapers, and secondary materials such as flakes and debitage.
Figure 85: A, B, C) Standard biface (see Willey et al. 1965: 425), D) Fragmentary biface
Figure 86: Standard biface (see Willey et al. 1965: 425)
One of the most notable trends in the database is that there is an increased number of blades and points, with a greater variety of forms and materials closer to Ka’kabish, such as chalcedony laurel-leaf points (Figure 87), which may have been used for cutting or slicing activities as knifes and spears (Stemp and Graham 2006: 49; Whittaker et al. 2009: 140). Even in the secondary material, the only evidence of chalcedony is from contexts closer to Ka’kabish. There were several small blades found in the survey zones near Lamanai, but for the most part, the lithic assemblage consists of domestic tools for forest clearance, field preparation, and food procurement. Although these trends are preliminary, owing to the constraining factors mentioned above, the tendency for more specialized lithic materials to occur closer to Ka’kabish than Lamanai requires further research.

Figure 87: Laural-Leaf, unstemmed, bifacial blade (see Willey et al. 1965: 421)
6.4 TEMPORAL DYNAMICS OF THE SETTLEMENT ZONE

This section shows the spatial and chronological distribution of structures in the settlement zone (see pg. 109-111 for a discussion of the methods used to create the spatial intensity maps). Although some of the survey zones are comparatively small, such as Settlement Zone A, each is still presented independently to maintain consistency with other sections in this Chapter. The first map on the top left of each settlement zone is labelled “All Phases” and shows the distribution of structures (represented by white dots) without considering the chronological data. Each structure with chronological data is next shown in sequence (represented by black dots), which are labelled with a specific time period and show the spatial distribution of occupation during these time periods. Appendix B shows a schematic version of the settlement dynamics in each settlement zone and the designation of each structure. In schematic drawings, structures are represented by squares or rectangles (larger squares/rectangles represent larger structures), with inner rectangles representing the height of structures (see Figures 3 and 8 for examples).

6.4.1 Settlement Zone A

The earliest evidence of occupation in Settlement Zone A is at Str. A4, the southernmost platform of a Type 6 plazuela group, which is dated to the Late Preclassic period (Figures 88 and 89). This structure, along with the largest, eastern, structure – Str. A6 – of this plazuela group also has evidence of occupation in the Early Classic period. The most heavily occupied period, represented by four structures in the eastern plazuela group, is the Terminal Classic. There is slightly less evidence of occupation in the Early Postclassic and no evidence of occupation in the Late Postclassic or Colonial period. In each chronological period, occupation is centred on the eastern group of the zone, which seems to have a long history of occupation, from the Late Preclassic to Early Postclassic periods. Settlement Zone A is only ca. 0.5 km from the civic-ceremonial centre of Ka’kabish, southeast of Group F (see Figure 6), and shares a similar historical trajectory as the site, with evidence of abandonment occurring at the end of the Early Postclassic (see pg. 145-148). As mentioned, Late Postclassic material is only found in chultuns in the civic-ceremonial centre of Ka’kabish. The abandonment of two plazuela groups in proximity of the monumental architecture of Ka’kabish further supports the theory that Late Postclassic materials were deposited by smaller remnant populations, or later pilgrimages to the site.

200
Figure 88: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone A. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic, e) Terminal Classic, f) Early Postclassic.
Like Settlement Zone A, there is no evidence of occupation in the Middle Preclassic period. The earliest evidence of occupation is Late Preclassic and derives from numerous structures (n=21) scattered throughout Settlement Zone B (Figures 90, 91 and 92). The largest structure, Str. B1, was constructed sometime during the Late Preclassic, as were several Type 1 structures. Str. B1 has evidence of occupation in the Early Classic, Terminal Classic, and Early Postclassic periods, which attests to its importance as a focus of settlement in the area. As mentioned, Str. B1, as well as several other structures in the vicinity of Str. B1, may have served as a causeway terminus for Ka’kabish (see pg. 180). Most of the Late Preclassic structures in Settlement Zone B have evidence of occupation in the Early (n=19) and Late (n=19) Classic periods. The most heavily occupied periods are the Terminal Classic (n=39) and Early Postclassic (n=37). During these periods, there is evidence of various Type 3 and Type 6 groups. There is a precipitous drop-off in evidence of occupation in the Late Postclassic, with only one structure, which is in the northeastern portion of the survey zone.
Figure 90: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone B. Black dots represent structures with evidence of occupation in specific periods of Pre Columbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic
Figure 91: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone B. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, c) Late Postclassic.

Settlement Zone B

0  600 m
6.4.3 Settlement Zone C

There is no evidence of occupation in the Middle Preclassic period in Settlement Zone C. The only evidence of occupation between Coco Chan and Ka’kabish in the Middle Preclassic period is at the civic-ceremonial centre of Ka’kabish (see pg. 145). It is likely that occupation started in the centre of Ka’kabish and slowly spread out over time into the peripheries, which are represented by Settlement Zone A and B. The earliest evidence of occupation in Settlement Zone C is Late Preclassic, from two Type 1 structures on opposite ends of the survey zone (Figures 93, 94 and 95). Like many of the structures and structure groups in the other survey zones, these early Type 1 structures turn into larger Type 3 and 6 groups in intervening periods. The heaviest occupation is in the Terminal (n=17) and Early Postclassic periods (n=16). Like Settlement Zone C, there is a significant decline in occupation, with no evidence of human habitation during the Late Postclassic and Colonial periods. Also, as has been noted in other sections (see pg. 157 and 183), most of Settlement Zone C was uninhabited in the past.
Figure 93: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone C. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic
Figure 94: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone C. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic.
6.4.4 Settlement Zone D

Like Settlement Zones A, B, and C, there is no evidence of Middle Preclassic occupation in Settlement Zone D. By the Late Preclassic period, there are numerous structures (n=16), Type 1 structures and Type 3 groups, with evidence of occupation (Figures 96, 97 and 98). In the Early (n=18) and Late Classic period (n=20), occupation is concentrated around the monumental structures of Coco Chan. The heaviest period of occupation is in the Terminal (n=40) and Early Postclassic (n=40), with evidence at almost every structure in the settlement zone. Like the other survey zones, there is a significant drop-off in occupation in the Late Postclassic period (n=2). However, unlike many of the other survey zones, there is evidence of settlement in the Colonial period (n=5). It seems that Settlement Zone D was mostly abandoned by the end of the Early Postclassic period and resettled in the Colonial period. Settlement Zone D and E are the only survey zones in the inter-site settlement zone that have evidence of occupation in the Colonial period.
Figure 96: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone A. Black dots represent structures with evidence of occupation in specific periods of Preclassic Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic.
Figure 97: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone D. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, b) Late Postclassic, c) Colonial
Figure 98: Chronology of structures (n=45) at Settlement Zone D

6.4.5 Settlement Zone E

The earliest evidence of occupation in Settlement Zone E is in the Late Preclassic, from a single structure in the centre of the survey zone (Figures 99, 100, and 101). There is limited evidence of the Early Classic period, with only two structures. By the Late Classic period, there is evidence of occupation from the largest structure (Str. E24) in the survey zone, as well as from a smaller structure (Str. E25) adjacent to it. The plazuela group (of which these structures are a part of) is the focus of settlement from the Late Preclassic to Colonial periods, with a gap in the Late Postclassic. Compared to the other survey zones, it seems that Settlement Zone E remained largely unoccupied in the earlier periods of Precolumbian Maya history. Unlike Settlement Zone B and D, which experience a noticeable increase in occupation in the Late Preclassic period, Settlement Zone E only has a single structure (n=1) dated to this period. The heaviest periods of occupation are during the Terminal (n=14) and Early Postclassic (n=18). There is no evidence of settlement in the Late Postclassic. One structure (Str. E23) in the upper, central, plazuela group, has evidence of occupation in the Colonial period.
Figure 99: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone E. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Late Preclassic, c) Early Classic, d) Late Classic
Figure 100: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone E. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Terminal Classic, b) Early Postclassic, c) Colonial
6.4.6 Settlement Zone F

The earliest evidence of occupation in Settlement Zone F is Middle Preclassic and comes from two structures (Str. F41 and Str. F81) (Figures 102, 103, 104, and 105). This is the only evidence of the Middle Preclassic period in the inter-site settlement zone. It is likely that Settlement Zone F was the first area settled in the inter-site settlement zone because of its proximity to Lamanai, which was occupied as early as ca. 1600 BC. However, Settlement Zone F is still a considerable distance from the civic-ceremonial centre of Lamanai (ca. 2.5 km) and the monumental architecture of Coco Chan (ca. 1.5 km). By the Late Preclassic, there are numerous structures (n=18) scattered throughout the survey zone that date to this period, with several groups of two structures arranged orthogonally – a Type 3 unit. In the Early (n=23) and Late Classic (n=19) the settlement is similar in size to the previous period. The heaviest period of occupation is in the Terminal (n=71) and Early Postclassic (n=69) periods. By the Late Postclassic, there are only three structures with evidence of occupation. A small group of structures (n=3) in the southern portion of Settlement Zone F continued to be occupied in the Colonial period (Str. F47, Str. F51, and Str. F52).
Figure 102: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone F. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) All phases, b) Middle Preclassic, c) Late Preclassic, d) Early Classic
Figure 103: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone F. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Late Classic, b) Terminal Classic, c) Early Postclassic
Figure 104: Plot of structures attributed to temporal phases. White dots represent all the structures in Settlement Zone F. Black dots represent structures with evidence of occupation in specific periods of Precolumbian Maya history. The underlying heat map is used to visualise the distribution of settlement. a) Late Postclassic, b) Colonial.
6.5 SUMMARY
This chapter illustrates some of the major developmental trends revealed by the inter-site settlement zone research. The settlement dynamics are similar in each settlement zone, with little to no evidence of occupation in the Middle Preclassic period and a dramatic increase in occupation in the Late Preclassic period, except for Settlement Zone E, which is only scarcely occupied until the Terminal and Early Postclassic periods. The density of occupation remains the same, or slightly reduced, in the Early to Late Classic periods in the inter-site settlement zone. The apogee of Precolumbian Maya occupation in the inter-site settlement zone is sometime in the Terminal to Early Postclassic. There are extensive settlement expansions in each settlement zone during these periods. By the Late Postclassic, evidence of occupation is greatly reduced and there are only several structures (n=6) scattered throughout the settlement zone. The only evidence of Colonial period occupation is at a few structures (n=3) surrounding the civic-ceremonial centre of Coco Chan. It seems that most of the structures in Settlement Zone D and E were abandoned by the end of the Early Postclassic period, with only a small, remnant, population in the inter-site settlement zone in the Late Postclassic and Colonial periods. In the next few chapters, the data from Lamanai, Ka’kabish, and the inter-site settlement zone, are compared to the environmental record from cores obtained in the New River.
Lagoon. In addition to examining the environmental record for Lamanai, I will consider
the results of my study of occupation sequence to what is known from other sites such as
La Milpa, Blue Creek, and Altun Ha. The intent is to highlight, and perhaps to begin to
explain, differences in the settlement dynamics of sites in the greater region of Northern
Belize. The data from Lamanai, Ka’kabish, and the inter-site settlement zone, are then
considered in the context of the larger corpus of Maya scholarship to address some of the
theoretical and methodological issues raised in Chapter’s 2 and 3.
Chapter 3 identified two different ways in which scholars have so far tried to characterize Maya settlements: as pristine and ecofriendly on one hand, or by contrast as erosion-inducing, forest-clearing, environmentally detrimental on the other. The purpose of this chapter is to address in more detail the evidence for human and environmental interactions at Lamanai, Ka’kabish, and the inter-site settlement zone. This discussion is informed by three environmental studies conducted in the area, as well as by the insights about the settlement dynamics of Lamanai, Ka’kabish, and the inter-site settlement zone, as detailed in the previous two chapters. Metcalfe et al. (2009) outline the major environmental changes in the region over the course of the Holocene and the ways in which these changes affected the New River Lagoon, a body of water adjacent to Lamanai. Rushton et al. (2013) trace the history of Maya cultivation, the Maya use of field-based agriculture, and other arboreal resources. Lentz et al. (2016) examine paleoethnobotanical data to reveal changes in the intensity of pine use from the Late Classic to Early Postclassic periods. By comparing the occupation history of Lamanai, Ka’kabish, and the inter-site settlement zone, to changes in the pollen record, and other environmental data, I aim to understand the environmental impact of Maya settlements, and the degree of management exerted over their agricultural, and arboreal resources.

7.1 ENVIRONMENTAL SETTING OF THE STUDY

Lamanai, Ka’kabish, and the inter-site settlement zone, which are in the south-eastern Yucatan peninsula, have a climate that is characteristic of the Northern Hemisphere tropical Americas, with summer seasons that are directed by the movement of the Inter-Tropical Convergence Zone (ITCZ), a belt of low pressure that roughly circles the equator (Metcalfe et al. 2009: 627). Northern Belize is generally drier and more seasonal
than southern Belize (Esselman and Botes 2001), with areas experiencing annual precipitation of between 1524 to 2032 mm (Metcalfe et al. 2009: 627; Walker 1973) (Figure 106). Belize experiences two seasons – wet and dry – with the latter roughly falling between February and April, with significantly decreased rainfall.

The New River Lagoon divides the area into two distinct ecozones. On the east side of the lagoon, all the way to the coast, lies pine savanna (known in Belize as “pine ridge”), which is subject to seasonal flooding and swamp, or marshland. Lamanai, Ka’kabish, and the inter-site settlement zone, are situated on the west side of the lagoon, an area characterized by higher elevation (owing largely to the remains of ancient Maya habitation), more fertile soils, and hence, broadleaf forests. Figure 107 shows a map of the distribution of ecosystems in the area (Bridgewater et al. 2002; Brokaw and Sabido 1998; Iremonger and Brokaw 1995; Meerman and Sabido 2001; Wright et al. 1959). Although the data behind Figure 107 were collected some time ago, the major changes to the environment in the intervening period have been an increase in agricultural use and a decrease in lowland broad-leaved forest coverage. However, the forests immediately surrounding the civic-ceremonial centre of Lamanai are protected from lumbering and farming by governmental conservation programs (Howie 2012: 69).

The New River drains the eastern part of the Orange Walk District. It flows northward out of the New River Lagoon for 132 km and empties into Chetumal Bay, the waters of which flow southwards over Belize’s coastal shelf and along the second largest barrier reef in the world (Mavroidis 2008: 31; Lentz et al. 2016: 287). The lagoon is freshwater, but there are stretches of mangrove, trees, and shrubs, along the lower reaches (towards the mouth of the New River) that are normally found in coastal saline water, albeit adapted to a range of salinities (0-90 degree/oo) (Spencer et al. 2016). Some scholars suggest that stretches of mangrove may have spread to the lagoon during periods of higher sea level sometime in the past (Furley and Ratter 1992; Metcalfe et al. 2009: 629; Romney 1959). There are reeds bordering the lagoon, with bands of logwood in the west and marshlands in the east (Rushton et al. 2013: 486). Soils west of the lagoon are attributed to the Yalbac Subsuite of the Yaxa Suite and, as mentioned earlier, support broadleaf forest, with species such as mahogany (Swietenia macrophylla), cahune
Figure 106: Average annual rainfall in Belize (see Meerman and Sabido 2001: 16 for average precipitation by months and districts)
Figure 107: Distribution of ecosystems in the Survey Zone (see Meerman and Sabido 2001)
(Orbigyna cohune), and sapote (Pouteria sapota) (King et al. 1992: 273; Howie 2012: 69). These soils are made up of “black, dark grey, and dark brown clays with blocky subsoils” (King et al. 1992: 273). Analysis of the Yalbec clay shows that its high clay content increases with depth and contains mostly smectite and vermiculite (Howie 2012: 70; King et al. 1992: 222-223). Excavations into several structures in the hinterlands of Lamanai encountered this layer of black clay directly beneath the construction core, with its thickness varying between 20-100 cm. Beneath this clay horizon, there was a layer of sandy, textured limestone, with nodules of dense limestone, similar to other tests in the ceremonial precinct of Lamanai (Howie 2012: 71).

7.2 EVIDENCE OF ENVIRONMENTAL CHANGE
7.2.1 Environmental Change and the New River Lagoon
Prior to the initiation of Metcalfe et al. (2009) study of the paleoenvironment in Northern Belize, most of the research on the reconstruction of past environments in the area was limited and based on palynology (Alcala-Herrera et al. 1994; Jacob 1992; Jacob and Hallmark 1996; Jones 1994; Jones and Bryant 1992). The major goal of Metcalfe et al. (2009) study is to understand the environmental changes that affected the New River Lagoon over the course of the Holocene and the Maya occupation in the region. To do this, they collected nine cores from the New River Lagoon, four of which were used in their study – two from Hillbank, one from Lamanai, and another from south of Lamanai, referred to as ‘Outpost.’ The site of Hillbank is located on the southwestern shores of the lagoon. Hillbank has evidence of Maya occupation in the terminal Postclassic and early Spanish Colonial periods (Metcalfe et al. 2009: 629), but the archaeological record is badly damaged, as British loggers in the 19th century sometimes altered or destroyed Maya structures by trenching through them to construct rail lines for the mahogany trade (Ng and Cackler 2006: 296). While several of these cores were used for comparative purposes, Metcalfe et al. (2009: 635) focused most of their efforts on the 319-cm core adjacent to Lamanai.

Each core was assigned a chronological age-depth model using radiocarbon and radionuclide measurements. This chronological framework was compared to plant microfossils to increase its accuracy, as studies carried out in the Peten region of Guatemala indicate difficulties in obtaining accurate radiocarbon dates from areas with limestone bedrock (Deevey et al. 1979; Metcalfe et al., 2009: 629; Leyden et al., 1994).
From the core at Lamanai, Metcalfe et al. (2009: 639) found peaks in several elements, such as silica, iron, and aluminium, between ca. 170 BC and AD 270, which indicate a period of increased erosion. Like the climatic changes reported in the northeastern Yucatan peninsula (Hodell et al. 2007), scholars (Metcalfe et al., 2009: 639) suggest these data reveal a “significant anthropogenic disturbance of the environment” in the Late Preclassic to Early Classic periods. By the middle of the Late Classic, Metcalfe et al. (2009: 639) argue that sudden changes in flora may reflect the end of major construction efforts in the civic-ceremonial centre of Lamanai. After ca. AD 1070, the loss of diatoms, changes in magnetic susceptibility, and decreased rates of sediment accumulation, indicate reduced activity at the site centre, decreased soil erosion, and the recovery of the forest, especially by the Late Postclassic and Colonial periods. Over the course of Maya occupation, they found evidence for periods of drier climate in the Lamanai core, but nothing to indicate a prolonged drought, as has been reported in other areas of the Maya world (Curtis et al. 1996; Douglas et al., 2016; Gill 2000; Medina-Elizalde and Rohling 2012; Rosenmeier et al. 2002).

7.2.2 History of Vegetation Change
Rushton et al. (2013) use pollen and charcoal records from the same 3 m core in the New River Lagoon as the previous scholars (Metcalfe et al. 2009) to investigate changes in vegetation from 1500 BC to AD 1500 (Figures 108 and 109). They used diatom, stable isotopes, mineralogical, and major elemental data, to document both the nature of vegetation change and the Maya impact on the flora of the landscape, particularly arboreal resources (Rushton et al. 2013: 485). Their research was focused on understanding three subjects: 1) the history of Maya forest clearance and archaeological evidence of forest clearance, 2) evidence of Maya management of vegetation sources, 3) periods of forest recovery from human disturbance (Rushton et al. 2013: 486). By 1240 BC, or the Early Preclassic period (2000-1000 BC), Rushton et al. (2013: 490) suggest that an increase in charcoal, disturbance of taxa, Z. mays, decreased forest, and savanna cover, indicate evidence of land clearance for agriculture near the New River Lagoon (Rushton et al. 2013: 490). They argue that as early as 1640 BC pollen data – Z. mays and Cucurbita – indicate that agriculture was “established and practiced” in the area (Rushton et al. 2013: 490). During this early period and onwards there is a “clear and consistent Z. mays signal” with only two breaks in the record, from 830-640 BC and 220-100 BC (Rushton et al. 2013: 490). Rushton et al. (2013) suggest that this high
concentration of *Z. mays* is likely due to the proximity of the coring site to the maize fields in the past.

The first evidence of the clearance of pine, an arboreal resource used by the Maya for fuel, implements such as torches, and construction (Abrams and Rue 1998; McNeil *et al.* 2010), occurs from 170 BC to AD 150 (Rushton *et al.* 2013: 490). Rushton *et al.* (2013: 490) argue that this period coincides with the expansion of the site in the Late Preclassic, with pollen records that show “heavy exploitation of *P. caribaea* for timber in nearby savannas.” These scholars also found further data to support their hypothesis, such as charcoal records that peak during periods of very low and absent *Pinus*. There is another period from AD 600-980 that has a complete absence of *Pinus* from the pollen record. Rushton *et al.* (2013: 490) suggest that pine was used to produce lime plaster for stucco,
which was used extensively in construction (see pg. 80-83 for a discussion on the use of lime). After AD 1000, Rushton et al. (2013: 491) found that an increase in Pinus coincided with “the end of major construction at the site.” By the 1500s, Rushton et al. (2013: 491) argue that another decrease in the arboreal signal, specifically Pinus, indicates continued use of pine for fuel by European settlers. By comparing the pollen record with excavations conducted in the ceremonial centre, Rushton et al. (2013: 491) suggest that Pinus can be a “proxy for periods of construction.”

Along with evidence of pine use, Rushton et al. (2013: 491) found evidence of palm cultivation, with higher levels of Acrocomia aculeate and Attalea cohune from both 1630 to 1150 BC and 100 BC to AD 1100. They argue that these periods of increased palm pollen – as compared to the current pollen assemblage – are evidence of Maya cultivation because these periods coincide with episodes of forest clearance for agriculture. These findings are supported by another study at Colha, Belize, which also found an increased palm signal during periods of Maya occupation (Jones 1994). This evidence suggests that the Maya managed their forest resources, cultivating palms and field-based agriculture,
“providing multiple resources, from a ‘managed mosaic’” (Fedick 1996; Rushton et al. 2013: 491).

7.2.3 Agroforestry and the Exploitation of Pine

The hypotheses discussed above rely on pollen data to draw inferences about the relationship between residents of Lamanai and the environment. Other archaeologists use palaeobotanical evidence from caches to investigate changes in use-patterns over time (Lentz et al. 2016). Lentz et al. (2016) analysed caches from three structures – Str. N10-77, Str. N10-12, and Str. N10-2 – which contained a mix of carbonized maize, beans, wood charcoal from conifer and hardwood species, among other materials (see Lentz et al., 2016: 284). They used pine (P. caribaea) as a proxy for understanding the extent of Pre-columbian Maya exploitation of arboreal resources. Lentz et al. (2016: 291) argue that pine was processed and exchanged as a commodity, especially in the Late and Terminal Classic periods.

As mentioned earlier, pine was used for various symbolic and utilitarian purposes, such as building materials and fuel (Dussol et al., 2016), and has been identified in burials (Morehart et al. 2005) and ritual offerings (Lentz et al., 2005, 2016: 288). Based on the abundance of pine in caches from the Late Classic period (Figure 110) and a decline in the pine pollen signature from cores of the New River Lagoon at the same time (Rushton et al., 2013), Lentz et al. (2016) argue that the Pre-columbian Maya at Lamanai overexploited this resource during the Late Classic to Terminal Classic periods. They suggest two possible explanations for its abundant use: 1) increased elite ritual offerings, with lavish smoke displays, 2) the proximity and availability of a large source of pine, which is on the eastern shores of the lagoon (Lentz et al. 2016: 292).

By the Early Postclassic period, there is no evidence of pine in ceremonial contexts and the pine pollen percentages have rebounded (Lentz et al. 2016: 292). The authors suggest that the absence of pine in later ceremonial contexts indicates a reduction in demand in the Postclassic, which allowed pine resources to replenish. A possible explanation for this reduced demand is that “unsustainable land use practices,” depleted the resource, which in turn, modified ritual activities.
that were dependent upon it (Rushton et al. 2013: 491) (see pg. 231-233 for a discussion of arboreal resources and the settlement dynamics at Lamanai, Ka’kabish, and the inter-site settlement zone).

7.3 SETTLEMENT DYNAMICS AND THE CHANGING ENVIRONMENT

7.3.1 Settlement Dynamics in the Study Zone

There has been a significant amount of speculation about settlement dynamics at Lamanai (see Lambert et al. 1984; Pendergast 1981), even though Mayanists have insisted that “information on population levels is limited” (Metcalfe et al. 2009: 629). Some scholars suggest the site reached its peak in the Late Preclassic to Early Classic periods, with 10,000 inhabitants (Lambert et al. 1984), while others argue that Lamanai peaked in the Postclassic (Lentz et al. 2016: 284; Pendergast 1981). Figure 111 and 112 shows the settlement dynamics of Lamanai, Ka’kabish, and the inter-site settlement zone. Although the pollen record indicates occupation in the area by at least 1600 BC, no material evidence of this date has yet been recovered in the civic-ceremonial centres, or in the hinterlands. This is likely because diagnostic materials from this time period are buried under hundreds of years of human occupation. There are several secure contexts at
Figure 111: Settlement dynamics of Lamanai and Ka’kabish

Figure 112: Settlement dynamics of Settlement Zones A to F
Lamanai and Ka’kabish with ceramics that are diagnostic of the Middle Preclassic (1000 BC-400 BC) (Powis 2002), and only secondary evidence from three structures in the inter-site settlement zone.

The first peak in settlement at Lamanai is during the Late Preclassic, with major construction in the northern ceremonial precinct of Lamanai and evidence of settlement throughout the Ka’kabish/Lamanai corridor. After the Late Preclassic, there seems to be a period of decline, or at least, stagnation, with less evidence of occupation at structures at Lamanai. In the hinterland, the Early Classic is marked by only a small increase in the number of structures. This inactivity continues into the Late Classic period in the peripheries, with two of the largest fields, Settlement Zones B and F, showing lower evidence of occupation than the previous two periods.

There is a second peak of construction at Lamanai during the Late Classic. Sometime in the Terminal to Early Postclassic (9th and 10th centuries), the site centre of Lamanai and its hinterland reaches the highest levels of occupation. Settlement expansion is most marked in the hinterlands, especially in Settlement Zone F, which is closest to Lamanai. There is some decline in occupation between the Terminal and Early Postclassic, albeit small, with reduced construction at Lamanai, and slightly less evidence of occupation in the hinterlands. By the Late Postclassic period, there is less evidence of occupation in the inter-site settlement zone, as ceramics from the Late Postclassic period were only found at 3 structures. This period of abandonment is entirely absent from the archaeological record at Lamanai, which experiences its third and final peak in construction in the Late Postclassic, with evidence of occupation at 27 structures. In the Spanish Colonial period (16th and early 17th centuries), there is still little evidence of occupation in the hinterlands and construction at Lamanai is greatly reduced and focused in the southern portion of the site, in the vicinities of the Spanish churches.

7.3.2 Human/Environment Interaction at Ka’kabish, Lamanai, and the Inter-Site Settlement Zone

Although some of the earliest evidence of occupation in the area is indicated by an increase in Z. mays (Rushton et al. 2013), there is no evidence of the Early Preclassic in the survey zone. However, archaeological remains from these early dates are often difficult to find or buried under subsequent construction efforts in the core (see Pohl et al. 2013).
Excavations at Ka’kabish and Lamanai, and other materials collected from the settlement zone, indicate occupation sometime during the Middle Preclassic. By the Late Preclassic, there is evidence of settlement throughout the survey zone, with episodes of construction at many structures at Lamanai. Metcalfe et al. (2009: 639) argue that peaks in δ\(^{13}\)C between ca. 320 BC and AD 1000 show increased productivity at Lamanai as a response to the “higher nutrient inputs from the growing Maya population.” The settlement dynamics in the survey zone support the environmental evidence of a population boom sometime in the Late Preclassic period. This population peak also coincides with evidence of erosion and other anthropogenic disturbances in the area (Metcalfe et al. 2009: 639).

By the Early Classic, there is decreased activity in the core of Lamanai and only slightly more evidence of occupation in the inter-site settlement zone. This period of less activity at Lamanai, and in the hinterlands, also follows evidence of major pine clearance from ca. 170 BC to AD 150 (Rushton et al. 2013: 490). It is possible the settlement density in the hinterlands was reduced for several periods after the Late Preclassic because of the environmental stresses caused by major construction efforts sometime between 200 BC and 200 AD. There is little evidence of settlement expansion in the inter-site settlement zone until sometime into the Terminal to Early Postclassic periods. Metcalfe et al. (2009: 639) argue that a change in diatom flora suggests an end to major construction efforts in the Late Classic, which seems to agree with evidence in the hinterlands. However, primary contexts show increased activity in the civic-ceremonial centre at Lamanai. Especially during the Late to Terminal Classic, there is a significant increase in evidence of occupation in the core of Lamanai and the inter-site settlement zone. This is supported by evidence from caches at several major structures at Lamanai (Rushton et al. 2013). Most of the structures at Lamanai, Ka’kabish, and the inter-site settlement zone, have evidence of occupation in the Terminal Classic and Early Postclassic periods. At Lamanai, activity in the core is at its highest, with 30 structures. This peak in activity in every study zone is again supported by environmental evidence that suggests heavy exploitation of Pinus in the pollen record from AD 600 to 980 (Rushton et al. 2013: 490). A major difference in the pollen data and the settlement dynamics is found from ca.1070 onwards, which Metcalfe et al. (2009: 639) argue is a period of less soil erosion and increased forest recovery. The Early Postclassic (AD 900-1250) is one of the most heavily occupied periods in the history of Lamanai, Ka’kabish, and the inter-site
settlement zone. It is possible that the Precolumbian Maya in the area exerted more control over their agricultural and arboreal resources in the Early Postclassic, creating, as Fedick (1996) called, a “managed mosaic.” This finding is supported by evidence of systems of forest conservation in the Late Classic at the site of Tikal, in the Peten (Lentz and Hockaday 2009).

By the Late Postclassic, the inter-site settlement zone is almost completely depopulated – or at least people do not seem to be building in these zones, although it is possible the land was used for swidden agriculture. Evidence of construction activity increases, however, in the core of Lamanai. The apparent abandonment of the peripheries in the Late Postclassic agrees with environmental data that shows less soil erosion and an increased arboreal signal (Metcalfe et al. 2009: 639). Pine percentages may have rebounded in the Postclassic (Lentz et al. 2016: 292), especially in the Late Postclassic, because of the depopulation of the areas surrounding these civic-ceremonial centres. Rushton et al. (2013: 491) suggest that “unsustainable land use practices” depleted pine in the area, but this is inconsistent with evidence of settlement from the Early Postclassic.

By the 1500s, Rushton et al. (2013: 491) identified another decrease in the arboreal signal, which they attribute to European settlers. The civic-ceremonial centre of Lamanai continues to be occupied from ca. AD 1250 to AD 1540, even as the inter-site settlement zone appears to be abandoned. Late Postclassic populations were inhabiting the area but may have been located closer to Lamanai and may not have been depleting arboreal resources significantly. The decrease in the arboreal signal in the 16th-century may reflect Spanish Colonial activities. The policy of congregación encouraged native populations to settle near recently built churches, such as those constructed at Lamanai, which allowed the Spanish to more effectively administer their settlements (Lovell 1988: 30). As well as consolidating their populations into easily controlled settlements, Spanish policies also resulted in the flight of Maya populations from areas of Spanish control. Lamanai was a mission community in the early Colonial period (Jones 1989; Graham 2011). The policy of reduction may have meant that the population of Ka’kabish and that of most of the hinterlands was moved to Lamanai. This may explain the absence of occupation at Ka’kabish and the hinterlands during the Spanish Colonial period. The only evidence of occupation in the hinterlands is close to Coco Chan, mid-way between the two sites.
7.3.3 The Environment and the Maya

Although it is sometimes difficult to understand the relationship between past peoples and their environment by comparing settlement dynamics to pollen data and other environmental proxies, there are several human and environmental trends in the history of Lamanai, Ka’kabish, and the inter-site settlement zone. The most notable trend in the data is indicated by times of environmental stress, which are consistently associated with periods of settlement stagnation, or abandonment. Evidence in the Late Preclassic suggests increased erosion and heavy exploitation of arboreal resources. After this period of increased anthropogenic disturbance, evidence of occupation in the area remains the same, or decreases, for the next several centuries. There is a possible exception to this trend in the Early Postclassic, which witnesses an increased arboreal signal during a period of settlement expansion, but by the Late Postclassic the hinterlands are almost completely abandoned. The depopulation of the hinterlands also occurs during a period of forest recovery and decreased soil erosion. Although the civic-ceremonial centre of Lamanai has evidence of occupation throughout its long history, the inter-site settlement zone seems more susceptible to the changing environmental dynamics of the region. However, another explanation for the abandonment of the hinterlands during the later portions of the Late Postclassic is the arrival of the Spanish.

Based on the developmental trajectory of Lamanai, Ka’kabish, and the inter-site settlement zone, as well as the environmental record, land modifications affected the prosperity of the region. Evidence from pollen data, such as higher levels of palm, and decreased pine, indicate the Maya were manipulating, as well as clearing, their forest resources. These periods of heavy exploitation of forest resources and soil erosion are also noted at the nearby site of Blue Creek (20 km northwest of Ka’kabish), which scholars have argued experienced increased anthropogenic disturbance in the Preclassic and Late Classic periods (Beach et al. 2006). Some scholars have argued that Precolumbian populations reacted to accelerated rates of deforestation and soil erosion in the Late and Terminal Classic period by changing their landuse practices (Anselmetti et al. 2007; Beach et al. 2002). The data in the study zone suggests a similar pattern, with evidence of environmental recovery occurring by the beginning of the Early Postclassic, during a period of settlement expansion. If the Procolumbian Maya in the area changed their landuse practices in the Early Postclassic, it did little to improve the sustainability of the inter-site settlement zone, which was mostly abandoned by the Late Postclassic.
7.4 SUMMARY

Three conclusions can provisionally be drawn: 1) the historical trajectory of the hinterland differed greatly from the civic-ceremonial centres, 2) evidence of environmental disturbance in the study zone is a strong indicator of periods of occupation expansion and subsequent decline 3) the Precolumbian Maya at Lamanai, Ka’kabish, and the inter-site settlement zone, both managed and depleted, some of their resources, which in turn, seems to have affected the prosperity of their cities. In the next chapter, these conclusions are compared to conditions proposed by the evidence from other sites in the region, such as Blue Creek, La Milpa, El Pozito, and Chau Hiix.
Chapter 8

LAMANAI, KA’KABISH, THE INTER-SITE SETTLEMENT ZONE, AND THE GREATER REGION OF NORTHERN BELIZE

The purpose of this chapter is to compare the cultural and historical trajectory of Lamanai, Ka’kabish, and the zone of more dispersed settlement between them, to other archaeological sites in the greater region of Northern Belize. The first section focuses on sites within 25 km of Lamanai, including Chau Hiix and El Pozito. The second section focuses on sites between 25 km and 50 km of Lamanai, including La Milpa, Blue Creek, Dos Hombres, Nohmul, San Estevan, Cuello, Altun Ha, Colha, and San Jose. The third and final section compares the historical trajectory of Northern Belize to other areas in the Maya world. For each site, there is a discussion of three topics: 1) the location and environment, 2) the archaeological history and composition of the site, 3) the settlement dynamics. By summarizing the setting, configuration, and temporality of each site, this chapter aims to reconstruct the historical trajectory of the region and uncover some of the processes that affected the variability in the archaeological record. Figure 113 shows a map of the sites that are mentioned in this chapter. Appendix D shows a map of the civic-ceremonial centre of each site, and where information is available, their surrounding communities.

There are sites in the region that are not included in my analysis. Several of the sites are excluded because they are not extensively surveyed or excavated, such as Las Abejas (Sullivan 1997), Guijarral (Hughbanks 1994, 1995), Gran Cacao (Levi 1994; Lohse 1995), Great Savanna (Houk 1996, 2003: 54), Sierra de Agua (Baker 2003), among others (see Hammond 1975a: 44; Sullivan 2002: 202).
Figure 113: Map of Precolumbian Maya centres mentioned in this chapter
Other sites, such as K’axob (Henderson 2003; McAnany 2004) and Ma’ax Na, are excluded because they are located close to other sites in the region. Also, there are sites 50 to 60 km north and west of Lamanai that are only briefly mentioned in this chapter, such as Rio Azul (Adams 1990, 1995, 1999), Kinal (Adams 1999; Hageman 1992), La Honradez (Adams 1999), Chan Chich (Guderjan 1991; Houk 1998, 2000), among others. These centres are included in the section that discusses other sites in the Maya world.

The 25 km and 50 km distinctions are arbitrary but are used to highlight differences in the socio-cultural history of sites in each zone, as social interactions are affected by distance decay, especially in low-mobility communities (Matous et al. 2013). Distance decay is a concept in geography that describes the effect of distance on social interactions and is based on Tobler’s first law of geography that “all things are related but near things are more related than far things” (Hanks 2011; Pun-Cheng 2017). The spatial distribution of ceramics is often subject to distance decay, such as the Champoton 5 complex, which are largely restricted to the coastal region of the western Yucatan and are less frequent inland from the coast (Ek 2014: 155). Evidence from the inter-site settlement zone shows a similar pattern, with some types of ceramics (such as Red Neck Mother) becoming less common in the peripheries of the civic-ceremonial centre of Lamanai (see pg. 178-194). Based on the relationship between distance and socio-cultural interaction, it is expected that cities and towns closer to Lamanai/Ka’kabish will have similar cultural and developmental trajectories, with similar settlement patterns and occupation histories. By distinguishing between sites that are 25 km and 50 km from Lamanai, I intend to highlight some of the similarities and differences between Precolumbian Maya settlements in Northern Belize.

Another reason for the 25 km and 50 km distinction (which also ties into the effect of distance decay) is because these distances represent roughly a day, and two days’ walk, from the civic-ceremonial centre of Lamanai. Although the speed of walking and the distance covered in a single trip are affected by a variety of environmental conditions, such as the “terrain, climate, season, weather, architecture and building practices, transportation options [and] surface conditions” (Orendurff et al. 2008: 1077-1078), scholars generally agree that people walk anywhere between 3 and 7 kilometres per hour (Cavagna and Margaria 1966). If an individual walked from Lamanai to any other site within 25 km, with several breaks for food or/and other activities, he/she could
hypothetically return to the site by the end of the day. Further locational and regional information on walking and the impact of terrain is needed to fully substantiate this hypothesis.

8.1 MAJOR SITES WITHIN 25 KM OF LAMANAI

Ka’kabish and Coco Chan, the closest sites to Lamanai, have been discussed in previous chapters (see Chapter 5 and 6). Although preliminary survey and reconnaissance in areas along the New River Lagoon have revealed numerous sites, with large-scale and/or small-scale architecture, these have not featured in any major reports or publications. Compared to other regions in the Maya world, such as the Three Rivers Region, which is 40 km west of Ka’kabish, Maya settlement along the New River Lagoon is understudied, with research focused on the civic-ceremonial centre of Lamanai. There are two other sites of note within 25 km of Lamanai: Chau Hiix and El Pozito.

8.1.1 Greater Lamanai Region

8.1.1.1 Chau Hiix

Chau Hiix is located between the two major centres of Lamanai and Altun Ha on the southern portion of the Western Lagoon near the wildlife reserve of Spanish Creek (Andres 2009: 1). Chau Hiix is separated from Lamanai by several small bodies of water or lagoons, however, as scholars have noted (Pyburn 2003; Andres 2009: 1), easily accessible local creeks connect these lagoon systems. Evidence of landscape modifications, such as dams, wells, canals, and raised fields, indicate the residents of Chau Hiix invested a significant amount of labour into the development of the lagoon shore, with increasing control of the local hydrology (Andres 2000: 11; Pyburn 2003). Spanish Creek, a water system that is formed by several small springs (part of the Belize River watershed), feeds the Western Lagoon, giving year-round access to water (Andres 2000: 11; Meerman et al. 2004: 9). The community of Chau Hiix is situated on roughly 12 sq. km of productive agricultural land (Andres 2000: 11; Pyburn 1998: 278). The agricultural fields extend to an area referred to as the “Cohune Ridge zone,” west of the site, which was extensively terraced (Andres 2000: 11; Cuddy 2000).

The site is aligned north-south, along the shores of the lagoon, in a way similar to the strip-like settlement pattern at Lamanai (Andres 2000: 11) (Appendix D). The settlement
at Chau Hiix covers 5 km of the shoreline, with settlement organized into “satellite”
groups of civic-ceremonial architecture (Andres 2000: 11; Goldsmith 2005; Sering 2002).
Chau Hiix is a medium-sized centre and consists of 25 major structures and four
courtyards, which, as Andres (2009: 1) comments, makes it slightly smaller than Altun
Ha (according to Adams and Jones [1981] scale of courtyard counts). The central
precinct is divided into two plazas – A and B – like the “twin-group” layout found at
many other sites (including Ka’kabish) (Andres 2009: 1; Ashmore 1981a: 57; Hammond
1981: 185). The central precinct is 0.3 sq. km, but there are other outlying communities
that cover an area of at least 2.5 sq. km (Andres 2000: 17; Sering 2002: 77).

The history of the civic-ceremonial centre, as well as several outlying groups, was
studied over the course of several decades (Andres 2000, 2002, 2005, 2006, 2009; Andres
Wille 2007; Wrobel 2003). The earliest evidence of occupation is in the early Middle
Preclassic, referred to as the Swasey Phase, with activity in the site centre and several
other outlying settlements (Andres 2009: 1). There is intensive occupation by the Late
Middle Preclassic, with a significant quantity of Mamom ceramic materials (Andres
2009: 1), a complex that is considered to represent increased social and political
integration in the Maya world (Estrada-Belli 2011: 52). By the Late Preclassic period, the
architectural development of the main plaza was underway, with evidence of occupation
at Structure 1, “the community’s dominant civic-ceremonial structure” (Andres 2009: 1).
Most of the major construction of the civic-ceremonial centre was sometime during the
Early Classic, with continued expansion and remodelling, in the Late Classic (Andres
2009: 1). As Andres (2009: 1) notes, this period of occupation continued into the
Terminal and Early Postclassic, with “architectural renewal” and “substantial new
construction.” Wrobel (2003: 40) argues that the site was densely occupied during the
Terminal Classic, as evinced by the number of burials and the increased density of
ceramics. Although there is evidence of construction, offerings, and mortuary activity, in
the civic-ceremonial centre during the Early Postclassic (Andres 2009: 2), Wrobel (2003:
40) argues the population of the site was significantly reduced. By the Late Postclassic,
the site was mostly abandoned and used as a pilgrimage destination (Wrobel 2003: 41).
In the Spanish Colonial period, there is no evidence of occupation in either the centre or
the hinterlands, however, Andres (2009: 2) argues that “ubiquitous Late Postclassic
material” found scattered in the main plaza and around the major temples suggests the site was still populated immediately after the arrival of the Spanish.

8.1.1.2 El Pozito

El Pozito is located mid-way between the Rio Hondo and the Rio Nuevo, ca. 20 km north of Lamanai. It is found on the San Pablo Ridge, a well-drained limestone crest that rises 30 to 40 m from the seasonally inundated land surrounding it (Eppich 2000: 3; Hammond 1985: 15). This ridge runs north to northeast and is the setting of many other Precolumbian Maya sites (see Hammond 1974: 179), such as Cuello (Hammond 1978), Nohmul (Hammond 1983), and Chan Chen (Sidrys and Andresen 1978). Like the geographic setting of other sites in the area, El Pozito is in a sub-tropical environment, with an average humidity of 80% and an annual rainfall of ca. 1320 mm (Sidrys 1983: 2). Although the soils in the area are thin (often less than 40 cm) and high in clay, they support a sapote-mahogany forest, a resource that was targeted by 19th century English logging companies (Eppich 2000: 3). The San Pablo Ridge decreases in elevation at its eastern and western margins and merges with high swamp forest. Hammond (1974: 177) suggests that margins of the ridge were used by prehistoric populations for raised field agriculture.

The El Pozito project started in the late 1970s at the same time as several other archaeological studies in Northern Belize, such as those at as Nohmul (Hammond 1985), Aventura (Sidrys 1983), Cuello (Kosakowsky 1987; Kosakowsky and Pring 1998), and Cerros (Walker 1990). The civic-ceremonial centre consists of two architectural groups – Complexes A and B – as well as several plazuela groups (C to F) and other smaller structures (Eppich 2007: 7) (Appendix D). Complex A comprises a central plaza, several large pyramidal and range structures – including the largest pyramid at the site, Str. A1, which stands 23 m above the plaza – and a ball court (Eppich 2000: 7, Neivens 1976: 54). Complex A and B are separated by a small depression, which served as a water reservoir. There is evidence of a sacbe at least partially connecting these major plazas. At one of the most intensively excavated groups – Complex E (ca. 100 m northwest of Complex A) – archaeologists found a well, measuring 5.75 m, that yielded a variety of materials from the Terminal Classic and Late Postclassic periods (Eppich 2000: 10). These materials, as
well as others found at Complexes A, B, and F, were used to reconstruct the historical trajectory of the site.

El Pozito has been the focus of several publications (Hester et al. 1991; Neivens 1976; Neivens and Libbey 1976) and dissertations (Case 1982; Eppich 2000). The first evidence of occupation is in the Middle Preclassic, similar to another site ca. 15 km northeast of El Pozito – Cuello – which is known for its Early and Middle Preclassic occupation (Hammond 1991a; Hammond et al. 1979). Excavations in the civic-ceremonial centre and structures in Complex A revealed evidence of significant construction in the Late Preclassic period, with materials from both the main plaza and several other residential structures north of the complex (Eppich 2000: 9). During the Early Classic, there is continued construction activity in the centre, with a series of tombs located along the east-west axis of Str. 1A. Eppich (2000: 175) argues that this is the most highly populated period at the site, with almost all the excavations uncovering Early Classic materials. In the Late Classic period, there is evidence of occupation at Complex E and Complex F. These complexes have evidence from the Terminal Classic, but ceramic types from this period have a “low frequency, limited variety and scarce context” (Eppich 2000: 181). The site is abandoned sometime after AD 800. There are Late Postclassic ceramics scattered in several areas of the site, which may indicate a small resident occupation, however, Eppich (2000: 188) argues that the site was uninhabited for four centuries before the arrival of the Spanish.

8.1.2 Dynamics of Sites within 25 km

Like Chau Hiix and El Pozito, the first evidence of occupation at Lamanai, Ka’kabish, and the inter-site settlement zone, is during the Middle Preclassic. Evidence of this period is rare at every site within 25 km of Lamanai, with only scattered Middle Preclassic ceramics at Chau Hiix and El Pozito (Cuddy 2000: 202). By the Late Preclassic, the region is more densely occupied, with major population expansions at each site and increased evidence of construction activity in the centres. One of the most significant differences in the developmental trajectory of the sites is in the Early Classic, as evidence at Chau Hiix shows increased residential and monumental construction (Andres 2000; Andres and Pyburn 2004; Cuddy 2000: 203; Wyburn 2003: 39). Although there is still evidence of occupation at Lamanai, Ka’kabish, and the inter-site settlement zone, there is decreased activity in the civic-ceremonial centre of Lamanai and the density of structures
in the inter-site settlement zone remains similar to the Late Preclassic. In the Late Classic, construction continues at Chau Hiix in some residential areas, but with less intensity than the Early Classic (Cuddy 2000: 203). There is increased activity in the civic-ceremonial centre of Lamanai and Ka’kabish, but like Chau Hiix, decreased evidence of occupation in the periphery of the sites.

The Terminal Classic period witnesses important changes in the dynamics of the region. Andres (2009: 2) suggests that architecture and ceramics at Chau Hiix reflects a social and political realignment as a result of the collapse of Altun Ha in the 9th century (Pendergast 1969, 1979a) and the growth of the social and political power of Lamanai. It is sometime during the Terminal Classic that the northern site of El Pozito is abandoned, perhaps, owing to the increased influence of Lamanai, which may have competed for trade resources with the smaller site. At Lamanai, Ka’kabish, and the inter-site settlement zone, settlement growth continues in the Early Postclassic, with construction in both the civic-ceremonial centres and peripheries of each site. Sometime during the Early Postclassic the site of Chau Hiix is mostly abandoned. In the Late Postclassic period there is a sharp decline in evidence of occupation in the inter-site settlement zone of Ka’kabish and Lamanai, with only scattered evidence of occupation at Chau Hiix. By the time the first church is established by the Spanish at Lamanai, evidence of abandonment at Ka’kabish, Chau Hiix, and El Pozito, could mean depopulation of the region or that populations were drawn to Lamanai as the regional centre.

8.2 MAJOR SITES BETWEEN 25-50 KM FROM LAMANAI
Archaeologists have studied several zones of occupation between 25-50 km distant from Lamanai: The Three Rivers Region (Scarborough et al., 2003), west-northwest of Lamanai, the Northern Belize Region (Hammond 1974), north of Lamanai, the Eastern Coastal Region, east-southeast of Lamanai, and the Southern Hondo-Nuevo Region, south of Lamanai.

8.2.1 Three Rivers Region
8.2.1.1 La Milpa
The site of La Milpa is in the Three Rivers Region in an area that overlooks the convergence of the Rio Azul, Rio Bravo, and Booth’s rivers, which form the Rio Hondo
La Milpa is on a limestone promontory near a drainage that runs north to Blue Creek, a river that forms the border between Mexico and Belize (Ford and Fedick 1988: 15; Scarborough et al. 1995). It is on the eastern edge of the Peten Karst Plateau, a landscape dominated by hills, dry valleys, and other karst landforms (Dunning et al. 2003; Marshall 2007: 82; Zaro and Houk 2012: 145). Like Lamanai, which is 40 km to the southeast, La Milpa is protected within a nature reserve, the Rio Bravo Conservation and Management Area. The flora and fauna of this region are similar to the area surrounding Lamanai and host a range of habitats, such as pine forest, secondary palm and broadleaf forest, and marsh forest. Also, like Chau Hiix, the Maya at La Milpa controlled their hydrological resources, creating a “microwatershed” to redistribute water during the dry season (Scarborough 1993; Scarborough et al. 1995: 115). Reservoirs and drainages were used to store and transport water, with channels and diversion weirs for erosion control. The Rio Bravo Conservation and Management area has helped to protect the site from damage, however, La Milpa was extensively looted in the past, with at least 41 individual trenches, some of which bisect major pyramidal structures (Ford and Fedick 1988: 16; Hammond 1991b: 50). These trenches, similar to Ka’kabish, were used by archaeologists to gain information on the occupation history of the site.

La Milpa was first visited by archaeologists in the late 1930s for the Carnegie Institution of Washington, and later, revisited the site in the 1970s and 1980s (Ford and Fedick 1988; Hammond 1991a). These early investigations revealed a major centre with monumental architecture that covered roughly 0.35 sq. km (Ford and Fedick 1988: 18) (Appendix D). The main plaza (ca. 130 x 160 m) is surrounded by several large pyramids (one over 25 m high), a ball court, and another major acropolis complex (Ford and Fedick 1988: 18; Hammond 1991b: 50). The site comprises 18 plazas and 60 major structures (with many between 18 and 25 m tall) and is one of the largest centres in the area, “equal to, if not larger than, its distant neighbors of Rio Azul, Lamanai, and Nohmul” (Hammond 1991b: 50).

2005; Scarborough et al. 1995; Schultz et al. 1994; Zaro and Houk 2012). There is evidence of population expansion at La Milpa in the Late Preclassic period, with occupation extending into the northern and southern portions of the site (Zaro and Houk 2012: 155). Evidence from the Early Classic suggests that there were two short periods of rapid decline (Adams et al. 2004), however, analysis of ceramics shows that certain Preclassic types continued in use during the Early Classic, leading to “overstated” population reconstructions (Sullivan and Sagebiel 2003; Sullivan and Valdez 2003; Zaro and Houk 2014: 155). Because of this overlap, archaeologists prefer to argue that the Early Classic period at La Milpa was marked by “modest prosperity,” with a more gradual build-up of monumental architecture over the next several centuries (Zaro and Houk 2012: 143). In the Terminal Classic, the site reaches its apogee, with major expansion in the size of the civic-ceremonial centre and the residential population (Zaro and Houk 2012: 147). Archaeologists initially thought the site was suddenly abandoned sometime in the early 9th century, as evinced by the abrupt cessation of several major construction projects (Hammond et al. 1998; Hammond and Tourtellot 2004). Although the political authority of the elite was reduced sometime in the Terminal Classic period, newer data suggests that the site was abandoned in the 10th century, or possibly even later (Zaro and Houk 2012: 143).

8.2.1.2 Blue Creek
The site of Blue Creek is located on the Rio Bravo Escarpment – ca. 20 km northwest of Ka’kabish – a limestone ridge immediately west of Rio Bravo, in north-western Belize (Clayton et al. 2005 Guderjan et al. 2010; Guderjan 2007, 2016a, 2016b: 5). The site is strategically and economically situated to participate in trade, as the Rio Hondo connects the coastal trade system to the southern lowlands (Guderjan 2016b: 5; see Barrett and Guderjan 2006). Blue Creek is located on an ecotone, a transitional area between two biomes that are biologically dense and diverse (Guderjan 2016b: 5). Because of this, the community was able to use “vast and variable” agricultural resources below and east of the Bravo Escarpment for ditched intensive agriculture (Guderjan 2016b: 6; see Baker 1997). Guderjan and Hanratty (2016: 227) argue that these fields have some of the “richest and most extensive soils in Central America” (see Beach et al. 2009; Giderjan 2007; Guderjan et al. 2003). Based on evidence from large-scale upland non-irrigated farming and lowland drained field farming, it is likely these agricultural systems supplied
an extensive surplus, which was exported to other sites in the region (Guderjan 2007; Guderjan and Hanratty 2016: 227).

Archaeological investigations of Blue Creek started in the early 1990s with the aim of identifying, mapping, and test-pit excavating, the civic-ceremonial centre (see Guderjan 2016a). Although the project was initially planned for three seasons of fieldwork, it eventually spanned two decades and four distinct phases of research (Guderjan 2016a: 2). Like Ka’kabish and Dos Hombres, Blue Creek is a medium-size centre, with a central precinct that comprises two main plazas and several other public buildings (Guderjan 2016b: 5) (Appendix D). The earliest research in the area was focused on the civic-ceremonial centre, but archaeologists also surveyed and excavated a number of residential groups to understand the occupation history of the site, construction technologies, and the socio-political status of its inhabitants (Guderjan 2016b: 5; Guderjan et al. 2003, Lichtenstein 2000). In Plaza A, archaeologists identified several large pyramidal and range structures, a ball court, and at least two stelae, both of which have been subsequently destroyed (Guderjan 2004, Guderjan and Hanratty 2016: 225).

The site of Blue Creek and its surrounding hinterland – an area that covers ca. 100-150 sq. km – has been extensively studied (Guderjan 1995a; Guderjan and Driver 1995; Guderjan and Hanratty 2016; Guderjan et al. 1993, 2003; Hanratty and Guderjan 2016). The first evidence of occupation is in the Middle Preclassic period, ca. 900 BC. In the Late Preclassic, Guderjan (2016b: 8-9) argues that evidence from several sources – a cache containing bloodletting materials, masks depicting an ajaw, and a columned structure (Driver 2002), show signs of a complex society and kingship. By the Early Classic, there is evidence of major construction in the central precinct and indications of occupation in other communities surrounding the site (Guderjan 2016b: 8-10). At the beginning of the Terminal Classic, ca. AD 810, the central precinct, as well as several nearby elite residences, are abandoned (Guderjan and Hanratty 2016: 234). Archaeologists found evidence of “termination deposits” at several elite and non-elite residences – that is, cultural material that has been deliberately smashed to mark the abandonment of a structure (Guderjan and Hanratty 2016: 237). Although the central precinct was abandoned by the beginning of the Terminal Classic period, another outlying community, referred to as the Rosita Group, continued to be occupied for at least another 50 to 75 years (Guderjan and Hanratty 2016: 240). By the Early Postclassic period, ca.
AD 1100, there is scattered evidence of occupation in a residential area northeast of the civic-ceremonial centre, named Chan Cahal, and at another group on the edge of the wetlands, known as Rempel, however, as Guderjan and Hanratty (2016: 240) comment: “…for all intents and purposes, the end of Blue Creek’s complexity [and occupation] came with the abandonment of Rosita.”

8.2.1.3 Dos Hombres

The site of Dos Hombres is located ca. 12 km southeast of La Milpa (ca. 35 km west of Lamanai), in the Rio Bravo Embayment zone, a flat and generally poorly drained bajo, or scrub swamp forest (Brokaw and Mallory 1993; Lohse 2001: 43). It is below the Rio Bravo Escarpment, east of the Rio Bravo and extends westward from the civic-ceremonial centre onto the face of the Escarpment (Lohse 2001; Trachman 2012: 199; Walling et al. 2005; Walling et al. 2006). Dos Hombres is a medium-sized centre, like Ka’kabish, that was supported by a “robust” hinterland settlement (Trachman 2012: 197). The hinterland settlement was the focus of a microscale analysis of household organization (Trachman 2006, 2007, 2009, 2010; Trachman et al. 2011). Similar to other sites in the area, such as La Milpa (Scarborough et al. 1995), or another small settlement nearby, Medicinal Trail (Brewer 2007), the Maya of Dos Hombres managed their water and agricultural resources, with evidence of a reservoir – south of Group C – and terraces (Trachman 2012: 201; Walling et al. 2006).

The site was first visited in the early 1990s by several members of the Programme for Belize (PfB), a non-profit organization that was established to promote the conservation of the natural heritage of Belize (Robichaux 1995: 61). Dos Hombres is aligned north-to-south, split in two parts, and connected by a sacbe, or causeway (Brown 1995; Houk 1994, 1995). The site has a ball court, three uncarved stelae, an altar, and several pyramidal structures over 10 m in height (Robichaux 1995: 63). The main plaza, Group A, is ca. 100 x 100 m in size, with a 13 m tall pyramid in the northwest, a 15 m “palace-type” structure in the east, and a 12 m range structure in the north (Robichaux 1995: 63). The spatial layout of the central precinct of Dos Hombres is like La Milpa, with large northern and southern settlements separated by a sparsely settled central area, which Robichaux (1995: 66) attests indicates the socio-political connection between the sites.
Dos Hombres has been the focus of several dissertations and publications (Houk 1996; Lohse 2001, 2004; Robichaux 1995; Trachman 2007, 2012), and more recently, presentations (Trachman 2017; Walling et al. 2017). The first evidence of occupation is in the Middle Preclassic. By the Late Preclassic, there is a small settlement in the northern portion of the site (Houk 1996; Trachman 2012: 200-201). Houk (1996) suggests the population declined at the end of the Late Preclassic and remained low into the next period, but there is evidence of occupation at two temple structures, an elite residential group, and Group D (Aylesworth 2005; Trachman 2012: 201). At the beginning of the Late Classic, there is major construction in the civic-ceremonial centre at Plaza A, Groups B, C, and D, and evidence of construction at the ballcourt (Houk 1996; Trachman 2012: 201). Trachman (2012: 201) suggests there was a major population expansion sometime in the Late to Terminal Classic periods. Most of the domestic structures in the periphery of the site are dated to the Late to Terminal Classic. By the end of the Terminal Classic, the civic-ceremonial centre of Dos Hombres is abandoned. Evidence from the Acropolis-Group C shows that the entryway to the upper platform was sealed and subsequently terminated with several deliberately smashed vessels (Houk 1996; Trachman 2012: 201). The limited and scattered evidence from the Postclassic period suggests that the civic-ceremonial centre was only later used for visitations, or possibly, pilgrimages (Houk 1996).

8.2.2 Northern Belize Region

8.2.2.1 Nohmul

Nohmul is located on a low undulating limestone hill, east of the perennial waters of the Rio Hondo, ca. 30 km north by east of El Pozito (Hammond 1982: 350-351; 1983: 245). Nohmul is found on an anticline of the San Pablo Ridge in an area with a maximum elevation of 20 m above sea level (Hammond et al. 1988: 1). The ridge is 6 km across and descends steeply into the western portions of Pulltrouser Swamp (Harrison and Fry 2000; McAnany 1989; Turner II and Harrison 1983). Nohmul is bounded by riparian wetlands in the west, some of which contain small distinct areas of drained fields (Hammond et al. 1988: 1). The soils on the ridge support tropical broad-leaf forests, however, most of the vegetation was removed in the 1980s for agricultural purposes (Hammond 1983: 245). These soils are free-draining and “well-suited” for milpa farming (Hammond 1983: 245).
The site was first recorded in the late 19th century and later excavated in the early-to-mid 20th century (Gann 1897; Gann and Gann 1939). Because of its archaeological potential, scholars returned to Nohmul in 1973, 1974, and 1978, as part of the British Museum-Cambridge University Corozal project (Hammond 1973, 1975b; Chase 1982a). Nohmul is one of the largest sites in Northern Belize, covering an area of ca. 35 sq. km (surveyors have mapped 22 sq. km of the site). The two main plazas that comprise the central precinct are ca. 400 m apart and connected by a sacbe, or elevated road. The eastern plaza is surrounded by several large pyramidal and range structures, a ball court, and the “central acropolis,” a structure that was 17 m tall (Pyburn 1988: 62). Recent construction activities have subsequently destroyed this structure by extracting crushed rock for a road-building project (McDermott 2013). The settlement surrounding the central precinct extends 3.5 km west to the Rio Hondo, 3 to 4 km to Pulltrouser swamp, and merges with two small sites: San Victor in the north and San Luis in the south (Pyburn 1988: 63-64).

In total, archaeologists identified 700 structures that range in size from 10 to 30 m in diameter and 1 to 5 m in height (Pyburn 1988: 62, 304).

In the 1980s, Hammond and a small crew returned to the site as part of the Nohmul project, which continued earlier excavations in the civic-ceremonial centre and in several areas surrounding the acropolis (Hammond 1989; Hammond et al. 1984, 1985, 1987a, 1987b, 1988). The first evidence of occupation is in the Early to Middle Preclassic. Like the other sites mentioned in this chapter, materials from these periods are limited (Pyburn 1988: 300). There is evidence of raised fields at Albion Island (Puleston 1977), a site ca. 15 km southwest of Nohmul, which, as Pyburn (1988: 300) argues, suggests the Maya were practicing intensive agriculture as early as the Middle Preclassic. By the Late Preclassic, excavations in the northern sector of the settlement indicate a population maximum (Hammond 1983: 247). Pyburn (1988: 303) cautions that the distribution of ceramics may over-represent the size of the population - archaeologists recovered Late Preclassic material from 67% of 76 excavations. Sometime between AD 100-250, there is major construction at the East Group, including the acropolis and several other plazas south and west of Str. 1 (Hammond et al. 1988: 2). By the Early Classic, the East Group is mostly abandoned, with only a small domestic occupation (Hammond et al. 1988: 2). Hammond (1983: 247) describes the Early Classic as a period of diminution and population estimates support this interpretation (Pyburn 1988: 309). The second
population maximum occurs in the Late Classic to Terminal Classic periods (Hammond 1983: 247). Based on excavations and well-established conventions for estimating population sizes (see Webster et al. 1992; Webster and Freter 1990), Pyburn (1988: 314) suggests Nohmul was inhabited by ca. 5899 people, the highest population estimate in its history. The East Group, mostly abandoned in the Early Classic, is reoccupied after AD 800 (Hammond et al. 1988: 2). There is also evidence in this period of construction in a “Yucatecan architectural style” that resembles several structures at Chichen Itza, particularly El Caracol (Chase and Chase 1982; Hammond 1983: 247-249). The last major structure, Str. 20, was constructed sometime between AD 1000-1100 (Hammond et al. 1988: 2). In the Late Postclassic, there is evidence of pottery on the surface of the site, which Hammond et al. (1988: 3, 6) suggest indicates either the presence of small, scattered communities, or pilgrimage use of abandoned temples.

8.2.2.2 San Estevan
San Estevan is located immediately east of the Rio Nuevo, ca. 45 km north by east of Lamanai, and ca. 10 km south-southeast of Nohmul. It lies at the western limits of Northern Belize’s coastal plain on an elevated limestone outcrop between two large marshlands – Long Swamp and Pulltrouser Swamp (Paling 2016: 6; Turner II and Harrison 1983: 31). The site is surrounded by low pine savannas (“pine ridge”), riverine wetlands, brackish marshes, and two lagoons – Progresso Lagoon and Button Lagoon (Levi 1993: 65; Paling 2016: 6). There is evidence of fertile alluvial soils and clays, which were used by the Maya for raised fields and canals, but the low-lying areas are susceptible to flooding (Levi 1993: 65; Turner II and Harrison 1983). The wetlands were a significant economic resource, but they restricted the settlement to higher elevations, which were more resistant to inundation, especially in the wet season (Levi 1993: 67).

San Estevan was first mapped and excavated in the 1960s (Bullard 1965) and later, Hammond (1975b) returned to the site, discovering several other plazas groups adjacent to the civic-ceremonial centre (Rosenswig and Kennett 2008: 124). Hammond (1975a: 42) categorizes the site as a “medium major ceremonial center,” which, as Rosenswig and Kennett (2008: 124) notes, is smaller than Nohmul and larger than Colha. The community was built on three limestone ridges, or uplands, which supported monumental architecture and residential structures (Levi 2002: 120). Most of the occupation is focused on these uplands, however, settlement extends to Long Swamp in the east and to
the shores of the bajo in the south (Levi 1993: 68). Although most of the civic-ceremonial centre was destroyed by construction, it originally consisted of six plazas, six pyramidal structures, a ballcourt, and several “elite-residence courts and plazuela groups” (Hammond 1975a: 42).

San Estevan has been extensively studied, with publications spanning six decades (Bullard 1965; Levi 1996, 2002; Paling 2016; Rosenswig and Kennett 2008). Unlike many of the sites in the region, San Estevan has an abundance of ceramic material from the Middle Preclassic period, most of which was exposed by construction in the late 20th century (Levi 1993: 98-99). Although there are many Middle Preclassic ceramics at the site, it is difficult to determine the size of occupation, as these materials are also found in Late Preclassic deposits. By the Late Preclassic, there is evidence of major construction in the monumental centre (Levi 1993: 99-103). This construction activity continues in the Early Classic period, with an increase in the number of residential structures and the size of the centre. The site reaches its apogee sometime in the Late Classic (Levi 2002: 121). During this period, there is evidence of extensive construction, with more densely occupied residential areas and structures on the margins of the site (Levi 1993: 115-116). By the end of the Terminal Classic period, the site is abandoned.

8.2.2.3 Cuello

Like other sites in this region, Cuello is located on the San Pablo Ridge, roughly mid-way between the northern site of Nohmul and the southern site of El Pozito. It is ca. 5 km west of the Rio Nuevo, ca. 15 km east of the Rio Hondo, and ca. 35 km north of Lamanai. Cuello is situated in a similar environmental region as Nohmul and El Pozito, with five distinct vegetation communities: Cohune Ridge, Monsoon Forest, High Marsh Forest, Herbaceous Swamp, and Pine Savanna (Hammond and Miksicek 1981: 262-263). As Hammond and Miksicek (1981: 263) mention, the cohune ridge was best suited for the cultivation of maize and beans, while the boundary between the high marsh forest and herbaceous swamp was channelled and used for raised fields. Also, like Chau Hiix, the community at Cuello likely used the pine savanna as a source of wood for construction activities and, as Hammond and Miksicek (1981: 263) argue, as a hunting preserve for white-tailed deer.
Cuello was first discovered by archaeologists in 1973 by examining aerial photographs and excavated in 1975 as part of the British Museum-Cambridge University Corozal project (Hammond 2005: 45). These excavations were ongoing for the next two decades, providing – as Kosakowsky and Pring (1998: 55) comment – the groundwork for a regional ceramic chronology (Pring 1977) and a “site-specific one” (Kosakowsky 1983, 1987). The settlement at Cuello covers 1.64 sq. km and contains at least 200 structures (Hammond et al. 1992: 956). The density of occupation decreases in lower-lying areas to the south and the eastern extent is unknown because of thick secondary tropical forest (Hammond et al. 1992: 956). It is a minor ceremonial centre that comprises several plazas and courtyards. Although the central precinct is comparatively small, Hammond (2000: 226) suggests that Cuello was the administrative and religious focus for a district of at least 80 sq. km. The site is one of the oldest settlements in the Maya lowlands and has one of the oldest recorded sweat baths, or *pib na*, which is dated to 900 BC (Hammond 2005: 52; Hammond and Bauer 2001).

The settlement of Cuello has been the focus of numerous publications and PhD dissertations (Clutton-Brock and Hammond 1994; Gerhardt 1988; Hammond and Miksicek 1981; Hammond et al. 1976, 1991, 1992, 1995; Kosakowsky 2003; Robin 1989). Although the chronology of the site has caused some controversy (Hammond 1984; Marcus 1983, 1984; Potter et al. 1984), scholars now generally agree it was occupied by at least 1200 BC, with evidence of occupation in the Early Middle Preclassic (1000-850 BC) to the Middle Preclassic (850-650 BC) periods (Koskowsky 2003: 62). By the late Middle Preclassic, Cuello was only a small village, but it already had evidence of trade, with “contact and communication” with Maya populations in the Peten and the Pasion region southwest of the site (Koskowsky 1998: 57). By the Late Preclassic, there is construction activity in the “burgeoning ceremonial precinct,” on Platform 34, which Hammond (1980: 189) suggests may have housed more than 1000 people. From the Early Classic to Late Classic periods there is evidence of continuous occupation, with construction activity shifting from Platform 34 and Str. 35, to other areas northeast of the civic-ceremonial centre (Hammond 1980). While there is little evidence to suggest continued occupation after AD 900, archaeologists have identified minor construction activities, domestic occupation, and animal remains, that indicate at least a small post-abandonment settlement sometime in the Middle Postclassic (Hammond et al. 1991: 73).
8.2.3 Eastern Coastal Region

8.2.3.1 Altun Ha

Altun Ha is in the Belize District, ca. 50 km north of Belize city and ca. 10 km west of the shores of the Caribbean Sea. It is found ca. 35 km east of Lamanai, which - as Pendergast (1992b: 71) comments – is close enough for interaction between the two sites, despite the “unpleasant nature” of the terrain. As Culbert (1984: 161) argues, Altun Ha is in an area of “unprepossessing agricultural potential,” with swamp-like conditions that are vulnerable to flooding in the wet season (Furley and Crosbie 1976), however, the site is located close to a marine estuary, which is one of the most productive natural habitats in the world (McLusky and Elliot 2004). There are few fresh water sources, with only a small pond south of the civic-ceremonial centre and a creek north of the site. This pond was likely used as a reservoir, as there is evidence to suggest it was altered to increase its capacity (Pendergast 1979; White et al. 2001a: 67). Although these conditions suggest that the site was on the social and environmental fringes of the Maya world, mangrove salt water lagoons provided easy access to coastal resources and trade (White et al. 2001b; Yermakhanova 2005: 4), as evinced by a diet higher in marine resources than other Maya centres and the relative richness in material culture (Pendergast 1979).

Altun Ha was excavated in the mid-to-late 1960s and 1970s, as part of a project for the Royal Ontario Museum, Canada (Pendergast 1979, 1982c, 1990). It is commonly referred to as a small site (Bray 1982; Hammond 1982), however, in an area that covers 2.33 sq. km, archaeologists identified 222 structures per sq. km, a higher density than many other sites in the Maya lowlands (see Culbert and Rice 1990). In total, over 500 structures were identified. The civic-ceremonial centre is divided into two groups, A and B, and comprises several large pyramidal and range structures. There are several other groups, or zones, surrounding the centre, mostly consisting of suburban, nucleated, settlements (Zones C to K). No stelae are reported, but there are two sacbeob, or causeways, that connect several of the outlying groups.

Altun Ha has been the focus of numerous studies (Pendergast 1969, 1970, 1971, 1992b, 1998; White et al. 2001a). The first evidence of occupation in the civic-ceremonial centre is in the Late Preclassic, ca. 200 BC, but there is evidence of occupation in Zone C, in the northwestern portion of the site, sometime in the Middle Preclassic, ca. 800 BC (White et
al. 2001a: 375; Yermakhanova 2005: 11). By the Early Classic period, there is construction at many structures in the civic-ceremonial centre and evidence of an extensive trade network, with materials from the Central Mexican site of Teotihuacan (Pendergast 1971). From the early-to-middle Late Classic period, there is continued construction activity at many of the monumental and domestic structures, with a peak of activity occurring sometime in the 8th century (Pendergast 1992b: 72). By the beginning of the Terminal Classic period, evidence from the civic-ceremonial centre and other nearby neighbourhoods, shows a decline in the power of the elite members of the community (Pendergast 1992b: 71). Pendergast (1992b: 71) argues that the diminished quality of construction during this period indicates a weakening of elite control over labour resources. However, there is evidence from plazuela groups and other residential structures that show continued occupation into the 9th century (Pendergast 1992b: 71). By the Early Postclassic period, the site is mostly abandoned, with only scattered evidence of occupation in the Late Postclassic, likely in the 15th century (Pendergast 1967, 1990; White et al. 2001b: 67).

8.2.3.2 Colha
Colha is located ca. 35 km north-northeast of Lamanai and ca. 25 km north by west of Altun Ha. It is intersected by a small stream of water, Rancho Creek, which drains into Cobweb Swamp, a perennial wetland that was used by the Maya for agriculture (Jacob 1995; Jacob and Hallmark 1996). The region is described by Dunning et al. (1988: 93) as swampy floodplains, with low, broad ridges, separated by slack water wetlands. Colha is linked to the Northern River Lagoon, ca. 17 km south-southeast of the site and to the Caribbean by a series of interconnected waterways, part of an extensive estuary network (Barrett and Scherer 2005: 101; Mock 1997). There is evidence of trade between Colha and a small salt-making site in the northern portions of the Northern River Lagoon (Valdez and Mock 1991; Mock 1994), which Mock (1997: 165) argues acted as a “coastal transhipment station or seaport” of Colha. There are surface and subsurface outcrops of chert both in and around the site, which were quarried and manufactured in stone tool workshops (Brown et al. 2004; Buttles 2002: 62; Shafer 1994). Barrett and Scherer (2005: 103) argue that many of the stone tools found at sites, such as Blue Creek (Barrett 2004) and Santa Rita Corozal (Dockall and Shafer 1993), were likely produced at Colha (see Hester and Shafer 1991b; McAnany 1991).
The site was first recorded by archaeologists in 1973 as part of the Corozal Project (Hammond 1973). It later became the focus of a multi-year study, the Colha Project, to understand lithic craft specialization in early Precolumbian societies (Barrett and Scherer 2005: 103). The civic-ceremonial centre, which includes a ball court, seven plazas, 27 plazuela groups, and over 100 structures, covers 2 sq. km (Barrett and Scherer 2005: 101; Eaton 1982). There is evidence of several other small communities surrounding Colha, all of which were discovered as part of the Colha Regional Survey, such as Ladyville, Lowe Ranch, and Sand Hill (Kelly 1993; Rosenswig 2004). Although the total size of Colha is undetermined, the surveys have identified structures that extend over at least ca. 7.5 sq. km (Barrett and Scherer 2005: 101; King 2000).

Colha was extensively studied over several decades (Hester et al. 1980, 1994; Hughes 2004; King 2000; White et al. 2001c). The site has some of the earliest evidence of occupation in the Maya region (Hester et al. 1993, 1996; Iceland 1997; Lohse 1993; Wood 1987). Excavations on the western edge of Cobweb Swamp uncovered preceramic lithic materials dated to the Late Archaic period, ca. 3400-1900 BC (Kelly 1993). The first evidence of villages, described as “a series of interactive small dispersed households” (Buttles 2002: 72), is in the early Middle Preclassic period. These households were built and expanded in the late Middle Preclassic, with evidence to suggest the existence of a “low-level chiefdom society” (Buttles 2002: 72). By the Late Preclassic, there is major construction activity in the civic-ceremonial centre, an area that covered ca. 1 sq. km and held a population of ca. 600 people (Buttles 2002: 78; Eaton 1980, 1982: 12). There is less evidence of occupation in the Early Classic period, with only minor construction activities in the centre (Potter 1982). However, like other sites in the region, some styles and forms of ceramics from the Late Preclassic continue in use in the Early Classic period (Buttles 2002: 88). By the Late to Terminal Classic period, there is continued evidence of construction in the civic-ceremonial centre and in the surrounding settlement, an area that covered 6 sq. km and contained ca. 4000 people (Eaton 1982). Towards the end of the Terminal Classic, occupation at Colha is more concentrated in the civic-ceremonial centre (Buttles 2002: 85). There is also evidence that some structures were intentionally destroyed (Eaton 1994). Archaeologists argue that a small lens of soil between the Terminal and Early Postclassic periods indicates the site was abandoned between the late 8th and early 10th centuries (Barrett and Scherer 2005:
By the Early Postclassic, the site is resettled by a small agrarian population that is restricted to the monumental centre (Hester and Shafer 1991a: 155). The site is abandoned sometime by the beginning of the Late Postclassic, AD 1400 (Barrett and Scherer 2005; King 2012).

8.2.4 Southern Hondo-Nuevo Region

8.2.4.1 San Jose

San Jose is ca. 45 km south-southwest of Lamanai and ca. 5 km west of Mun Diego, another site in the Upper Hondo-Nuevo Region (Thompson 1939: 2; Hammond 1981: 158, 164). The site is located on a hilly outcrop, ca. 120 m above sea level. It is a minor centre, with only a small number of residential structures, which housed probably “twenty-five or thirty families” (Thompson 1939: 3). There are a couple of water sources nearby: a creek in the southeast that is dry for most of the year and a small spring. There is also evidence of a water reservoir west of Str. C7. The site comprises only a small residential population, but Thompson (1939: 3) suggests it was the religious and economic centre for a radius of anywhere between 5-15 km. Like many other sites in this section, San Jose has evidence of an extensive trade network, with slate ware from Northern Yucatan and red-painted vessels from Honduras (Thompson 1939: 221).

Between 1931 and 1936, archaeologists for the Field Museum of Natural History and the Carnegie Institution, mapped and excavated the civic-ceremonial centre and some of its surrounding structures (Meierhoff et al. 2012: 1; Thompson 1939). The centre consists of four groups: A to D. The largest group, Group A, is made up of seven structures, with the highest rising 13 m off the plaza floor (Meierhoff et al. 2012: 2). The second largest group, Group C, has a ball court, a palace-like structure, and a ceremonial/elite residential group. Group B, north of Group A, has several small multi-room structures, likely forming a residential patio group (Hammond 1981: 164). In the southernmost portion of the site, Group D consists of a large temple on a raised platform/plaza (Meierhoff et al. 2012: 2). There is evidence of smaller, platform structures north and south of the centre, but these were not mapped or excavated (Thompson 1939: Fig. 1).

The site of San Jose has been the focus of a couple of publications (Meierhoff et al. 2012; Thompson 1939) and mentioned in several others (Guderjan 2006; Hammond 1981: 164).
Although the site was intensively excavated, as Guderjan (2006: 101) notes, the excavations were not standardized, or “regularized from building to building,” which creates an uneven understanding of the developmental history of the site. Ceramic seriation, a relative dating method, was used to determine the occupation history of the site (Thompson 1939). Ceramic groups, San Jose I-V, have been attributed to specific chronological periods (Meierhoff et al. 2012: 2), which allows for a basic temporal reconstruction. The first evidence of occupation is at Group D in the Late Preclassic period. There is evidence of continuous occupation in Group A and B, with a sequence that spans the Late Preclassic to Terminal/Early Postclassic periods. Group C originally consisted of a single large structure in the Early Classic, but it was enlarged in the Late Classic (Hammond 1981: 164). There was significant construction activity between the end of San Jose IV and the abandonment of the site, sometime between the Terminal to Early Postclassic, at Str. C4, Str. C5, and Str. C6 – an elite residential group (Hammond 1981: 164; Thompson 1939: 233). There is no evidence of occupation in the Late Postclassic and Colonial periods.

8.2.5 Dynamics of Sites within 50 km

The earliest evidence of occupation in the Maya world is found within 50 km of Lamanai at Colha, which shows signs of human activity – as well as evidence of deforestation and cultigens (Chase et al. 2014b: 19) – as early as the Archaic period, ca. 3400 BC. By the beginning of the early Middle Preclassic period, there is evidence for the first villages. At Colha and Cuello, archaeologists uncovered evidence of small dispersed households arranged in informal groups, or clusters, of settlement. It is likely that most of the sites in the region are founded sometime in the Middle Preclassic, between ca. 1000-400 BC. The materials from this period are usually scarce, but it is probable that early signs of habitation become buried under subsequent construction efforts, especially in the civic-ceremonial centres, as attested by the bulldozing of San Estevan.

The first major population expansion in the region occurred in the Late Preclassic period. There is evidence of major construction activity in the civic-ceremonial centre and in the hinterlands of every site, as well as evidence of intensive agricultural methods, such as raised fields and terraces. At Blue Creek, archaeologists uncovered evidence of kingship, which suggests that many of the sites in the region were already established as central,
independent polities. There is evidence of extensive trade between coastal and inland sites.

The transition from the Late Preclassic to the Early Classic is problematic for several reasons. As mentioned, archaeologists first argued that La Milpa declined in the Early Classic, but further analysis showed that some Preclassic ceramic types continued in use in the Early Classic period. Because of this overlap, archaeologists revised their earlier reconstructions, suggesting the site experienced modest prosperity during the Early Classic period, with a gradual build-up of populations over time. Chronological uncertainty is mirrored in the historical trajectory of sites in this region. There is less evidence of occupation at Colha, Dos Hombres, and Nohmul, and modest prosperity at Cuello, Blue Creek, and Altun Ha, in the Early Classic. Perhaps, the Preclassic to Early Classic trajectory is difficult to clarify because ceramic types span long periods of time. At Lamanai, evidence from the centre suggests a declining population in the Early Classic, but evidence from the inter-site settlement zone shows the same level of occupation there as in the Late Preclassic. Based on an absence of clear signs of depopulation or abandonment, it is more likely that the region was gradually building towards the major changes witnessed in the Late Classic.

The region reaches its apogee sometime in the Late Classic to Terminal Classic periods. There is evidence of major construction activity in the civic-ceremonial centre of every site. The peripheries, or hinterlands, are densely populated and cover a greater areal extent than any other period. However, by the Terminal Classic period, there is evidence of decline, with some sites being abandoned. By AD 810, many of the elite and non-elite residences at Blue Creek are ritually terminated, with only several outlying communities lasting for another 50-75 years. At Dos Hombres, the entryway to Group C is blocked and covered with the debris of broken vessels. Termination rituals suggest the sites were rapidly abandoned, but the abandonment process is in fact slow and extended in this area of the Maya world. At Nohmul, the last structure is constructed sometime between AD 1000-1100. At Cuello, there is evidence of a small domestic occupation until the Middle Postclassic. Colha is abandoned in the Terminal Classic, but it is reoccupied by a small residential population in the Early Postclassic. The process of abandonment is almost complete by the end of the Early Postclassic, except for Lamanai, Ka’kabish, and Chau Hiix. Lamanai reaches its apogee in the Terminal Classic and continues to prosper in the
Early Postclassic. It is not until the beginning of the Late Postclassic that evidence from the inter-site settlement zone suggests decline. By the end of the Late Postclassic, Lamanai is the only site in the region that is still populated, with construction activities at several major temple structures.

8.3 COMPARISON WITH THE WIDER MAYA WORLD

There are several sources that provide general discussions on the historical trajectory of the greater Maya world (see Chase et al. 2014b; Demarest 2004; Estrada-Belli 2011; Foias 2013). It is important to re-evaluate these discussions considering the data from Lamanai, Ka’kabish, and the inter-site settlement zone, to create a more accurate portrayal of the past. Chase et al. (2014b: 18) refer to the area within 50 km of Lamanai as Zone 5, or “La Milpa and Northern Belize.” As mentioned, there is evidence from this area that dates to the Paleo-Indian period (Lohse 2010), with early Archaic occupation at Colha, however, the first distinctly Maya occupation is in the Early to Middle Preclassic. This span of time is characterized by small, simple villages, with modest public structures that were limited in size and complexity (Demarest 2004: 82). Although Demarest suggests this characterization will eventually be replaced by the discovery of significant Early Preclassic civic-ceremonial centres, there is no indication in Zone 5 of complex societies until the beginning of the Late Preclassic.

At the site of Nakbe, in northern Peten, there is evidence for the construction of large pyramidal structures by 600 BC (Hansen 1991, 1992, 2001). At the beginning of the Late Preclassic, similar forms of architecture are found throughout the Maya world at El Mirador, Calakmul, and many of the sites in Zone 5 (Demarest 2004: 83). Chase et al. (2014b: 14) refer to this period as a time of “large vertical monumental constructions.” During the second half of the Late Preclassic, Chase et al. (2014b: 14) suggest there is evidence of “changes potentially reflective of a mini-collapse.” This uncertainty in the Late Preclassic to Early Classic periods has been discussed in previous sections, but to summarize, there is no indication of collapse at any of the sites in Zone 5. Evidence at Lamanai, Ka’kabish, and the inter-site settlement zone, shows that settlement remained the same as in the previous period. There is reduced construction activity in the civic-ceremonial centre, but perhaps, as mentioned in the previous chapter, this is owing to the depletion of key construction materials at the end of the Late Preclassic (see Chapter 7).
The Early Classic period witnesses several significant changes, with major centres such as Nakbe, El Mirador, and other northern Peten sites, experiencing depopulation and a reduction in construction activities (Demarest 2004: 103). Some scholars have included Lamanai in this list, describing it as a site with a primary Late Preclassic occupation “followed by permanent or temporary abandonment” (Estrada-Belli 2011: 52). The only site in the area that collapses in the Early Classic is Cerros, a small centre at the mouth of the New River and Chetumal Bay (Scarborough 1991). In central Peten, Tikal rises to prominence during this period, with evidence of interaction with the distant site of Teotihuacan, in Central Mexico (Demarest 2004: 104-105). Altun Ha has evidence of expansion in the Early Classic, and like Tikal, has materials from Teotihuacan. It is likely that many of the sites in Zone 5 were involved in similar networks of trade, as they are all connected by riverine and/or oceanic routes.

The Late Classic is a period of population growth with striking artistic and monumental elaboration throughout most of the Maya world, a “Golden Age” of Maya civilization, with the densest, “most populous and most complex cities” (Foias 2013: 13). Lamanai, Ka’kabish, and the inter-site settlement zone, experience a period of growth in the Late Classic, however, the area reaches its apogee in the Terminal Classic to Early Postclassic periods. There are several sites that rise to prominence following the collapse of the southern lowlands, a transitional period that witnesses a shift of activity and power to the northern Maya lowlands (Foias 2013: 15). Chichen Itza becomes a dominant city by the beginning of the Terminal Classic and competes with several other major centres, such as Ek Balam, Coba, and Dzibilchaltun (Cobos 2004; Foias 2013: 16; Kowalski and Kristan-Graham 2007; Ringle et al. 2004). Lamanai, Ka’kabish, and the inter-site settlement zone, survive the dissolution of many Maya centres in the Late Classic to Terminal Classic periods. Yet, most of the sites in Zone 5 are depopulated over the next several centuries. Although Chase et al. (2014b: 19) suggest that the region was “rapidly abandoned between AD 800 and 900,” newer evidence suggests a slower, more protracted period of depopulation.

Another major centre that rises to power during the apogee of Lamanai and Ka’kabish is Mayapan (Masson and Peraza Lope 2014). This site was originally viewed as contemporaneous with Chichen Itza, but newer research places it in the 11th century, chronologically parallel to the decline of Chichen Itza (Foias 2013: 16; Masson et al. 2014).
Mayapan was heavily involved in coastal transportation networks, which flourished in the Postclassic (Masson and Peraza Lope 2014; Sabloff and Rathje 1975). Lamanai and Mayapan share a similar ceramic tradition, known as Chen Mul Modelled, however, there is no evidence of trade between the two sites. The Greater Lamanai area survives the political turmoil of the south in the Late to Terminal Classic and thrives in the coastal-oriented Postclassic. However, sometime in the Late Postclassic, there is a period of depopulation in the inter-site settlement zone, as evidence demonstrates a process of abandonment in many of the communities surrounding Lamanai. Mayapan collapses towards the end of the Late Postclassic period, sometime between AD 1441 to 1461 (Peraza Lope et al. 2006). Most of the evidence of occupation in the study zone during the late 15th and early 16th centuries are restricted to Lamanai.

8.4 SUMMARY
This chapter started from a local window on settlement change and then stepped back to consider increasingly regional and culture-wide perspectives. The sites closest to Lamanai demonstrate a historical trajectory like that of Lamanai, with evidence of occupation in the Middle Preclassic, population growth in the Late Preclassic, peak densities in the Late Classic, Terminal Classic, and Early Postclassic, and decline in the Late Postclassic. Lamanai is unique, however, in that it exhibits continued evidence of occupation into the Late Postclassic. From a regional and culture-wide perspective, the Greater Lamanai Area continues to be a focus of occupation during the social and political reorientation of the Maya world, bridging the gap between the political turmoil in the south and the coastal-driven trade in the north.
Chapter 9

THE INVISIBLE MAYA, LOW-DENSITY URBANISM, SUSTAINABILITY, AND SETTLEMENT

The objective of this chapter is to reassess several methodological and theoretical problems in Maya archaeology in light of the settlement pattern data at Lamanai, Ka’kabish, and the inter-site settlement zone. The first section discusses the issue of the invisible Maya, or invisible settlement, which is a problem that is caused by archaeologists’ inability to identify and record low-lying platform structures and features made of perishable materials. Invisible settlement is potentially a major component in many reconstructions of past populations and is particularly problematic for the theory of low-density urbanism, which holds that Precolumbian Maya centres comprise mostly scattered settlements that were spatially different from many ancient and historical cities.

The second section discusses sustainability and the Precolumbian Maya city. Although Fletcher (2009: 1) views low-density urbanism as vulnerable to “some combination of social and ecological factors,” as attested by the collapse of urban life in Mesoamerica, Sri Lanka, and South-East Asia, other archaeologists argue that low-density, forest garden cities were sustainable, flourishing for many centuries, even millennia (Chase and Chase 2016b; Graham and Isendahl 2018; Isendahl and Smith 2013). By comparing the settlement pattern data of Lamanai, Ka’kabish, and the inter-site settlement zone, to findings from sites such as Caracol and Chunchucmil, I will add another perspective to this debate – one from the vantage point of a site that has the longest occupation history in the Maya world, Lamanai. The third section discusses the evidence for continuity at Lamanai, Ka’kabish, and the inter-site settlement zone, and offers an explanation for the sustainability of populations in this region. This section is followed by a discussion of the
evidence for migration in the region and the relationship of migration to settlement. The notion of a developmental cycle will be used to model settlement dynamics.

9.1 THE INVISIBLE MAYA, LOW-DENSITY URBANISM, AND URBAN SCALING

Settlement pattern studies in the Maya lowlands rely on surface survey to discover evidence of past occupation, with subsurface techniques used to establish chronology and building function (Johnston 2004: 145; see Ashmore 1981b). As Johnston (2004: 145) notes, surface survey can cause data to be “incomplete and non-representative,” especially when important cultural features are missed. This problem has long been recognized by Mayanists, who refer to it as “invisible settlement,” or the “invisible Maya” (Chase 1990; Fash 1986; Graham 1996: 9-11; Hutson and Magnoni 2017: 35; Johnston 2004; Kurjack et al. 1965). Invisible structures were made mostly of perishable materials and constructed on low platforms, which were subsequently buried by natural and cultural formation processes (Hutson and Magnoni 2017: 34). At the site of Nohmul, archaeologists used test-pit excavations to uncover sub-surface features, which were interpreted as residential because they were associated with “hearts, burials, middens, and storage pits;” an ancient limestone quarry was also discovered through excavation spanning vacant terrain (Hammond et al. 1988; Graham 1975: 70, Fig. 2.96; Pyburn 1989, 1990; Pyburn et al. 1998: 42). At Itzan, a Precolombian Maya site 8 km from the Pasion River, in the Peten, Guatemala, Johnston (2004: 146) discovered eight “invisible structures,” with several forming patio groups. Figure 114 shows a profile of one of these houses, referred to by Johnston (2004) as “minimally mounded structures.”

The arrangement in patio groups and the association of domestic features suggests a residential function for structures built on very low platforms, however, archaeologists sometimes argue that the structures served other purposes (Hutson and Magnoni 2017: 34; Tourtellot 1988b: 437). At Copan, archaeologists suggest that small, low mounds could represent structures that serve as field huts, or as storage or other houses that were used for agricultural purposes (Webster et al. 2000: 82-83). Structures interpreted as field huts were found farther away from residential areas and were not accompanied by domestic artefacts such as obsidian blades and manos/metates. Hutson and Magnoni (2017: 35) call field huts, which comprise low-lying, circular piles of limestone, “chich
“chich mounds,” a Yucatec word for “limestone cobbles” and gravel (Barrera Vasquez 1980: 134; Bricker et al. 1998: 83). Although Hutson and Magnoni (2017: 35) recognize that chich mounds may represent structures that served residential purposes, other archaeologists have suggested they are the remains of temporary field houses (Kunen and Hughbanks 2003), or planting surfaces for tree crops (Kepecs and Boucher 1996). Domestic structures are the most important missing features for this discussion. However, as Wyatt (2014: 450) mentions, other important cultural features, such as small-scale water management systems in residential areas (dams and reservoirs) are also hidden, or invisible, on the surface.

At Lamanai, Ka’kabish, and the inter-site settlement zone, I encountered limestone spreads, or chich mounds. The conditions of the fields in the inter-site settlement zone, which were slash-and-burned, chained, and ploughed, provided ideal visibility for the identification of structures represented by spreads of limestone cobbles or fragments that had once formed platforms for buildings or other features. Figures 115 and 116 show two such spreads of limestone found in the inter-site settlement zone. At Chunchucmil, archaeologists found that chich mounds seldom exceeded 35 sq. m (Hutson and Magnoni 2017: 35). The sample of structures at Itzan is small, but 5 (out of 8) structures were less than 35 sq. m (Johnston 2004: 157). In the inter-site settlement zone, 34% of the structures are less than 35 sq. m – a figure that is far higher than many other estimates of invisible settlement (Hutson and Magnoni 2017: 35).
Figure 115: Chich mound in Settlement Zone B (Str. B15) (27.82 sq. m)

Figure 116: Chich mound in Settlement Zone F (Str. F32) (35.90 sq. m)
The highest number of small structures represented by limestone spreads or scatters in my survey are found in Settlement Zone B (17%), and Settlement Zone F (8%) – two areas that are peripheral to the civic-ceremonial centres of Ka’kabish and Lamanai. Structures tend to be smaller further from the civic-ceremonial centre. Such is the case at Coba, where archaeologists found that higher status households were closer to the urban centre (Folan et al. 2009: 64) (Figure 117). At Coba, higher status households are defined by the size of the basal platform, the height of the platform, and presence/absence of vaulted superstructures (Folan et al. 2009: 63). A similar pattern of settlement was found radiating outwards from Coco Chan, with smaller structures found further from the monumental architecture of the site. Where low-elevation or sub-surface features have been sought out, identified, and examined, they appear to form a significant part of the settlement landscape of Maya sites, particularly the hinterlands. Therefore, it is likely that rural areas were far more populated than is suggested by surface survey alone.

To compensate for the problem of settlement that remains invisible to surface survey, such as in areas with thick vegetation, archaeologists have attempted to apply an arbitrary increase in the number of structures found through ordinary survey methods. At Chunchucmil, archaeologists tried to adjust for the probability of invisible settlement by increasing the residential total by 5% - an admittingly small adjustment because Hutson and Magnoni (2017: 35) argued that “minimal vegetation and soil accumulation” increased their ability to identify smaller structures. The number of chich mounds undoubtedly varied from site-to-site, however, 5% is a minor adjustment for a potentially major portion of settlement. Minimal vegetation and soil accumulation may have increased the visibility of invisible settlement, but Hutson and Magnoni (2017: 35) also argued that an “abundant use of rock” in the past made it less likely that the Maya at Chunchucmil built perishable structures. It is unclear how an “abundant use of rock” was determined in the archaeological record, especially as it is impossible to reveal the extent of use of perishable materials. Based on my findings, the 5% may need to be adjusted upward, especially in areas farther from the central precinct.

The issue with the “invisible Maya” is that findings from settlement pattern studies have been used to support the theory of low-density urbanism (Fletcher 2009; Isendalh and Smith 2013; Prufer et al. 2015; Scarborough et al. 2012a) without explicitly recognising
Figure 117: Distribution of elite compounds at Coba (Folan et al. 2009: 62)
the invisible settlement problem. As Isendahl and Smith (2013: 132) comment,

The non-monumental components of [Maya] cities differed from the high-density ancient and historical cities in the Old World that are often considered the norm for pre-modern urbanism. Distinctive features include the practice of intensive agricultural cultivation within urban settlements, residential zones that were dispersed and unplanned, and the arrangement of houses into spatial clusters that served as urban neighborhoods.

In Settlement Zone F, there is little evidence to suggest the practice of “intensive agricultural cultivation within a dispersed urban settlement.” Unlike the pattern of settlement at Caracol, with discrete groups of structures separated by 100-150 m (Chase and Chase 2016a: 6), Settlement Zone F is densely occupied, with groups only 50 m apart. Evidence from Settlement Zone C also shows that large expanses of the landscape were unoccupied (Figure 118).

Figure 118: Image of an area inferred to be unsettled in Settlement Zone C
This area, only 1 km from the monumental centre of Coco Chan, is particularly suited for agricultural purposes, as attested by the present-day farming of corn and may have been used by the Maya for large-scale agriculture. At Chunchucmil, the density of settlement made it impossible to support the population with solely forest gardens, or agricultural urbanism. Perhaps, high density cities imported food from other areas of the Maya world, such as Blue Creek, which Guderjan and Hanratty (2016: 227) argue created enough of a crop surplus to export to other sites in the region. Recent LiDAR studies have shown that many of the sites in northern Guatemala were far more densely occupied than originally suggested by surface survey (Canuto et al. 2018). LiDAR data has revealed a fuller picture of Precolumbian Maya settlement, with “substantial ancient population as well as complex previously unrecognized landscape modifications” (Canuto et al. 2018:1).

Most of the survey at Caracol was conducted via traditional archaeological methods, which are problematic for the reasons stated above. However, data from LiDAR reinforces the idea that Caracol was a low-density, urban agricultural city (Chase and Chase 2016a). Yet like the problems with surface survey, which are constrained by limited visibility, archaeologists have identified issues with LiDAR-based studies (Prufer et al. 2015). At Uxbenka, a Precolumbian Maya site in Belize’s southernmost district of Toledo, archaeologists surveyed fields that were recently cleared by local Mopan Maya farmers, allowing unexamined portions of the landscape to be explored with “relative ease” (Prufer et al. 2015: 4). Prior to the clearing, thick secondary growth made identification nearly impossible. After land clearing, however, archaeologists identified 57 residential compounds (Kalosky and Prufer 2012; Prufer et al. 2015: 4). Prufer et al. (2015) resurveyed these fields with LiDAR several seasons later, which were left fallow, allowing the regrowth of shrubs, weedy species, and grasses. Only 3 structures out of the 135 structures that were previously identified were visible in the bare earth hill shade raster (Prufer et al. 2015: 8). Based on these results, Prufer et al. (2015: 11) argue that “raster files derived from point clouds and profiles are not reliable for identifying small settlement structures or groups in disturbed tropical environments with low, dense regrowth or understory vegetation.” Although the LiDAR data at Caracol were collected in undisturbed high-canopy forest, Prufer et al. (2015: 11) note that low, dense vegetation, particularly plants with wide leaves, affect the visibility of ground features. Even in ideal conditions, it is likely that vegetation, as well as alluviation, colluviation,
and bioturbation, decreases the visibility of a range of low-lying structures or features (Johnston 2002: 5-12, 2004: 147; Pyburn et al. 1998).

The problem of the invisible Maya affects the theory of low-density urbanism, but it also affects the interpretation of urban scaling patterns in contemporary and ancient cities. As Ortman et al. (2015) mention, many scholars have shown that the characteristics of contemporary urban settlements, such as socioeconomic output, land area, and extent of infrastructure, are dependent on population size (Bettencourt 2013; Bettencourt et al. 2007, 2010; Samaniego and Moses 2008; Sveikauskas 1975). Ortman et al. (2015) posit that cities are “social reactors” that support, sustain, and magnify social interactions. The theory of urban scaling has recently been applied to archaeological data (Ortman et al. 2014, 2015; Smith 2017). The most important relationship in urban scaling for archaeologists is that between population size and land area. As Smith (2017: 3) notes, large settlements (in area) are denser than small settlements and the area of a settlement scales with its population, or as Ortman et al. (2009: 1) note, “total settlement area increases with population size, on average, according to a scale invariant relation with an exponent in the range 2^{\text{a}} - 5^{\text{a}} = 6.”. The scaling of population size and land area has been demonstrated for settlements in 14th century Europe (Cesaretti et al. 2016), the Basin of Mexico (Ortman et al. 2014), the Andes (Ortman et al. 2016), the Mesa Verde region, and Middle Missouri (Ortman and Coffey 2015), in 20th century peasant systems (Cesaretti 2016), and in contemporary societies (Bettencourt 2013). As Smith (2017: 4) notes, there are only two exceptions to the model: campsites of mobile hunter-gatherers, which have larger (in area) campsites that are less dense than smaller campsites (Lobo and Ortman 2016) and the low-density, agrarian-based settlements of the Classic Maya. Either the cities of the Maya are a unique case of urbanism in history, in the present and in the past, or methodological issues have created an “absence of evidence” argument that is ignoring invisible segments of Maya populations.

9.2 URBAN TRADITIONS, SUSTAINABILITY, CARACOL, AND CHUNCHUCMIL

Invisible settlement likely forms a major component missed by Maya archaeologists. However, there is still considerable debate about the spatial distribution and density of Pre Columbian Maya cities. This debate is important because some scholars argue that Pre Columbian low-density cities were unsustainable, as attested by the collapse of many
Maya centres in the 9th and 10th centuries (Fletcher 2009, 2011), whereas others argue that the unique form of Maya urbanism was sustainable and survived for many centuries (Chase and Chase 2016a; Isendahl and Smith 2013). Chase and Chase (2016a: 3) add to this debate by suggesting that there are various types of urbanism in the Precolumbian Maya world – one form, characterized by the settlement at Caracol, in which sustainable agricultural practices were carried out within the urban community and the other form, characterized by the settlement at Chunchucmil, that is “too dense and compact for the practice of sustainable agriculture,” and is reliant on agricultural fields outside the city boundaries. At Caracol, archaeologists used traditional survey methods to identify a complex settlement pattern in which settlement was connected by a dendritic causeway system covering ca. 23 sq. km (Chase and Chase 1987, 2001, 2016a: 4). Surface survey was supported by LiDAR to reveal the northern, southern, and eastern extent of the site, uncovering numerous residential structures and an urban community over 200 sq. km in size (Chase et al. 2011; Chase et al. 2014b). Based on these data, Chase and Chase (2016a: 6) argue that 1) households were self-sustaining, with access to land for gardens and crops, 2) subsistence activities determined the spacing of residential groups, 3) households were interdependent for goods and services. In comparison, Chase and Chase (2016a: 7) argue that the walled residential groups of Coba (Garduno 1979) and Chunchucmil (Hutson 2016, Hutson et al. 2008) represent a different urban tradition, one that did not rely on “inter-household agriculture.” By comparing population size and land area, settlements in the southern lowlands, such as Caracol and Tayasal, are viewed as sustainable cities, with “longer stratigraphic and development sequences” than the “agriculturally non-self-sustainable” cities in the Northern Lowlands, such as Coba and Chunchucmil (Chase and Chase 2016a: 9-10).

The identification of different forms of urban tradition opposes arguments that characterize Maya settlements solely and more broadly as low-density agrarian cities (Chase and Chase 2016a: 9; see Fletcher 2009; Isendahl and Smith 2013). As Graham and Isendahl (2018: 166) note, Fletcher (2009) argues that low-density, agrarian-based cities of the Maya, the Khmer, and the Singhalese were susceptible to a variety of problems, such as environmental degradation and social disintegration, which were caused by the settlement system itself. Low-density urbanism was listed as another one of the many causes for the dissolution of the Classic Maya centres in the southern lowlands (see Aimers 2007b). While Fletcher uses the collapse of Maya centres to argue
that they were intrinsically unsustainable, Isendahl and Smith (2013) use the extended history of the Maya, spanning centuries, to suggest that Maya cities were sustainable. Like Chase and Chase (2016a), Isendahl and Smith (2013: 132) argue that the practice of intensive agriculture within urban settlements, with unplanned, dispersed residences forming urban neighborhoods was key to their longevity. This raises a significant problem in Maya archaeology: were Precolumbian Maya cities sustainable and what urban characteristics made them resilient to collapse? Chase and Chase (2016a: 9) suggest that the term “low density agrarian city” is outdated and hides important differences in urban sustainability mechanisms. They argue that there are at least two types of Maya cities – agriculturally self-sustainable and agriculturally non-self-sustainable – and that the relationship between urban settlement and agriculture determined the developmental path of the city (Chase and Chase 2016a: 11). Most important, Chase and Chase (2016a) suggest that agriculturally self-sustainable cities were adapted to survive in the tropical setting of the southern lowlands.

Major unsurveyed areas between Lamanai and Ka’kabish make it difficult to compare the settlement pattern to sites such as Caracol and Chunchucmil. Nonetheless, several inferences can be made about the urban tradition at Lamanai, Ka’kabish, and the inter-site settlement zone, and its relation to different types of cities, as defined by Chase and Chase (2016a). Figure 119 shows Lamanai and the southeastern half of Settlement Zone F at the same scale as the maps of Caracol and Chunchucmil. Based on the density of structures at Lamanai and Settlement Zone F (which is ca. 2.5 km from a major temple at Lamanai, Str. N10-9), it seems that the urban tradition more closely resembles the higher density cities of the Northern Lowlands. This argument is supported the density of structures in Settlement Zone F (ca. 215 structures per sq. km) and by the large, open fields southeast of Ka’kabish, which may have been used for agriculture. It seems that the residential spacing starts to increase further from the civic-ceremonial centre of Lamanai, but this area was surveyed with traditional methods and probably missed structures with largely sub-surface remains. It is likely that the area between Lamanai and Coco Chan was continuously occupied, as attested by Baker’s (1995) study of milpa fields between the two sites and my own observations of structures located along the road.
Figure 119: Comparison of the geographic extent of Caracol, Chunchucmil, and Lamanai
There is no evidence of occupation northeast of Settlement Zone F, but as mentioned, it is low-lying in elevation and susceptible to seasonal flooding. It is likely that settlement connected to Lamanai south of Settlement Zone F. Owing to the long developmental history of Lamanai and based on the more compact, Northern Lowlands urban tradition, settlement density may not have been a determining factor in the abandonment of Classic Maya cities. Even Chase and Chase (2016a: 10) note that “in an ironic twist” several “non-sustainable” cities, such as Mayapán and Santa Rita Corozal, flourished in the periods following the collapse of the 9th and 10th century.

9.3 POLITICAL DISINTEGRATION, MARKET FORCES, AND MANAGED CITIES

The discovery of long stratigraphic sequences at Lamanai that span the periods of collapse at many other Maya sites in the southern lowlands inspired archaeologists to ask an important question: how did Lamanai survive the collapse of the Classic Maya centres, particularly in the transition from the Terminal to Early Postclassic periods? Pendergast (1987) offers several explanations for the continuity of evidence in this area: 1) the location of Lamanai along the shores of the New River Lagoon, which provided aquatic resources for sustenance, 2) accessible harbours that facilitated trade with many other parts of Mesoamerica, 3) charismatic community leaders who provided stability during periods of social upheaval (Metcalfe et al. 2009: 640). Metcalfe et al. (2009: 640) adds to this explanation by suggesting that the New River Lagoon also provided a reliable source of water, especially during major climatic variations of the Holocene. Even though there is little evidence of drought in the region (Metcalfe et al. 2009), Valdez and Scarborough (2014: 268) also suggested that the continued access to water was one reason behind the unusual sustainability of Lamanai. Graham argues that the collapse of Classic dynasties heavily affected Lamanai, but at the level of elite rivalry, conflict, and shifts in power. Non-traditional elites played a role in displacing traditional social and political structures. Lamanai nonetheless continued because it was a hub of commerce and trade. Its viability was of value no matter who was at the top of the hierarchy (Graham 2006; Aoyama and Graham 2018).

Economic factors, especially a secure network of trade, was likely paramount to the longevity of the site. In introductory textbooks, one of the common characteristics that distinguishes the Classic and Postclassic periods is a reorientation of trade networks
(Demarest 2004; Evans 2008; McKillop 2006). However, rather than a cause of the changes witnessed during these periods, the reorientation of trade is viewed as an effect of the disintegration of elite control. At one of the most revealing sites for commoner economic behaviour, Ceren, archaeologists argue that commoner relationships with the elite were indirect, through marketplace transactions (Sheets et al. 2015). They suggest that commoners traded surplus crops, or goods, for speciality items crafted from jade and obsidian, which were brought to the market by elites from sometimes great distances. Archaeologists at Ceren also argue that commoners were able to peddle their goods at multiple markets to secure the most profitable trade (Sheets et al. 2015). Perhaps, Precolumbian Maya centres, or more specifically, the elite, were particularly vulnerable to these market-driven relationships. This explains the slow and often protracted depopulation of Classic Maya sites. Archaeologists argue that market exchange (as described in anthropology) was “foundational to the stability of Classic era polities,” and a “key strategic interest to dynasts and their retinues” (Masson and Friedel 2012). The disintegration of political control may be a side effect of a weakening of economic control. Isendahl and Smith (2013: 135) argue that some cities with shorter lifespans saw “rapid-scale colonization associated with maximized unsustainable exploitation of an initially abundant resource,” reflecting a boom-and-bust economic history. It seems that the prosperity of Maya cities was highly dependant on the supply and demand of materials. Lamanai’s access to a wide and diversified network of trade may have promoted the continuity of the centre and by extension, may also explain the evidence of continuity in this region.

Another possible explanation for the evidence of continuity at Lamanai, Ka’kabish, and the inter-site settlement zone, is the management of vegetation resources. Contrary to arguments by Metcalfe et al. (2009: 639), who suggest that there was reduced activity at Lamanai after AD 1070, evidence from my study indicates that the population was the largest during the Terminal and Early Postclassic periods. Metcalfe et al. (2009: 639) argue that environmental data from pollen cores demonstrate less soil erosion than the Classic period and forest recovery by the beginning of the Early Postclassic. Rather than indicating a reduction in activity, Rushton et al. (2013: 491) argue that an increase in seasonal forest taxa, the abundant presence of Z. mays, and a peak in palm signatures, shows the Maya were managing their forest resources, as well as the cultivation of palms and field-based agriculture. This evidence is even more striking considering the increased
anthropogenic effect on the environment in the Late Preclassic to Early Classic periods (Metcalfe et al. 2009). Following the evidence of environmental stress in the Late Preclassic to Early Classic periods, the population in the region stabilises until the Terminal Classic. It seems that Pre Columbian populations in the region reacted to earlier periods of soil erosion and deforestation by managing their arboreal resources in the Terminal Classic to Early Postclassic periods.

9.4 MIGRATION, DEVELOPMENTAL HISTORY, AND SETTLEMENT
Aimers (2008: 120) offers two explanations for stylistic changes in pottery types at Lamanai in the Terminal to Early Postclassic periods: 1) the Maya at Lamanai adopted exotic and foreign styles of pottery, similar to the adoption of Olmec style artefacts at Maya sites (Flannery 1968), 2) serpent and scroll motifs indicate that populations migrated into the Greater Lamanai area sometime during the Terminal to Early Postclassic periods. Other materials from Central Mexico and the Gulf Coast, such as comals and grater bowls, are found in the Belize Valley, which Aimers (2004, 2008: 120) argues indicates that new people moved in the area after the Classic period. Similar comals and graters were identified at Lamanai, with igneous rock inclusions that may have been produced in the Maya mountains, another indication of population migration (Aimers 2008: 120). Howie (2012: 217-218) suggests that the “ongoing conflict and instability” in southern and northern lowland sites stimulated population movements, which are most evident at Lamanai in the appearance of a new ceramic tradition of coarse ware manufacture in the Terminal Classic period. Howie (2012: 218) suggests the new tradition relates to population migration because the raw material resources were available, but not previously exploited, by local potters. Coarse ware was manufactured with similar clays in inland areas adjacent to the Caribbean coast and in Northern Belize (Howie 2012: 218). Howie argues that the location of these clays, on the opposite side of the New River Lagoon, discouraged its use by local potters, especially because of the abundance of clays in the vicinity of the civic-ceremonial centre. Based on the changes in local patterns of pottery production, Howie (2012: 219) claims that immigrants moved into the region with new ceramic traditions in the Terminal Classic.

Marcus and Sabloff (2008a: 324) note that the normal internal growth of a city is difficult to distinguish from immigration and that only careful excavations can reveal the influx of different ethnic or occupational groups. They suggest that one of the indicators of in-
migration is an expansion of population in the city at the same time as the hinterlands are depopulated, as in the case of Teotihuacan, which expanded its streets in “anticipation of an influx” (Marcus and Sabloff 2008a: 325). However, there may be other ways to understand migration events in the archaeological record by investigating changes in settlement patterns over time. The developmental cycle model, which was developed by anthropologists working with various hunter-gatherer groups, is based on an idea that domestic groups experience cycles of development like the growth cycle of living organisms (Fortes 1958: 2). The group, or unit, experiences a “regular sequence of changes” that “culminates in the dissolution of the original unit and its replacement by one or more units of the same kind” (Fortes 1958: 2). As Ashmore and Wilk mention (1988: 3), the developmental cycle associate’s variation in “residential composition to social norms” such as kinship and descent. Goody (1958: 58) notes that the problem with the developmental cycle is that the division of groups is a slow process that is not observable in its totality. Archaeology, on the other hand, is aptly suited to understand the developmental cycle process, as the process is reflected in the material record.

In the Maya area, one of the most common archaeological features is a group of structures arranged around an outdoor area. Groups of structures configured in this way are referred to as plaza, or patio, groups and were occupied by an extended family, with each dwelling representing the household of a nuclear family (Haviland 1963, 1965, 1988; Sweitz 2011: 188; Tourtellot 1983, 1988a; Willey et al. 1965). As Haviland (1988: 121) and Tourtellot (1988a: 98) note, variability in the number and size of structures in patio groups reflects stages in the developmental cycle of extended families (Sweitz 2011: 188). This principle is known as the “family growth” hypothesis and holds that “units occupied for a longer time should have more dwellings than units occupied for a short time” (Manzanilla and Barba 1990: 44; Tourtellot 1988a: 104). Tourtellot applied this concept to Seibal for the Late Classic, a period that spans 280 years, with the hypothesis that units with one or two structures are likely in the minority (Tourtellot 1988a: 106). At Seibal, 36% of domestic units consisted of two or less structures, while 64% had more than two structures. This principle was also applied to Coba with some success, as Manzanilla and Barba (1990: 43-44) showed that two contemporaneous units with a shared access route, and a similar orientation, were later extended to include several other structures to “satisfy [the] needs” of an extended family (Figure 120).
The expansion of population in the hinterlands of Maya cities may indicate periods of rapid growth. The speed of the expansion, as well as the composition of the structures during the expansion, however, may also indicate periods of increased migration. In the inter-site settlement zone, the growth of the settlement is slow and consistent from the Late Preclassic to the Late Classic. Figure 121 is a relative-risk surface that shows the proportion of settlement in the Late Classic and Terminal Classic periods in Settlement Zones B and F.
Figure 121: Relative-risk surface of Settlement Zone B (left) and Settlement Zone F (right), showing changes in the intensity of occupation (blue-to-beige = low-to-high) from the Late Classic to Terminal Classic periods.

Compared to the other temporal periods, there is a major settlement expansion in the Terminal Classic, right at the same time as the introduction of coarse ware manufacture, as documented by Howie (2012). In Settlement Zone B, 71% of the domestic units consist of two or fewer structures. In Settlement Zone F, 74% of the domestic units consist of two or fewer structures. This percentage is unexpectedly high, especially in comparison to Seibal and owing to the long, extended developmental history of Lamanai, Ka’kabish, and the inter-site settlement zone.
The high percentage may be representative of a “baby boom,” but another hypothesis is that it is an indication of migration. There are also several other assumptions that may be applied to potentially disenfranchised, migratory populations: 1) the structures are smaller, as there is less time to acquire resources and construct houses, 2) migrant populations are settled in the periphery of larger settlements, 3) there are fewer material resources at migrant dwellings, as materials are less likely to be carried from distant locations. These defining characteristics are all present in the settlement data in the inter-site settlement zone.

9.5 SUMMARY
Invisible settlement, or “the invisible Maya,” is likely a significant component in many reconstructions of past population dynamics. The non-recognition of the missing data greatly influences the theoretical trajectory of the discipline, especially the idea that Maya cities were spatially defined by scattered settlements organized around forest gardens, otherwise referred to as low-density agrarian-based urbanism. Examples of urban scaling in present and past societies reinforces the notion that scattered settlement organized around forest gardens is a form of urbanism truly unique to the tropical cities of the Maya – or, it reveals that the problem of the invisible Maya is creating an “absence of evidence” argument that is contradicting current urban theory. Lamanai, Ka’kabish, and the inter-site settlement zone, most closely resemble the high-density urbanism found in the Northern Lowlands, rather than the low-density form of urbanism found at Caracol. This conclusion suggests that the urban plan, or layout, of the city is unrelated to the collapse of centres in the southern lowlands during the 9th and 10th centuries AD. Lamanai, Ka’kabish, and the inter-site settlement zone, survived the disintegration of many Classic Maya polities owing to: 1) proximity to the New River Lagoon, which provided a steady supply of water and sustenance, 2) engagement with Lamanai’s wide and diversified commerce and trade network, 3) charismatic leaders, 4) management of arboreal resources and field-based agriculture. It is likely that the disruption of settlement in many centres in the southern and Northern Lowlands created an influx of new populations into the area, as evinced by the dramatic expansion in the number of structures in the inter-site settlement zone between Lamanai and Ka’kabish, the composition of structures in the inter-site settlement zone, as well as changing ceramic traditions.
Chapter 10

CONCLUSION

The goal of this chapter is to reassess my research questions, discuss possible opportunities for future research at Lamanai, Ka’kabish, and the inter-site settlement zone, and offer some concluding remarks about the discipline of Maya archaeology and the study of urbanism and human settlements. My major research questions were addressed in the latter half of this thesis, but this chapter provides explicit answers to each question. Research at Lamanai and Ka’kabish is ongoing, with small crews of archaeologists returning each year to conduct minor excavations and work on the recovered artefact assemblages. Future work should continue between the two sites, especially near the edges of Lamanai, an area which is largely unsurveyed and protected by the nature reserve. The research at Lamanai, Ka’kabish, and the inter-site settlement zone, increases our understanding of the Precolumbian Maya in Northern Belize and illustrates the efficacy of the application of certain methods and theories to Maya archaeology. The last section of the chapter offers some of my thoughts on the direction of the discipline and studies on human settlements.

10.1 RESEARCH QUESTIONS

10.1.1 What is the character of the settled landscape between Ka’kabish and Lamanai (number of structures; patterns and distribution of settlement; modifications to the natural environment) and how does this compare to other sites in Northern Belize?

In total, we (the survey teams working with me in 2010-2016) identified 252 structures in the inter-site settlement zone. We surveyed six sections of a 10 km transect between Lamanai and Ka’kabish, covering ca. 2.5 sq. km of the landscape. There is significant variability in the size and organization of structures in Settlement Zones A to F, with the smallest structures covering only ca. 20 sq. m and the largest covering ca. 950 sq. m (see Chapter 6). Most of the structures are formally arranged in groups that contain between
2-4 structures, however, there are a significant amount of isolated structures standing less than 2 m tall, especially in Settlement Zones B and F. The orientation of Type 1 structures and their associated materials suggests they were used for residential purposes. Most of the Type 1 structures are in the peripheries of Ka’kabish, Coco Chan, and Lamanai, and are dated to the Terminal Classic and Early Postclassic. Based on the spatial organization and density of Type 1 structures – and the appearance of different ceramic manufacturing techniques (Howie 2012) – in the Terminal Classic to Early Postclassic, it is likely that these structures represent hastily constructed residences of migrant populations. It has long been posited that Precolumbian peoples fled the social and political unrest of the Southern Maya lowlands and moved north to new territories in the Yucatan. Perhaps, evidence of migration to Lamanai reflects abandonment of some of the Precolumbian cities that collapsed in the Terminal Classic. Most of the Type 1 structures in the peripheries at Ka’kabish, Coco Chan, and Lamanai, are abandoned by the end of the Early Postclassic.

It is difficult to compare the number and spatial organization of structures in the inter-site settlement zone to Precolumbian Maya centres in Northern Belize for a number of reasons: the size of the survey area is different at each site, areas are surveyed at different distances from the civic-ceremonial centres, and the methods used to record (and report on) structures are different at each site. For example, the typology used in the inter-site settlement zone, which differentiates between the form and organization of types of units, has only been applied by archaeologists to several sites, however, archaeologists have commonly identified single, isolated (Type 1) structures at many Maya sites. As mentioned (see Chapter 9), smaller structures are often missed by archaeological survey (referred to by Mayanists as “invisible settlement”). To compensate for the invisible component of settlement, archaeologists increase the number of structures in their sample by applying an arbitrary percentage to their population estimates (for example, 5% at Chunchucmil). Based on the findings from the inter-site settlement zone, the arbitrary percentage needs to be increased, especially for the periphery of the settlement, where it is more likely to encounter small structures.

There are several other noticeable trends in the inter-site settlement zone. Generally, the size of structures decreases as the distance increases from the civic-ceremonial centres. This pattern is most clearly seen in Settlement Zone E (an area peripheral to Coco Chan),
which is comprised of mostly smaller structures (n=9). A similar pattern is witnessed in Settlement Zone A and B. Settlement Zone B, which is ca. 2.5 km southeast of Ka’kabish, consists of many smaller structures (less than 35 sq. m) (n=20). This pattern is comparable to some of the earliest observations of Maya social organization, with wealthy, higher status households located close to the city centre. However, the average size of structures in Settlement Zone B is offset by a group of large structures in the southeastern portion of the survey zone. The size of the structures and their material assemblage suggest that this group of structures served as a causeway terminus. I did not identify any evidence of a Pre-columbian road, but this may be due to road construction and other agricultural damage to the archaeological record. Causeways can be anywhere from ground level to 3 m in height. I suspect that the group in Settlement Zone B was connected to Ka’kabish by a road and helped to facilitate local trade.

In Northern Belize, civic-ceremonial centres and their peripheries are often connected by causeways. At one of the closest sites to Lamanai, El Pozito, a sacbe (causeway) connects two of the major plazas, Complex A and B. At Dos Hombres, a site 12 km from Lamanai, two of the main plazas, Group A and B, are connected by a sacbe. Perhaps, the settlement pattern in the periphery of these sites (and others in Northern Belize) are similar to the inter-site settlement zone, with structures that generally decrease in size as the distance from the civic-ceremonial centres increases (with the exception of structures located at the end of causeways). Archaeologists argue that the “concentric zonation model” of settlement applies to Pre-columbian Maya cities (see pg. 65-66), however, others suggest that elite (wealthy) and commoner (poor) populations were interspersed throughout the settlement pattern. It is likely that different forms and systems of settlement existed in the Pre-columbian Maya world. These different forms of settlement may suggest a different relationship between wealth and status at Maya cities. For example, at Ka’kabish, Lamanai, and the inter-site settlement zone, the pattern of declining structure size and material wealth as the distance increases from the civic-ceremonial centres may indicate the importance of economic systems and trade at these centres, and in Northern Belize.

Each area in the inter-site settlement zone has evidence of Pre-columbian Maya occupation, except the western and northwestern sections of Settlement Zone C. As mentioned, it is possible that populations in the past used this area for agriculture. The
absence of occupation suggests a settlement pattern that is different from some of the other low-density cities in the Precolumbian world, which are characterized by sprawls of urban settlement. The absence of data in this area suggests that the settlement pattern more closely resembles some of the centres in Northern Lowlands, with densely settled centres and areas outside the city used for large scale agriculture. It is also possible that the edge of Precolumbian Maya occupation in Settlement Zone C represents the polity boundary of Coco Chan. This hypothesis may be validated by future work southwest of Settlement Zone C, which might identify the southwestern extent of the site. It is likely that the area southwest of Settlement Zone C was occupied by Precolumbian populations, however, it has only recently been cleared and ploughed for agriculture.

There is evidence of settlement patterns in Northern Belize with large sections of uninhabited land, such as Blue Creek, which archaeologists argue was used for large scale agriculture. Archaeologists at Blue Creek suggest that these fields were large enough to export food to other surrounding sites (Guderjan 2007; Guderjan and Hanratty 2016: 227), possibly even Lamanai and Ka’kabish. As mentioned (pg. 272), this type of settlement pattern is far different than the low-density, forest gardens that many archaeologists have argued characterized Precolumbian Maya settlements. Also, unlike many settlements in Northern Belize and the greater Maya world, many structures were identified in low-lying areas, sometimes at the base of large hills. This is particularly evident in Settlement Zone B, with its largest structure, Str.B1, located 20 m below the highest point in the landscape (see pg. 156). Although LiDAR studies (see Prufer et al. 2015) suggest that many of the low-lying areas were unsettled, traditional ground-based survey and excavation may be needed to confirm the absence of evidence.

Other than the construction of monumental architecture and residential neighbourhoods, I did not identify any significant Precolumbian alterations to the natural environment. Many of the sites in Northern Belize have evidence of landscape modifications, such as raised fields, water reservoirs, wells, terraces, and large platform constructions. At Chau Hiix, settlement is arranged in a similar pattern as Lamanai, with a strip-like organization of structures and evidence of dams, wells, canals, and raised fields. The north side of Barber Creek, an area that forms the northern border of the civic-ceremonial centre of Lamanai, has evidence of raised fields, however, little work has been done to uncover evidence of dams and canals. At Ka’kabish, there is possibly a large aquada south of
Group D, which may have acted as a water reservoir in the Pre Columbian past (see pg. 56). Ka’kabish is the farthest away (in the survey zone) from a naturally replenishing source of water (10 km), but there is little evidence of water retention systems. Archaeologists have identified a number of chultuns at Ka’kabish, which may have been used for water storage, but scholars have suggested a variety of functions for these subterranean chambers (food storage, burials, ritual, alcohol production). I recorded several natural, replenishing water sources (ponds) on the surface throughout the Lamanai-Ka’kabish corridor. Current farmers are known to dig wells in the area, and I have seen several successful (and unsuccessful) attempts at digging wells in the inter-site settlement zone. I found one close to Ka’kabish that had evidence of use by the Pre Columbian Maya, but I could not obtain permission to document the property. It is likely that Ka’kabish, Coco Chan, and Lamanai, did not require extensive reservoirs because of the year-round accessibility of water. Further research (especially LiDAR) is needed to fully document and explore the hydrological potential of the study area.

At Lamanai, Ka’kabish, and the inter-site settlement zone, I did not identify any evidence of terraces. Terraces are mostly found in densely settled upland landscapes and are often constructed in marginal lands to sustain high-density populations. In Northern Belize, terraces have been found at a number of the larger sites, such as Dos Hombres and La Milpa. It is likely that terraces are not found in the areas surrounding Lamanai, Ka’kabish, and the inter-site settlement zone, because of the nature of the landscape, which is dominated by a gentle, gradual downslope towards the lagoon and the low-lying elevation of the settlement. Although the absence of terraces may suggest a smaller, low-density population in the survey zone, this is not supported by the number and density of structures. Perhaps, as mentioned, food was being imported from other locations, or large areas of viable agricultural land (and raised fields) were enough to support the population of the centres.

10.1.2 How does the chronology of the inter-site settlement zone compare to the chronology of the two civic-ceremonial centres – Lamanai and Ka’kabish – as well as the core-periphery dynamics at other sites in Northern Belize?

The presence of corn (Zea mays) and squash (Cucurbita) pollen in a core adjacent to Lamanai suggests the site was occupied by at least 1600 BC. Evidence of occupation in
the Middle Preclassic is found in the northern portion of the site, at three structures (Str. N9, Str. P8-9, and Str. P8-14) (see Figure 3 for the location of the structures). It is likely that occupation at Lamanai started in the northern portions of the site and spread to the southern portions in later periods, as evidenced by the density of structures in the north of Lamanai in the Late Preclassic (see the relative-risk surface in Figure 34, c). There is an increase in the size and number of structures in the Late Preclassic (n=17), which suggests that the site underwent a major population expansion. In the Early Classic, there is decreased construction activity in the core of Lamanai. Only six structures have evidence of occupation during this period. It is likely that Lamanai continued to be a focus of settlement, however, there is little evidence to suggest the site continued to expand in the Early Classic. There is evidence of Late Classic period occupation at 22 structures in the civic-ceremonial centre of Lamanai. For the first time in the history of Lamanai, settlement seems to be focused in the central precinct of the site (see the relative-risk surface in Figure 36, c). The apogee of Precolumbian occupation at Lamanai occurs in the Terminal Classic, with evidence of occupation at 30 structures. Settlement is focused in the central and northern portions of the site. One of the most striking changes in the distribution of settlement at Lamanai happens in the Early Postclassic. Evidence of occupation is found at 27 structures, all in the centre of the site (see the relative-risk surface in Figure 38, c). This pattern is important because the Early Postclassic is the most heavily occupied period in the inter-site settlement zone and potentially a period that witnessed a large influx of migrant populations. The distribution of settlement in the centre of the site suggests a consolidation of elite power at Lamanai, especially considering the evidence of migration in the peripheries. By the Late Postclassic, settlement at Lamanai shifted to the southern portions of the site, in the vicinity of the Spanish churches, which were established in the Spanish Colonial period. This area continues to be a focus of settlement in the Spanish and English Colonial periods.

At Ka’kabish, the first evidence of occupation is in the Middle Preclassic. As early as 800 BC some of the earliest building works were initiated at two major pyramidal structures in the civic-ceremonial centre (Str. D-4 and Str. FA-6). By the Late Preclassic period, there is evidence of occupation at four structures (Str. D4, Str. D9, Str. FA-6, and Str. FA-8). It is likely the site experienced a period of settlement growth in the Late Preclassic, with architectural expansion in the site core. This period of growth continues
in the Early Classic, with evidence of occupation at four structures (Str. FA-6, Str. FA-8, Str. D9, and Str. D10). This may be the first indication of a split in the prosperity of Lamanai and Ka’kabish, as occupation declines in the civic-ceremonial centre of Lamanai in the Early Classic. There is continued construction activity at Ka’kabish in the Late (n=4) and Terminal Classic (n=4) and slightly reduced activity in the Early Postclassic (n=3). There is, to date, no evidence of occupation, or building works, at Ka’kabish in the Late Postclassic, Spanish, or British Colonial periods. Although several Late Postclassic period materials have been identified in chultuns at the site, by the time of the arrival of the Spanish, Ka’kabish seems to have been mostly abandoned.

The chronology of the inter-site settlement zone and the civic-ceremonial centres of Lamanai and Ka’kabish differ in several significant ways. The history of the civic-ceremonial centre of Lamanai is extensive and traces its occupation from as early as the Middle Preclassic, into the Late Postclassic, Spanish, and English Colonial periods. There is some evidence to indicate that Ka’kabish began to be occupied at the same time, or a little later than Lamanai, but there are only scattered finds on the surface and in chultuns to indicate occupation in the Late Postclassic period. The apparent scarcity of Late Postclassic pottery at Ka’kabish may mean that it was abandoned by the end of the Early Postclassic period. On the other hand, farmers have brought in fragments of Late Postclassic censers and further research may yet yield more Late Postclassic material. Like Lamanai and Ka’kabish, the inter-site settlement zone has evidence of occupation in the Middle Preclassic, however, most of the settlement zone is depopulated by the beginning of the Late Postclassic period, with only scattered evidence of Spanish Colonial occupation near the monumental architecture of Coco Chan. In Settlement Zones D and E, there is evidence the area was abandoned at the end of the Early Postclassic and resettled in the Spanish Colonial period. There are also two structures near the monumental architecture of Coco Chan that have evidence of British Colonial period occupation.

The earliest evidence of occupation in Northern Belize is at Colha, a site 35 km north-northeast of Lamanai. Colha has some of the earliest evidence of occupation in the Precolumbian Maya world (see pg. 254-256). Archaeologists have dated lithic materials at the site to the Late Archaic period, sometime between 3400-1900 BC. By the Early to Middle Preclassic, most of the sites in Northern Belize have evidence of occupation in the
civic-ceremonial centres. It is likely that the earliest evidence of Precolumbian occupation is found in the civic-ceremonial centre, making it difficult to distinguish between core-periphery dynamics at this point in Maya history. Most of these early sites, such as at Cuello and Colha, consist of small dispersed households, informally arranged, forming clusters of settlement.

By the Late Preclassic, the civic-ceremonial centres at sites in Northern Belize experience a period of monumental construction and the peripheries have evidence of population expansion. There is some evidence of decline in the Early Classic, such as at Nohmul, which has a smaller population and evidence of abandonment (in the East Group). At other sites, such as Chau Hiix, most of the monumental structures in the core of the site were constructed in the Early Classic. At El Pozito, archaeologists found that the Early Classic was the most populated period, with almost all excavations revealing Early Classic materials. The Late Preclassic-Early Classic transition sees the first divergence in prosperity at sites in Northern Belize, with some expanding while others decrease in size. There is some concern over the dating of Early Classic materials (see pg. 243-245 for a discussion of the changing chronology at La Milpa), however, it is likely that centres in Northern Belize experienced different patterns of growth and decline over their extended occupation history.

The Late Classic is the most densely populated period in the history of Precolumbian Maya occupation. Almost every site in Northern Belize has evidence of large populations, with heavily straitified societies, spread across substantial portions of the landscape. The peripheries, or hinterlands, are densely populated and cover a greater areal extent than any other period, sometimes pushing into less productive portions of the landscape. At San Estevan, residential areas are more densely occupied than any other period, with many structures on the margins of the settlement. At Dos Hombres, almost every structure in the periphery is dated to the Late Classic period. This period of prosperity is short-lived at many of the sites in Northern Belize, with a precipitous decline in population over the next several centuries.

By the Terminal Classic, there is evidence that occupation at some sites (such as Colha) become concentrated in the civic-ceremonial centre. The movement of people from the peripheries to the core of the settlement at Colha coincides with evidence of conflict, as
some structures are deliberately smashed. Lamanai experiences a similar pattern of settlement in the Early Postclassic period, during a possible influx of migratory populations. Perhaps, the movement of populations to the core of the settlement is a symptom of social and political stress for Precolombian Maya cities. Sometime between the Late Classic and Terminal Classic periods, many of the sites in Northern Belize (such as Dos Hombres, Altun Ha, and San Estevan) have evidence of depopulation and eventually, abandonment. By the Early to Late Postclassic periods most of the sites in Northern Belize are only occupied by small, remnant populations, or visited as pilgrimage sites. There is evidence to suggest that people still inhabited areas of Northern Belize, but there is no evidence of monumental construction in the civic-ceremonial centres.

10.1.3 How does the distribution and density of occupation (as defined by the location and date of each structure) in the inter-site settlement zone change over time, and how does this compare to occupation of the centres, as well as other sites in Northern Belize?

There are two major periods of settlement expansion at Lamanai, Ka’kabish, and the inter-site settlement zone, in the Late Preclassic and Terminal to Early Postclassic periods. The density and distribution of settlement seems to stabilize after the major settlement expansion of the Late Preclassic period. The region is most heavily occupied in the Terminal and Early Postclassic periods. The most notable discrepancy in the occupation of the inter-site settlement zone and the centres is the transition from the Early Postclassic to Late Postclassic periods. As mentioned, the density of the inter-site settlement zone is greatly reduced by the beginning of the Late Postclassic period, however, the Late Postclassic witnesses continued residential and construction activity at Lamanai. One hypothesis is that areas outside of Lamanai were depopulated because people moved to the centre under Spanish pressure.

Most of the sites in Northern Belize experience a period of major monumental construction in the core and population growth in the periphery in the Late Preclassic period. This pattern continues into the Late Classic (with the exception of the Early Classic, in which some sites record a period of depopulation, but as mentioned, this may be due to an error in ceramic analysis, as some Late Preclassic types continue to be used in the Early Classic). By the Late to Terminal Classic, many of the sites in Northern Belize, such as Blue Creek, in the Three River’s Region, experience a rapid abandonment.
of the civic-ceremonial centre followed by a slower process of depopulation in the periphery. At Blue Creek, a small outlying community is occupied for another 50 to 75 years after the fall of the central precinct. Lamanai is unique in that it experiences a period of depopulation in the periphery prior to the cessation of monumental construction in the core in the Late Postclassic. Perhaps, as mentioned, the size of the settlement contracted in the Late Postclassic, especially towards the end of the period, because of the arrival of the Spanish. By the Late Postclassic to Colonial periods, the inter-site settlement zone is almost completely abandoned.

10.1.4 To what extent is there consistency or variation in material culture found at structures in the region within and between these two major centres?

There is a high degree of consistency in the material culture, especially the types of ceramics, at Lamanai, Ka’kabish, and the inter-site settlement zone. The most notable change in the consistency and variation in the material culture between Lamanai and Ka’kabish is an increase in the ceramic type, Red Neck Mother, an unslipped jar with red-slipped rim, as one approaches Lamanai. The greater quantity of fragments of Red Neck Mother near Lamanai could reflect greater density of occupation nearer to the centre in the Terminal and Early Postclassic Classic. Or, if Lamanai continued to be occupied into the Middle Postclassic, and people continued to use Red Neck Mother, and they were drawn to the centre from the peripheries, then we might expect greater concentrations. These vessels were large and heavy (used to store liquids) and were likely imported to Lamanai from other sites, which may explain its distribution, which is more concentrated on the shoreline.

Another ceramic style that was widely adopted in the region in the Postclassic is called Chen Mul Modelled, a censer type that likely originated at Mayapan (Milbrath and Peraza Lope 2013), which was a large regional capital from AD 1150-1450. This ware has been identified in the civic-ceremonial centre of Lamanai (but not at Ka’kabish or the inter-site settlement zone), which is probably because occupation is mostly restricted to this area in the Late Postclassic period. This ware has been found at many Precolumbian Maya sites in the Late Postclassic and provides evidence of Lamanai’s participation in an extensive coastal trade system, which connected centres along the Yucatan Peninsula. By tracking changes in the density of trade goods over time (especially imported ceramics), it is
possible to identify periods of increased, or decreased trade. This is important at Lamanai because the switch from inland to coastal trade routes in the Terminal Classic to Early Postclassic periods has been cited as a major reason for Lamanai’s long occupation history (Pendergast 1981, 1987). For future research, archaeologists at Lamanai should investigate the transition in trade goods between the Late/Terminal Classic and the Early/Late Postclassic periods to attempt to discover a reorientation of trade networks. This will further validate the conclusion that Lamanai’s longevity was based on its continued access to goods and resources.

10.1.5 What does the environmental evidence from pollen cores collected adjacent to Lamanai suggest about the settlement patterns at Lamanai, Ka’kabish, and the inter-site settlement zone?

There are two noticeable trends in the environmental and settlement data at Ka’kabish, Lamanai, and the inter-site settlement zone: 1) After the major settlement expansion in the Late Preclassic, which saw increased deforestation and soil erosion, the settlement stabilized (or declined) throughout the study area, 2) There is evidence of major settlement expansion in the Terminal Classic and Early Postclassic during a period of forest recovery. Archaeologists argue that environmental data from pollen cores suggests that there was reduced activity at Lamanai during the Terminal and Early Postclassic periods (Metcalfe et al. 2009). However, evidence of occupation at Lamanai, Ka’kabish, and the inter-site settlement zone, suggests that these periods were the most populated in the history of the area (73% of structures in the inter-site settlement zone date to the Terminal and Early Postclassic periods, or 185 out of 252 structures). The discrepancy in the environmental and settlement data suggests two possible conclusions: 1) people in the area learned to better manage their arboreal and agricultural resources in the face of growing populations (especially compared to the Late Preclassic), reducing soil erosion and reforestation areas that were cleared in the past, 2) Chronological uncertainty in the duration of ceramic traditions inflated the length of a settlement expansion in the 9th and 10th centuries and by the time of forest recovery in the 11th century, the settlement was greatly reduced. By the Late Postclassic, the inter-site settlement zone is almost completely depopulated (2% of structures date to the Late Postclassic period, or 6 out of 252 structures). Whatever the result of the increased control over agricultural and arboreal resources in the Terminal and Early Postclassic, the settlement seems to be
concentrated, although not restricted, to the southern portions of Lamanai by the arrival of the Spanish in the 16th century.

The timing of the increased arboreal signal and population expansion in the Early Postclassic is the most striking difference in the environmental and settlement data. Migration is the leading theory for the increase in structures in the Terminal to Early Postclassic in the inter-site settlement zone. One of the major causes for the changes in the Southern Maya Lowlands in the Late to Terminal Classic periods is environmental instability, especially as caused by increased deforestation and soil erosion. Perhaps, migrants brought new farming and subsistence techniques (along with new ceramic traditions), which increased the arboreal signal in the Early Postclassic period.

10.2 IMPLICATIONS FOR FUTURE STUDY

There are many implications arising from the preceding chapters for future study at Lamanai, Ka’kabish, and the inter-site settlement zone, as well as for the study of settlements in the Pre Columbian Maya world. At Lamanai, further research should be conducted to investigate changes in the density of settlement between the civic-ceremonial centre and the proximal zone of the inter-site settlement, Settlement Zone F. Settlement Zone F and Lamanai are ca. 2.5 km apart. Based on the density of structures in Settlement Zone F (Figure 121) and preliminary observations of settlement between Coco Chan and Lamanai, it is possible that the entire region was heavily populated in the Terminal and Early Postclassic, with potentially 25 sq. km of settled urban space. This is significantly denser and more populated than the settlement at Caracol. At Ka’kabish, further research should be undertaken to map and analyse the trenches in the civic-ceremonial centre to better understand changes in the historical trajectory of the site. Ka’kabish and Lamanai experienced significantly different historical trajectories, especially towards the end of the Late Postclassic period. The temporal discrepancy between the developmental dynamics at Ka’kabish and Lamanai raises an important question: why was Ka’kabish seemingly abandoned by the end of the Early Postclassic period, especially in an area marked by stability?

The density and distribution of settlement at Lamanai, Ka’kabish, and the inter-site settlement zone, suggests that there is much to learn about the urban character of Pre Columbian Maya cities. It is a generalization to characterize Maya settlements as
“low-density.” Traditional survey-based studies have missed many forms of Precolumbian Maya settlement, creating an apparently less densely occupied pattern of settlement than existed. The number of small, isolated structures in the periphery of Ka’kabish and Lamanai suggests that many population estimates for sites in forested areas are low. Evidence of urban scaling in historical and contemporary cities further reinforces this conclusion – either Precolumbian Maya centres were more populated than settlement pattern studies suggest, or the Precolumbian Maya city was a truly unique human system. Continued survey and mapping of settlement between Ka’kabish and Lamanai has the potential to resolve many of these issues.

Through a comparison of Precolumbian centres in the Southern Lowlands (Caracol) and the Northern Lowlands (Chunchucmil), I argue that Lamanai, Ka’kabish, and the inter-site settlement zone, may have had more similarities to the settlement patterns of centres in the Northern Lowlands (see pg. 272). This conclusion is based on a visual comparison of the density of structures, their spatial distribution, and the distance between groups of structures. The settlement pattern at Caracol is spread over a larger area, with a lower density of structures, and a greater distance between groups than Lamanai, Ka’kabish, and the inter-site settlement zone (see pg. 270-274). To support this conclusion, future research should attempt to quantify the differences in the number and density of structures at each site in Northern Belize. There are several inherent problems in quantifying settlements and comparing their numbers/densities (amount of area covered by the survey, location and distance of structures from the centre, missed/invisible settlement), however, this approach may reinforce the idea that the spatial organization of Lamanai was more similar to sites in the Northern Lowlands.

The character of the settlement is important for understanding human/environment interactions, especially as they relate to sustainable cities. Archaeologists have suggested that certain forms of urbanism were more suited to the rainforest environment of Central America. Low-density, forest garden, settlements are viewed as environmentally friendly and self-sustaining, as compared to dense urban developments that rely on food imports, or large open agricultural fields in their peripheries (Chase and Chase 2016a). This is an interesting avenue of research (identifying differences in the spatial organization of Precolumbian cities), however, evidence from Lamanai, Ka’kabish, and the inter-site settlement zone, suggests that the density and distribution of occupation did not affect the
sustainability of their cities. Many of the low-density, forest garden, cities in the Southern Lowlands collapsed in the 8th and 9th centuries. This raises the question: what are the mechanisms that made Precolumbian Maya cities sustainable? Further research at Lamanai, Ka’kabish, and the inter-site settlement zone, may provide an answer to this question.

Although there are still several problems with LiDAR (detectability in secondary growth forests), and ground-truthing is still needed to verify findings from digital elevation models, the technique has led to several major discoveries in Maya archaeology. Evidence from Guatemala suggests that many of the centres were far more populated than some of the original population estimates and the landscape was more heavily altered than traditional ground-based surveys have suggested (Canuto et al. 2018). At Lamanai, LiDAR has the potential to uncover many of the major landscape modifications that have been missed by previous surveys, such as dams, canals, roads, raised fields, and harbours. Also, the effectiveness of the method in uncovering small, isolated structures can be tested against a large database of already identified structures. Although many archaeologists have attempted to acquire funding for LiDAR at Lamanai, Ka’kabish, and the inter-site settlement zone, their efforts have so far been unsuccessful (because of the cost of the technology). It is likely that LiDAR will reveal many characteristics of the urban environment that have so far been missed, allowing for a more complete picture of the Precolumbian past.

10.3 CONCLUDING REMARKS
The main purpose of my study has been to understand the developmental history of Ka’kabish, Lamanai, and the inter-site settlement zone, and to compare this trajectory to environmental evidence from pollen cores, as well as other sites in Northern Belize. My work provides a contribution to the understanding of Precolumbian Maya settlements by illustrating the ways in which the settlements change over time and proposing reasons for these changes. There are very few studies that show clearly the changes in the density and distribution of settlement over time in the core and periphery of two major civic-ceremonial sites. For comparative purposes, it would be beneficial to see timelines of changing core-periphery relationships at other Maya centres, as there is much still to be learnt from such urban/hinterland dynamics.
REFERENCES

Abrams, E., and D. Rue

Adams, R.


Adams, R., and R. Jones

Adams, R., H. Robichaux, F. Valdez Jr., B. Houk, and R. Mathews

Adams, R., and W. Smith

Adams, R., and F. Valdez

Adovasio, J., and J. Page
Aimers, J.  


Aimers, J., D. Farthing, and A. Shugar  

Aimers, J., and E. Graham  

Aimers, J., T. Powis, and J. Awe  

Alcala-Herrera, J., J. Jacob, M. Machian Castillo, and R. Neck  
1994 *Holocene Palaeosalinity in a Maya Wetland, Belize, Inferred from the Microfaunal Assemblage.* *Quaternary Research* 41:121-130.
Alford, A., W. Griffith, and O. Bolland
2019 Belize. Electronic document,

Andres, C.
2000 Caches, Censers, Monuments, and Burials: Archaeological Evidence of
Postclassic Ritual Activity in Northern Belize, Unpublished M.A.
dissertation, Southern Illinois University, Carbondale.

2002 Summary of the 2001 Investigations in the Main Plaza, Chau Hiix, Belize:
Interim Report, edited by C. Andres, pp. 12-43. Bloomington, Indiana
University.

2005 Building Negotiation: Architecture and Sociopolitical Transformation at
Chau Hiix, Lamanai, and Altun Ha, Belize, Ph.D. dissertation, Indiana
University, Bloomington, Ann Arbor: University Microfilms.

Archaeological Project 2005 Interim Report, edited by C. Andres, pp. 40-
76. Bloomington, Indiana University.

2009 Architecture and Sociopolitical Transformation at Chau Hiix, Belize.

Andres, C., and K. Pyburn
2004 Out of Sight: The Postclassic and Early Colonial Periods at Chau Hiix,
Belize. In The Terminal Classic in the Maya Lowlands: Collapse,
Transition, and Transformation, edited by A. Demarest, P. Rice, and D.

Andrews, A.
1993 Late Postclassic Lowland Maya Archaeology. Journal of World Prehistory
7:35-69.

Andrews, A., E. Andrews, and F. Castellanos
2003 The Northern Maya Collapse and Its Aftermath. Ancient Mesoamerica
14:151-156.

Andrews IV, E.
1965a Archaeology and Prehistory in the Northern Maya Lowlands: An
Introduction. In Handbook of Middle American Indians, edited by R.
Wauchope, and G. Willey, pp. 288-330. vol. 2. University of Texas Press,
Austin.

1965b Progress Report on the 1960-64 Field Seasons. In Archaeological Studies
in Middle America, pp. 23-67. Middle American Research Institute,
Publication 31. Tulane University, New Orleans.
1988 Ceramic Units from Komchen, Yucatan, Mexico. *Ceramica de Cultura Maya* 15:51-64.

Anselmetti, F., D. Ariztegui, M. Brenner, D. Hodell, and M. Rosenmeier

Aoyama, K., and E. Graham (in press)

Appenzeller, T.

Ardren, T.
2015 *Social Identities in the Classic Maya Northern Lowlands: Gender, Age, Memory, and Place*. University of Texas Press, United States of America.

Arensberg, C.

Arnold, J., and A. Ford

Ashmore, W.

Ashmore, W. (editor)


Ashmore, W., S. Connell, J. Ehret, C. Gifford, L. Neff, and J. Vandenbosch

Ashmore, W., E. Schortman, and R. Sharer
Ashmore, W., and R. Wilk

Ashmore, W., and G. Willey

Atkinson, C., A. Yates, and M. Wyatt

Atran, S.

Awe, J.

Aylesworth, G.

Bachand, B.

Bairoch, P.

Baker, Jeff

Baker, John

Baker, R.

Ball, J.
1977 The Archaeological Ceramics of Becan, Campeche, Mexico. Middle American Research Institute Publication 43. Tulane University, New Orleans.

1979 Ceramics, Culture History, and the Puuc tradition: Some Alternative Possibilities. Middle Research Institute Publication 43. Tulane University, New Orleans

Ball, J., and J. Tashek
1991 Late Classic Lowland Maya Political Organization and Central-Place Analysis. Ancient Mesoamerica 2:149-165.


Banning, E.

Banning, E., A. Hawkins, and S. Steward

Barrera Vasquez, A.

Barrett, J.
2004 Constructing Hierarchy Through Entitlement: Inequality in Lithic Resource Access Among the Ancient Maya of Blue Creek, Belize, Unpublished Ph.D. dissertation, Department of Anthropology, Texas A&M University, College Station.

Barrett, J., and T. Guderjan
2006 An Ancient Maya Dock and Dam at Blue Creek, Rio Hondo, Belize. Latin American Antiquity 17(2):227-239.
Barrett, J., and A. Scherer  
2005  Stones, Bones, and Crowded Plazas: Evidence for Terminal Classic Maya  

Barthel, S., and C. Isendahl  
2012  Urban Gardens, Agriculture, and Water Management: Sources of  
Resilience for Long-Term Food Security in Cities. *Ecological Economics*  
86:224-234.

Bartlett, M.  
Cotsen Institute of Archaeology, Los Angeles, California.

Beach, T., N. Dunning, S. Lazzadder-Beach, D. Cook, and J. Lohse  
2006  Impacts of the Ancient Maya on Soils and Soil Erosion in the Central  

Beach, T., S. Luzzadder-Beach, D. Cook, N. Dunning, D. Kennett, S. Krause, R. Terry,  
D. Terry, D. Trein, and F. Valdez  
2015a  Ancient Maya Impacts on the Earth's Surface: An Early Anthropocene  

Beach, T., S. Luzzadder-Beach, and N. Dunning  
2009  A Review of Human and Natural Changes in Maya Lowlands Wetlands  
over the Holocene. *Quaternary Science Reviews* 28:1710-1724.

Beach, T., S. Luzzadder-Beach, N. Dunning, J. Hageman, and J. Lohse  
2002  Upland Agriculture in the Maya Lowlands: Ancient Maya Soil  

Beach, T., S. Luzzadder-Beach, T. Guderjan, and S. Krause  
2015b  The Floating Gardens of Chan Cahal: Soils, Water, and Human  

Berrin, K., and E. Pasztory (editor)  
1993  *Teotihuacan: Art from the City of the Gods*. Thames and Hudson, New  
York.

Bettencourt, L.  

Bettencourt, L., and J. Lobo  

Bettencourt, L., J. Lobo, and D. Strumsky  
2007  Invention in the City: Increasing Returns to Patenting as a Scaling  
Bettencourt, L., J. Lobo, D. Strumsky, and G. West  

Bevan, A.  


Bevan, A., and J. Conolly  

Bevan, A., J. Conolly, C. Hennig, A. Johnston, A. Quercia, L. Spencer, and J. Vroom  

Bevan, A., E. Jobbova, C. Helmke, and J. Awe  

Bevan, A., and M. Lake (editor)  
2013 *Computational Approaches to Archaeological Spaces*. Left Coast Press, Walnut Creek, California.

Bey, G.  

Bey, G., T. Bond, W. Ringle, C. Hansen, C. Houck, and C. Lope  

Bey, G., C. Hanson, and W. Ringle  

Blanton, R., S. Kowalewski, G. Fienman, and L. Finsten  

Bradley, R., and B. Dahlin  
Brady, J., and J. Ball, R. Bishop, D. Pring, N. Hammond, and R. Housley  
1998  The Lowland Maya 'Protoclassic': A Reconsideration of Its Nature and  

Bray, W.  

Breheny, M.  
1992  The Contradictions of the Compact City: A Review. In *Sustainable  
Development and Urban Form*, edited by M. Breheny, pp. 138-159. Pion,  
London.

Brewer, J.  
2007  Understanding the Role of a Small Depression in Ancient Maya Water  
Management at the Medicinal Trail Site, Northwest Belize, Unpublished  
M.A. dissertation, University of Cincinnati, Ohio.

Bricker, V., E. Po'ot Yah, and O. Dzul de Po'ot  
1998  *A Dictionary of the Maya Language as Spoken in Hocaba, Yucatan. With a  
Botanical Index by Anne S. Bradburn*. University of Utah Press, Salt Lake  
City.

Bridgewater, S., A. Ibanez, J. Ratter, and P. Furley  
2002  Vegetation Classification and Floristics of the Savannas and Associated  

Brokaw, N., and E. Mallory  
1993  *Vegetation of the Rio Bravo Conservation and Management Area, Belize*.  
Manomet Bird Observatory, Manomet, Massachusetts, U.S.A.

Brokaw, N., and E. Sabido  
1998  *Vegetation of the Rio Bravo Conservation and Management Area, Belize*.  
Manomet Bird Observatory, Manomet, Massachusetts, U.S.A.

Brown, D., M. Dreiss, and R. Highes  
2004  Preclassic Obsidian Procurement and Utilization at the Maya Site of  

Brown, K.  
1995  1994 Interim Report on Investigations of the Preclassic at Dos Hombres,  
Interim Report*, edited by R. Adams, and F. Valdez, Jr., pp. 96-101. The  
Center for Archaeology and Tropical Studies, The University of Texas,  
San Antonio.

Brown, M.  
2003  Emerging Complexity in the Maya Lowlands: A View from Blackman  
University, Dallas.
Brown, C., and W. Witschey  

Brueckner, J.  

Bruegmann, R.  

Brundtland, G.  

Bullard, W.  


Burney, D., and T. Flannery  

Buttles, P.  
2002 Material and Meaning: A Contextual Examination of Select Portable Material Culture from Colha, Belize, Unpublished Ph.D. dissertation, University of Texas, Austin.

Butzer, K.  

Callaghan, M.  

Callaghan, M., and N. de Estrada  

Calthrope, P.  
Canter, R., and D. Pentecost  


Carlos, T.  

Carr, R., and J. Hazard  

Carr, C., E. Weaver, N. Dunning, and V. Scarborough  

Case, R.  

Castells, F. de P.  

Cavagna, G., and R. Margaria  

Cesaretti, R.  

Cesaretti, R., L. Bettencourt, J. Lobo, S. Ortman, and M. Smith  
Chase, A.
1992 Elites and the Changing Organization of Classic Maya Society. In
_Mesoamerican Elites: An Archaeological Assessment_, edited by D. Chase,

Chase, A., and D. Chase
1983 Intensive Gardening Among the Late Classic Maya: A Possible Example

1985 Introduction. In *The Lowland Maya Postclassic*, edited by A. Chase, and

Monograph 3, Pre-Columbian Art Research Institute, San Francisco.

1998 Scale and Intensity in Classic Period Maya Agriculture: Terracing and
Settlement at the "Garden City" of Caracol, Belize. *Culture and
Agriculture* 20(2/3):60-77.

2001 Ancient Maya Causeways and Site Organization at Caracol, Belize.
_Ancient Mesoamerica_ 12:273-281.

2007 Ancient Maya Urban Development: Insights from the Archaeology of

2012a Interpreting Ancient Maya Society Through Neighborhoods: Investigation
of Adjacent Residential Complexes near Caracol's Epicenter: Caracol
Archaeological Project Investigations for 2012. Institute of Archaeology,
Belmopan, Belize.

2012b Interpreting Form and Context: Ceramic Subcomplexes at Caracol,
Nohmul, and Santa Rita Corozal, Belize. In *Ancient Maya Pottery:
Classification, Analysis, and Interpretation*, edited by J. Aimers, pp. 46-

2016a The Ancient Maya City: Anthropogenic Landscapes, Settlement
Archaeology, and Caracol, Belize. *Research Reports in Belizean
Archaeology* 13:3-14.

2016b Urbanism and Anthropogenic Landscapes. *Annual Review of Anthropology*
45(22):22.21-22.16.

Chase, A., D. Chase, J. Weishampel, J. Drake, R. Shrestha, J. Awe, and W. Carter
2011 Airborne LiDAR, Archaeology, and the Ancient Maya Landscape at

Chase, A., D. Chase, J. Awe, J. Weishampel, G. Iannone, H. Moyes, J. Yaeger, M.
Brown, R. Shrestha, W. Carter, and J. Fernandez-Diaz
2014a Ancient Maya Regional Settlement and Inter-site Analysis: The 2013

Chase, A., and P. Rice
1985 *The Lowland Maya Postclassic*. University of Texas Press, Austin.

Chase, D.


Chase, D., and A. Chase

Childe, G.

Clayton, S., D. Driver, and L. Kosakowsky
2005 Rubbish or Ritual? Contextualizing a Terminal Classic Problematical Deposit at Blue Creek, Belize: A Response to ‘Public Architecture, Ritual, and Temporal Dynamics at the Maya Center of Blue Creek, Belize.’ *Ancient Mesoamerica* 16(1):119-130.

Clement, C., and A. Junqueira

Clendinnen, I.

Closs, M.

Clutton-Brock, J., and N. Hammond


Connor, J. 1983 The Ceramics of Cozumel, Quintana Roo, Mexico, Ph.D. Dissertation, University of Arizona, University Microfilms, Ann Arbor.


Cuddy, C. 2000 Socioeconomic Integration of the Classic Maya State: Political and Domestic Economies in a Residential Neighborhood, Ph.D. dissertation, Department of Anthropology, Columbia University, Ann Arbor: University Microfilms.
Culbert, T.  


Culbert, T., and D. Rice (editor)  

Curtis, J., D. Hodell, and M. Brenner  
1996 Climate Variability on the Yucatan Peninsula (Mexico) During the Past 3500 Years, and Implications for Maya Cultural Evolution. *Quaternary Research* 46:37-47.

Dahlin, B.  

Davies, T., M. Hazelton, and J. Marshall  

Davy, C., and M. Fenton  

Deevey, E., D. Rice, P. Rice, H. Vaughan, M. Breener, and M. Flannery  

Demarest, A.  

Demographia

Dockall, J., and H. Shafer

Donkin, R.

Douglas, P., M. Brenner, and J. Curtis


Drennan, R., C. Berrey, and C. Peterson
2015 Regional Settlement Demography in Archaeology. Eliot Werner Publications, Clinton Corners, NY.

Driver, D.

2002 An Early Classic Colonnaded Building at the Ancient Maya Site of Blue Creek, Belize. Latin American Antiquity 13(1):63-84.

Dunning, N., T. Beach, P. Farrell, and S. Luzzadder-Beach

Dunning, N., J. Jones, T. Beach, and S. Luzzadder-Beach

Dunning, N., S. Luzzadder-Beach, T. Beach, J. Jones, V. Scarborough, and T. Culbert


Erickson, C., and J. Walker

Erlandson, J., M. Graham, B. Bourque, D. Corbett, J. Estes, and R. Steneck

Esselman, P., and E. Botes

Estrada-Belli, F.

Evans, S.
2008 *Ancient Mexico and Central America: Archaeology and Culture History*. 2nd ed. Thames and Hudson, United Kingdom.

Ewing, R., T. Schmid, R. Killingsworth, A. Zlot, and S. Raudenbush

Fash, W.


Favreau, J., and R. Patalano (editor)
2017 *Shallow Pasts, Endless Horizons: Sustainability and Archaeology*. The Chacmool Archaeological Association of the University of Calgary, Alberta, Canada.

Fedick, S.


Ferrand, E., N. Dunning, D. Lentz, and J. Jones  

Fick, S., and R. Hijmans  

Fisher, C.  

Fladmark, K.  

Flannery, K.  


Flannery, K., and J. Marcus  

Fletcher, R.  


Foias, A.  

Folan, W.  
Folan, W., L. Fletcher, and E. Kintz  
1979  Fruit, Fiber, Bark and Resin: Social Organization of a Maya Urban Center.  
*Science* 204:697-701.

Folan, W., A. Hernandez, E. Kintz, L. Fletcher, R. Heredia, J. Mau, and N. Canche  
2009  Coba, Quintana Roo, Mexico: A Recent Analysis of the Social, Economic and Political Organization of a Major Maya Urban Center. *Ancient Mesoamerica* 20:59-70.

Folan, W., E. Kintz, and L. Fletcher  

Folan, W., E. Kintz, L. Fletcher, and B. Hyde  

Ford, A., and R. Nigh  

Forsyth, D.  


<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Authors</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td><em>Mangrove Distribution, Vulnerability and Management in Central America</em>.</td>
<td>Furley, P., and J. Ratter</td>
<td></td>
</tr>
<tr>
<td>1926</td>
<td><em>Ancient Cities and Modern Tribes: Exploration and Adventure in Maya Lands</em>.</td>
<td>Gann, T., and M. Gann</td>
<td></td>
</tr>
<tr>
<td>1939</td>
<td>Archaeological Investigations in the Corozal District of British Honduras.</td>
<td>Garber, J., M. Brown, J. Awe, and C. Hartman</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td><em>Introduccion al patron de asentamiento del sitio de Coba, Quintana Roo.</em></td>
<td>Garduno Argueta, J.</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td><em>Preclassic Maya Architecture at Cuello, Belize</em>.</td>
<td>Gerhardt, J.</td>
<td></td>
</tr>
</tbody>
</table>

316
Gifford, J.  

Gill, R.  

Gillespie, S.  

Glavic, P., and R. Lukman  

Glaesel-Kohler, K., and R. Anzola-Betancourt  

Golden, C., and A. Scherer  

Goldsmith, S.  

Gomer, A.  

Gonzales, A.  

Gonzalez, T.  
Goody, J.

Gordon, G.

Graham, E.
1975 Operation 301E. In *Archaeology in Northern Belize: British Museum – Cambridge University Corozal Project—1974-75 Interim Report*, p. 70, Fig. 2.96. Centre of Latin American Studies, University of Cambridge.


Graham, E., and C. Isendahl

Graham, E., and D. Pendergast (editor)

Graham, E., D. Pendergast, and G. Jones

Graham, E., and H. Ritscher (editor)


Graham, E., S. Simmons, and C. White

Grube, N.


Grube, N., and N. Hammond
Grube, N., and S. Martin

Grund, B., T. Surovell, and S. Lyons

Guderjan, T.


Hageman, J. 1992 The 1991 Test Pit Program at Kinal, Guatemala, Unpublished M.A. dissertation, Department of Anthropology, University of Texas, Austin.

Haines, H.
2006 Report to the Institute of Archaeology, NICH, Belize of the June 2005 Reconnaissance of Ka'kabish, Orange Walk District. Institute of Archaeology, Belmopan, Belize.  
2010 The 2009 Spring Mapping Project of the Ka'kabish Archaeological Research Project (KARP). Institute of Archaeology, Belmopan, Belize.  
2011a How the Other-Half Lived: Continuing Discussions of the Enigma that is Ka'kabish, Belize. Research Reports in Belizean Archaeology Vol. 8:137-150.  

Haines, H. (editor)
2011b The 2010 Spring Mapping Project of the Ka'kabish Archaeological Research Project (KARP). Institute of Archaeology, Belmopan, Belize.  

Haines, H., C. Belanger, and K. Sagebiel

Haines, H., and C. Helmke

Hammond, N.


2001  A New Maya Stela from La Milpa, Belize. *Antiquity* 75(288):267-268.


Hammond, N. (editor)  


Hammond, N., and J. Bauer  

Hammond, N., and M. Bobo  

Hammond, N., A. Clarke, and F. Belli  

Hammond, N., A. Clarke, and S. Donaghey  

Hammond, N., C. Clark, M. Horton, M. Hodges, L. Mcnatt, L. Kosakowsky, and A. Pyburn  


Hammond, N., R. Housley, and I. Law  

Hammond, N., and C. Miksicek  
Hammond, N., M. Neivens, and G. Harbottle  

Hammond, N., D. Pring, R. Berger, V. Switsur, and A. Ward  


Hammond, N., A. Pyburn, J. Rose, J. Staneko, and D. Muyskens  


Hammond, N., and G. Tourtellot  

Hammond, N., G. Tourtellot, S. Donaghey, and A. Clarke  


Hanks, R.  

Hanna, J., E. Graham, D. Pendergast, J. Hoggarth, D. Lentz, and D. Kennett  

Hanratty, C., and T. Guderjan (editors)  

Hansen, M.  
Hansen, R.


Hansen, R., W. Howell, and S. Guenter

Harrison, P., and R. Fry

Harrison-Buck, E., and P. McAnany

Hasse, J., and R. Lathrop

Hassig, R.

Haviland, W.


Hayden, D.

Haynes, C.

Hazelton, M., and T. Davies

Healy, P., C. Helmke, J. Awe, and K. Sunahara

Healy, P., J. Lambert., J. Arnason, and R. Hebda

Heath, L.
2011 Toward a "Full Biography of Obsidian:" Studies of Obsidian Use and Exchange in the Maya Area. A thesis submitted to the faculty of Wesleyan University in partial fulfillment of the requirements for the Degree of Bachelor of Arts with Departmental Honors in the Archaeology Program, Middletown, CONN.

Heckenberg, M., J. Russell, J. Toney, and M. Schmidt

Helmke, C.
Helms, M.

Henderson, H.

Hermon, S., and F Niccolucci

Hester, T., J. Eaton, and H. Shafer (editor)

Hester, T., H. Iceland, D. Hudler, R. Brewington, H. Shafer, and J. Lohse

Hester, T., H. Iceland, D. Hudler, and H. Shafer

Hester, T., T. Kelly, and G. Ligabue

Hester, T., and H. Shafer


Hester, T., H. Shafer, and T. Berry

Hester, T., H. Shafer and J. Eaton (editor)
1994 *Continuing Archaeology at Colha, Belize*. Texas Archaeological Research Library, University of Texas, Austin.
Hewett, E.  

Hirth, K.  

Hodell, D., M. Brenner, and J. Curtis  
2007 Climate and Cultural History of the Northeastern Yucatan Peninsula, Quintana Roo, Mexico. *Climate Change* 83:215-240.

Horn, S.  

Houk, B.  


1996 The Archaeology of Site Planning: An Example from the Maya site of Dos Hombres, Belize, Unpublished Ph.D. dissertation, University of Texas, Austin.


2000 *The 1998 and 1999 Seasons of the Chan Chich Archaeological Project*. Papers of the Chan Chich Archaeological Project, Number 4, Mesoamerican Archaeological Research Laboratory, University of Texas, Austin.


Houston, S.  
Houston, S., H. Escobedo, M. Child, C. Golden, and R. Munoz

Houston, S., H. Escobedo, R. Terry, D. Webster, G. Veni, and K. Emery

Howell, W., and D. Copeland

Howie, L.

Hughbanks, P.


Hughes, R.

Hutson, S.

Hutson, S., and A. Magnoni

Hutson, S., D. Hixon, A. Magnoni, D. Mazeau, and B. Dahlin

Iannone, G.
2005 The Rise and Fall of an Ancient Maya Petty Royal Court. Latin American Antiquity 16:26-44.
Iannone, G. (editor)  

Iceland, H.  

Inomata, T., and K. Aoyama  

Inomata, T., D. Triadan, K. Aoyama, V. Castillo, and H. Yonenobu  

Iremonger, S., and N. Brokaw  

Isendahl, C.  

Isendahl, C., and M. Smith  

Jablonski, N. (editor)  

Jacob, J.  
1992 The Agroecological Evolution of Cobweb Swamp, Belize, Unpublished Ph.D. dissertation, Department of Soil and Crop Science, Texas A&M University, College Station.


Jacob, J., and C. Hallmark  
Jacobi, K.

Jenks, M., E. Burton, and K. Williams (eds)

John, J.
2008 Postclassic Maya Ceramic Iconography at Lamanai, Belize, Central America, Unpublished Ph.D. dissertation, Institute of Archaeology, University College London.

Johnson, C.

Johnston, K.


Johnstone, D.

Jones, G.

Jones, G., R. Kautz, and E. Graham

Jones, J.

Jones, J., and V. Bryant Jr.
Kalosky, E., and K. Prufer

Kantner, J.

Katz, P.

Kelly, T.

Kelly, R., and D. Thomas

Kelsall, J., and P. Diggle

Kendal, J., J. Tehrani, and J. Odling-Smee

Kepecs, S., and S. Boucher

Kidder, A., J. Jennings, and E. Shook

King, E.


King, R., I. Ballie, T. Abell, J. Dunsmore, D. Gray, J. Pratt, H. Versey,
Kolb, M., and J. Snead

Kosakowsky, L.


Kowalski, J., and C. Kristan-Graham

Kosawkowsky, L., and J. Lohse

Kosakowsky, L., and D. Pring

Kristan-Graham, C. and Kowalski, J.

Kunen, J.

Kunen, J., and P. Hughbanks  

Kurjack, E.  
1974 *Prehistoric Lowland Maya Community and Social Organization: A Case Study at Dzibilchaltun, Yucatan, Mexico*. Middle American Research Institute Publication 38. Tulane University, New Orleans.

Kurjack, E., J. Scheffler, and J. Collier  

Lachniet, M., J. Bernal, Y. Asmerom, V. Polyak, and D. Piperno  

Laland, K., B. Matthews, and M. Feldman  

Lambert, J., and T. Arnason  

Lambert, J., A. Siemens, and J. Arnason  

Lamoureux-St-Hilaire, M., S. Macrae, C. McCane, E. Parker, and G. Iannone  

Laurance, W.  

Lazure, L., and M. Fenton  
Lecount, L., and J. Yaeger  


Lentz, D., N. Dunning, and V. Scarborough  

Lentz, D., E. Graham, X. Vinaja, V. Slotten, and R. Jain  

Lentz, D., and B. Hockaday  

Lentz, D., J. Yaeger, and R. Ashmore  

Leventhal, R.  

Levi, L.  


Leyden, B., M. Brenner, D. Hodell, and J. Curtis

Lichtenstein, R.

Lichtfouse, E., M. Navarrete, P. Debaeke, V. Souchere, C. Alberola, and J. Menassieu

Lithourgidis, A., C. Dordas, C. Damalas, and D. Vlachostergios

Lockett-Harris, J.

Lohse, J.
1993 Operation 4046 Colha, Belize: A Reconsideration of a Lowland Archaic Deposit, Unpublished M.A. dissertation, Department of Anthropology, University of Texas, Austin.


Lohse, J., J. Awe, C. Griffith, R. Rosenswig, and F. Valdez Jr.

Lohse, J., and F. Valdez Jr.

Lohse, J., and F. Valdez Jr. (editor)
2004b *Ancient Maya Commoners*. University of Texas Press, Austin.

Longstaffe, M.
2011 Ancient Maya Site Core Settlement at Minanha, Belize: Development, Integration, and Community Dynamics, Unpublished M.A. dissertation, Department of Anthropology, Trent University, Peterborough.

Longyear, J.

Lopez de Cogolludo, D.

Lopez Varela, S.


Loten, S.


Loten, S., and D. Pendergast
Love, M.  

Lovell, G.  

Lovisek, J.  

Lowe, G.  

Lowe, G., and P. Agrinier  
1960  *Mound 1, Chiapa de Corzo, Mexico*. Papers of the New World Archaeological Foundation Publication No. 7. Brigham Young University, Provo, Utah.

Lucero, L., S. Fedict, N. Dunning, D. Lentz, and V. Scarborough  

Lucero, L., R. Fletcher, and R. Coningham  

Lundell, C.  

Lyons, S., F. Smith, and J. Brown  

Mabit, L., F. Zapata, G. Dercon, M. Benmansour, C. Bernard, and D. Walling  

MacKinnon, J., and E. May  
MacNeish, R., and A. Nelken-Terner

Macrae, S., and G. Iannone

Magnoni, A.

Magnoni, A., T. Ardren, S. Hutson, and B. Dahlin

Magnoni, A., S. Hutson, and B. Dahlin

Manzanilla, L., and L. Barba

Marans, R.

Marcus, J.


1988  *The Calakmul State and Its Expansionist Policies.* Manuscript on file, Department of Anthropology, University of Michigan, Ann Arbor.

Marcus, J., and A. Sabloff  

Marcus, J., and J. Sabloff (editor)  

Marshall, J.  

Martin, S., and N. Grube  
2000  *Chronicles of the Maya Kings and Queens.* Thames and Hudson, London.

Masson, M.  

Masson, M., and D. Freidel  

Masson, M., T. Hare, and C. Peraza Lope  

Masson, M., and S. Mock  

Masson, M., and C. Peraza Lope  

Masson, M., and R. Rosenswig  
Matous, P., Y. Todo, and D. Mojo  

Maudslay, A.  

Mavroidis, S.  

Mavroidis, S., E. Schurter, S. Johnson, B. Putman, and S. Sattler  

Mayfield, T.  
2015 The Nineteenth Century British Plantation Settlement at Lamanai, Belize 1837-1868, Department of Anthropology, University of Arizona, Tucson.

McAnany, P.  


McAnany, P. (editor)  

McCoy, J., and K. Johnston  

McDermott, K.  

McDow, D.  
1997 An Analysis of the Whole Ceramic Vessels from Kichpanha, Northern Belize. Unpublished M.A. dissertation, Department of Anthropology, University of Texas, Austin.
McKillop, H.

McKillop, H., and Healy, P. (editors)
1989 *Coastal Maya Trade*, Occasional Papers in Anthropology, Trent University, Peterborough, ON.

McLellan, A.


2013 Survey and Settlement at the Ancient Maya Site of Ka’kabish, Northern Belize, Unpublished M.A. dissertation, Department of Anthropology, Trent University, Peterborough.


McLellan, A., and H. Haines

McLusky, D., and M. Elliot

McNeil, C., D. Burney, L. Burney, and J. Marcus
Medina-Elizalde, M., S. Burns, D. Lea, Y. Asmerom, L. Von Gunten, V. Polyak, and M. Vuille

Medina-Elizalde, M., and E. Rohling

Meerman, J., P. Herrera, B. Holland, and A. Howe

Meerman, J., and W. Sabido

Meier, K.
2002 The Ballcourt at Chau Hiix: Architectural Insight into Changing Patterns of Political Dominance, Unpublished M.A. dissertation, Department of Anthropology, Indiana University, Bloomington.

Meierhoff, J., M. Golitko, G. Feinman, and P. Williams

Meltzer, D.
2009 *First Peoples in a New World: Colonizing Ice Age America*. University of California, Berkeley.

Meskill, F.

Metcalfe, S., A. Breen, M. Murray, P. Furley, A. Fallick, and A. McKenzie

Michaels, G.
Milbrath, S., and C. Peraza Lope


Mock, S.
1994 The Northern River Lagoon Site: Subsistence, Saltmaking, and Survival on the Belize Coast during the Late to Terminal Classic Period, Ph.D. dissertation, University of Texas, Austin, University Microfilms, Ann Arbor.


Morehart, C., D. Lentz, and K. Prufer

Morgan, L.


Morgan, R.

Morris, E., J. Charlot, and A. Morris

Morton, S., M. Peuramaki-Brown, P. Dawson, and J. Seibert

Nash, J.

Nations, J.
2006 *The Maya Tropical Forest: People, Parks, and Ancient Cities*. University of Texas Press, Austin.
Neivens, M.  

Neivens, M., and D. Libbey  

Ng, O., and P. Cackler  

O'Brien, K.  

O'Brien, M., and K. Laland  

O'Brien, M., and T. Holland  

Odling-Smee, J.  

Odling-Smee, J., K. Laland, and M. Feldman  


Oglesby, R., T. Sever, W. Saturno, D. Erickson III, and J. Srikishen  

Orendurff, M., J. Schoen, G. Bernatz, A. Segal, and G. Klute  

Ortman, S., A. Cabaniss, J. Sturm, and L. Bettencourt  

Ortman, S., and G. Coffey

Ortman, S., K. Davis, J. Lobo, M. Smith, L. Bettencourt, and A. Trumbo

Palka, J.

Paling, J.

Parsons, J.

Patino-Contreras, A.

Patterson, C.

Pearson, G., and P. Bostrom

Pendergast, D.

1969 *Altun Ha: A Guidebook to the Ancient Maya Ruins*. University of Toronto Press.


1992a After the Dig is Over, After the Thrill is Gone. *Rotunda* 25(3):36-40.


Peniche May, N., M. Perez, and T. Ceballos Gallareta

Peraza Lope, C.
1993 Estudio y Secuencia del Material Ceramico de San Gervasio, Cozumel, Tesis Profesional, Universidad Autónoma de Yucatán, Merida, Mexico.

Peraza Lope, C., M. Masson, T. Hare, and P. Delgado Ku

Piedallu, C., and J. Gegout

Pierce, K.
Piperno, D., K. Clary, R. Cooke, A. Ranere, and D. Weiland  
1985 Preceramic Maize in Central Panama: Phytolith and Pollen Evidence.  

Pitre, C.  
2012 Exploration of Structures F-1 and F-2 at Ka’kabish. In Ka’kabish  
Archaeological Research Project (KARP) Interim Report on the 2011  
Field Season, edited by H. Haines, pp. 49-54. Institute of Archaeology,  
Belmopan, Belize.

Pohl, M., K. Pope, J. Jones, J. Jacob, D. Piperno, S. deFrance, D. Lentz, J. Gifford, M. Danforth, and J. Josserand  
1996 Early Agriculture in the Maya Lowlands. *Latin American Antiquity*  

Pohl, M., and C. Robinson  

Politis, G.  

Pool, C.  

Pope, K., M. Pohl, J. Jones, D. Lentz, C. Nagy, F. Vega, and I. Quitmyer  

Potter, D.  

Potter, D., T. Hester, S. Black, and F. Valdez Jr.  

Powis, T.  
2002 An Integrative Approach to the Analysis of the Late Preclassic Ceramics at Lamanai, Belize. Unpublished Ph.D. dissertation, Department of Anthropology, University of Texas, Austin.

Powis, T., and D. Cheetham

Powis, T., S. Horn III, G. Iannone, P. Healy, J. Garber, J. Awe, S. Skaggs, and L. Howie

Powis, T., S. Mazzullo, and E. Graham

Pring, D.

Prufer, K., A. Thompson, and D. Kennett

Pugh, T.

Puleston, D.


Pun-Cheng, L.

Pyburn, A.


Pyburn, K., B. Dixon, P. Cook, and A. McNair

Ranere, A., and R. Cooke

Rapoport, E.

Ravetz, J., C. Fertner, and T. Nielsen
Reents, D.
1980 The Prehistoric Pottery from Petroglyph Cave, Saves Branch Valley, El Cayo District, Belize, Central America, Unpublished M.A. dissertation, Department of Anthropology, University of Texas, Austin.

Reents-Budet, D.

Renfrew, C.

Rice, P.

Rice, P., and T. Culbert

Richerson, P., R. Boyd, and R. Bettinger

Ricketson, O. and E. Ricketson

Ringle, W.

Robertson, R. and Freidel, D. (editors)

Robertson-Freidel, R.
Robichaux, H. 1995 Ancient Maya Community Patterns in Northwestern Belize: Peripheral Zone Survey at La Milpa and Dos Hombres, Unpublished Ph.D. dissertation, University of Texas, Austin.


Sabloff, J.  

Sabloff, J., and W. Rathje  

Sagebiel, K.  

2014 *The Late and Terminal Classic Ceramic Sequence at La Milpa, Belize: Implications for its Occupation History.* *Ancient Mesoamerica* 25(1):115-137.


Sagebiel, K., and H. Haines  

Sagebiel, K., and H. Haines (editor)  

Samaniego, H., and M. Moses

Sanders, W.

Sanders, W., and D. Webster

Santamouris, M. (editor)

Scarborough, V.


Scarborough, V., M. Becher, J. Baker, G. Harris, and F. Valdez Jr.

Scarborough, V., and W. Burnside

Scarborough, V., A. Chase, and D. Chase
2012 Low-Density Urbanism, Sustainability and IHOPE-Maya: Can the past provide more than history? UGEC Viewpoints 8:20-24.

Scarborough, V., N. Dunning, K. Tankersley, C. Carr, E. Weaver, L. Grazioso, B. Lane, J. Jones, P. Buttles, F. Valdez Jr., and D. Lentz
Scarborough, V., and L. Grazioso Sierra

Scarborough, V., F. Valdez, and N. Dunning (editor)

Schele, L., and D. Freidel.

Schmidt, P.

Schreiner, T.

Schultz, K., J. Gonzalez, and N. Hammond

Schwagerl, C.

Seaburn, P.

Sering, L.

Shafer, H.
Sharer, R.

Sharer, R. J., Loa, and P. Traxler

Shaw, J.

Sheets, P., C. Dixon, D. Lentz, R. Egan, A. Halmbacher, V. Slotten, R. Herrera, and C. Lamb

Shelby, T.


Shelby, T., and D. Reents-Budet

Sidrys, R.
1983 *Archaeological Excavations in Northern Belize, Central America*. University of California, Monograph 17, Institute of Archaeology.

Sidrys, R., and J. Andresen

Simmons, S.


Simmons, S., E. Graham, J. Aimers, L. Howie, A. Shugar, and I. Villasenor


Simmons, S., and L. Howard


Simmons, S., and A. Shugar

2013 Maya Metallurgical Technology in Late Postclassic-Spanish colonial Times: The View from Lamanai, Belize. Archaesciences-Revie D Archeometrie (37):105-121.

Sinclair, A.


Smith, M.


Smith, M., and F. Berdan

Smith, R.
1936a Ceramics at Uaxactun: A Preliminary Analysis of Decorative Technics and Design. mimeographed, Guatemala.

1936b Preliminary Shape Analysis of the Uaxactun Pottery. mimeographed, Guatemala.

1955 Ceramic Sequence at Uaxactun, Guatemala. Middle American Research Institute Publication 20. New Orleans, Tulane University.


Smith, R., and J. Gifford
1966 Maya Ceramic Varieties, Types, and Wares at Uaxactun: Supplement to "Ceramic Sequence at Uaxactun, Guatemala". In Middle American Research Institute Publication 28. Tulane University, New Orleans.

Smith, S.

Sole, R., D. Alonso, and A. McKane

Spencer, T., I. Moller, and R. Reef

Stambaugh, G.

Stanford, D., and B. Bradley


Stanton, T.
Stanton, T., M. Brown, and J. Pagliaro

Stein, M.

Stemp, J., and E. Graham

Stemp, J., and J. Awe

Steward, J.

Steward, J., and F. Setzler

Storey, G.

Strong, W.

Stuardo, R.

Sullivan, L.
1997 Classic Maya Social Organization: A Perspective from Las Abejas, Belize, Unpublished Ph.D. dissertation, University of Texas, Austin.


Sullivan, L., and K. Sagebiel
Sullivan, L., and F. Valdez

Sveikauskas, L.

Sweitz, S.

Taha, H.

Taladoire, E., S. Dzul, P. Nondedeo, and M. Forne

Tate, C.
2011  Yaxchilan: The Design of a Maya Ceremonial City. University of Texas Press, Austin.

Taylor, W.

Thompson, E.


Thompson, J.


1991 *The Maya of Belize: Historical Chapters since Columbus*. Cubola Productions, Benque Viejo del Carmen, Belize.

Tourtellot, G.


Tourtellot, G., A. Clarke, and N. Hammond


Tourtellot, G., F. Estrada Belli, J. Rose, and N. Hammond


Tourtellot, G., G. Everson, and N. Hammond


Tourtellot, G., J. Gonzalez


Tozzer, A.


Trachman, R.


Trachman, R., K. Farah, T. Ewing, and J. Murdock

Tremain, C.

Tremain, C., and H. Haines (editor)

Trigger, B.

Troy, P.  

Turner, B.  

Turner, B., and P. Harrison  

Turner, B., and J. Sabloff  

Valdez, F.  
1987 The Prehistoric Ceramics of Colha, Northern Belize, Unpublished PhD Dissertation, Department of Anthropology, Harvard University, Cambridge.

Valdez, F., and G. Aylseworth  

Valdez, F., and S. Mock  

Valdez, F., V. Scarborough.  

Valliant, G.  

Vandermeer, J., M. van Noordwijk, J. Anderson, C. Ong, and I. Perfecto  

Villasenor, M.  
Villasenor, I., and E. Graham  

Villasenor, M., E. Graham, R. Siddall, and C. Price  

Walker, D.  
1990  Cerros Revisited: Ceramic Indicators of Terminal Classic and Postclassic Settlement and Pilgrimage in Northern Belize, Unpublished Ph.D. dissertation, Southern Methodist University, Dallas, Texas.

Walker, G., Y. Sub, and R. Atlas  

Walker, S.  

Walling, S., P. Davis, S. Dias, and M. DeVito  

Walling, S., T. Cornish, C. Coughenour, J. Hanna, and C. Taylor  

Walling, S., P. Davis, J. Hanna, L. Matthews, N. Prasarn, and C. Taylor  

Wallis, W.  


Webster, D., A. Freter and N. Gonlin 2000 *Copan: The Rise and Fall of an Ancient Maya Kingdom.* Harcourt Brace, Fort Worth, Texas.


White, C., and H. Schwarcz  


Wilbert, J.  

Wilk, R.  

Wilk, R.  


Wille, S.  
2007 Sociopolitics and Community-Building: The Entanglement of Prehispanic Maya Culture, Objects, and Place at Chau Hiix, Belize, Ph.D. dissertation, Indiana University, Bloomington, Ann Arbor: University Microfilms.

Willey, G.  

Willey, G.  

Willey, G.  

Willey, G., W. Bullard Jr., J. Glass, and J. Gifford  


Yaeger, J.

Yermakhanova, O.
2005  Kingship, Structures and Access Patterns on the Royal Plaza at the Ancient Maya City of Altun Ha, Belize: The Construction of a Maya GIS, Unpublished M.A. dissertation, Louisiana State University, Department of Geography and Anthropology.

Yigitcanlar, T., F. Dur, and D. Dizdaroglu

Zaro, G., and B. Houk

Zhang, C., X. Zou, J. Gong, L. Liu, and Y. Liu

Zralka, J., and B. Hermes
APPENDIX A: CHRONOLOGY OF STRUCTURES AT LAMANAI
Table A1: Chronology of structures at Lamanai (0=no evidence of occupation,
1=evidence of occupation)

<table>
<thead>
<tr>
<th>Structure ID</th>
<th>Mid Pre</th>
<th>Late Pre</th>
<th>Ear Cla</th>
<th>Late Cla</th>
<th>Term Cla</th>
<th>Early Pos</th>
<th>Late Pos</th>
<th>Span Col</th>
<th>Brit Col</th>
</tr>
</thead>
<tbody>
<tr>
<td>N9-33</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-53</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N9-56</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-58</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-59</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-70</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-71</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P9-2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P9-24</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P9-35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P9-36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-11</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-12</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-9</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>N10-4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-15</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-17</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-27</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-29</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-42</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-43</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-59</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-63</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-64</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N11-18</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N12-4</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N12-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>P8-27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P8-35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-9</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-15</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-17</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-27</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-29</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-42</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-43</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-59</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-63</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-64</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N11-7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N11-18</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N12-4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N12-6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N12-10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N12-11</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N12-12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N12-13</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N12-23</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>N12-26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N13-3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P8-102</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P8-104</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N9-76</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-74</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-66</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N13-14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N9-69</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P8-9</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>P8-14</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-29</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-42</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>N10-43</td>
<td>0 1 0 1 1 1 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-59</td>
<td>0 0 0 1 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-63</td>
<td>0 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-64</td>
<td>0 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-10</td>
<td>0 0 0 1 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-4</td>
<td>0 0 0 0 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-3</td>
<td>0 0 0 0 1 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-5</td>
<td>0 0 0 0 0 1 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-6</td>
<td>0 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-9</td>
<td>0 0 0 1 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-7</td>
<td>0 0 0 0 1 1 0 1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-18</td>
<td>0 1 0 0 0 0 1 1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-4</td>
<td>0 0 0 1 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-6</td>
<td>0 0 0 0 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-10</td>
<td>0 0 0 0 0 0 0 0 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-11</td>
<td>0 1 0 0 0 0 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-12</td>
<td>0 0 0 0 0 0 0 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-13</td>
<td>0 1 0 0 0 0 0 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-23</td>
<td>0 0 0 0 0 0 0 0 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-26</td>
<td>0 0 0 0 1 0 1 0 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N13-3</td>
<td>0 0 0 0 0 0 0 1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-102</td>
<td>0 0 0 1 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-104</td>
<td>0 0 0 0 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N9-76</td>
<td>0 0 0 0 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-11</td>
<td>0 0 0 0 0 1 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-74</td>
<td>0 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-66</td>
<td>0 0 0 0 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N13-14</td>
<td>0 0 0 0 0 1 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N9-69</td>
<td>1 1 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-9</td>
<td>1 1 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-14</td>
<td>1 1 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-5</td>
<td>0 0 0 0 1 1 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-6</td>
<td>0 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-9</td>
<td>0 0 0 1 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-7</td>
<td>0 0 0 1 1 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N11-18</td>
<td>0 1 0 0 0 0 1 1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-4</td>
<td>0 0 0 1 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-6</td>
<td>0 0 0 0 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-10</td>
<td>0 0 0 0 0 0 0 0 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-11</td>
<td>0 1 0 0 0 0 1 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-12</td>
<td>0 0 0 0 0 0 1 1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-13</td>
<td>0 1 0 0 0 0 0 1 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N12-23</td>
<td>0 0 0 0 1 0 1 0 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N13-3</td>
<td>0 0 0 0 0 0 0 1 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-102</td>
<td>0 0 0 1 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-104</td>
<td>0 0 0 0 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N9-76</td>
<td>0 0 0 0 0 1 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-11</td>
<td>0 0 0 0 0 0 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-74</td>
<td>0 0 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N10-66</td>
<td>0 0 0 0 1 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N13-14</td>
<td>0 0 0 0 0 1 1 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N9-69</td>
<td>1 1 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-9</td>
<td>1 1 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P8-14</td>
<td>1 1 0 0 0 0 0 0 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-------</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>N12-26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>N13-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-102</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-104</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-76</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-74</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N10-66</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N13-14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>N9-69</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-9</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P8-14</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
APPENDIX B: DESIGNATION, SIZE, LOCATION, SPATIAL DISTRIBUTION, AND CHRONOLOGY, OF THE INTER-SITE SETTLEMENT ZONE
Figure B1: Designation of structures in Settlement Zone A

<table>
<thead>
<tr>
<th>Title</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (sq.m)</th>
<th>Ceramics</th>
<th>Ceramics (per sq. m)</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>15.46</td>
<td>8.49</td>
<td>131.26</td>
<td>18</td>
<td>0.14</td>
<td>317003.2</td>
<td>1970311</td>
</tr>
<tr>
<td>A2</td>
<td>12.73</td>
<td>7.5</td>
<td>95.48</td>
<td>15</td>
<td>0.16</td>
<td>317055.3</td>
<td>1970313</td>
</tr>
<tr>
<td>A3</td>
<td>10.32</td>
<td>6.68</td>
<td>68.94</td>
<td>26</td>
<td>0.38</td>
<td>317055.7</td>
<td>1970297</td>
</tr>
<tr>
<td>A4</td>
<td>9.73</td>
<td>6.78</td>
<td>65.97</td>
<td>21</td>
<td>0.32</td>
<td>317075.6</td>
<td>1970288</td>
</tr>
<tr>
<td>A5</td>
<td>8.12</td>
<td>4.49</td>
<td>36.46</td>
<td>12</td>
<td>0.33</td>
<td>317005.9</td>
<td>1970291</td>
</tr>
<tr>
<td>A6</td>
<td>22.15</td>
<td>14.08</td>
<td>311.87</td>
<td>25</td>
<td>0.08</td>
<td>317094.5</td>
<td>1970300</td>
</tr>
<tr>
<td>A7</td>
<td>21.67</td>
<td>7.48</td>
<td>162.09</td>
<td>46</td>
<td>0.28</td>
<td>317075.4</td>
<td>1970328</td>
</tr>
</tbody>
</table>

Table B1: Size and location of structures
Figure B2: a) Late Preclassic, b) Early Classic, c) Late Classic, d) Terminal Classic, e) Early Postclassic
Figure B3: Designation of structures in Settlement Zone B
<table>
<thead>
<tr>
<th>Title</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (sq.m)</th>
<th>Ceramics</th>
<th>Ceramics (per sq. m)</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>38.9</td>
<td>24.2</td>
<td>941.38</td>
<td>66</td>
<td>0.07</td>
<td>318414.8</td>
<td>1969310</td>
</tr>
<tr>
<td>B10</td>
<td>6.64</td>
<td>5.45</td>
<td>36.19</td>
<td>31</td>
<td>0.86</td>
<td>318378.6</td>
<td>1969594</td>
</tr>
<tr>
<td>B11</td>
<td>7.17</td>
<td>6.14</td>
<td>44.02</td>
<td>47</td>
<td>1.07</td>
<td>318314.3</td>
<td>1969549</td>
</tr>
<tr>
<td>B12</td>
<td>5.41</td>
<td>4.59</td>
<td>24.83</td>
<td>43</td>
<td>1.73</td>
<td>318316.3</td>
<td>1969499</td>
</tr>
<tr>
<td>B13</td>
<td>5.17</td>
<td>4.39</td>
<td>22.7</td>
<td>25</td>
<td>1.1</td>
<td>318340.7</td>
<td>1969477</td>
</tr>
<tr>
<td>B14</td>
<td>5.66</td>
<td>4.52</td>
<td>25.58</td>
<td>123</td>
<td>4.81</td>
<td>318310</td>
<td>1969473</td>
</tr>
<tr>
<td>B15</td>
<td>5.07</td>
<td>4.54</td>
<td>23.02</td>
<td>18</td>
<td>0.78</td>
<td>318055.7</td>
<td>1969513</td>
</tr>
<tr>
<td>B16</td>
<td>5.93</td>
<td>4.92</td>
<td>29.18</td>
<td>20</td>
<td>0.69</td>
<td>318070</td>
<td>1969492</td>
</tr>
<tr>
<td>B17</td>
<td>6.67</td>
<td>5.21</td>
<td>34.75</td>
<td>22</td>
<td>0.63</td>
<td>318532</td>
<td>1969405</td>
</tr>
<tr>
<td>B18</td>
<td>4.49</td>
<td>3.39</td>
<td>15.22</td>
<td>21</td>
<td>1.38</td>
<td>318118.3</td>
<td>1969824</td>
</tr>
<tr>
<td>B19</td>
<td>3.61</td>
<td>3.53</td>
<td>12.74</td>
<td>110</td>
<td>8.63</td>
<td>318116.1</td>
<td>1969880</td>
</tr>
<tr>
<td>B2</td>
<td>16.9</td>
<td>7</td>
<td>118.3</td>
<td>72</td>
<td>0.57</td>
<td>318517.2</td>
<td>1969338</td>
</tr>
<tr>
<td>B20</td>
<td>3.87</td>
<td>3.49</td>
<td>13.51</td>
<td>24</td>
<td>1.78</td>
<td>318129.8</td>
<td>1969906</td>
</tr>
<tr>
<td>B21</td>
<td>9.99</td>
<td>6.76</td>
<td>67.53</td>
<td>36</td>
<td>0.53</td>
<td>318149</td>
<td>1969903</td>
</tr>
<tr>
<td>B22</td>
<td>6.76</td>
<td>5.55</td>
<td>37.52</td>
<td>29</td>
<td>0.77</td>
<td>318156.9</td>
<td>1969918</td>
</tr>
<tr>
<td>B23</td>
<td>7.4</td>
<td>5.77</td>
<td>42.7</td>
<td>17</td>
<td>0.4</td>
<td>318197.5</td>
<td>1969933</td>
</tr>
<tr>
<td>B24</td>
<td>8.26</td>
<td>7.51</td>
<td>62.03</td>
<td>44</td>
<td>0.71</td>
<td>318190.3</td>
<td>1969916</td>
</tr>
<tr>
<td>B25</td>
<td>5.33</td>
<td>4.86</td>
<td>25.9</td>
<td>23</td>
<td>0.89</td>
<td>318265.7</td>
<td>1969966</td>
</tr>
<tr>
<td>B26</td>
<td>5.21</td>
<td>3.58</td>
<td>18.65</td>
<td>21</td>
<td>1.13</td>
<td>318231.7</td>
<td>1969976</td>
</tr>
<tr>
<td>B27</td>
<td>5.16</td>
<td>4.46</td>
<td>23.01</td>
<td>41</td>
<td>1.78</td>
<td>318201.7</td>
<td>1969977</td>
</tr>
<tr>
<td>B28</td>
<td>5.82</td>
<td>3.57</td>
<td>20.78</td>
<td>23</td>
<td>1.11</td>
<td>318088.1</td>
<td>1969931</td>
</tr>
<tr>
<td>B29</td>
<td>5.32</td>
<td>3.21</td>
<td>17.08</td>
<td>24</td>
<td>1.41</td>
<td>318059.8</td>
<td>1969895</td>
</tr>
<tr>
<td>B3</td>
<td>10.7</td>
<td>10.1</td>
<td>108.07</td>
<td>39</td>
<td>0.36</td>
<td>318309.9</td>
<td>1969321</td>
</tr>
<tr>
<td>B30</td>
<td>5</td>
<td>4.27</td>
<td>21.35</td>
<td>29</td>
<td>1.36</td>
<td>318070</td>
<td>1969892</td>
</tr>
<tr>
<td>B31</td>
<td>4.21</td>
<td>3.05</td>
<td>12.84</td>
<td>21</td>
<td>1.64</td>
<td>318067.3</td>
<td>1969845</td>
</tr>
<tr>
<td>B32</td>
<td>4.61</td>
<td>3.17</td>
<td>14.61</td>
<td>20</td>
<td>1.37</td>
<td>317785.8</td>
<td>1969790</td>
</tr>
<tr>
<td>B33</td>
<td>4.12</td>
<td>2.97</td>
<td>12.24</td>
<td>45</td>
<td>3.68</td>
<td>317799.9</td>
<td>196806</td>
</tr>
<tr>
<td>B34</td>
<td>5.02</td>
<td>4.12</td>
<td>20.68</td>
<td>51</td>
<td>2.47</td>
<td>317801.9</td>
<td>1969805</td>
</tr>
<tr>
<td>B35</td>
<td>5.32</td>
<td>4.99</td>
<td>26.55</td>
<td>17</td>
<td>0.64</td>
<td>317889.1</td>
<td>1969920</td>
</tr>
<tr>
<td>B36</td>
<td>3.13</td>
<td>2.57</td>
<td>8.04</td>
<td>16</td>
<td>1.99</td>
<td>317925</td>
<td>1969954</td>
</tr>
<tr>
<td>B37</td>
<td>3.66</td>
<td>3.39</td>
<td>12.41</td>
<td>22</td>
<td>1.77</td>
<td>318037.1</td>
<td>1970088</td>
</tr>
<tr>
<td>B38</td>
<td>5.29</td>
<td>3.5</td>
<td>18.52</td>
<td>25</td>
<td>1.35</td>
<td>318068.7</td>
<td>1970133</td>
</tr>
<tr>
<td>B39</td>
<td>6.21</td>
<td>5.72</td>
<td>35.52</td>
<td>16</td>
<td>0.45</td>
<td>318205.7</td>
<td>1969902</td>
</tr>
<tr>
<td>B4</td>
<td>16.5</td>
<td>9.61</td>
<td>158.57</td>
<td>44</td>
<td>0.28</td>
<td>318291.2</td>
<td>1969394</td>
</tr>
<tr>
<td>B40</td>
<td>8.18</td>
<td>7.92</td>
<td>64.79</td>
<td>55</td>
<td>0.85</td>
<td>318064.9</td>
<td>1969940</td>
</tr>
<tr>
<td>B41</td>
<td>4.81</td>
<td>4.27</td>
<td>20.54</td>
<td>7</td>
<td>0.34</td>
<td>318061.8</td>
<td>1969885</td>
</tr>
<tr>
<td>B42</td>
<td>5.45</td>
<td>4.35</td>
<td>23.71</td>
<td>13</td>
<td>0.55</td>
<td>318046.9</td>
<td>1969871</td>
</tr>
<tr>
<td>B43</td>
<td>5.24</td>
<td>4</td>
<td>20.96</td>
<td>59</td>
<td>2.81</td>
<td>318208.3</td>
<td>1969550</td>
</tr>
<tr>
<td>B44</td>
<td>3.3</td>
<td>3.22</td>
<td>10.63</td>
<td>6</td>
<td>0.56</td>
<td>318211.4</td>
<td>1969577</td>
</tr>
<tr>
<td>B45</td>
<td>4.1</td>
<td>2.85</td>
<td>11.69</td>
<td>28</td>
<td>2.4</td>
<td>318224.5</td>
<td>1969567</td>
</tr>
<tr>
<td>B46</td>
<td>4.45</td>
<td>3.49</td>
<td>15.53</td>
<td>5</td>
<td>0.32</td>
<td>318227.7</td>
<td>1969547</td>
</tr>
<tr>
<td>B47</td>
<td>4.41</td>
<td>3.34</td>
<td>14.73</td>
<td>33</td>
<td>2.24</td>
<td>318231.1</td>
<td>1969629</td>
</tr>
<tr>
<td>B48</td>
<td>4.72</td>
<td>4.61</td>
<td>21.76</td>
<td>10</td>
<td>0.46</td>
<td>318293</td>
<td>1969763</td>
</tr>
<tr>
<td>B49</td>
<td>5.72</td>
<td>4.27</td>
<td>24.42</td>
<td>65</td>
<td>2.66</td>
<td>318073.7</td>
<td>1969669</td>
</tr>
<tr>
<td>B5</td>
<td>5.74</td>
<td>4.85</td>
<td>27.84</td>
<td>53</td>
<td>1.9</td>
<td>318303.7</td>
<td>1969436</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>--------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>B50</td>
<td>4.36</td>
<td>3.76</td>
<td>16.39</td>
<td>19</td>
<td>1.16</td>
<td>318165.8</td>
<td>1969707</td>
</tr>
<tr>
<td>B51</td>
<td>5.07</td>
<td>4.66</td>
<td>23.63</td>
<td>6</td>
<td>0.25</td>
<td>318345.5</td>
<td>1969695</td>
</tr>
<tr>
<td>B52</td>
<td>4.19</td>
<td>3.49</td>
<td>14.62</td>
<td>23</td>
<td>0.64</td>
<td>318351.7</td>
<td>1969703</td>
</tr>
<tr>
<td>B53</td>
<td>4.96</td>
<td>3.26</td>
<td>16.17</td>
<td>14</td>
<td>0.87</td>
<td>318358.1</td>
<td>1969696</td>
</tr>
<tr>
<td>B54</td>
<td>6.75</td>
<td>6.14</td>
<td>41.45</td>
<td>60</td>
<td>1.45</td>
<td>318267.3</td>
<td>1969682</td>
</tr>
<tr>
<td>B55</td>
<td>4.58</td>
<td>4.09</td>
<td>18.73</td>
<td>28</td>
<td>1.49</td>
<td>318254.8</td>
<td>1969695</td>
</tr>
<tr>
<td>B56</td>
<td>5.67</td>
<td>4.96</td>
<td>28.12</td>
<td>9</td>
<td>0.32</td>
<td>318242.6</td>
<td>1969685</td>
</tr>
<tr>
<td>B57</td>
<td>7.66</td>
<td>7.15</td>
<td>54.77</td>
<td>9</td>
<td>0.16</td>
<td>318256.8</td>
<td>1969669</td>
</tr>
<tr>
<td>B58</td>
<td>9.73</td>
<td>4.57</td>
<td>44.47</td>
<td>12</td>
<td>0.27</td>
<td>317688.4</td>
<td>1969830</td>
</tr>
<tr>
<td>B59</td>
<td>6.55</td>
<td>4.43</td>
<td>29.02</td>
<td>14</td>
<td>0.48</td>
<td>317760.1</td>
<td>1969937</td>
</tr>
<tr>
<td>B6</td>
<td>8.16</td>
<td>6.26</td>
<td>51.08</td>
<td>78</td>
<td>1.53</td>
<td>318290.6</td>
<td>1969485</td>
</tr>
<tr>
<td>B60</td>
<td>6.03</td>
<td>4.97</td>
<td>29.97</td>
<td>11</td>
<td>0.37</td>
<td>317772.1</td>
<td>1970033</td>
</tr>
<tr>
<td>B7</td>
<td>7.29</td>
<td>5.86</td>
<td>42.72</td>
<td>67</td>
<td>1.57</td>
<td>318522.8</td>
<td>1969536</td>
</tr>
<tr>
<td>B8</td>
<td>6.24</td>
<td>4.91</td>
<td>30.64</td>
<td>69</td>
<td>2.25</td>
<td>318499.4</td>
<td>1969462</td>
</tr>
<tr>
<td>B9</td>
<td>5.69</td>
<td>5.18</td>
<td>29.47</td>
<td>115</td>
<td>3.9</td>
<td>318533.9</td>
<td>1969384</td>
</tr>
</tbody>
</table>

Table B2: Size and location of structures
Figure B4: Late Preclassic occupation at Settlement Zone B
Figure B5: Early Classic occupation at Settlement Zone B
Figure B6: Late Classic occupation at Settlement Zone B
Figure B7: Terminal Period occupation at Settlement Zone B
Figure B8: Early Postclassic occupation at Settlement Zone B
Figure B9: Late Postclassic occupation at Settlement Zone B
Figure B10: Designation of Structures in Settlement Zone C
<table>
<thead>
<tr>
<th>Title</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (sq.m)</th>
<th>Ceramics</th>
<th>Ceramics (per sq. m)</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>11.84</td>
<td>5.29</td>
<td>62.63</td>
<td>13</td>
<td>0.21</td>
<td>320517.4</td>
<td>1967832</td>
</tr>
<tr>
<td>C10</td>
<td>10.46</td>
<td>5.74</td>
<td>60.04</td>
<td>33</td>
<td>0.55</td>
<td>320692.7</td>
<td>1967861</td>
</tr>
<tr>
<td>C11</td>
<td>7.75</td>
<td>7.09</td>
<td>54.95</td>
<td>29</td>
<td>0.53</td>
<td>320710.9</td>
<td>1967864</td>
</tr>
<tr>
<td>C12</td>
<td>5.8</td>
<td>4.45</td>
<td>25.81</td>
<td>15</td>
<td>0.58</td>
<td>320717.4</td>
<td>1967858</td>
</tr>
<tr>
<td>C13</td>
<td>11.13</td>
<td>7.03</td>
<td>78.24</td>
<td>17</td>
<td>0.22</td>
<td>320720.8</td>
<td>1967844</td>
</tr>
<tr>
<td>C14</td>
<td>14.41</td>
<td>5.1</td>
<td>73.49</td>
<td>42</td>
<td>0.57</td>
<td>320701.4</td>
<td>1967840</td>
</tr>
<tr>
<td>C15</td>
<td>4.6</td>
<td>3.69</td>
<td>16.97</td>
<td>10</td>
<td>0.59</td>
<td>320680.5</td>
<td>1967993</td>
</tr>
<tr>
<td>C16</td>
<td>6.14</td>
<td>4.7</td>
<td>28.86</td>
<td>9</td>
<td>0.31</td>
<td>320685.8</td>
<td>1968003</td>
</tr>
<tr>
<td>C17</td>
<td>6.13</td>
<td>3.81</td>
<td>23.26</td>
<td>12</td>
<td>0.52</td>
<td>320636.9</td>
<td>1968007</td>
</tr>
<tr>
<td>C18</td>
<td>5.62</td>
<td>3.8</td>
<td>21.36</td>
<td>8</td>
<td>0.37</td>
<td>320634.4</td>
<td>1967997</td>
</tr>
<tr>
<td>C19</td>
<td>4.63</td>
<td>4.38</td>
<td>20.28</td>
<td>13</td>
<td>0.64</td>
<td>320606.2</td>
<td>1968019</td>
</tr>
<tr>
<td>C2</td>
<td>9.37</td>
<td>5.8</td>
<td>54.35</td>
<td>14</td>
<td>0.26</td>
<td>320531</td>
<td>1967905</td>
</tr>
<tr>
<td>C20</td>
<td>5.66</td>
<td>5.19</td>
<td>29.38</td>
<td>18</td>
<td>0.61</td>
<td>320497.6</td>
<td>1968063</td>
</tr>
<tr>
<td>C21</td>
<td>5.32</td>
<td>4.22</td>
<td>22.45</td>
<td>17</td>
<td>0.76</td>
<td>320506.2</td>
<td>1968074</td>
</tr>
<tr>
<td>C3</td>
<td>6.02</td>
<td>5.28</td>
<td>31.79</td>
<td>17</td>
<td>0.53</td>
<td>320523.5</td>
<td>1967920</td>
</tr>
<tr>
<td>C4</td>
<td>8.78</td>
<td>4.71</td>
<td>41.35</td>
<td>12</td>
<td>0.29</td>
<td>320540.3</td>
<td>1967961</td>
</tr>
<tr>
<td>C5</td>
<td>4.77</td>
<td>3.36</td>
<td>16.03</td>
<td>13</td>
<td>0.81</td>
<td>320546.7</td>
<td>1967968</td>
</tr>
<tr>
<td>C6</td>
<td>5.04</td>
<td>4.01</td>
<td>20.21</td>
<td>4</td>
<td>0.2</td>
<td>320604.4</td>
<td>1967940</td>
</tr>
<tr>
<td>C7</td>
<td>5.52</td>
<td>4.17</td>
<td>23.02</td>
<td>6</td>
<td>0.26</td>
<td>320609.7</td>
<td>1967933</td>
</tr>
<tr>
<td>C8</td>
<td>4.83</td>
<td>3.17</td>
<td>15.31</td>
<td>8</td>
<td>0.52</td>
<td>320622</td>
<td>1967934</td>
</tr>
<tr>
<td>C9</td>
<td>5.15</td>
<td>3.79</td>
<td>19.52</td>
<td>17</td>
<td>0.87</td>
<td>320610</td>
<td>1967946</td>
</tr>
</tbody>
</table>

**Table B3: Size and location of structures**
Figure B11: a) Late Preclassic, b) Early Classic, c) Late Classic, d) Terminal Classic, e) Early Postclassic
**Figure B12: Designation of structures in Settlement Zone D**

<table>
<thead>
<tr>
<th>Title</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (sq.m)</th>
<th>Ceramics</th>
<th>Ceramics (per sq. m)</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>12.54</td>
<td>9.95</td>
<td>124.77</td>
<td>22</td>
<td>0.18</td>
<td>32059.2</td>
<td>1966556</td>
</tr>
<tr>
<td>D10</td>
<td>13.68</td>
<td>8.36</td>
<td>114.37</td>
<td>16</td>
<td>0.14</td>
<td>32068.7</td>
<td>1966696</td>
</tr>
<tr>
<td>D11</td>
<td>6.76</td>
<td>5.1</td>
<td>34.48</td>
<td>18</td>
<td>0.52</td>
<td>32069.3</td>
<td>1966685</td>
</tr>
<tr>
<td>D12</td>
<td>11.02</td>
<td>6.77</td>
<td>74.61</td>
<td>17</td>
<td>0.23</td>
<td>32069.4</td>
<td>1966676</td>
</tr>
<tr>
<td>D13</td>
<td>8.16</td>
<td>5.01</td>
<td>40.88</td>
<td>13</td>
<td>0.32</td>
<td>32056.9</td>
<td>1966639</td>
</tr>
<tr>
<td>D14</td>
<td>12.08</td>
<td>7.62</td>
<td>92.05</td>
<td>8</td>
<td>0.09</td>
<td>32056.5</td>
<td>1966647</td>
</tr>
<tr>
<td>D15</td>
<td>6.75</td>
<td>6.13</td>
<td>41.38</td>
<td>21</td>
<td>0.51</td>
<td>32055.7</td>
<td>1966641</td>
</tr>
<tr>
<td>D16</td>
<td>7.33</td>
<td>6.38</td>
<td>46.77</td>
<td>15</td>
<td>0.32</td>
<td>32060.0</td>
<td>1966618</td>
</tr>
<tr>
<td>D17</td>
<td>9.24</td>
<td>5.94</td>
<td>54.89</td>
<td>37</td>
<td>0.67</td>
<td>32060.7</td>
<td>1966723</td>
</tr>
<tr>
<td>D18</td>
<td>8.02</td>
<td>3.71</td>
<td>29.75</td>
<td>15</td>
<td>0.5</td>
<td>32066.7</td>
<td>1966763</td>
</tr>
<tr>
<td>D19</td>
<td>8.38</td>
<td>4.22</td>
<td>35.36</td>
<td>19</td>
<td>0.54</td>
<td>32067.2</td>
<td>1966770</td>
</tr>
<tr>
<td>D2</td>
<td>15.39</td>
<td>8.91</td>
<td>137.13</td>
<td>25</td>
<td>0.18</td>
<td>32064.5</td>
<td>1966564</td>
</tr>
<tr>
<td>D20</td>
<td>9.28</td>
<td>8.73</td>
<td>81.01</td>
<td>18</td>
<td>0.22</td>
<td>32071.4</td>
<td>1966743</td>
</tr>
<tr>
<td>D21</td>
<td>8.18</td>
<td>5.88</td>
<td>48.1</td>
<td>5</td>
<td>0.1</td>
<td>32071.4</td>
<td>1966722</td>
</tr>
<tr>
<td>D22</td>
<td>8.61</td>
<td>7.05</td>
<td>60.7</td>
<td>22</td>
<td>0.36</td>
<td>32072.9</td>
<td>1966726</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>D23</td>
<td>6.12</td>
<td>4.72</td>
<td>28.89</td>
<td>38</td>
<td>1.32</td>
<td>320729.6</td>
<td></td>
</tr>
<tr>
<td>D24</td>
<td>9.71</td>
<td>6.42</td>
<td>62.34</td>
<td>121</td>
<td>1.94</td>
<td>320711.3</td>
<td></td>
</tr>
<tr>
<td>D25</td>
<td>8.85</td>
<td>5.44</td>
<td>48.14</td>
<td>36</td>
<td>0.75</td>
<td>320723</td>
<td></td>
</tr>
<tr>
<td>D26</td>
<td>9.04</td>
<td>4.55</td>
<td>41.13</td>
<td>13</td>
<td>0.32</td>
<td>320726.3</td>
<td></td>
</tr>
<tr>
<td>D27</td>
<td>9.75</td>
<td>6.09</td>
<td>59.38</td>
<td>51</td>
<td>0.86</td>
<td>320718.5</td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>17.19</td>
<td>10.96</td>
<td>188.4</td>
<td>144</td>
<td>0.76</td>
<td>320792.3</td>
<td></td>
</tr>
<tr>
<td>D29</td>
<td>19.99</td>
<td>7.33</td>
<td>146.53</td>
<td>113</td>
<td>0.77</td>
<td>320796.8</td>
<td></td>
</tr>
<tr>
<td>D30</td>
<td>13.53</td>
<td>8.10</td>
<td>108.24</td>
<td>24</td>
<td>0.22</td>
<td>320658.5</td>
<td></td>
</tr>
<tr>
<td>D31</td>
<td>9.79</td>
<td>6.42</td>
<td>59.92</td>
<td>20</td>
<td>0.33</td>
<td>320713.5</td>
<td></td>
</tr>
<tr>
<td>D32</td>
<td>7.24</td>
<td>4.43</td>
<td>32.07</td>
<td>29</td>
<td>0.9</td>
<td>320722.8</td>
<td></td>
</tr>
<tr>
<td>D33</td>
<td>12.44</td>
<td>12.65</td>
<td>157.37</td>
<td>76</td>
<td>0.48</td>
<td>320770.2</td>
<td></td>
</tr>
<tr>
<td>D34</td>
<td>12.98</td>
<td>12.45</td>
<td>161.6</td>
<td>141</td>
<td>0.87</td>
<td>320775</td>
<td></td>
</tr>
<tr>
<td>D35</td>
<td>7.45</td>
<td>4.61</td>
<td>34.35</td>
<td>37</td>
<td>1.08</td>
<td>320916.6</td>
<td></td>
</tr>
<tr>
<td>D36</td>
<td>15.51</td>
<td>6.02</td>
<td>93.37</td>
<td>133</td>
<td>1.42</td>
<td>320863</td>
<td></td>
</tr>
<tr>
<td>D37</td>
<td>24.6</td>
<td>15.16</td>
<td>372.94</td>
<td>92</td>
<td>0.25</td>
<td>320934.2</td>
<td></td>
</tr>
<tr>
<td>D38</td>
<td>10.59</td>
<td>5.6</td>
<td>59.3</td>
<td>64</td>
<td>1.08</td>
<td>320946.3</td>
<td></td>
</tr>
<tr>
<td>D39</td>
<td>10.79</td>
<td>6.57</td>
<td>70.89</td>
<td>43</td>
<td>0.61</td>
<td>320946.2</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>10.42</td>
<td>8.38</td>
<td>87.32</td>
<td>47</td>
<td>0.54</td>
<td>320673.7</td>
<td></td>
</tr>
<tr>
<td>D40</td>
<td>14.66</td>
<td>8.18</td>
<td>119.92</td>
<td>98</td>
<td>0.82</td>
<td>321024.5</td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>18.69</td>
<td>11.7</td>
<td>218.67</td>
<td>128</td>
<td>0.59</td>
<td>321036.4</td>
<td></td>
</tr>
<tr>
<td>D42</td>
<td>11.12</td>
<td>9.37</td>
<td>104.19</td>
<td>50</td>
<td>0.48</td>
<td>321050.3</td>
<td></td>
</tr>
<tr>
<td>D43</td>
<td>10.2</td>
<td>6.29</td>
<td>64.16</td>
<td>44</td>
<td>0.69</td>
<td>321037.9</td>
<td></td>
</tr>
<tr>
<td>D44</td>
<td>14.95</td>
<td>14.76</td>
<td>220.66</td>
<td>45</td>
<td>0.2</td>
<td>321044.5</td>
<td></td>
</tr>
<tr>
<td>D45</td>
<td>7.99</td>
<td>5.97</td>
<td>47.7</td>
<td>17</td>
<td>0.36</td>
<td>321132.3</td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>8.35</td>
<td>6.07</td>
<td>50.69</td>
<td>16</td>
<td>0.32</td>
<td>320625.4</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>12.83</td>
<td>8.49</td>
<td>108.93</td>
<td>54</td>
<td>0.5</td>
<td>320681.5</td>
<td></td>
</tr>
<tr>
<td>D7</td>
<td>14.34</td>
<td>9.19</td>
<td>131.79</td>
<td>27</td>
<td>0.2</td>
<td>320703.7</td>
<td></td>
</tr>
<tr>
<td>D8</td>
<td>9.16</td>
<td>6.54</td>
<td>59.91</td>
<td>25</td>
<td>0.42</td>
<td>320725.6</td>
<td></td>
</tr>
<tr>
<td>D9</td>
<td>9.34</td>
<td>6.79</td>
<td>63.42</td>
<td>11</td>
<td>0.17</td>
<td>320678.9</td>
<td></td>
</tr>
</tbody>
</table>

Table B4: Size and location of structures
Figure B13: a) Late Preclassic, b) Early Classic, c) Late Classic, d) Terminal Classic
Figure B14: a) Early Postclassic, b) Late Postclassic, c) Colonial
Figure B15: Designation of structures in Settlement Zone E
<table>
<thead>
<tr>
<th>Title</th>
<th>Length(m)</th>
<th>Width (m)</th>
<th>Area (sq.m)</th>
<th>Ceramics</th>
<th>Ceramics (per sq. m)</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>11.16</td>
<td>5.35</td>
<td>59.71</td>
<td>6</td>
<td>0.1</td>
<td>320466.9</td>
<td>1966511</td>
</tr>
<tr>
<td>E10</td>
<td>10.94</td>
<td>9.18</td>
<td>100.43</td>
<td>19</td>
<td>0.19</td>
<td>320924.3</td>
<td>1966244</td>
</tr>
<tr>
<td>E11</td>
<td>13.26</td>
<td>7.82</td>
<td>103.69</td>
<td>12</td>
<td>0.12</td>
<td>320889.4</td>
<td>1966198</td>
</tr>
<tr>
<td>E12</td>
<td>10.23</td>
<td>9.18</td>
<td>93.91</td>
<td>5</td>
<td>0.05</td>
<td>320461.2</td>
<td>1966539</td>
</tr>
<tr>
<td>E13</td>
<td>10.66</td>
<td>9.18</td>
<td>97.86</td>
<td>4</td>
<td>0.04</td>
<td>320460.3</td>
<td>1966490</td>
</tr>
<tr>
<td>E14</td>
<td>10.43</td>
<td>8.23</td>
<td>85.84</td>
<td>15</td>
<td>0.17</td>
<td>320460.3</td>
<td>1966440</td>
</tr>
<tr>
<td>E15</td>
<td>8.13</td>
<td>6.52</td>
<td>53.01</td>
<td>0</td>
<td>0</td>
<td>320472.1</td>
<td>1966086</td>
</tr>
<tr>
<td>E16</td>
<td>10.63</td>
<td>6.21</td>
<td>66.01</td>
<td>11</td>
<td>0.17</td>
<td>320477.6</td>
<td>1966094</td>
</tr>
<tr>
<td>E17</td>
<td>8.23</td>
<td>5.36</td>
<td>44.11</td>
<td>6</td>
<td>0.14</td>
<td>320521.2</td>
<td>1966087</td>
</tr>
<tr>
<td>E18</td>
<td>8.96</td>
<td>6.89</td>
<td>61.73</td>
<td>10</td>
<td>0.16</td>
<td>320643.8</td>
<td>1966200</td>
</tr>
<tr>
<td>E19</td>
<td>8.81</td>
<td>5.36</td>
<td>47.22</td>
<td>2</td>
<td>0.04</td>
<td>320652</td>
<td>1966190</td>
</tr>
<tr>
<td>E2</td>
<td>7.68</td>
<td>6.56</td>
<td>50.38</td>
<td>15</td>
<td>0.3</td>
<td>320469.9</td>
<td>1966406</td>
</tr>
<tr>
<td>E20</td>
<td>7.87</td>
<td>6.5</td>
<td>51.16</td>
<td>2</td>
<td>0.04</td>
<td>320662</td>
<td>1966199</td>
</tr>
<tr>
<td>E21</td>
<td>7.56</td>
<td>5.39</td>
<td>40.75</td>
<td>11</td>
<td>0.27</td>
<td>320654.7</td>
<td>1966211</td>
</tr>
<tr>
<td>E22</td>
<td>10.21</td>
<td>7.52</td>
<td>76.78</td>
<td>27</td>
<td>0.35</td>
<td>320709.2</td>
<td>1966400</td>
</tr>
<tr>
<td>E23</td>
<td>8.75</td>
<td>8.28</td>
<td>72.45</td>
<td>102</td>
<td>1.41</td>
<td>320698.3</td>
<td>1966394</td>
</tr>
<tr>
<td>E24</td>
<td>24.24</td>
<td>11.87</td>
<td>287.73</td>
<td>184</td>
<td>6.4</td>
<td>320682.9</td>
<td>1966401</td>
</tr>
<tr>
<td>E25</td>
<td>5.6</td>
<td>5.51</td>
<td>30.86</td>
<td>18</td>
<td>0.58</td>
<td>320683.8</td>
<td>1966418</td>
</tr>
<tr>
<td>E26</td>
<td>10.94</td>
<td>8.07</td>
<td>88.29</td>
<td>15</td>
<td>0.17</td>
<td>320919.1</td>
<td>1966105</td>
</tr>
<tr>
<td>E27</td>
<td>12.85</td>
<td>8.38</td>
<td>107.68</td>
<td>26</td>
<td>0.24</td>
<td>320592</td>
<td>1966455</td>
</tr>
<tr>
<td>E28</td>
<td>11.79</td>
<td>7.44</td>
<td>87.72</td>
<td>8</td>
<td>0.09</td>
<td>320607.5</td>
<td>1965996</td>
</tr>
<tr>
<td>E29</td>
<td>10</td>
<td>7.44</td>
<td>74.4</td>
<td>3</td>
<td>0.04</td>
<td>320604.8</td>
<td>1966005</td>
</tr>
<tr>
<td>E30</td>
<td>8.01</td>
<td>4.59</td>
<td>36.77</td>
<td>6</td>
<td>0.16</td>
<td>320485.5</td>
<td>1966402</td>
</tr>
<tr>
<td>E31</td>
<td>12.23</td>
<td>10.1</td>
<td>123.52</td>
<td>5</td>
<td>0.04</td>
<td>320641.1</td>
<td>1966001</td>
</tr>
<tr>
<td>E32</td>
<td>7.28</td>
<td>6.37</td>
<td>46.37</td>
<td>12</td>
<td>0.26</td>
<td>320781.9</td>
<td>1965995</td>
</tr>
<tr>
<td>E33</td>
<td>9.65</td>
<td>6.14</td>
<td>59.25</td>
<td>5</td>
<td>0.08</td>
<td>320761</td>
<td>1966000</td>
</tr>
<tr>
<td>E34</td>
<td>8.51</td>
<td>5.1</td>
<td>43.4</td>
<td>4</td>
<td>0.09</td>
<td>320779.2</td>
<td>1966013</td>
</tr>
<tr>
<td>E4</td>
<td>8.29</td>
<td>7.7</td>
<td>63.83</td>
<td>5</td>
<td>0.08</td>
<td>320529.4</td>
<td>1966338</td>
</tr>
<tr>
<td>E5</td>
<td>11.97</td>
<td>11.62</td>
<td>139.09</td>
<td>19</td>
<td>0.14</td>
<td>320516.3</td>
<td>1966394</td>
</tr>
<tr>
<td>E6</td>
<td>10.97</td>
<td>8.17</td>
<td>89.63</td>
<td>16</td>
<td>0.18</td>
<td>320526.4</td>
<td>1966402</td>
</tr>
<tr>
<td>E7</td>
<td>11.87</td>
<td>6.07</td>
<td>72.05</td>
<td>8</td>
<td>0.11</td>
<td>320528.9</td>
<td>1966451</td>
</tr>
<tr>
<td>E8</td>
<td>9.89</td>
<td>7.19</td>
<td>71.11</td>
<td>21</td>
<td>0.3</td>
<td>320522.6</td>
<td>1966498</td>
</tr>
<tr>
<td>E9</td>
<td>8.54</td>
<td>6.53</td>
<td>55.77</td>
<td>7</td>
<td>0.13</td>
<td>320502.2</td>
<td>1966515</td>
</tr>
</tbody>
</table>

Table B5: Size and location of structures
Figure B16: a) Late Preclassic, b) Early Classic, c) Late Classic, d) Terminal Classic, e) Early Postclassic, f) Colonial
Figure B17: Designation of structures in Settlement Zone F

<table>
<thead>
<tr>
<th>Title</th>
<th>Length (m)</th>
<th>Width (m)</th>
<th>Area (sq. m)</th>
<th>Ceramics</th>
<th>Ceramics (per sq. m)</th>
<th>Easting</th>
<th>Northing</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>5.22</td>
<td>3.73</td>
<td>19.47</td>
<td>18</td>
<td>0.92</td>
<td>321606</td>
<td>1966065</td>
</tr>
<tr>
<td>F10</td>
<td>5.74</td>
<td>3.51</td>
<td>31.34</td>
<td>6</td>
<td>0.19</td>
<td>321610.2</td>
<td>1965928</td>
</tr>
<tr>
<td>F11</td>
<td>7.7</td>
<td>4.36</td>
<td>33.57</td>
<td>43</td>
<td>1.28</td>
<td>321595.4</td>
<td>1965930</td>
</tr>
<tr>
<td>F12</td>
<td>9.09</td>
<td>5.74</td>
<td>52.18</td>
<td>26</td>
<td>0.5</td>
<td>321713</td>
<td>1966004</td>
</tr>
<tr>
<td>F13</td>
<td>10.45</td>
<td>6.97</td>
<td>72.84</td>
<td>34</td>
<td>0.47</td>
<td>321720.2</td>
<td>1966010</td>
</tr>
<tr>
<td>F14</td>
<td>9.32</td>
<td>4.34</td>
<td>40.45</td>
<td>32</td>
<td>0.79</td>
<td>321723.2</td>
<td>1965990</td>
</tr>
<tr>
<td>F15</td>
<td>10.24</td>
<td>5.95</td>
<td>60.93</td>
<td>63</td>
<td>1.03</td>
<td>321751.5</td>
<td>1966066</td>
</tr>
<tr>
<td>F16</td>
<td>9.24</td>
<td>5.79</td>
<td>53.5</td>
<td>19</td>
<td>0.36</td>
<td>321800.2</td>
<td>1966080</td>
</tr>
<tr>
<td>F17</td>
<td>8.78</td>
<td>4.29</td>
<td>37.25</td>
<td>24</td>
<td>0.64</td>
<td>321795.9</td>
<td>1966024</td>
</tr>
<tr>
<td>F18</td>
<td>8.09</td>
<td>7.56</td>
<td>61.16</td>
<td>33</td>
<td>0.54</td>
<td>321756.7</td>
<td>1965874</td>
</tr>
<tr>
<td>F19</td>
<td>12.11</td>
<td>7.2</td>
<td>87.19</td>
<td>31</td>
<td>0.36</td>
<td>321884.9</td>
<td>1966045</td>
</tr>
<tr>
<td>F2</td>
<td>4.61</td>
<td>3.51</td>
<td>16.18</td>
<td>19</td>
<td>1.17</td>
<td>321606.4</td>
<td>1966072</td>
</tr>
<tr>
<td>F20</td>
<td>4.35</td>
<td>2.84</td>
<td>12.35</td>
<td>13</td>
<td>1.05</td>
<td>321893.4</td>
<td>1966044</td>
</tr>
<tr>
<td>F21</td>
<td>3.46</td>
<td>2.45</td>
<td>8.48</td>
<td>11</td>
<td>1.3</td>
<td>321898.4</td>
<td>1966045</td>
</tr>
<tr>
<td>F22</td>
<td>3.79</td>
<td>2.52</td>
<td>9.55</td>
<td>3</td>
<td>0.31</td>
<td>321902.5</td>
<td>1966049</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F23</td>
<td>4.59</td>
<td>3.22</td>
<td>14.78</td>
<td>10</td>
<td>0.68</td>
<td>321898.1</td>
<td>1966055</td>
</tr>
<tr>
<td>F24</td>
<td>6.24</td>
<td>4.44</td>
<td>27.71</td>
<td>6</td>
<td>0.22</td>
<td>321909.7</td>
<td>1966036</td>
</tr>
<tr>
<td>F25</td>
<td>9.55</td>
<td>6.9</td>
<td>65.9</td>
<td>26</td>
<td>0.39</td>
<td>321851.7</td>
<td>1965860</td>
</tr>
<tr>
<td>F26</td>
<td>10.79</td>
<td>7.6</td>
<td>82</td>
<td>21</td>
<td>0.26</td>
<td>321862.5</td>
<td>1965866</td>
</tr>
<tr>
<td>F27</td>
<td>11.16</td>
<td>7.58</td>
<td>84.59</td>
<td>59</td>
<td>0.7</td>
<td>321877.7</td>
<td>1965854</td>
</tr>
<tr>
<td>F28</td>
<td>9.58</td>
<td>5.94</td>
<td>56.91</td>
<td>23</td>
<td>0.4</td>
<td>321891.2</td>
<td>1965842</td>
</tr>
<tr>
<td>F29</td>
<td>7</td>
<td>4.58</td>
<td>32.06</td>
<td>19</td>
<td>0.59</td>
<td>321880.8</td>
<td>1965919</td>
</tr>
<tr>
<td>F3</td>
<td>7.41</td>
<td>5.3</td>
<td>39.27</td>
<td>19</td>
<td>0.48</td>
<td>321611.6</td>
<td>1966075</td>
</tr>
<tr>
<td>F30</td>
<td>6.8</td>
<td>3.77</td>
<td>25.64</td>
<td>16</td>
<td>0.62</td>
<td>321877.1</td>
<td>1965916</td>
</tr>
<tr>
<td>F31</td>
<td>5.68</td>
<td>3.43</td>
<td>19.48</td>
<td>24</td>
<td>1.23</td>
<td>321991.9</td>
<td>1966053</td>
</tr>
<tr>
<td>F32</td>
<td>6.93</td>
<td>5.18</td>
<td>35.9</td>
<td>2</td>
<td>0.06</td>
<td>321973</td>
<td>1965965</td>
</tr>
<tr>
<td>F33</td>
<td>10.9</td>
<td>7.99</td>
<td>87.09</td>
<td>12</td>
<td>0.14</td>
<td>321862.5</td>
<td>1965746</td>
</tr>
<tr>
<td>F34</td>
<td>11.25</td>
<td>6.07</td>
<td>68.29</td>
<td>45</td>
<td>0.66</td>
<td>321875.5</td>
<td>1965742</td>
</tr>
<tr>
<td>F35</td>
<td>16.75</td>
<td>7.93</td>
<td>132.83</td>
<td>12</td>
<td>0.09</td>
<td>321867.3</td>
<td>1965762</td>
</tr>
<tr>
<td>F36</td>
<td>8.74</td>
<td>5.8</td>
<td>50.69</td>
<td>16</td>
<td>0.32</td>
<td>321971</td>
<td>1965933</td>
</tr>
<tr>
<td>F37</td>
<td>8.6</td>
<td>6.18</td>
<td>53.15</td>
<td>19</td>
<td>0.36</td>
<td>322173.4</td>
<td>1966193</td>
</tr>
<tr>
<td>F38</td>
<td>8.97</td>
<td>5.92</td>
<td>53.1</td>
<td>9</td>
<td>0.17</td>
<td>322253.4</td>
<td>1966333</td>
</tr>
<tr>
<td>F39</td>
<td>8.53</td>
<td>6.54</td>
<td>55.79</td>
<td>17</td>
<td>0.3</td>
<td>322134.7</td>
<td>1966063</td>
</tr>
<tr>
<td>F4</td>
<td>7.96</td>
<td>5.58</td>
<td>44.42</td>
<td>14</td>
<td>0.32</td>
<td>321619</td>
<td>1966064</td>
</tr>
<tr>
<td>F40</td>
<td>11.47</td>
<td>5.34</td>
<td>61.25</td>
<td>19</td>
<td>0.31</td>
<td>322043.7</td>
<td>1965979</td>
</tr>
<tr>
<td>F41</td>
<td>10.75</td>
<td>6.6</td>
<td>70.95</td>
<td>26</td>
<td>0.37</td>
<td>322053.9</td>
<td>1965972</td>
</tr>
<tr>
<td>F42</td>
<td>8.04</td>
<td>7.62</td>
<td>61.26</td>
<td>9</td>
<td>0.15</td>
<td>322044.9</td>
<td>1965964</td>
</tr>
<tr>
<td>F43</td>
<td>11.85</td>
<td>8.79</td>
<td>104.16</td>
<td>28</td>
<td>0.27</td>
<td>322034.1</td>
<td>1965963</td>
</tr>
<tr>
<td>F44</td>
<td>7.68</td>
<td>4.96</td>
<td>38.09</td>
<td>23</td>
<td>0.6</td>
<td>321958.3</td>
<td>1965839</td>
</tr>
<tr>
<td>F45</td>
<td>6.08</td>
<td>3.79</td>
<td>23.04</td>
<td>24</td>
<td>1.04</td>
<td>321844</td>
<td>1965648</td>
</tr>
<tr>
<td>F46</td>
<td>6.93</td>
<td>4.81</td>
<td>33.33</td>
<td>17</td>
<td>0.51</td>
<td>321853.6</td>
<td>1965642</td>
</tr>
<tr>
<td>F47</td>
<td>6.27</td>
<td>3.78</td>
<td>23.7</td>
<td>18</td>
<td>0.76</td>
<td>321839.3</td>
<td>1965642</td>
</tr>
<tr>
<td>F48</td>
<td>6.5</td>
<td>3.58</td>
<td>23.27</td>
<td>8</td>
<td>0.34</td>
<td>321935.7</td>
<td>1965574</td>
</tr>
<tr>
<td>F49</td>
<td>10.91</td>
<td>5.5</td>
<td>60.01</td>
<td>74</td>
<td>1.23</td>
<td>321955.6</td>
<td>1965640</td>
</tr>
<tr>
<td>F5</td>
<td>7.82</td>
<td>5.1</td>
<td>39.88</td>
<td>53</td>
<td>1.33</td>
<td>321580.9</td>
<td>1965965</td>
</tr>
<tr>
<td>F50</td>
<td>8.53</td>
<td>4.91</td>
<td>41.88</td>
<td>56</td>
<td>1.34</td>
<td>321948.7</td>
<td>1965650</td>
</tr>
<tr>
<td>F51</td>
<td>10.75</td>
<td>5.67</td>
<td>60.95</td>
<td>47</td>
<td>0.77</td>
<td>321960.1</td>
<td>1965654</td>
</tr>
<tr>
<td>F52</td>
<td>8.6</td>
<td>5.72</td>
<td>49.19</td>
<td>19</td>
<td>0.39</td>
<td>321986.6</td>
<td>1965559</td>
</tr>
<tr>
<td>F53</td>
<td>12.35</td>
<td>8.04</td>
<td>99.29</td>
<td>33</td>
<td>0.33</td>
<td>322014.6</td>
<td>1965543</td>
</tr>
<tr>
<td>F54</td>
<td>6.8</td>
<td>5.72</td>
<td>38.9</td>
<td>61</td>
<td>1.57</td>
<td>322022</td>
<td>1965649</td>
</tr>
<tr>
<td>F55</td>
<td>5.86</td>
<td>5.24</td>
<td>30.71</td>
<td>16</td>
<td>0.52</td>
<td>322036.5</td>
<td>1965645</td>
</tr>
<tr>
<td>F56</td>
<td>9.23</td>
<td>5.81</td>
<td>53.63</td>
<td>31</td>
<td>0.58</td>
<td>322042.2</td>
<td>1965707</td>
</tr>
<tr>
<td>F57</td>
<td>9.54</td>
<td>5.66</td>
<td>54</td>
<td>37</td>
<td>0.69</td>
<td>322052.2</td>
<td>1965703</td>
</tr>
<tr>
<td>F58</td>
<td>7.54</td>
<td>5.51</td>
<td>41.55</td>
<td>24</td>
<td>0.58</td>
<td>322002.6</td>
<td>1965729</td>
</tr>
<tr>
<td>F59</td>
<td>9.11</td>
<td>6.36</td>
<td>57.94</td>
<td>21</td>
<td>0.36</td>
<td>322010.4</td>
<td>1965741</td>
</tr>
<tr>
<td>F6</td>
<td>11.79</td>
<td>8.41</td>
<td>99.15</td>
<td>85</td>
<td>0.86</td>
<td>321563.1</td>
<td>1965910</td>
</tr>
<tr>
<td>F60</td>
<td>11.81</td>
<td>9.82</td>
<td>115.97</td>
<td>20</td>
<td>0.17</td>
<td>321999.5</td>
<td>1965780</td>
</tr>
<tr>
<td>F61</td>
<td>9.91</td>
<td>6.09</td>
<td>60.35</td>
<td>67</td>
<td>1.11</td>
<td>322008.9</td>
<td>1965786</td>
</tr>
<tr>
<td>F62</td>
<td>9.07</td>
<td>7.15</td>
<td>64.85</td>
<td>54</td>
<td>0.83</td>
<td>322017.2</td>
<td>1965778</td>
</tr>
<tr>
<td>F63</td>
<td>8.29</td>
<td>6.14</td>
<td>50.9</td>
<td>12</td>
<td>0.24</td>
<td>322008.1</td>
<td>1965772</td>
</tr>
<tr>
<td>F64</td>
<td>6.54</td>
<td>4.41</td>
<td>28.84</td>
<td>12</td>
<td>0.42</td>
<td>322110.1</td>
<td>1965849</td>
</tr>
<tr>
<td>F65</td>
<td>7.44</td>
<td>5.07</td>
<td>37.72</td>
<td>11</td>
<td>0.29</td>
<td>322103</td>
<td>1965888</td>
</tr>
<tr>
<td>F66</td>
<td>8.04</td>
<td>4.87</td>
<td>39.16</td>
<td>15</td>
<td>0.38</td>
<td>322121.1</td>
<td>1965859</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F67</td>
<td>9.68</td>
<td>7.67</td>
<td>74.25</td>
<td>16</td>
<td>0.22</td>
<td>322137.2</td>
<td>1965807</td>
</tr>
<tr>
<td>F68</td>
<td>21.9</td>
<td>16.95</td>
<td>371.21</td>
<td>25</td>
<td>0.07</td>
<td>322123.6</td>
<td>1965828</td>
</tr>
<tr>
<td>F69</td>
<td>11.74</td>
<td>7.03</td>
<td>82.53</td>
<td>41</td>
<td>0.5</td>
<td>322156.4</td>
<td>1965972</td>
</tr>
<tr>
<td>F7</td>
<td>8.02</td>
<td>6.45</td>
<td>51.73</td>
<td>50</td>
<td>0.97</td>
<td>321693.4</td>
<td>1966032</td>
</tr>
<tr>
<td>F70</td>
<td>12.06</td>
<td>8.25</td>
<td>99.5</td>
<td>6</td>
<td>0.06</td>
<td>322180.6</td>
<td>1965811</td>
</tr>
<tr>
<td>F71</td>
<td>9.92</td>
<td>6.11</td>
<td>60.61</td>
<td>18</td>
<td>0.3</td>
<td>322111.7</td>
<td>1965753</td>
</tr>
<tr>
<td>F72</td>
<td>10.43</td>
<td>7</td>
<td>73.01</td>
<td>44</td>
<td>0.6</td>
<td>322087.9</td>
<td>1965737</td>
</tr>
<tr>
<td>F73</td>
<td>8.98</td>
<td>5.98</td>
<td>53.7</td>
<td>12</td>
<td>0.22</td>
<td>322062.9</td>
<td>1965617</td>
</tr>
<tr>
<td>F74</td>
<td>12.1</td>
<td>6.43</td>
<td>77.8</td>
<td>33</td>
<td>0.42</td>
<td>322071.7</td>
<td>1965623</td>
</tr>
<tr>
<td>F75</td>
<td>7.78</td>
<td>4.65</td>
<td>36.18</td>
<td>18</td>
<td>0.5</td>
<td>322072.7</td>
<td>1965612</td>
</tr>
<tr>
<td>F76</td>
<td>9.81</td>
<td>4.98</td>
<td>48.85</td>
<td>17</td>
<td>0.35</td>
<td>322105.4</td>
<td>1965616</td>
</tr>
<tr>
<td>F77</td>
<td>24.67</td>
<td>24.41</td>
<td>602.2</td>
<td>17</td>
<td>0.03</td>
<td>322122.7</td>
<td>1965642</td>
</tr>
<tr>
<td>F78</td>
<td>9.58</td>
<td>5.5</td>
<td>52.69</td>
<td>8</td>
<td>0.15</td>
<td>322159.8</td>
<td>1965650</td>
</tr>
<tr>
<td>F79</td>
<td>8.49</td>
<td>5.25</td>
<td>44.57</td>
<td>14</td>
<td>0.31</td>
<td>322170.1</td>
<td>1965645</td>
</tr>
<tr>
<td>F8</td>
<td>7.64</td>
<td>4.16</td>
<td>31.78</td>
<td>30</td>
<td>0.94</td>
<td>321652.5</td>
<td>1966004</td>
</tr>
<tr>
<td>F80</td>
<td>10.37</td>
<td>7.81</td>
<td>80.99</td>
<td>9</td>
<td>0.11</td>
<td>322244</td>
<td>1965694</td>
</tr>
<tr>
<td>F81</td>
<td>13.99</td>
<td>8.95</td>
<td>125.21</td>
<td>47</td>
<td>0.38</td>
<td>322132.1</td>
<td>1965592</td>
</tr>
<tr>
<td>F82</td>
<td>11.5</td>
<td>6.41</td>
<td>73.72</td>
<td>23</td>
<td>0.31</td>
<td>322137.7</td>
<td>1965530</td>
</tr>
<tr>
<td>F83</td>
<td>10.07</td>
<td>6.07</td>
<td>61.13</td>
<td>34</td>
<td>0.56</td>
<td>322137.7</td>
<td>1965519</td>
</tr>
<tr>
<td>F84</td>
<td>12.2</td>
<td>7.65</td>
<td>93.33</td>
<td>23</td>
<td>0.25</td>
<td>322068.7</td>
<td>1965512</td>
</tr>
<tr>
<td>F85</td>
<td>9.4</td>
<td>6.09</td>
<td>37.25</td>
<td>52</td>
<td>0.91</td>
<td>322133.1</td>
<td>1965562</td>
</tr>
<tr>
<td>F86</td>
<td>9.87</td>
<td>7.99</td>
<td>78.86</td>
<td>25</td>
<td>0.32</td>
<td>321687</td>
<td>1965821</td>
</tr>
<tr>
<td>F9</td>
<td>11.81</td>
<td>7.51</td>
<td>88.69</td>
<td>41</td>
<td>0.46</td>
<td>321602</td>
<td>1965937</td>
</tr>
</tbody>
</table>

**Table B6: Size and orientation of structures**
Figure B18: a) Middle Preclassic, b) Late Preclassic, c) Early Classic, d) Late Classic
Figure B19: a) Terminal Classic, b) Early Postclassic, c) Late Postclassic, d) Colonial
<table>
<thead>
<tr>
<th>Structure ID</th>
<th>Mid Pre</th>
<th>Late Pre</th>
<th>Ear Cla</th>
<th>Late Cla</th>
<th>Term Cla</th>
<th>Early Pos</th>
<th>Late Pos</th>
<th>Span Col</th>
<th>Eng Col</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A6</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>A7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B11</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B13</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B15</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B16</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B17</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B18</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B20</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B21</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B23</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B25</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B29</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B31</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B33</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B34</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B36</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B37</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B38</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B39</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B41</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B42</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B43</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>B44</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>D15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D16</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D17</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D18</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D21</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D23</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D25</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D26</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D27</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D28</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D29</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D30</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D31</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>D32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D33</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D34</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D35</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D37</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D38</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D39</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D40</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D41</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D42</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D43</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D44</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D45</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D7</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E10</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E13</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E17</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F31</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F33</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F34</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F35</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F36</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F37</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F38</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F39</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F40</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F41</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F42</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F43</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F44</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F45</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F46</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F47</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F48</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F49</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F5</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F50</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F51</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F52</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F53</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F54</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>F55</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F56</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F57</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F58</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F59</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F6</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F61</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F62</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F63</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F64</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F65</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F66</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F67</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F68</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F69</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F70</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F71</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F72</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>F73</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>F74</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>F75</td>
<td>F76</td>
<td>F77</td>
<td>F78</td>
<td>F79</td>
<td>F80</td>
<td>F81</td>
<td>F82</td>
<td>F83</td>
</tr>
<tr>
<td>---</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table B7: Chronology of the inter-site settlement zone (0=no evidence of occupation, 1=evidence of occupation)
APPENDIX C: LITHIC DATA FROM THE INTER-SITE SETTLEMENT ZONE
<table>
<thead>
<tr>
<th>ID</th>
<th>Mat.</th>
<th>Cat.</th>
<th>Cha.</th>
<th>Cla.</th>
<th>object</th>
<th>Cond.</th>
<th>Sect.</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano rect. variety</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>A1</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>A7</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate - foot</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>A6</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>A6</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>hammerstone</td>
<td>compl</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A3</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>hammerstone</td>
<td>compl</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>B1</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>misc</td>
<td>frag</td>
<td>indeter</td>
<td>3</td>
</tr>
<tr>
<td>B1</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>trimming</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B1</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B10</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>scraper</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B10</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B10</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B10</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B11</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B13</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>scraper</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>B14</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>indeter</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B3</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>B3</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B4</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B4</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>macro blade</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B4</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>B5</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B5</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>scraper</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B5</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>preform</td>
<td>indeter</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B6</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>general</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B6</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>indeter</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B7</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>laurel-leaf point</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>B7</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>chopper</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B7</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>whole</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B9</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>B28</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
</tr>
<tr>
<td>B29</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>misc</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B29</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>formal</td>
<td>misc</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B30</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B33</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>Bark Beater</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B33</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>B35</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B38</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>B40</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>laurel-leaf point</td>
<td>frag</td>
<td>comple</td>
<td>1</td>
</tr>
<tr>
<td>B42</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B42</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>trimming</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B22</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>B25</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>2</td>
</tr>
<tr>
<td>B25</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B25</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B51</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B51</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>B51</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>indeter</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B52</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>trimming</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B43</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>core</td>
<td>expended</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B43</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>whole</td>
<td>compl</td>
<td>2</td>
</tr>
<tr>
<td>B43</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>trimming</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B43</td>
<td>chalcedony</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>trimming</td>
<td>frag</td>
<td>indeter</td>
<td>4</td>
</tr>
<tr>
<td>B45</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>indeter</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B45</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B45</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>cutting tool</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B47</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>scraper</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
</tr>
<tr>
<td>B49</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>misc</td>
<td>frag</td>
<td>indeter</td>
<td>2</td>
</tr>
<tr>
<td>B49</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>general</td>
<td>frag</td>
<td>indeter</td>
<td>2</td>
</tr>
<tr>
<td>B55</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>B60</td>
<td>red sandstone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B60</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>B60</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C7</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C7</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C7</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C9</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C12</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>pestle</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C21</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>C21</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>celt</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D33</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>axe</td>
<td>whole</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D33</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>indeter</td>
<td>whole</td>
<td>compl</td>
<td>3</td>
</tr>
<tr>
<td>D33</td>
<td>chert</td>
<td></td>
<td>core</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>hammerstone</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>Granite</td>
<td>ground</td>
<td>tool</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>metate</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>D41</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
</tr>
<tr>
<td>D41</td>
<td>chert</td>
<td></td>
<td>core</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D25</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>D25</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>D29</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>D29</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D29</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>Type</td>
<td>Material</td>
<td>Description</td>
<td>Tool Type</td>
<td>Fragment</td>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
<td>----------</td>
<td>-------------</td>
<td>-----------</td>
<td>----------</td>
<td>----------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D17</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake</td>
<td>compl</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D17</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>point frag</td>
<td>medial</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D9</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D17</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>pestle frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D14</td>
<td>Granite</td>
<td>ground</td>
<td>tool</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D24</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>hammerstone compl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D24</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>distal</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D24</td>
<td>chert</td>
<td>chunk debris</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D21</td>
<td>limestone</td>
<td>ground</td>
<td>tool</td>
<td>metate frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D21</td>
<td>sandstone</td>
<td>ground</td>
<td>tool</td>
<td>metate frag concave centre</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>debris</td>
<td>chunk</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>prox</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>point frag</td>
<td>distal</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>medial</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>debris</td>
<td>chunk</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D28</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>prox</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>metate frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D40</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>distal</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D27</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>prox</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D30</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>medial</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D38</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D42</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>prox</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D42</td>
<td>chert</td>
<td>chipped</td>
<td>debris</td>
<td>chunk</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D37</td>
<td>chert</td>
<td>chipped</td>
<td></td>
<td>core</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D37</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>point frag</td>
<td>distal</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D11</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>metate frag</td>
<td>indeter</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D11</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>point frag</td>
<td>prox</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E7</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E11</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>metate frag</td>
<td>indeter</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E12</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E13</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E14</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E15</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>distal</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E16</td>
<td>basalt</td>
<td>ground</td>
<td>tool formal</td>
<td>celt frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E17</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E18</td>
<td>chert</td>
<td>chipped</td>
<td>manu flake</td>
<td>flake compl</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E19</td>
<td>chert</td>
<td>chipped</td>
<td>tool formal</td>
<td>axe frag</td>
<td>distal</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E20</td>
<td>sandstone</td>
<td>ground</td>
<td>tool formal</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E21</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E22</td>
<td>basalt</td>
<td>ground</td>
<td>tool formal</td>
<td>metate frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E23</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>metate frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E24</td>
<td>granite</td>
<td>ground</td>
<td>tool formal</td>
<td>metate frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E25</td>
<td>limestone</td>
<td>ground</td>
<td>tool formal</td>
<td>mano frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E26</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>-----</td>
<td>-------</td>
<td>---------</td>
<td>------</td>
<td>--------</td>
<td>-----</td>
<td>------</td>
<td>------</td>
<td>---</td>
</tr>
<tr>
<td>E27</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag w/ cortex</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>E28</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E29</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E30</td>
<td>chert</td>
<td>debris</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>E31</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E32</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E33</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
</tr>
<tr>
<td>E34</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E35</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E36</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>E37</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
</tr>
<tr>
<td>E38</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
</tr>
<tr>
<td>F58</td>
<td>granite</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F58</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F60</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F40</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F61</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>hammerstone</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F33</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F39</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F80</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F4</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F70</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>bark beater</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F70</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F85</td>
<td>granite</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F85</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F11</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F26</td>
<td>granite</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F25</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>2</td>
</tr>
<tr>
<td>F25</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>2</td>
</tr>
<tr>
<td>F53</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>adze</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F53</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F81</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F35</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F64</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F27</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F27</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F28</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F28</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F34</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F62</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F19</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F67</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>mano</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F12</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F12</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F32</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F13</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
</tr>
</tbody>
</table>

413
<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Type</th>
<th>Component</th>
<th>Form</th>
<th>Object</th>
<th>Fragment</th>
<th>Condition</th>
<th>Notes</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>F37</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F57</td>
<td>Limestone</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>metate</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F50</td>
<td>basalt</td>
<td>ground</td>
<td>tool</td>
<td>formal</td>
<td>manuport</td>
<td>Water</td>
<td>damage</td>
<td>indeter</td>
<td>1</td>
</tr>
<tr>
<td>F65</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>indeter</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F8</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>flake</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F72</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F10</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>thumbscraper</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F10</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F55</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade, lance-like</td>
<td>compl with retouch</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F55</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F6</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F6</td>
<td>chert</td>
<td>chipped</td>
<td>core</td>
<td>core</td>
<td>core</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F6</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F14</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>blade</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F14</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F47</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F68</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F85</td>
<td>chert</td>
<td>chipped</td>
<td>core</td>
<td>core</td>
<td>core</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F85</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F85</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F85</td>
<td>chert</td>
<td>chipped</td>
<td>debris</td>
<td>chunk</td>
<td>chunk</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F79</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>utilized</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F38</td>
<td>chert</td>
<td>chipped</td>
<td>debris</td>
<td>chunk</td>
<td>chunk</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F33</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F39</td>
<td>chert</td>
<td>chipped</td>
<td>debris</td>
<td>chunk</td>
<td>chunk</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F72</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F5</td>
<td>chert</td>
<td>chunk</td>
<td>debris</td>
<td>chunk</td>
<td>chunk</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F74</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F74</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>point</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F49</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F48</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Axe</td>
<td>frag</td>
<td>medial</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F48</td>
<td>chert</td>
<td>chunk</td>
<td>debris</td>
<td>Chunk</td>
<td>Chunk</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F48</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>flake</td>
<td>compl</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>Material</td>
<td>Category</td>
<td>Chaine</td>
<td>Class</td>
<td>Object</td>
<td>Condition</td>
<td>Section</td>
<td>Quantity</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>----------</td>
<td>--------</td>
<td>-------</td>
<td>--------</td>
<td>-----------</td>
<td>---------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>F84</td>
<td>chert</td>
<td>chunk</td>
<td>debris</td>
<td></td>
<td>Chunk</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F84</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F45</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Point</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F13</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Axe</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F15</td>
<td>chert</td>
<td>chunk</td>
<td>debris</td>
<td></td>
<td>Core</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F82</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Point</td>
<td>frag w/ cortex</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F24</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Point</td>
<td>frag</td>
<td>prox</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F8</td>
<td>chert</td>
<td>chipped</td>
<td>manu</td>
<td>debitage</td>
<td>Flake</td>
<td>compl</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F73</td>
<td>chert</td>
<td>chipped</td>
<td>core</td>
<td></td>
<td>Core</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>F73</td>
<td>chert</td>
<td>chipped</td>
<td>tool</td>
<td>formal</td>
<td>Point</td>
<td>frag</td>
<td>distal</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Table C1: ID, Material, category, chaine, class, object, condition, section, and quantity of lithics, in the inter-site settlement zone
APPENDIX D: MAPS OF SITES WITHIN 50 KM OF LAMANAI, KA’KABISH, AND THE INTER-SITE SETTLEMENT ZONE
Figure D1: Chau Hiix (Andres 2009: 5)
Figure D2: El Pozito (Eppich 2000: 8)
Figure D3: La Milpa (Tourtellot *et al.* 1993: 101)
Figure D4: Blue Creek (Guderjan 2007: 23)
Figure D5: Dos Hombres (Trachman 2007: 30)
Figure D6: Nohmul (Hammond et al. 1985: 179)
Figure D7: San Estevan (Hammond 1975a: 51)
Figure D8: Cuello (Hammond 1991a: 10)
Figure D9: Altun Ha (White et al. 2001b: 379)
Figure D10: Colha (Barrett and Scherer 2005: 108)
Figure D11: San Jose (Guderjan 2006: 102)