GORDION SITE CONSERVATION PROGRAM

2009 FIELD REPORT

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1.0 Introduction

Continuation in 2009 of the Six-Year Site Conservation Program established in 2007 to address architectural and site conservation issues at Gordion has included the evaluation of past recent efforts and the implementation of new work addressing remedial masonry stabilization, advanced recording and documentation methods, and improvements to the visitor experience. As a result, implementation of the program during the 2009 season required simultaneous efforts to document and conserve extant architectural fabric and upgrade visitor amenities, including signage, perimeter railings and wayside viewing platforms. The proposed 2010 plan prioritizes issues concerning life safety by identifying the need to address basal erosion of the escarpments supporting the visitor circuit route; the plan then outlines individual treatment programs required for the conservation and presentation of extant architectural fabric and emphasizes necessary measures for site management and interpretation. These incremental changes will lead to yearly advancements in improving Gordion's safety and interpretation with the intention of establishing a sustainable long-term plan.

View of the Citadel mound from the northeast with the buried Megarons in the foreground and the Early Phrygian Gate behind.

2.0 Objectives

The Gordion Citadel Mound remains the prime focus of the UPenn Site Conservation team. The current conservation program was begun in summer 2006 at the invitation of G. Kenneth Sams, Project Director, and C. Brian Rose, Co-Director of the Gordion Excavation Project. In 2007, the Six-Year Site Conservation Plan was developed and launched with dedicated funds from the Penn Museum/1984 Foundation in 2008. Through a Cooperative Agreement signed in 2008 between Middle East Technical University (METU) and UPenn, a parallel three year program under the direction of Dr. Evin Erder (METU) with Ayşe Gürsan-Salzmann (UPenn) has been funded by TUBITAK to develop a regional Conservation Management Plan for Gordion and vicinity. The Six-Year Site Conservation Program—directed by UPenn in conjunction with these newly funded programs—addresses current and urgent needs, and its implementation is critical for both immediate and long term display and interpretation of the site and vicinity. The Six-Year Site Conservation Program identified several parallel projects for the 2009 field season, all of which represent high priority needs at the site. These were:

- **Documentation and condition survey of the Early Phrygian Gate** including laser scanning and structural monitoring of unstable areas in danger of collapse
- **Design and installation of a visitor circuit** including perimeter railings, new paths and steps, and wayside platforms and signage
- **Design, monitoring and implementation of new wall capping methods**, specifically the use of "soft" or vegetative caps to stabilize the masonry, control water intrusion, reduce maintenance and improve site appearance. Focus areas are the Gate and Terrace Building
- **Masonry conservation in the Terrace Building**, which requires masonry stabilization (wall retrofitting) and conservation, and testing of various capping systems
- **Overall emergency stabilization of masonry** by shoring and other methods

3.0 Observations

3.1 Site Characteristics

The current Citadel site is a large subgrade area defined by high artificial escarpments and the impressive Citadel Gate on the southeast end. The excavated area is characterized by planned terraces and 'dug' grade changes, freestanding and retaining masonry walls, pavement blocks, and steps. The exposed architectural features represent various occupation phases. A mixture of building materials, especially stone, is evident and includes rhyolite, siltstone, limestone, alabaster, and basalt. Mudbrick and wood were also used but are no longer exposed or extant. Although visitors cannot enter the excavated area, a fenced visitor circuit atop the mound has been installed around the escarpment perimeter beginning southwest of the gate.

3.2 Current Conditions

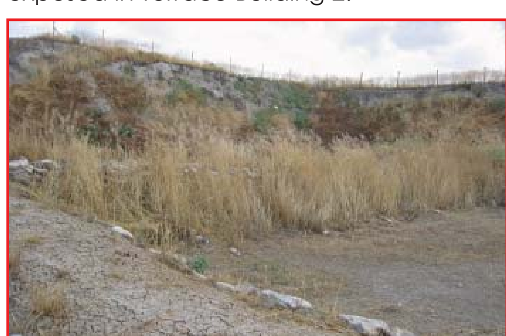
2009 was a very wet year resulting in dense vegetation at the site. The encircling escarpments continue to vary in condition from stable vegetated slopes to large unstable overhangs created from basal erosion. Collapses occur yearly. Many of the excavated wall segments are unstable with tilted and splayed walls, loose and missing individual blocks, and friable and delaminating stone fabric. Undermining from animal burrowing is evident. Drainage varies in areas depending on the topography. After a recent heavy rain, escarpment collapse, stone deterioration (especially Middle Phrygian walls), and standing water was observed.

Site Characteristics and Current Conditions - Summer 2009

Unstable escarpments exhibiting basal erosion.

Wall undermining from animal burrowing.

Friable and delaminating stone fabric exposed in Terrace Building 2.



Dense vegetation growing on the Terrace Building slope and escarpments.

The excavation pit located northeast of Megaron 2.

Eroded escarpments showing evidence of past collapses and current detachment.

The unusually wet year resulted in dense vegetation.

Middle Phrygian Gate courses exhibiting deterioration and instability.

4.0 Field Projects

4.1 Laser Scanning of Site and Architectural Features

Scanning Middle Phrygian Gate courses east of the Early Phrygian Gate's north pylon.

Point cloud data collected during laser scanning.

Since the relatively recent introduction of laser imaging (scanning) into the conservation field, two main functions have developed for its use: documentation of extant features (e.g., architectural) and monitoring of material change generally produced by environmental deterioration (e.g., weathering). Advancements in scanning technology now allow a range of scanning options from low or moderate density recording at sub-meter intervals (referred to as resolution) to high density recording at submillimeter intervals as a means to generate digital constructions of scanned objects and identify rates of deterioration. For site surveying at Gordion, the Trimble VX100 mid-range scanner was chosen for its ability to produce high-quality scans for documentation of the Early Phrygian Gate, escarpments and general Citadel excavation and its capability to output panoramic and rectified elevation images of the site and its individual architectural features.

4.1.1 Objectives

The Architectural Conservation Laboratory of the Department of Historic Preservation rented a mid-range laser scanner (Trimble VX100) to perform scans of the archaeological features and overall site at Gordion. An initial experimentation period was established to determine—through a series of test scans—the range, resolution and limitations of the mid-range scanner in recording and documenting both monumental structures, such as the Early Phrygian Gate, and the general archaeological elements and site topography of the mound.

A project list for the 2009 season prioritized the high-density scanning of the intact Early Phrygian Gate and Middle Phrygian Gate remains, followed by lower resolution documentation of the encircling escarpments and basic survey of the Citadel interior. In addition to recording point cloud data, the scanner collected images of each gate elevation as additional documentation. Collected information will then be manipulated during post processing to create a site plan of the current extant features to supplement the existing layered phase drawings that delineate Gordion's various construction periods. Additionally, panoramic and rectified elevation images will be produced from the series of images collected during the scanning process for general use and possibly as the basis for condition surveys. Plan, elevation and section drawings of individual architectural features will also be generated.

4.1.2 Process

The initial scanning phase involved the creation of a network of benchmarks, test scans and evaluation of collected data. Preexisting, permanent benchmarks established for past site survey work were incorporated into the network developed for laser scanning. The preexisting points offer a means to ensure point accuracy and to utilize known coordinates when registering and geo-referencing point cloud data. During the trial period, the scanner's performance was measured through close-range data collection of the Early Phrygian Gate, as well as long-range recording of a section of the escarpment (*for records of each scan, refer to Appendix N*).[1] Single, high-density scans did not produce adequate data on the gate elevations; inadequacies usually resulted when scanning from an acute angle due to range requirements or obstructions in the scanning radius. However, these trial scans indicated that resolution could be maximized by scanning a

1 High-density scans of the Citadel Gate were generally collected at a distance ranging from 30-80' (although most commonly recorded at a distance of 70') and with horizontal and vertical intervals of 0.25'. Long-range scans of the escarpments and general Citadel were recorded at a distance ranging from 125-300' with horizontal and vertical intervals of 0.25-0.5'; however, to acquire a point cloud of moderate density when recording a large area (such as the escarpments) at long range, inputs for distance were decreased to allow for the collection of a higher volume of points.

single elevation from multiple viewpoints, which increased point cloud density. Consequently, all features were scanned from several benchmarks.

The restrictive height of the Early Phrygian Gate resulted in several sparse areas in the graphic representation of both the roof and those Middle Phrygian courses situated above the North and South Court structures. The scanner's range did allow for scans from the visitor circuit; however, the notable distance between the circuit and gate roof prevented the scanner from obtaining a density comparable to the elevation scans.

4.1.3 Results

The raw data generated from the Trimble VX100 mid-range scanner requires manipulation in the post-processing RealWorks Survey software. The compatible software allows for the production of panoramic and rectified elevation images, 2-dimensional plans, topographic site mapping, 3-dimensional representations of scanned objects and plans, sections and elevations of architectural features. As a result, the amount and type of data collected for each project was dictated by the anticipated end product.

Used largely as a documentation tool during the 2009 season, the laser scanner recorded the Early Phrygian Gate's surficial characteristics and several conditions. The process provides an alternative means to document complex construction features which traditional methods—such as hand recording or total station surveying— reproduce less successfully. The wall sections generated in post processing of the laser scanning data replicate the incline of the battered walls. Similarly, current conditions—particularly displacements within the wall system—are easily identifiable and measurable.

Although not currently utilized for monitoring wall displacement of the Early Phrygian Gate, laser scanning can map areas exhibiting bulging and distinguish displacement of individual stones. Through a comparison of the north and south pylons, other types of displacement, such as rotation about the base, may be identified. These comparisons are especially advantageous in future recording to understand new behavior and movement of the grouted South Court system in contrast to the remaining dry stone construction of the North Court. By isolating problematic areas within the wall systems, the 2009 documentation will be used to determine placement of monitoring devices and detect possible emergent conditions.

The data collected from scanning the escarpments serves a function similar to the higher-density data recorded from the Early Phrygian Gate. The sections created from the escarpment documentation provide information on the degree of basal erosion and inherent instabilities detected from the examination of an escarpment's angle of repose. The angle of repose can indicate whether sufficient material exists at the escarpment's base, which is critical in determining the safety of the path situated above.

The general site survey recorded topographical data to increase the accuracy of existing plans and to generate a 3-dimensional representation of the Citadel's extant fabric. This representation will enable spatial relationships between architectural features to be drawn and will supplement existing site plans with elevations and topography. Because the site is largely understood in plan by visitors, the survey will increase Gordion's interpretive value by providing a 3-dimensional presentation of the architectural features and provide the basis for hypothetical digital reconstructions of specific elements, such as the Megarons and Terrace Building Complex.

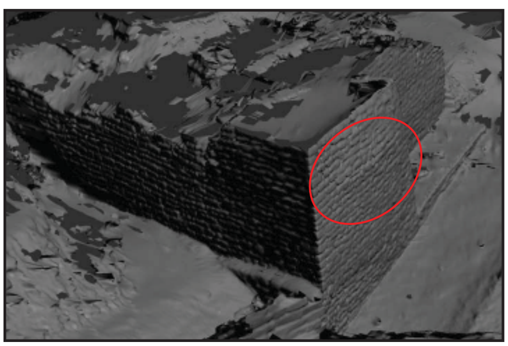
Laser Scanning

Using laser scanning to record the North Court elevations of the Early Phrygian Gate.

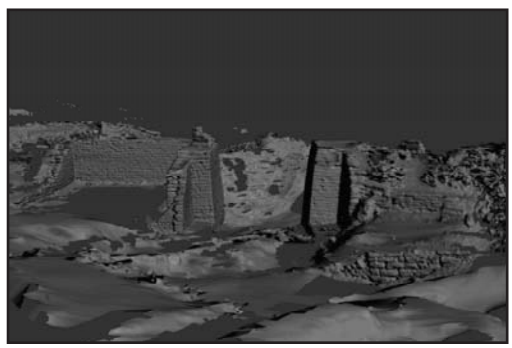
Point cloud data showing the Early Phrygian Gate.

Rectified and montaged image of the south pylon from the east.

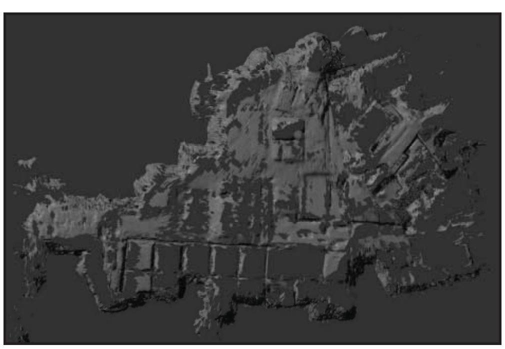
Rectified and montaged image of the south pylon at the central ramp.



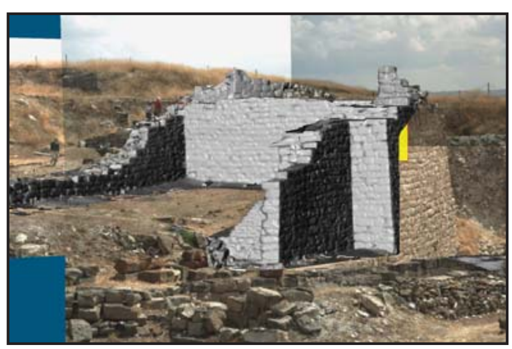
Solid 3-dimensional representation of the south pylon bulge.



Solid 3-dimensional representation of the gate from the Citadel interior.



Plan view of the scanned Citadel mound.



Point cloud data draped over montaged photographs.

4.2 Visitor Circuit

The segment of the visitor circuit before the prototype was installed.

After installation of the wayside viewing platform, masonry steps and path and perimeter railings.

Encircling the site from atop the escarpments, the current visitor circuit spans nearly 880 meters over relatively level terrain and provides viewing access into the Citadel Mound excavation and outward to the surrounding landscape. Irregular stone steps have been placed in several sloped locations, most notably to the north and south of the gate providing access to the top of the mound. Barbed wire fencing has been installed along the entire circuit perimeter and operates as a safety barrier between the visitor and excavation. Commencing at the massive dry stone gate, the visitor circuit leads guests to view other prominent Phrygian architecture, such as the Megarons and Terrace Building Complex. Rudimentary signage currently exists at four primary locations along the path and provides basic information on Phrygian culture and the Citadel.

4.2.1 Existing Conditions

Factors contributing to the inadequate visitor experience range from the poor condition of existing features to the lack of basic amenities. With little to no maintenance, the footpath suffers from unstable steps and the overgrowth of native grasses. Although vegetation does not inhibit circuit use, the grasses obscure the path, and deteriorated stone steps present safety issues at several steeply sloped areas. The heavily rusted barbed wire perimeter fencing stands as an unattractive and oppressive feature along the circuit and is an inappropriate selection for an archaeological site open to tourists. The site's few interpretive signs have succumbed to the harsh environmental conditions and exhibit varying degrees of deterioration at their concrete footings, posts or plaques. Victim to vandalism, the plaques have also been bent and scratched, although the text remains legible. Finally and most importantly, several areas of the visitor circuit traverse undercut escarpments and pose a serious hazard for visitors and danger to the features below.

Aside from physical conditions resulting from environment and vandalism, the site suffers from too few visitor amenities. With no bathrooms, benches, shaded rest areas or wayside viewing platforms, the average visitor passes through the site with few stops and little understanding of the extant architectural features, innumerable archaeological objects uncovered during the sixty year excavation history or the many periods of occupation at the Citadel.

4.2.2 Program Implementation

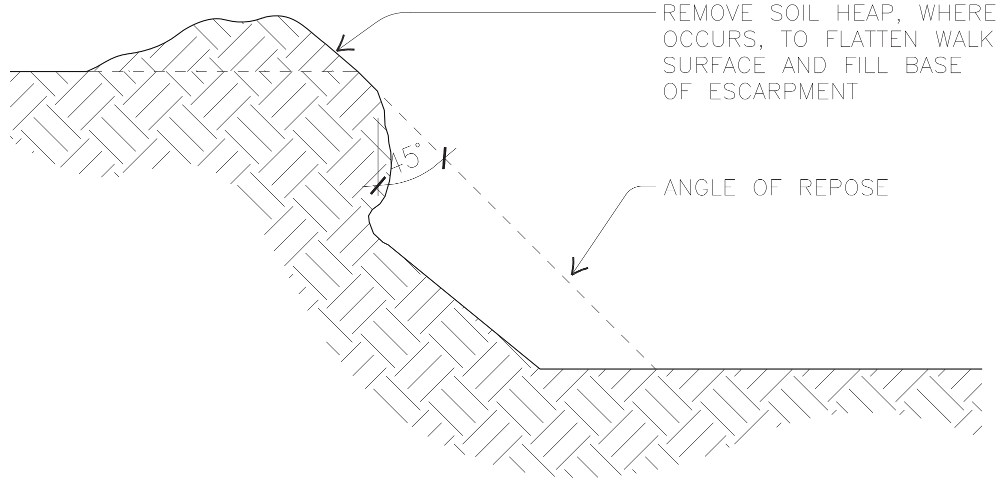
Efforts for the 2009 season were focused on upgrading public access and experience by designing and implementing a circuit prototype comprised of new perimeter railings, stone steps, signage and wayside viewing platforms. The materials and design selected for the visitor circuit prototype refined the aesthetic and increased site appeal to create a more welcoming experience for visitors. Improvements to interpretation and understanding of the architectural and archaeological features were vital characteristics for the installation of the new segment of the visitor circuit. The upgrades were also implemented with the objective of lengthening the average visit and establishing a connection between the Citadel Mound and its surrounding context—including the Central Anatolian landscape, neighboring tumuli, the village of Yassıhöyük and the Sakarya River landscape.

As part of the Six-Year Conservation Treatment Plan, ten locations around the excavation mound have been identified for the placement of interpretive signage and wayside viewing platforms. This season, two platforms—one at grade near the gate and one atop the mound—were designed, constructed and installed as prototypes (*refer to Appendix L for viewing platform construction drawings*). These platforms, equipped with new metal signage in English and Turkish, hopefully will serve as an impetus for the large-scale modifications anticipated over the next few seasons.

Several limitations concerning portability, material availability and affordability influenced design and construction decisions. Both wayside viewing platforms were constructed of locally available yellow pine and galvanized piping and accommodated the need for annual disassembly/reassembly through the modularity of their designs. The first platform prototype faces the monumental dry laid masonry gate and serves as the visitor's introduction to the gate. Its design frames the architectural features of the Citadel entryway without obscuring the view from this initial vantage point. The second platform design provides an elevated view of both the Citadel interior and the surrounding landscape (with particular importance placed on the site's relationship to Tumulus MM). Although similar design principles concerning portability and materials were applied in the construction of this second platform, further requirements to provide a source of shade led to the addition of a lightweight woven canvas roof.

One of the ten anticipated interpretive signs was installed on the railing of the wayside platform. Completed in modules and etched on stainless steel, the plaques were designed to be easily replaceable, low cost and vandal proof. The rusting barbed-wire fencing between wayside platforms was replaced with galvanized piping and wire to create a new perimeter railing system, which would allow for maximum visibility into the Citadel Mound. New stone steps were installed on the slope to improve the safety and clarity of the widened pathway. For further information on the installation of the visitor circuit prototype, please refer to Appendix E.

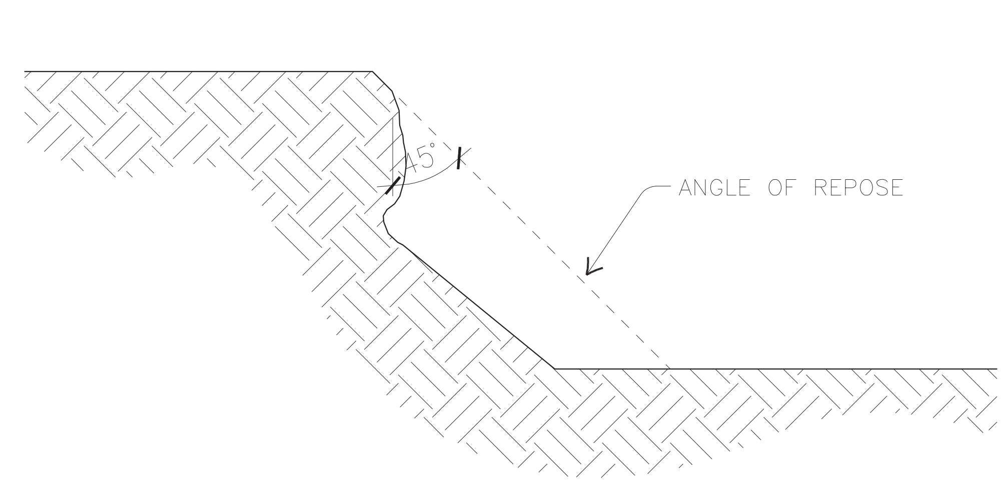
Escarpment Condition and Treatment Details



CONDITION C

REMOVE SOIL HEAP TO LEVEL OFF TO WALKWAY AND USE SOIL TO FILL BELOW

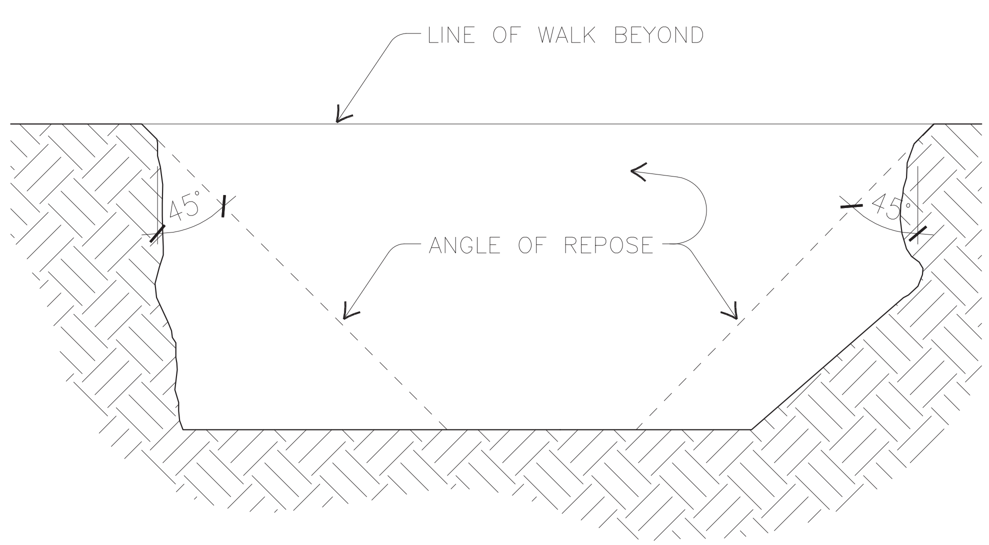
3 ESCARPMENT DETAIL C – FLATTEN WALK AND FILL SLOPE
SCALE: NTS



CONDITION A

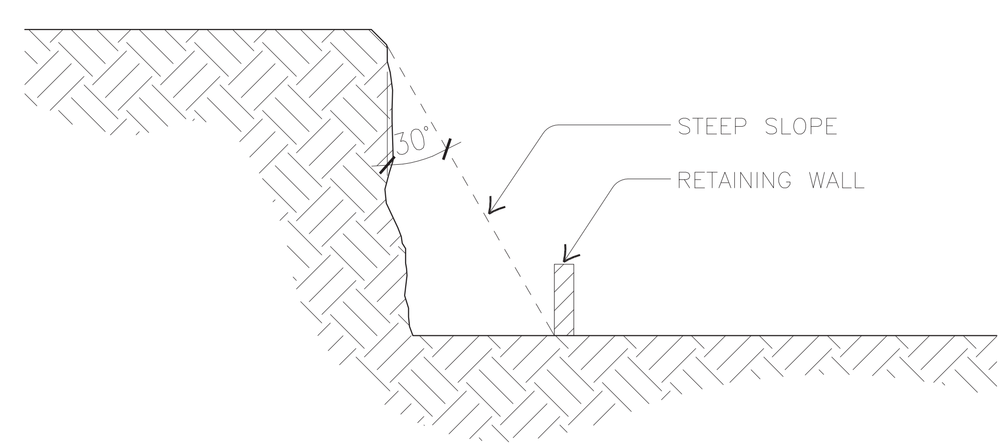
FILL UNDERCUT ESCARPMENT TO ANGLE OF REPOSE

1 ESCARPMENT DETAIL A – ANGLE OF REPOSE
SCALE: NTS



CONDITION D

AT ADJACENT AND FACING ESCARPMENTS, FILL TO ANGLE OF REPOSE



CONDITION B

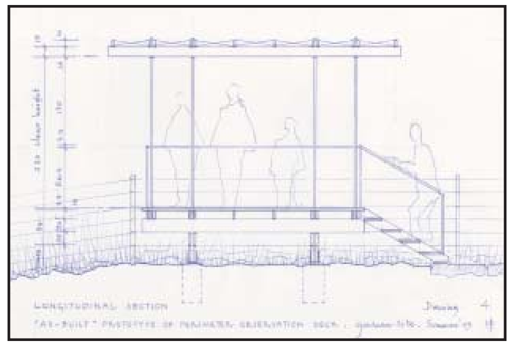
FILL TO STEEP ANGLE AND PROVIDE RETAINING WALL AT BASE

Visitor Circuit Prototype


Wayside viewing platform #1 installed at the Early Phrygian Gate entrance.


Wayside viewing platform #2 installed northeast of the Early Phrygian Gate.


Woven canvas roof of wayside viewing platform #2.


Elevation drawing of wayside viewing platform #2 by Lindsay Falck.


The existing rusted barbed wire perimeter railing.


The galvanized piping and wire of the prototype perimeter railing.


The deteriorated masonry steps and dirt path before replacement.


Installation of the new masonry steps and path leading to wayside platform #2.

4.3 Citadel Gate

The Early Phrygian Gate following excavation in the 1950s. *Penn Museum Gordion Archive.*

The gate in 2009 with evidence of displacement in the South Court elevation.

At nearly ten meters in height, the massive ashlar masonry gate is very complete. Structural settlement is evident with areas of shear cracking and course displacement. Veneer detachment has occurred as bulging, most evident on the north face of the south pylon. The southwest wall of the north pylon, rebuilt by Rodney Young, was rebuilt again after earthquake damage (1999) in 2006. The tops of both pylons—capped with cement and subsurface drains—have cracked over the years and have been periodically sealed with silicone sealant. Large cracks exist between the cement and the uppermost stone course allowing water to penetrate into the core. These caps are currently under redesign as vegetative caps. Injection grouting was discontinued in 2006 until structural monitoring and assessment are completed.

A detailed investigation of Phrygian construction methods has been conducted this season to supplement the digitized 2006 condition assessment; both surveys will assist in structural monitoring (*please refer to Appendix A: Gate Construction Survey*). Based on environmental monitoring data collected in 2008 on the cap of the south pylon, a vegetative cap has been installed on the north pylon and will be monitored for one year before complete installation on the north and south pylons.

4.3.1 Early Phrygian Gate Construction Methods and Materials

A detailed investigation of the Early Phrygian Gate's outer veneer layer was undertaken to better understand the Phrygian construction methods. The investigation required the notation of specified aspects of both individual stones and their overall position (or function) within the wall system. Observations pertaining to individual stones included bedding orientation, shaping and tooling, stone type (where identifiable) and stone shape. Extant earthen plaster, course regularity and evidence of reconstruction or interventions were also investigated.

The construction survey indicated that the Phrygians built the gate with careful planning and consistency, which was evident in the uniformity of courses, complexly battered faces, masonry bonded corners and tooth-shaped headers found within the wall system. With the exception of chinking stones, all limestone blocks were bedded with a horizontal orientation. Upper courses are of mixed composition of limestone and rhyolite and largely retained their original tooling marks, while lower courses demonstrated a higher number of shaped stones (which lack the uniform, surficial markings produced by chiseling) and showed some signs of erosion or weathering. Since its exposure to the environment approximately sixty years ago, the Early Phrygian Gate has been subjected to several localized reconstructions and injection grouting on four walls. Although the gate has largely maintained its original aesthetic, areas receiving interventions exhibit variations in chinking technique and, in some cases, stone type. Additionally, exposure to the environment for the past sixty years has compromised the original earthen finish that once covered at least the interior passage of the Early Phrygian Gate walls.

4.3.2 Gordion Citadel Gate Soft Vegetative Capping Pilot Project

An alternative "soft" vegetative capping system was implemented in summer 2008 at the South Court structure of the Citadel Gate complex, known as Pilot Area #1, to address water infiltration issues caused by the failed concrete cap installed in previous years, stabilize the masonry, reduce maintenance and improve site appearance. This alternative soft capping system was tested to determine if a waterproof capping system with use of a growing medium would be an acceptable alternative to the traditional hard mortar and lead capping systems used in the conservation of archaeological sites. After dismantling Pilot Area #1, the capping system was evaluated for its efficacy in arresting moisture penetration, and a new vegetative cap was installed—with several revisions—in a larger section of the Gate roof at Pilot Area #2.

Pilot Area #1 – South Court

In the summer of 2008, a new soft cap system was designed and installed at Pilot Area #1 with a structure and function similar to an extensive "green roof" used in the building industry—a multi-layered roofing system consisting of water proofing, drainage, growing media and local grasses. Today, green roofs are commonly used to better insulate buildings and prevent heat island effects in urban environments. Within the context of Gordion's harsh climate, the new capping system installed at Pilot Area #1 provides a simple and sustainable approach that proposes to eliminate water ingress, while creating a more compatible system that blends visually into the surrounding landscape.

The soft vegetative capping system consisted of a bituminous liquid waterproofing membrane, protection mat, a gravel drainage layer, two different moisture retention mats, a filter layer, soil and substrate, and three different types of seeds and plants. Pilot Area #1 was disassembled during the 2009 field season, and the effectiveness of each layer was recorded and assessed to identify weaknesses in the system. The evaluation showed several inadequacies in material selection and design, which were addressed in the installation of the 2009 capping system at Pilot Area #2. The presence of biological growth indicated that water infiltration and improper drainage occurred in both the moisture retention and drainage layers. Additionally, plant roots penetrating the filter layer suggest the opening size may be too large.

The system's general installation requires minor modifications to prevent wetting below the liquid waterproofing layer. Consideration into flashing and drainage design is necessary to improve water resistance. Water ingress occurred in vulnerable areas, such as the roof/wall juncture; obstructed drainpipes, improperly sloped grading and clogged weep holes also contributed to wetting by preventing moisture exodus.

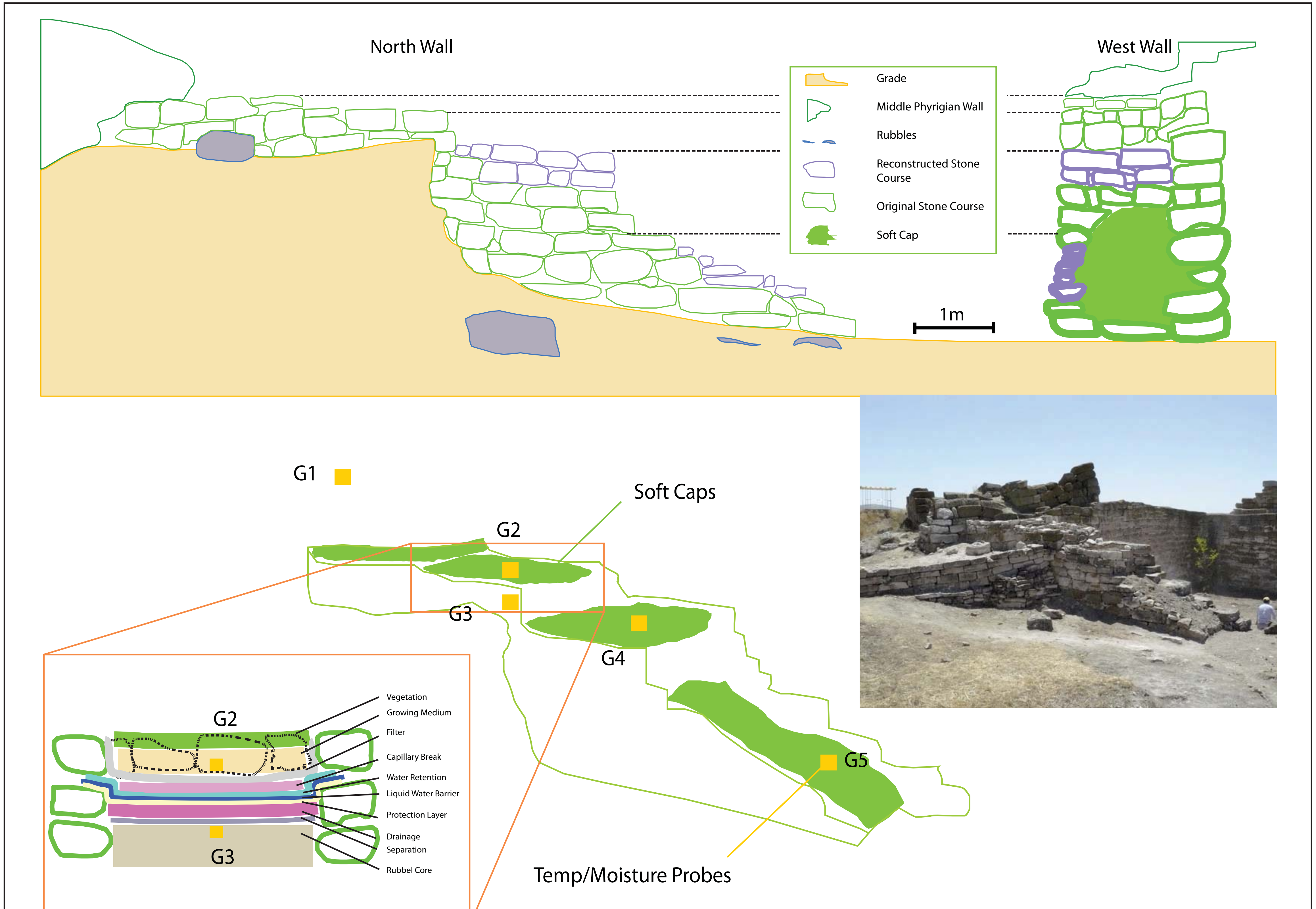
By aiding in the absorption and evapo-transpiration of moisture, plants provide a critical component to the green capping system. In consultation with an archaeobotonist (N. Miller), vegetation for Pilot Area #1 included a variety of native grasses and annuals. Review of the established plantings prior to disassembly of the soft cap indicates that the native vegetation—particularly *poa* sod—provide the necessary coverage to be effective in absorbing moisture.

Pilot Area #2 – North Court

The Pilot Capping Program was expanded to evaluate a larger section of the North Court roof for the 2009 season. Pilot Area #2 consists of three stepped sections located on the north wall of the North Court structure. The inadequacies found during the disassembly and assessment process of Pilot Area #1 were addressed prior to installation of the soft cap on the North Court structure. Material revisions included the use of Tyvek as the liquid waterproofing membrane and the addition of an existing red gravel aggregate to fill voids within the rubble core and level the system base. The stepped roof levels were also gently sloped beneath the waterproofing layer to prevent standing water on the cap layers, and a drainage system was configured to transport moisture from the Gate roof and walls.

Five sets of environmental monitoring devices were installed to record soil moisture, temperature and relative humidity. These monitors will remain installed in the system for at least one year, and the data will be evaluated during the 2010 field season to assess the efficacy of the North Court capping system. Although water infiltration occurred in the 2008 Pilot Program, the results confirmed that with minor modifications to the drainage design and material selection, a soft capping system at the Citadel Gate would be a viable and preferable alternative to the current concrete cap. For further analysis of Pilot Area #1 and #2, material specifications and documentation of the installation process, please refer to Appendix B: Soft Vegetative Capping of the Gate Roof.

Pilot Area #2 Vegetative Capping System



Gate Construction and Pilot Capping Systems


Extant earthen finish on the North Court elevation at the central ramp.


Shaped and tooled limestone on lower courses of the North Court.


Pilot Area #1 installed in 2008 shows extensive growth of *poa* grasses.


Biogrowth found during disassembly of Pilot Area #1.


Pilot Area #2 prior to installation of soft capping.


Protection sheet and gravel mix before inserting probes.


Gravel drainage layer prior to addition of *poa* sod.


The completed soft capping system at Pilot Area #2 prior to revegetation.

4.4 The Terrace Building Complex

The Terrace Building Complex prior to exposure and treatment.

Following stabilization of Terrace Building 2 (center).

The Terrace Building (TB) Complex incorporates eight nearly identical units and spans more than 100 meters on the northwest-southeast axis of the Citadel. The dry laid masonry walls are composed of two roughly squared ashlar stone veneers of local limestone, siltstone and sandstone with a rubble core of small stones and clay/silt debris. The Phrygian builders likely installed wooden timbers as leveling courses within the masonry walls and as vertical support posts for the roof and inner galleries. The extant walls currently maintain a maximum of four courses and stand approximately 1-1.5 meters in height.

4.4.1 General Condition

The deteriorated condition of the Terrace Building masonry partially results from the catastrophic 9th century BCE fire. The collapse of the roof and burning of timber caused an outward rotation of the two wall veneers, which separated the wythes and compacted the rubble core. More recently, full exposure to the harsh Anatolian climate following the 1950s excavations has contributed to further damage. Freeze/thaw cycling has caused numerous fire-damaged stones to crack and disintegrate, and seismic activity has produced structural instabilities. As a consequence, the outward splaying of veneer walls increased. Additionally, the temporary wall stabilizations of TB 1-8 installed in 1996-2000 involve the use of sandbags for buttressing covered by geofabric and a capping of geofabric, stone edging and expansive clay. They are in generally poor condition now due to deferred maintenance. Some sandbags have burst from fabric failure, and the geofabric has torn from UV degradation. The clay caps are in good condition and were observed to perform well after a heavy rainfall (further analysis of the capping system and pilot reburial project is available in Appendix C). The rebuilt stone walls of TB 4 appear to be in excellent condition; however, this technique of wall preservation has been rejected as too extreme.

4.4.2 Conservation Treatment Pilot Program of Terrace Building 2

The 2009 site program has explored new methods of conservation and presentation of the Terrace Building Complex, which will maximize the archaeological value of the existing walls (with no or limited rebuilding) and floors and improve legibility (with no or limited reburial). Objectives for the conservation of the Terrace Building Complex included documentation of previously reburied walls, collection of environmental monitoring data from data loggers, condition survey of the three main sections from the 2006-2009 TB2 pilot program, and development of guidelines for future work at the TB Complex. Chosen intervention strategies, designs and materials adhered to a set of principles established to minimize visual impact, reduce maintenance requirements and limit the need for future interventions. Tested and reviewed conservation techniques included the use of adhesives (epoxy resins) and grout injection of cracked and delaminated stones, pinning and cable support of dislodged stones and wall capping. These treatments will be left in place for one year before a full program of treatment is implemented during the 2010 field season.

Terrace Building 2 (TB2) was selected for designing, installing and testing long term solutions of structural stabilization and wall capping that could allow the walls to remain exposed. The selection was based on the existing conditions found in TB2, which are typical not only of the Terrace Building Complex but for much of the extant architectural features in the Citadel Mound. Various interventions were carried out along the south wall (TB2-2), a section of the north wall (TB2-5) and along a section of the east wall (TB2-1). For the 2009 field season, the pilot treatment program was applied to two walls—TB2-1 and TB2-5—and the efficacy of the 2006-2009 TB2-2 reburial program was evaluated.

All TB2 walls were previously protected by reburial material from soil and sand along both sides of the wall and a capping system of plastic sheeting, stone edging and expansive clay placed on the top. The reburial program implemented during the 2006 season was introduced to arrest deterioration and included monitoring moisture content to determine the efficacy of various burial systems. Following the removal of the sandbags and capping from the test walls, the exposed stone courses were photographically documented and surveyed for cracking and deformation, detachment, material loss, and discoloration and deposits. Specific causative factors resulting from reburial—such as general stone condition, the presence of salts in either stone or soil and inadequate drainage—were identified for further evaluation of the reburial program. Necessary revisions to both the 2006 and earlier reburial programs required the exploration of treatment options during the 2009 field season.

TB2-1

This wall was selected for conservation treatment and a test trial of three capping systems in order to evaluate the performance of the wall after one year of exposure. After the preliminary evaluation of conditions, the core material was temporarily removed from the test section in preparation for conservation treatment. The treatment program involved in-situ reattachment of cracked and delaminated stone using epoxy resins and stainless steel rods, grout injection into major and minor cracks, resetting of displaced blocks with a soil-based mortar and selective replacement of stone laid in a soil-based mortar. Following treatment, the original core material was reinstalled, and three experimental capping systems—consisting of variations on vegetative and hard capping systems—were assembled for evaluation during a one-year monitoring period.

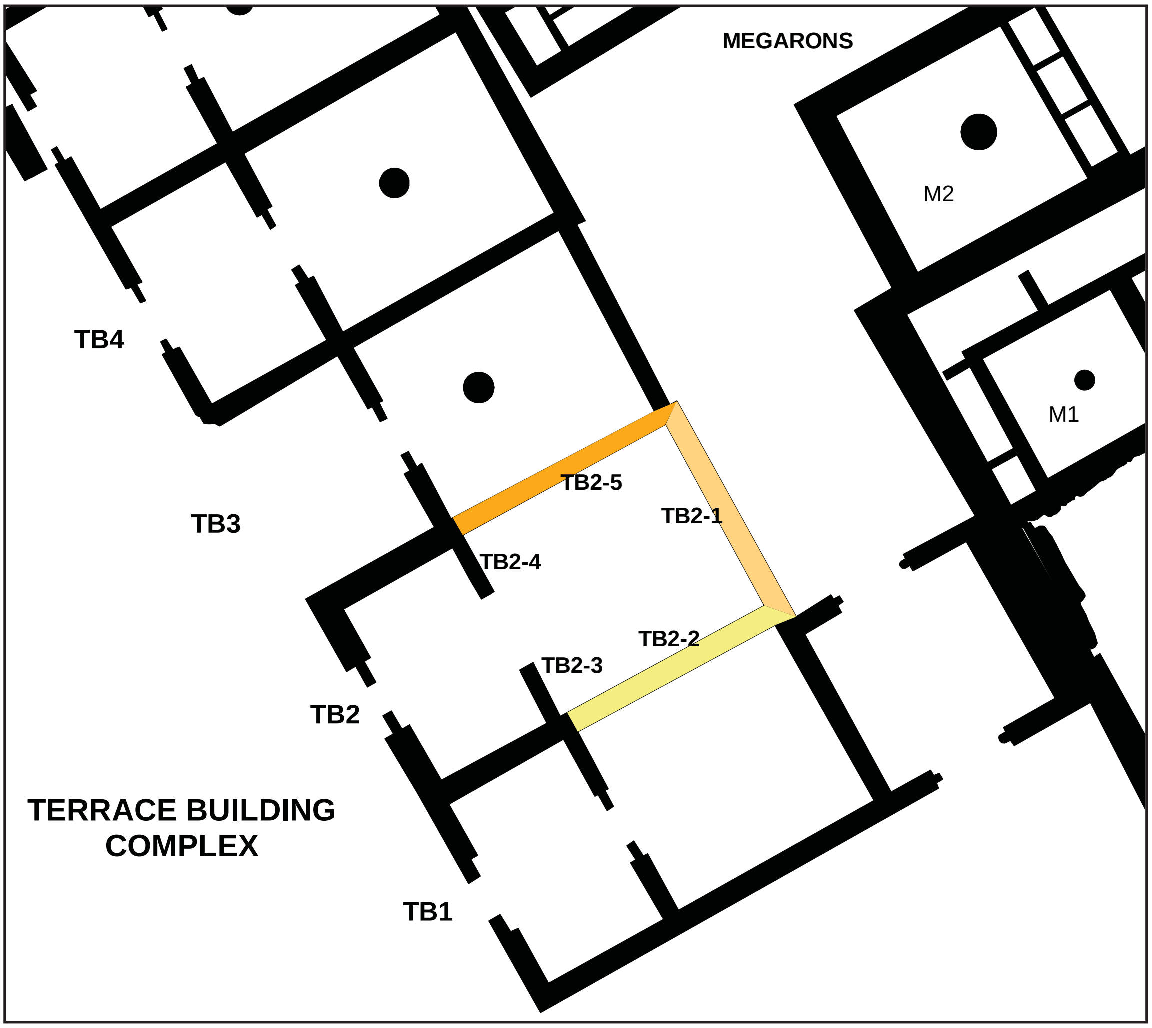
TB2-5

This wall was selected for conservation treatment and structural retrofitting. Following exposure and evaluation of the stone courses, an extensive conservation treatment program was designed for TB2-5, which included both consolidation and structural stabilization. Because the wall exhibited areas of major loss, the conservation program required stone replacement. Unused stone from the TB4 reconstruction project in the 1990s was shaped and laid in a hydraulic lime/sand/brick dust mortar (2.5:1:0.5) to bond the new material to the existing stone. Reattachment was performed on stone showing advanced deterioration, such as cracking and delamination; epoxy resins[2] mixed with calcium carbonate served as the stone to stone adhesive, and stainless steel rods were inserted, when necessary, for additional structural support or to secure large stone fragments.

Structural stabilization measures included retrofitting the wall core with a system of interconnected stainless steel rods and tension cable. This preventive intervention method stabilizes the two ashlar veneer leafs in place, while allowing for individual stone movement without rebuilding. A temporary protective cap composed of geofabric, stone edging and expansive clay was installed to prevent moisture ingress over the winter. A more thorough analysis of the pilot treatment program is available in Appendix D: Terrace Building 2 Conservation Program.

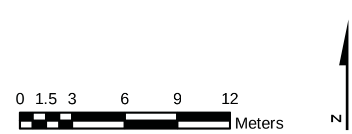
2 Sikadur-31 and Sikadur-52 Injection Type N. Both products manufactured by Sika and purchased in Ankara.

TERRACE BUILDING 2 PLAN



Conservation Work Completed During 2009 Field Season

- TB2-1: Pilot installation of three capping systems
- TB2-2: Exposed and shored
- TB2-5: Consolidation and structural retrofitting
- Early Phrygian architecture



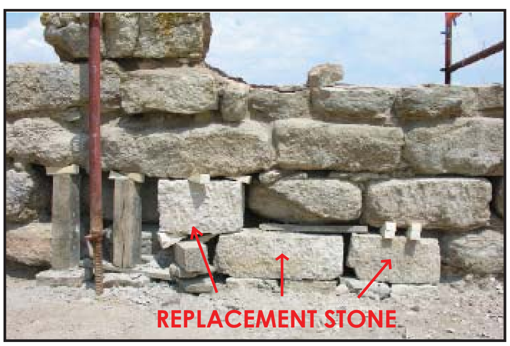
Stone Replacement

Disassembly of the wall capping and slopes of TB2-5.

Missing stone blocks and temporary wall stabilization after exposure.

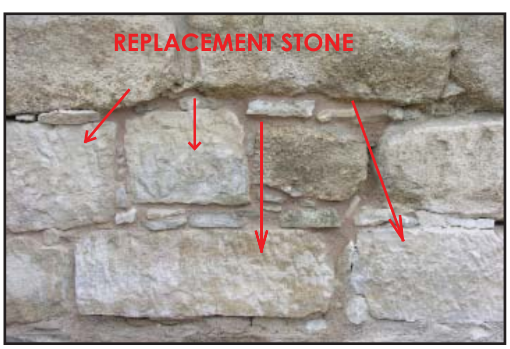
Choosing stone for replacement.

Stone replacement to stabilize TB2-5 elevation.



Replacement stones installed in wall with temporary wooden chinks.

Grouting replacement stone.



The completed installation of the replacement stone.

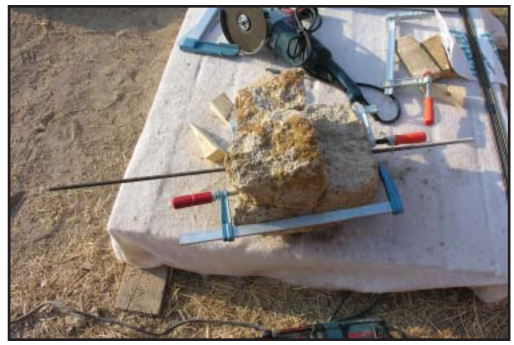
Applying a clay patina to darken the new stone.

Adhesive Repair


A deteriorated stone prior to adhesive repair.


Drilling for insertion of a stainless steel pin.


Insertion of stainless steel pin and application of epoxy resin.


Clamping treated stone fragments after insertion of stainless steel pin.


After partial treatment of deteriorated stone.


Drilling for insertion of a second stainless steel pin.

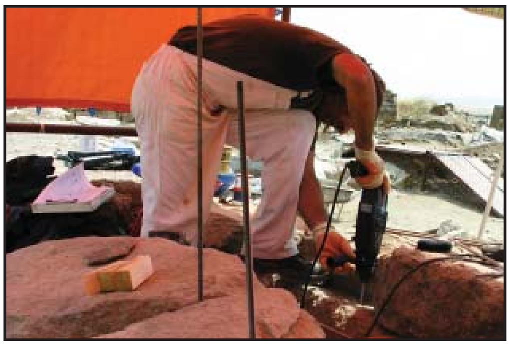

Lifting the treated stone for reinstallation on TB2-5.


The stone in place following repairs.

Structural Retrofitting

Temporary shoring of TB2-5 (from TB3).

Clearing core material in preparation of structural retrofitting.



Drilling for insertion of stainless steel rods.

Pouring lime grout into hole prior to insertion of stainless steel rod.

Hammering stainless steel rod into stone.

The cable system installed to prevent further splaying.

Detail of cable system.

Refilling original dry core material after completion of structural retrofitting.

Wall Capping


Exterior elevation of TB2-1 prior to intervention.


Plan view of TB2-1 after removal of capping and added coping material.


Reinstallation of an original stone with soil-based mortar.


Filling with original core material.


Repointing masonry with soil and lime-based mortar.


Construction of the capping system using mudbrick.


Installation of the stone and soil mortar capping system.


The completed capping system with three experimental prototypes.

View of Yassıhöyük village.

The agricultural land surrounding Yassıhöyük.

4.5 Yassıhöyük Village Study

In addition to conservation and planning work completed at the Citadel Mound, village surveying and research continued under the guidelines created in the Conservation Management Plan for Gordion and the surrounding community. The research was focused on three primary areas: documentation of economic change of neighboring villages, continuation of the management conservation survey and establishment of guidelines for a new women's cooperative pilot project. During July 2009, Dr. Ayşe Gürsan-Salzmann, collaborated with a team from Middle East Technical University to conduct a series of village surveys and interviews with village women.

The long-term ethnographic survey, begun in 1995 and continued through the current season, included documentation of economic changes and their social and physical manifestations at Yassıhöyük village and 14 neighboring villages within a 6-25 km distance from the ancient Phrygian citadel. Incremental changes to the landscape have occurred over recent years and resulted in the slow rise of the ground level due to deep plowing and irrigation; this rise in ground level has visually impacted the landscape by causing a subtle and gradual burial of the 2,500 year old tumuli. Other land use changes, such as the occupation of grazing land with modern cement-block housing, have visually altered Yassıhöyük's rural landscape and have created a potential conflict between the village's move toward modern construction and the preservation of its traditional character.

The conservation planning team—comprised of members from both the University of Pennsylvania and Middle East Technical University—surveyed and documented 50 households and 185 structural units within their courtyards. The documentation was done systematically, using GPS to pinpoint locations of units within courtyards on a 1/5,000 scale topographic map. The mudbrick and timber-stone vernacular architecture, building materials and construction techniques were drawn, photographed and digitized. Also included in the documentation was extensive socio-economic data for each household. The architectural documentation of Yassıhöyük village begun in 2008 was completed during the 2009 season.

A new pilot project was established within the parameters of the Conservation Management Plan to revitalize the village through a Women's Cooperative. The cooperative would allow women to combine skills and resources to produce and sell traditional handicrafts and local foodstuffs as a vehicle to promote and preserve their traditions, while permitting them to generate a personal income. The idea materialized through personal conversations with local women, who expressed some level of dissatisfaction with their only role as head of household chores. The desire for a new role (in addition to being a housewife) and to contribute their time and efforts toward a larger community need outside the home resulted in the concept of the women's cooperative. The women requested help from an outsider to establish the program, and Gürsan-Salzmann—together with a group of women—formulated the basic requirements for the cooperative, which included:

- allowing 10 to 15 women producers and one coordinator
- funding to start the venture, which requires investment in establishing a center for the cooperative
- obtaining a building not currently in use to serve as a center—preferably one that requires minimal repair—where the cooperative's activities could be based for sale of products, and where women could meet on certain days to socialize and discuss

their products; two likely candidates are either the unused old mosque or the one-room schoolhouse (although the latter would require more repair than the mosque); obtaining and repairing a building for the Women's Cooperative Center is proposed in 2010

- producing handicrafts and prepared foods made from local products (jams, sun-dried vegetables and fruits, fresh yoghurt, pastries, wheat/barley-based dried soups, bread etc.)
- maintaining an active role to create, advertise and sell their products under the supervision of a woman coordinator
- creating attractive signs placed in the Museum to advertise the village and to get site visitors—both local and foreign—to walk to the food and handicraft stands; along the way, several traditional mudbrick houses could be visited

This project has the potential for not only providing an income-generating market environment in the village, lively tourism and a spirit of collaboration among women, but also for establishing a closer relationship between members of the Gordion Project and the villagers. The answer to why a closer relationship is needed underlines the basic premise of the Management Conservation Plan—to open the door to an understanding and recognition by the local community of preserving the ancient site which sits over the village lands and tumuli. The most effective method is to inform and involve the local people as well as the municipal bureaucracy through collaborative efforts, to encourage them to be willing stakeholders and to be proud of a heritage that they should leave intact for future generations.

Yassıhöyük Women's Cooperative Pilot Project

The first three-story mudbrick building in the village constructed around 1940.

The old mosque is a potential center for the women's cooperative.

Women in Yassıhöyük who may participate in the cooperative pilot project.

Village women who produce handmade woolen items.

5.0 Recommendations

The following recommendations for the 2010 f eld season are based on the high priority needs identif ed in the Six-Year Site Conservation Program for Gordion. Focus should remain on visitor safety, the conservation treatment program of archaeological fabric and visitor experience. These goals will be met through the evaluation and continued implementation of the 2009 projects. An assessment of the 2009 prototypes and pilot projects at the visitor circuit, Early Phrygian Gate and Terrace Building will inform further design and treatment programs scheduled for the 2010 season. Conservation efforts will include stabilization of the escarpments, more extensive upgrades to the visitor circuit including construction of additional waysides, structural monitoring and installation of the f nalized soft cap design at the Citadel Gate, complete treatment of TB3 and 5 and the initial assessment and formulation of treatment programs for six additional project areas. Pending additional project-specif c funding, work will begin on the Mosaic Building and Megaron 2 mosaics and the Citadel's extant walls.

5.1 Visitor Circuit

The 2009 program addressed the deteriorated condition of the current visitor circuit by improving a segment of the circuit through the installation of a prototype. The prototype—which included two wayside viewing platforms, signage, perimeter railing and steps—will need to be evaluated and modif ed during the 2010 season. After necessary revisions are made to the design, complete installation will begin. Each component of the 2010 visitor circuit program is outlined below:

Wayside Viewing Platforms

- Assess the durability and performance of the platforms when reinstalled on site—after transportation and storage during the off-season months.
- Identify a long-term storage solution for the platforms during the winter months in

order to resolve lack of storage on site.
- Explore other alternatives of platform design in order to decrease the weight, eliminate the need for storage space and dismantling efforts and reduce cost.
- Continue building and installing prototypes on site under UPenn supervision.

Signage and Visitor Information

- Design and install permanent interpretive signage.
- Design and install signs to improve access points to the Citadel. Signs should designate entrance points from the road, parking areas, entrance to the visitor circuit, etc.
- Improve the segment of the dirt road which spans from the road to the Citadel entrance.
- Design brochures or informational booklets.

Perimeter Railing

- Assess the performance of the perimeter railing prototype for durability, overall design and potential for theft and vandalism.
- Revise design and materials for complete installation of the final perimeter railing system around entire circuit.
- Installation should be completed by a local contractor.

Steps

- Assess the performance of the masonry and construction techniques used during 2009 installation.
- Perform any necessary modifications and repairs.
- Find a reliable stone quarry in Gordion vicinity to provide a source of stone for the remaining visitor circuit steps and paths.
- Continue with masonry step and path installation along the visitor circuit (specifically the area south of the Citadel entrance).

Visitor Management

- Identify number of visitors entering the site and evaluate visitor experience.
- Determine amenities (benches, shaded areas, bathrooms) required to meet needs of visitors.

Evaluation

- Provide a forum for receiving official feedback from various stakeholders regarding the prototypes of the visitor circuit (perimeter railings, steps, wayside viewing platforms).

5.2 Citadel Gate

Scheduled for installation in fall 2009, structural monitoring devices will provide the data necessary to determine the structure's stability and will allow for implementation of a stabilization program. Additionally, evaluation of the soft capping system will continue with revisions and new installations for the 2010 season.

Structural Monitoring

- Continue with structural monitoring of the Gate.
- Analyze data to determine whether displacement has occurred.
- Research possible stabilization programs.
- Organize periodic site visits with the consulting structural engineer.

Green or Vegetative Cap

- Retrieve and analyze data logger information from the north pylon cap of the Citadel Gate.
- Allow data loggers to continue collecting data for another year to improve consistency of results.

5.3 Terrace Building

A series of conservation treatments—adhesive injection and reattachment, stone replacement, grouting, pinning and cable support—were implemented in the 2009 pilot treatment program. These treatments require evaluation prior to the creation of a complete stabilization plan for the Terrace Building Complex; the assessment should determine if the materials and intervention implemented during 2009 are suitable for application on the remaining untreated walls.

- Evaluate the conservation treatment program carried out on each elevation of TB2 in the summer of 2009. Emphasis should be given to the assessment of the epoxy resins used in injection and stone reattachment and the retrofitting system installed in the core of the wall (TB2-5).
- Assess the wall capping systems installed on an exposed wall section of TB2-1. As per the results of the assessment, select and start applying the most suitable capping system on walls remaining exposed.
- Find a reliable and compatible source of new stone blocks in Gordion's vicinity to be used in future stone replacement.
- Conduct a condition assessment of the pilot wall sections after conservation and exposure to the environment for one year.
- Continue implementation of the conservation program within the Terrace Building.

5.4 General Citadel

The documentation and stabilization completed during the 2009 season should continue over the next few seasons. Although the general site was recorded by a moderate resolution scan, the important architectural features, such as extant walls, require high resolution documentation. The 2010 season will focus on six additional archaeological features—the Megarons, PPB, CC Building, Citadel walls, Mosaic Building and Megaron 2 Mosaic—with complete documentation and assessment of conditions. Also, safety issues arising from unstable escarpments supporting the visitor circuit remain to be addressed. Stabilization efforts will continue on the escarpments and Middle Phrygian Gate remains, and emergency shoring will mitigate structural instabilities in masonry walls.

Laser Scanning

- Continue site recording with laser scanner; priority for the 2010 season will be given to high resolution scanning of extant walls.

Documentation and Recording

- Document, assess conditions and establish treatment programs for the Megarons, PPB, CC Building, Citadel walls, Mosaic Building and Megaron 2 Mosaic (moved and installed at the Gordion Museum in 1963).

Emergency Stabilization of Masonry and Shoring

- Inspect all shoring installed during 2009 and revise system as per conditions found.
- Identify unstable masonry walls in need of stabilization and shoring.
- Purchase metal tubes, metal clamps and wood planks for emergency stabilization and shoring.

Stabilization of Middle Phrygian Gate Remains

- Find an engineering to help in the design and implementation of a stabilization system for the Middle Phrygian Gate Remains located near the main entrance to the Citadel.
- Identify prospective local contractors to carry out site installation of stabilization system.

Stabilization of Escarpments

- Continue researching suitable alternatives to stabilizing escarpments exhibiting severe basal erosion.

Fill depressions/open trenches inside the Citadel

- Fill depressions and open trenches inside the Citadel, which were identif ed in 2007.

5.5 Human Resources

In order to ensure the longevity and eff cacy of the conservation treatment program at Gordion, local workers from the village and immediate area have been hired and trained to perform the specialized work required to treat the archaeological fabric. The program's sustainability relies on the retention of these workers during the next few seasons and their continued involvement following completion of the Six-Year Site Conservation Plan.

- Retain local work crew and masons who have been involved with site projects since 2000.
- Continue site training of the local crew in masonry conservation techniques.
- Continue providing site training opportunities to young conservation professionals and conservation students, both Turkish and international.

6.0 Conclusion

If it can be assumed that the current Citadel excavation has reached its overall size (area and depth) for the immediate future due to the temporary moratorium on excavation. Now is the time to review and assess past and current conservation efforts in preparation for an overall site conservation plan. All conservation impacts display and interpretation as well as physical preservation; therefore it is critical that discussions continue as to how the preservation of the physical evidence as well as the site narratives can best be served. As proposed and initiated by Mark Goodman in 1999, a tri-part plan based on a conservation program, interpretive program, and maintenance program (assuming excavation is complete) is proceeding. This will continue to require input from site archaeologists as well as conservators, architects, engineers, planners and landscape architects.

The site's narrative of successive occupation, building, destruction, and rebuilding can be best told through the remaining architecture. In this case, architecture means the individual buildings and urban plan. As any plan is best visualized from afar, the current visitor circuit still affords the best view and understanding of the individual buildings, courts, streets, ramps, outer walls, and other architectural features as well as their temporal relationship (e.g., through plan over-lay and level change).

The conservation and interpretive programs must find a balance between physical preservation and architectural legibility. This will require the construction of 'decision trees' based on selected criteria: archaeological significance, extent of physical survival, condition, and location/visitor access. Possible interventions will include stabilization and display of original fabric, reburial, reburial and partial literal representation (e.g., masonry walls) or reburial and referential representation. Total reconstruction will be avoided. Given the diversity of building feature types, construction techniques, masonry materials (stone types), and levels, it should be possible to capitalize on this diversity of fabric to present the archaeological evidence to clearly portray Gordion's citadel and its associated narratives. This may in fact require a return to the immediate post-excavation condition of the site before degradation from weathering and temporary reburial.