

**Progress Report to the US Department of State for Phnom Bakheng
July 2011**

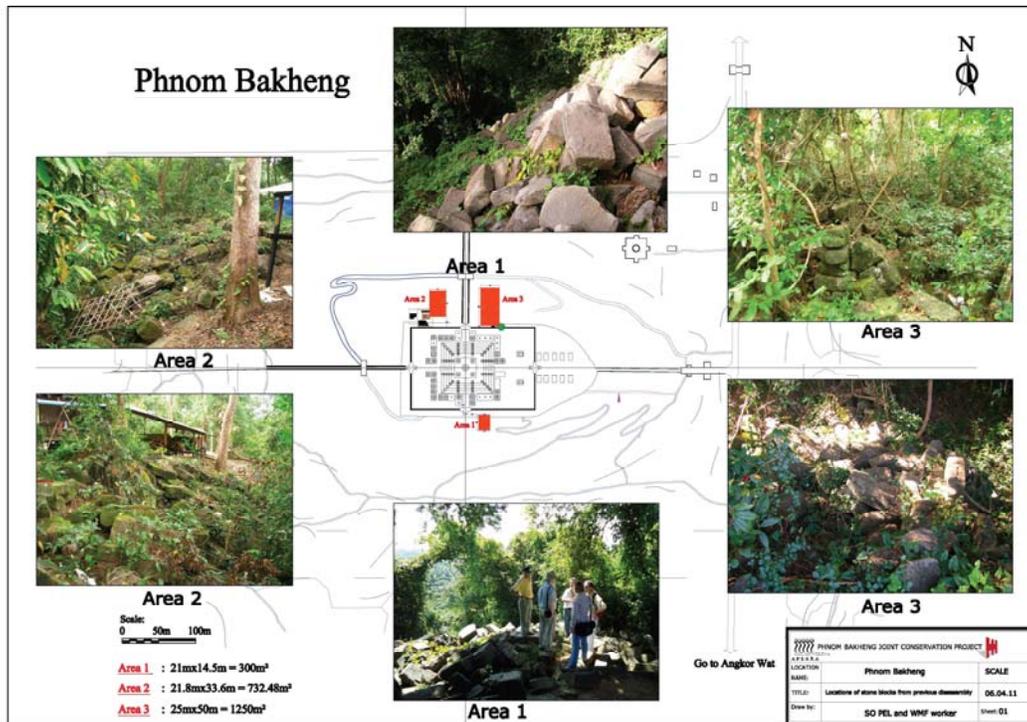
Work at Phnom Bakheng has been very productive in 2011. WMF provided a report in February 2011 illustrating work completed in the fall and winter. WMF submitted a summary of the results of the Site Planning Workshop held in New York in May, which was an extraordinary opportunity to work closely with the leadership of APSARA on the approach to be taken to assure continued visitor enjoyment and safety, as well as ongoing sustainable maintenance and stewardship of the site. The week in New York also provided an opportunity for WMF to acknowledge publicly the productive collaboration with Cambodian partners that has endured for twenty years. WMF began its field work at Angkor in 1992 and today WMF employs more than 100 Cambodians at four sites. The personnel include architects, engineers, conservators, archaeologists, artisans, office workers, and laborers. Thirty individuals have worked with WMF for more than ten years. WMF's head architect Cham Phally has been working with us since 1992. In addition to directing much of the daily activities at WMF project sites, she also serves as an important liaison with APSARA National Authority. WMF brings international experts to the sites when conservation challenges arise that benefit from outside expertise. As an example, the installation of the crane at Phnom Bakheng in an earlier phase of work was assisted by foreign experts and in 2010 and 2011, the design and installation of the waterproofing membrane at Phnom Bakheng was achieved with an international team of experts working with WMF staff on site. WMF's philosophical approach is to save as much original material as is possible, to respect the original intent of the designers and craftspeople who constructed the temple and to design architectural conservation programs that are physically and aesthetically compatible with the original construction materials. This work requires a great deal of archival research and extensive documentation. Systematic unit-by-unit conditions surveys are carried out and documented to help the project team understand fully changes to the monument over time and to define work priorities. WMF makes regular presentations to the UNESCO ICC for Angkor and to the UNESCO Ad Hoc Experts. Thus both APSARA National Authority and UNESCO representatives are briefed regularly on progress and participate in decisions made throughout all phases of the project. For both the 2010 Brick Shrine Workshop and the 2011 Site Management Planning Workshop, WMF had full participation of APSARA and members of the Ad Hoc Experts committee. The current phase of work was initiated in 2008 subsequent to receipt of an award from the US Department of State and approval from APSARA.

As has been reported previously, initial work focused on documentation and site preparation. An initial project was the rebuilding of the road to transport materials and equipment. WMF surveyed numerous stones scattered at the site to determine if they could be utilized for replacement of missing elements or if it could be discovered where they originally were on the temple. Experienced masons surveyed the stones to determine if any may have been from façade walls or pavers. This survey resulted in the discovery of 15 façade stones. The survey indicated that many original pavers were completely gone. This image of terrace level F clearly shows that very few pavers remain.





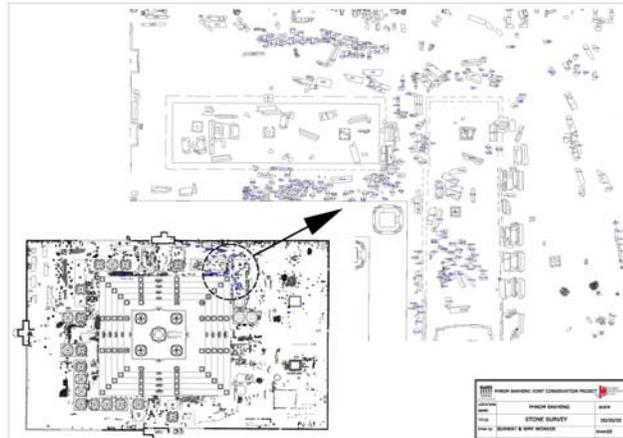
Archival research revealed that when the French arrived at the site and studied it in the 19th and early 20th century, a seated Buddha had been created subsequent to the original temple construction. Those who constructed this seated Buddha must have scavenged the site looking for any stone they could find to complete this effort. A review of the diaries of those working for the Ecole Française d'Extrême Orient in that era provided the information that the French disassembled the seated Buddha to expose the central shrine at Phnom Bakheng. Thus, the scattered stones at the site are the result of the documentation and conservation work of EFEO decades ago. This was a major effort and we believe ramps were constructed to assist in this disassembly and stone relocation project. WMF's work has involved archaeological investigation of these ramps to determine how the topography around the base of the temple has changed over time and to understand if some of the water infiltration problems can be addressed through regarding these ramps. It is also necessary to remove ramps that are inappropriately covering parts of the temple.



Today there are three major locations where the majority of these stones were deposited over the side of the hill. The largest one is at the South East corner of the site. Beginning in February 2011 after the completion of work at level F on the northeast corner, WMF removed approximately 600 stone and found that 300 were not usable due to highly specific decorative details on them, 200 could be utilized for new terrace paving stones and 100 could be used for replacement wall units. These units are being incorporated into the work above level F.



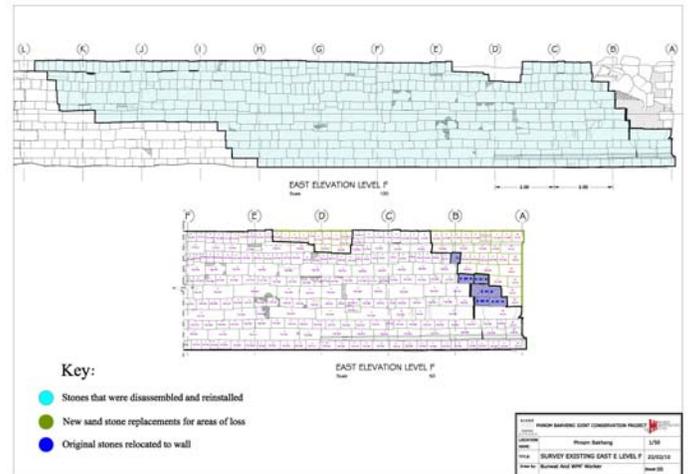
The south east corner at level F, as found at the beginning of the project



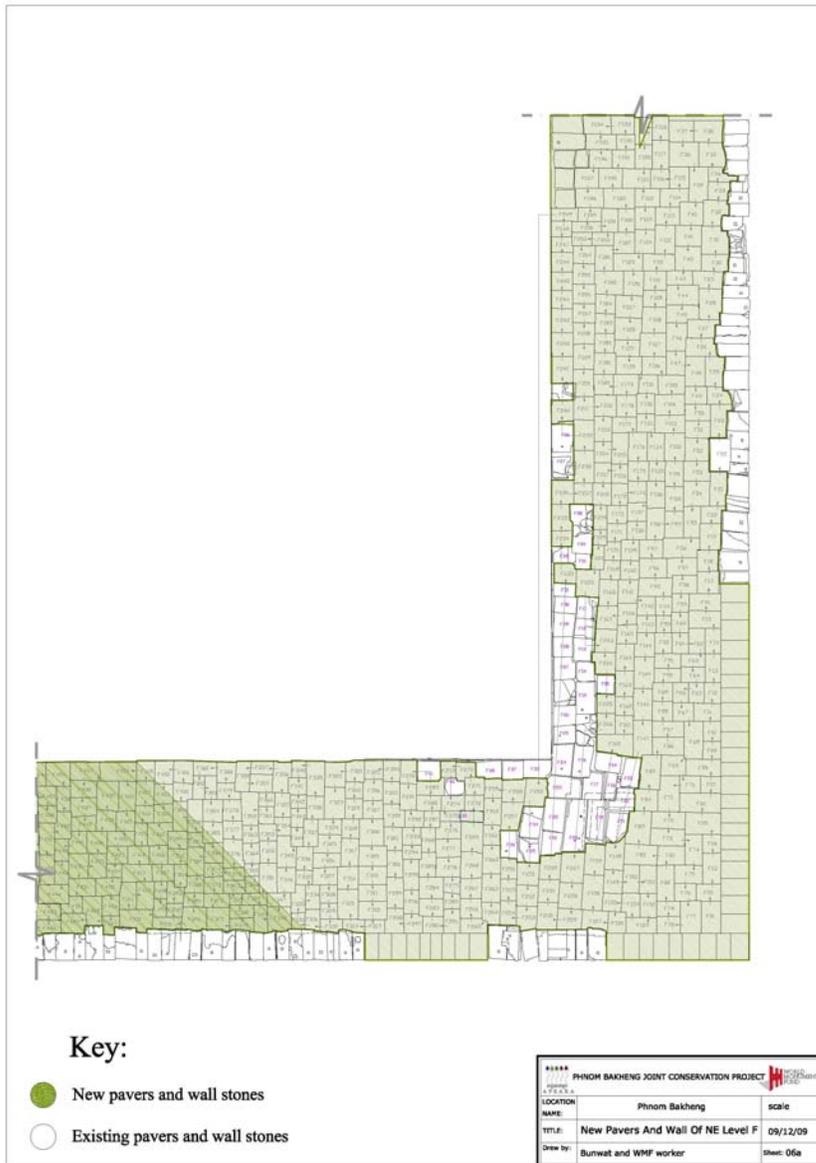
The image on the right shows mapping of the loose pieces around the upper sections of the site.



After the careful disassembly of the sections of level F that required resetting, the team exposed and cleaned bedrock.



The image at right shows the required number of stone replacement units at the east corner of level F.



This plan drawing of level F terrace shows there are almost no original stone pavers left on this terrace. 25 original stones were remaining in place or found at the site. 630 new pavers were required to complete this corner of level F. During the course of work, a number of unforeseen conditions arose, forcing WMF to move slowly and work closely with APSARA to design appropriate solutions. In all cases so far these unforeseen circumstances were related to conditions that the ancient Khmers faced as well, which are related to the fact that the bedrock used to support the sandstone façade was not perfect. In many cases the bedrock does not extend out far enough to support the far reaching corners of the temple. WMF’s work has demonstrated that ancient Khmers used laterite to fill in these voids.

In some locations there were large geological inclusions that were weak and or missing that separated sound bedrock. In many sections the decay of this laterite, used as fill by ancient Khmer artisans, is one of the main causes of the erosion at the corners and the collapse of the stone façades and stone terrace shrines.



At left and below is a geologically weak section of the bedrock at level F.

After much discussion it was agreed that WMF would continue to dig out the soft material until sound material was found on all sides. Then the opening was squared up to receive stone infill.



It was decided that laterite would be placed where support of the terrace was required and sandstone would be placed where upper sections of façades were to be supported. Working with a structural engineer, the team determined how many rock bolts were required, their size and installation locations to secure this section of wall and serve as a sound substrate on which to place the façade and paving stones. Once the substrate is sound and ready to support the façade and upper level pavers the stone was reinstalled.



At level F, 695 original stones were removed and 145 stones were missing. 6 original stones were found in our survey of the site so 139 new stones were required to fill the void. In a similar study at level E, 294 stones had to be removed and 91 stones were missing. Surveying of the site provided the means to find 9 replacement units for level E from the random stones at the site, so 82 new stones were required. As work progresses toward the top of the temple the number of new stones required diminishes significantly.



This image shows the installation of the paving system. First gravel is put down to insure the proper pitch of the terrace.



A geotextile fabric is inserted to prevent the gravel from being filled with debris and to act as a cushion to prevent the PVC membrane from coming into direct contact with the gravel. A great deal of research went into finding the correct membrane for this purpose and this was reviewed and approved by the Ad Hoc Experts.



The material has been in use in the construction and engineering field for over 30 years and withstands exposure to the elements and UV light. The material has a very low expansion and contraction coefficient, allowing vast quantities of the material to be used at one time without the installation of expansion joints. In the case of WMF's work at Phnom Bakheng, it will be concealed by the installation of pavers. Thus it will serve as the barrier for which it is intended, but will not mar the visual experience at the site. Also, in the future, if the need arises, it can be removed.



WMF's work is now addressing conservation needs at levels E and D and documentation at level C. Although WMF's current project focuses only on the East façade of the central temple, WMF was encouraged by UNESCO to give more thought to the surrounding brick shrines. Because a more aggressive approach was required to stabilize and waterproof the stone terrace shrines, it was necessary to review the brick shrines to determine if in-situ stabilization and conservation could take place.



WMF and APSARA convened the first brick shrine workshop in June of 2010. WMF selected two of the 44 brick shrines at Phnom Bakheng that were representative of the overall conditions of the majority of the brick shrines at Phnom Bakheng. A comprehensive workshop handbook was developed and provided to each of the participants in advance of the workshop.. The goal of the workshop was to establish a plan of action for the stabilization and conservation of brick shrine G10 and to develop a methodology that would be applicable to other similar brick

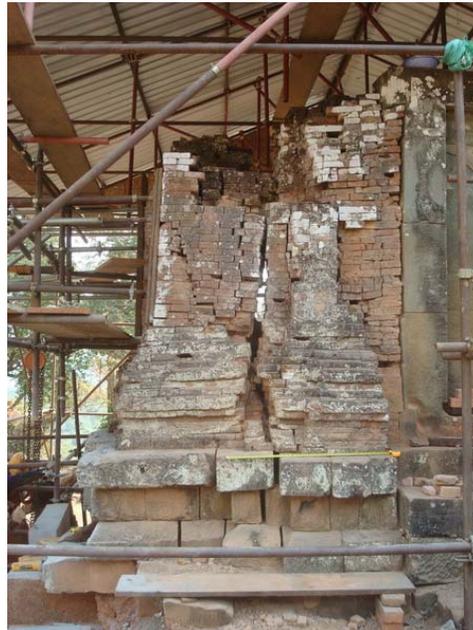
shrines at the site. APSARA and the Ad Hoc Experts believed what would be learned at Phnom Bakheng would be useful for other brick shrines throughout Angkor Archaeological Park. The handbook and results of the June 2010 workshop are available on the WMF website. To follow up on this work, in February of 2011, Giorgio Croci, a renowned conservation engineer and a member of the Ad Hoc Experts, joined WMF on site to implement many of the action plans that were developed at the June 2010 workshop.



One of the most significant efforts was to reposition sections of threatened displaced brick walls without disassembly. Using a sophisticated series of hydraulic jacks that could be precisely controlled Professor Croci worked with the WMF team to move this large section of brick back into place, as show in the images below.



Before



After

Today the APSARA brick conservation crew is working closely with WMF at brick shrine G10 to fill in the voids and cracks in this section as well as the other sections of separation. In June 2011, WMF presented this work to the Ad Hoc Experts. The review with the Ad Hoc Experts in June provided an opportunity to discuss additional issues that should be considered such as capping of brick walls, water management that will be required at the exposed shrine base platform once the protective scaffolding is removed and finally what the configuration of the reconstructed base should be. Working with APSARSA, WMF will develop plans for these activities before the December 2011 ICC meeting..