

# The Legacy of Nora, Sardinia: A Project for the Conservation, Restoration, and Maintenance of Mosaics

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**Abstract:** *This paper describes the project for conservation and maintenance of the floor mosaics of the site of Nora, Sardinia, that was designed in 2002 by the Centro di Conservazione Archeologica–Rome (CCA) for the Soprintendenza Archeologica di Cagliari. Because of the large number of visitors and the site's marine environment, extensive restorations and reburials were undertaken during the 1960s. The 2002 project was based on an analysis of the state of conservation of the mosaics and the performance of previous restorations and reburials. It produced a detailed technical program for treatment of the mosaics and a general plan for regular maintenance of the mosaics and the site. Today this project is the basis for the management plan of the Soprintendenza for Nora.*

**Résumé:** *Cette communication décrit le projet de conservation et entretien des pavements en mosaïques du site de Nora, Sardaigne, conçu en 2002 par le Centro di conservazione archeologica de Rome pour la Soprintendenza archeologica di Cagliari. Du fait de la fréquentation importante et de son environnement marin, des restaurations importantes et des réenfouissements ont été effectués dans les années 60. Le projet 2002 s'est basé sur l'analyse de l'état de conservation des mosaïques et des résultats des restaurations et réenfouissements précédents. Cela a débouché sur un programme technique détaillé pour le traitement des mosaïques et un plan pour leur entretien et celui du site. Ce projet constitue la base du plan de gestion de la Soprintendenza de Nora.*

In the current panorama of mosaic conservation at archaeological sites, a new problem has emerged that calls for active responses. This is the enormous number of mosaics exposed to the outdoors that were subjected to radical restoration

treatments in the 1960s and 1970s, following a wave of enthusiasm for technical approaches. Mosaics were detached and reapplied on cement, as conservators were convinced that this would settle things once and for all. This was based on their faith in the modern materials developed for the building trade and adopted in the conservation of ancient monuments and the techniques used for removing surface features.

In Italy, which became a major center of study because of these treatments, it soon became apparent that they not only had limitations but also caused damage to the artifacts and their context. The situation is quite different in other places, where these treatment techniques were introduced some twenty years later and are still often practiced.

By the early 1980s protests were arising from various professional groups about the inadequacy of these treatments. Archaeologists, art historians, restorers, and scientists joined forces to point out the erroneous theoretical and ethical basis for such treatments, especially the serious and obviously damaging impact on the ancient materials and the sites in general, as well as the high cost of implementing and managing them afterward. They maintained that other solutions, apart from the purely technical ones, could be used to conserve the mosaic heritage. The critical review obtained in the large “laboratory” of all the archaeological sites with detached mosaics presented a strong case for a radical cultural change in the field of archaeological conservation. This led to a theoretical and methodological reversal in policy, whereby conservation in situ has now become the guiding principle for safeguarding archaeological areas with mosaics.

As a result of this new approach the practice of in situ conservation during the past ten years has led to the

**FIGURE 1** The archaeological site of Nora. Courtesy Centro di Conservazione Archeologica–Rome (CCA).



formation of not only its own objectives but also, notably, the tools needed to achieve them. Among these—and quite apart from developing specific techniques for the direct and preventive conservation of surfaces—there is now a major emphasis on planning treatments as part of a global project of site management that includes not only the material conservation of the artifacts but also the relationships that exist among research, scholarship, presentation, and the dissemination of information.<sup>1</sup>

This paper discusses the project for the conservation and restoration of floor mosaics at the archaeological site of Nora, located in the province of Cagliari, Sardinia, Italy. In 2002 the Soprintendenza Archeologica di Cagliari (Archaeological Superintendency of Cagliari) commissioned the Centro di Conservazione Archeologica (CCA) to head a project to respond to the serious conservation problems posed by the mosaics. It was possible to analyze thirty-one pavements in detail, totaling 720 square meters of mosaics. About half had been detached and relaid on reinforced concrete in the 1970s, thus permitting a comparative study of their state of conservation under different display conditions in the same environmental and archaeological context. It also provided an opportunity to study the effect of contact coverings placed over some pavements in the early 1980s and to evaluate the benefits some twenty-five years after they had been placed on surfaces that had been first restored and laid on cement and on surfaces that were still in situ on original layers.

### The Archaeological Site of Nora

Founded by the Phoenicians, Nora was colonized by the Carthaginians and conquered by the Romans in 238 B.C.E., becoming the capital of the Roman province under their dominion. It is located by the sea on the promontory of the Cape of Pula, which dominates the Gulf of Cagliari in the southeast of Sardinia (fig. 1). The gradual penetration of the sea and the arrival of the Vandals in the fifth century C.E. led to its slow decline and eventual abandonment in the eighth century (Tronchetti 1986). In the stratigraphic phases now open to the public, the city is characterized by a series of important mosaics, notable for the quality of their decorative compositions and extent. The site spreads over more than 3 hectares and is composed of fourteen monumental groups (720 square meters of mosaics), all belonging to the Roman phase of its life. It has public and private buildings, including a theater, a basilica, baths, temples and houses, streets and squares. With white beaches and crystal-clear sea nearby, the site draws tourists from all parts of the world, especially in spring and summer, and is a focus of regional development.

The conservation history of the mosaics and their display begins in the second half of the twentieth century with the first systematic excavations of the site. Although the city was known from the sixteenth century for its ruins emerging from the water, it was only extensively excavated in the period between 1952 and 1960 by Gennaro Pesce, then superintendent of antiquities of Sardinia. He brought to light most of the surface that

is now on display. Further archaeological investigations were conducted in the late 1970s and early 1980s by Carlo Tronchetti of the Cagliari Superintendency, who uncovered the entire area of the baths near the sea. Research activities continue today under the direction of the Cagliari Superintendency, in collaboration with various Italian universities.

After the excavations in the 1960s an initial major restoration campaign was started in order to prepare the site for public display. Following the popular approach of the time, most of the pavements were detached, mounted on reinforced concrete panels, and relaid in situ, again on cement. By the end of the 1970s, some twenty years after treatment, the restored surfaces presented such serious deterioration that the Superintendency, in the person of Tronchetti, sought various solutions to protect the mosaics. The practice of detachment was abandoned, and newly excavated mosaics were left in situ. The treatments varied according to the seriousness of the condition of the surfaces, as did the decision as to whether or not to leave them on view. Eight pavements still on their original bedding layers and one restored pavement on reinforced concrete were given protective contact covering as follows: a layer of about 5 centimeters of river sand (or quarry sand, without salts), a layer of polyethylene, and a layer of lime-cement mortar of an average thickness of 5 centimeters. This completely isolated the surfaces from exposure to the

environment (fig. 2). Treatment of the remaining, unrestored pavements was limited to reinforcing the edges and filling the lacunae with lime-cement mortar.

From 1988 to 1990, given a dangerous worsening in the condition of the still-exposed mosaics relaid on reinforced concrete, further treatments were performed to restore the restorations. Either the entire surface was detached again and the iron armature removed, or the tesserae were lifted and then replaced after the bars were removed. These treatments affected only those pavements restored in the 1960s; the pavements still on reinforced concrete are currently in desperate condition.

### The Project for Conservation of the Mosaics

The objective of the project requested by the Cagliari Superintendency in 2002 was for the CCA of Rome to devise a global strategy for conserving the mosaics for both the short and the long term. The idea was to categorize and prioritize problems and to develop a plan for project implementation and the management and supervisory activities of the Superintendency. To formulate the project, the following phases were undertaken:

1. collecting information to determine the characteristics and conditions on the site;

**FIGURE 2** The protective contact covering of lime-cement mortar completely isolates the surfaces from contact with the environment. Courtesy Centro di Conservazione Archeologica-Rome (CCA).



2. analyzing data, defining the site, and identifying problems and their types (condition, regional context, threats, human resources, users, managers, development of research and knowledge);
3. listing treatment priorities; and
4. defining a strategy for the site's conservation and management based on priorities and drafting a comprehensive action plan including operations and materials as well as necessary professional and financial resources.

**1. Collecting Information**

The first phase was dedicated to examining every component of the site. This included collecting all available information along with a technical analysis of the current situation in order to discover the physical characteristics of the mosaic surfaces; to quantify their exact extent; to reconstruct the conservation history from the time of excavation to the present; and to clarify the relationship between the current state of affairs, the environmental parameters, and the normal habits of life, use, and management of the site. The procedure was as follows:

- collecting archival photographs of the mosaics and all available written information, either published or in the form of internal reports;
- studying existing archaeological publications about the site;
- directing activity in the field to analyze and document all the pavements;
- producing base maps to record and describe the current condition (documentation); and
- visiting existing infrastructure (routes, visitor services, site museum) and interviewing personnel responsible for certain tasks, with particular attention to tour guides.

At the end of the study, it was possible to

- estimate the exact extent of the exposed surfaces;
- define and document their current condition;
- clearly identify the risk, deterioration factors, and deterioration processes under way;
- trace a picture of the relationship among the exposed mosaics, visitor routes, and current use.

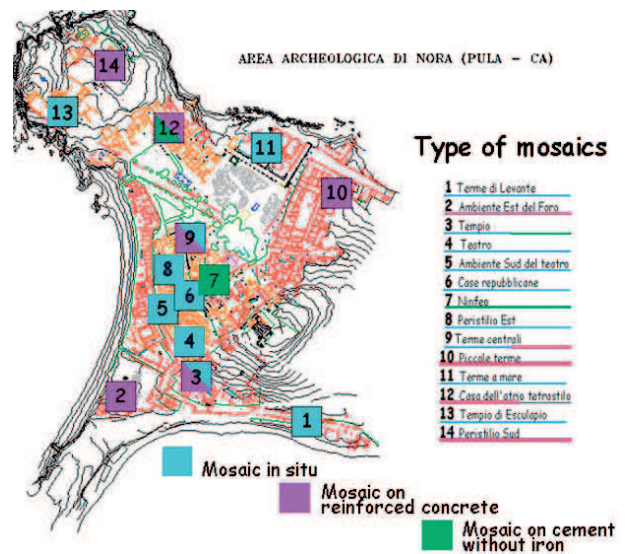
The results of this first phase led to the drafting of a detailed report covering each mosaic analyzed: dimensions, composi-

tional character, visible appearance of deterioration, conservation history (including the period of exposure and presence of preceding restoration treatments and their typology), the onset of deterioration and mechanisms at work, an evaluation of the gravity of the material condition found, and the degree of risk. A further element, studied individually for each monumental group, was presentation to the public in its current state. The evaluation process included the importance of the monument and its mosaic surfaces for understanding the site, the efficacy of any possible use, and the direct effect on its condition.

Three categories were identified among all the mosaics (fig. 3):

1. pavements laid on original bedding layers and never detached;
2. pavements detached and relaid on reinforced concrete and still on reinforced concrete;
3. pavements detached and relaid on reinforced concrete, with subsequent removal of the metal parts (1988–90).

This initial division corresponds to a substantial difference in the condition of the pavements. In fact, it became apparent that the greatest risk is to the pavements still on reinforced



**FIGURE 3** Three categories of the Nora mosaics. Courtesy Centro di Conservazione Archeologica–Rome (CCA).

**FIGURE 4** Central baths, *frigidarium*. The pavement is on reinforced concrete with metal rods and suffers from such serious deterioration that the survival of the original material is at great risk. Courtesy Centro di Conservazione Archeologica–Rome (CCA).



concrete with metal rods (fig. 4). For some years now mosaic specialists have known the reasons for this situation: oxidation and consequent expansion of the iron, the excessive hardness and low porosity of cement, and solubilization and crystallization of soluble salts—all these factors take their toll on the ancient materials.

The mosaic pavements of Nora can be divided into three broad categories based on their condition:

(1) *Pavements on original setting beds*: Generally, the original preparatory mortars of these pavements have partially or totally disintegrated, with resultant detachment of the *tessellatum*, which is therefore often resting on the ground, as well as formation of lacunae. Where the mortars are still partially cohesive, there is cleavage between the original layers and infiltration of dirt and other organic material between the tesserae and the layers beneath, leading to the growth of weeds. The surface of the tesserae is covered with biological incrustations, lichen in particular.

In this category only two cases are serious. One is the pavement of the Temple of Aesculapius, which has been left exposed since excavation in an area that is especially unfavorable because it is close to the sea and far from the usual visitor routes. The other is the *apodyterium* of the central baths, which had been protected since excavation by a tile roof (perhaps because of its condition) and was then pro-

tected again in the 1980s with a contact covering. Almost all the other pavements that are still in their original position exhibit, to a similar degree, the same forms of deterioration. Seven of these can be defined as stable, thanks to the contact coverings that keep their microclimate in equilibrium and do not expose them to mechanical damage. In the four cases that have good general surface condition, this is due to their protected location and to the composition of the original layers. This is the case with the *opus signinum* and the *spicatum* of the Republican houses. Because they are situated lower than the adjacent spaces and because of the presence of *cocciopesto* (lime mortar with crushed brick) in the composition, their materials possess general compactness and resistance.

(2) *Pavements detached and reapplied on reinforced concrete in the 1960s*: The majority of these pavements suffer from such serious deterioration that the survival of the original materials is greatly at risk. Because of the total instability of the restoration materials on which the mosaics are bedded, entire portions of *tessellatum* are literally disappearing. On this type of pavement one generally finds explosions beneath the tesserae, with resulting detachment and raising of the *tessellatum*, cracks, subsidence, and progressive and exponential increase in lacunae, along with growth of roots under the tesserae.

Of the eleven pavements bedded on reinforced concrete, only one—Room L of the House of the Tetrastyle Atrium—can

be defined as stable. This is due to the presence of the contact covering that sealed the pavement, impeding its interaction with the environment for more than twenty years. The two principal factors responsible for the current poor condition of the surfaces are exposure to the marine environment since excavation and the damaging restoration materials used in the 1960s.

(3) *Pavements detached from reinforced concrete support and relaid on cement alone:* These pavements are generally in good condition thanks to their restoration in the late 1980s, when iron elements in the bedding layers were removed. While this treatment eliminated the major element of instability, it was not without consequences, given the ample presence of patching along the cuts that were made while removing the sections of the mosaic. This patching indicates a high percentage of loss of original surface.

Although these pavements were exposed for twenty years after this treatment, they did not suffer rapid or dramatic deterioration. The three pavements that were re-restored are generally solid, except for occasional detachment of the *tessellatum* from the cement layer beneath and a slight loss of tesserae. Forms of decay are found principally on the tesserae surfaces and the interstitial spaces, with extensive accumulations of dirt and microflora.

## 2. Analyzing Data and Defining Treatment Priorities

Comparative analysis of the data led to defining and characterizing categories of problems, which in turn allowed for the planning of specific types of treatment to meet the various conservation needs of the pavements and the creation of a list of priorities. The chemical-physical processes acting on the artifact from the marine environment (i.e., rain, wind, strong and prolonged exposure to sun, frequent thermal fluctuations, and a significant presence of chlorides in the environment) were found to be the main factors responsible for the decline in the condition of the mosaics. These mosaics were already strongly compromised by the natural deterioration of their constituent materials, especially from the numerous imbalances introduced by past restorations. Moreover, some mosaics are directly exposed to erosion from the sea nearby.

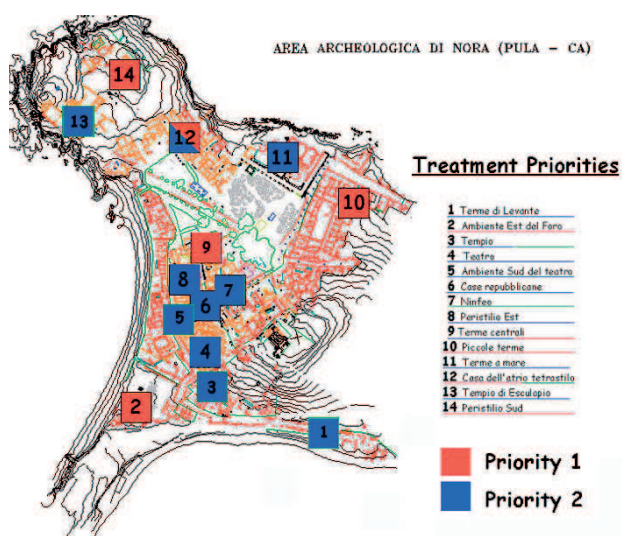
The impact of poorly controlled tourism was also found to be among the principal causes of damage. The surfaces were subject to light and heavy damage from improper visitor behavior, such as walking on the mosaics or removing tesserae. This results from the lack of maintenance of paths, the illegibility of information panels, and insufficient control of the entire visitor access area, which receives peak numbers in summer without a corresponding increase in guards or additional ordinary maintenance.

In brief, the general picture regarding the state of the mosaics shows large surfaces where the mosaic fabric is detached from the support, the tesserae no longer adhere to each other, the original mortars are mostly crumbled or completely lost, and the materials used in previous restorations have activated the dangerous phenomenon of detachment of the *tessellatum*.

An encouraging fact that emerged from the comparative study was the efficacy of stabilization and protection of the surfaces through contact covering, which was carried out in the 1980s on nine pavements. In the case of those mosaics still on original layers and in the sole case of a mosaic on reinforced concrete, these coverings kept the mosaics' condition unaltered over the course of twenty years. The mosaics on original layers and those applied on cement without reinforcement are in serious but not alarming condition. In contrast, all those on reinforced concrete are in an advanced state of decay and urgently need treatment.

Starting from these objective considerations, the pavements were divided according to a hierarchy of treatment priority and a two-phase program devised (fig. 5):

- phase 1, treatment of pavements needing urgent and immediate attention;



**FIGURE 5** Treatment priorities determined for the mosaics. Courtesy Centro di Conservazione Archeologica-Rome (CCA).

- phase 2, pavements that can be treated later on—thanks to a medium to low level of deterioration or to contact protection that maintains the status quo.

### 3. Defining a Strategy and Drafting an Operational Plan

The main objective of the strategy was to create a long-term, sustainable conservation approach for Nora's mosaic heritage and to keep down the future management costs without diminishing the historical and archaeological interest of the monuments and the site as a whole. In other words, a compromise was sought between pure conservation needs and developing the site's tourism potential. It was felt that the greater the public appreciation and awareness of archaeological heritage and the benefits of economic and social development of the region, the greater the benefit to safeguarding the heritage itself—in a case in which presentation to the public is managed as part of a defined cultural program with all the structural and auxiliary support required.

Therefore, two treatment approaches were contemplated. One was a treatment aimed at conserving the surfaces, with a study of various specific treatments for each category of mosaic noted, including preventive conservation measures and maintenance plans. The other was the management and strengthening of the current visitor facilities for the site (which already has an archaeological museum in the nearby town of Pula), visitor routes, information panels, and other services such as a café, bookshop, guides who give free tours for the Superintendency, and shaded parking areas.

### Restoration and conservation treatments

The following methodologies were given precedence when formulating the project:

- in situ maintenance and consolidation of the pavements not already detached;
- detachment, restoration, stabilization, and reapplication in situ of the pavements that are now on reinforced concrete;
- use of lime-based materials compatible with the original materials and structures;
- full documentation of the current state of affairs and of the operations to be performed.

Three types of treatment were identified for the various conservation needs of the pavements at Nora. The choice of one type or another was dictated by the condition of the original materials, by the presence of previous restorations

carried out with unsuitable materials, by the condition of such restorations, and by the presence or absence of suitable environmental conditions for keeping the pavements in situ.

(1) *Conservation in situ through consolidation*: This treatment can be performed on pavements that have their original preparatory layers and on pavements that—although previously detached and relaid in situ—are basically in a solid and stable condition.

(2) *Detachment, restoration in the workshop, and replacement in situ*: This treatment is needed for all those pavements detached and relaid in situ on reinforced concrete during previous treatments that now show considerable deterioration due to the materials used in the restoration but also have environmental conditions that permit their replacement in the original position.

(3) *Detachment, restoration in the workshop, application on honeycomb panels, and display in the museum*: This treatment is needed for all those pavements detached and reapplied in situ on reinforced concrete during previous treatments that have major deterioration and almost total loss of the original *tessellatum* and do not have the environmental conditions necessary for being kept in situ for the long term.

The various typologies entail thorough documentation, including thematic base maps and photographs to register the current condition of the surfaces and all the treatments to be performed, such as cleaning of surfaces, consolidation of tesserae, repairing the interstitial mortar, and treatment of lacunae. An integral part of the treatment involves plans using indirect measures to prevent damage, managed presentation of the mosaics with periodic covering/exposure along the visitor routes, and implementing schedules for regular maintenance and long-term conservation. Each type of treatment has its related cost estimate, which clearly shows the high expense of treatment for those mosaics that are now on reinforced concrete.

### Preventive conservation and maintenance

Long-term conservation of the mosaic heritage of Nora calls for the implementation of combined action plans to minimize the environmental impact on the surfaces, control deterioration factors, and maintain the positive benefits of the conservation work performed. Given that the mosaics are in an outdoor setting with unfavorable environmental factors (growth of weeds and lichen, proximity to the sea, wind, pronounced temperature changes) and are also subjected to heavy tourism during spring and summer, a plan was devised to respond in a balanced way to the needs of conservation and those of public enjoyment of the site. The plan involves a program of covering and exposure

of the mosaics along the visitor route, combined with regular maintenance of the exposed mosaic surfaces.

The covering/exposure program will reduce the total surface area of mosaics exposed to the risks of environmental deterioration (and hence management costs) and will also limit the exposure time to periods of minor climatic risk. The regular maintenance program—through direct action performed on a consistent and continuous basis—will eliminate or limit the resurgence of alteration phenomena on the surfaces due to environmental decay factors that cannot be prevented. The combined action of these activities will ensure the enhancement of the site and its conserved monuments, increase visitor enjoyment, and drastically reduce the impact of decay factors on the original materials.

### **Program for covering or exposing the mosaics**

The program for periodic or permanent covering of the mosaics was devised with the following factors in mind: condition, exposure to environmental risks, risk due to wear and small acts of vandalism by visitors, typology, geographic location along the visitor itinerary, and enhancing understanding of the monument and the site.

The pavements were classified on the basis of these factors and grouped according to different methods of display:

- always visible: a maintenance plan was foreseen for the mosaics on permanent view.
- seasonal visibility: implementing a schedule for seasonal covering with a temporary contact cover of geotextile bags filled with expanded clay granules, which will protect the surfaces from chemical, physical, and biological decay during the period of greatest climatic risk (winter) and lowest tourist presence.
- always covered: permanent contact covering was proposed for pavements far from the main visitor routes and/or those exposed to environmental and human risk factors such that they might not survive even with regular maintenance. Given the proven efficacy of the covering previously used, the mosaics will be protected using the same system.

### **Maintenance program**

Maintenance must be performed on the mosaics that are always visible and those covered seasonally while also considering the paths and information panels. The maintenance program will involve cleaning the surfaces, manual and chemical weed

removal, biocide treatments, inspection of materials, updating of information panels and replacement of damaged or illegible ones, and inspection of paths and routes with eventual modifications if they are not effective. These operations must be continuous and performed at regular intervals (table 1).

### **Conclusion**

Fifty years after excavation Nora is one of the many archaeological sites with mosaics where conservation solutions were tested and became part of the history of archaeological restoration, from detachment and reapplication on reinforced concrete to temporary coverings to contact coverings and re-restoration. While strolling through the site, one can thus read the attempts made over half a century to reconcile the needs of conservation with those of heritage appreciation and knowledge. One can read the errors made and see the devastating impact of massive technical-type treatments and the sad outcome of the effects of natural forces and of human action or the lack thereof.

What clearly emerges is that so far the approach has been to adopt specific solutions one case at a time, without a broader perspective that sees the problems and the context as a whole. In other words, there is no global overview, not only of the risk factors, but also of the objectives set forth for future use of the archaeological area, including the complex relationship among conservation, management, and cultural use and the cost of operation. A critical examination of this situation allowed us to evaluate the material conservation of the works in real terms and to quantify the financial ramifications of the treatments that until recently were emblematic of our archaeological sites. We were also able to see more clearly the validity of the technical and methodological solutions offered by conservation *in situ*.

At Nora we have inherited mosaics that—precisely because they were restored—are now seriously damaged. Some have been irremediably transformed and will require substantial funds for conservation. We also inherit the certainty of a proven technical tool such as contact covering, which merits increasing consideration for the prevention of damage and for long-term conservation, together with regular maintenance. Moreover, we inherit the important signs of a cultural change in process. The Nora project is a key example of policy planning on the part of a local administration that intends to perform its duty of heritage protection, following a program that has examined the various current priorities and cultural objectives and attempts to acquire the tools that will permit the best autonomous, long-term management of the treatments and resources available.

**Table 1** Program for the presentation of the mosaics and scheduled time for maintenance

Locale	Mosaic Surface (m <sup>2</sup> )	Presentation and Maintenance	Annual Frequency	Workdays per Year
Baths of Levante, room A	91	Seasonally covered, with ordinary maintenance	7	11
Forum	12	Displayed in the museum of Nora with ordinary maintenance	12	2
Temple	21	Exposed, with ordinary maintenance	12	9
Theater	14	Seasonally covered, with ordinary maintenance	8	4
Republican houses	25	Permanently covered; no maintenance required	0	0
Spaces south of theater	9.5	Permanently covered; no maintenance required	0	0
East peristyle portico	33	Exposed, with ordinary maintenance	12	4
East peristyle porticos	23.5	Permanently covered; no maintenance required	0	0
Nymphaeum	83	Exposed, with ordinary maintenance	12	12
Central baths, <i>apodyterium</i>	39	Seasonally covered, with ordinary maintenance	7	11
Central baths, <i>frigidarium</i>	101.5	Exposed, with ordinary maintenance	12	12
Small baths, corridor	25	Permanently covered; no maintenance required	0	0
Small baths, <i>frigidarium</i>	9	Exposed, with ordinary maintenance	12	4
Small baths, <i>apodyterium</i>	18	Seasonally covered, with ordinary maintenance	7	11
Baths on the sea	63	Exposed, with ordinary maintenance	12	9
House with Tetrastyle Atrium	78.5	Exposed, with ordinary maintenance	12	12
Temple of Aesculapius	70	Exposed, with ordinary maintenance	12	12
South peristyle	4	Displayed in the museum of Nora with ordinary maintenance	12	2
<b>Total workdays per year</b>				<b>115</b>

## Acknowledgments

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## Notes

- 1 For an analysis of the theme of conservation in situ, the issues connected to its implementation, and the objectives involved, see Melucco Vaccaro 2003: 17–22.

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