DOCUMENTATION OF THE LOWER BATH IN METROPOLİS, TORBALI, İZMİR FOR THE ASSESSMENT OF HERITAGE CHARACTERISTICS

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ABSTRACT

DOCUMENTATION OF THE LOWER BATH IN METROPOLIS, TORBALI, İZMİR FOR THE ASSESSMENT OF HERITAGE CHARACTERISTICS

The study evaluates the excavation results of the Lower Bath and *Palaestra* in the archaeological site of Metropolis, Torbalı, İzmir with an eye on its original qualities and alterations. In fact, the understanding of the alterations will enable one to take conscious decisions for the preservation of the bath ruins. First, the existing scaled drawings of the Bath ruins were gathered and evaluated. Then, the historical background of the Roman Bath buildings was investigated. Rectified image mosaics based on photogrammetric survey are combined with plan, sections and elevations based on tachometric survey. In addition, a 3D model of the present state of the building was produced based on photogrammetric and tachometric survey. The 2D representations were used for mapping the original elements and the altered ones. The obtained data is supported with historical research and comparative study of similar buildings. The end results are presented in large appended tables. In turn, the heritage characteristics of the Lower Bath ("Aşağı Hamam" or "Han Yıkığı") in Metropolis, Yeniköy, Torbalı, İzmir is documented in detail. The Lower Bath has an asymmetrical plan organisation. It is middle in scale (812 m^2). It is a typical example of the Roman Baths dated to between 2^{nd} and 4^{th} century. Its original features were sustained onwards. However perception of its third dimension has been demolished. It is important to plan a documentation study systematically as parallel to the excavation studies and to develop conservation decisions.

ÖZET

MİRAS ÖZELLİKLERİNİN DEĞERLENDİRİLMESİ İÇİN METROPOLİS, TORBALI, İZMİR'DEKİ AŞAĞI HAMAM'IN BELGELENMESİ

Bu çalışma, Torbalı, İzmir'de yer alan Metropolis arkeolojik alanındaki Aşağı Hamam'da bu güne değin yürütülmüş olan kazılarda ulaşılan bulguları; özgün nitelikleri bağlamında değerlendirmektedir. Böylece dönem müdahaleleri açıklık kazanacak ve hamam kalıntılarının korunması için bilinçli kararlar alınması mümkün olabilecektir. Çalışma kapsamında ilk olarak, hamama ait ölçekli çizimler bir araya getirilmiş ve değerlendirilmiştir. Daha sonra, Roma Hamam yapılarının tarihi geçmişi araştırılmıştır. Fotogrametrik çalışmaya dayanan düzeltilmiş imaj mozaikleri, takometrik çalışmaya dayanan plan, kesitler ve cephelerle birleştirilerek mevcut durum ayrıntılı olarak hem iki boyutlu, hem de üç boyutlu sunumlarla betimlenmiştir. 2 boyutlu sunumlar özgün ve değişmiş elemanları haritalamak için kullanılmıştır. Elde edilen veriler tarihi araştırma ve benzer yapılarla yapılan karşılaştırmalı çalışma ile desteklenmiştir. Sonuç ürünler eklerde yer alan, geniş kapsamlı tablolarda ayrıntılı olarak sunulmuştur. Buradan hareketle Metropolis, Yeniköy, Torbalı, İzmir'deki Aşağı Hamam'ın (Han Yıkığı) miras özellikleri mekansal ve yapısal nitelikleri ile tariflenmiştir. Aşağı Hamam asimetrik bir plan kurgusuna sahiptir. Orta ölçekli bir hamamdır (812 m^2). İkinci ve dördüncü yüzyıl arasına tarihlenen Roma hamamlarının tipik bir örneğidir. Özgün niteliklerini koruyarak bugüne kadar ulaşmıştır. Ancak, üçüncü boyut algısı zarar görmüştür. Yürütülen kazı çalışmalarına paralel olarak sistemli belgeleme çalışmalarının planlanması ve koruma ölçütlerinin oluşturulması önem taşımaktadır.

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LIST OF ABBREVIATIONS

SLR camera	Nikon D70s equipped with 28 mm lens
Theodolite	Nedo ET-5 Theodolite
PicTran	Picture Transfer Software
Photoshop	Adobe Photoshop CS2 Software
SketchUp 7	Google SketchUp 7 Software
SketchUp 8	Trimble SketchUp 8 Software
AutoCAD	AutoCAD Architecture 2008 Software
PC	Personal Computer equipped with equipped with a hardlock input, 2.00 GB RAM and NVIDIA GeForce 8400M GS display card with 1008 MB memory.
w	width
h	height
di	diameter
d	depth
(w x l x h)	width x length x height
t	thickness
r	rise
cs	clear span
gc	ground clearance
s	scale

CHAPTER 1

INTRODUCTION

Bathing has an old history. Besides the purpose of cleaning, it is a social and cultural activity.

Baths are the places where these activities are realised. Bathing was an important tradition in Roman Period. Documentation of the Roman baths, which are historical evidences of this tradition, is important. In the ancient city of Metropolis, Torbalı, İzmir; three Roman bath ruins have been documented so far. The Lower Bath in Metropolis was selected as the case study of this thesis.

The first step of conservation is documentation. ICOMOS Charter for the Protection and Management of the Archaeological Heritage (1990) emphasizes the importance of gathering data upon the fullest possible knowledge of the extent and nature of the archaeological heritage. The investigation technique prefered in the Lower Bath, Metropolis, Ionia is total excavation (Aybek, et al. 2009). An archaeological survey is a basic obligation in developing strategies for the protection of the related resource (ICOMOS, 1990, article 4). The documentation method of the historic data should be selected correctly. In this study, it was preferred to apply the combination of the photogrammetric and tacheometric techniques for the documentation of the heritage characteristics of the Lower Bath. This combined technique is evaluated with its advantages and disadvantages.

1.1. Problem Definition, Aim and Method

Assessment of the architectural heritage can be done with classified written data besides 2D and 3D visual documents. Defining the optimum method that will be used for the assessment of the data including written and drawn elements is a contemporary discussion subject. In the scope of this study, it was studied for developing a documentation method that will make easier to assess the architectural heritage characteristics.

The ruins of the Lower Bath are partially excavated at present. Within the limits of this study, the excavation results gathered until August 2012 have been taken into consideration. Understanding the nature of alterations of the case study bath ruins is a prerequisite for its scientific evaluation. In turn, restitution hypotheses and the protection decisions can be formulated at the next studies. So, the aim is to combine photogrammetric and tachometric techniques in order to survey the Lower Bath, Metropolis, Torbalı, İzmir and to decipher the heritage characteristics so that the conservation decisions can be prosperously formulated. The characteristics of the bath ruins were mapped on rectified image mosaics enriched with scaled CAD drawings. The end results are presented on thematic tables. The details of the method are as below:

- Before taking photographs of the archaeological heritage, targets were stuck on the facades with glazier's putty. Every photo includes minimum four targets and the photos were taken sequentially sharing minimum two targets.
- The single images were rectified by using the coordinates of the targets coming from the theodolite measurements and they were used to prepare photo mosaics. The photo mosaics were prepared appropriately in 1/50 scale.
- The surfaces which could not be rectified were drawn with the measurements coming from the second tachometric survey that was realised specifically for this purpose.
- The case study building was modelled by using the scaled photo mosaics prepared.
- The case study was compared with similar type and period buildings in Anatolia.
- Spatial and structural characteristics, alterations, failures and deteriorations of the case study were presented on tables.

1.2. Content

First, the Roman Baths in Western Anatolia are introduced and an overview of the studied building type based on excavations and survey of the building remains at the surface is provided. Secondly, details of the documentation process are discussed under the headings of data gathering, processing and classifying. Thirdly, the elements of the Roman Bath design that are characteristic of the Roman architecture in Anatolia are outlined. Fourthly, heritage characteristics of the case study are identified. Finally, the relevancy of the proposed method is discussed.

1.3. Literature Review

There are many researches on single image rectification, 3D modelling and attribute data provided from a model (information management, BIM, database). The most important main institution which paves the way for discussing these arguments is CIPA.

Single image rectification is a documentation method based on the photographs taken parallel to the object surface. The photogrammetric evaluation aimed photographs are rectified and scaled representations are obtained (Bryan, et al., 2009). There are a lot of studies that were realized from its beginning onwards. Hemmleb, et al. (1997) discuss single image rectification techniques and shows that the suitable technique should be selected according to the surface geometry of the facades. As a result of this study, it is understood that pictorial representations provide detailed information to the user. The image mosaics of the facades at Qayseriyyah Souq (market) in Bahrain were produced by Elzawani, et al. (2007). The surfaces at different plane were separately rectified in Adobe Photoshop CS2 software and then, they were brought into the same reference plane. Digital data composed of the combined photo mosaics provided lasting, measurable documents of the Qayseriyyah Souq, so future changes can be added to it easily. It is seen that rectification is generally applied to the facades. Plan rectification is applied as limited.

Modelling of the historical monuments has been a research study for last decade. 3D models produced are grouped as two: realistic building models and virtual building models. In this study, 3D model of the present situation of the historical buildings are

emphasized. 3D model can be produced by using different options such as laser scanning, stereo photogrammetry and bundle adjustment etc. (Hamamcıoğlu-Turan, 2004). Alshawabkeh, et al. (2005) formed 3D photorealistic models of the Alkasneh monument in Petra city. Firstly, triangulated surfaces were formed by using data coming from 3D laser scanning and then, texture mapping was applied. Visible parts without any occlusions could be mapped with textures, so different viewpoints were used. The textured 3D model was obtained easily. Remondino, et al. (2009) documented the Great Inscription of Gortyna, Crete by using reality based 3D technologies such as range sensors and at the same time, some detailed partial areas was modelled by using digital images also. The surface models produced from the multi photo matching method and produced from the triangulation based range data were compared partly. They both provided detailed information. The 3D model obtained can be used to produce a physical replica of the epigraphic text. Gruen, et al. (2003) was documented Great Buddha statue in Bamiyan, Afghanistan after demolishing by Taleban militia. Its older images were collected and its metric images taken before were used. They were oriented by using bundle adjustment. 3D point cloud was generated. Triangulated shaded model and the textured model were obtained. The point cloud was imported to Starrag NF100 machine and the model of Buddha was produced in scale 1/200.

Defining and developing a method for the integration of the non-spatial and spatial data in a database has been the scope of the recent studies. This topic is a newer than the other two topics. Researches focus on obtaining the non-spatial data via a model. Interface of database consists of the model. There are many researches from different nations. Researches of the French and Italian workgroups are remarkable. Chevrier, et al. (2010) examined to model the architectural elements with the help of parametric components. They developed a Graphical User Interface (GUI) which provides opportunity for making adjustments. Openings and lintels were used as case study. It is understood that this method helps to save time. De Luca, et al. (2011) aimed to organise multiple representations around a semantic description model to define a system for the multi-field analysis of the historical buildings. The courtyard of the Sorbonne was used as the case study. Informatic systems were applied and Nubes used as a tool. In this article, it was introduced an integrated approach for producing digital representations of the historical buildings with the aim of the analysis and documentation in an effective way. Agugiaro, et al. (2011) acquired high resolution 3D data of the archaeological Maya site in Copan (Honduras) by using terrestrial

photogrammetry, unmanned aerial vehicle (UAV) platforms and terrestrial laser scanning. QueryArch3D tool was used and discussed. As a result, the 3D models were integrated with attribute data and 3D navigation of the models in a virtual environment was provided.

Besides the technical dimension, there is an information production on the archaeological monument. The studies based on Metropolis archaeological site was done systematically. They were published at the excavation results symposiums. Excavation reports prepared were presented to the Ministry of Culture and various articles and books were published (Appendix R). These are systematic studies based on the archaeological information. Apart from that, there are various projects regarding Metropolis archaeological site.

CHAPTER 2

HISTORICAL EVOLUTION OF ROMAN BATHS

In this chapter, the historical evolution of the Roman Baths, with emphasise on Anatolian examples, history of the antique city of Metropolis and the Roman Baths in Metropolis will be introduced.

2.1. Bathing Traditions in Pre-Roman Period

There were no independent baths in Asia Minor, Near East and America in the early periods (Abbasoğlu, 1997). There were bathing spaces in the palaces and in the houses of rich people. The early baths in America were built close to the natural water sources by Incas. Common baths in China were constructed at later periods. Only aristocrats had private baths. Baths had a holy meaning in India. Bathing was important in terms of religion in Mesopotamia and rich people had baths. The oldest bath in Asia Minor is *Mari Palace* in Tell Hariri, Syria (5^{th} century B.C.). It is understood that baths in Mesopotamia were not independent units and were not part of daily life. Bathing first started to be a widespread activity in Greek culture, but independent baths were first seen in Roman period (Abbasoğlu, 1997).

It can be said that there are various factors which gave way to the birth of Roman Baths: mid Italy farm baths (*lavatrina*s), large spas, *balnea* of the Greek culture and the *gymnasium*s and *palaestras* of the late Hellenistic period (Yegül, 2011).

The Greek settlers, colonized in Southern Italy and Sicily, played a role in the evolution of the Roman bathing culture. Their baths inspired Roman baths, but the heating system of their baths was primitive in comparison with the ones of Roman baths. Beside this, the idea of the heating spaces at different levels is not seen in the Hellenistic baths. Presence of a *gymnasium* or *palaestra* in the bath or bath complex is another feature of the Hellenistic baths that inspired Roman baths (Yegül, 2011).

Any trace of bathing room or bath is not observed before 2^{nd} millennium B.C. in Anatolia. A room was discovered for cleaning at Later 5 of the palace at Beycesultan (1850-1650 B.C.).

2.2. Roman Bathing Traditions

Roman Baths can be grouped into two types according to their water usage: thermal baths (spas) and the baths that heat their water. Their plan organisations are different from each other. Spas are not discussed within the limits of this study.

Bathing culture has become gorgeous at the Roman period, so, the architecture of the baths developed a lot in this period. The bathing tradition was continued by the Byzantines and Turks (Uluşans, 2003).

Romans refer to their Baths as *balneae* or *thermae*. *Balneae* are modest scaled institutions in comparison with *thermae*.

It is documented that the bathing tradition in Rome and Campania Region was started after 2nd and 1st century BC. One of the earliest written sources on Roman Baths was the "New Comedy" of Plautus written in between 205-180 B.C. Also, the archaeological remains of bath buildings dating the same time in Italy provide information (Yegül, 2011).

The universal acceptance is that bathing is a central event in daily life of Romans. Baths were open to anyone who could pay the entrance fee. The baths were ideal institutions to create classless society illusion. Since every type of people such as poor and rich, wise and fool, etc. were together in the bath. Romans were waking up early. In the afternoon, they were eating light meals and taking a nap. Then, they were going to the bath for a few hours (Yegül 2011). It can be understood from many inscriptions that men and women bathed separately. However, there could be mixed bathing in some cases because of the toleration of the emperor.

Romans were bathing once every eight days. Slaves were allowed to have bath at the holidays. However, bathing became more important starting with the 2nd century B.C. and the number of *balneum* and *balneae* increased (Yegül, 1992).

When an aristocrat went to a bath, there were servants with him to carry his linen towels and the other properties such as exercise and bathing garments, sandals, toilet kit, etc. He paid entrance fee, took off his clothes, put them in a certain place and had himself massaged with perfumed oils. Then, he had a sweating bath before going into the marble tubs with sparkling warm water. The last phase of the bath ritual was wishing good bath and good supper to others and saying thank you to the *balneator*.

Apart from the hygienic functions, the baths provided facilities for sports and recreation. Generally, there are some places to do exercise inside and outside of the baths. Romans were not very interested in athletics, which was a Greek originated activity. On the contrary, there are a lot of inscription panels which document the continuity of the idea of athletics education in Roman Anatolia. Besides this, there are lists recorded about the ephebos, young men who go to the *gymnasium*. There are *neoi*s, athletism clubs for people at the age after ephebos, in the palaestras of the bath-*gymnasium* institutions (Yegül, 2011). So, it can be understood that the baths in Anatolia has a closer relationship with physical skills.

Baths have a lot of spaces to realise public activities besides sportive ones. These spaces are auditoriums, libraries, chambers for worshipping, porticos, walkways and gardens, etc.

Agrippa Baths are the first example of *thermae* (Figure 2.1). There were 170 public bath in Agrippa period (33 B.C.) in Rome. They were free at this period and so, it was seen social and architectural developments. Bathing and sport facilities were organized together in a gorgeous garden atmosphere. There were 856 baths at the 5th century B.C. in Rome. (Abbasoğlu, 1997). One of the early Roman *Thermae* are Nero Baths reconstructed in 226 after a fire. Actually, the building lost most its original parts, but its huge, square formed *palaestra*s surrounded by columns repeat the peristyle typology of the era. Another example for this type is Traianus Baths (109 A.D.). It is the most developed and the first documented example (320x340 m$^{2)}$. There are various design improvements in this building (Figure 2.4). *Frigidarium* is a rectangular planned hall which has a cross vaulted covering and it is at the centre of the bath. Double *palaestra*s are at the two sides of the *frigidarium*. *Natatio* is on the axis of *frigidarium*. The secondary spaces that surround three sides of the main building are *apodyterium*s, sport and club chambers, auditoriums, libraries and the semicircular exedras. The spaces between these parts are evaluated as gardens. The other examples are Caracalla Baths (200 - 220 A.D.) and Diocletianus Baths (298 - 360 A.D.). They covered land approximately 300.000m^2. *Natatio*s surrounded by columns, arches and vaults at the Caracalla (Figure 2.2) and Diocletianus (Figure 2.3) Baths are documented. Diocletianus Bath is similar to the Caracalla Bath in terms of its plan, size, glory and luxury. The last large *thermae* is Constatinus Baths dated to 320 A.D.

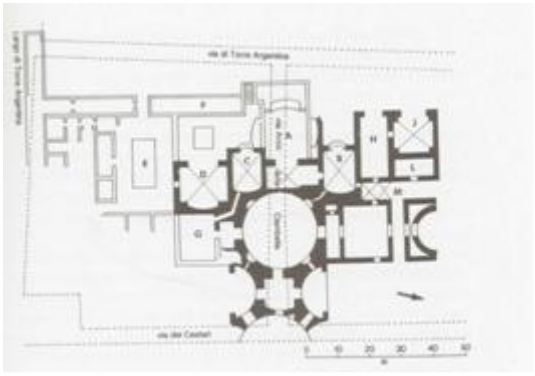

Figure 1.1. Agrippa Baths in Rome (Source: Huelsen, 1910)

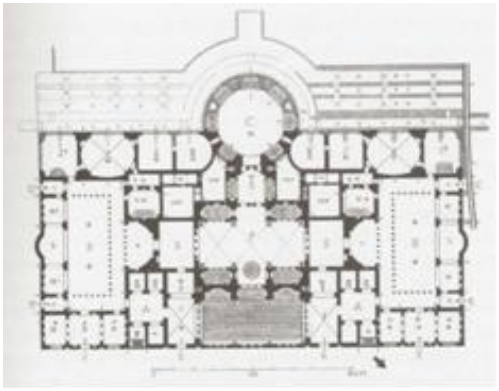

Figure 2.2. Caracalla Baths in Rome (Source: Yegül, 2011, revised from Knecker, et al., 1929)

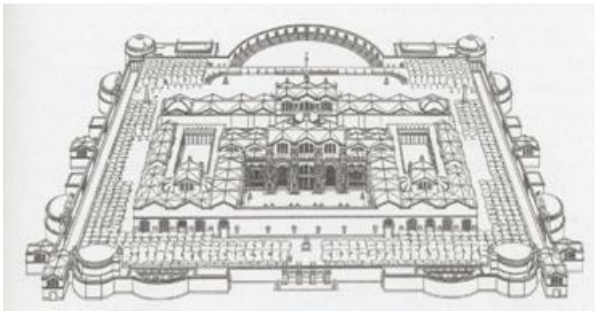

Figure 2.3. Diocletianus Baths in Rome (Source: Paulin, 1890)

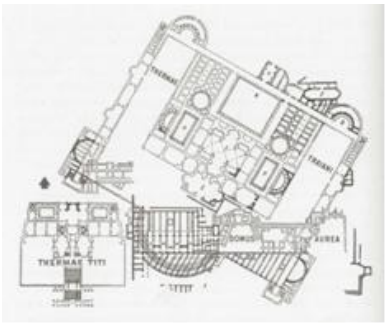

Figure 2.4. Traianus Baths in Rome (Source: Krencker et al., 1929)

2.3. Roman Baths in Anatolia

Bathing started to be a necessity of the civilization in Anatolia in the 2nd century A.D. Bath - *gymnasium* complex is one of the most important creation of Anatolia. J. B. Ward - Perkins (1981) states that the baths in Anatolia are not copies of the ones in Italy. Roman Baths in Anatolia have a relationship with sport activities more than the ones in Italy. *Gymnasiums* or palaestras built as their part were built related to the baths.

The baths that heat their usage water in Anatolia will be examined. Aleksandreia Troas, Ephesos, Miletos and Perge are some examples of Anatolian Baths that heat their usage water.

Roman Baths in Anatolia were built with the local materials and techniques.

2.3.1. Spatial Organisation Principles

The spaces were organised adjacent to each other without corridors and passageways. So, heat loss could be avoided. The spaces were organised starting from the coldest room to the most heated one. It provides people to get used to the temperature of the spaces gradually. So, circulation is realised easily.

The baths were designed so that one could enjoy the landscape, while bathing. Bathing spaces have large windows opening to spectacular views.

There are design differences between the Baths in Rome and the Baths in Anatolia. Anatolian Baths are not mostly built with curves, circles and semi-circles. The spaces are designed generally orthogonally. Curves are used only at niches or in small rooms. Large curve usage is rare; for example, the Bath-*Gymnasium* in Sardis, *Thermae* in Caunos. The existence of the wide apses of the Capito and Faustina Baths in Miletus are not understood from the exterior of the buildings. Apsidal units fill and hide the irregularities of the site such as Faustina and Miletus Baths.

*Palaestra*s were used as places for education and athletics. They were for simple physical exercises and they belong to the bath - *gymnasium* complexes. Their sizes can be very different from each other. Bath - *gymnasium*s are large complexes.

Yegül (2011) has stated that the spaces of the bath complex are either organised around a symmetry axis or they are balanced asymmetrically.

Generally, the cold spaces surround the hot ones. In turn, heat loss is prevented (Uluşans, 2003)

Baths are planned asymmetrically because of the site restrictions. Generally, major halls are arranged at right angles to each other, secondary units fill up the area between these halls at the asymmetrical baths. Scholastica, Faustina (Figure 2.8), Aspendos, Side, Perge (Figure 2.7), Sagalassos, etc. can be displayed as example of the asymmetrical baths. Another asymmetrical plan type consists of the major halls parallel to each other. And, some of these halls have apsidal projections. There are arched or flat - topped windows with projections (Yegül 2011). If the asymmetrical baths in western Anatolia are compared to the symmetrical ones; it is seen that the asymmetrical baths are smaller than the symmetrical ones.

The bath-*gymnasium* complexes which have symmetrical and axial organisations can be considered as the large programmed baths of Anatolia, similar to the Imperial Baths in Italy. When the so far published work (Yegül, 1992, Usman Anabolu, 2001, Yegül, 2011, Uluşans, 2003) is reviewed, 9 bath- *gymnasium* are underlined with their symmetrical plan organisations and palaestras. These are Ephesos Theatre Bath-*Gymnasium*, Hadrianic Baths and Porticos of Tiberus Aphrodisias, Capito Baths in Miletus, Harbour Bath-*Gymnasium*, Vedius Bath-*Gymnasium*, Ephesos East Baths, Bath-*Gymnasium* Complex in Sardis, Caracallan Bath-*Gymnasium* in Ankara, Humeitepe Bath and Palaestras (Figure 2.5, Figure 2.6, Figure 2.9, Figure 2.10, Figure 2.11, Figure 2.12, Figure 2.13, Figure 2.14, Figure 2.15). Relatively small baths emphasized with their asymmetrical plans are 6 in number, two of them are without palaestra while 4 of them are with palaestra. Asymmetrical baths without palaestra are Scholastica Baths and Agora Bath in Side (Figure 2.20, Figure 2.21). Asymmetrical baths with palaestra are Faustina Bath in Miletus, Anemurium Bath, Salamis Bath and South Gate Bath in Perge (Figure 2.16, Figure 2.17, Figure 2.18, Figure 2.19).

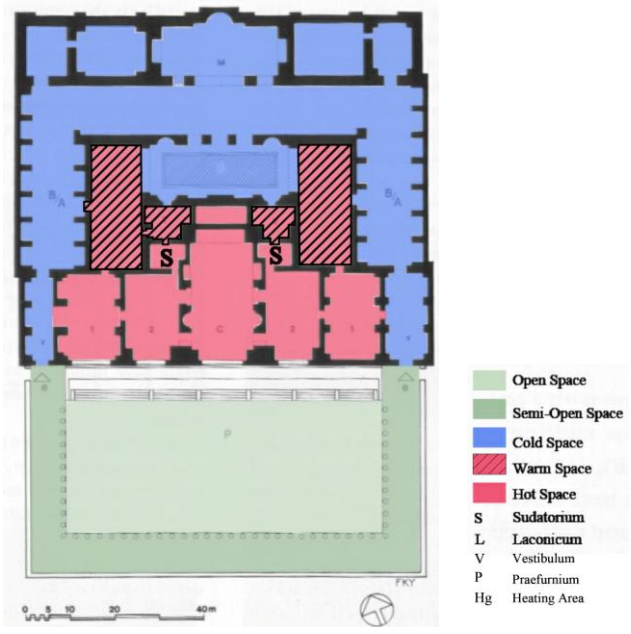

Figure 2.5. Ephesos Theatre Bath *Gymnasium*, İzmir
(Source: revised from Yegül, 1992)

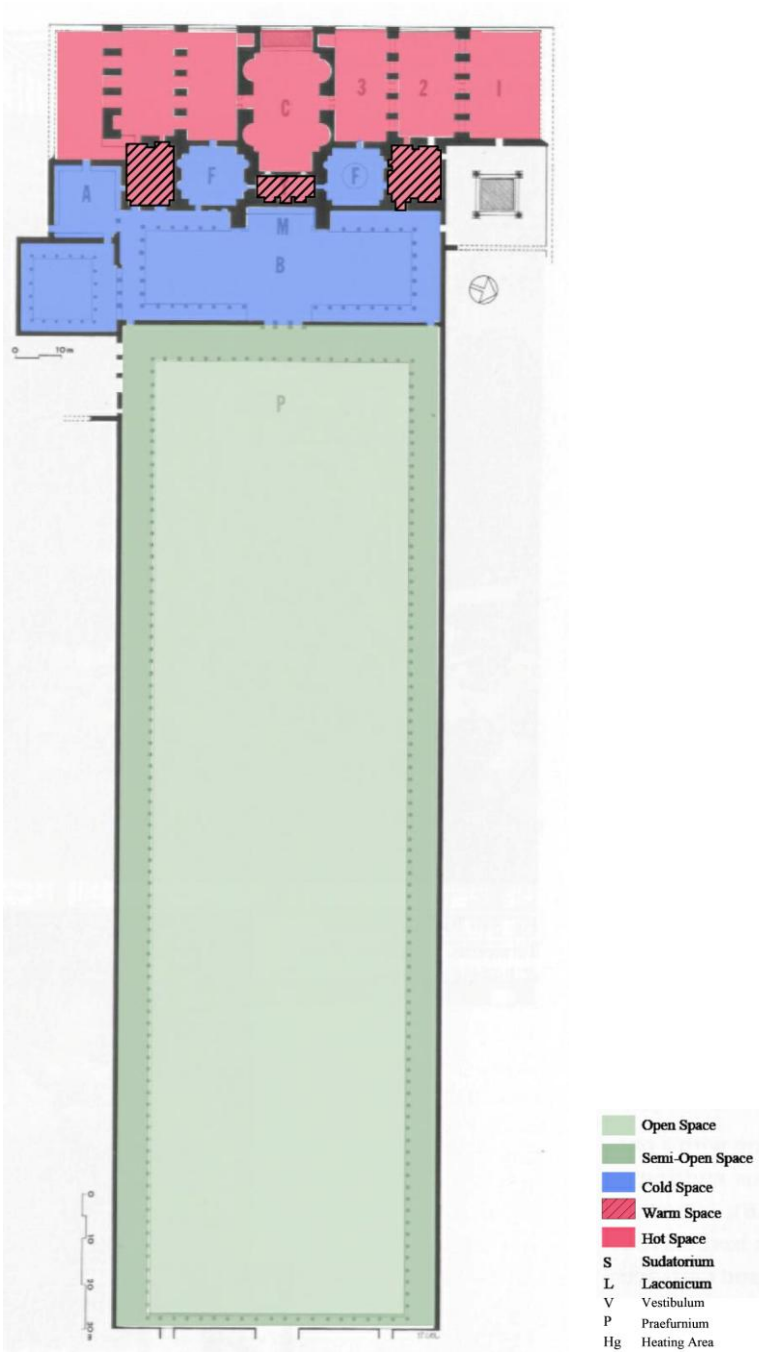

Figure 2.6. Hadrianic Baths and Porticos of Tiberus Aphrodisias, Aydın (Source: revised from Yegül, 1992)

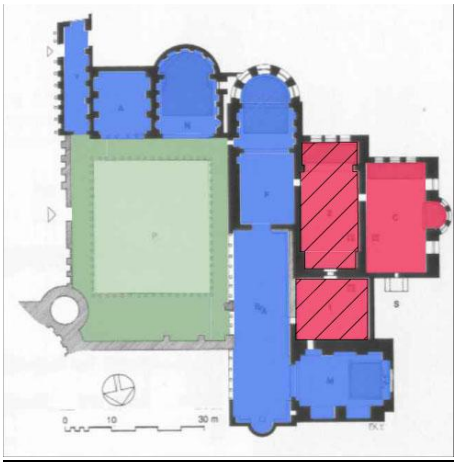

Figure 2.7. Perge South Gate Bath
(Source: revised from Yegül 1992)

Figure 2.8. Miletus Faustina Bath
(Source: revised from Yegül 2011)

Symmetrical baths in Anatolia investigated in detail are introduced below.

Capito Baths in Miletus (14-54 A.D.) are the earliest example of the bath-*gymnasium* complexes. It is symmetrical planned in two direction and square courtyarded. Its entrance is from the palaestra. The bath has eight main rooms, where 7 rooms are covered with barrel vaults that are organised paralel to each other. Hot spaces have niches and pools. They are semicircular or rectangular in plan. *Laconicum* is a circular room and it is covered with a dome. The palaestra is surrounded by columns in corinth sytle at its three sides. There is a semi-circular exedra which has an exterior pool at the fourth side.

Figure 2.9. Capito Baths in Miletus
(Source: revised from Yegül, 1992)

Harbour Bath-*Gymnasium* (337-340 A.D.) in Ephesos has a symmetrical plan. There is a square planned *palaestra* at the eastern part of the bath. There are heated space zones at the outer part of the building. They are at the western direction. The cold spaces are at the inner part of the building; they are between the *palaestra* and the hot spaces.

Hot spaces are covered with barrel vaults. The largest space is *caldarium*. It is projected from the building mass and from the centre of the hot spaces. It has large windows. *Frigidarium* is at the centre of the cold spaces. It is linked to the *apodyteria* through columnar screens. There is a longitudinally planned, rectangular pool at its centre. It has projecting piers. Its *apodyteria* has niches at its western and eastern sides.

There are Verulanus Porticos in the *gymnasium* of the building and the building is primarily entered from these porticos. There is a secondary entrance from Arcadine Street. There are two rectangular spaces reached from *palaestra*. The one at the north is named *Kaisersaal*. It is one of the good examples of this kind of halls. It is used for ceremonies, it is multi-storied and it has a marble covered facade with columns. It is lavishly decorated. There is Skolastikia sculpture here (Usman-Anabolu, 2001). The one at the south is an *auditorium* (a lecture room). There are monumental gates (*propylon*) close to the bath. They make the travellers aware of the fact that they have entered the city and they should clean themselves.

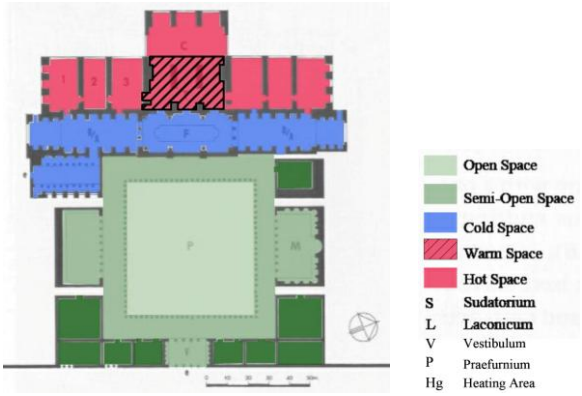

Figure 2.10. Harbour Bath-*Gymnasium*
(Source: revised from Yegül, 1992)

Vedius Bath-*Gymnasium* (138-162 A.D.) in Ephesos is planned symmetrically. The main mass of the bath and palaestra is on the same axis. There are *frigidarium*, *tepidarium* and *caldarium* on the axis perpendicular to the palaestra.

The H shaped hall is as large as half of the bath block. It is entered from the palaestra. Here, there are projecting ashlar piers connected by arches. This hall, which is for Imperial Cult, is one of the well preserved examples.

Frigidarium, which is between *caldarium* and palaestra, is at the centre of the bath. It is barrel vaulted. *Frigidarium* is modest in scale. There are semicircular niches on its long walls. There are fountains in these niches. So, cold bathing might be taking place here. God of River Kaistros and Emperor Hall Sculptures are seen at the *frigidarium*, Emperor Hall and latrina of the Vedius Bath-*Gymnasium* (Usman-Anabolu, 2001). There is a transition zone between the palaestra and the *frigidarium*.

Caldarium is a rectangular hall with projecting piers.

The ground of the palaestra is earth covered. The propylon provides entrance to the palaestra.

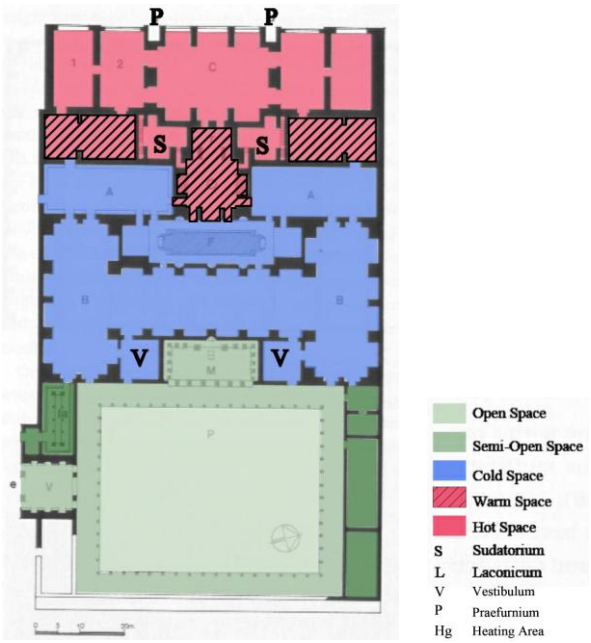

Figure 2.11. Vedius Bath-*Gymnasium*
(Source: revised from Yegül, 1992)

Ephesos East Baths (~200 A.D.); the *caldarium*, which is at the centre of the bath building, is a rectangular hall with projecting piers. *Caldarium* is surrounded by cold spaces. Cold spaces provide an isolation zone for hot spaces. Cold spaces have a lot of niches on its long sides.

There are two rectangular halls on the west and east sides of the palaestra. The western hall is Kaisersaal. It is one of the good examples of halls for Imperial Cult. It has a central apse and a continuous podium. It is dedicated to the Emperor Septimus Severus and the other one is dedicated to a sophist philosopher Flavius Damianus.

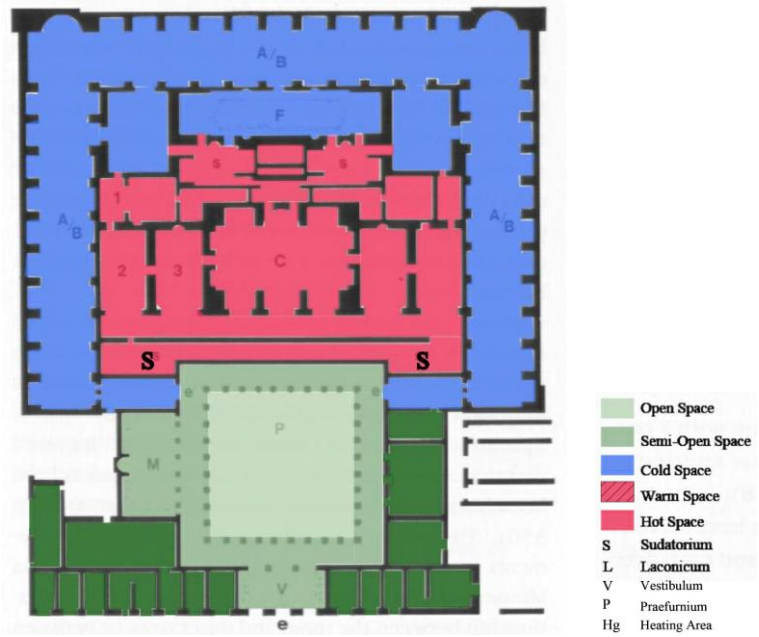

Figure 2.12. Ephesos East Baths
(Source: revised from Yegül, 1992)

The Emperor Bath-*Gymnasium* in Sardis' (~100 A.D.) *caldarium* also is a hall with projecting piers like Vedius Bath-*Gymnasium*. Hot spaces are at outer zone. Cold spaces are between *caldarium* and *palaestra*.

There is a marble room (like *Kaisersaal* in Ephesos). It is entered from the palaestra through a series of openings enriched with columns and it is also at the main mass side. There are square planned rooms at the two sides of the marble room. The marble room is two storied. Its facades are decorated with marble covering and a pediment. There is an altar pointed out that it was used for ceremonies.

There are closed spaces at two sides of *palaestra*. A base of a sculpture dedicated to Lucius Verus was found at the southern room. So, it is thought that this space was used for ceremonies.

Figure2.13. Bath-*Gymnasium* Complex, Sardis
(Source: revised from Yegül, 1992)

Caracallan Bath-*Gymnasium* (211-217 A.D.) bath building in Ankara consists of two zone; cold and hot zone. Its hot spaces are *caldarium*, *tepidaria*, *sudatorium* and *laconicum*. Cold spaces are between hot spaces and *palaestra*. The *frigidarium* of the Caracallan Bath-*Gymnasium* is designed with alternating semicircular and rectangular niches. It is flanked by long *ambulacra* with projecting piers. It is entered from *palaestra*. *Palaestra* has colonnaded porticoes at its four sides. Behind the porticoes, it is surrounded by closed spaces at its four sides and semi-open spaces at its two sides.

Figure 2.14. Caracallan Bath-*Gymnasium* in Ankara
(Source: revised from Yegül, 1992)

Humeitepe Bath and Palaestra (98-117 A.D.) consists of bath at north and *palaestra* at south. The semi-open area at the central part south of bath is opened two cold spaces at its east and west. The entrance of the bath is provided from these cold spaces. Hot spaces are placed as outer spaces of the bath. They form a hot zone. This zone is finished with a linear heating area at the north. Its palaestra is with colonnaded porticoes. There are closed spaces behind these porticoes at its three sides.

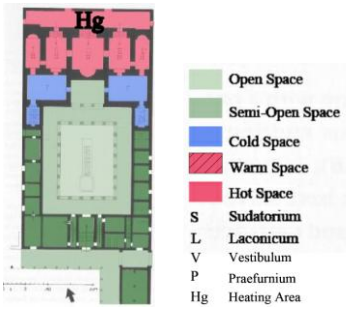

Figure 2.15. Humeitepe Bath and Palaestra in Miletus, Aydın
(Source: revised from Yegül after Krencker, 1992)

Asymmetrical baths are discussed under two headings; with palaestra and without palaestra.

Asymmetrical baths with palaestra are Faustina Baths in Miletus, Bath in Anemurium, Salamis Bath and South Gate Bath in Perge. The ones without palaestra are Scholastica Baths and Agora Bath in Side.

Faustina Baths in Miletus (138-161 A.D.) is a bath-*gymnasium* complex planned asymmetrically. The bath block has eight rectangular halls placed adjacently to each other. Service halls surround the east and north of the bath at the outmost part. There is a circulation system that starts with the ambulacrum and museion, and is terminated by the *caldarium*. The other spaces in the circulation system are *frigidarium* spaces, *tepidarium*, two *sudatoriums* and a hot chamber. There are God of Maiandros and River Lion sculptures at the sudatoriums (Usman-Anabolu, 2001). Generally *frigidarium* is a rectangular hall. But, here it is close to a square in proportions. It has a square palaestra (62x64 m). There is a long basilical hall with a space named as *Museion* between the palaestra and the bath block. The *ambulacrum* has an arched gate. It has been used as a lecture hall or a *museion*.

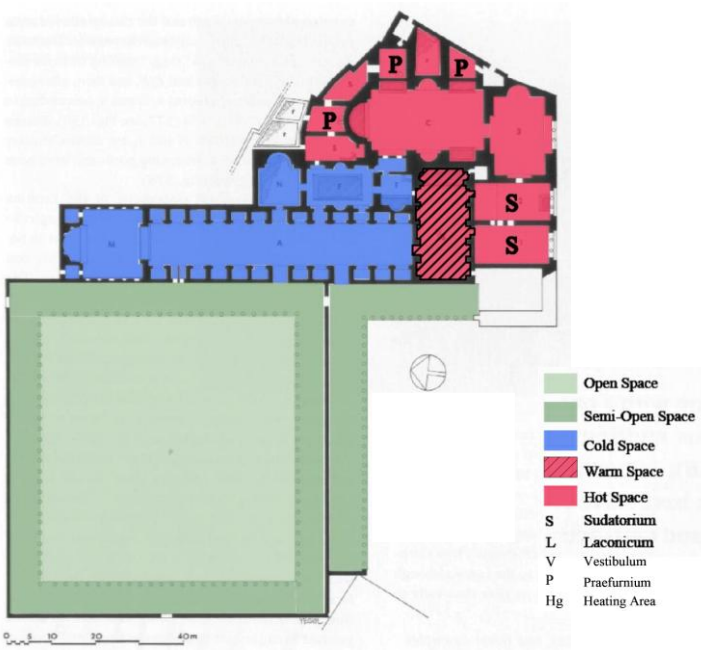

Figure 2.16. Faustina Baths in Miletus
(Source: revised from Yegül, 1992)

Bath with *palaestra* at Anemurium (~300 A.D.) is one of the asymmetrical planned baths in Anatolia. The bath block is at the west of the *palaestra*. It has small and medium sized barrel vaulted halls with apses. The block has three parallel heated units. *Caldarium* is a simple rectangular hall with apse. There are two halls with apse in hot spaces area. There is a *frigidarium* with pool at the north. The hall of the *frigidarium* is close to a square in form. Its walls are opened to the landscape through large windows. There is a limestone-paved gallery between the *palaestra* and the three rooms of the bath block. The middle unit is *museion*. It is opened to the gallery through a pair of square piers facing one another (Yegül, 1992). *Palaestra* is colonnaded at its three sides. The bathing halls are at its side without any colonnade. *Palaestra* is covered with mosaic. *Palaestra* is dated to approximately mid-third century A.D.

Figure 2.17. Anemurium Bath, Mersin
(Source: revised from Yegül, 1992)

Salamis (~150 A.D.) consists of hot spaces, cold spaces and *tepidarium* providing adaptation from cold to hot or from hot to cold. Entrance is from palaestra. *Apodyterium* is the entrance space of the bath. Then, it is entered to *frigidaria*. They are at northern and western sides of the *tepidarium*. *Tepidarium* is entered from *frigidaria*. Then, it is reached to hot spaces. Hot spaces are rectangular halls. Two of them are with apse. Service areas are attached to the northern and southern sides of the hot spaces.

Palaestra is at the west of the bath. It is surrounded by colonnaded porticoes at its three sides and closed spaces behind the one at north and south. The bath is at east.

Figure 2.18. Salamis Bath, Cyprus
(Source: revised from Yegül, 1992)

South Gate Perge (98-117 A.D.) is planned asymmetrically. There is a pair of apsidal rectangular halls next to each other. These are cold spaces. They surround *palaestra* from its western and southern sides. They are one of the most monumental sample of the simple rectangular hall with apse. Hot spaces are at the west of cold spaces. They composed of *tepidaria* and *caldarium*. *Tepidaria* are between cold spaces and *caldarium*. *Palaestra* is entered from its eastern side. It consists of colonnaded porticoes and mosaic inlay.

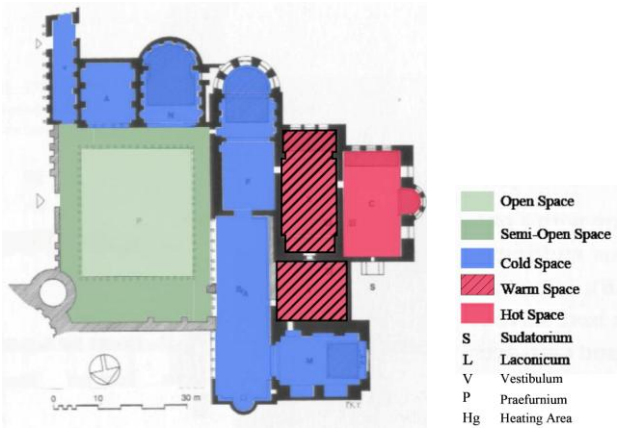

Figure 2.19. South Gate Perge Bath
(Source: revised from Yegül after J. İnan, 1992)

Asymmetrical baths without *palaestra*:

The plan of the Scholastica Baths (1st century A.D.) is asymmetrical in plan. It is placed according to the trapezoidal lot. The entrance is from the street by a flight of stairs and through narrow corridor. There is no axiality. The bath has two multipurpose halls. They might have served for an indoor athletic activities as well as a grand entrance hall, a lounge and and an *apodyterium* (Yegül, 1992).

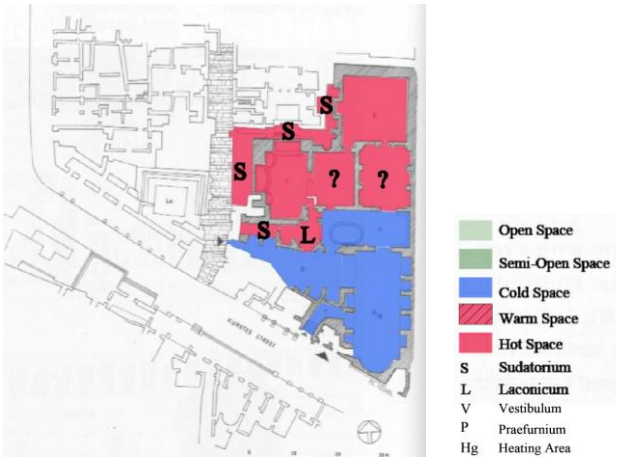

Figure 2.20. Scholastica Baths in Ephesos, İzmir
(Source: revised from Yegül after Miltner, 1992)

Agora Bath in Side (5th century A.D.) is smaller than Scholastica Baths in terms of plan size. Spaces of Agora Bath in Side are grouped as two; hot spaces and cold spaces. Cold spaces are at west. Hot spaces are at east. Hot spaces consist of a *laconicum* besides *caldarium* spaces. *Laconicum* is a circular room. Cold spaces consist of a apsidal pool inside *frigidarium* space at the north.

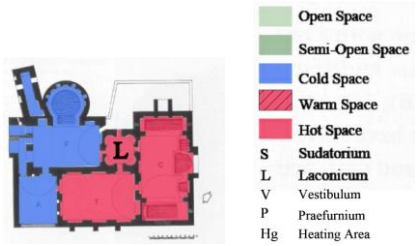

Figure 2.21. Agora Bath Side
(Source: revised from Mansel, 1978)

2.3.2. Spatial Elements

The spaces of the bath can be grouped as main spaces, secondary spaces and service spaces. Main spaces are connected with each other by arched openings or doors.

Main spaces included *apodyterium*, *frigidarium*, *tepidarium* and *caldarium*. They were the prerequisites of the bathing activity. As it was mentioned in section 2.3.1, these spaces were organised according to their interior temperature. Secondary spaces were for oiling, massaging, sportive activities and recreation. Service spaces consisted of service halls, hypocaust and *latrine*.

Apodyterium was an *ambulacrum* with a basilical plan and it was a space to take off clothes and get dressed. It is close to the entrance generally. It can be said that it provides a relation between bathing spaces and *palaestra*. It might have been used for informal celebrations and meetings. Mostly, it is rectangular planned. There were platforms at the long sides of the space. There were wooden cupboards, boxes, niches and places made of stone for sitting used individually. There might have been a pool in square form at the early samples. This space was covered with marble. It is not heated generally (Uluşans, 2003).

Frigidarium was a cold room and it was at the centre of the cold rooms. The first step of the cleaning activity was realised here. *Frigidarium* was the only central element on the main axis and, it was between *caldarium* and *palaestra*. There was a longitudinal pool full with unheated water which covers approximately all of the space. This was for diving. Except from this pool there was an open pool (*natatio*) in rectangular or apsidal form for swimming in *palaestra*. *Frigidarium* is placed adjacently after *palaestra* at the buildings without *natatio. Frigidarium* was not covered with any superstructure.

Tepidarium consisted of a warm room or a group of warm rooms. The *caldarium* is entered from *frigidarium* by passing from *tepidarium*. There is hypocaust system under *tepidarium*. It can be seen pool and *praefurnia* belong to itself at the late examples while it is heated from *caldarium* at the early examples. It is covered with barrel or cross vaults. If there is not any massaging room, massaging is done here. Vitruvius says that *tepidarium* should get sunlight from southwestern direction or southern direction (Uluşans, 2003).

Caldarium was the most heated part of the bathing space. It might be planned in rectangular, square or T form. It is covered with vault or dome. If it is planned in rectangular form, the superstructure is vault, if it is in square form, superstructure is dome. It was the largest room in a bath and its vault was the highest one. It had a wide apse. It is distinguished from the other main spaces by projecting apse. It was placed at the southwestern or western part of the bath. And also it could be placed at the centre of the building or a protuberant mass. Bathing was done at the bath tubes -round basin- (*labrum*) or at the heated pools -quadrangular- (*alveus*) placed at the short sides of the *caldarium*. *Alveus* is at the lower level than *caldarium*'s ground level. It has steps. They are used for sitting. There is no system to send away the used water. It provides vapour for the bath. *Caldarium* should have well-insulated walls and doors should be small to save heated air in the room. But windows are deep and large (Uluşans, 2003). *Caldarium* had some sub-spaces such as hot chambers, *laconicum* and *sudatorium*. Number of hot chambers might be one, two or three accordingly to the size of the bath. Hot chambers were placed parallel to the heated spaces. They were protuberant masses, with apsis and they had windows opening to the landscape. *Laconicum* and *sudatorium* were sweating rooms. There was no humidity in *laconicum*, but *sudatorium* is for steam bathing. Hot-steam rooms might be with or without pool. They are also used as decorative elements of the bath. They were covered with dome. Vitruvius stated that *sudatorium*s should be built adjacent to the *tepidarium* and their heights until the dome

levels should be equal to the widths of the spaces. Yegül claimed that there should be a barbecue to heat the room or stones in a glow were put in a pit at the centre of the space. The double or triple apsed, centralized *caldarium* types observed in Italy and North Africa are not seen in Anatolia.

Secondary spaces were *gymnasium*, palaestra, *museion*, *kaisersaal*, *propylaea* or monumental gateway, *basilica thermarum*, *heliocaminus*, *loutron*, *impluvium* and *destrictorium* (Uluşans, 2003).

Gymnasium was a place for athletism and education in Greek world. In time, it was started to be built with Roman bath. It consisted of some open or closed spaces. Every *gymnasium* had a *palaestra*. Then, it became a part of bath - *gymnasium* complex in Anatolia.

Palaestra was a courtyard for outdoor sports and athletism. People exercised, swam and played games there. Its orientation is organised according to the position of flat ground. It could be built as a part of a *gymnasium* or related to the bath only. It was reached from the *propylon* way. It was at the northern part of the building and adjacent to the cold spaces of the bath. It was a peristyle in square form and it covered approximately half of the complex with its secondary spaces. Closed or semi-open spaces might have surrounded it. People had a cold bath at some rooms around the *palaestra* . So, they can be named bathing rooms. There might have been an outdoor pool. Open pool is *natatio*. The courtyard was earth covered. *Palaestras* could be in private ownership or public property (Yegül, 2011).

Museion was an informal worshipping space. It had a wide apsis and a lot of niches. It was square planned. It was neighbour of the *apodyterium* and sculptures were exhibited here.

Kaisersaal or emperor hall was a rectangular planned semi-open monumental space. It was adjacent to the bath. It was entered from the *palaestra*. There were pediments and decorative ornaments enriching interior facades. There might have been inscriptions and altars. It was all over covered with marble and they had rich marble covered facades. It was used for ceremonies and conferences. Their function and social meaning changed in time. They became important spaces of cities. They were dedicated to the Emperor and his family.

Propylon or monumental gateway was close to the bath or provides entrance to the *palaestra*. It was the entrance of the antique city. Passengers were reminded for bathing.

Basilica thermarum consisted of a group of basilical planned halls used for social purposes and athletism if the weather was not good enough to do sport at *palaestra*. It served as *apodyterium* at some baths. It was at the cold spaces part of the bath. It is roofed by barrel vault. There might had been a sculpture on its apse. It was covered with a wooden roof.

Heliocaminus was a space used for sunbathing in some baths. It was at the south or southwestern part of the bath. Probably, it had large windows with glass.

Loutron was a part of the *palaestra* where one could have bath with cold water. There was marble or limestone bath tubes and water connection in most of them.

Impluvium was a space which consists of an entrance hall. It is as wide as the building's facade. It has a shallow and square pool.

Destrictorium was a room for massaging with oil in Roman baths.

Addition to these, there are reading and resting rooms, passages with columns, library, auditoriums, shops or houses in front of the wall which surrounds the bath complex. The complex is surrounded by a green area enriched with sculptures and trees (Uluşans, 2003).

Third group was service spaces. Service halls, hypocaust and latrines were in this group.

Service halls could surround *caldarium* or provide link to the heating system under the floor. If they surrounded *caldarium*; there were *praefurniums* in form of niches in them. They might had been covered with vault or semi-vault.

Hypocaust was an underground space where the heating system of the bath was located. It provides a homogeneous temperature distribution. The hypocaust system consists of *pilae*, the elements which support the system (Basaran, 2007). The height of the system enables people to clean (Akok, 1968). *Pilae* are quadrilateral or cylindrical. They are generally made of brick or limestone. There is a floor which was made of brick and horasan mortar on the system. Charcoal and wood were burned in the *praefurnium* and the flue gas arose from them provides bath to be heated.

Latrines were communal toilets. They were generally built inside the bath, but also reached from outside (Gülbay, 2005). There were water channels passing through the walls for sewerage; sitting places as holes inside wooden or marble platforms at the latrines. In front of the sitting places, there are usage water channels (Uluşans, 2003).

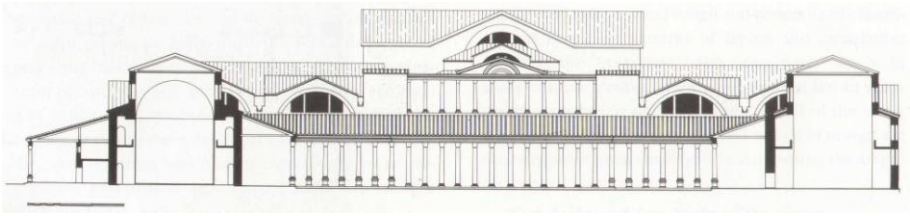

Figure 2.22. Sardis Bath-*Gymnasium*
(Source: Yegül, 1992)

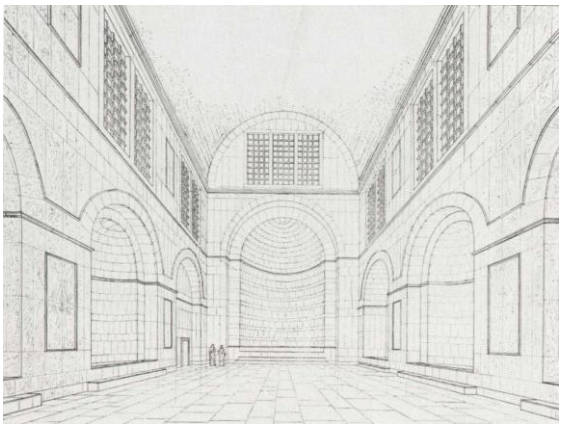

Figure 2.23. Restored perspective of the caldarium of Faustina Bath in Miletus, Aydın
(Source: Yegül, 1992)

2.3.3. Architectural Elements

Architectural elements of the Roman Baths are sculptures, niches, pilasters, stairs, reliefs, furnaces, pool-plunges, pool-swimmings, oculis, lanterns, windows, doors, marble coverings, mosaics and channels.

Sculptures can be seen at the *apodyterium*, *frigidarium*, *sudatorium*, emperor hall and *latrina*. These sculptures are God of River Kaistros, Emperor Hall Sculptures, Skolastikia, God of Maiandros and River Lion (Usman-Anabolu, 2001).

Semicircular and rectangular niches are used commonly in the Roman Baths. Usage of the simple rectangular niches as row is also common.

Romans used solar energy to heat large buildings. So, the windows were important elements (Figure 2.24, Figure 2.25). These windows provided sun light from the south from early afternoon to sunset (Ring, 2007).

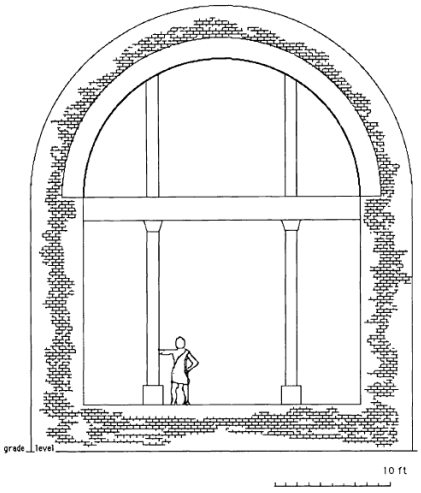

Figure 2.24. Southern Elevation of room 4 at the Forum Baths of Ostia (Source: Ring, 2007)

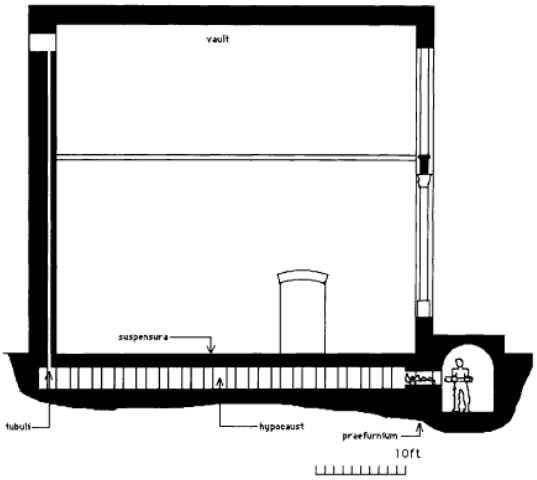

Figure 2.25. North-South section of room 4 at the Forum Baths of Ostia (Source: Ring, 2007)

Windows were made of transparent marble.

Generally, there are different entrances for women, men and slaves (Uluşans, 2003).

The grounds of the heated rooms were covered with marble or mosaics.

2.3.4. Structural System

Masonry system was used to build Roman Baths in Anatolia. This system's elements are vaults, domes, arches, walls, piers, columns, and stone slabs. Generally, barrel vaults were used. Masonry walls, piers, columns and arches carry the building. The floors of the heated spaces are supported with brick columns. Floor covering is composed of, tile mortar 30-40 cm in thickness and 60x60 cm square tiles (Figure 2.26).

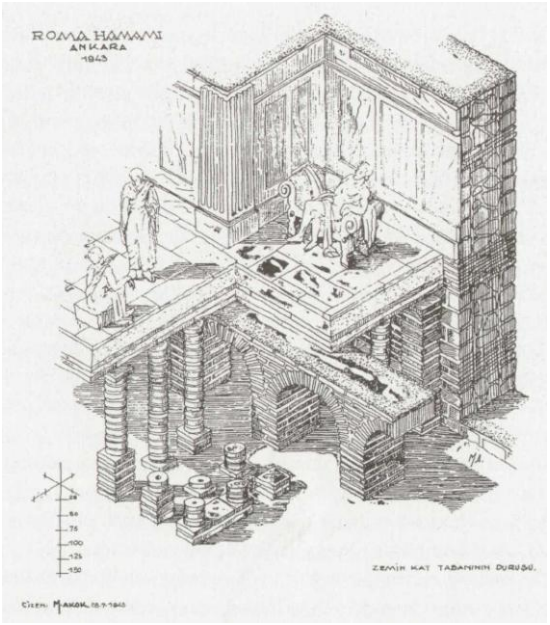

Figure 2.26. Floor system of the Roman Bath in Ankara
(Source: Yegül 2011)

2.3.5. Construction Technique and Material Usage

Material usage and construction techniques of the Anatolian Baths differ from region to region.

Vaults were ornamented with stucco and frescoes (Uluşans, 2003). Strong brick arches were used with the stone walls at the Meander Valley cities such as Ephesos and Sardis. They were partly supported with the rubble with dense mortar. Besides this, brick was used to reduce the weight of arches (Uluşans, 2003).

Walls were made out of stone; the main construction material (Figure 2.27, Figure 2.28). The baths generally were constructed with stone in different sizes. The mixture of the rough cut stone and the small rough stones is used in Ionia and the western part of Anatolia. Various materials were used together. Cut stone was used at the facades of the baths at Caria, Lycia and Pisidia. These were best examples of stone dressing in Anatolia. All stone construction of irregular blocks was common. There was rubble with mortar inside of the thick walls. Rough ashlar was used at the facade because of its beautiful appearance. The regular system with cut stone was applied to the facade construction because of their importance. Brick was used at vaults or arches

and as covering material of the walls. Romans used fire brick as a fire proof construction material (Uluşans, 2003). The mortar was strengthened with *pozzolana* in Italy (Ward-Perkins, 1981) and also in Anatolia (Sağın, et al. 2012). Inspite of the usage of different sources of raw materials at the different regions, the compressive strength and water resistance of the final product mortar display similar features (Sağın, 2012). Walls were covered with marble. Moreover, marble revetment also is seen at some baths.

Laths of the doors were out of brick.

Floors were covered with marble or mosaics. Colourful marbles were used inside the building. Brick was the material of heating system elements (Uluşans, 2003).

Foundations were made of stone.

Figure 2.27. Stone piers, stone walls and the brick vault system of the Eastern Bath-Gymnasium Ephesos (Source: Yegül, 2011)

Figure 2.28. Stone northern wall of the *caldarium* of Hierapolis Bath (Source: Yegül, 2011)

2.3.6. Heating System

Heating system of the Roman baths consists of heating from floors, from walls and sometimes from vaults (Figure 2.29). Heating from vault is provided by pipes or boxes placed into the vault but, this usage is rare (Uluşans, 2003). Using solar power is also useful: the heated rooms at the southern or southwestern have large windows. Besides this, main spaces of the bath are organised in an intelligent way. They are arranged according to their heat increase starting from the coldest space to the hottest one. *Praefurniums* are places which provide heated gas for the spaces to be heated. The fire is burned here. Wood and coal are stored here. Air circulation is provided through a metal cover. There is a gallery for entrance and departure of material.

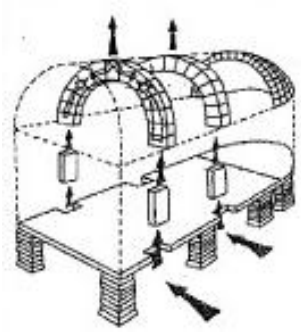

Figure 2.29. Heating from vaults
(Source: Uluşans, 2003)

2.3.6.1. Heating from Floors: Hypocaust

Hypocaust system was first applied at Greek baths. The oldest example is at the Vovine Palace (5th century B.C.) at Cyprus (Abbasoğlu, 1982). Heating baths are first based on heating floors. The most primitive way of realising this is installing pipes which provide circulation of hot gases under the floor. A more developed system is the floor elevated on small columns (Figure 2.30). They are named as *pilae*. The heights of these columns are between 40 cm-75 cm and they are built 60 cm from the centre of each other. They are almost always made of bricks approximately 20 cm each side.

Sometimes variation can be observed and they are built up with circular bricks. They might be ceramic elements moulded in a single piece, forming hollow pillars also and if so, there are footing at their both end (Adam, 2005). Air and gases circulate between these *pilae*. Furnace (*praefurnium*) that provides hot gases is out of the heated space and adjacent to one of the exterior walls of it or it is in line with the heated spaces. Furnace is connected to the hypocaust with a brick arch or a square opening spanned with stone lintel (approximately 0.5x0.5 m). The space for service in front of the furnace is built 0.5-0.8 m less in height. Wood can be put in the furnace easily. There is a wide service hall covered with vault to link the furnaces in the *thermae*. This system is called hypocaust system. The heated gas coming from the *praefurnium* filled the hypocaust before going out through vertical ducts. Hypocaust was covered with a suspended floor named *suspensura*. *Suspensura* is 30 - 40 cm thick and it consists of one or more thicknesses of large bricks, layer of concrete made with fragments of broken tiles 15 - 20 cm thick, layer of mortar and marble tiling or mosaic.

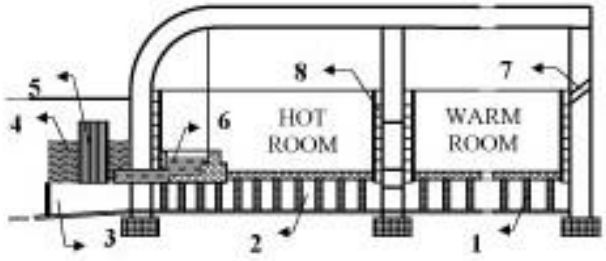

Figure 2.30. A section of Roman Bath
(Source: Başaran, et al., 2005)

2.3.6.2. Heating from Walls

The tubuli system is a Roman invention. Tubuli is a box made out of terra cotta. The size of the boxes range from 8.5x15 cm to 14x24 cm and they are placed related to each other horizontally and vertically (Uluşans, 2003). These boxes are placed on one another paralel to the wall surface. Another alternative is the provision of spaces behind the walls or behind the wall covering for gas circulation. Gas is provided from the same

furnace mentioned above. Terracotta plaques were knocked on the walls. These plaques under the plaster or the marble are covered with mortar 2-3 cm in thickness .

2.3.7. Usage Water System

The extensive aquaduct systems were developed to get sufficient water (Ring, 1996). So, the usage water could be brought from distant places in distance (Uluşans, 2003). They provided indoor plumbing. The water sources of the Roman Baths could also be deep wells, cisterns and roof reservoirs.

2.3.8. Used Water System

The sewer system was planned carefully. So, the used water could be sent away. The system included terra cotta pipes for transfering and sending away used water. Pipes were installed in the spaces created under the bath.

2.3.9. Illumination System

There is limited information on artificial illumination system of the Roman Baths in written sources. Beside this, some oil lamps were found (Yegül, 2011). However, night bathing was rare because customers prefered bathing, while day light was coming through their large windows. Sunbathing at terraces of baths or at the halls with southwestern windows without any glass was part of the bathing ritual at some baths as revealed in southwestern orientation. The shutters of the windows were closed, if it was cold. Public baths were closed after sunset.

2.4. Roman Baths in Metropolis

Three buildings, which are thought as bath remains, will be discussed with reference to the evolution of the city.

2.4.1. History of Metropolis

Metropolis (Figure 2.31) is on a hill, which is approximately 30 km away from ancient city Ephesos and 40 km away from the ancient city of Smyrna. It is near the Kaystros Plain (Little Maender).

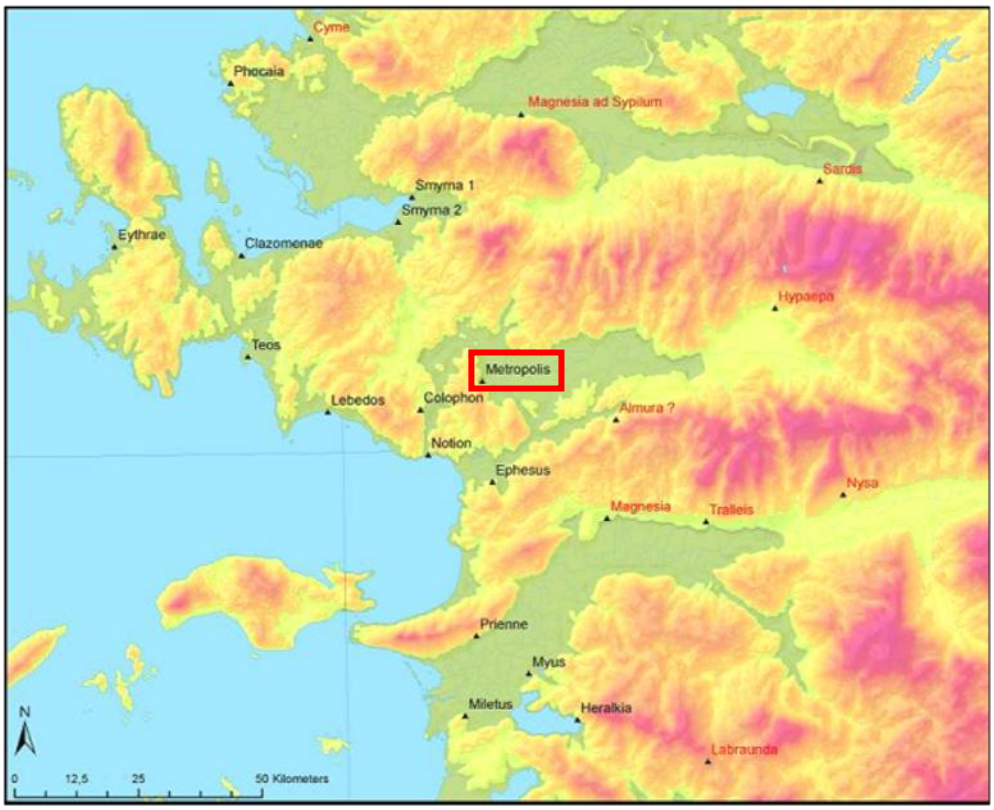

Figure 2.31. Metropolis and the other antique cities in the Aegean Region (Source: http://tr.wikipedia.org/wiki/Dosya:Cost_distance_ratser_no_text.jpg)

Although some research on Metropolis was started in 1904 (Appendix A) a comprehensive study was started in 1971 by Recep Meriç as a case study for his Ph.D. thesis. First excavations in Metropolis were carried out in between 1989 and 1991.

As a result of these studies, it was understood that the early settlements near Metropolis go back to the Neolithic Age (10.000-3.000 BC), but the ancient city itself was occupied first in Late Bronze Age (1550-1200 BC). The area was preferred because of its rich soil and its connections with the trade ways. The water used in the city was

coming from a cave which is at the northeastern direction of the city and is 20 km away from the city by horse. It is an extremely beautiful cave and there is a spring whose flow rate is stable in the winters and in the summers. Water was carried to the city with pipes. But, the traces of the water ways were lost (Weber, 1904).

Ceramic findings point out the Ionian Colonization (7-6th BC). Also, Phrygia and Lydia were active at this period. There was some limited information belonging to the Classical Period in the area. After the death of Alexander the Great in 334 B.C., Metropolis became subject to Lysimakhos. Then, it was dominated by Seleucid Empire. Metropolis was a modern city of this period (first half of the 3rd century B.C.) and it was surrounded by city walls. Hellenistic buildings, inscriptions and sculptures are discovered in the city as well. Metropolis was dominated by Eumenes, the King of Pergamon. During his rule, significant development in the fields of city planning, architecture and statuary took place. This development is especially in the 2nd century B.C. The city became more active at the period of Augustus, the founder of the Roman Empire. The theatre and the *bouleterion* were repaired. There was also a *gymnasium* constructed at this period. There was an earthquake in 17 A.D. This situation damaged some of the buildings in the city. Development of the city stopped for a while. After the period of Emperor Traianus (98-117 A.D.), construction activity restarted. It is thought that the Upper Bath-*Gymnasium* Complex, the Reception Hall and the Lower Bath were built in this period. The attacks of Goths caused great damage in the city. After that, it is thought that another undesirable development took place although its details could not be deciphered yet. The 4th and 5th centuries A.D. were wealthy times of the city. The Byzantine Castle in the city was built against Turkish attacks probably around 1204-1261. In this castle, coins dating to the İzzettin Keykavus I (1210-1219) and Gıyaseddin Keyhüsrev (1236-1246) period have also been recorded. This castle is named as Kızılhisar in Ottoman records. The castle was used by the Aydın Emirate and the Ottomans as well. Later, the castle came under the rule of the Aydın Emirate and then came under the rule of the Ottoman Empire again. Torbalı became a village of the Sığla Sanjak (sancak) of the Anatolian Province (*beylerbeylik*) in 1425. It was controlled from İstanbul starting with late 18th century as a result of the modifications in the Ottoman administrative system. It became a township of Aydın province (*vilayet*) as a part of İzmir sanjak (sancak) in 1841. The immigrants from Crete, Serbia and Bulgaria were placed in Torbalı, Özbey Village and Yeniköy Village at the 19th century. Torbalı was

saved from Greeks on September 7, 1922. It became a town in 1926 and became a municipality in 1927 (Aybek, et al. 2009).

2.4.2. Evolution of Baths in Metropolis

There are three bath ruins in Metropolis; the upper bath (bath-*gymnasium* complex), the lower bath (bath-*palaestra* complex) and the bath with niches (Figure 2.32). The Lower Bath and the bath with niches may be part of the evolution of the same complex which will become definite in future excavations.

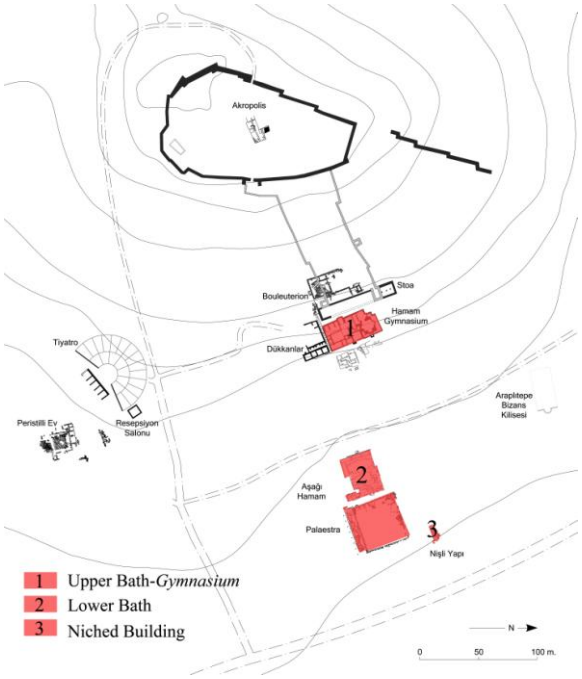

Figure 2.32. Baths in Metropolis
(Source: Öz, 2011)

The Upper bath was a bath-*gymnasium* complex (Figure 2.33) with a palaestra dated to Roman period (2^{nd}-4^{th} century AD). The complex was planned asymmetrically within an insula (47 m x 27 m). *Gymnasium* and palaestra were at the south of the bath. The bath complex included main bath building, *gymnasium* spaces, palaestra and the other spaces such as piscina, portico, cistern, latrine, spaces between cistern and latrine

and spaces with channels at the west of latrine (Uluşans, 2003). The Upper Bath was at the north of the complex. Palaestra was at its south. *Gymnasium* spaces were at the west of the palaestra and the other spaces were mostly at the east of the palaestra. There was no *frigidarium*. The entrance is provided from palaestra and the bathing spaces were placed being ordered as line. The bathing spaces are terminated with two hot bathing spaces. They are at the northern part of the complex and positioned side to side on the east west axis. Piscina is at the west of the palaestra between *gymnasium* spaces and front bathing spaces. It might have been used both from palaestra and *tepidarium*. Front bathing spaces has two sub-spaces. The smaller one (~5x3.1 m) might have been used as a massage and oiling room, and it is separated from the other with columns. There is a door with casing between the hot space and the massage room. It was probably for preventing the heated air waste (Aybek, et al. 2009). Latrine, space number 1 and space number 2 were at the east of the palaestra. The cistern was at the southeastern corner of the main bath building and, the space number 3 and 4 was at south of the palaestra. The Upper Bath has an *hypocaust* system. The walls are covered with marble.

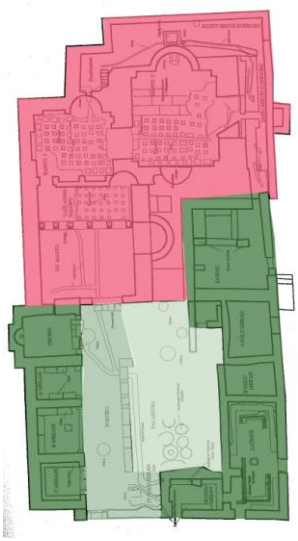

Figure 2.33. Upper Bath-Gymnasium, Metropolis
(Source: revised from Uluşans 2003)

The Lower Bath ("Aşağı Hamam" or "Han Yıkığı") was first explored in 2003 (Figure 2.34). As a result of the excavations, there were findings belonging to a Roman

Bath dating to 2nd century A.D. The Lower Bath is at the northeastern part of Metropolis. There is a Niched Building at the north of the Bath which is thought to be a later period bath as an extension of the Lower Bath (Öz, 2012).

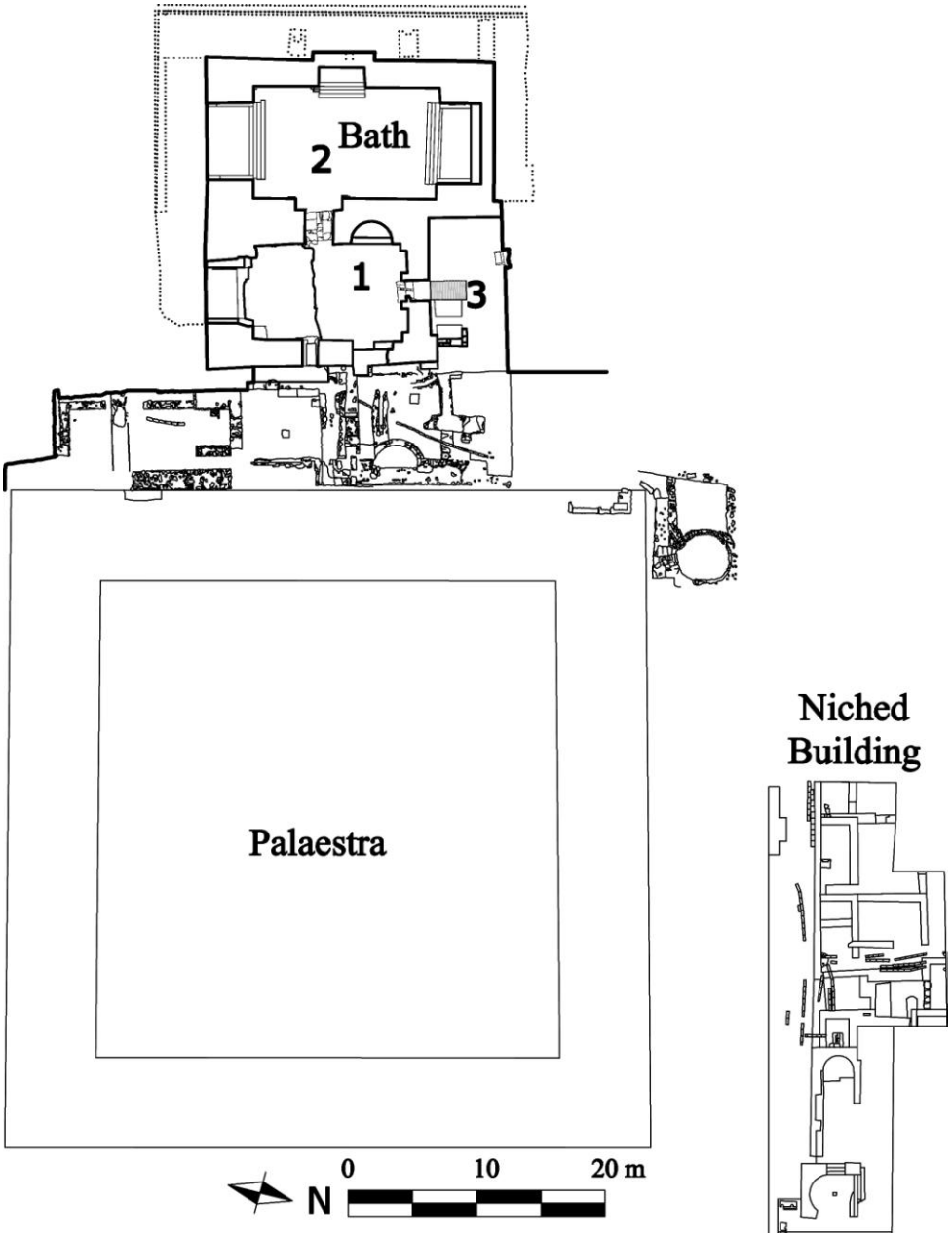

Figure 2.34. Plan of The Lower Bath and The Niched Building in Metropolis (Source: Revised from Öz 2011)

Ceramics dating to the Hellenistic period were found at the excavations, but there are no building traces. The space at east is dated to the end 1st century A.D. Other indoor spaces and palaestra are dated to the middle of the 2nd century A.D. The floor of palaestra was covered with mosaics at the end of the 3rd century A.D. The bath was not used after the 6th century A.D (Öz, 2012). It was used as lime kiln from that time onwards.

Weber (1904) states that the source of the usage water of Metropolis antique city is placed in a cave at the northeast (see section 2.4.1). Thus, it can be said that the source of the usage water of the Lower Bath is this spring in the cave.

It is thought that the building with niches was a bath as well (Öz, 2011). This building is dated to the late antiquity.

2.4.3. Historical Evaluation of the Lower Bath

The Lower Bath is one of the building which are thought as bath remains in Metropolis antique city. It is planned asymmetrically and dated to between 2nd and 4th century. It is middle in scale (28x29 m) and with palaestra (56x53 m). Its construction period, plan organisation and plan size are similar to Upper Bath in Metropolis antique city.

The South Gate Bath in Perge and Capito Baths in Miletus are very similar to the Lower Bath in terms of their asymmetrical plan organisation, their plan size which are middle in scale and period to built (Öz, 2012).

So, it is understood that the Lower Bath is a typical example of Roman Baths built in this period (2nd-4th century AD). It reflects their plan organisation, plan size and period characteristics.

CHAPTER 3

DOCUMENTATION PROCESS

Documentation process consists of two parts related to each other. These parts are data gathering and data processing.

3.1. Data Gathering

Data gathering for the documentation of the Lower Bath consists of two steps: preparation of visual documents and historical research. Preparation of visual documents was realized in two phases: photographic documentation and theodolite measurements.

The tools used at the site survey are Laptop with 2,00 GB RAM and 32-bit Operating System, SLR camera (NikonD70s equipped with 28 milimeters lens), Nedo ET-5 theodolite, ladder, squared paper, paper clips, drawing board, pencil, eraser, paper targets, glazier's putty and gardener's scissors.

3.1.1. Taking Photographs

Photographs were taken with two different purposes: checking the necessary details after the site survey (pictorial photographs) and rectification.

3.1.1.1. Pictorial Photographs

Pictorial photographs were taken to remember the case study building during the office work and to prepare the tables. Quadrages of the photographs were set appropriately to remember the space first as a whole and then its details.

The photographs taken consisting of the building itself with its environment and just the building itself with all its spaces were used to remember the position of the building in the site and the position of the spaces of the building with reference to each

other. The inclined area surrounding the case study building was suitable for enlarging the quadrage. So, the photographs taken with this method were used to remember the spaces as a whole (Figure 3.1).

Figure 3.1. Taking photographs of the Lower Bath with its environment

For documenting the interior spaces and details of the elements, two different shooting positions were considered. First, standing at the centre of each space and making a 360º turn for covering all surfaces; second, standing parallel to each element and using the quadrage just to include the architectural element itself (Figure 3.2).

Figure 3.2. Taking photographs of the details of the Bath

3.1.1.2. Photogrammetric Evaluation Aimed Photographs

The system of taking photographs for the rectification will be mentioned in detail here.

- Before shooting with rectification purpose, the presentation scale and maximum shooting distance was planned. Taking photographs from longer distances saves time; the quadrage includes larger areas. Nevertheless, the maximum distance rule should be followed for a qualified resolution of the end product. The calculation table of Peter Swallow and his team was used at this step (Swallow, et al. 2004).
- The scale was determined by investigating the features of the cultural heritage selected as the case study. Ruined buildings in Archeological sites are generally documented in 1/50 scale. They can be perceived well and can be analysed better in terms of their architectural or archeological characteristics, structural characteristics, alterations, and deteriorations and failures. So, conservation decisions can be prosperously taken. In turn, the output scale was determined as 1/50. So, negative scale should be between 1/150 and 1/250 (Swallow, et al. 2004). As an average value; 1/200 was preferred for this study.

- The maximum distance to the object was calculated by using the values of negative scale (1/200) and focal length (28 mm) with the formula below:

$$\text{Negative Scale} = \frac{\text{Focal Length}}{\text{Distance}}$$

$$1/200 = \frac{28 \text{ mm}}{X}$$

$$X = 5600 \text{ mm} = 5.6 \text{ m}$$

- The distance to the object was kept as maximum 5.6 m, while taking photographs at the site.
- Inclined and curved surfaces can not be rectified. Flat surfaces are suitable for applying the single image rectification technique. So, flat surfaces were determined at the site.
- The maximum distance calculated (5.6 m) was measured with a steel tape.
- The surface was analysed with the calibrated camera equipped with 28 millimeters lens and the approximate distance between the control points was determined.
- Targets used for marking the control points were 5 x 5 cm in size with the purpose of accurate marking at the evaluation step and preventing covering of the surface too much.
- Targets (Figure 3.3) were placed, keeping in mind that minimum four control points should be in a photograph, while taking photos.

Figure 3.3. Target s: 1/1

- They were stuck with glazier’s putty. Wind causes problems; so, they should be stuck well.
- The facades were composed of planes at different depths. Each plane was documented with overlapping photographs.
- Minimum two control points should be shared by the overlapping photographs..
- Horizontal tilts were avoided, while taking photograps.
- Vertical tilts were minimized with the use of a ladder, while documenting upper parts of the facades.
- Uneven surfaces composed of rubble and rough cut stones exposed without plastering and/or well-established surface deterioration (> 2.5 cm in depth) sometimes could not be rectified properly.
- Because of the additional unmovable shelter structures covering some parts of the facades, the number of the photographs regarding these surfaces had to be increased.
- Taking a lot of photographs of the same surface helped producing more accurate rectifications and also the obstacles in front of the surfaces could be hidden in the image mosaic with the help of these large number of photographs.
- The rectified photographs taken were saved in jpeg format.

3.1.2. Theodolite Measurement

Curvilinear surfaces such as apses, domes, etc. and areas too damaged could not be rectified. The surfaces that can not be reached because of their heights and the areas that can not be rectified were measured with the theodolite.

- The theodolite was placed appropriately to measure maximum surface area with minimum number of the station points. At the same time, very acute angles were avoided.
- The plan size of the spaces (space no1: 15.6x7.7 m, space no2: 20.5x8.7 m, space no3: 5.3x11.2 m, total plan size of transition spaces: 20.4x9.6 m) were suitable to set the theodolite at the centre of them.
- Sketches of the areas to be measured were prepared (Figure 3.4).

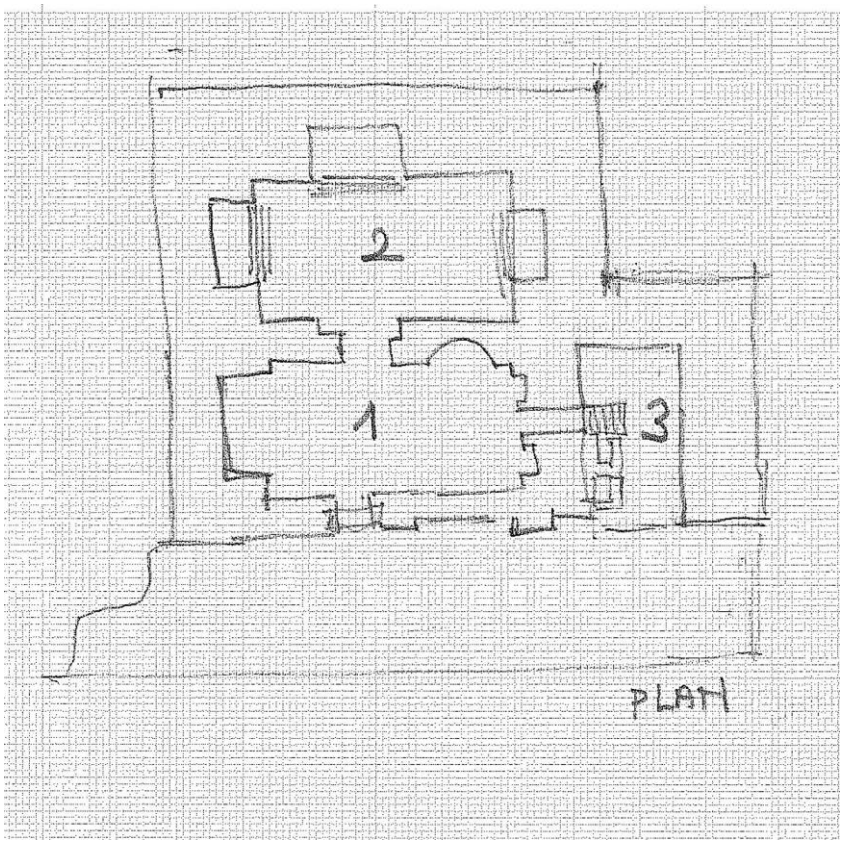

Figure 3.4. Sketch of the Spaces in the bath

- The contours of the areas and the openings on them were measured with the theodolite.
- The points were marked with their ID on the sketches while they were being measured with the theodolite at the same time (Figure 3.5).

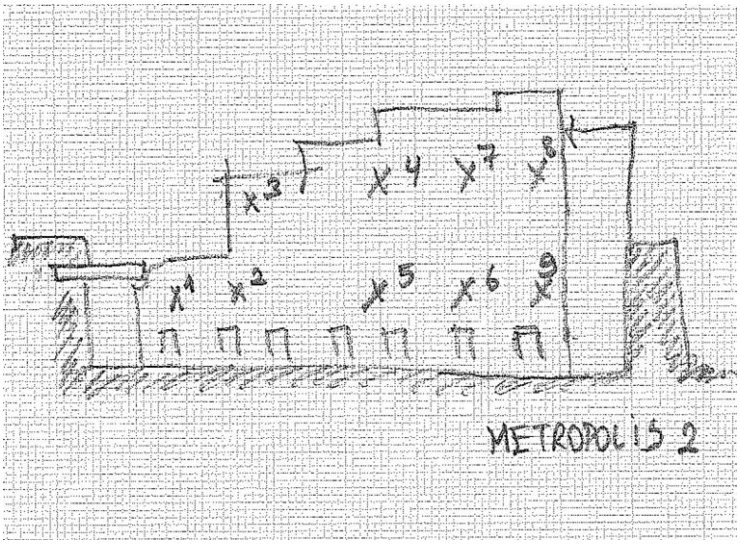

Figure 3.5. Sketch of a surface to be measured

- The measurements were produced in asc format as a list and in dxf format as a point cloud.

3.2. Data Processing

Data gathered at the site survey are processed on the computer in five phases: single image rectification, photo mosaic production, mosaic-drawing combination, CAD drawing and modelling.

The tools used are a PC (Personal Computer) equipped with a hardlock input, 2.00 GB RAM and NVIDIA GeForce 8400M GS display card with 1008 MB memory; Notepad, AutoCAD 2012, Pictran 4.0, Adobe Photoshop CS2 and SketchUp 7 and SketchUp 8 softwares.

3.2.1. Preparation of Visual Documents

Visual documents were prepared in six steps respectively: single image rectification, photo mosaic production, combining the photo mosaic and theodolite measurement, preparation of thematic maps, CAD drawing, and 3D modelling (Appendix B). Firstly the photogrammetric evaluation aimed photographs were imported to Pictran software. X, Y and Z coordinates of the control points on the surfaces to be rectified were added. The control points were marked on the images and then, they were rectified. The rectified photographs were exported in Jpeg format. Secondly, they were opened in Adobe Photoshop software separately and they were scaled in 1/50 with the help of the measurements of the control points coming from the first tachometric survey. They were put in right order by overlapping the control points or placing them according to some calculation which shows their position to each other. The photo mosaics were saved in Jpeg format. Thirdly, 2D drawings of the surfaces that cannot be rectified were prepared in AutoCAD software. The surfaces that cannot be rectified were drawn by associating the points to each other. The photo mosaics in Jpeg format were imported to AutoCAD software. 2D drawings and image mosaics prepared were combined. Fourthly, thematic maps were painted on them in AutoCAD software. However, if there was a photo mosaic to be painted as solid, thematic maps were prepared in Adobe Photoshop software to use its opacity function while painting. Fifthly, 2D CAD drawings were produced from the combination prepared by drawing all of the details of the mosaic parts and then by deleting the image mosaics in AutoCAD software. Lastly, the case study building was modelled in SketchUp software. The prepared drawings were used as base map and the surfaces of the case study bath were formed. And then, photo mosaics were added to these surfaces as texture. 3D model was exported as 2D graphic.

3.2.2. Preparation of Tables

Spatial characteristics, architectural elements, and characteristics of construction techniques and material usage tables were prepared with the help of observations at the site, pictorial photographs, photogrammetric evaluation aimed photographs, and historical research.

In office work, first of all, all of the spaces, structural elements, architectural elements and finishing elements were listed starting from south and continuing in clockwise order, and in an order from top to bottom (Figure 3.36). All of these items were identified with an ID number. The list with three columns with heading ID, element name and element type was prepared as an auxiliary table supporting the main tables (Appendix L).

For preparing spatial characteristics table; ID numbers with space names were taken from the auxiliary list. They were placed as two initial columns of the table. Characteristics of space, alteration of space, conservation state and recommendations columns were formed as the succeeding, columns respectively. The graphic column as the last column of the table was made available to include axonometric model views, 2D representations combining the photo mosaics and theodolite measurements or 2D CAD drawings.

For preparing architectural elements table; ID numbers with architectural element names were taken from the auxiliary list. They were placed as two initial columns of table. Morphological characteristics and alteration columns were formed as the succeeding columns, respectively. Graphic column was formed as the last column to include related photographs and references of the illustrations in the appendices.

For preparing characteristics of construction techniques and material usage table; ID numbers with structural, architectural and finishing element names together with the column demonstrating their element type were taken from the auxiliary list. They were placed as three initial columns of table. Construction technique, and failure and deterioration columns were formed as the succeeding columns, respectively. Graphic column consisting of the photographs taken at the site survey and the related appendix name including the illustrations was added as the last column of the table.

ID	Element Name	Element Type	ID	Element Name	Element Type
1	Bath building as an element of the cultural landscape.	Spatial	59	Fountain spout - caldarium 1, western plunge pool.	Architectural
2	Caldarium Main Space 1.	Spatial	60	Fountain spout - caldarium 2, southern *alveus*.	Architectural
3	Caldarium Main Space 2.	Spatial	61	Fountain spout - caldarium 2, western *alveus*.	Architectural
4	Caldarium Main Space 3.	Spatial	62	Fountain spout - caldarium 2, northern *alveus*.	Architectural
5	Service corridor.	Spatial	63	Furnace opening - caldarium 1, southern *alveus*, southern wall.	Architectural
6	Hypocaust.	Spatial	64	Furnace opening - caldarium 2, southern *alveus*, southern wall.	Architectural
7	Transition space.	Spatial	65	Furnace opening - caldarium 2, western *alveus*, western wall.	Architectural

Figure 3.6. Preparing the auxialiary table

CHAPTER 4

IDENTIFICATION OF THE CASE STUDY

The studied part of the Lower Bath in Metropolis (28x29 m) is described in detail in the below.

4.1. Spatial Characteristics

The bath building (28x29 m) as an element of the archaeological site is composed of five spaces at present: *caldarium* main space 1, *caldarium* main space 2, *caldarium* main space 3, service corridor and hypocaust (Appendix M). There is a *palaestra* (56x53 m) at the east of the bath. There is a transition zone (40x10 m) between the discussed building ruins and the *palaestra*. The ruins here belong to various archaeological strata (Appendix M).

4.1.1. Bath Building as an Element of the Archaeological Site

Lower Bath is a landmark in the Metropolis antique city. It has a monumental character but this was diminished with the loss of vaults and wall pieces, and embedding of the mass into the earth. In parallel with the excavations, a comprehensive restoration project should be developed.

In its present state the bath building is composed of three rectangular planned main spaces juxtaposing one another and a U formed service corridor circumscribing it at its south, west and north.

The ground plane surrounding the bath building from its south, west and north is inclined and elevated. Starting from the area where *palaestra* is present, it becomes a flat terrain. This differentiation stems basically from the contrast between excavated and unexcavated zones (Figure 4.1).

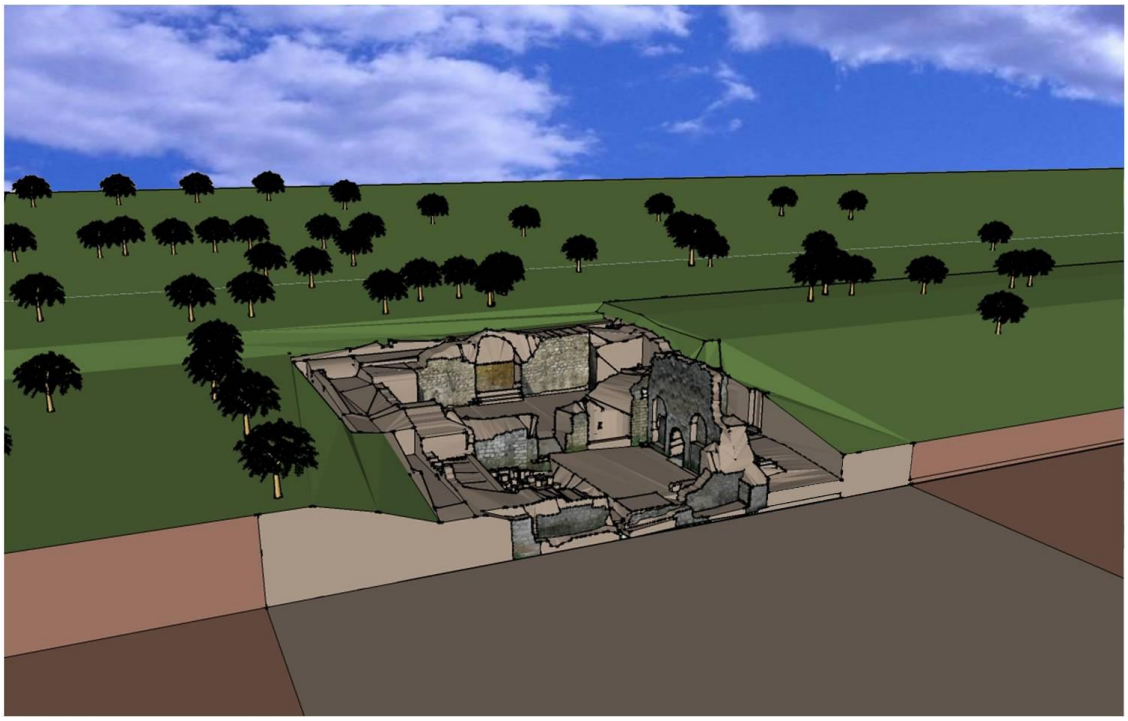

Figure 4.1. A view of the Lower Bath with its environment

4.1.2. Caldarium Main Space 1

Caldarium main space 1 (15.6x8.2 m) is at the eastern part of the bath ruins, and forms the present entrance. The highest wall (hmax: ~6.97 m) of the bath ruins is here and it provides a monumental characteristic to the space. Its *suspensura* is covered with debris layer. Its south part has collapsed. This makes it difficult to perceive the real size of the space and its wholeness. Nevertheless, it provides observation of the hypocaust system under the *suspensura*. There is an *alveus* with a furnace arch at the south of the space. Western wall of the space includes a narrow door opening with two pilasters on its two sides. There are two niches at the west and east of the northern wall and there is a narrow door opening at the centre of this wall. These narrow doors at the west (2.21x2.26 m) and north (1.65x1.81 m) open to the *caldarium* main space 2 and *caldarium* main space 3, respectively (Figure 4.2).

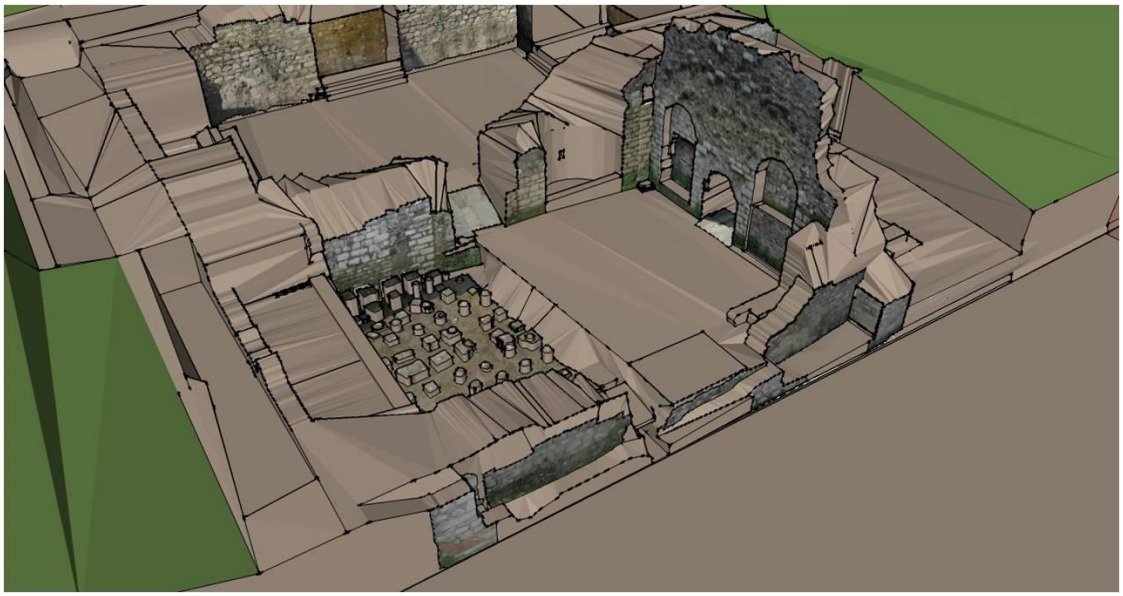

Figure 4.2. Caldarium main space 1

4.1.3. Caldarium Main Space 2

Caldarium main space 2, the largest closed space of the bath (14.5x8.7 m), is at the western part of the bath building. Its superstructure is not preset today. Its walls are partially lost. Southern part of its eastern wall is the lowest wall (hmax: ~2.87 m) of the space. It has a symmetrical plan organisation with the arrangement of its three *alvei*. These *alvei* are at the centre of southern, western and northern walls of the space. There is a pilaster on south side of the western *alveus*. Other two pilasters are on two sides of the door opening at the centre of the eastern wall. There are baseboards at the southern and northern walls of the space, at eastern and western walls of the northern and southern *alveus* and at all walls of the western *alveus*. The majority of its architectural elements such as pilasters, baseboards, marble coverings, etc. are missing. This situation causes a reduction in the perception of its brilliancy. Its three sub spaces (*alveus*) are covered with protective additional roofs providing control of rain water. Its ground is covered with debris (Figure 4.3).

Figure 4.3. Caldarium main space 2

4.1.4. Caldarium Main Space 3

Caldarium main space 3 (5.3x11.8 m) is at the northern part of the bath building. The superstructure is completely lost. Its original spatial boundries are not legible. It is a narrow, unilluminated space with high boundries: the original wall pieces at the south (hmax: ~6,97 m) and west (hmax: ~4.04 m), and the excavation border at the north (hmax: 3.51 m). So, the original spatial quality can not be deciphered at present. In addition to the narrow door at the south (1.65 m), there is a second door at the north (1.36 m), as traced from the marble steps. The L planned wall piece (w: ~0.5 m, hmin: ~0.45, hmax: 0.99 m) at the southeast is not united with the original southern wall with a construction joint. The sub-space formed within this wall is protected with an additional roof providing control of rain water. There are marble pieces stored in this sub-space. Excavation of this space should be completed (Figure 4.4).

Figure 4.4. Caldarium main space 3

4.1.5. Service Corridor

Service corridor is a U formed space which surrounds the bath building from its three sides: south (w: ~4 m), west (w: ~3 m), east (w: ~2.5 m). It is covered with barrel vault made of brick. Its superstructure is partially covered with debris layer. There are two flues at south and north of its western part. There is an arch at its southern wall of southern part. Excavation of this space should be completed. There are bricks (30x30x5) on the ground independent from the surfaces (Figure 4.5).

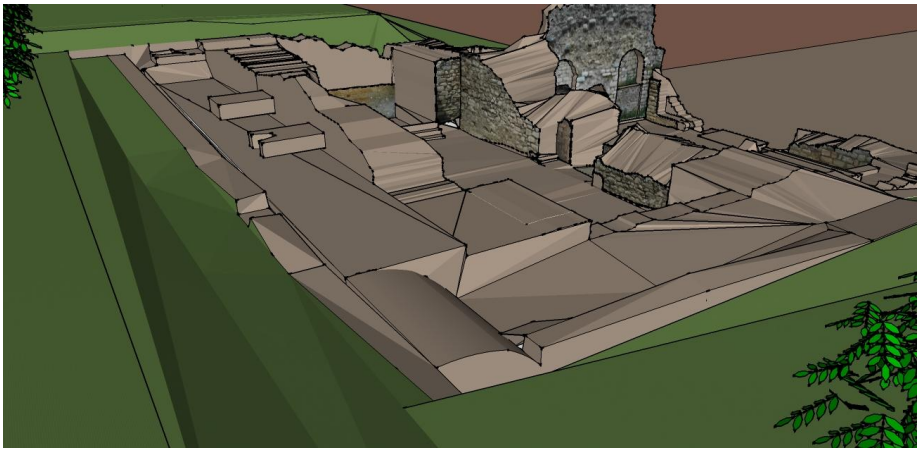

Figure 4.5. A view of service corridor

4.1.6. Hypocaust

In this section, the hypocaust portion exposed in connection with caldarium main space 1 is to be discussed. The hypocaust (~5.17x7.32 m) is a depressed (~1.10 m) and dense service space underneath *caldarium* main space 1. Its *suspensura* part is missing so, its original spatial character is lost. The columns supporting the *suspensura* are positioned in a gridal order (approximate distance between the axes: ~0.80 m). The 69 columns visible at present are in circular (23), quadrilateral (39) or mixture (7) of a circle and quadrilateral in plan. Ground of the hypocaust is covered with debris layer. Conservation and presentation measures should be developed (Figure 4.6).

Figure 4.6. Rectified plan of hypocaust

4.1.7. Transition Space

It is between the bath building at the west and the *palaestra* at the east. It is an illegible space (40x10 m) at present because of the overlapping historical strata. Excavation of this space should be completed. Its historical periods should be deciphered. Conservation and presentation measures should be developed.

4.1.8. *Palaestra*

Palaestra is at the east of the bath building. It is composed of a squarish courtyard (56x53 m) surrounded by colonnaded porticoes (w: ~7 m). The courtyard is unpaved, while the porticoes are richly decorated with mosaic inlay. Although the original superstructure of the porticoes is missing, a protective roof is provided. In addition, geotextile and sand are used to cover the mosaics. Because of the collapsed columns, it is difficult to perceive the boundaries of the original *palaestra* organisation at present. Nevertheless, the aesthetic quality of the mosaics contributes to the picturesque quality of the antique site (Figure 4.7, Figure 4.8).

Figure 4.7. A general view of *palaestra*

Figure 4.8. A detail of mosaics

4.2. Architectural Elements

Fifteen different types of architectural elements were defined in the bath ruins (Appendix N). These are flues, vertical duct, fountain spouts, furnace openings, platforms, stairs, pilasters, niches, *tubuli* systems, *alvei*, plunge pools, baseboards, doors, marble inlays and wood floor covering in the order from top to bottom.

4.2.1. Flues

Flues provide draught to hot gas in Roman baths. There are two flues detected at present: at the south of the western part of the service corridor (~109x180 cm), at the north of the western part of the service corridor (~143x197 cm) and at the centre of the western part of the service corridor (~55x43 cm). Debris covers the output at present.

4.2.2. Vertical Duct

Vertical ducts provide a draught to hot gas in Roman baths. There is only a single vertical duct (w: ~52 cm) deciphered at the case study building. It is at the west of *caldarium* 1 and partially preserved.

4.2.3. Fountain Spouts

Water is provided through fountain spouts to the pools in Roman baths. Four fountain spouts were observed at the Lower Bath building: one of them (17x30 cm) at caldarium 1 western plunge pool, the other (19x23 cm) at caldarium 2 southern *alveus*, third (16x25 cm) at caldarium 2 western *alveus* and fourth (18x12 cm) at caldarium 2 northern *alveus*. They are in quadrilateral form. Their function was controlling the flow of water into the *alveus* (3/4) or plunge pool (1/4).

4.2.4. Furnace Openings

In order to keep the water in the pools hot, furnace openings providing direct heat transfer opportunity from the furnaces to pool tanks are designed in Roman Baths. There are four furnace openings at the case study building: first caldarium 1 southern *alveus* southern wall, the second at caldarium 2 southern *alveus* southern wall, the third at caldarium 2 western *alveus* western wall and fourth at caldarium 2 northern *alveus* northern wall. They provide their pool tanks heat. They are semicircular, arched openings. The one at the western alveus is in the middle of the new wall infill and the others are in the middle of the original walls.

4.2.5. Platforms

Platforms are the sitting elements of Roman baths. Four platforms are seen at the Lower Bath: at eastern wall and western wall of caldarium 2 southern *alveus*, and at eastern wall and western wall of caldarium 2 northern *alveus*. They extend throughout the short edge of *alveus* (~w: 29-37, hmax: ~88, hmin: ~30 cm). Their finishing elements are baseboards. They are partially preserved. Partial loss of plaster probably lime in character is seen at the one at the southern *alveus* western wall. Extensive loss of plaster probably hydraulic lime in character is seen at the one at the southern *alveus* eastern wall. Total loss of plaster probably lime in character covering is seen at the one at the northern *alveus* western wall. Total loss of plaster covering is seen at the one at the northern *alveus* eastern wall.

4.2.6. Stairs

Stairs may be designed to provide access to the pools in Roman Baths. There are seven stairs (w: ~30, h: ~15-35 cm) detected in the Lower Bath at present: at *caldarium* 1 western plunge pool, at *caldarium* 1 eastern plunge pool, at *caldarium* 1 southern *alveus*, at *caldarium* 2 southern *alveus*, at *caldarium* 2 western *alveus*, at *caldarium* 2 northern *alveus* and at *caldarium* 3 north. They can be classified according to their step number: one stepped (3/7), 3 stepped (1/7) and four stepped (3/7).

Two of one stepped ones extend throughout the diameters of the eastern and western plunge pools of *caldarium* 1. The other one extends throughout the long edge of the southern *alveus* of *caldarium* 1. The stairs are detected only with their traces at the southern *alveus* of *caldarium* 1, excluding one step. Plaster probably hydraulic lime in character is partially observed at this preserved step of southern *alveus* of *caldarium* 1. There is partial loss of the element and total loss of covering material at the eastern plunge pool of *caldarium* 1. Total loss of covering material is observed at the western plunge pool of *caldarium* 1.

Three steps provide access to the alveus and one step is for sitting at the four stepped stairs in caldarium 2. They all extend throughout their pool's long edges. The one at the caldarium 2 southern *alveus* has lost its marble covering extensively. The other ones have lost their covering material totally.

The three stepped stairs at the north of *caldarium* 3 is composed of horizontal marble pieces lying on the bottom of the door opening. It is slightly embedded into the earth.

4.2.7. Pilasters

There are six varieties of pilasters at the case study building. They are seen at the *caldarium* 1 (3/6) and *caldarium* 2 (3/6). They are decorative elements slightly projecting from the related walls (~18 cm). Two of them are with quadrilateral shaft (~18x35x36 cm) and quadrilateral base (~40x40x17 cm), 3 of them are just with quadrilateral shaft (~18x45x128 cm), and 1 of them is just with quadrilateral base (~40x40x17 cm).

Partial loss of shaft and total loss of covering are seen at the ones with quadrilateral shaft and quadrilateral base. Partial loss of shaft, loss of base and total loss of covering are observed at the ones just with quadrilateral shaft. Total loss of shaft is seen at the one just with quadrilateral base.

4.2.8. Niches

There are 3 niches at the bath building. Two varieties of niches are observed: the recesses with rectangular plan (~48x170 cm), arch (r: ~86, cs: ~175 cm) and with a

pedestal and elevated slightly from the present ground level (2/3), recess with rectangular plan (~43x32 cm) and elevated 241 cm from the ground level (1/3). Two of them (arched ones) are at the *caldarium* 1 northern wall and the other one is at *caldarium* 3 western wall.

Alterations are observed at the ones at *caldarium* 1: partial loss of pedestal and additional infill on the original pedestal remain are seen at the one at eastern part, and total loss of plastering is observed at the one at western part.

4.2.9. *Tubuli* Systems

Tubuli systems providing circulation for hot gases in Roman baths may be in form of series of rectangular prisms running vertically parallel to the wall surfaces, *tubuli* system is observed at two places: at the western wall of *caldarium* 1's *alveus* and at the western wall of *caldarium* 2. The one at *caldarium* 1 has only four *tubuli* and the other one has only a single *tubulus*.

The one in *caldarium* 1 is relatively more preserved, while the one in *caldarium* 2 is identified with limited traces.

4.2.10. *Alvei*

Alvei are bathing pools heated by *praefurnium* in Roman baths. There are four *alvei* at the Lower Bath building. They are in rectangular form. One of them is at the south side of *caldarium* 1 (253x512 cm) and 3 of them are at *caldarium* 2 ; on south (334x541 cm) , west (115x362 cm) and north (237x547 cm) sides. Two of them, the ones at east and west of *caldarium* 2 are enriched with platforms on their two sides. The ones at *caldarium* 2, are accessed with four steps. The one at *caldarium* 1 is extensively ruined and accessed with a single step at present.

4.2.11. Plunge Pools

There may be semicircular bathing pools accessed with a single step in Roman baths. Two plunge pools are observed at the case study building. One of them is at the west and the other one is at the east of *caldarium* 1.

The one at the west is well preserved while the other is ruined extensively.

4.2.12. Baseboards

Baseboards in form of linear transition elements extending throughout the wall surfaces between wall and floor surfaces may enrich Roman baths. Eleven baseboards (t: ~1.5 cm) were deciphered at the building: at the western wall of the *alveus* of *caldarium* 1 (1/11), at the southern, northern and eastern walls of *caldarium* 2 (3/11), at the eastern and western walls of southern *alveus* of *caldarium* 2 (2/11), at the southern, western and northern walls of western *alveus* of *caldarium* 2 (3/11), and at the western and eastern walls of northern *alveus* of *caldarium* 2 (2/11).

Partial loss of the element is seen at the one *caldarium* 1 and at the ones at southern and eastern wall of *caldarium* 2.

4.2.13. Doors

Four doors were detected at the bath building. They are rectangular planned openings and small in size to control heat loss (~125x200 cm).

The first is at the east of *caldarium* 1 and provides circulation between *caldarium* 1 and transition spaces. It is ennriched with a curvilinear wall on its southern side and it has a space underneath to provide circulation for hot gases.

The second is at the east of *caldarium* 2 and provides circulation between *caldarium* 1 and *caldarium* 2. It is enriched with pilasters on its two sides, with recesses on the two sides of its *caldarium* 2 face and with marble inlay.

Third is at the south of *caldarium* 3 and provides circulation between *caldarium* 1 and *caldarium* 3. It is arched and enriched with recesses on its two sides at its *caldarium* 1 face and marble inlay with trace of a channel.

The last one is at the north of *caldarium* 3 and provides circulation between *caldarium* 3 and an unexcavated space. It is enriched with recesses on its two sides and 3 marble steps leading to the opening.

Total loss of finishing elements is seen at all of them and besides this extensive (3/4) or partial (1/4) loss of wall bounding the opening is observed.

4.2.14. Marble Inlays

Marble inlays in the Lower Bath are in form of marble pieces in different sizes (between 67-90x170-172 cm) lying on the bottom of the door openings or on the ground of some *alvei* at present. They are detected in five positions: at the east of *caldarium* 2, at the southern, western and northern *alveus* of *caldarium* 2, and at the south of *caldarium* 3. First one is slightly embedded into the earth and it is relatively better preserved .

4.2.15. Wood Floor Covering

It is observed only at the south of *caldarium* 3. It consists of linear wooden elements covering the floor and these elements are arranged side by side. This covering is additional.

4.3. Characteristics of Construction Techniques and Material Usage

Construction techniques and material usage of the structural, architectural and finishing elements will be discussed, respectively in the below (Appendix O).

4.3.1. Structural Elements

Vaults, protective roofs, arches, walls, partitioning wall and hypocaust columns are structural elements in order of top to bottom.

4.3.1.1. Vaults

Barrel vaults are observed at two positions at present: at western *alveus* of *caldarium* 2 and at the southwest of the service corridor. Dimensions of the first one are: r: 597 cm, cs: 647 cm and d: 148 cm. They are out of rubble stones (~1x1x0.5 cm) and bricks (~1.5x1x0.5 cm) put together with brick lime mortar (t:~4.5 cm) and dressed with rubble stones (~50x17x13 cm) and bricks (~30x5 cm) embedded in lime mortar (thorizontal:~3 cm, tvertical:1 cm). The core of the vault spanning the *alveus* has become vulnerable against weathering since the facing has been ruined extensively on both side.

Consequently, the vault piece over the service corridor has been overloaded with a thick layer of earth. Well developed deterioration, as revealed through the presence of algae, lichen and higher plants on the intrados, is observed.

4.3.1.2. Protective Roofs

There are four protective roofs added to the bath building. They either protect the remains in *alveus* (3/4) or those at the southwest corner of *caldarium* 2 (1/4). They consist of metal guttered sheets carried by metal posts. Slight rusting is observed on all of them.

4.3.1.3. Arches or Arch Systems

Arches or arch sistems are observed in relation to the doors, niches or furnaces: at the southern *alveus* of *caldarium* 1 (1/8), at the west, centre and east of the northern wall of *caldarium* 1 (3/8), at the southern, western and northern *alveus* of *caldarium* 2 (3/8), at the south of the service corridor (1/8). They are all semicircular.

The arches at the northern wall of *caldarium* 1 span the niche recesses at the west and east (~ cs: 86, r: 175 cm) and the door at centre (~ cs: 85, r: 168 cm). They are out of rubble stone (~16x6x25 cm) embedded in lime mortar (t: ~6-7 cm) and dressed with rough cut stone (~43x19x12 cm).

The arch systems at the southern *alveus* of *caldarium* 1 and at the northern *alveus* of *caldarium* 2 are composed of an arch spanning the opening and a discharging over it. These arch systems and the arch observed partially at the south of the service corridor are constructed with radially laid bricks (~30x30x5 cm) and brick lime mortar (t: ~0.5-5 cm). Addition to this, the one at the southern *alveus* of *caldarium* 1 and the one at the south of service corridor has infill covered with plaster probably brick lime in character.

The one at southern *alveus* of *caldarium* 2 is covered with double layered plaster system consisting of brick lime as an under-layer and hydraulic lime as a top-layer.

The last one, at the western *alveus* of *caldarium* 2 is an additional arch within the wall repaired with brick, rubble stone and mortar.

The facing of the arches at west, centre and east of the northern wall of *caldarium* 1 have extensively damaged.

The arch systems at southern *alveus* of *caldarium* 1 has partial loss of plastering and partial loss of infill.

The arch at northern *alveus* of *caldarium* 2 has slight loss of plastering probably hydraulic lime in character and deposit formation.

The arch at the south of the service corridor has been overloaded with extensively covering with earth.

The one at southern *alveus* of *caldarium* 2 has lost almost all of its infill; only mortar pieces are observed in place of the infill.

The last one, at the western *alveus* of *caldarium* 2 is a random arch opening, it is observed the lack of radial or corbelled order.

4.3.1.4. Walls

There are 30 walls bordering the spaces of the case study building. All of the walls have collapsed partially. The wall between the *caldarium* 1 and *caldarium* 2 is the most preserved one. All of the walls were built with core out of rubble stone and brick embedded lime mortar, dressed with irregular sized rough cut stones in *opus vittatum* technique (10/30) or irregular sized rubble stones in *opus incertum* technique (20/30) (Figure 4.9) (Öz, 2012). Only the wall at the northern wall of the northern *alveus* of *caldarium* 2 has three rows of bricks. Repair brick and stone (2/3) or repair brick (1/3)

wall piece at 3 locations are detected. Except from these, there are slight differences between them. It is not observed any covering material at some of the walls (12/30) besides this there are some finishing material traces at the other walls (18/30). If these traces are deciphered; 9 of them are partially covered with plaster probably in lime character, 3 of them are partially covered with plaster probably in brick lime character, 4 of them are partially covered with double layered plaster: probably lime in character under-layer, probably hydraulic lime in character top-layer (2/4), probably brick lime in character under-layer, probably hydraulic lime in character top-layer (1/4) and gray under-layer, probably hydraulic lime in caharacter top-layer (1/4), and 2 of them are partially covered with mortar of *tubuli* at present .

Similar failures and deteriorations are observed at all of the walls of the building. Partial collapse is seen in all of the walls. Plastering layer is totally (15/30), extensively (6/30) or partially (9/30) lost at the walls covered with single layered plastering. Extensive loss of finishing layer is seen at the walls covered with double layered plastering. Problems in the facings are either in the form of well-developed surface loss or in the form of local surface loss. Loss of integrity and discoloration are observed at the facings of the walls. Deposit formation; lichen, algea etc. formation is observed at both facing and core.

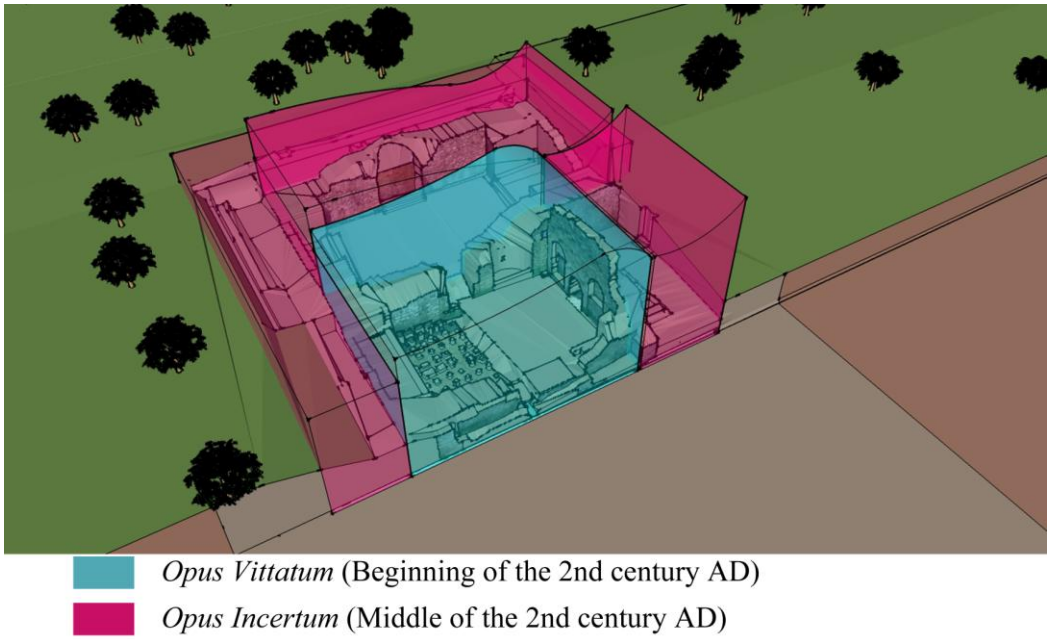

Figure 4.9. Construction Techniques of the Walls

4.3.1.5. Partitioning Wall

There is only one partitioning wall at the case study building. It is at the south of *caldarium* 3. This is an independent wall without any construction joint to the adjacent south wall. It consists of reused stone blocks (62x44x20 cm), bricks (30x30x5 cm) and mortar (t: ~3 cm), and finished with plaster probably lime in character (t: ~3.5 cm). Maximum height of the wall is 114 cm.

It is understood that they have been exposed to weathering conditions for a long time. There is also partial loss in its plastering. It is understood that it was slightly higher, when it was erected.

4.3.1.6. Hypocaust Columns

There are series of columns (h: ~30-56 cm) at the south of *caldarium* 1. They are in circular, squarish, linear or L formed plans. They are made of circular (di: ~30 cm) or squarish (30x30 cm) bricks and gray mortar (t: ~4 cm). Partial collapse is observed at all of the columns. It is understood that they have been exposed to weathering conditions for a long time.

4.3.2. Architectural Elements

Flues, vertical duct, fountain spouts, furnace openings, platforms, stairs, pilasters, niches, *tubuli* systems, *alvei*, plunge pools, baseboards, doors are the architectural elements (Appendix O).

4.3.2.1. Flues

Flues are made of bricks (30x5x27 cm) and lime mortar (t: ~2.5 cm). Partial collapse is observed at all of them: their outflows are damaged. No trace of the finishing material has reached today.

4.3.2.2. Vertical Duct

There is a single vertical duct at the western wall of *caldarium* 1 and it is made of bricks (30x5 cm) and mortar (t: ~2.5 cm). It has partially collapsed and lost its plastering.

4.3.2.3. Fountain Spouts

Fountain spout is detected at four positions (4.2.3). They are holes within the wall without any finishing material. The pipes could not be observed. The one at the caldarium 2 southern *alveus* has brick infill at present.

4.3.2.4. Furnace Openings

Furnace opening is observed at four positions (4.2.4). Furnace openings are with an arch (2/4) or arch system (2/4). They are covered with plaster probably brick lime in character (2/4) or double layered plastering consisting of plaster probably brick lime in character as under-layer and plaster probably hydraulic lime in character as top-layer (2/4). Their infill is partially (2/4) or totally (1/4) lost.

4.3.2.5. Platforms

There are four platforms at the case study building. They are made of bricks (30x30x5 cm) and lime mortar (t: ~4 cm). All of them are at southern and northern *alveus* of *caldarium* 2. The ones at southern *alveus* are covered with plaster probably hydraulic lime in character (t: ~2.5 cm) and the ones at northern *alveus* are covered with plaster probably lime in character (t: ~2.5 cm).

The spread of damages in the platforms of the southern *alveus* has led to partial decomposition of the element, while the platforms of the northern *alveus* suffer from local damages. Partial loss of plastering is seen at the western wall of northern *alveus* and extensive loss of plastering is seen at the others.

4.3.2.6. Stairs

There are four kind of stairs at the bath building: stairs made of bricks (~30x30x5 cm) and gray mortar (t: ~2.5 cm) (2/7), stairs made of stones (45x32 cm) and brick lime mortar (2.5 cm) and finished with plastering probably hydraulic lime in character (inside the pool) (t: ~2.5 cm) (3/7) or finished with marble (outside the pool) (t: ~1.5 cm) (1/7), and stairs made of marbles and mortar (1/7).

Failures and deteriorations of the stairs are partial loss of the element (3/7), slight crack (1/7), extensive loss of marble covering (1/7), total (2/7), extensive (3/7) or partial (1/7) loss of plastering and deposit formation (4/7).

4.3.2.7. Pilasters

There are three kind of pilasters: with shaft made of bricks (~15 or 30x5x30 cm) and lime mortar (t: ~3 cm) (3/6), with shaped marble base (1/6), and with shaft made of bricks (~15 or 30x5x30 cm) and lime mortar (t: ~3 cm) on the shaped marble base (2/6). There is no finishing material at the one of the shaft (1/5) and the others are covered with plaster probably brick lime in character (t: ~5 cm) (3/5) or gray plaster (1/5).

Similar failures and deteriorations are observed at the pilasters: extensive (4/6) or partial (2/6) loss of the element, total (2/6), extensive (1/6) or partial (2/6) loss of plastering, loss of integrity (2/6) and deposit formation (6/6).

4.3.2.8. Niches

There are three niches at the building. They are out of rubble stone (~16x6x25 cm) and lime mortar (t: ~6-7 cm): core and dressed with irregular sized rough cut stones: *opus vittatum*. The one at the west of the northern wall of *caldarium* 1 has repair brick and stone at its central part and it has metal supporting elements. The one at the east of the northern wall of caldarium 1 has repair stone at central part and repair brick at buttom part.

Partial loss of the element is seen at the one at the west of the northern wall of *caldarium* 1. Besides this, total loss of plastering, deposit formation and plant growth are observed in all of them.

4.3.2.9. *Tubuli* Systems

Tubuli system consists of terracotta elements attached to the walls with lime mortar. It is seen as a single element and as a group of elements at two different positions in the Lower Bath.

Loss of integrity and deposit formation are observed at the elements.

4.3.2.10. *Alvei*

Alveus is deciphered at four positions (4.2.10). Two of these pools are surrounded by a wall , two platforms and stairs on its four sides. The others does not have platforms; there are walls instead of them. Their ground is covered with marble (3/4) except from the one at the south of *caldarium* 1. Their superstructures are not present today.

4.3.2.11. Plunge Pools

Two plunge pools are present at the building today (4.2.11). They are surrounded by a curvilinear wall and a stair on its sides. Their ground is covered with debris layer today. Their superstructures are collapsed.

4.3.2.12. Baseboards

There are eleven baseboards at the bath and all of them are made of marble (t: ~1.5 cm) and they are all attached to the wall with mortar (t: ~5 cm).

Both loss of integrity and deposit formation or just deposit formation are seen at these elements.

4.3.2.13. Doors

Door openings are the elements within the wall. Addition to the wall bounding the door; the one at the centre of the northern wall of *caldarium* 1 has a stone block on one side and arch spanning the opening and the one at the south of *caldarium* 2 has brick facing on the wall on both sides.

Deposit formation are observed at all of them. Addition to this, total loss of spanning element (3/4), no covering material on side walls (3/4) and loss of integrity (2/4) also are observed.

4.3.3. Finishing Elements

Marble inlays, wood floor covering and debris are finishing elements (Appendix O).

4.3.3.1. Marble Inlays

Pieces of marble inlay is observed at five positions (4.2.14). Marble pieces are attached to the ground with mortar. Total involvement of surface deterioration in form of deposit formation. Besides this, slight cracks on the pieces at the east of *caldarium* 2, and partial loss at the southern *alveus* of *caldarium* 2 and at the one at the south of *caldarium* 3 with detachment.

4.3.3.2. Wood Floor Covering

It consists of wood panels brought together with a metal frame.

4.3.3.3. Debris

It consists of fragments of original building elements, earth and plants, and observed throughout the bath ruins.

CHAPTER 5

DISCUSSION AND CONCLUSION

This study was carried out in order to explore a documentation methodology for assessment of the heritage characteristics of an archaeological monument. Contemporary documentation techniques such as photogrammetric and tachometric surveying, and building information modelling were combined with conventional techniques such as historical research and mapping. The Lower Bath in Metropolis, Torbalı, İzmir was taken as the case study. The representations produced, which are scaled photo mosaics and 2D drawings, 3D model, and thematic maps, are realistic documents providing opportunity for perceiving the authentic qualities of the heritage object. The principles of the proposed methodology were explained with their advantages and disadvantages. As a result, documentation guidelines for assessment of heritage characteristics of an archaeological monument are defined as in the below:

Taking pictorial photographs;

- Camera should be set appropriate to the purpose of the photograph; the building itself with its environment, building itself with all its spaces, interior spaces of the building or details of the elements.

Taking photogrammetric evaluation aimed photographs;

- Presentation scale and maximum shooting distance should be determined before starting the site survey.
- Scale should be determined by investigating the features of the antique building.
- Flat surfaces should be determined.
- Approximate distance between the control points should be determined before sticking the targets.
- Targets in appropriate size should be used.
- Targets should be sticked well.
- Planes in different depths should be documented separately.
- Horizontal tilts should be avoided.

- The number of photographs taken must be optimum for making a backup before the targets disappear.

Theodolite Measurement;

- Theodolite should be placed appropriately to measure maximum surface area with minimum number of the station points.
- Very acute angles should be avoided.
- Sketches should be prepared to write ID number of the points on.

Single Image Rectification;

- X, Y and Z coordinates' columns should be determined.
- Coordinates should be typed in their correct location in Pictran.
- "Cross Hair" should be placed at the centre of the points.
- Files should be saved in different folders according to their type.

Photo Mosaic Production;

- Photographs should be opened and scaled one by one.
- Resolution should be typed 300 pixels/inch.
- Unnecessary areas should be deleted.
- Rectified and scaled photographs should be gathered in a new file in appropriate size and with 300 pixels/inch resolution.
- The photographs should be placed in right order and according to the relationship between their control points.

Combining the photo mosaic and theodolite measurement;

- Layers should be created for different line types.

3D Modelling;

- The part to be modelled should be saved as a block in AutoCAD software by using "Wblock" command.
- SketchUp 7 should include AutoCAD DWG/DXF Import Plugin.

- If Texture>Position command does not appear while adding texture; the surface modelled with “Line” tool should be drawn at a new plane to acquire a surface appropriate to add texture.

Rendering;

- View to be rendered should be set according to the purpose; the building itself with its environment, building itself with all its spaces, interior spaces of the building or details of the elements.

Preparation of tables;

- Auxiliary table helping the identification of building characteristics, such as spatial characteristics, architectural elements, and construction techniques and material usage, and their alterations, and failures and deteriorations should be prepared.
- Thematic tables should be prepared as a prerequisite for effective management of the documentary data.
- Each building element should be given a specific ID number and name to each building element to follow the relation between the tables and to catch the characteristics of the same element in different thematic tables.
- Characteristics of each building element should be defined in the related rows with the relevant visual documents.

As a result; 2D and 3D scaled representations necessary to assess the heritage characteristics were prepared and presented based on photogrammetric and tachometric measurement.

The Lower Bath is one of the historical three baths excavated in Metropolis. The so far documented *caldarium* spaces with their architectural elements such as pools, pilasters, baseboards and hypocaust system etc. are important in their archaeological site. These elements together with the authentic construction features sustained intact so far are among the heritage characteristics of the monument.

The application of the guidelines has pointed out that the photogrammetric process makes possible to collect very detailed information about the present condition of the building itself. The proposed method reduces site survey time and provides to

viewing the photorealistic details. Thus, the original qualities and the problems are analysed better.

The photo mosaics are effective documents for perceiving the authenticity of the building: they provide data including both the geometric precision and the realistic material features. Rectification is applied to the facades generally; there is a limited amount of study on plan rectification application. Rectification of a hypocaust plan is a special study that was realized in the scope of this study.

The thematic maps prepared on the photo mosaic and 2D drawing combination have made it possible to perceive the spatial characteristics, architectural elements, construction techniques and material usage, alterations, and failures and deteriorations of the building in a systematic and realistic way. The conventional thematic map presentation became more realistic: spatial and architectural condition of the monument with its authenticity is the base map of the themes.

The photo mosaics helped to produce accurate and detailed drawings in short time. The 2D drawing prepared with this contemporary technique had more information than the drawings prepared with conventional technique. Besides this, 2D conventional drawings were prepared relatively easier, with the help of photo mosaics.

The 3D representations provided ease in understanding the 3D qualities of the monument and its details. They have made it possible to perceive the spatial qualities with their conservation problems.

All data provided from the documentation technique used was presented together in the thematic tables. The tables were filled in systematically by using all data including both visual and written. In turn, a database of this monument can be easily prepared. Besides the written data, visual data of the tables such as thematic maps, 3D model and photographs provided ease in understanding the building. Present condition of each building element was deciphered in detail by the help of the tables.

The results demonstrate that photo mosaics combined with tachometric technique is an effective way of presenting the heritage characteristics of the antique baths with high geometric precision.

The limitation of this technique is that it is time consuming during office work. Nevertheless, it gives the opportunity of understanding the monument with its whole details.

If the methodology is compared to the conventional technique, it is understood that the combination of the contemporary and conventional techniques requires less

time at the site survey. But, the office work requires much more time for the proposed technique. They both require the same amount of people. Combination of the photo mosaics and 2D drawings, and the 3D model has the advantage of producing qualitative information such as details, textures and colours of the architectural elements; so the representations presented include more comprehensive information in comparison with those based on conventional techniques.

As a result of the study, it is found that the original spatial characteristics and architectural elements of the study have been sustained to a great extent. It is middle in scale (28x29 m) and with palaestra (56x53 m). The South Gate Bath in Perge and Capito Baths in Miletus are very similar to the Lower Bath in terms of their asymmetrical plan organisation, their plan size which are middle in scale and period to built (Öz, 2012**).** This bath reflects the spatial layout and the architectural characteristics of the Roman Bath architecture in Ionia and in Anatolia. Asymmetrical plan organisation, presence of a *palaestra*, location of the hot *caldarium* spaces with hypocaust system, service corridor surrounding the hot spaces are the spatial features of the Roman Baths in Anatolia. Masonry construction technique consisting of the walls with core out of rubble stones and bricks embedded in thick lime mortar and with rough cut stone facing, vaults constructed with rough cut stone or bricks, original architectural elements such as flues, vertical duct, fountain spouts, furnace openings, platforms, stairs, pilasters, niches, *tubuli* systems, *alvei*, plunge pools, baseboards, door, marble inlays all reveal the characteristics of this period. This building is a typical representative of Roman Baths in Anatolia with its architectural characteristics.

The thematic representations make it possible to perceive the building with all its details and features in a realistic way and to evaluate its values better. So, conservation decisions might be prosperously taken.

In conclusion, the method developed in this study can be used to identify heritage characteristics of other Roman baths: the guidelines of the proposed methodology can be easily applied for the documentation of historical monuments, when assessment of their heritage characteristics is aimed. The illustrations can be used as a base for a conservation study. The 3D model can be used to create a virtual tour or 360º panorama, etc. Since the whole data is digital; it is suitable for further development. New excavation results can be added to it easily.

Time spent at the office work for learning the contemporary softwares and solving their technical problems may be criticized. However, this timing includes the

learning time for the softwares and also the method investigation time. So, if this technique is used at another documentation study of a monument; the office work will be more efficient. Thematic tables prepared can be used to develop a database based on the cultural heritage characteristics; so it is provided ease in taking conservation decisions, managing the restoration project, managing the restoration application and organizing archive documents.

As a result, an architect-restorer should give place to contemporary techniques and new ideas in his/her studies; so that he/she can benefit from the advantages of it; maybe a little now, but absolutely a lot at the next studies.

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APPENDIX A

METROPOLİS WATER WAYS

İzmir'den Efes'e giden yolun üzerinde, (Torbalı) Trianda tren istasyonunda, sağdaki tepenin yamacında su yolu kalıntıları görülmektedir. Bunların nereden gelip nereye gittiği belirsizdir. Texier, Prokesch von Osten, Spon ve Arundell su yollarını ayrıntılı araştırmamışlardır.

Efes Rehberi kitabımda, bu su yollarının Metropolis'e ait olduğunu belirtmiştim. Su yollarının Trianda'nın kuzeyinden başladıkları halk arasında söylenmektedir. Texier, bu su kaynağından "su pınarı" olarak söz etmektedir.

Texier'e göre, bu pınarın suyu Pjelat Kaive bataklığına boşalmaktadır. "Visit to the Seven Church" (p.19-199) kitabında bataklığın adı. Astraios olarak belirtilmiştir. Trianda'nın 20 dakika kuzeydoğusunda (atla), komşu vadide, muhteşem güzellikteki bir mağarada bu pınar yer almaktadır. Mağara kalker tabakanın altındadır. Mağaranın altında kanal izi görülememiştir. Kaya tabakalarında işlenmişlik yoktur. Daha aşağıda yer alan beş değirmen bu su yollarının yok olmasının nedeni olabilir. Kaynağın debisi yaz ve kış aynıdır. Suyun yarısı güneybatıdaki Kayas Bataklığına akmaktadır. Kanal izlerinin bir çiftliğe ulaştığı, kısmen yıkık kemerli bir duvarın üzerinden geçtiği, bir tepeciğe ulaştığı görülmüştür. Tren yolu inşaatının kalıntıları azalttığı anlaşılmaktadır.

Kemerli duvar, 4-5 m yükseklikte olup, içi moloz taş ve harçla örülmüş, dış yüzeyleri kesme taşla oluşturulmuştur. Kemerleri taşıyan ayakların temelleri 2x2 m'dir. Temeller, büyük bloklardan oluşmaktadır. Kemer açıklığı 3 m civarındadır. Güney tarafta yapı izi birden yok olmaktadır. 4 m batısında bir ayak daha izlenmektedir.

İzmir-Efes eski yolu buradan geçmektedir. 4 m'lik açıklık yolun geçişine olanak sağlamak için olabilir.

Tepe üzerinde 30 m uzunluğunda duvar kalıntıları olup kuzey köşesi 3 m yüksekliğindedir. Duvar içinde üç açıklık izi gözlenmektedir. Bunlardan güneydekinde kemer kalıntısı açıkça görülmektedir. Su kanallarının izleri İzmir'deki Ak Pınar ile benzerlikler gösterir.

Metropolis kentine giden güzergah incelendiğinde, kanal izlerinin tepelerde yoğunlaştığı dikkati çeker (0,4 m genişlik, 30 cm kenar yüksekliği) (Weber, 1904; translated by Assist. Prof. Dr. Gürsoy Turan).

APPENDIX B

GUIDELINES FOR VISUAL DOCUMENTS

Guidelines for visual documents are introduced in detail in the below.

Single Image rectification;

For rectifying the photographs, Pictran Software was used. The steps below were followed:

- Pictran Software was opened.
- File>New Project on the top toolbar was clicked (Figure B.1).

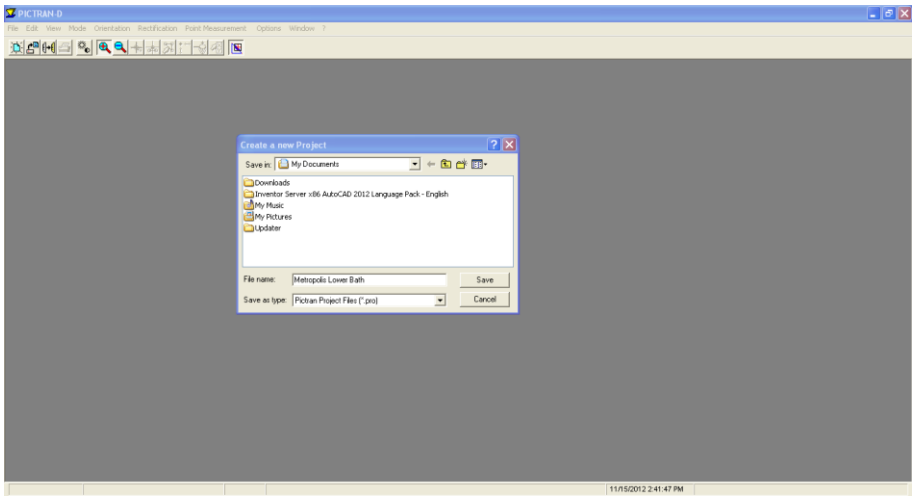


Figure B.1. Creating new project in Pictran software

- File name of the project was typed, for example “Metropolis” and “save” was selected. The new file with Pictran Project Files (*.pro) file name extension was ready for starting rectification.

- The photographs were imported to the file. File>Import was clicked. “Add” was selected. The photographs in Jpeg format were clicked and “open” was selected. Then, the photographs were seen as a list in the import window.
- Preview was to be selected to see the photographs at the same time.
- The photographs were clicked one by one, and the correct camera, for example “NikonD70S_28” and the correct direction were selected for them (Figure B.2).

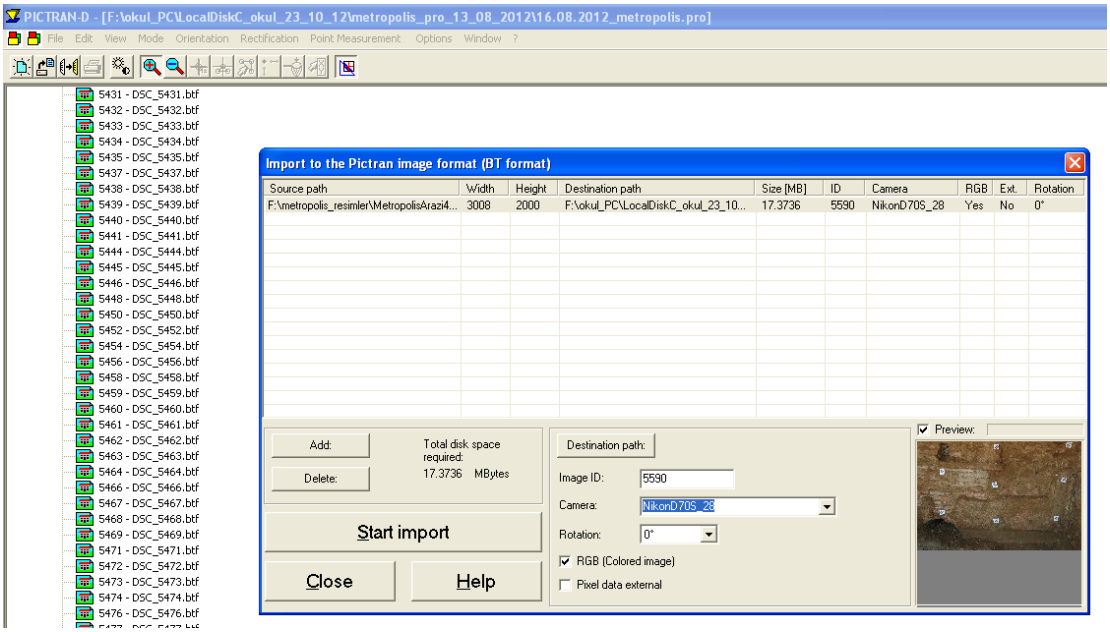


Figure B.2. Correct camera and direction selection

- After finishing this operation for all of the photographs, “Start Import” was selected.
- The success window was seen on the screen. Then, import window was closed.
- The new file that was named Metropolis before on the Pictran software window was clicked.
- Then, “Images” was clicked to see the photographs imported in btf format as a list.
- The photograph to be rectified was clicked twice.

- Top line of the new window was clicked twice and it was fitted to the screen.
- The photograph inside this window was fitted using Zoom+ or Zoom- command on the top toolbar.
- Orientation>Exterior Orientation was selected from the top toolbar. The coordinates belonging to the control points on the photograph and its ID were typed in the boxes on the Exterior Orientation window (Figure B.3).

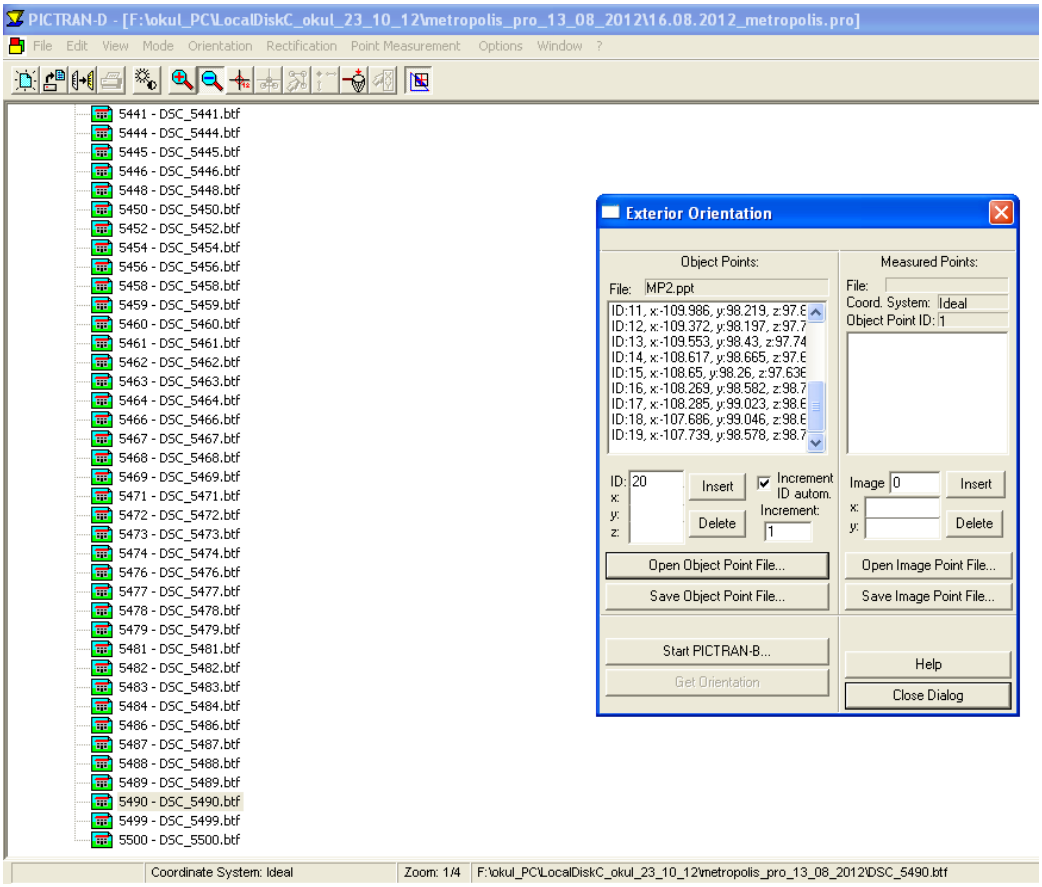


Figure B.3. Typing coordinates coming from teodolite measurement

- Measurements coming from theodolite were in asc format and dxf format. The coordinate list in asc format was opened using Notepad software. The critical point was typing the coordinates in their correct locations. X is horizontal coordinate, Y is vertical coordinate and Z is depth. The theodolite measurements

list should be examined. There are three coordinate columns on the list. If all of the values in the same column are very similar to each other; this column is Z column. Consequently, the photographs help to decide on which one is X and Y. Two points on the photograph are investigated. For example, it might be seen that Y coordinate of the control point with ID 1 is approximately on the same level with Y coordinate of point with ID 2 and they have different coordinate values at X direction. If coordinate values of point 1 and point 2 are investigated on the list, X and Y columns might be found correctly.

- After typing the coordinates, "insert" was selected.
- Then, "Save Object Point File" was clicked. The communication window opening shows the place where the points oriented will be saved. It is better to create a new folder with name "Measured Points" and to save these kinds of files with Control Point Files (*.ppt) file extension here. It helps the program user to save time while searching these files to open. So, file name was typed; and the file was saved in the "Measured Points" folder.
- Exterior Orientation window was closed.
- Rectification>Single Image Rectification was selected from the top toolbar.
- Open Object Point File was clicked.
- The file including control points that were saved with Control Point Files (*.ppt) file extension in the "Measured Points" folder was opened.
- The control points were marked on the image one by one; the point ID and coordinate line was clicked, then the same point on the photograph was zoomed using "Zoom +" command on the top toolbar (Figure B.4). If the centre of the point is desired to be zoomed well; "Cross Hair" should be selected from the top toolbar and the centre of the point should be clicked twice.

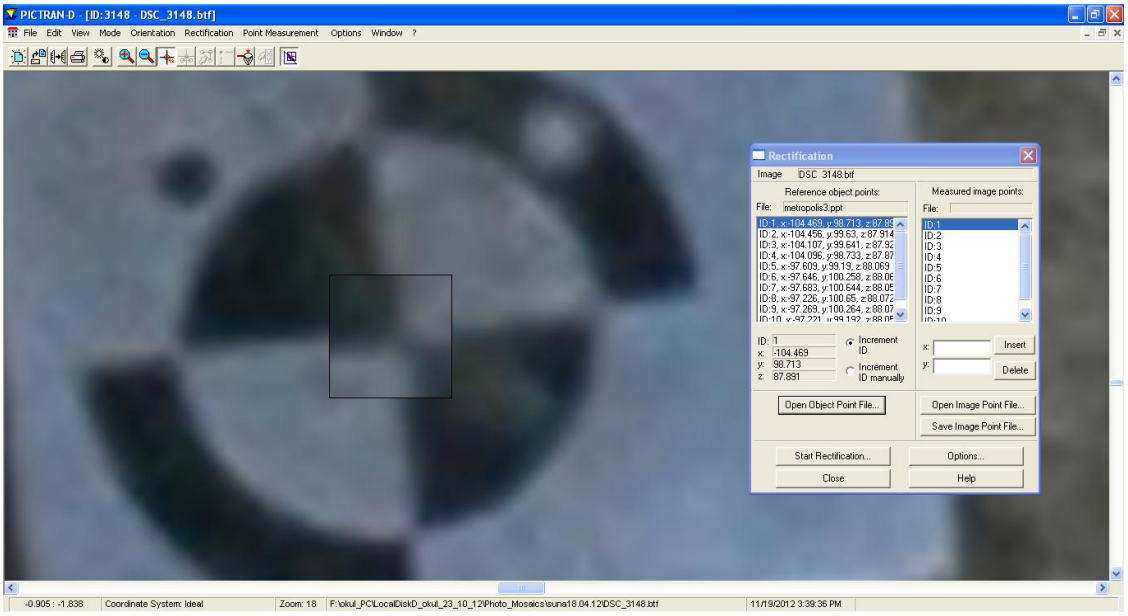


Figure B.4. Zooming to control point

- Start Rectification was clicked (Figure B.5). A question window asking to open editor with file was seen on the screen. “No” was clicked. After that, another window about Format of BT-File appears, “Ok” was clicked.

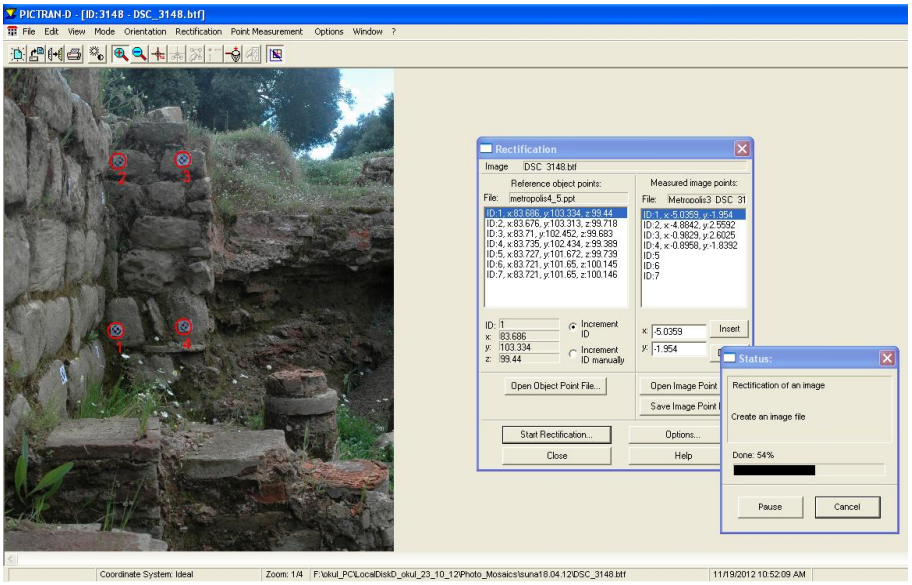


Figure B.5. Rectifying a photograph

- In the communication window asking the desired location of the rectified image, it is better to create a new folder to save time while searching the related file. The file with Pictran Image Files (*.btf) file extension was named and saved in the new folder created with name “Rectified Points”.
- The rectified photograph appears on the screen. The photograph may appear as a mirrored version of the desired image. Then, the coordinates typed at the orientation step should be revised with the addition of a minus either in the X or Y columns. The new file was saved and the processing steps were repeated again.
- If the rectified photograph was satisfactory; it was exported in Jpeg format (Figure B.6). A new folder was created with name “Exported Photographs” to export the rectified photographs. File>Export was clicked. It was exported after clicking the “Exported Photographs” folder before saving.

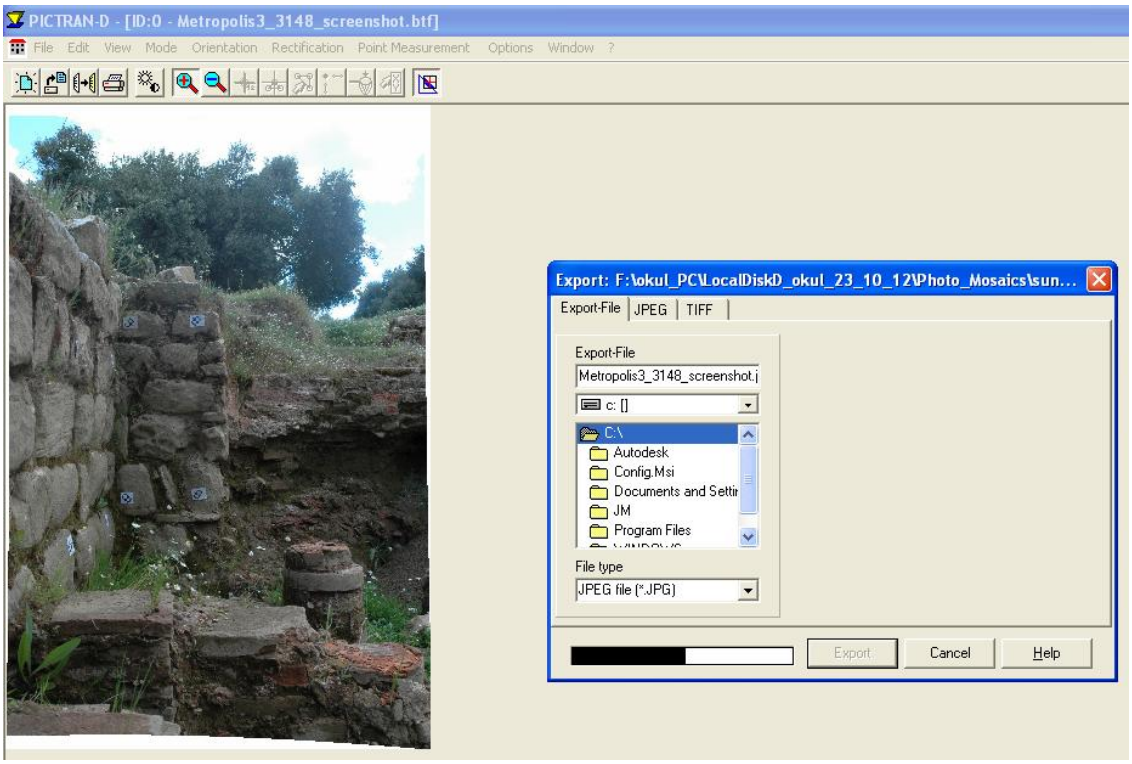


Figure B.6. Exporting the rectified photograph

- Rectification was completed. Pictran was closed.

Photo Mosaic Production;

To create photo mosaics, the rectified photographs were opened one by one in Adobe Photoshop Software and then the steps given in the below were followed for each of them.

- File>Open from the top toolbar was clicked and the photograph to be scaled was selected and opened.
- Image >Image Size from the top toolbar was selected. “Resolution” was typed 300 pixels/inch (Figure B.7).

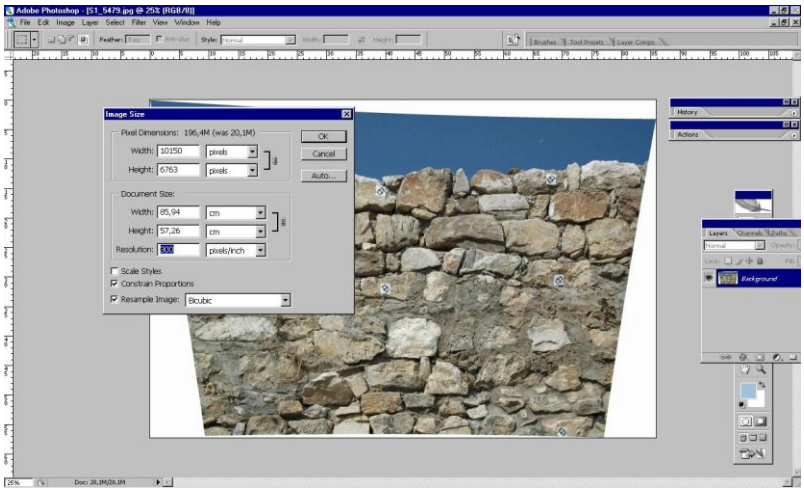


Figure B.7. Typing resolution

- For scaling; two points’ coordinates at one direction are necessary. For example, point 64 and point 67 were on a rectified photograph (Figure 8). They were selected for scaling. X coordinate of point 64 is 97.828. X coordinate of point 67 is 98.908. The difference between the two numbers is 1.08 meters. This value is 108 cm. 108 cm is measured 2.16 cm in 1/50 scale. The difference between these points should be 2.16 cm in Adobe Photoshop Software.

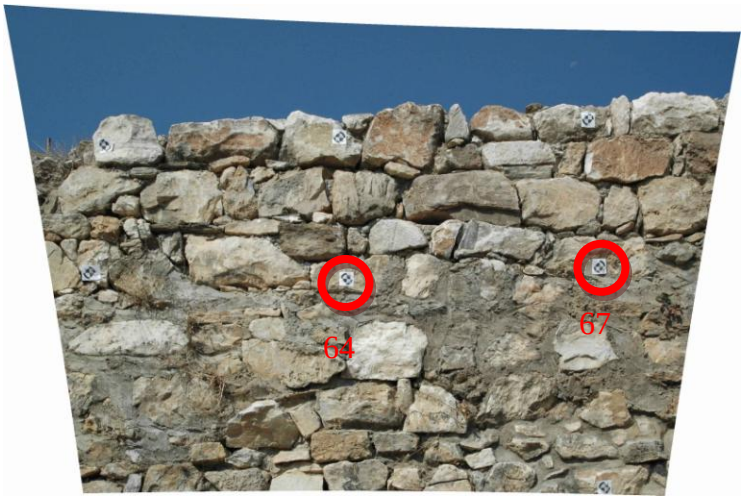


Figure B.8. ID numbers of the points measured on the surface

- This distance was measured on the image using rulers. It was measured 29.5 cm in this example.
- If 29.5 was divided by 2.16 the result is 13.66. So, the image should be 13.66 times smaller.
- The present image size was checked. The width was divided by 13.66: 85.94/13.66=6.29. This value was entered as the new image width (Figure B.9). Constraints were locked. If the coordinate used was in Y direction, "Height" size was changed.

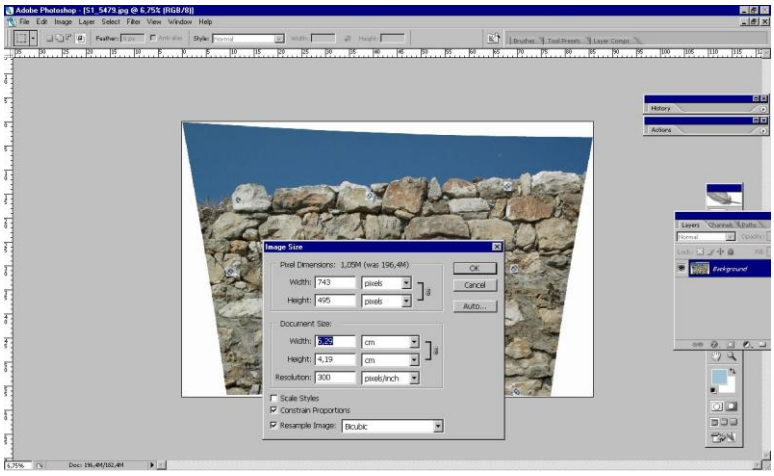


Figure B.9. Scaling

- The background layer was unlocked by clicking twice on it and then, OK was clicked.
- The areas excluding the rectified flat surfaces of the facade were deleted. For deleting the large white areas and blue sky; “Magic Wand Tool” on the left toolbar was used (Figure B.10). The areas were selected with this tool and then, delete was pressed.

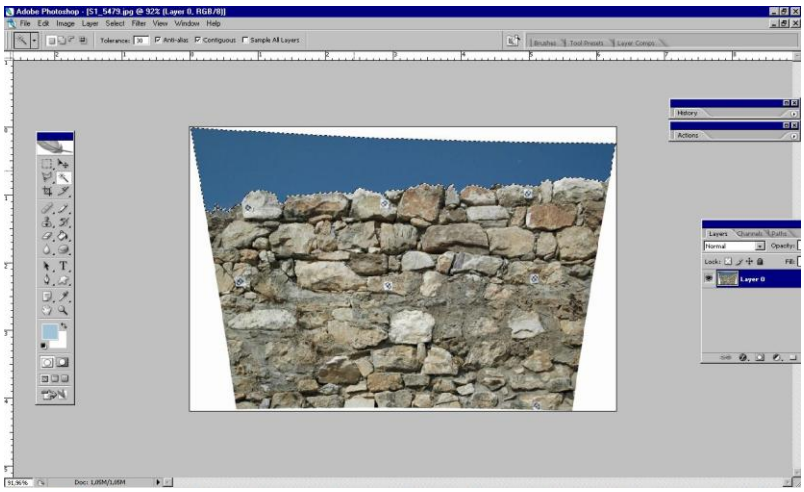


Figure B.10. Using magic wand tool

- For cleaning in detail; “Polygonal Lasso Tool” on the left toolbar was used (Figure B.11). The contours of the area to be used were marked with this tool and then, “Select Inverse” was selected inside the menu opening by clicking inside the selected area with the right button of mouse. Delete was pressed.

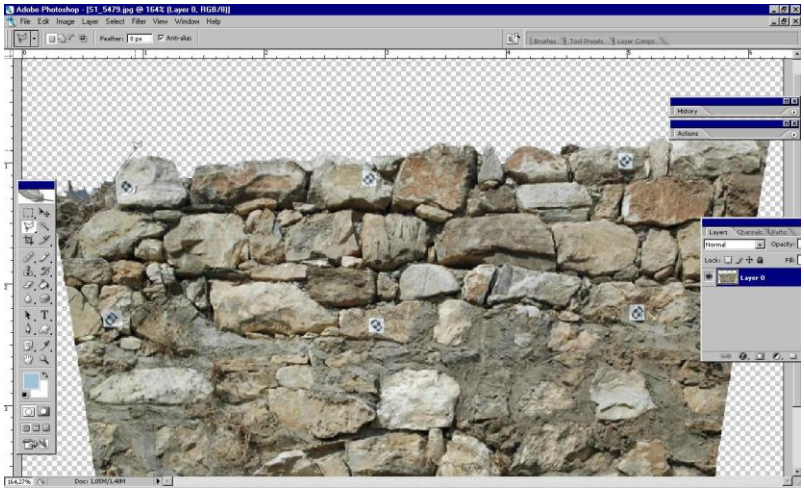


Figure B.11. Using polygonal lasso tool

- The photograph was saved in Psd format.
- To complete the facade, the same procedure was repeated for all of the rectified photographs belonging to the facade composition.
- A new file was created. File>New was selected from the top toolbar. File was named; for example “Metropolis1_Image Mosaic”.
- Resolution should be typed in accordance with the photographs scaled. The photographs’ resolution was 300 pixels/inch at the case sudy. So, the new file’s resolution was also defined as 300 pixels/inch.
- The size of the file should be determined remembering the facade’s size in scale 1/50. If the file size written is not enough for the facade or larger than necessary; Image>Canvas Size was selected from the top toolbar and the size was written again and then, OK was clicked.
- The photographs scaled were opened in Photoshop one by one.
- “Move” tool from the left toolbar was clicked and then, the photographs were moved on the new file created.
- Photographs should be put together in the right order.
- If the photographs belong to the same plane of the facade they should be put together by overlapping the shared control points (Figure B.12).

Figure B.12. Overlapping the control points

- The planes at different depths and belonging to the same facade were put together in accordance with the relationship between their control points (Figure B.13).

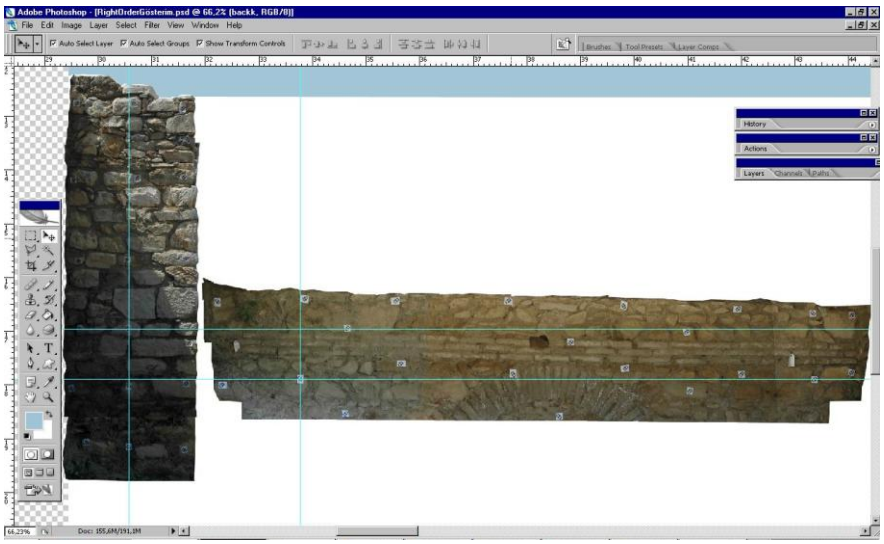


Figure B.13. Putting planes together in the right order

- They were placed by calculating the distances between their control points in 1/50 scale and moving them in accordance with the distances calculated in 1/50.
- Centre of a control point of the first plane was marked with the rulers from X and Y direction forming a cross.
- Then, another cross was formed calculating the place where the other control point which belongs to the second plane had to be placed.
- The second plane was moved using “Move” command.
- “Move” command from the left toolbar was clicked. The layers of all photographs belonging to the plane to be moved were selected by clicking on the name of them in Layers toolbar and by pressing “ctrl” button at the same time.
- Then, they were moved to the right place (control point should be placed under the cross formed) by clicking on the plane once and then, taking them away or using arrows on the keyboard.
- Image mosaic’s upper part was painted with blue to represent the blue sky (Figure B.14). The area to be painted was selected using “Polygonal Lasso Tool” from the left toolbar.

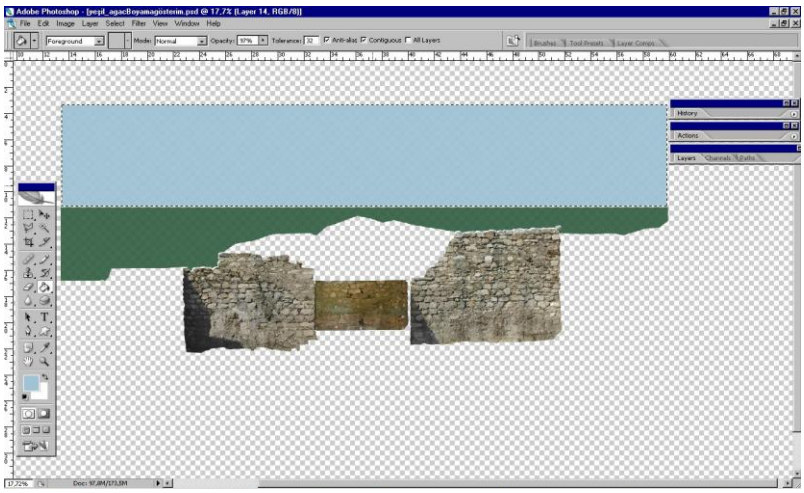


Figure B.14. Painting blue sky and green spaces

- A new layer was created. Layer>New>Layer was selected from the “Layer” menu of the top toolbar. The new layer was given a name and OK was clicked.
- Blue was clicked from the left toolbar.
- “Paint Bucket Tool” was selected from the left toolbar.
- Inside the area selected with “Polygonal Lasso Tool” before was clicked for painting.
- Green spaces were painted like the blue sky. The related area was selected with “Polygonal Lasso Tool”, a new layer was created, green was selected and the area selected was painted using the “Paint Bucket Tool”.
- Trees used in the representations were photographs shot the site. A tree photograph in jpeg format was opened with Adobe Photoshop software, if there are unnecessary areas, they were cleaned.
- The tree was dragged on the image mosaic and moved to its appropriate position.
- Its dimensions were changed. “Move” tool was selected from the left toolbar. The tree photograph was clicked. It was made larger or smaller by clicking its corner and dragging the mouse to the direction where scaling was made and also pressing shift at the same time to constrain proportions.
- Layer of the tree was clicked with right mouse button and “Duplicate Layer” was selected to copy the tree (Figure B.15).

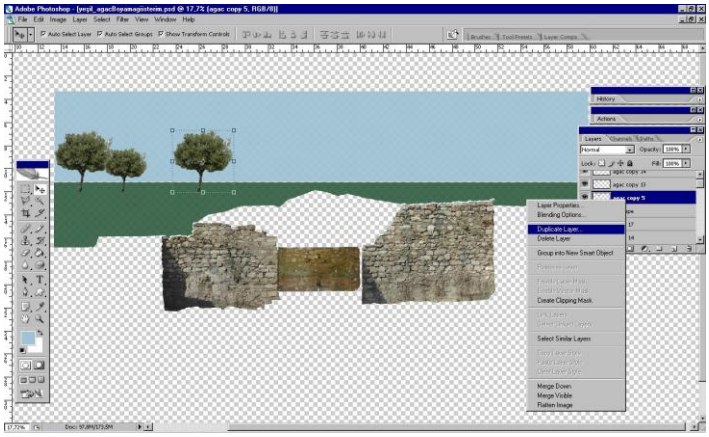


Figure B.15. Copying tree layer

- The tree copied were moved to their appropriate positions.
- Image Mosaic created was saved in Jpeg format.

Combining The Photo Mosaic and Theodolite Measurement;

AutoCAD software program was used for the combination of photo mosaics created and measurements coming from the theodolite. The steps of combining photo mosaic and theodolite measurement are in the below:

- AutoCAD software program was opened.
- Insert>Raster Image Reference was selected (Figure B.16).

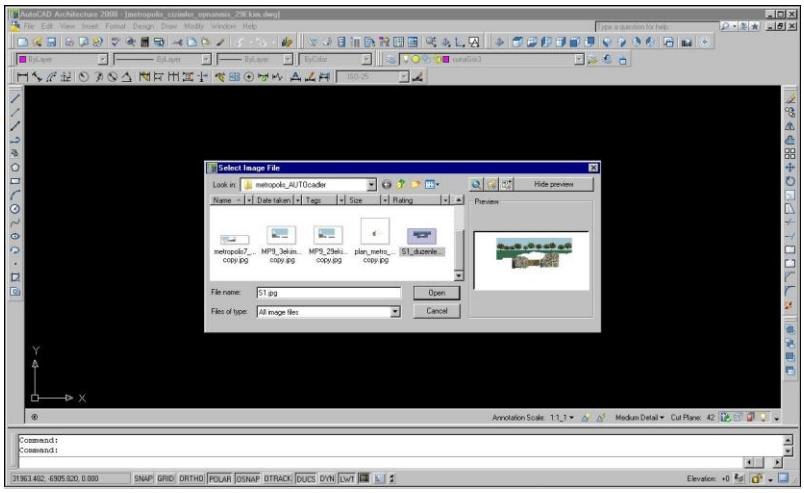


Figure B.16. Inserting image mosaic saved in Jpeg format

- Image mosaic saved in Jpeg format before was clicked, open was selected.
- "Image" window appeared on the screen. OK was selected.
- AutoCAD screen was clicked once to see the image.
- The scale of the photo mosaic was written on the command line. 50 was written because the scale of the photograph is 1/50.
- "Enter" was pressed. Then, the photo mosaic was with its real dimensions in AutoCAD software.

- "Layer Manager" from the top toolbar was opened and the layers to be used were created (Figure B.17). A layer name was given; and color, line type and line weight were selected for each layer. Using 4 kinds of line weight was enough for this study.

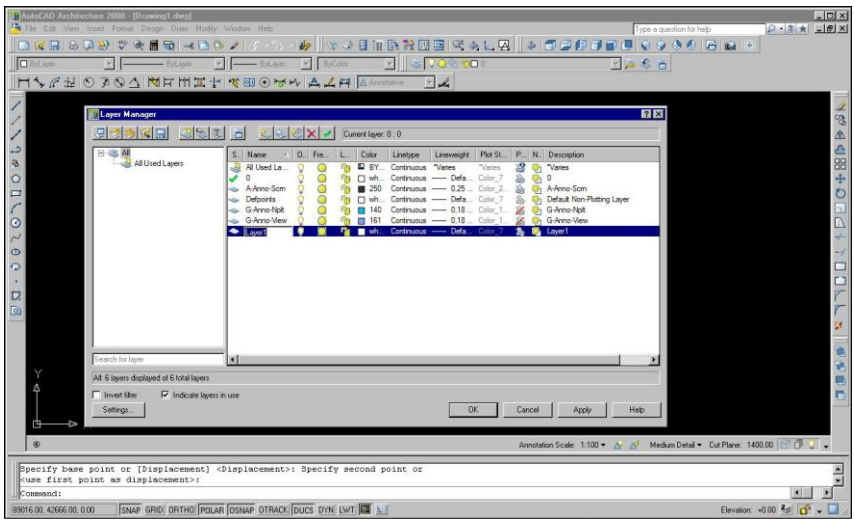


Figure B.17. Creating layers to be used

- The contours of the surfaces in the image mosaic were drawn by using the layers created.
- The areas to be completed were drawn with the measurements coming from the teodolite.
- Dxf file of teodolite measurements was opened with AutoCAD software.
- View>3D Views>Front was selected from the top toolbar and the point cloud was viewed from the front (Figure B.18).

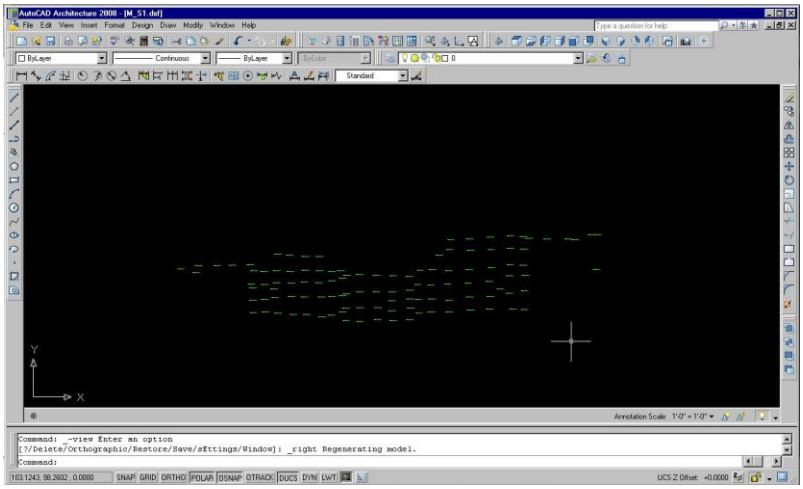


Figure B.18. Viewing point cloud from front

- "Polyline" command was selected from the left toolbar. The points were associated with each other by using this command with the proper layer and using the points' relations showed on the sketches prepared at the site survey (Figure B.19).

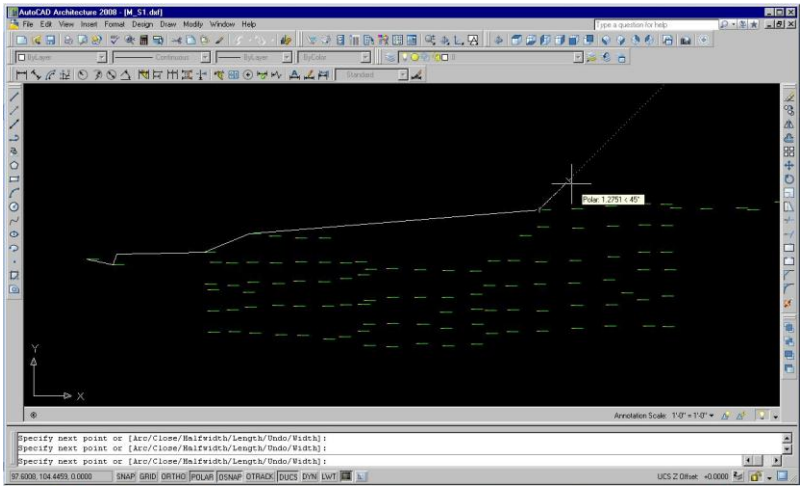


Figure B.19. Associating points measured with teodolite by using polyline

- The facade part drawn with teodolite measurements was copied and pasted on the AutoCAD file where the image mosaic was inserted.

- Plan was placed below the section or elevation.
- If it was necessary; the plan was rotated using “rotate” command from the right toolbar of AutoCAD software.
- The temporary lines were drawn from the walls’ interior and exterior parts where the section was going to be formed.
- The image mosaic combined with the drawing was compared with the plan.
- The sizes of plan and the mosaics were compensated.
- The part of line that will be modified was selected.
- Lines of the plan drawings were extended or shortened using “strech” command from the right toolbar of AutoCad software.
- The line was clicked with the mouse and the modification was made towards the direction necessary.
- Areas that could not be rectified, but measured with the teodolite and the areas that came from the archive drawing were hatched (Figure B.20). “H” typed, enter was pressed, “SOLID” was selected from “Hatch Pattern Palette”, “OK” was clicked, “Add:Pick points” was clicked and area to be hatched was clicked.

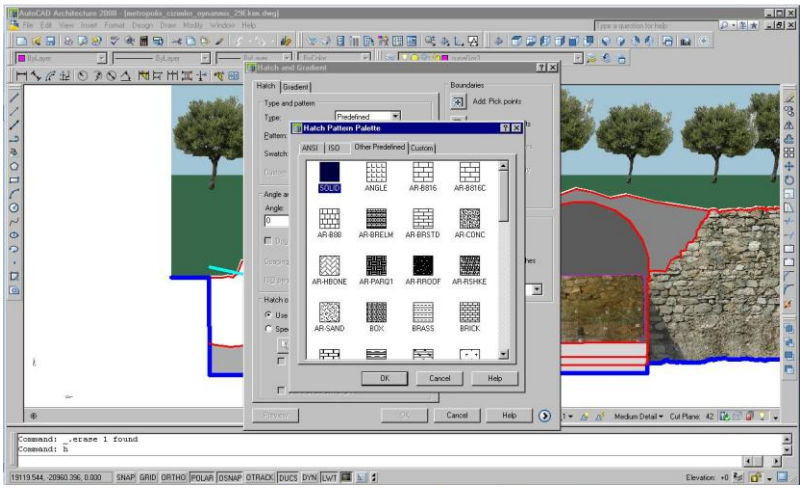


Figure B.20. Hatching

- File prepared was saved in dwg format.

- Then, the drawing prepared was saved as pdf (Figure B.21). Ctrl+P was pressed. DWG To PDF.pc3 was selected as printer/plotter name.

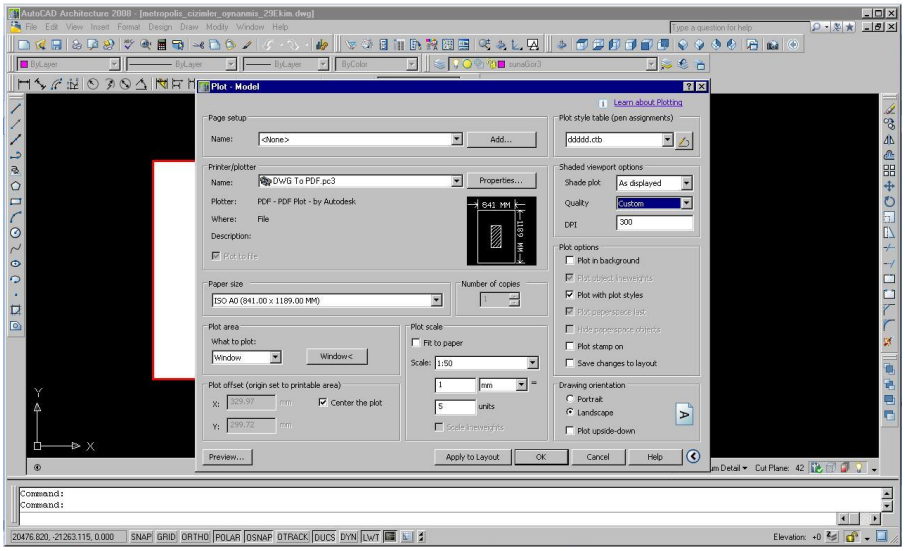


Figure B.21. Saving the file in pdf format

- "Paper Size" was selected in accordance with the drawing to be printed. Because drawing should be fitted well into the paper. A0 (841x1189 mm) was selected for this study.
- To set the plot scale, "fit to paper" command should not be selected. Because the scale used was 1/50; 5 was typed in the "units" line while mm was selected.
- "Monocrome" was selected from Plot style table (pen assignments) to produce black and white print.
- "Shade plot" was selected as "as displayed" and "quality" was selected as "custom" (300 dpi).
- Drawing orientation was portrait or landscape.
- "Window" command was selected from"What to plot" part and plot area was selected from the drawing.
- Preview was selected to see the file prepared before saving as pdf.
- If there was a problem; the screen was clicked with the right mouse button and exit was selected. Settings were controlled and fixed again.

- If there was no problem; the screen was clicked with the right mouse button and plot was selected.
- The file was named and saved as *.pdf to the location desired.

Preparation of Thematic Maps;

Thematic maps are prepared under four headings: architectural characteristics, alterations, construction techniques and material usage, and failures and deteriorations. All of them are painted on Section AA. Besides this, architectural characteristics and alterations are painted also on the plan of the bath.

- First, the case study building are investigated and analyzed in terms of the architectural characteristics, alterations, construction techniques and material usage, and failures and deteriorations.
- Legends are prepared with its presentation technique.
- The drawings of combination of photo mosaics and theodolite measurements are painted in AutoCAD and Photoshop. It is important not to cover the rectified surfaces, so presentation technique should not be solid painting on this kind of surfaces. Photoshop provides transparent solid painting for the rectified surfaces.
- Thematic maps prepared are saved in pdf or Jpeg format (Figure B.22).

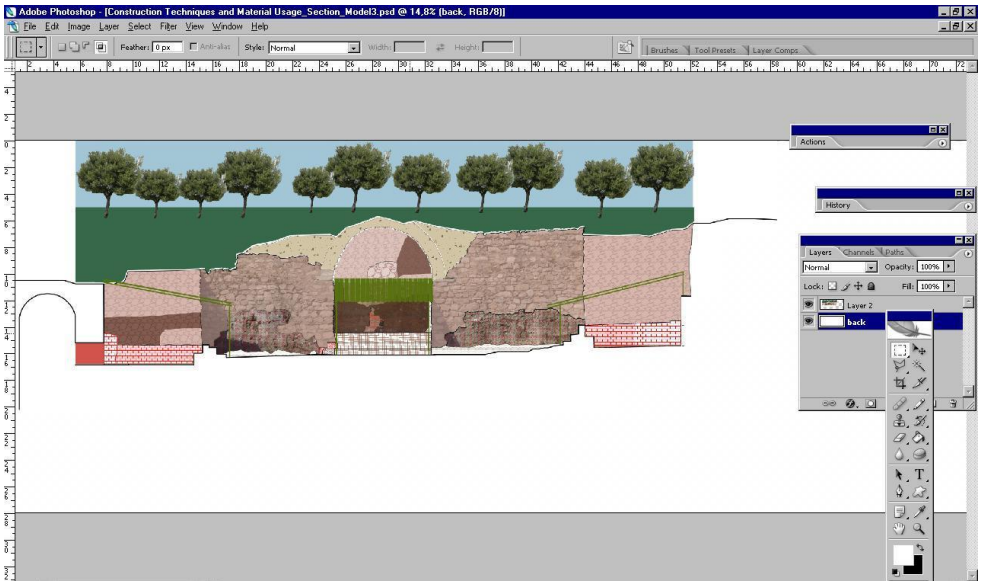


Figure B.22. Thematic Maps

2D CAD Drawing;

- The combined photo mosaic and 2D CAD drawing is opened in AutoCAD software.
- Details of the elements in the in photo mosaic part is drawn.
- Photo mosaic part is deleted.
- 2D CAD drawing (Appendix K) is saved as mentioned in the above.

3D Modelling;

The plan previously prepared with conventional techniques (Öz, 2011) in AutoCAD format was modified using image mosaics of the sections and the elevations. This revised plan was used as a base in the construction of the 3D model.

- The combined photo mosaic and CAD drawing were opened in AutoCAD.
- "Wblock" was written on command line and "enter" was pressed. "OK" was clicked in "Write Block" window opening and then, "OK" was clicked again in the next communication window (Figure B.23).

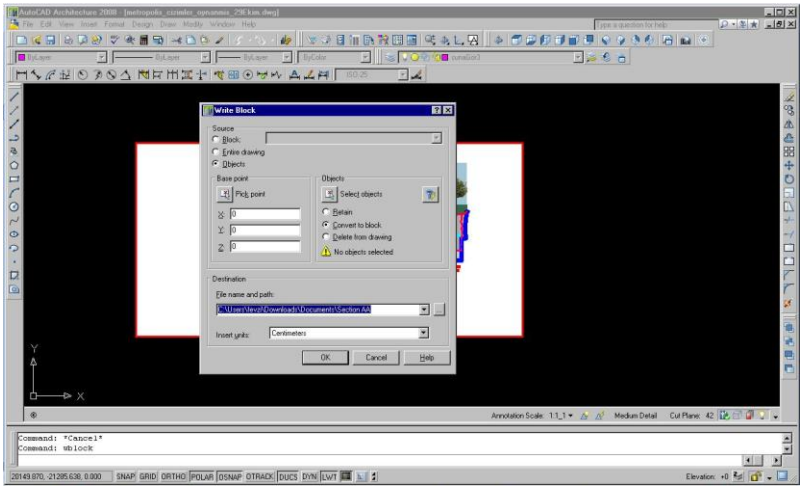


Figure B.23. Saving drawing to be modelled as block with wblock command

- Plan drawing was selected and “enter” was pressed. Then, plan drawing was ready to be used as a layout to model the bath.
- SketchUp 7 software with dwg importer plug in was opened.
- File>Import was clicked (Figure B.24).

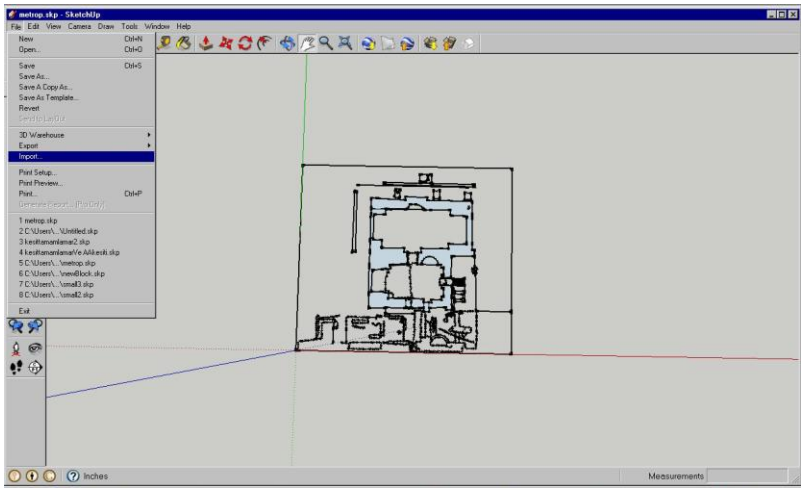


Figure B.24. Importing dwg file to SketcUp software

- The plan drawing saved as dwg was selected and “Open” was clicked.
- Drawing was selected with the help of “Select” tool from the top toolbar.
- Ctrl+C was pressed.
- SketchUp 8 software was opened.
- Ctrl+V was pressed. SketchUp 7 was closed.
- Plan was not at 0 level of Z axis. Move/Copy tool was selected from the top toolbar and the corner of the plan which was on the blue axis was clicked and the plan was moved to the origin by using its corner as a reference point.
- SketchUp 8 software was minimized.
- AutoCAD was opened.
- Dwg file of sections were also saved as block using “wblock” command in AutoCAD software.
- AutoCAD was minimized.
- SketchUp 8 was maximized.

- They were imported to the SketchUp 7 software.
- Sections were parallel to the ground plane when they were imported, but they should have been perpendicular to the ground plane.
- They were selected with the “Select” tool from the top toolbar.
- “Rotate” tool was clicked and drawing was rotated. Shift should be pressed at the same time to rotate by using directions of the axes; Green (X), Red (Y) and Blue (Z).
- They were copied with ctrl+c command from SketchUp 7 software.
- They were pasted with ctrl+v command into SketchUp 8 software.
- They were moved to their place by using Move/Copy tool from the top toolbar.
- Surface formation was made with the help of “Line” tool from the top toolbar. So, the surfaces were formed by drawing their edges.
- Adobe Photoshop software was opened.
- Photo mosaic of the section studied was opened.
- File>New was selected and a new file with resolution 300 pixels/inch was created.
- Mosaic part belonging to the surface formed in SketchUp was copied into the new file created in Adobe Photoshop. It was saved as jpeg. Adobe Photoshop was minimized.
- SketchUp 8 was maximized. Window>Materials was selected. “Create Material” was clicked. “Browse for Material Image File” was clicked (Figure B.25).

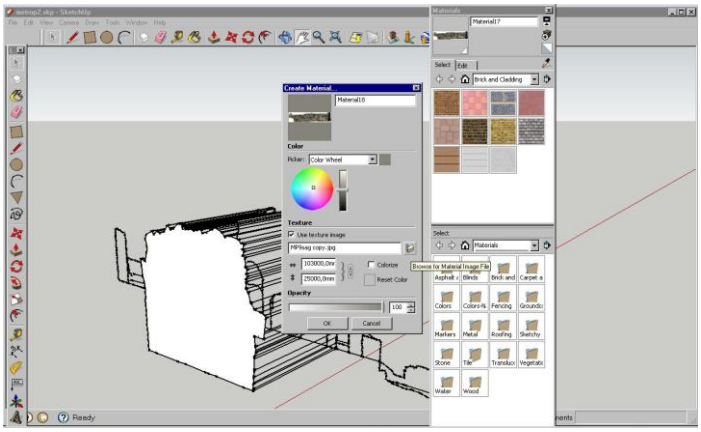


Figure B.25. Creating new material

- Jpeg to be added as texture was opened.
- Lock/Unlock Aspect Ratio was clicked and the dimensions of jpeg known from Adobe Photoshop were typed. Its name was typed. “OK” was clicked.
- “Paint Bucket” tool was selected and the surface was clicked once. So, the new material created had become the surface material with the help of this tool.
- In surfaces with relatively less irregular edges, clicking of the surface with the right mouse is sufficient for activating the texture positioning command. This regular method, however, was invalid for the irregular edged surfaces of the case study. So, every surface on the section was drawn at a new plane to acquire a surface appropriate to add texture.
- Lines in same length and perpendicular to the section plane were drawn from each vertex of the surface edges (Figure B.26). A new surface was formed by connecting every point with a line to each other.

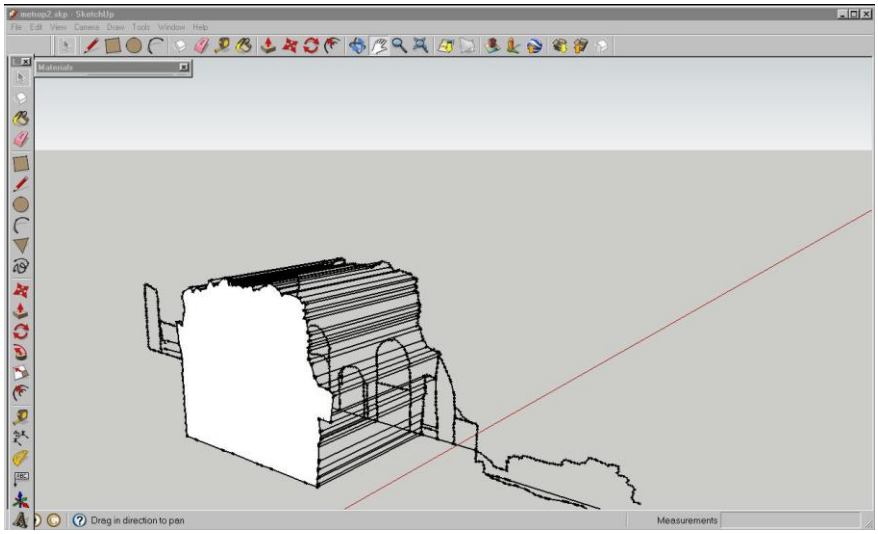


Figure B.26. Creating a new surface at another plane

- The material created, as mentioned in the above; was added to the surface drawn as material with the help of “Paint Bucket” tool and texture could be positioned (Figure B.27).

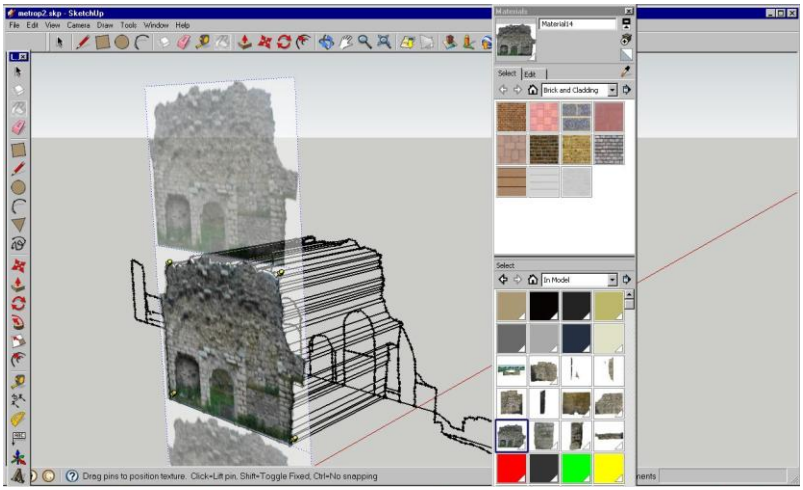


Figure B.27. Positioning of the texture

- The surface created was moved to its place by using plan drawing as base map and by clicking shift at the same time to save the level on section plane.
- After modelling of the photo mosaic parts of the sections, the parts drawn with the help of theodolite measurements were imported to SketchUp software.
- They were parallel to plan plane; so, they were rotated and then moved to the place where they belong to as introduced above.
- They were modelled with the help of "Line" tool. Triangles were formed to model the surfaces of these parts. Corners of the triangles were the points coming from the theodolite measurements and the points on intersected borders of the section part were drawn with theodolite measurements and photo mosaic part.
- The areas excluding the rectified flat surfaces of the facade were deleted; e.g. a projected architectural element attached to the flat surface. These elements were also modelled associating their points measured with theodolite by using "Line" tool (Figure B.28).

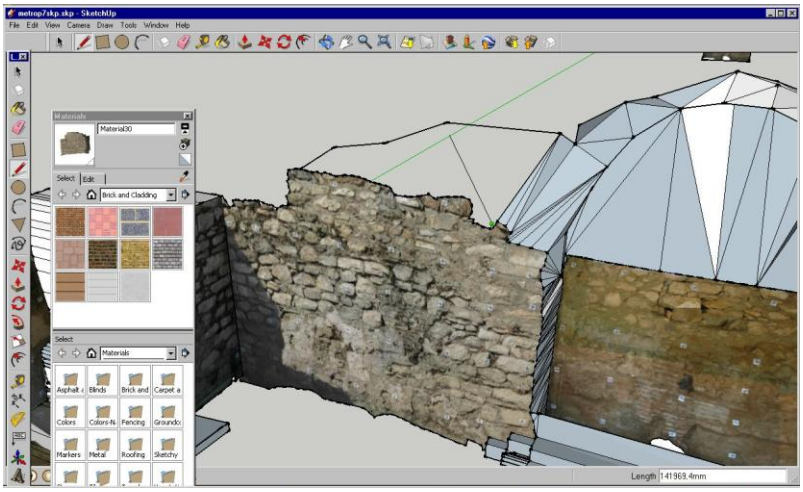


Figure B.28. Drawing the areas excluding the flat surfaces

- After modelling the sections, ground floor was modelled.
- For every space; sections' edges intersecting with the ground were associated with each other with "Line" tool by forming triangles. So, the surfaces of the ground were modelled.
- Photo mosaic parts were added as texture.
- Small columns of the hypocaust were also modelled. The edges of the columns were drawn by using "Freehand" tool from the left toolbar.
- Heights of the columns at east and west line were obvious because they were deleted from the rectified photographs of these sections. They are in front of the facade to be rectified. The areas cut show their intersection parts with the facade. The area drawn was clicked with "Select" tool from the top toolbar and it was pushed until its height level (Figure B.29).

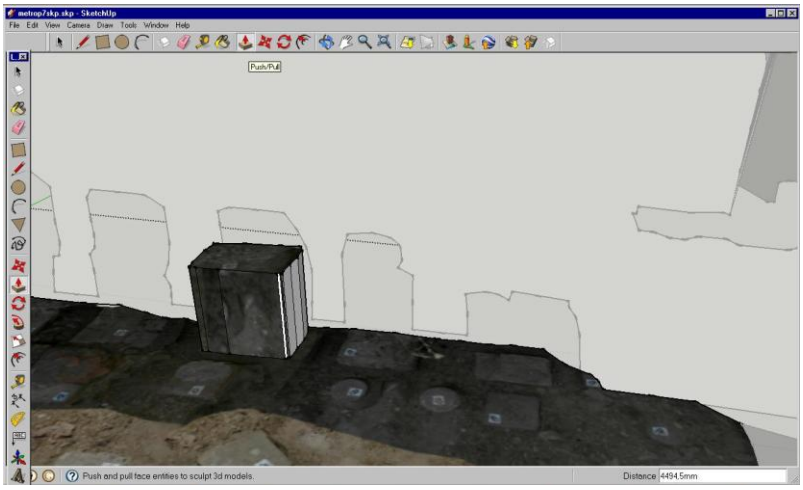


Figure B.29. Drawing hypocaust columns with Push/Pull tool

- Other columns' height were calculated from the measurements coming from theodolite measurements. The height difference was calculated. Firstly, the column was modelled at the same level with the other column and then it was pushed or pulled by typing the height difference between them at the same time and then, enter was pressed.
- The environment of the case study building was modelled with "Line" tool.
- Window>Components was opened from the top toolbar.
- "Navigation" was clicked.
- "Landscape" was selected.
- "Plants" was clicked.
- "Trees 3D" was clicked and tree to be used was selected.
- It was scaled by using "Scale" tool from the left toolbar.
- It was moved to its place.
- It was copied by clicking with "Select" tool and then clicking "Move/Copy" tool. Ctrl was pressed once before using "Move/Copy" tool to copy it and it was moved to its place.
- The surfaces without texture were added an appropriate material from the material list of SketchUp 8 with the help of "Paint Bucket" tool from the top toolbar.

- Edges of the surfaces were softened. Edge was clicked with “Select” tool and then it was clicked with right mouse button. “Soften” was clicked.
- For rendering, first of all Camera>Parallel Projection is selected from the top toolbar.
- The view is set with Orbit tool according to the purpose; the building itself with its environment, building itself with all its spaces, interior spaces of the building or details of the elements.
- File>Export>2D Graphic is selected. Export is clicked and render is saved in Jpeg format (Figure B.30).

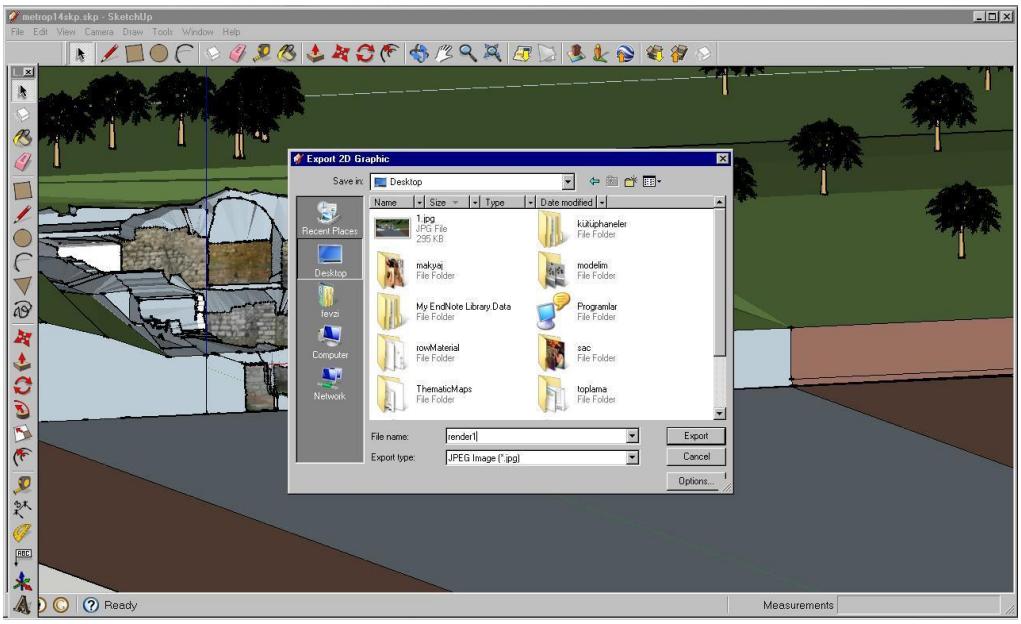


Figure B.30. Rendering

APPENDIX C

COMBINATION OF THE PHOTO MOSAICS AND THE THEODOLITE MEASUREMENTS: PLAN

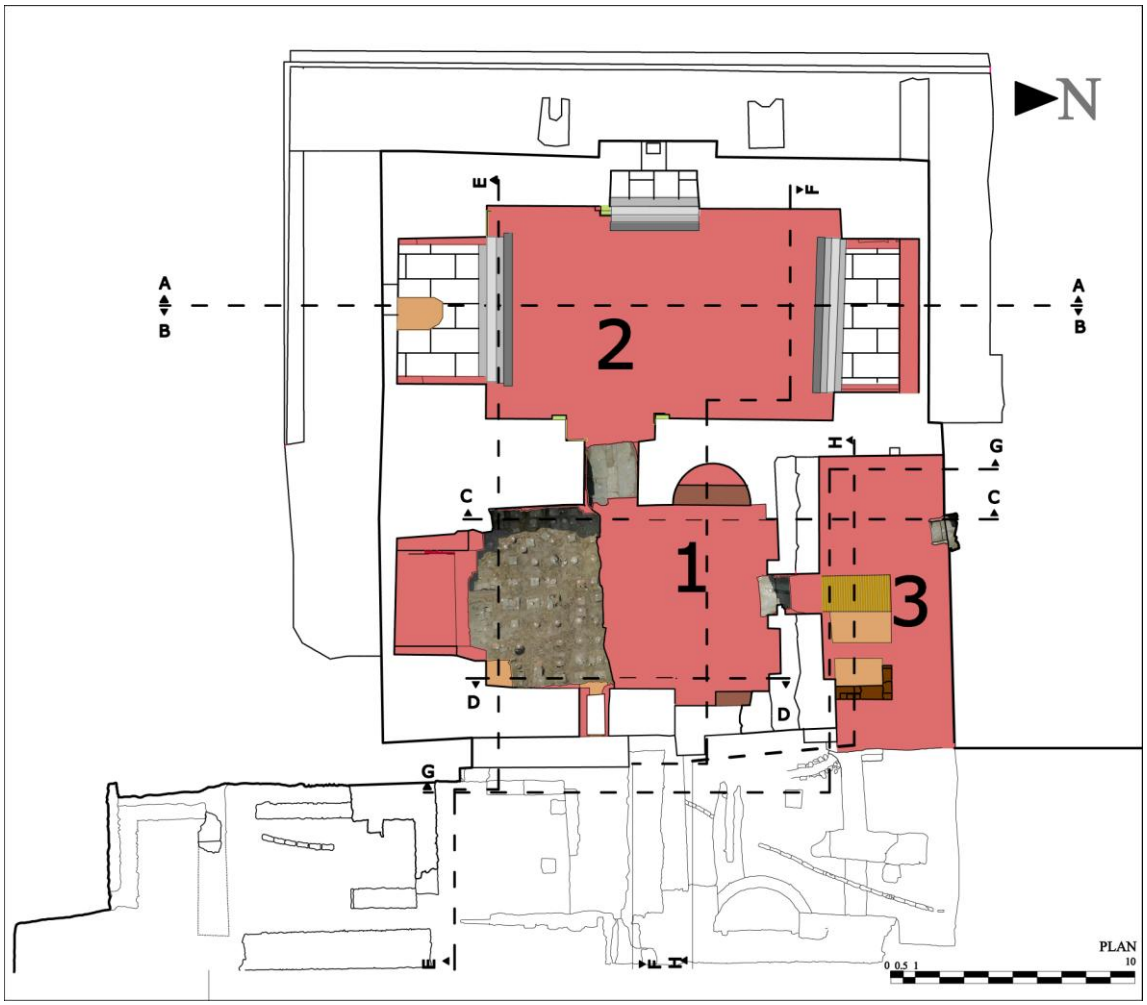


Figure C.1. Plan Drawing

APPENDIX D

COMBINATION OF THE PHOTO MOSAICS AND THE THEODOLITE MEASUREMENTS: SECTION AA & SECTION BB

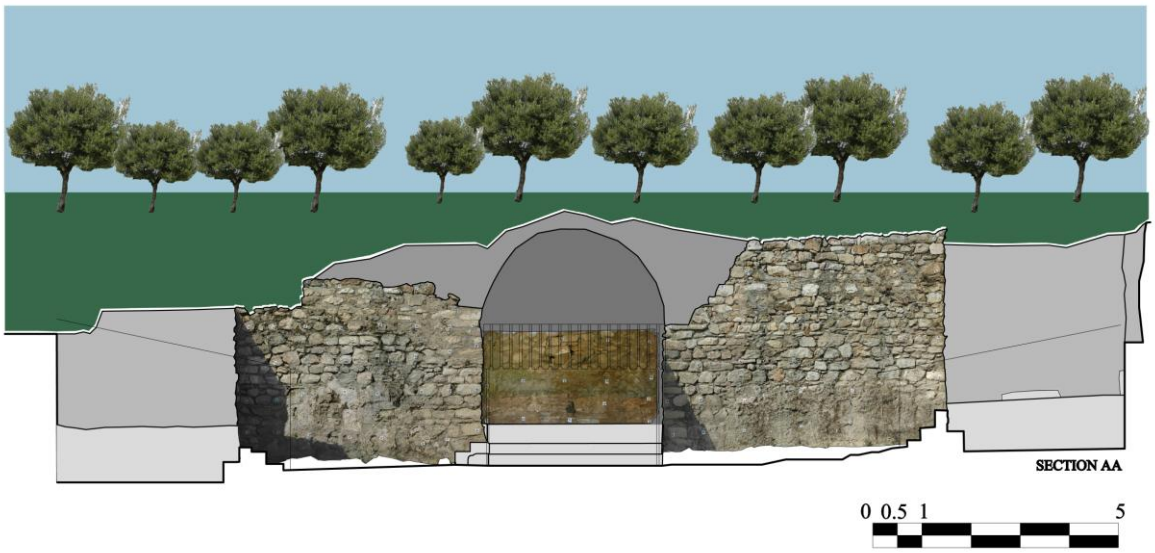


Figure D.1. Section AA

Figure D.2. Section BB

APPENDIX E

COMBINATION OF THE PHOTO MOSAICS AND THE THEODOLITE MEASUREMENTS: SECTION CC & SECTION DD

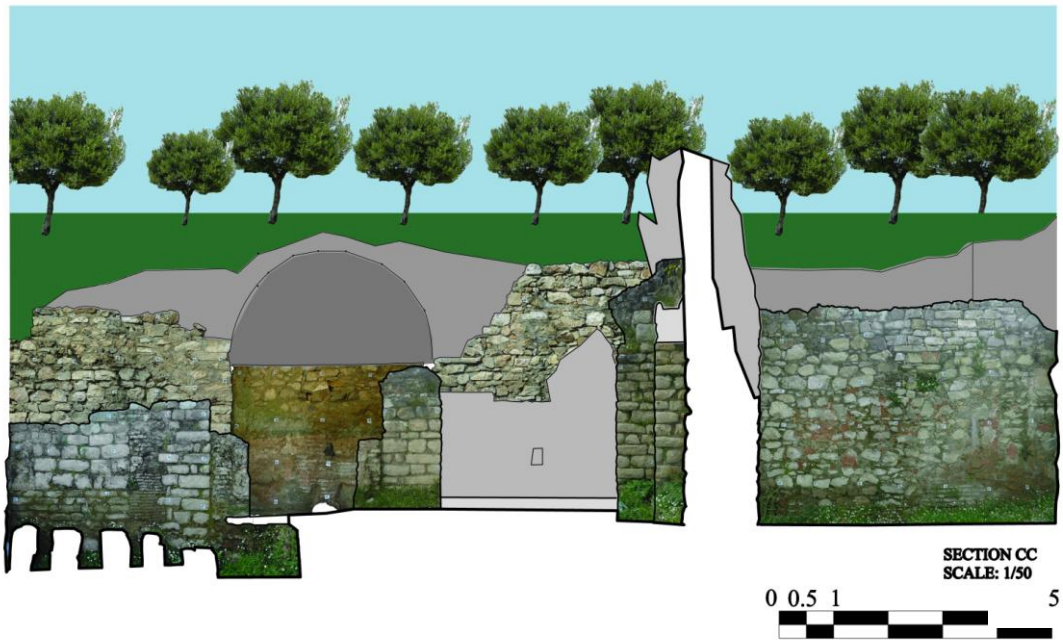


Figure E.1. Section CC

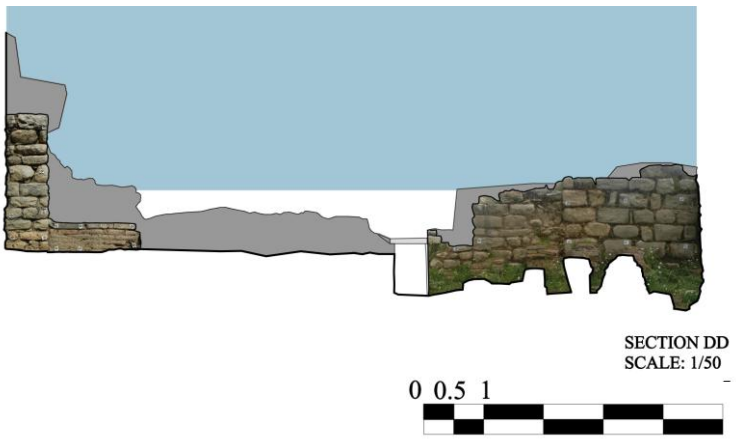


Figure E.2. Section DD

APPENDIX F

COMBINATION OF THE PHOTO MOSAICS AND THE THEODOLITE MEASUREMENTS: SECTION EE & SECTION FF

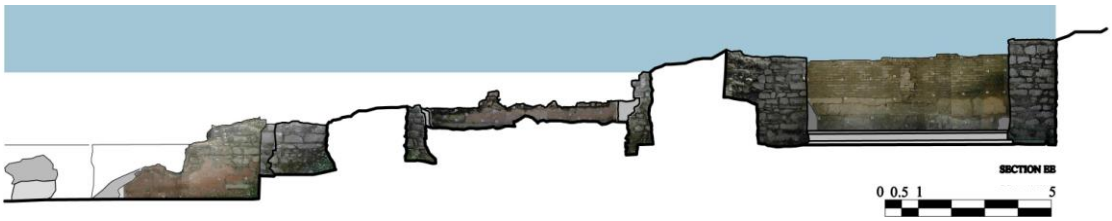


Figure F.1. Section EE

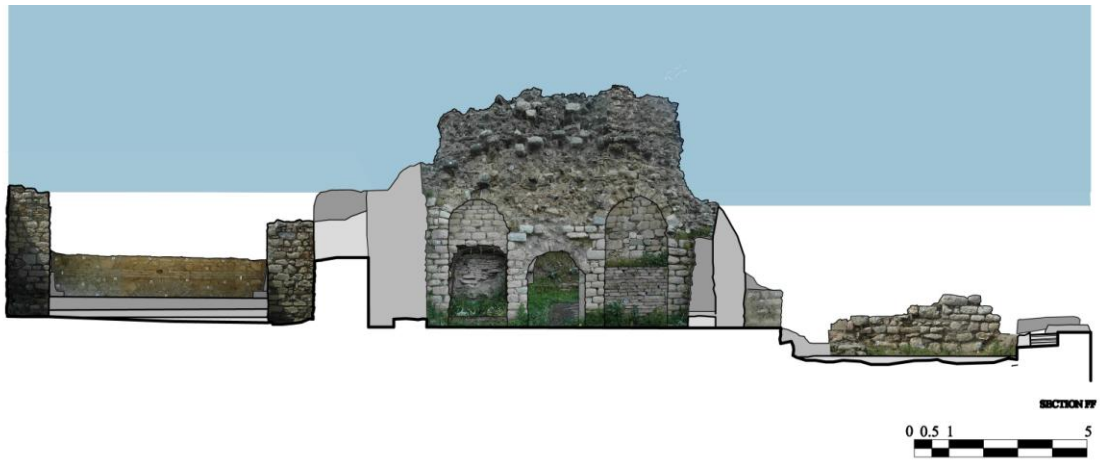


Figure F.2. Section FF

APPENDIX G

COMBINATION OF THE PHOTO MOSAICS AND THE THEODOLITE MEASUREMENTS: SECTION GG & SECTION HH

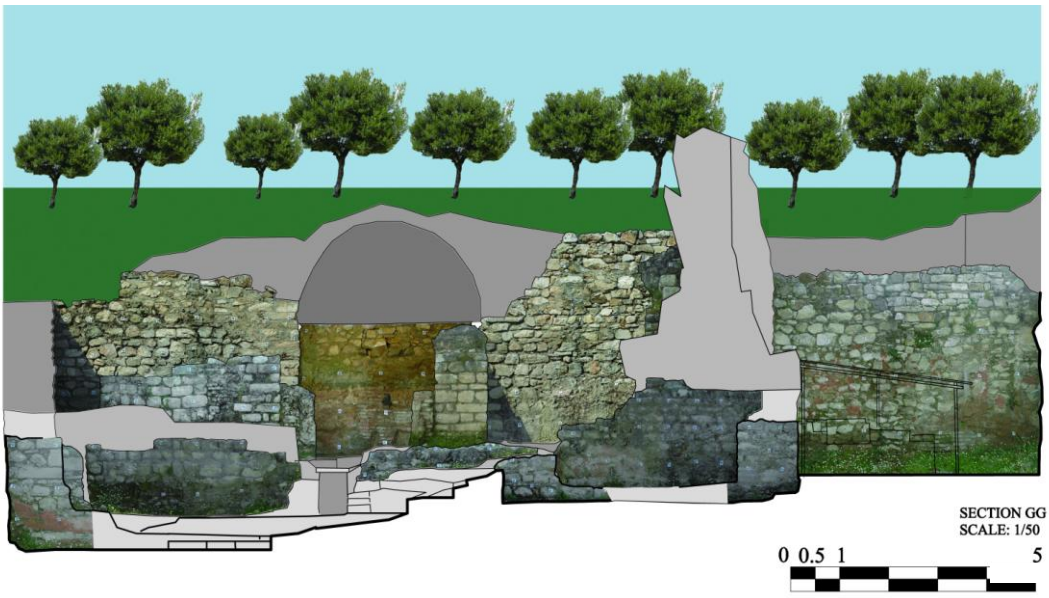


Figure G.1. Section GG

Figure G.2. Section HH

APPENDIX H

THEMATIC MAPS: ARCHITECTURAL CHARACTERISTICS

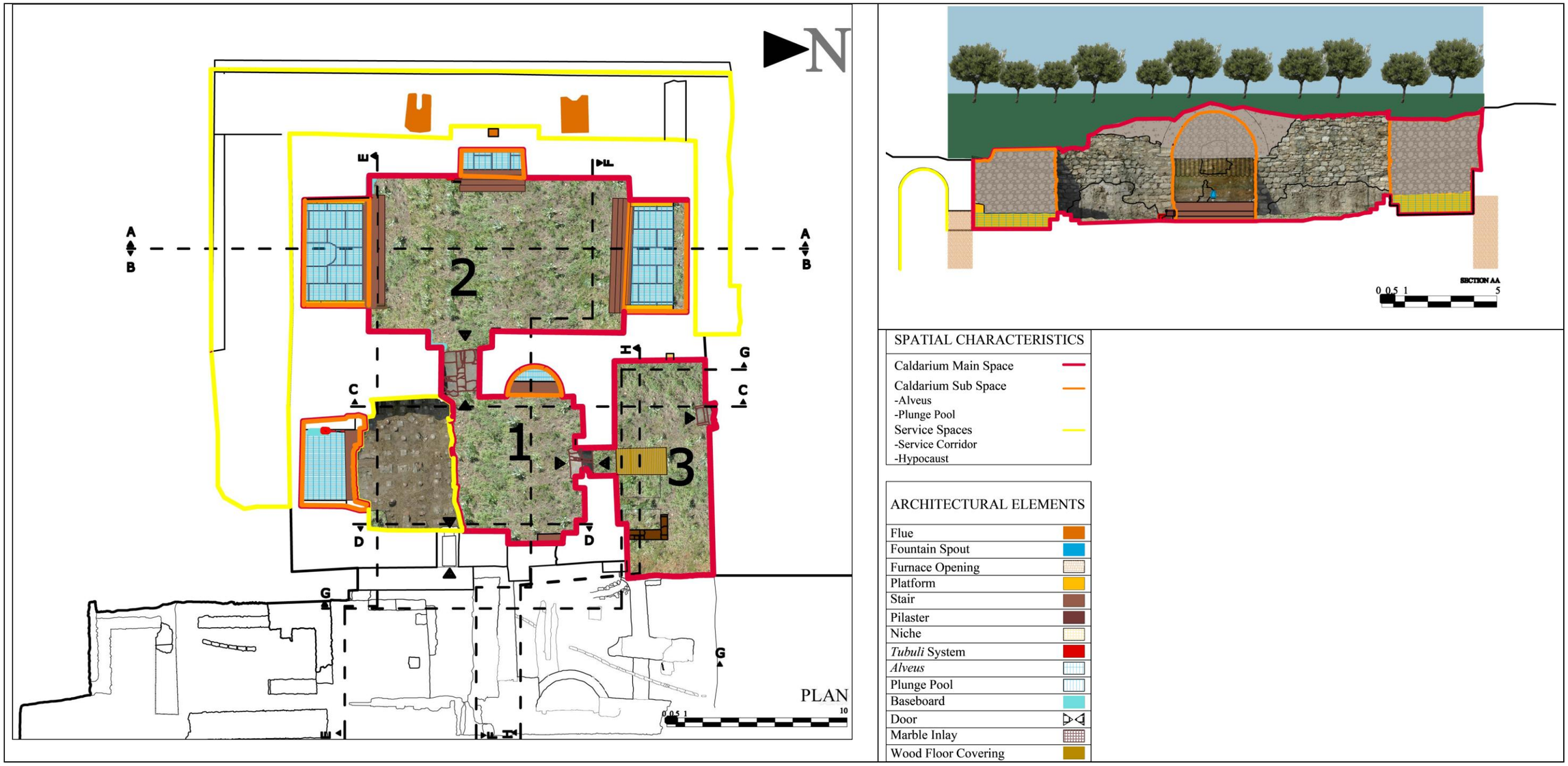


Figure H.1. Architectural Characteristics

APPENDIX I

THEMATIC MAPS: ALTERATIONS

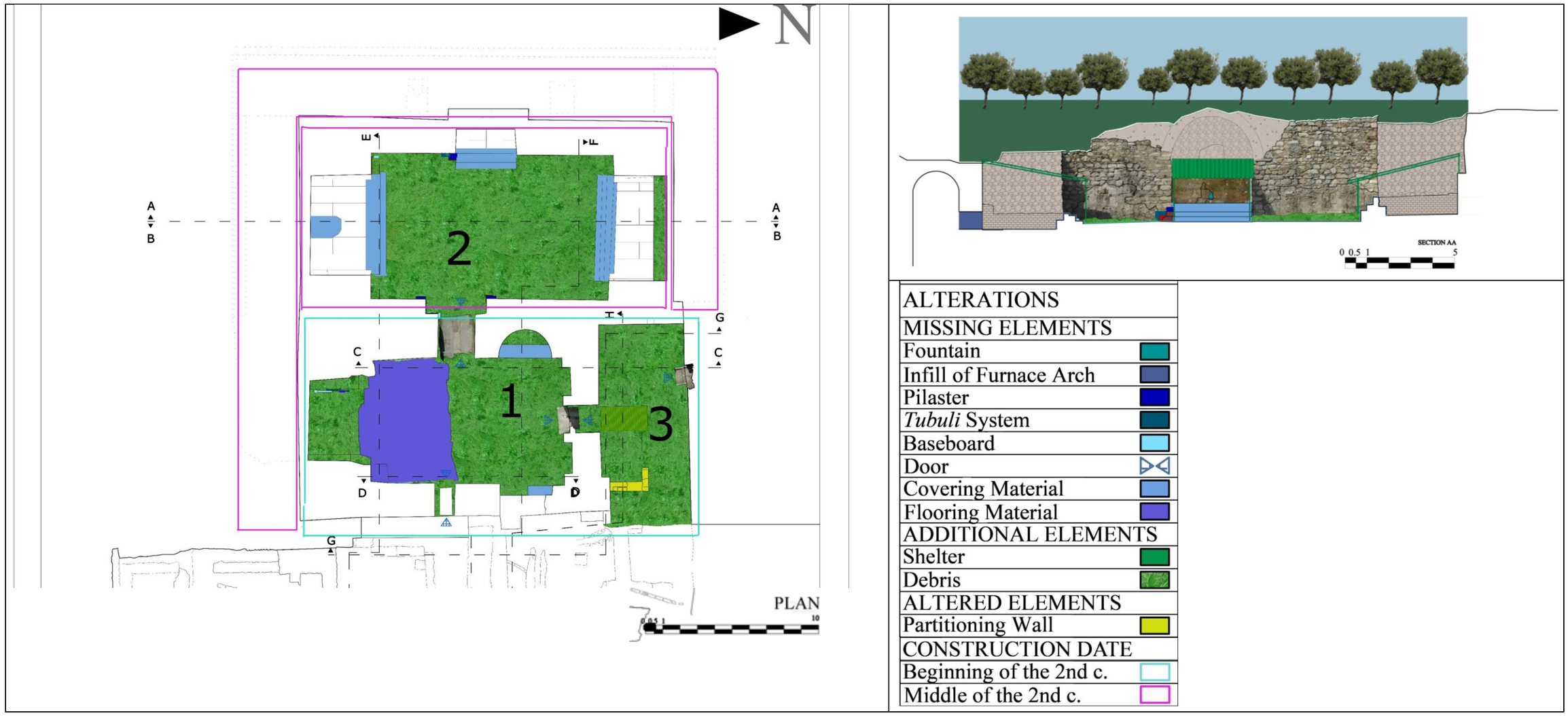
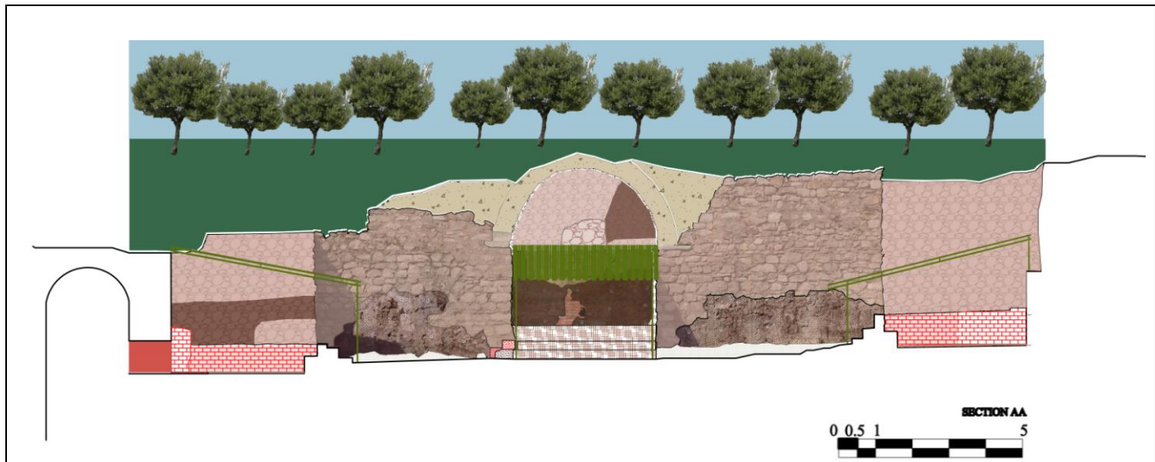


Figure I.1. Alterations

APPENDIX J

THEMATIC MAPS: STRUCTURAL CHARACTERISTICS, AND FAILURES AND DETERIORATIONS



CONSTRUCTION TECHNIQUES & MATERIAL USAGE

Vault
1. Core : Core is made up of small rubble stones bonded with mortar with nodules of lime.
Core+Facing (*Opus Incertum*): Core + Radial coursed rubble stone.
Core+Facing+Plaster: *Opus Incertum* + Brick lime plaster.
2. Brick: Constructed of bricks in horizontal courses bonded with rough mortar with nodules of lime.

Wall
Core : Core is made up of small rubble stones bonded with mortar with nodules of lime.
Core+Facing (*Opus Incertum*): Core + Facing of 'petit appareil'; irregular sized rubble stones and their approximate alignment.

Furnace Arch: The arrangement of radially laid bricks.

Platform: Brick
Brick + Plastering

Stair: Stone
Stone + Marble Facing

Pilaster: Shaft: Brick
Base: Marble

***Tubuli* System:**
Tubuli: Terra Cotta Tubes attached with rough mortar with nodules of lime on walls and finished with brick lime plaster.

Mortar of *Tubuli*: Rough mortar with nodules of lime on walls for attachment of terra cotta tubes.

Brick Infill of Furnace Arch

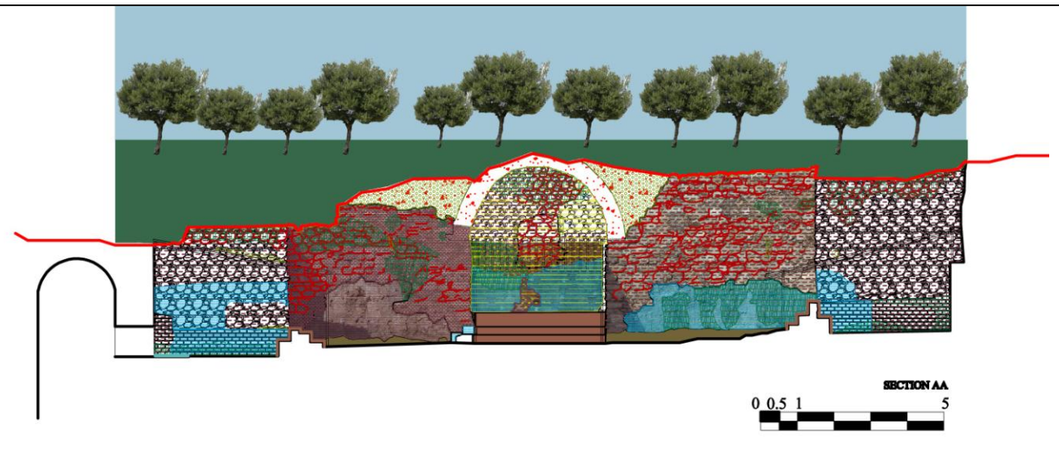
Baseboard: Marble

Marble Inlay

New Stone Infill

New Brick Infill

Debris



FAILURES & DETERIORATIONS

STRUCTURAL FAILURES

Collapsed Superstructure and/or Wall

MATERIAL DETERIORATION

- Loss of Flooring Material
- Loss of Facing Material
- Loss of Plaster
- Loss of Mortar + *Tubuli*
- Empty Joints
- Plaster Decay
- Mortar Decay
- Discoloration
- Plant Growth
- Microbiological Formation

Figure J.1. Structural Characteristics, and Failures and Deteriorations

APPENDIX K

2D CAD DRAWING

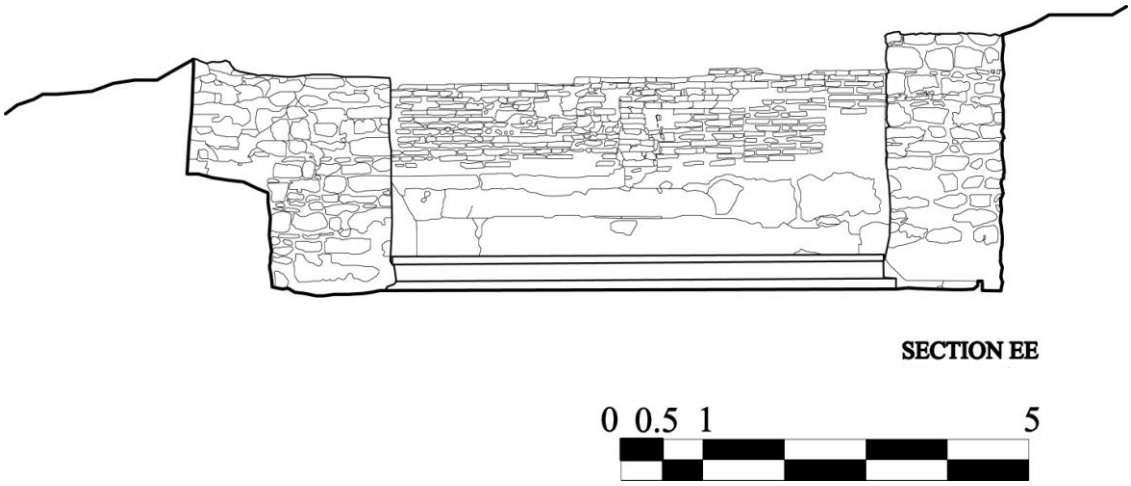


Figure K.1. 2D CAD Drawing

APPENDIX L

AUXILIARY TABLE

Table 1.1 Auxiliary Table

ID	Element Name	Element Type	ID	Element Name	Element Type
1	Bath building as an element of the archaeological site.	Spatial	59	Fountain spout - caldarium 1, western plunge pool.	Architectural
2	Caldarium Main Space 1.	Spatial	60	Fountain spout - caldarium 2, southern *alveus*.	Architectural
3	Caldarium Main Space 2.	Spatial	61	Fountain spout - caldarium 2, western *alveus*.	Architectural
4	Caldarium Main Space 3.	Spatial	62	Fountain spout - caldarium 2, northern *alveus*.	Architectural
5	Service corridor.	Spatial	63	Furnace opening - caldarium 1, southern *alveus*, southern wall.	Architectural
6	Hypocaust.	Spatial	64	Furnace opening - caldarium 2, southern *alveus*, southern wall.	Architectural
7	Transition space.	Spatial	65	Furnace opening - caldarium 2, western *alveus*, western wall.	Architectural
8	Palaestra.	Spatial	66	Furnace opening - caldarium 2, northern *alveus*, northern wall.	Architectural
9	Vault - caldarium 2, western *alveus*.	Structural	67	Platform - caldarium 2, southern *alveus*, western wall.	Architectural
10	Vault - service corridor, west, south corner.	Structural	68	Platform - caldarium 2, southern *alveus*, eastern wall.	Architectural
11	Protective roof - caldarium 2, south.	Structural	69	Platform - caldarium 2, northern *alveus*, western wall.	Architectural
12	Protective roof - caldarium 2, west.	Structural	70	Platform - caldarium 2, northern *alveus*, eastern wall.	Architectural
13	Protective roof - caldarium 2, north.	Structural	71	Stair - caldarium 1, western plunge pool.	Architectural
14	Protective roof - caldarium 3, south.	Structural	72	Stair - caldarium 1, eastern plunge pool.	Architectural
15	Arch system - caldarium 1, southern *alveus*, south.	Structural	73	Stair - caldarium 1, southern *alveus*.	Architectural

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Table 1.1 (cont.)

16	Arch - caldarium 1, northern wall, western niche.	Structural	74	Stairs - caldarium 2, southern alveus.	Architectural
17	Arch - caldarium 1, northern wall, eastern niche.	Structural	75	Stairs - caldarium 2, western alveus.	Architectural
18	Arch - caldarium 1, northern wall, centre, door.	Structural	76	Stairs - caldarium 2, northern *alveus*.	Architectural
19	Arch -caldarium 2, southern *alveus*, furnace opening.	Structural	77	Stairs - caldarium 3, north.	Architectural
20	Arch -caldarium 2, western *alveus*, furnace opening.	Structural	78	Pilaster -caldarium 1, western wall, southern part.	Architectural
21	Arch system - caldarium 2, northern *alveus*, furnace opening.	Structural	79	Pilaster -caldarium 1, western wall, northern part.	Architectural
22	Arch –service corridor, southern wall.	Structural	80	Pilaster -caldarium 1, northern wall.	Architectural
23	Wall - caldarium 1, south, eastern part.	Structural	81	Pilaster -caldarium 2, western wall.	Architectural
24	Wall - caldarium 1, south, western part.	Structural	82	Pilaster -caldarium 2, eastern wall, northern part.	Architectural
25	Wall - caldarium 1, west, southern part.	Structural	83	Pilaster -caldarium 2, eastern wall, southern part.	Architectural
26	Wall - caldarium 1, west, northern part.	Structural	84	Niche - caldarium 1, northern wall, west.	Architectural
27	Wall - caldarium 1, north.	Structural	85	Niche - caldarium 1, northern wall, east.	Architectural
28	Wall - caldarium 1, east, northern part.	Structural	86	Niche - caldarium 3, western wall.	Architectural
29	Wall - caldarium 1, east, southern part.	Structural	87	*Tubuli* system - caldarium 1, alveus, western wall.	Architectural
30	Wall - caldarium 1, southern *alveus*, eastern wall.	Structural	88	*Tubuli* system - caldarium 2, western wall.	**Architectural**
31	Wall - caldarium 1, southern *alveus*, southern wall.	Structural	89	*Alveus* - caldarium 1, south.	Architectural
32	Wall - caldarium 1, southern *alveus*, western wall.	Structural	90	*Alveus* - caldarium 2, south.	Architectural
33	Wall - caldarium 2, south, eastern part.	Structural	91	*Alveus* - caldarium 2, west.	Architectural
34	Wall - caldarium 2, south, western part.	Structural	92	*Alveus* - caldarium 2, north.	Architectural
35	Wall - caldarium 2, west, southern part.	Structural	93	Plunge pool - caldarium 1 ,west.	Architectural

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Table 1.1 (cont.)

36	Wall - caldarium 2, west, northern part.	Structural	94	Plunge pool - caldarium 1, east.	Architectural
37	Wall - caldarium 2, north, western part.	Structural	95	Baseboard - caldarium 1, alveus western wall.	Architectural
38	Wall - caldarium 2, north, eastern part.	Structural	96	Baseboard - caldarium 2, southern wall.	Architectural
39	Wall - caldarium 2, east, northern part.	Structural	97	Baseboard - caldarium 2, northern wall.	Architectural
40	Wall - caldarium 2, east, southern part.	Structural	98	Baseboard - caldarium 2, eastern wall.	Architectural
41	Wall - caldarium 2, southern *alveus*, east.	Structural	99	Baseboard - caldarium 2, southern *alveus*, eastern wall.	Architectural
42	Wall - caldarium 2, southern *alveus*, south.	Structural	100	Baseboard - caldarium 2, southern *alveus*, western wall.	Architectural
43	Wall - caldarium 2, southern *alveus*, west.	Structural	101	Baseboard - caldarium 2, western *alveus*, southern wall.	Architectural
44	Wall - caldarium 2, western *alveus*, south.	Structural	102	Baseboard - caldarium 2, western *alveus*, western wall.	Architectural
45	Wall - caldarium 2, western *alveus*, west.	Structural	103	Baseboard - caldarium 2, western *alveus*, northern wall.	Architectural
46	Wall - caldarium 2, western *alveus*, north.	Structural	104	Baseboard - caldarium 2, northern *alveus*, western wall.	Architectural
47	Wall - caldarium 2, northern *alveus*, west.	Structural	105	Baseboard - caldarium 2, northern *alveus*, eastern wall.	Architectural
48	Wall - caldarium 2, northern *alveus*, north.	Structural	106	Door - caldarium 1, east.	Architectural
49	Wall - caldarium 2, northern *alveus*, east.	Structural	107	Door - caldarium 2, east.	Architectural
50	Wall - caldarium 3, south.	Structural	108	Door - caldarium 3, south.	Architectural
51	Wall - caldarium 3, west.	Structural	109	Door - caldarium 3, north.	Architectural
52	Wall - caldarium 3, north.	Structural	110	Marble inlay - caldarium 2, east.	Finishing
53	Partitioning wall - caldarium 3, south.	Structural	111	Marble inlay - caldarium 2, southern alveus.	Finishing
54	Hypocaust columns - caldarium 1, south.	Structural	112	Marble inlay - caldarium 2, western alveus.	Finishing
55	Flue - service corridor, western part, south.	Architectural	113	Marble inlay - caldarium 2, northern alveus.	Finishing

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Table 1.1 (cont.)

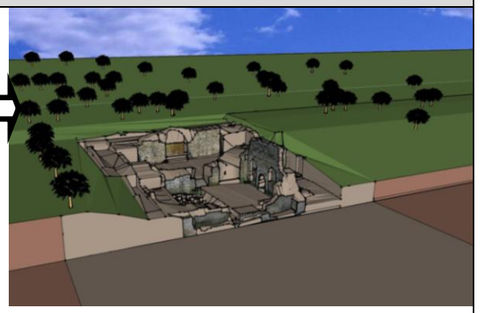
56	Flue - service corridor, western part, centre.	Architectural	114	Marble inlay - caldarium 3, south.	Finishing
57	Flue - service corridor, western part, north.	Architectural	115	Wood floor covering - caldarium 3, south.	Finishing
58	Vertical duct - caldarium 1, west.	Architectural	116	Debris - all floors of the bath where can not be seen any covering material.	Finishing

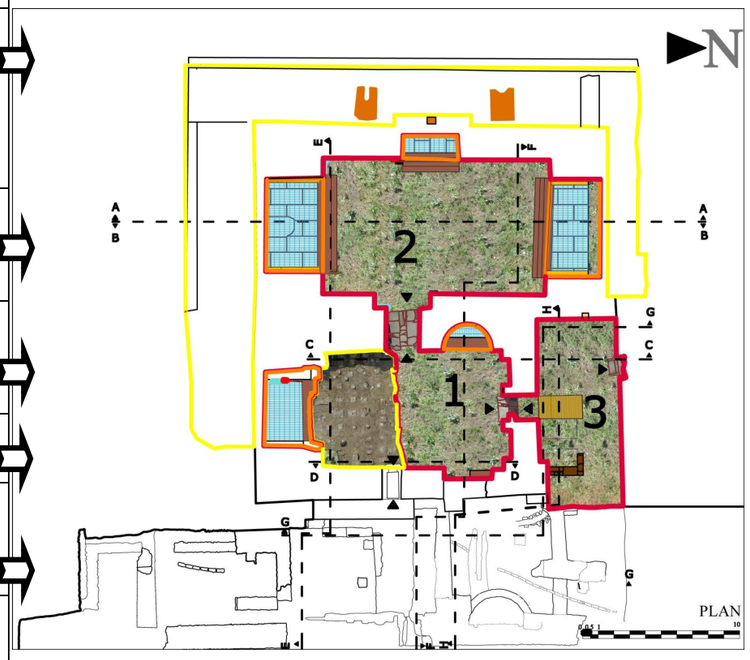
APPENDIX M

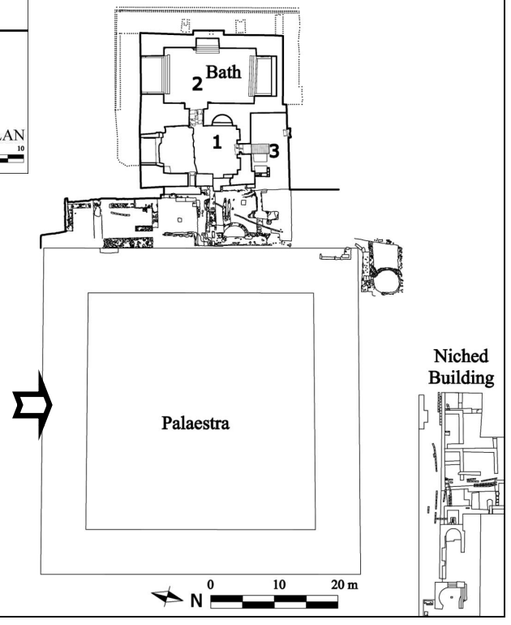
SPATIAL CHARACTERISTICS TABLE

Table 1.2 Spatial Characteristics

ID	Element Name	Characteristics of Space	Alterationof Space	Conservation State	Recommendations	Graphic
1	Bath building as an element of the archaeological site.	Landmark in the Metropolis antique city.	Monumental character ruined with loss of vaults and wall pieces, and embedding of the mass into the earth.	-	Completion of excavations. Comprehensive restoration project should be developed.	
2	*Caldarium* Main Space 1.	Monumental characteristic because the highest wall of the building stands here.	Perception of the real size of the space ruined with loss of part of suspensurae, difficult to understand the wholeness of space.	-	Development of conservation and presentation measures.	
3	*Caldarium* Main Space 2.	Symmetrical organisation with arrangement of three alveus. The largest (14.5x8.7 m) closed space of the bath.	Loss of brillancy with missing pilasters, baseboards, marble coverings, etc.	3 sub spaces (*alveus*) covered with protective additional roofs, providing control of rain water.	Development of conservation and presentation measures.	
4	*Caldarium* Main Space 3.	Original spatial boundries not legible, misleading spatial effect: narrow, unilluminated space with high boundries.	Loss of original spatial perception.	Sub space covered with a protective additional roof, providing control of rain water.	Completion of excavation.	
5	Service corridor.	Linear space which surrounds the bath building from its 3 sides.	-	-	Completion of excavation.	
6	Hypocaust.	Depressed and dense space.	Loss of the original spatial character because of its missing suspensurae part.	-	Development of conservation and presentation measures.	
6	Transition space.	Illegible space with overlapping historical strata.	Loss of spatial perception with ruined architectural and structural elements.	-	Completion of excavation. Deciphering of historical periods. Development of conservation and presentation measures.	
8	Palaestra.	Picturesque ruins with mosaic inlay possessing aesthetic and documentary value.	Difficult to perceive the boundries of the space because of the collapsed columns and the superstructure of the semi-open areas.	Mosaics covered with geotextile and sand and protective additional roof on them.	Development of conservation and presentation measures.	







APPENDIX N

ARCHITECTURAL ELEMENTS TABLE (DIMENSIONS IN CM)

Table 1.3 Architectural Elements

ID	Element Name	Morphological Characteristics	Alteration	Graphic
55	Flue - service corridor, western part, south.	Providing hot gas a draught through a tube with quadrilateral cross section and projecting from the superstructure of service corridor, ~w: 109, l: 180	Loss of function with debris covering the output.	 AppendixH, Appendix I
56	Flue - service corridor, western part, centre.	Providing hot gas a draught through a tube with quadrilateral cross section and projecting from the superstructure of service corridor, ~w: 43, l: 55	Loss of function with debris covering the output	
57	Flue - service corridor, western part, north.	Providing hot gas a draught through a tube with quadrilateral cross section and projecting from the superstructure of service corridor, ~w: 143, l: 197	Loss of function with debris covering the output.	
58	Vertical duct - *caldarium* 1, west.	A tube providing hot gas a draught.	Loss of height: partial loss of the element.	AppendixH, Appendix I
59	Fountain spout - *caldarium* 1, western plunge pool.	A quadrilateral hole (~17x30) in the wall forming the mouth of the probable outlet pipe controlling the flow of water into the plunge pool.	-	 Appendix H, Appendix I
60	Fountain spout - *caldarium* 2, southern *alveus*.	A quadrilateral hole (~19x23) in the wall forming the mouth of the probable outlet pipe controlling the flow of water into the *alveus*.	Loss of the function: new infill.	
61	Fountain spout - *caldarium* 2, western *alveus*.	A quadrilateral hole (~16x25) in the wall forming the mouth of the probable outlet pipe controlling the flow of water into the *alveus*.	-	
62	Fountain spout - *caldarium* 2, northern *alveus*.	A quadrilateral hole (~18x12) in the wall forming the mouth of the probable outlet pipe controlling the flow of water into the *alveus*.	-	

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Table 1.3 (cont.)

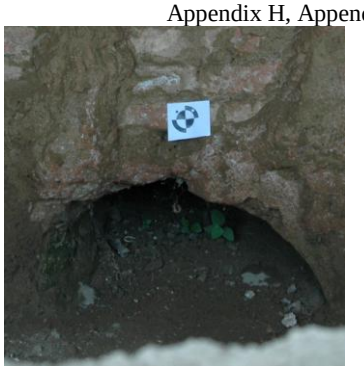
ID	Element Name	Morphological Characteristics	Alteration	Graphic
63	Furnace opening - *caldarium* 1, southern *alveus*, southern wall.	Semicircular, arched opening in the middle of the wall, furnace opening directly underneath, so the tank receiving the greatest heat, (r: 55, cs: 90).	Remains of lost infill.	Appendix H, Appendix I
64	Furnace opening - *caldarium* 2, southern *alveus*, southern wall.	Semicircular, arched opening in the middle of the wall: furnace opening directly underneath, so the tank receiving the greatest heat, (r: 35, cs: 40).	Total loss of infill.	 Appendix H, Appendix I
65	Furnace opening - *caldarium* 2, western *alveus*, western wall.	Semicircular, arched opening in the middle of the wall infill, furnace opening directly underneath, so the tank receiving the greatest heat, (r: 30, cs: 40).	New infill in the wall with an arched opening.	
66	Furnace opening - *caldarium* 2, northern *alveus*, northern wall.	Semicircular, arched opening in the middle of the wall, furnace opening directly underneath, so the tank receiving the greatest heat, (r: 89, cs: 96).	Partial loss of double-layered plastering.	Appendix H, Appendix I
67	Platform - *caldarium* 2, southern *alveus*, western wall.	Sitting element extending throughout the short edge of *alveus*, finishing with a baseboard, (w: 37, ~hmax: 43)	Partial loss of the element, partial loss of lime plaster.	
68	Platform - *caldarium* 2, southern *alveus*, eastern wall.	Sitting element extending throughout the short edge of *alveus*, finishing with a baseboard, (w: 35-, ~hmax: 30)	Partial loss of the element, extensive loss of hydraulic lime plaster covering.	Appendix H, Appendix I
69	Platform - *caldarium* 2, northern *alveus*, western wall.	Sitting element extending throughout the wall behind, finishing with a baseboard, (w: 37, ~h: 82)	Partial loss of the element, total loss of lime plaster covering.	
70	Platform - *caldarium* 2, northern *alveus*, eastern wall.	Sitting element extending throughout the short edge of *alveus*, finishing with a baseboard, (w: 29, ~h: 88)	Partial loss of the element, total loss of plaster covering.	Appendix H, Appendix I

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Table1.3 (cont.)

ID	Element Name	Morphological Characteristics	Alteration	Graphic
71	Stair - *caldarium* 1, western plunge pool.	One step, extending throughout the diameter of semicircular plunge pool, providing access to the pool, ~w: 49, l: 325, h: 25	Total loss of covering material.	Appendix G, Appendix H
72	Stair - *caldarium* 1, eastern plunge pool.	One step, extending throughout the diameter of the remain of the semicircular plunge pool, providing access to the pool, ~w: 57, l: 149, h: 25	Partial loss of the element and total loss of covering material.	 Appendix H, Appendix I
73	Stair - *caldarium* 1, southern *alveus*.	One step, extending throughout long edge of *alveus*, providing access to the pool, ~w: 50, l: 393, ~h: 30	Total loss of some steps and partial loss of hydraulic lime plaster.	
74	Stairs - *caldarium* 2, southern *alveus*.	Three steps providing access to the *alveus* (each w~30, h~15) and one step for sitting (w~35, h~40) in the *alveus*, all extending throughout the pool long edge.	Extensive loss of marble covering.	
75	Stairs - *caldarium* 2, western *alveus*.	Three steps providing access to the *alveus* (each w~30, h~35) and one step for sitting (w~35, h~37) in the *alveus*, all extending throughout the pool long edge.	Total loss of covering material.	 Appendix H, Appendix I
76	Stairs - *caldarium* 2, northern *alveus*.	Three steps providing access to the *alveus* (each w~31.5, h~…) and one step for sitting (w~35, h~33) in the *alveus*, all extending throughout the pool long edge.	Total loss of covering material.	
77	Stairs - *caldarium* 3, north.	Three stepped horizontal marble pieces lying on the bottom of the door opening (h: 15x12x30).	Slightly embedded into earth.	
78	Pilaster - *caldarium* 1, western wall, southern part.	Decorative element, slightly projecting from the wall … cm, quadrilateral shaft (w: 18, l: 69, h: 152).	Partial loss of shaft, total loss of base, total loss of covering.	 Appendix H, Appendix I
79	Pilaster - *caldarium* 1, western wall, northern part.	Decorative element, slightly projecting from the wall … cm, quadrilateral shaft (w: 15, l: 45, h: 128).	Partial loss of shaft, total loss of base, total loss of covering.	
80	Pilaster - *caldarium* 1, northern wall.	Decorative element, quadrilateral base (w:40, l: 40, h: 17).	Total loss of shaft.	

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Table 1.3 (cont.)

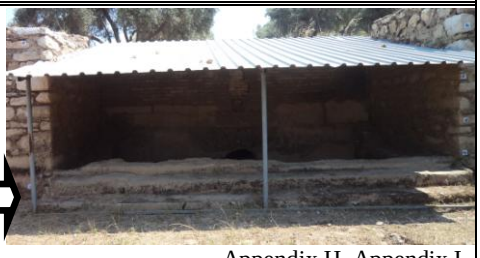
ID	Element Name	Morphological Characteristics	Alteration	Graphic
81	Pilaster - *caldarium* 2, western wall.	Decorative element, slightly projecting from the wall … cm, quadrilateral shaft (w: 18, l: 33, h: 36), quadrilateral base (w: 40, l: 40, h: 17).	Partial loss of shaft, total loss of covering.	 Appendix H, Appendix I
82	Pilaster - *caldarium* 2, eastern wall, northern part.	Decorative element, slightly projecting from the wall … cm, quadrilateral shaft (w: 18, l: 41, h: 36), quadrilateral base (w: 40, l: 40, h: 17).	Partial loss of shaft, total loss of covering.	 Appendix H, Appendix I
83	Pilaster - *caldarium* 2, eastern wall, southern part.	Decorative element, slightly projecting from the wall … cm, quadrilateral shaft (w: 18, l: 35, h: 43).	Partial loss of shaft, total loss of base, total loss of covering.	
84	Niche - *caldarium* 1, northern wall, west.	Rectangular (w:48, l:170), arched recess in the wall with a pedestal (h:30).	Total loss of plastering.	 Appendix H, Appendix I
85	Niche - *caldarium* 1, northern wall, east.	Rectangular (w:50, l:184), arched recess in the wall with a pedestal (h:33).	Partial loss of pedestal, additional infill on the original pedestal remain.	
86	Niche - *caldarium* 3, western wall.	Square recess in the wall (w: 43, l: 38, d:32), being higher level from the ground (gc: 241).	-	
87	*Tubuli* system - *caldarium* 1, *alveus*, western wall.	Voids in form of series of rectangular prisms, running vertically parallel to the wall surface, providing circulation for gases, 4 *tubuli* only, w: 15, l: 30, h: 30, t: 2.	3 of 4 *tubuli* remains partially lost, others completely lost.	 Appendix H, Appendix I
88	*Tubuli* system - *caldarium* 2, western wall.	Voids in form of rectangular prism, running vertically parallel to the wall surface, providing circulation for gases, 1 *tubulus* only, w: 15, l: 30, h: 30,t: 2.	Almost complete loss of *tubuli* system.	
89	*Alveus* - *caldarium* 1, south.	Bathing pool (w: 253, l: 512, d: 30) heated with a *praefurnium*, entered with a single step.	Partial loss of its stairs.	 Appendix H, Appendix I
90	*Alveus* - *caldarium* 2, south.	Bathing pool (w: 334, l: 541, ~d: 55) heated with a *praefurnium*, enriched with platforms on 2 sides, entered with a 4 steps.	-	

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Table 1.3 (cont.)

ID	Element Name	Morphological Characteristics	Alteration	Graphic
91	*Alveus* - *caldarium* 2, west.	Bathing pool (w: 115, l: 362, ~d: 58) heated with a *praefurnium*, entered with 4 steps.	-	Appendix H, Appendix I
92	*Alveus* - *caldarium* 2, north.	Bathing pool (w: 237, l: 547, d: 74.5) heated with a *praefurnium*, enriched with platforms on 2 sides, entered with a 4 steps.	-	Appendix H, Appendix I
93	Plunge pool - *caldarium* 1 ,west.	Bathing pool, semicircular plan, entered with a single step, di: 313, d: 86	-	 Appendix H, Appendix I
94	Plunge pool - *caldarium* 1, east.	Traces of bathing pool, semicircular plan, entered with a single step, di: 316 d: 41	Partial loss of its stair.	
95	Baseboard - *caldarium* 1, *alveus* western wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 17, t: 1.5.	Partial loss of the element, nearly all embedded into debris.	Appendix H, Appendix I
96	Baseboard - *caldarium* 2, southern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h:15, t: 1.5.	Partial loss of the element.	 Appendix H, Appendix I
97	Baseboard - *caldarium* 2, northern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 15, t: 1.5.	Partial embedding into the earth.	
98	Baseboard - *caldarium* 2, eastern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 12, t: 1.5.	Partial loss of the element.	
99	Baseboard - *caldarium* 2, southern *alveus*, eastern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 17, t: 1.5.	-	 Appendix H, Appendix I
100	Baseboard - *caldarium* 2, southern *alveus*, western wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 17, t: 1.5.	-	

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Table 1.3 (cont.)

ID	Element Name	Morphological Characteristics	Alteration	Graphic
101	Baseboard - *caldarium* 2, western *alveus*, southern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 17, t: 1.5.	-	
102	Baseboard - *caldarium* 2, western *alveus*, western wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 19, t: 1.5.	-	 Appendix H, Appendix I
103	Baseboard - *caldarium* 2, western *alveus*, northern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 17, t: 1.5.	-	
104	Baseboard - *caldarium* 2, northern *alveus*, western wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 15, t: 1.5.	-	 Appendix H, Appendix I
105	Baseboard - *caldarium* 2, northern *alveus*, eastern wall.	Linear transition element between wall and floor surfaces, extending throughout the wall, h: 16, t: 1.5.	-	
106	Door - *caldarium* 1, east.	Rectangular (w:120, l:200) planned opening enriched with curvilinear wall on its sourhern side, providing circulation between caldarium 1 and transition spaces, small in size to control heat loss, with a space underneath to provide circulation for hot gases.	Extensive loss of wall and floor bounding the opening, total loss of finishing elements.	 Appendix H, Appendix I
107	Door - *caldarium* 2, east.	Rectangular (w:221, l:226) planned opening enriched with pilasters on its two sides + a recess (~50x15) on its caldarium 2 face, on its two sides + marble inlay, providing circulation between caldarium 1 and caldarium 2, small in size to control heat loss.	Extensive loss of wall bounding the opening, total loss of finishing elements.	

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Table 1.3 (cont.)

ID	Element Name	Morphological Characteristics	Alteration	Graphic
108	Door - *caldarium* 3, south.	Rectangular (w:165, l:181) planned arched opening on its two sides enriched with recesses (~30x15) on its caldarium 1 face, + marble inlay with trace of channel, providing circulation between caldarium 1 and caldarium 3, small in size to control heat loss.	Partial loss of wall bounding the opening, total loss of finishing elements.	 Appendix H, Appendix I
109	Door - *caldarium* 3, north.	Opening (w:136, l:50) providing circulation between caldarium 3 and an unexcavated space, enriched with recesses (~36x15) on its two sides + 3 marble steps leading to the opening, small in size to control heat loss.	Extensive loss of wall bounding the opening, total loss of finishing elements.	
110	Marble inlay - *caldarium* 2, east.	Horizontal marble pieces in different sizes lying on the bottom of the door opening only (~w:221, l:262).	Slight embedding into the earth.	 Appendix H, Appendix I
111	Marble inlay - *caldarium* 2, southern *alveus*.	Horizontal marble pieces in different sizes lying on the ground of the alveus (~w:70, l:170).	-	
112	Marble inlay - *caldarium* 2, western *alveus*.	Horizontal marble pieces in different sizes lying on the ground of the alveus (~w:70, l:170).	-	
113	Marble inlay - *caldarium* 2, northern *alveus*.	Horizontal marble pieces in different sizes lying on the ground of the alveus (~w:70, l:170).	-	
114	Marble inlay - *caldarium* 3, south.	Horizontal marble pieces in different sizes lying on the bottom of the door opening only (~w: 166, l: 127).	-	
115	Wood floor covering - *caldarium* 3, south.	Linear wooden elements covering the floor, arranged side by side; (w: 144, l: 280)	Additional element.	 Appendix H, Appendix I

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APPENDIX O

CHARACTERISTICS OF CONSTRUCTION TECHNIQUES AND MATERIAL USAGE TABLE (DIMENSIONS IN CM)

Table 1.4 Characteristics of Construction Techniques and Material Usage

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
9	Vault - *caldarium* 2, western *alveus*.	Structural	Barrel (r:597 cs:607, d: ~148), rubble stone (~1x1x0.5) + brick (~1.5x1x0.5) embedded in brick-lime mortar (t:~4.5); covered with rubble stones (~50x17x13).	Extensive damage at facing: only a single rubble stone remaining.	 Appendix J
10	Vault - service corridor, west, south corner.	Structural	Barrel (could not be measured), brick (~30x5) in isodomic order + mortar (t horizontal: ~3, t vertical:1).	Overloading due to earth covering; plant, lichen, algae growth.	
11	Protective roof - *caldarium* 2, south.	Structural	Metal guttered sheet carried by metal posts.	Slight rusting.	 Appendix J.
12	Protective roof - *caldarium* 2, west.	Structural	Metal guttered sheet carried by metal posts.	Slight rusting.	
13	Protective roof - *caldarium* 2, north.	Structural	Metal guttered sheet carried by metal posts.	Slight rusting.	
14	Protective roof - *caldarium* 3, south.	Structural	Metal guttered sheet carried by metal posts.	Slight rusting.	
15	Arch system - *caldarium* 1, southern *alveus*, south.	Structural	Two arches, one within the other, lower arch; radially laid bricks (~32x32x5), brick lime mortar (t: ~0.5-5), upper arch; brick (32x32x5) + brick lime mortar (tvertical: ~0.5-5, thorizontal:7.5),infill covered brick lime mortar.	Partial loss of plaster of arch, partial loss of infill.	 Appendix J
16	Arch - *caldarium* 1, northern wall, western niche.	Structural	Semicircular arch (r:86, cs:175), rubble stone (~16x6x25**)** embedded in lime mortar (t: 6-7): core; irregular sized rough cut stone facing (~43x19x12).	Extensively damaged facing: only four rough cut stone remaining, plaster totally lost.	

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
17	Arch - *caldarium* 1, northern wall, eastern niche.	Structural	Semicircular arch (r:86, cs:180), rubble stone (~16x6x25) embedded in lime mortar (t: 6-7): core; irregular sized rough cut stone facing (~43x19x12).	Extensively damaged facing: only a few rough cut stone remaining.	 Appendix j
18	Arch - *caldarium* 1, northern wall, centre, door.	Structural	Semicircular arch (r: 85, cs:168), rubble stone (~16x6x25) embedded in lime mortar (t: 6-7): core; irregular sized rough cut stone facing (~43x19x12).	Extensively damaged facing: only a single rough cut stone remaining.	
19	Arch - *caldarium* 2, southern *alveus*, furnace opening.	Structural	Covered with double layered plaster system: brick lime under-layer, hydraulic lime top-layer.	Almost total loss of infill: slight mortar remains.	
20	Arch - *caldarium* 2, western *alveus*, furnace opening.	Structural	Wall repaired with brick, rubble stone + mortar, additional arch within this infill.	Random arch opening: lack of radial or corbelled order	 Appendix J
21	Arch system - *caldarium* 2, northern *alveus*, furnace opening.	Structural	Two arches, one within the other, radially laid bricks (~32x32x5), brick lime mortar (t: ~0.5-5), upper arch; brick (32x32x5) + brick lime mortar (tvertical: ~0.5-5, thorizontal:7.5), infill covered with hydraulic lime plaster (t: ~2.5).	Slight loss of hydraulic lime plaster , deposit formation.	
22	Arch - service corridor, southern part, southern wall.	Structural	Radially laid bricks (~30x30x5), brick lime mortar (t: ~0.5-5).	Nearly all embedded into earth.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
23	Wall - *caldarium* 1, south, eastern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, h: ~166.	Partial collapse, total loss of plastering, empty joints.	 Appendix J
24	Wall - *caldarium* 1, south, western part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, h: ~245.	Partial collapse, total loss of plastering, empty joints.	
25	Wall - *caldarium* 1, west, southern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, hmax: ~325.	Loss of height: partial collapse, total loss of plastering.	 Appendix J
26	Wall - *caldarium* 1, west, northern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, hmax: ~332	Loss of height: partial collapse, total loss of plastering.	

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
27	Wall - *caldarium* 1, north.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, h: ~697.	Partial collapse at highest parts, partial loss of facing (at the highest parts), total loss of plastering.	 Appendix J
28	Wall - *caldarium* 1, east, northern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, hmax: ~354.	Loss of height: partial collapse, total loss of plastering.	 Appendix J
29	Wall - *caldarium* 1, east, southern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, hmax: ~241.	Loss of height: partial collapse, total loss of plastering.	
30	Wall - *caldarium* 1, southern *alveus*, eastern wall.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, brick lime plaster (t: ~2.5), hmax: ~70.	Loss of height: almost total collapse, partial loss of plastering.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
31	Wall - *caldarium* 1, southern *alveus*, southern wall.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, brick lime plaster (t: ~3); hmax: ~111.	Loss of height: almost total collapse, partial loss of plastering.	 Appendix J
32	Wall - *caldarium* 1, southern *alveus*, western wall.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, double layered plaster: lime under-layer (t: ~3), hydraulic lime top-layer (t: ~2), hmax: ~73.	Loss of height: almost total collapse, partial loss of plastering.	
33	Wall - *caldarium* 2, south, eastern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, hmax: ~287.	Loss of height: partial collapse, total loss of plastering.	 Appendix J
34	Wall - *caldarium* 2, south, western part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, hmax: ~311.	Loss of height: partial collapse, total loss of plastering.	

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
35	Wall - *caldarium* 2, west, southern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum* + mortar of tubuli covering at some places, hmax: ~462.	Loss of height: partial collapse, partial loss of facing at highest parts, extensive loss of tubuli covering, empty joints.	Appendix J
36	Wall - *caldarium* 2, west, northern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum* + partial covering of mortar of tubuli, lime plaster (t: ~5), hmax: ~467.	Loss of height: partial collapse, partial loss of facing, extensive loss of plastering, empty joints, licken, algea formation.	 Appendix J
37	Wall - *caldarium* 2, north, western part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, hmax: ~377.	Loss of height: slight collapse, total loss of plastering, empty joints.	Appendix J
38	Wall - *caldarium* 2, north, eastern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, hmax: ~299.	Loss of height: slight collapse, total loss of plastering, empty joints.	 Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
39	Wall - *caldarium* 2, east, northern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, lime plaster (t: ~…), hmax: ~385	Loss of height: partial collapse, slight loss of facing, extensive loss of plastering, empty joints.	 Appendix J
40	Wall - *caldarium* 2, east, southern part.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, hmax: ~125.	Loss of height: extensive collapse, total loss of plastering, empty joints.	Appendix J
41	Wall - *caldarium* 2, southern *alveus*, east.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, lime plaster (t: ~3.5), h: ~284.	Loss of height: partial collapse, partial loss of plastering, empty joints.	 Appendix J
42	Wall - *caldarium* 2, southern *alveus*, south.	Structural	Brick (~30x30) + brick-lime mortar (t: ~3), double layered plaster: gray under-layer (t:3), hydraulic lime top-layer (t:2), h:~294.	Loss of height: partial collapse, extensive loss of finishing layer of plastering.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
43	Wall - *caldarium* 2, southern *alveus*, west.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, lime plaster (t: ~3.5), h: ~333.	Loss of height: partial collapse, partial loss of plastering.	Appendix J
44	Wall - *caldarium* 2, western *alveus*, south.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, plaster: lime under-layer (t:~3), hydraulic lime top-layer (t:~2), h:~340.	Loss of height: partial collapse, extensive loss of finishing layer of plastering, discoloration.	
45	Wall - *caldarium* 2, western *alveus*, west.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, repair brick and stone at central buttom part, h: ~521.	Partial loss of plastering, deposit formation, discoloration.	 Appendix J
46	Wall - *caldarium* 2, western *alveus*, north.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, lime plaster (t: ~4), h: ~305.	Loss of height: slight collapse, slight loss of plastering, loss of integrity.	

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
47	Wall - *caldarium* 2, northern *alveus*, west.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, lime plaster (t: ~3.5), h: ~383.	Loss of height: partial collapse, extensive loss of plastering.	
48	Wall - *caldarium* 2, northern *alveus*, north.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum* + coursing of three rows of bricks (~30x5), double layered plaster: brick lime under-layer (t: ~3) + hydraulic lime top-layer (t: ~2), h: ~208.	Loss of height: extensive collapse, extensive loss of plastering.	 Appendix J
49	Wall - *caldarium* 2, northern *alveus*, east.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, lime plaster, h: ~307.	Partial collapse, partial loss of lime plaster.	

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
50	Wall - *caldarium* 3, south.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, repair stone and brick at the western buttom part; lime plaster, hmax: ~697	Loss of height: partial collapse, loss of facing at some places, almost total loss of plastering, empty joints.	 Appendix J
51	Wall - *caldarium* 3, west.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, repair brick at central buttom part, brick lime plaster (t: ~4), hmax: ~404.	Loss of height: partial collapse, extensive loss of plastering, empty joints.	 Appendix J
52	Wall - *caldarium* 3, north.	Structural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rubble stones (~43x19x12), brick lime mortar (t: 3): *opus incertum*, brick lime plaster (t: ~4), hmax:~ 351.	Loss of height: extensive collapse, partial loss of plastering.	 Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
53	Partitioning wall - *caldarium* 3, south.	Structural	Independent wall without any construction joint to the adjacent south wall, reused stone block (62x44x20) + bricks (30x30x5) + mortar (t: ~3), lime plaster (t:3.5), hmax: ~114.	Loss of height: partial collapse, partial loss of plastering.	 Appendix J
54	Hypocaust columns - *caldarium* 1, south.	Structural	Series of columns (hmin: ~30, hmax: 56) in circular, squarish, linear or L formed plans, circular (di: ~30) or squarish (30x30) bricks (t: ~5) + gray mortar (t: ~4).	Loss of original heights of columns: partial collapse.	 Appendix J
55	Flue - service corridor, northern part, south.	Architectural	Bricks (15 or 30x5x27-30) + lime mortar (t: ~2.5).	Partial collapse: damage to outflow, total loss of covering material.	
56	Flue - service corridor, northern part, centre.	Architectural	Bricks (15 or 30x5x27-30) + lime mortar (t: ~2.5).	Partial collapse: damage to outflow, total loss of covering material.	
57	Flue - service corridor, northern part, north.	Architectural	Bricks (15 or 30x5x27-30) + lime mortar (t: ~2.5).	Partial collapse: damage to outflow, total loss of covering material.	Appendix J
58	Vertical duct - *caldarium* 1, west.	Architectural	Brick (~30x5) + mortar (t: ~2.5) in a single vertical part of the wall, w: ~65.	Loss of height: partial collapse, total loss of plastering.	Appendix J
59	Fountain spout - *caldarium* 1, western plunge pool.	Architectural	A hole without plastering, within the wall.	Loss of pipe and finishing material.	
60	Fountain spout - *caldarium* 2, southern *alveus*.	Architectural	A hole infilled with brick, without plastering.	Brick infill: damage to spout, loss of finishing material.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
61	Fountain spout - *caldarium* 2, western *alveus*.	Architectural	A hole without plastering, within the wall.	Loss of pipe and finishing material.	Appendix J
62	Fountain spout - *caldarium* 2, northern *alveus*.	Architectural	A hole without plastering, within the wall.	Loss of pipe and finishing material.	 Appendix J
63	Furnace opening - *caldarium* 1, southern *alveus*, southern wall.	Architectural	Opening with a wall piece covered brick lime plaster, covered a brick arch system.	Partial loss of the infill.	 Appendix J
64	Furnace opening - *caldarium* 2, southern *alveus*, southern wall.	Architectural	Opening covered with an arch covered with double layered plastering: brick lime under-layer, hydraulic lime top-layer.	Mortar pieces on the intrados surface of arch, partial loss of double-layered plastering, loss of integrity, deposit formation.	
65	Furnace opening - *caldarium* 2, western *alveus*, western wall.	Architectural	Partially covered with brick lime plaster.	New, random arch opening, loss of integrity, deposit formation.	
66	Furnace opening - *caldarium* 2, northern *alveus*, northern wall.	Architectural	With an infill partially covered with double layered plastering: brick lime under-layer, hydraulic lime top-layer, covered with a brick arch system.	Loss of integrity, deposit formation.	 Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
67	Platform - *caldarium* 2, southern *alveus*, western wall.	Architectural	Bricks (30x30x5) + lime mortar (t: ~4), hydraulic lime plaster (t: ~2.5).	Loss of height: partial collapse, extensive loss of plastering.	 Appendix J
68	Platform - *caldarium* 2, southern *alveus*, eastern wall.	Architectural	Bricks (30x30x5) + lime mortar (t: ~4), hydraulic lime plaster (t: ~2.5).	Loss of height: partial collapse, extensive loss of plastering.	
69	Platform - *caldarium* 2, northern *alveus*, western wall.	Architectural	Bricks (30x30x5) + lime mortar (t: ~4), lime plaster (t: ~2.5).	Loss of height: slight collapse, partial loss of plastering.	 Appendix J
70	Platform - *caldarium* 2, northern *alveus*, eastern wall.	Architectural	Bricks (30x30x5) + lime mortar (t: ~4), hydraulic lime plaster (t: ~2.5).	Loss of height: slight collapse, extensive loss of plastering.	
71	Stair - *caldarium* 1, western plunge pool.	Architectural	Bricks (30x30x5) + gray mortar (t: ~2.5).	Total loss of plastering, deposit formation.	 Appendix J
72	Stair - *caldarium* 1, eastern plunge pool.	Architectural	Bricks (30x30x5) + gray mortar (t: ~2.5).	Total loss of plastering, deposit formation.	Appendix J
73	Stairs - *caldarium* 1, southern *alveus*.	Architectural	Stones (45x32) + brick lime mortar (t: ~2.5), hydraulic lime plastering (t: ~2.5) (inside the pool), marble covering (t: ~1.5) (outside the pool).	Partial loss of the element, extensive loss of marble covering, partial loss of plastering.	 Appendix J
74	Stairs - *caldarium* 2, southern *alveus*.	Architectural	Stones (45x32) + brick lime mortar (t: ~2.5), hydraulic lime plastering (t: ~2.5) (inside the pool).	Extensive loss of plastering, deposit formation.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
75	Stairs - *caldarium* 2, western *alveus*.	Architectural	Stones (45x32) + brick lime mortar (t: ~2.5), hydraulic lime plastering (t: ~2.5) (inside the pool).	Partial loss of the element, extensive loss of plastering.	Appendix J
76	Stairs - *caldarium* 2, northern *alveus*.	Architectural	Stones (45x32) + brick lime mortar (t: ~2.5), hydraulic lime plastering (t: ~2.5) (inside the pool).	Partial loss of the element, extensive loss of plastering.	 Appendix J
77	Stairs - *caldarium* 3, north.	Architectural	Marble + mortar .	Slight crack, deposit formation.	Appendix J
78	Pilaster - *caldarium* 1, western wall, southern part.	Architectural	Bricks (~15 or 30x5x30) + lime mortar (t: ~3); brick lime plastering.	Partial loss of the element, partial loss of plastering, loss of integrity, deposit formation.	Appendix J
79	Pilaster - *caldarium* 1, western wall, northern part.	Architectural	Bricks (~15 or 30x5x30) + lime mortar (t: ~3); gray plastering.	Partial loss of the element, partial loss of plastering, loss of integrity, deposit formation.	 Appendix J
80	Pilaster - *caldarium* 1, northern wall.	Architectural	Shaped marble base.	Extensive loss of the element: total loss of shaft, deposit formation.	 Appendix J
81	Pilaster - *caldarium* 2, western wall.	Architectural	Bricks (~15 or 30x5x30) + lime mortar (t: ~3); shaped marble base.	Extensive loss of the element: extensive loss of shaft, total loss of plastering, deposit formation.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
82	Pilaster - *caldarium* 2, eastern wall, northern part.	Architectural	Bricks (~15 or 30x5x30) + lime mortar (t: ~3); brick lime plaster (t: ~5), shaped marble base.	Extensive loss of the element: extensive loss of shaft, almost total loss of plastering, deposit formation.	 Appendix J
83	Pilaster - *caldarium* 2, eastern wall, southern part.	Architectural	Bricks (~15 or 30x5x30) + lime mortar (t: ~3); brick lime plaster (t: ~5).	Extensive loss of the element: extensive loss of shaft, extensive loss of plastering, deposit formation.	
84	Niche - *caldarium* 1, northern wall, west.	Architectural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, repair brick and stone at central part, metal supporting elements.	Partial loss of the element, total loss of plastering, deposit formation, plant growth.	 Appendix J
85	Niche - *caldarium* 1, northern wall, east.	Architectural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*, repair stone at central part, repair brick at buttom part.	Total loss of plastering, empty joints, deposit formation, plant growth.	
86	Niche - *caldarium* 3, western wall.	Architectural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7): core; facing with irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3): *opus vittatum*.	Total loss of plastering, empty joints, plant growth.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
87	*Tubuli* system - *caldarium* 1, *alveus*, western wall.	Architectural	4 terra cotta elements attached to the wall with lime mortar.	Loss of integrity, deposit formation.	 Appendix J
88	*Tubuli* system - *caldarium* 2, western wall.	Architectural	A single terra cotta element attached to the wall with lime mortar.	Loss of integrity, deposit formation.	
89	*Alveus* - *caldarium* 1, south.	Architectural	Surrounded by three walls, a stair on its sides, marble inlay on the ground.	Loss of the superstructure.	
90	*Alveus* - *caldarium* 2, south.	Architectural	Surrounded by a wall, two platforms, stairs on its sides, marble inlay on the ground.	Loss of the superstructure.	 Appendix J
91	*Alveus* - *caldarium* 2, west.	Architectural	Surrounded by three walls, stairs on its sides, marble inlay on the ground.	Loss of the superstructure.	
92	*Alveus* - *caldarium* 2, north.	Architectural	Surrounded by a wall, two platforms, stairs on its sides, marble inlay on the ground.	Loss of the superstructure.	
93	Plunge pool - *caldarium* 1 ,west.	Architectural	Surrounded by a curvilinear wall and a stair, ground is debris covered.	Loss of the superstructure.	 Appendix J
94	Plunge pool - *caldarium* 1, east.	Architectural	Surrounded by a curvilinear wall and a stair, ground is debris covered.	Loss of the superstructure.	
95	Baseboard - *caldarium* 1, *alveus* western wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	Appendix J

(cont. on next page)

Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
96	Baseboard - *caldarium* 2, southern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	 Appendix J
97	Baseboard - *caldarium* 2, northern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	
98	Baseboard - *caldarium* 2, eastern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	
99	Baseboard - *caldarium* 2, southern *alveus*, eastern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	
100	Baseboard - *caldarium* 2, southern *alveus*, western wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	Appendix J
101	Baseboard - *caldarium* 2, western *alveus*, southern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Deposit formation.	
102	Baseboard - *caldarium* 2, western *alveus*, western wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Deposit formation.	
103	Baseboard - *caldarium* 2, western *alveus*, northern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Deposit formation.	Appendix J
104	Baseboard - *caldarium* 2, northern *alveus*, western wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Deposit formation.	Appendix J

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Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
105	Baseboard - *caldarium* 2, northern *alveus*, eastern wall.	Architectural	Marble element (t: ~1.5) attached to the wall with mortar (t: ~5).	Loss of integrity, deposit formation.	Appendix J
106	Door - *caldarium* 1, east.	Architectural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7) + irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3).	Total loss of spanning element, no covering material on side wall, deposit formation.	 Appendix J
107	Door - *caldarium* 2, east.	Architectural	Brick (15 or 30x5x30) + lime mortar (t: ~4).	Total loss of spanning element, no covering material on side walls, deposit formation.	
108	Door - *caldarium* 3, south.	Architectural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7) + irregular sized rough cut stones (~43x19x12), brick lime mortar (t: 3).+ stone block.	Total loss of spanning element, no covering material on side walls, loss of integrity, deposit formation.	
109	Door - *caldarium* 3, north.	Architectural	Rubble stone (~16x6x25) + embedded in lime mortar (t: 6-7) + irregular sized rough cut stones (~43x19x12), lime mortar (t: 3).	Total loss of spanning element, loss of integrity, deposit formation.	
110	Marble inlay - *caldarium* 2, east.	Finishing	Marble floor covering attached with mortar.	Slight craks, deposit formation.	
111	Marble inlay - *caldarium* 2, southern *alveus*.	Finishing	Marble floor covering attached with mortar.	Partial loss, deposit formation.	
112	Marble inlay - *caldarium* 2, western *alveus*.	Finishing	Marble floor covering attached with mortar.	Deposit formation.	Appendix J

(cont. on next page)

Table 1.4 (cont.)

ID	Element Name	Element Type	Construction Technique	Failure and Deterioration	Graphic
113	Marble inlay - *caldarium* 2, northern *alveus*.	Finishing	Marble floor covering attached with mortar.	Deposit formation.	 Appendix J
114	Marble inlay - *caldarium* 3, south.	Finishing	Marble floor covering attached with mortar.	Partial loss, detachment of marble, deposit formation.	
115	Wood floor covering - *caldarium* 3, south.	Finishing	Wood panels brought together with a metal frame.	-	Appendix J
116	Debris - all floors of the bath excluding the original remains.	Finishing	Fragments of building elements, earth, plants.	-	Appendix J

APPENDIX P

TERMINOLOGY FOR ROMAN BUILDINGS

Alveus: (plural *alvei*) Bathing tub (Wiktionary, 2012 a).

Ambulacrum: (plural *Ambulacrums* or *Ambulacra*) A place for walking or promenade planted with trees (Wikipedia, 2012 a).

Apodyterium: (plural *apodyteriums* or *apodyteria*) The apartment at the entrance of the baths, or in the palaestra, for getting undressed (Wiktionary, 2012 b).

Auditorium: (plural *auditoriums* or *auditoria*) A large room for public meetings or performances (Wiktionary, 2012 c).

Balneator: Bath attendant (Wiktionary, 2012 d).

Balneum: (plural *balnea*) Bath (Wiktionary, 2012 e).

Basilica Thermarum: Exercise hall (Wikipedia, 2012 b).

Caldarium: (plural *caldaria*) A room containing warm water for bathing (Wiktionary, 2012 f).

Destrictorium: Room for massage with oil (Yegül, 1992).

Ephebos: Youth, adolescent (Wiktionary, 2012 g).

Exedra: (plural *exedra* or *exedrae*) A semicircular recess used for discussion (Wiktionary, 2012 h).

Frigidarium: (plural *frigidaria*) In Roman Baths; a room with a bath of cold water (Wiktionary, 2012 i).

Gymnasium: (*gymnasiums* or *gymnasia*) A large room or building for indoor sports (Wiktionary, 2012 j).

Heliocaminus: Solar furnace, roman architects added glass to windows to allow for the passage of light and to conserve interior heat as it could not escape (Wikipedia, 2012 c).

Hypocaust: (plural hypocausts) An under floor space or flue through which heat from a furnace passes to heat the floor of a room or a bath (Wiktionary, 2012 k).

Impluvium: (plural *impluviums* or *impluvia*) A low basin in the centre of a household atrium, into whivh rainwater flowed down from the roof through the compluvium (Wiktionary, 2012 l).

Kaisersaal: Ceremony hall richly decorated (Yegül, 1992).

Labrum: (plural *labra*) A large round basin of warm water, with an overhanging lip in a Roman Bath (Wiktionary, 2012 m).

Laconicum: (plural *laconica*) A hot dry sweating room, next to the *caldarium* in Roman Baths (Wiktionary, 2012 n).

Latrina: (plural *latrine*) a communal facility containing many toilets (Yegül, 1992).

Loutron: The cold water washroom of the Greek *Gymnasium* (Yegül, 1992).

Lavatrina: Mid Italy farm baths (Yegül, 2011).

Museion: Informal worshipping space (Yegül, 2011).

Natatio: Open or roofed unheated swimming pool (Yegül, 1992).

Neois: A Greek association of youths who, having completed their ephebic education and continued their gymnastic training (Yegül, 1992).

Opus Vittatum: Core made up of small rubble stones bonded with lime and facing in the irregular size of the rough cut stones and their approximate alignment (Adam, 2005).

Palaestra: (plural *palaestras* or palaestrae) An open public area with colonnaded porticoes in ancient Greece or Rome dedicated to the teaching or practice of wrestling and other sports (Yegül, 1992).

Peristyle: a coulumned porch or open colonnade in a building surrounding a court that may contain an internal garden (Wikipedia, 2012 d).

Pila: (plural *pilae*) Pillar, pier (Wiktionary, 2012 o).

Piscina: (plural *piscinae*) Swimming pool with drain (Wiktionary, 2012 p).

Portico: (plural *porticos* or *porticoes*) A porch or a small space with a roof supported by columns (Wiktionary, 2012 q).

Propylon: (plural *propylons* or *propyla*) The porch, vestibule or entrance of an edifice (Wiktionary, 2012 r).

Pozzolana: It is a siliceous or aluminous material which reacts with calcium hydroxide in the presence of water at room temperature (Wikipedia, 2012 e).

Sudatorium: (plural *sudatoria*) A hot room used to induce sweating (Wikipedia, 2012 f).

Suspensura: A suspended floor of a Roman Bath (Wikipedia, 2012 g).

Tepidarium: (plural *tepidariums* or *tepidaria*) A warm room in Roman Baths that was usually heated by a hypocaust (Wikipedia, 2012 h).

Thermae: (plural only) Springs or baths of warm or hot water (Wiktionary, 2012 s).

Tubulus: (plural *tubuli*) Small pipe or tube (Wiktionary, 2012 t).

APPENDIX R

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