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The Harbours of Carthage and a Graphic Reconstruction of 2nd Century A.D. Buildings at the Ilot de L'Amiraute

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THE HARBOURS OF CARTHAGE
AND A GRAPHIC RECONSTRUCTION OF 2ND CENTURY A.D. BUILDINGS
AT THE ILOT DE L'AMIRAUTE

BY

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THESIS

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I N D E X

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LIST OF ILLUSTRATIONS

P R E F A C E

The following thesis is a visual reconstruction of the 2nd century A.D. architectural concept of the Ilot de l'Amiraute as part of the Roman harbours at Carthage.

We recognise two principles by which the physical aspects of a village, town or city developed in antiquity. In the first, natural and topographical features are utilized and its development proceeds along or on top of such features. It is essentially Archaic. In the second, the concept of a planned town, city or harbour, with man made features, developed by man's rationale,is followed. It is essentially Hellenistic. This second principle is applied in some of the large independent harbour installations of the Roman Empire to which the re-building of the Roman harbours of Carthage belong.

Both concepts were present and made up the life of the ancient city of Carthage. It is for this reason that the historical review has been embodied in the study, mainly in chapters I and II. Chapter II also describes the evidence arrived at by archaeological field research on which the attempt of Roman reconstruction is based.

Excerpts of the important literary evidence describing Punic Carthage are collected and presented in Appendix 'A'.

The architectural reconstruction of the 2nd century A.D. buildings is graphically shown in figures 5 to 8. They

are based on field measurement of excavated material and field data published to date and applied calculations using principles and rules for the erection of public buildings as recommended by Vitruvius. They are summarized as excerpts and included as Appendices B, C and D, while a glossary of architectural terms used in the study has been incorporated under Appendix 'E'.

CHAPTER I

Historical Introduction

The westward movement of the Phoenicians began as early as the 11th century B.C. and represents the only successful expansion of peoples from the Near East into the western Mediterranean before the conquest of North Africa by the Arabs in the 7th century A.D. This expansion was aided by the relative economic and military weakness of the indigenous populations which were made up of small tribal groups who were living for the most part as semi-nomadic pastoralists. They had little mineral wealth and no large urban centres.

North Africa, that is, the area between the Mediterranean Sea and the Sahara, was in the 9th century B.C. a vast 'island' stretching from east to west whose population was cut off on all sides from the movements of peoples and the spread of technology and ideas. The Sahara formed an effective barrier in the south, preventing easy contact with the rest of Africa, and the Libyan Desert cut the area off from the Nile Valley.

It appears that for centuries the early Phonecians travelling westwards were traders rather than colonists. Their settlements were characterized by a small population and developed into colonial towns only in the 3rd and 4th centuries B.C. We can assume that with the exception of some

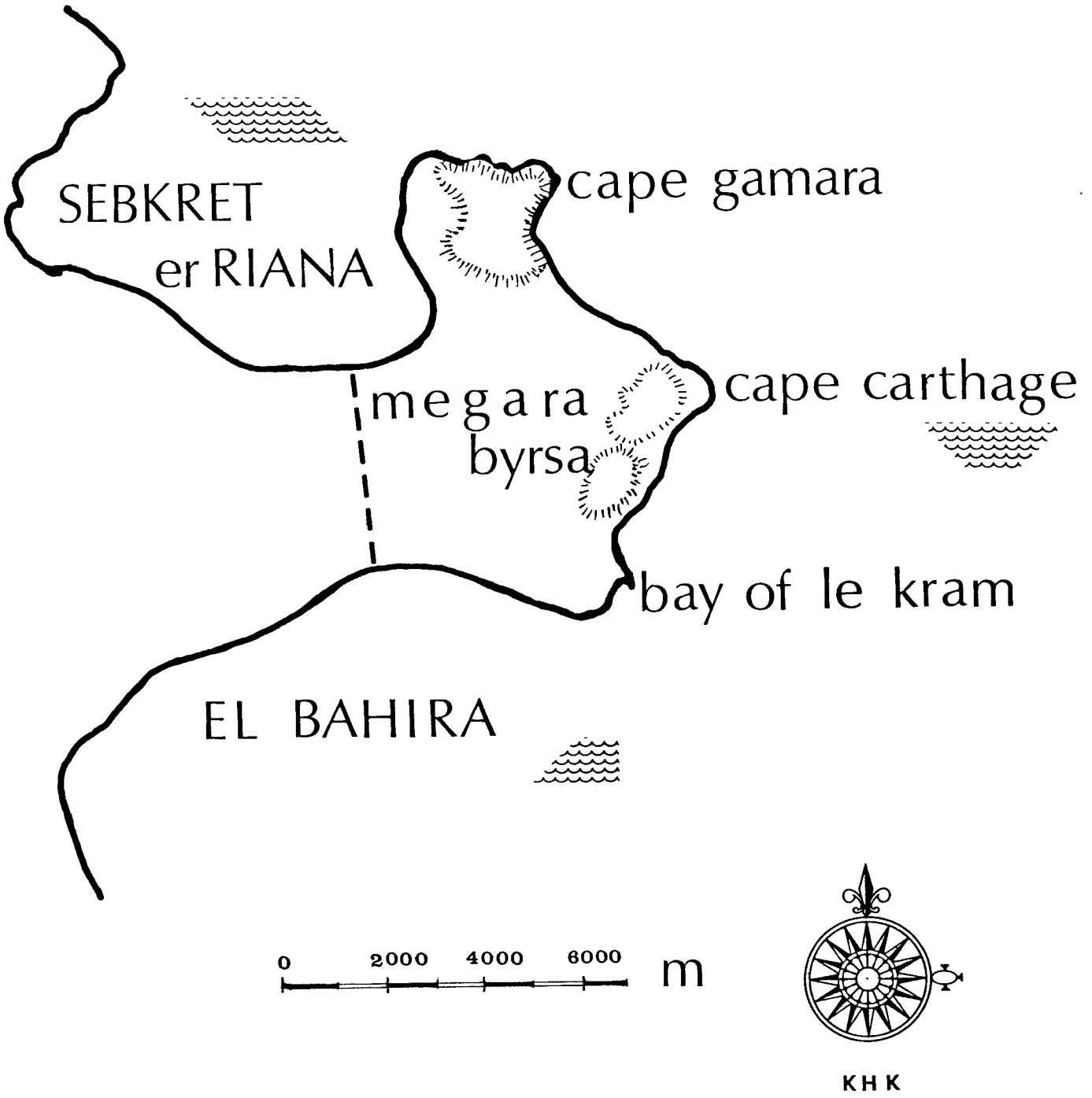

SEBKRET
er RIANA
cape gamara
megara
byrsa
cape carthage
bay of le kram
EL BAHIRA
0
2000
4000
6000
m
KHK

FIG.1

key sites, such as Carthage,[1] most of the early settlements around the western Mediterranean were small anchoring places in which ships could safely be tied up or beached after a days sailing. These sites were, therefore, chosen on the basis of being a suitable sailing distance one from the other. Preferred were off-shore islands or uninhabited peninsulas with sandy bays, forming a natural harbour where ships could be beached.

The selection of the site for Carthage followed this pattern. Located near the end of a peninsula, which in prehistoric times must have been an island, with 'Cape Carthage' projecting eastwards into the Mediterranean, the peninsula is joined to the mainland by an isthmus, 3 miles wide at the narrowest point. It is bordered on the south by El Bahira (Lake of Tunis) and in the north by the Sebkret er Riana.[2] The site was well situated to expand into the fertile lands of the interior and coastal areas. (Fig. 1)

The Founding of Carthage

According to Appian,[10] "a group of Tyrians led by Elissa, or Dido, the sister of Pygmalion (Pucm - yaton)[3] greatest of the kings of Tyre, set sail from their Phoenician homeland to found a 'new town' (Qart-hadsht)[3] near Utica."[4] The anglicised form of this name is Carthage. The traditional date of the founding of Carthage is given as 814 B.C.[5,8]

Indigenous people from whom Dido had purchased the plot were presumably settled in the area, but the type of settlement of pre-Punic Carthage is unknown. The earliest form of Phoenician settlement is also uncertain. Was it a colony founded on virgin territory from the beginning, or was it a trading post of some sort set into the midst of a pre-existing settlement? In any event, the existing natural harbour conditions have no doubt influenced the decision of settlement.

The first event of Carthage's history is recorded by Herodotus[8] as the seabattle of Alalia (Corsica) in 535 B.C. There the carthagenian fleet of 60 ships joined with an equal number of Etruscans to destroy the Phocaeans which had settled earlier in Corsica. From this period on, the city state of Carthage expanded and developed into the powerful empire of the 4th century B.C. which for 150 years controlled large territories surrounding the western Mediterranean, rivaling Rome.

The following description of Punic Carthage in the 2nd century B.C. is based on the material concerning the city provided by classical authors. (c.f. APPENDIX 'A')

The fortification walls of the Punic city were about 20 miles in total length. They were built of square stones, in triple rows on the landward side and in single rows against the sea. The citadel, in antiquity called Byrsa, was located towards the western side of the City, overlooking the entire

harbour and the lake. It was surrounded by houses of the city and had a circumference of about two miles. Standing on its summit was the temple of Eshmun. The walls of the citadel formed part of the city's fortification system. Also within its fortifications was Megara, a large area of cultivated agricultural land, and gardens, with escarpments overlooking the sea. The two main harbours were separated from the dominating citadel by the forum. The harbours lay near a tongue of land 300 feet wide, stretching westwards between the lake and the sea. The 70 ft. wide entrance to both harbours faced west. The outer harbour, rectangular in shape, served to accommodate the loading and unloading of the merchant vessels, while the inner harbour, circular in shape with an island in its centre, was reserved for the navy. Both harbours were connected, one with the other, but access to the city was from the north quays of the rectangular harbour only. Carthage was apparently surrounded by harbours, which provided other anchoring places.

From 264 B.C. to 146 B.C., Carthage and Rome fought three wars for the control of the territories surrounding the western Mediterranean. At almost every meeting of the Roman Senate, Cato the Elder was heard demanding that the power of Carthage must be broken and Carthage be destroyed.[6] Cato died in 149 B.C. at the age of 85, just as Rome started its final campaign against Carthage, which ended in the complete destruction of the city in 146 B.C. The campaign was headed by the grandson of the victorious Scipio, called Africanus,

P. Cornelius Scipio Aemilianus. He, in following the orders of the Senate, had all defensive structures, all buildings of the city and the harbours levelled to the ground, the site ceremoniously placed under a curse, and sown with salt.[7]

Twenty-four years later Rome changed its policy and the final gesture of 146 B.C. was reversed.

As part of the agrarian land reform planned under the Tribunal of Gaius Gracchus, a Roman colony was established on the territory of Carthage in 123 B.C. It was intended to give land to 6000 settlers and the colony was named COLONIA JUNO.[9] The settlers arrived. However, for political reasons beyond the Carthaginian Territory the status of the settlement as a colony was revoked in 122 B.C., but the settlers retained their assigned land.

Under Julius Caesar the plan of Graccus was resurrected and Mark Antony, as Consul, supported by an order of the Roman Senate implemented the establishment of the new colonial status settling 3000 landless Roman citizens, including a smaller number of vetrans. This Colony was named under Augustus COLONIA JULIA CARTHAGO,[10] and survived as the Capital of Roman Africa for 560 years. From the 1st Century A.D. on, the new Roman city of Carthage became a metropolis of the first rank, rivaling or surpassing Antioch and Alexandria.

NOTES FOR CHAPTER I

1 Other sites are Utica and Gades.

2 Harden, The Phoenicians, p. 28.

One difficulty has been that the Sebkret er-Riana on the north side of the Isthmus, now a land-locked bay owing to the deposition of silt by the River Bagradas (mod. Medjerda), was in Punic times open to the sea; while on the south the lake of Tunis (El-Bahira), though its shore line has remained more or less the same, has become shallower. Nowadays it will take little more than a rowing boat; formerly it would provide water for larger craft, and Punic ships could ride at anchor, both here and in the Sebkret er-Riana. (Gsell, II, p. 77, citing Appian and Polybius.)
Hubner, Carthago Nova in Pauly-Wissowa, Realencyclopedie der Classischen Altertumswissenschaft, p. 2152 (40-70).
The topographical transformation from an island to a peninsula is caused by three natural phenomena: the wind, the action of the sea and the silt carried by rivers. All three forces interplay in the formation of land masses. The peninsula of Carthage, particularly its north shore, received for millenia the products of erosion from the action of waves on the coast to the north, as well as the surface soil from the interior carried by the waters of the Bagradas. The Sebkret er-Riana was once the Gulf of Utica and Utica was a harbour city. Today the ruins of Utica are found to be located about ten miles inland.

3 This is the semitic form of the word.

4. Picard, G., C. & C, The Life and Death of Carthage, 1968:31.

5. Timaeus gives the date as 814 B.C.; Pompeus-Trogas gives it as 825 B.C.

The date of 814 B.C. is accepted by Albright, Cintas, Picard and Harden.

6. Stobart, J. C., The Grandeur that Was Rome, 1961:51

7. Picard, G., C. & C., Ibid , 1968:31

8. Herodotus, The Histories, Book I, Penguin Books, 1954:165

9 Hubner, op. cit., p. 2162.

Coins from the period of Augustus and circulated in Africa were inscribed with CIC, standing for COLONIA JULIA CARTHAGO.

Inscriptions from the middle of the 1st century A.D. (the reign of Tiberius) show the letters CCIC, standing for COLONIA CONCORDIA JULIA CARTHAGO.

10 Appian's Roman History, Book VIII, pp. 569-645.

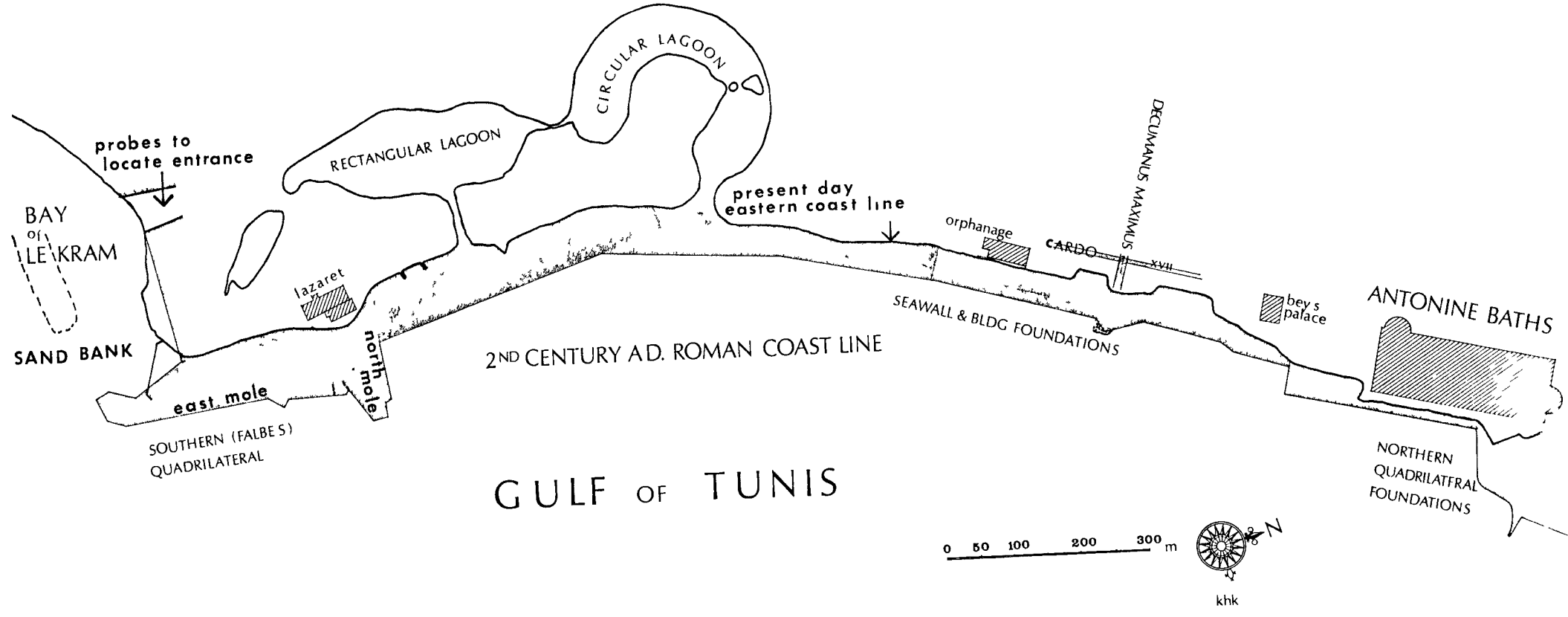

CIRCULAR LAGOON
RECTANGULAR LAGOON
probes to locate entrance
BAY of LE KRAM
SAND BANK
lazaret
north mole
east mole
SOUTHERN (FALBES) QUADRILATERAL
present day eastern coast line
2ND CENTURY A.D. ROMAN COAST LINE
orphanage
CARDO
DECUMANUS MAXIMUS
XVII
SEAWALL & BLDG FOUNDATIONS
bey's palace
ANTONINE BATHS
NORTHERN QUADRILATERAL FOUNDATIONS
GULF OF TUNIS
0 50 100 200 300 m
N
khk

FIG. 2

CHAPTER II

A Survey of the Archeological Evidence Excavated by Current and Previous Expeditions

Most of the coastal and harbour features of the ancient Punic city as well as a large section of the later Roman city are to be found within the confines of Salammbo,[2] a modern suburb of present day Carthage. It is a built up section of private homes and villas. Evidences of the former Roman presence are visible in some of the modern villas in the form of building blocks and decorative fragments, i.e. columns and capitals which have been taken from the old Roman structures and reused to enhance the appearance of buildings and grounds.

Three groups of ancient buildings and harbour remains dominate the coastal area. (Fig. 2)

A. The building blocks and foundation remains of what is known as 'Falbe's Quadrilateral'.

B. Off-shore foundations north of 'Falbe's Quadrilateral' extending along the coast to the Antonine Bath and below the Bordj Djedid.

C. Two inland lagoons located parallel to the eastern coast-line.[2]

Falbe's Quadrilateral

Falbe's Quadrilateral is the name given to the largest and most southerly complex on the eastern shoreline. It is made up of four elements: 1) the north mole, 2) the east mole, 3) the south mole, and 4) foundation compartments.

The first three elements are constructed of massive rough-hewn blocks up to 2.00 m long, which would have been lowered into shallow water and built up in a way consistent with the method of mole construction as described by Vitruvius.[3]

The north mole projects at right angles proceeding from the present eastern shore line. At a distance of 100 m east it meets the east mole and continues from there for another 50 m extending into the sea.

On the western end, coursed blocks aligned on either side and joined by tying courses are the evidence for the existence of a paved road extending along the total length of the mole.[4] The road was protected on both sides by rough hewn blocks, built up above the surface level of the road. At its forward east end the mole widens to approximately 35 m, suggesting the existence of a building structure to which the road was leading.[5]

The northern end of the east mole is separated by a distance of 13.00 m from the north mole, which has caused

York and Little to put forward the idea that this was the location of an east entrance into the man-made harbours.[6] The east mole extends approximately 360 m to the south and has an average width of 25 m. At the south end the width increases to approximately 35 m.[7]

From the south two clearly identifiable rows of blocks can be seen. These are separated from one another by a distance of 32.5 m from outer face to outer face. It is postulated that they are the outer walls of the south mole forming the connection between the south end of the east mole and the shoreline.

A series of compartment foundations, bordered on one side by a 90 m long concrete wall extends in a northeasterly direction into the quadrilateral. The wall is faced with fine coursed masonry and is fronted by a platform 2.50 m wide. The remains of five short walls project at 90 degrees from the concrete wall. They are placed at regular intervals of 5 to 6 m from centre to centre. Similar foundation structures, belonging to off-shore foundations, are located outside the Bourgiba Orphanage, the former Bey Ismail Palace. They are interpreted as being foundation vaults belonging to 2nd or 3rd century warehouses or stores.[8]

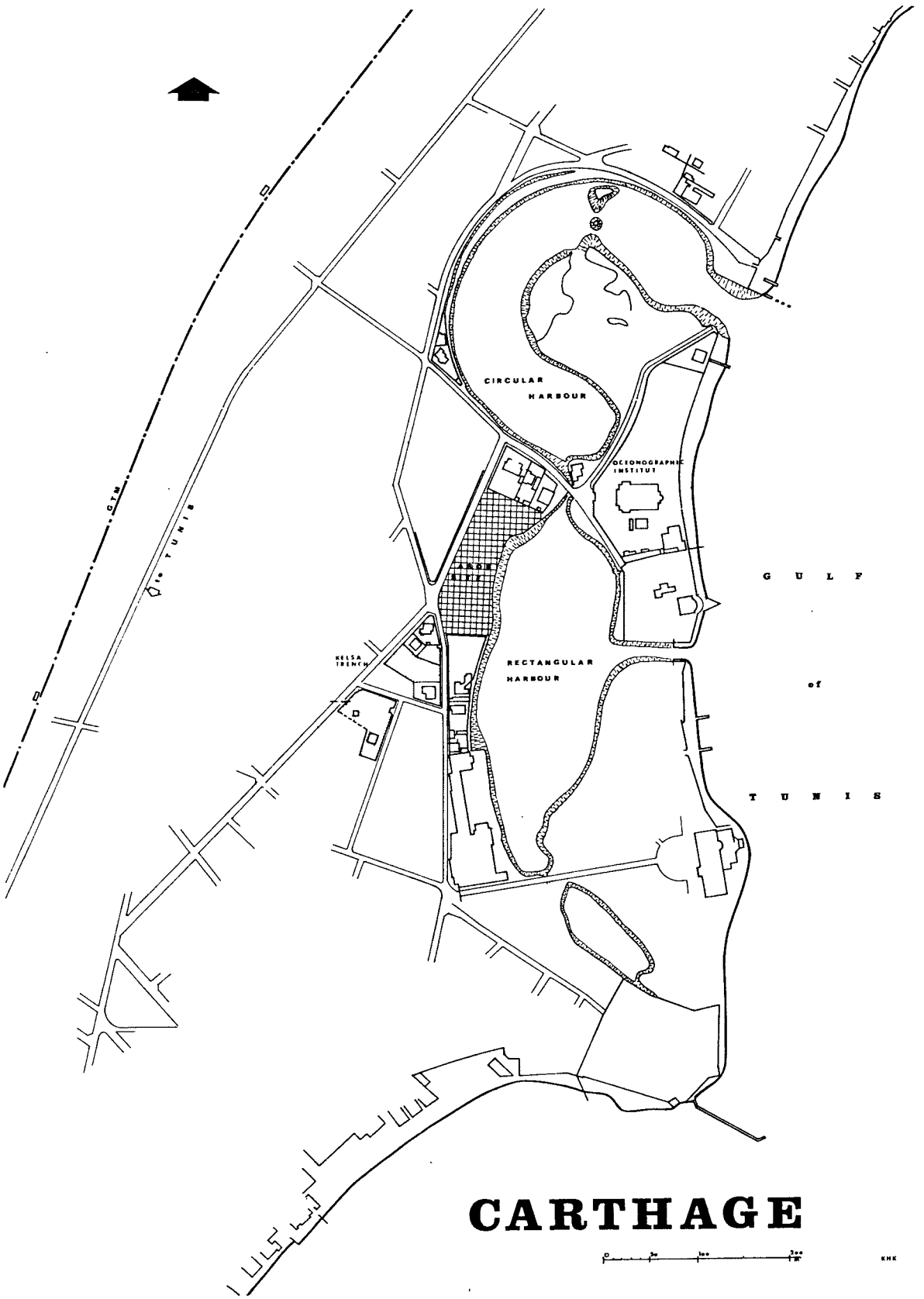

CIRCULAR
HARBOUR
OCEANOGRAPHIC
INSTITUT
LARGE
BASIN
KOTSA
TRENCH
RECTANGULAR
HARBOUR
G U L F
of
T U N I S
CARTHAGE

FIG. 3

Off-Shore Seawall and Building Foundations North of Falbe's Quadrilateral

These foundations have been interpreted as belonging to a vaulted promenade, which appears to have been raised to 5.00 m above sea level and was aligned with the Roman street grid between Cardo XlX and XX east (c.f. fig. 3).[9]

Two groups of foundations are described in detail:

The first is located in front of the Bourgiba Orphanage and consists of a rear concrete wall which is 1.50 m wide and extends 200 m along the shoreline. From it, walls project at right angles. They are 0.80 m wide and extend outwards for 5.00 m forming a series of single compartments facing onto a 12.00 m wide paved road. On the seaward side of the road remains of a double lined, coffered sea wall protecting the road and the building are visible. The projecting walls on the land side are spaced at regular intervals and form sections of foundation vaults which could serve to support warehouses or shops.[10] Saumage dates these structures as belonging to the 2nd century A.D.[11] The regularity of the plan and the similarity of the building materials and methods to those used at the Antonine bath suggest that they are contemporary with the bath, i.e. A.D. 142-161.

The second group of building remains is located in front of the Antonine baths, extending for approximately

200 m along the shore. The submerged visible construction remains display direct similarities to those in front of the Orphanage and the north mole of Falbe's Quadrilateral. Coursed blocks extend in a straight row for about 130 m. Parallel to the blocks and at a distance of about 8.0 m from them, remains of an embankment of massive rough blocks are visible. The embankment takes a turn of 90 degrees to the west and ends at the shoreline, forming a large rectangular area immediately south of the Antonine baths.

Related to the above described group of foundation structures, north of the Orphanage, a massive concrete foundation projects about 40 m east of the general building line of the 2nd century A.D. promenade. The heavy foundations are interpreted in the context of current excavations as representing the core of a massive pier, projecting into the sea. The pier is alligned with the seaward end of the Decumanus Maximus.[12]

Two Inland Lagoons (Fig. 3)

The two lagoons, one circular and the other rectangular in shape, are set into an area of flat coastland. A 12 m high man-made hill (Koudiat el Hobsia) is located 300 m west of the rectangular lagoon.[13] The entire area has been extensively surveyed since 1833 and the lagoons confirmed as the site of the ancient Punic harbour.

There are a number of factors suggesting a location for the entrance to the island lagoons on the south shore, i.e. from the Bay of Le Kram.

The first is the contouring of the land as it slopes to form a natural bowl at this location.

Secondly, the south shore is parallel to the narrow end of the rectangular lagoon. A third factor is based on the soundness of the navigational principle of entering a harbour perpendicular to the strong prevailing easterly winds.

Current excavations are searching for evidence of the harbour entrance at the Bay of Le Kram by conducting core drillings on the shore and the sea bed in this location. Hopefully, the results will be forthcoming soon.

Based on the literary description by Appian, Cintas and Courted have developed two different theories for the placement of the harbour entrances.

Courted places the entrance to the "exterior" harbour at the east shore, north of Falbe's quadrilateral.[14]

Cintas believes that the entrance was from the south, the Bay of Le Kram, but its accessibility was from the west, secured by extensive breakwater and pier construction. In

1974, York and Little conducted a hydrographic survey in the area which failed to produce evidence of construction remains to support either one of the theories put forward by Cintas or Courted.[15]

It is to be noted that the water level along the coast and in the lagoons has changed since the 2nd century A.D. The water level in the lagoons currently ranges between 0.45 m and 1.00 m. Core drill samples, taken in 1975, confirm a 1.00 to 1.25 m change in the sea level from the period just mentioned.[16] Bedrock, exposed by the current excavations of the circular harbour, is reached at 0.50 m below the 1974 sea level, while in the rectangular harbour it is recorded as being 2.60 m below the present day sea level.

Excavation probes at the circular harbour in the 1977 season have produced flat stone paving fragments bedded in fine silt packed gravel at a depth of + or - 1.50 m below the ancient sea level. From this evidence it is conjectured that the floor of at least the circular harbour basin was at one time paved.[20]

The harbour of Carthage can be considered the first large scale man-made harbour of the Mediterranean, its construction coinciding in time, or even preceding, that of the large harbour built by the older Dionysios of Syracuse.[17] It appears that the artificially created harbour was built into

the security system of the walled city. It was probably constructed in phases, phase one referring to the first archaic harbour in the Bay of Le Kram, an outer harbour in which the ships were anchored in the open sea. Large piers and breakwaters date from this period and were extended in the 4th century B.C. to include the Choma,[18] i.e. Falbe's Quadrilateral In the 3rd century B.C., the rectangular man-made basin was added as phase two. Phase three refers to a later period in the 3rd century B.C. when the harbour was extended by the addition of the circular basin, which completed the hellenistic harbour installation as described by Appian.

Why was the harbour constructed? At the time of the 1st Punic war (264 B.C.) the number of ships, quoted at 350, included many small boats and merchant vessels.[19] The combined facilities of the Bay of Le Kram with its shore length of approximately 1,000 m and the rectangular basin, providing mooring quays for a length of 900-1,000 m were large enough to accommodate the number (350) quoted. After the first Punic war, the size of the Carthaginian navy and, therefore, the number of warships decreased in favour of an increase in the numbers of ships for the merchant fleet. This might very possibly have stimulated the construction of a new man-made military harbour basin, i.e. the circular basin, thereby permitting the rectangular basin to be used entirely for merchant and trading vessels. The new circular military harbour was able to accommodate 220 shipsheds together with navy related facilities.[21]

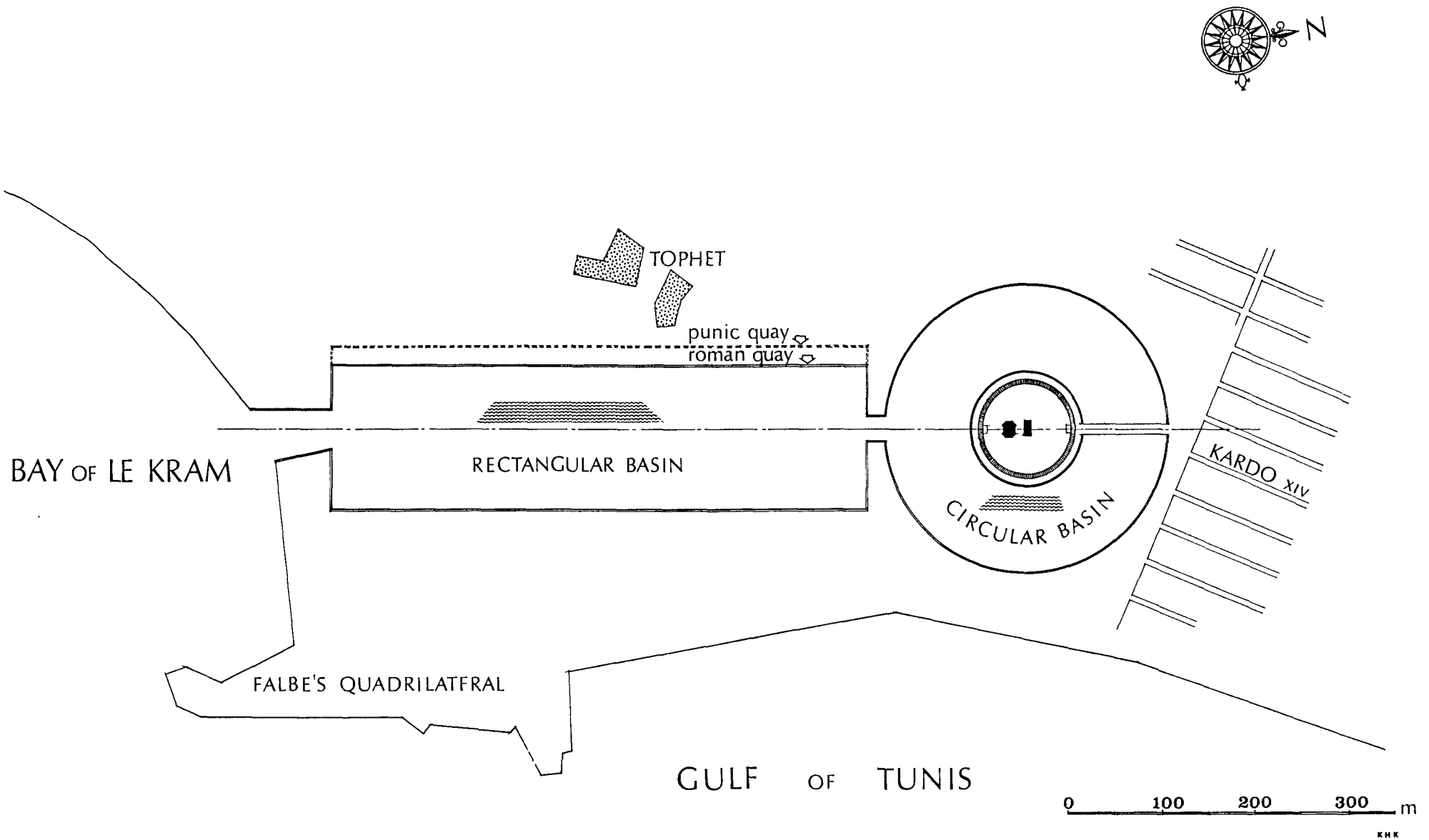

N
TOPHET
punic quay
roman quay
BAY OF LE KRAM
RECTANGULAR BASIN
CIRCULAR BASIN
KARDO XIV
FALBE'S QUADRILATFRAL
GULF OF TUNIS
0 100 200 300 m
KHK

FIG. 4

The overall plan of the harbour was based on an abstract, geometric concept of symmetry, developed along a north-south axis. (Fig. 4)

Both harbour basins are estimated to have covered an area of approximately 170,000 square m.[22] Current excavations have established the circular harbour basin (including the island in the centre) as having an area of 70,000 square m. From this we can deduce the area occupied by the rectangular basin as being 100,000 square m. Since the width of the rectangular basin in the life of the Punic city has been verified at 160 m (current excavation) the length can be calculated as being 620 m.[23]

Systematic excavations to locate the southern and eastern limits of the rectangular basin are currently in process, but the Punic quay walls on its western side have been located 70.0 m from the main N/S harbour axis and traces of the wall have been uncovered separating it from the Roman wall by a distance of approximately 16 m and running parallel to it. (cf. fig. 4)

The Roman wall is constructed of large ashlar blocks of 'Cape Bone' sandstone with no visible traces of mortar joints. Its construction could have proceeded following the double coffer-dam technique described in detail by Vitruvius.[24] (cf. APPENDIX 'D')

The Circular Harbour Basin

The southern tangent of the circular basin is located 20.0 m to the north of the rectangular harbour. The basin has a diameter of 300 m and is centred on the north-south axis of the rectangular basin extending to the north. A circular island, 120 m in diameter, is placed in a position concentric with the circular basin. A circular waterchannel, 90 m wide, surrounding the island was thus created. To connect the island with the landside quay, a 12 m wide causeway was constructed to the north of the island. This was centred on the north-south axis of the harbour plan.

Three periods of prime occupation have been established on the island and confirmed by stratigraphic analysis; an early Punic period, a later Punic period and a Roman period.[25]

The early Punic period is represented at the centre of the island by a series of parallel trenches extending in an east-westerly direction and are spaced at 6.40 m from centre to centre. The trenches are 0.40 to 0.50 m wide, 0.30 m deep and are sand filled. They are cut by a series of round postholes, also sand filled and spaced 1.20 - 1.30 m on centre. Hurst interpreted trenches and postholes as belonging to the 4th century B.C. timber version of the Punic ship sheds built on the island.[26]

The later Punic period can be clearly identified by two aspects of a single complex of buildings: a) a substantial building in the centre of the complex, and b) repetitive rows of blocks abutting the central structure and projecting out from it.

a) The central structure has the shape of a truncated rhomboid with a longitudinal axis of 38.50 m and a width of 17.50 m at its centre and 10 m at each truncated end. Its walls are represented by 90 cm wide loam and rubble-filled foundation trenches cut into bedrock, but robbed of the building stones which they once contained.[27]

A cistern base is located 5.20 m south of the building, its position and alignment suggesting it to be contemporary with the building. Its construction on an opus signinum mortar base with clay stone walls relates to two traces of similar opus signinum located within the confines of the building, and can be paralleled in later punic context.

Possible indications of the building's superstructure come from a layer containing fragments of white stucco-faced limestone, large blocks of stone, 60 x 50 x 40 cm in size and fragments of fluted columns and mouldings.

Appian has described the existence of a central building as the admiral's quarters, which according to his description,

must have been multi-storeyed, with the top storey above the height of the ship sheds to permit a broad overview of the harbours, the city and the open sea to the east.[28]

b) From an imaginary line running in a north-south direction, more or less parallel to the main axis of the central structure and in line with the outer face of the west wall, 16 rows of blocks project outwards in a herringbone formation. The rows are not completely parallel, as the angles of projection towards the east and the west vary from 90 degrees at the centre row to 82 degrees at the southern end and 88 degrees on the north. Rows 2 to 15 are made up of individual blocks, while rows 1 and 16 are assumed to represent walls. A total of 48 blocks have been located in situ. They vary in size from an average of 1.00 m to 1.50 m in plan with a depth of 0.75 m. The distance of the rows, from centre to centre, varies from 5.90 m to 6.00 m. The blocks are course shelley limestone from the El Haouria quarries at Cape Bone.[29] In all but the outside two rows, they are regularly spaced at 2.90 m from centre to centre. The blocks are set into individual foundation pits and rest on bedrock. Some of them have dowel holes cut into the upper surface, indicating further courses. Surface levels of the foundation stones vary, reflecting the variations in the bedrock surface.[30]

The blocks have been identified as foundations for individual column bases,[31] supporting colonnaded ship sheds similar to those excavated in Piraeus and Oeniadae. The

ship sheds were probably placed more or less symmetrically on either side of the central axis in such a way that they abutted the central building, and are equally spaced one from the other.[32] Rows one and sixteen represent the outer walls of the first and the 28th ship shed. The length of the sheds appears to have been between 42 and 45 m. At the northern end of the island, beginning about 2.00 m south of the sixteenth row, traces of blockwall 11.00 m long can be seen. The western face of this wall is located along the north-south axis of the island and forms the 'spine' separating the herringbone patterned foundation blocks into easterly and westerly direction and in this way dividing the eastern from the western rows of ship sheds.[33]

The Roman period foundations of two buildings built successively one on top of the other, were found at the centre of the island. Both buildings have been identified as temples.[34] A third building, dating from the same period, was excavated adjacent to the temple foundations.

The first temple has an overall measurement of 12.6 m x 28.3 m. No traces of its walls have been found, but foundation trenches, in which uncut stones have been set into compacted sand, exist. This temple is assumed to be of Punic origin.

The second temple was a smaller building, located well within the perimeter of the foundations of the earlier building. Its remains show three chambers with a podium size of 7.25 m x 13.20 m and adjoining footings to the east of 7.25 m x 2.20 m. The floor level has been established at 2.80 m above sea level.[37] Based on related pottery dating, a 2nd century or later date has been ascribed to the building.[35]

The third building has a 2.00 m wide rubble foundation, octagonal in plan, with a circular inner face. The external sides of the octagon are 5.25 m long and the diameter of the inner circle is 8.30 m. The foundations are set into bedrock and their massiveness indicate that they were designed to carry a considerable load.[36]

The octagonal core foundations are flanked on the east and west at a distance of 1.40 m x 0.60 m wide foundation trenches. The trenches were severely robbed, but the walls which they contained were of similar mortar and rubble construction as the core. The easterly trench runs parallel to the three most easterly sides of the octagon, with the westerly trench corresponding in a similar way to the octagon's westerly sides. Parts of both trenches have been destroyed by earlier excavations.

Five drum fragments of at least three columns of Numidian (Chemtou) marble were found either on or near the

octagonal foundation remains.[37] The diameter of the columns measures 0.90 m, tapering to 0.75 m and are, therefore, too large to belong to the foundations of the second temple.

A sunken feature with steps leading down to it was added later to the exterior face of the flanking foundation trenches on the westerly side. It has an overall width of 3.75 m at its north end and appears to have extended along at least two sides of the flanking walls. When found, the steps led down to a compacted earth surface, formed by an earlier stratification, on which a floor of stone or marble slabs might have been set. Above the steps there was a thick, apparently undisturbed deposit of building rubble. This contained fragments of architectural moulding, veneer or slab fragments of Cipollino, Prokonnesian, Numidian, and Cape du Gard marble, imbrux and tegula fragments, as well as lumps of sherd filled mortar, which had probably been used as a setting for the marble slabs. An arm of an unfinished life-sized statue of Pentelic marble and a fragment of drapery folds belonging to a statue of Phrygian marble were also found in the layer, together with coins and lamps of the fourth century A.D.[38] All occupational layers associated with the octagonal building have been destroyed by earlier excavations, leaving only the rubble. However, since the method of construction and the composition of the mortar used for the octagon was similar to that of the second temple and as the alignment of both buildings was the same, it seems likely that they were contemporary, or that the octagon was

built slightly later than the temple.

The foundations of the second temple and the octagonal building are centred on the north-south axis of the harbour layout, south of the east-west axis of the island. They are in line with the entrance channel of the rectangular basin, an advantageous position for a lighthouse or signal tower to guide ships through the entrance of both harbour basins.

The Rectangular Basin

Remains uncovered by current excavations on the west side of the harbour basin are of early and late Roman origin.[39] They consist of:

1) A Roman quay wall on the west side of the basin, running in a north-south direction;
2) Footings and foundations belonging to a colonnade, which is parallel to the quay wall;
3) A flagstone paved 'plaza' which faces on the western front of the colonnaded structure;
4) Foundation vaults of a multi-storeyed vaulted building fronting on and forming the western limit of the paved plaza.

1) The Roman quay wall has been traced and excavated for 50 m. It is a massive structure measuring 3.5 m high and consisting of large ashlar blocks of Cape Bone sandstone, 7 courses in height. The bottom course rests on a virgin sandbed 2.60 m below the present sea level. The lower courses have been protected from the damaging effects of the weather and are, therefore, well preserved, while the fourth course shows signs of extensive weathering and abuse. This evidence would seem to indicate that the lower three courses were consistently below sea level, while the 4th course was under water only at certain times and that the depth of the basin at the wall was 1.50 - 1.80 m. The depth of the water here was evidently comparable to that in other man-made harbour basins around the Mediterranean.[40]

2) Evidence of a colonnade running in a north-south direction, facing the harbour and fronting onto the paved plaza, consists of footings for a continuous rear wall and individual footings for the support of the columns making up the colonnade. From the footings, the columns can be calculated to have had a diameter of 0.50 - 0.60 m. The columns supported a roof that was probably mono-pitched, the pitch sloping towards the west, as evidenced by a continuous open trough, running north-south, which would have served to collect the water run-off from the roof. The trough also served to collect water from the individual storm drains, which ran in an east-west direction, beneath the flagstone paved plaza.

3) The remains of the flagstone paved plaza indicate that the plaza extended between the front faces of the warehouse (the multi-storeyed vaulted building) on the west side and the colonnade on the east. It is evident from the wear pattern and the ruts on the surface of the pavings stones, that they were worn down by the hauling of heavy loads from the docks of the harbour.

4) The west side of the plaza was bordered by a large multi-storeyed building, probably housing warehouses or stores. The subterranean foundation vaults of the building have been excavated, and the bases of the vaults located 5.00 m apart, from centre base to centre base. The building supported by the vaults has a depth of 28.0 m.

The Roman harbour buildings described above have been identified as belonging to the late 4th century A.D.[41] Their foundations were placed over an earlier 2nd century harbour, which was in turn built on the remains of the original Punic harbour.

NOTES FOR CHAPTER II

1 HISTORY OF EXCAVATIONS AT THE HARBOURS

	Campaign of Excavations
Falbe's, Plan Recherches sur l'emplacement de Carthage	Paris, 1833
Dureau de la Malle Researches sur la topography de Carthage	Paris, 1835
Beule, M. (Paris 1861) Fouilles a Carthage	1859
Merlin, Bulletin Archeologique du Comite (1909) pp. 51-53 and pl.VI	1909-1913
Carton, Documents pour Servir a l'Etude des Ports et de l'Enceinte de la Carthage Punic. Reprint - Revue Tunesienne, Vols. IXXXVIII-XCVI	Paris, 1913
De Roquefeuil for underwater evidence, Comptes Rendus de l'Academie des Inscriptions pp. 20-39, 653-666	1898-1899
J. Baradez (Aerial Survey), Karthago, IX, pp.45 ff.	1958
H. Hurst, Antiquaries Journal 55:11-40	1974, Current
L. Stager, World Archaeology 1977- 8	1975, Current

2 The words harbour, commercial harbour, naval harbour, rectangular basin, circular basin and cothon are all used to identify the two lagoons located at Salammbo. The word 'basin' will refer specifically to the man-made circular and rectangular harbour construction.

3 Vitruvius, The Ten Books on Architecture, translated by Morris Hicky Morgan (New York: Dover Publications Inc., 1960) pp. 162-164, see Appendix D.

(Referred to simply as Vitruvius.)

4 R. A. York and J. H. Little, 'Off-shore Survey at Carthage, Tunisia 1973', International Journal of Nautical Archeology and Underwater Exploration, IV, 1 (1975) p. 96.

5 This is perhaps the location of an early signal tower.

6 York and Little, op. cit., p. 96 are suggesting this to be the possible location of an east entrance at the north end of the east mole.

7 This would be a functional location for a lighthouse.

8 York and Little, op. cit., p.88

S. Gsell, Histoire ancienne de l'Afrique du Nord, II (1920) p. 48, has interpreted Falbe's Quadrilateral as being either a wide quay or a choma (c.f. footnote 21). He believes it to be a wide quay.

J. Baradez, Nouvelles Recherches sur les ports antiques de Carthage, 45:78 (1958), postulates that the quadrilateral mole enclosed an outer 3rd harbour which protected the entrance to the rectangular harbour basin. Based on evidence of the difference between the sea level in antiquity (1.20 - 1.50 m lower in antiquity) and the current depth of the quadrilateral, the conclusion must be reached that the quadrilateral lay above the sea level, thereby disproving the existence of an outer harbour in this location. It seems to indicate that the quadrilateral was itself an elevated platform, with the choma (c.f. note 23), as described by Appian, between the seaward side of the rectangular harbour and the sea. It is quite conceivable that warehouse buildings also stood on the platform. The only evidence for this, however, are the foundation vaults described with reference to the compartment foundations on the harbour side of the quadrilateral.

9 York and Little, Off-shore Survey at Carthage, 1973. p.88

The same features also appear on Rochefeuil's map of the soundings. D. Roquefeuil, Comptes Rendus de l' Academie des Inscriptions (1898), pp. 20-39.

Aerial photographs show the coastal structures.

10 Similar to excavated foundation vaults at the west quay of the rectangular basin. Stager, A.I.A. Archeology, Vol. 30:3.

11 Saumagne, (1960) Le 'Lungomare' de la Carthage Romaine, p. 166.

12 A 4th century B.C. mosaic, now at the Bardo Museum (Salla des Mosaiques: Inventory No. 2772) has its main feature a triumphal arch standing in front of a porticoed marine prominade. The museum's catalogue describes the feature as a pictorial representation of 4th century Roman Carthage.

York and Little, op. cit., p. 93.

13 The hill seems to have been made of the material excavated in the construction of the basins.

14 C. R. Courted, Notes sur les constructions en mer voisines des ports de Carthage, Vol. 25, pp. 125-131.

This suggestion is based on the assumption that the cothons were too small to serve the volume of trade in which such a flourishing maritime city would be engaged.

15 Roquefeuil, H de, Recherches sur les ports de Carthage, CRAI, 4th S, 26, 1898:20-39.
Hantz, Notes sur les recherches sous-marines aux alentours de Carthage, CRAI, 4th S., 28, 1900: 53-78
York and Little, op. cit., pp. 94-95
Examination of the sea bed using divers and echo sounders found no evidence supporting any harbour construction.

16 Core drill samples were taken under the direction of Dr. R. Bullard and the American Schools of Oriental Research in 1975.

17 The date for the harbour construction given by the older Dionysios of Syracuse in 399 B.C. is 399 B.C. (Diodorus of Sicily, Book XIV, 42).

18. The word choma (a bank or mound of earth) in one of its meanings signifies a mole or pier (cf. L. moles). It is different from an ordinary pier as explained by Lehman-Hartleben,"Die Antiken Hafenanlagen des Mittelmeers", pp. 30 and 138.

19 Meltzer, O., Geschichte der Karthager, Vol. III, pp. 11-40. Berlin, 1913.

20 Excavations at the entrance channel to the smaller rectangular island basin at MOTYA, which was excavated by Whiteker in the 1920's, produced similar evidence of ashlar pavers set into the bottom floor. At the middle of the entrance the pavers were fitted with wide grooves, seemingly to accommodate ships' keels. The Motya basin was dated at the time to the late 6th century B.C.

21 Appian's Roman History, 96, p. 567.

22 Bartoccini, Il Porto Romano Di Leptis Magna, p. 19

compared the size of the Carthaginian harbour with that of the harbour at Leptis Magna, which was to have been 3/5 of the Carthaginian harbour size. As the Leptis Magna harbour covered an area of 102,000 square m, its Carthaginian counterpart must have had an area of approximately 170,000 square m.

23 Falbe's original plan, York and Little, op.cit., p.87 shows a rectangular basin, 200 m wide and 500 m long, and places the ancient shoreline 675 m south of the east-west axis of the circular harbour basin.

Cintas, le port de Carthage.

Fig. 10, p. 24, locates the ancient shoreline at about 640 m from the circular harbour's east-west axis.

York and Little's survey, op.cit., p.86, Fig. 1, locates it at 740 m from the east-west axis.

The size of the present rectangular lagoon is 320 m x 120 m. The present 2 entrances from the east into the harbour basins are of modern construction, designed to permit the entry of fresh water into the shallow lagoons.

24 Vitruvius, Book V, Chapter 12, pp. 5 & 6 (c.f. Appendix 'D').

25 These periods have been confirmed by stratagraphic analysis made by H. Hurst, The Antiquaries Journal, 55, p. 17.

26 Ibid.

27 4th century B.C. southern Italian black glazed sherds found in one of the trenches antedate the buildings. In the west wall foundation trench, traces of 'pavimentum punicum' floor, consisting of mortar with tesserae of white marble and tessellated pavement made of amphora sherds were found, together with the building rubble, a large find of late Punic pottery and sherds of southern Italian import and sherds of 1st century B.C. eastern terra sigillata.

28 Appian, 96, p. 567

29 Ruben, Bullard, op.cit., p.19

30 Hurst, H., Excavations at Carthage 1974, p.19.

The foundation blocks have been dated by H. Hurst as belonging to the late 5th or early 4th centuries B.C., based on black glazed attic vase fragments found in the same strata of archaeological excavation.

Beulè, M., Fouilles a Carthage (Paris, 1861) p.108

has described some of the same foundation blocks, found on the side of the circular harbour towards the land. They were set in rows perpendicular to the perimeter of the circular basin, at a distance of 5.80 m to 5.90 m apart from centre of the row to centre. They were clearly distinguishable from later Roman structures. Beule associates the blocks with shipsheds of the Punic arsenal.

31 Hurst, H., Excavations at Carthage, 1974. p. 19

has located fragments of fluted white stucco columns in robbed out trenches and destruction levels related to the latest Punic period. From those fragments, column shafts of about 50 cm in diameter can be reconstructed.

Beulè, M., Fouilles a Carthage (Paris, 1861) p.p.108 & 109

reported a column find of engaged columns, also fluted and of white stucco. From these fragments, a column diameter of 47 cm was constructed. One column find was located on the island and the other below the Roman quay wall on the landside of the harbour.

32 Hurst and Stager, A Metropolitan Landscape, p.13.

Excavations in the 1975 season appear to have located evidence of the earth and timber slipways, which rise from the water's edge toward the centre of the island to an artificially built up height of approximately 2.50 m. The presumed floor level is 3.60 m above the current sea level, or 4.80-5.00 m above the sea level in antiquity, based on evidence provided by the relationship of the cistern foundations to the floor of the central building.

33 Report of probes taken near the edge of the island (1977) remains unpublished material. The length of the shipsheds and the rock - cut shipways can, therefore, only be approximated.

34 Hurst, H., The Antiquaries Journal, (1975) p.p. 22,25. York and Little's survey of the area shows a differential of up to 1.50 m between the 2nd century A.D. and the current sea level. p.91.

35 Hurst, H., op. cit., p. 27.

36 Ibid., p. 27.

37 Ibid., p. 27.

Beule's plan suggests that the largest of tne column fragments was found close to its present position.

38 Hurst, H., The Antiquities Journal, 1974:27.

39 Reports on the excavations of the west side of the harbour basin conducted by the ASOR team in three successive seasons (1975-1977) have been published only in part. Tne following descriptions of the excavated finds are based on the measurements and observations made by the author and on a preliminary excavation report by L. E. Staeger, 'Carthage 1977: The Punic and Roman Harbors', Archaeology, Vol. 30, no. 13, pp. 198-200.

40 The depth of the basin at the cothon at Motya is measured as being 1.50 m.
Isserlin, B. S. J., 'New Light on the cothon at Motya', Antiquity, XLV, 1971:178 ff.

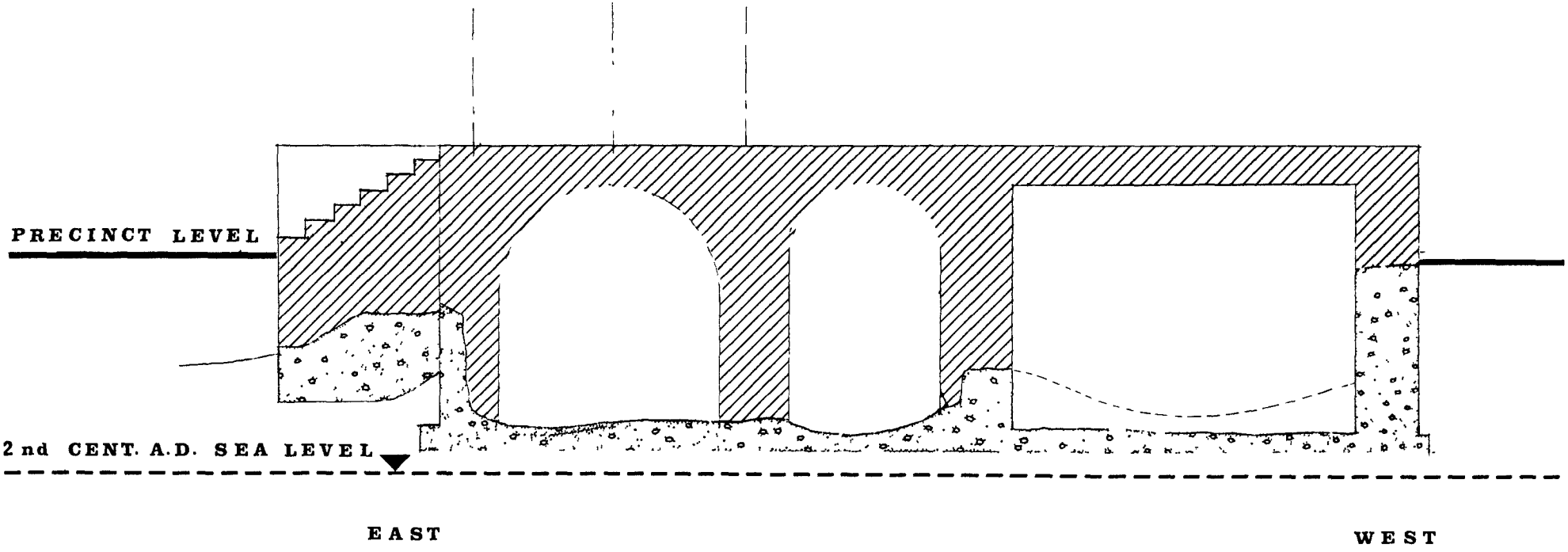
41. Staeger, L. E., op. cit. (note 38), p. 198.

CHAPTER III

Graphic Reconstruction of 2nd Century A.D. Buildings

The proposed graphic reconstruction of the three major conjectured buildings and the circular island (Ilot de l'amiraute) is based on the following evidences and premises:

1. The excavated foundations of the buildings.
2. The excavated column fragments, mouldings, and other decorative elements, and their postulated association with a particular building in question:
   a) 0.90 m (diameter) column section for the signal tower (building III);
   b) 0.50 m (diameter) and 0.47 (Beule') column section for the temple II;
   c) 0.60 m (diameter) column section for the colonnade and entrances.
3. The order for column capitals intuitively proposed:
   a) Corinthian for temple II and the signal tower;
   b) Ionic for the colonnade.[2]
4. The application of rules for proportions and symmetry as given by Vitruvius.[1]



reconstructed

excavated foundation

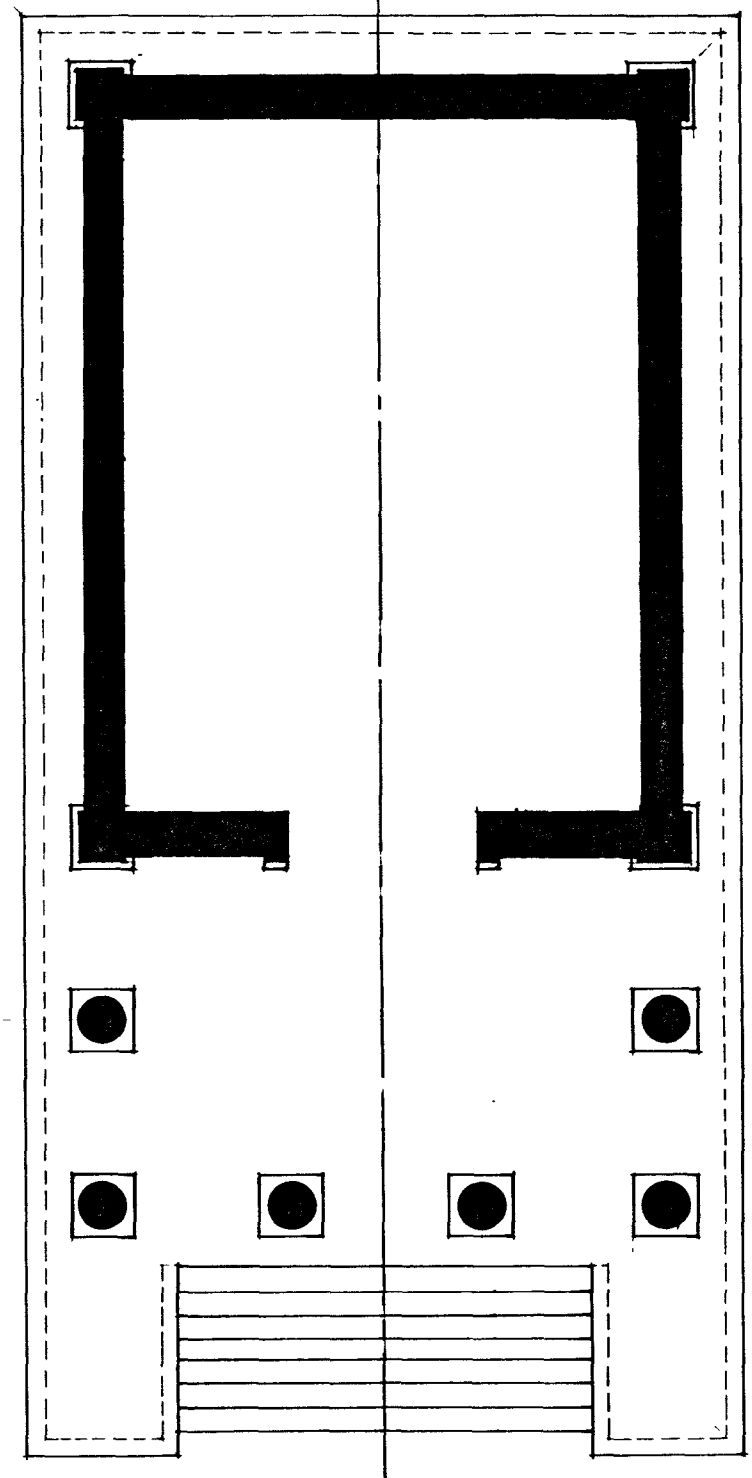
FIG. 6a

TEMPLE II

PODIUM SECTION

0 1 2 3 4 m

khk



N

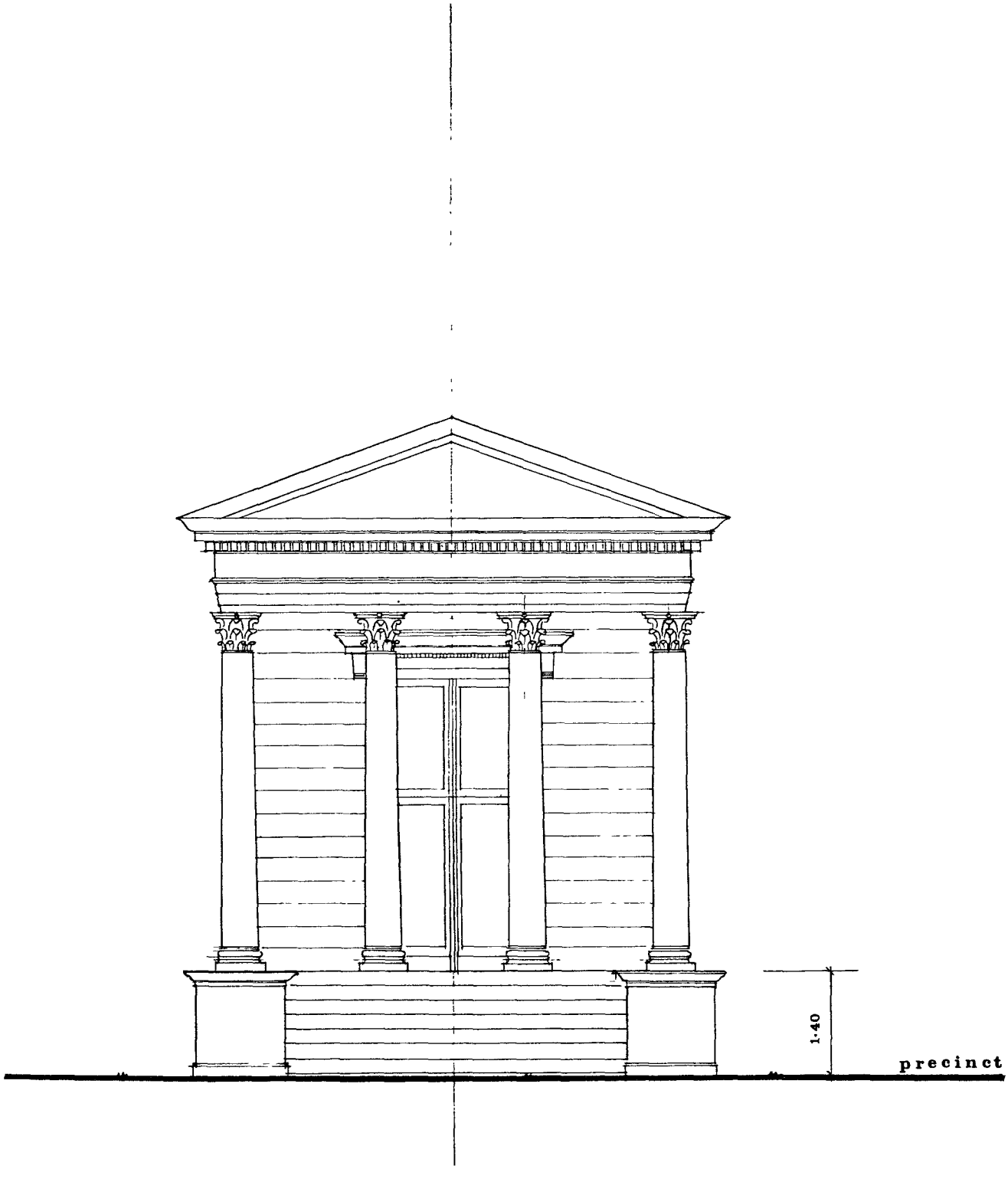
TEMPLE II

PLAN

0 1 2 3 4 m

FIG.6b

khk



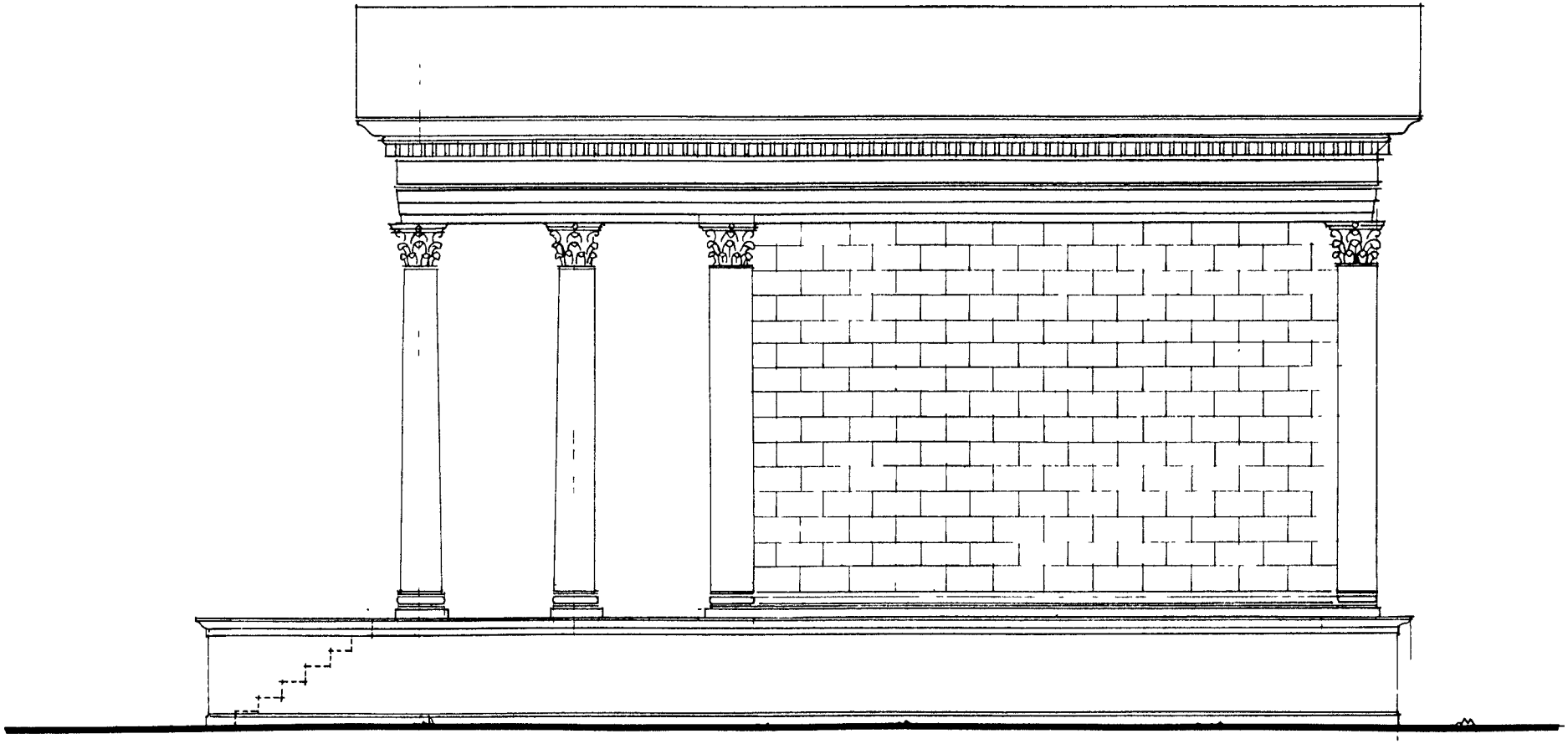
TEMPLE II

EAST ELEVATION

0 1 2 3 4 m

khk

FIG. 6c



TEMPLE II

NORTH ELEVATION

0 1 2 3 4 m

khk

FIG. 6d

Temple II [3] (c.f. Fig. 6 a,b,c,d)

The excavated coarsed rubble foundations[4] measure 15.40 m deep by 7.25 m wide, excluding the footing off-set projecting from the podium on which the temple rests. Four vaulted chambers support the podium: 2 vaults in the rear and 2 supporting the front. The span over the rear 2 vaults runs in a north-south direction, while that of the other pair runs in an east-west direction. The foundation vaults, making up the building's perimeter and the one interior wall, have a width of 0.80 m, and the two interior cross walls have been measured as being 1.00 m wide.

A projection of 2.20 m (in the easterly direction) extends along the full length of the perimeter foundations forming a solid ledge supporting the frontal steps which give access to the temple podium.[5] The excavated perimeter foundations forming the STYLOBATE were left in a rough and unfinished state to a height of 2.10 m above the foundation off-set. This suggests that the surrounding grade level was 2.80 m above sea level. The vaulted podium substructure was then built up from the grade or precinct level.

The solid ledge foundations which presumably supported the steps in front could conveniently accommodate no more than 7 risers and 6 treads of about 35 cm, the number of risers and treads being determined by the depth of the ledge. As the height of a riser is limited to a maximum 20 cm, the

conjectured height of the platform is 1.40 m above the surrounding precinct level. (The depth of the tread of 0.35 m is less than suggested by Vitruvius (Ch. IV) whose minimum depth for a -read is 0.45 m - all measurements are accurate within 10 cm. The result would be front steps consisting of four treads and five risers which then would place the podium level about 1.00 m above the precinct level.) Visually the height of 1.40 m is more pleasing, as it appears to be more in proportion to the building and is therefore more probable.

The width of the stylobate (0.80 m) suggests a supporting column shaft of 0.50 m in diameter over the base.

Column fragments found near the Temple II foundations have a diameter of 0.50 m. Therefore, this diameter can be adopted as a module. From the 5 classes of temple styles, the proportions governing the intercolumnations of the diastyle were selected as being the most suited mathematically to the reconstructed model. In this style the intercolumnation space is three times the size of the adopted module equaling 1.50 m. Following the principle of twice as many column spaces on the longer side as are placed on the front,[6] the centre to centre dimension of the center columns at the front is twelve times the module or 6.00 m, while the dimension from the centre of the outer columns on the sides is 24 modules, or 12.00 m.

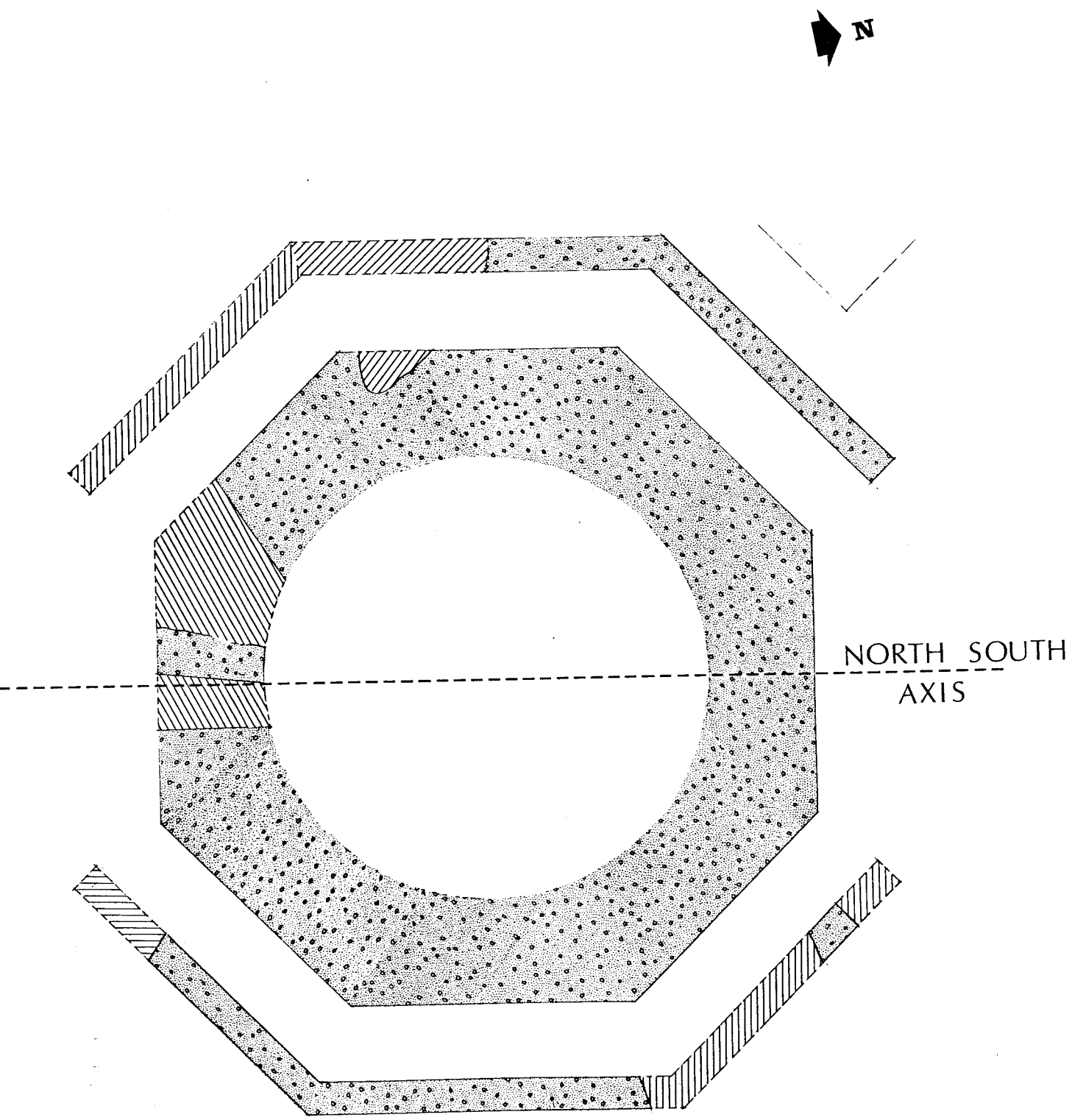
The podium platform, excluding its corona, is 7.25 m x 13.20 m, the exact measurements required to support a Diastyle temple as reconstructed in the floor plan shown in Figure 4b.

The exterior walls enclosing the single cella are assumed to be one module in thickness. The inside measurements of the cella are 5.50 x 7.50 m. The measurements from the centre axis of the outer columns to the exterior face of the Stylobate are 0.625 m, which allows for a symmetrically placed stair 4.75 m wide.

Applying the rules of proportions as outlined by Vitruvius,[7] the vertical height from podium to the underside of the architrave is 10 modules or 5.00 m, excluding the height of a Corinthian column capital.

A relief covered frieze is conjectured. This establishes the height of the entablature from the underside of the architrave to the top of the corona to be 0.82 m.

The proportions of the Pediment suggest a roof slope enclosing an angle of 15 degrees at the north and south ends. Thus, the height of pediment, corona and sima add 1.04 m to the height at its centre, making the total height from the top of the podium level to the ridge of the roof 6.86 m.



reconstructed

excavated foundation

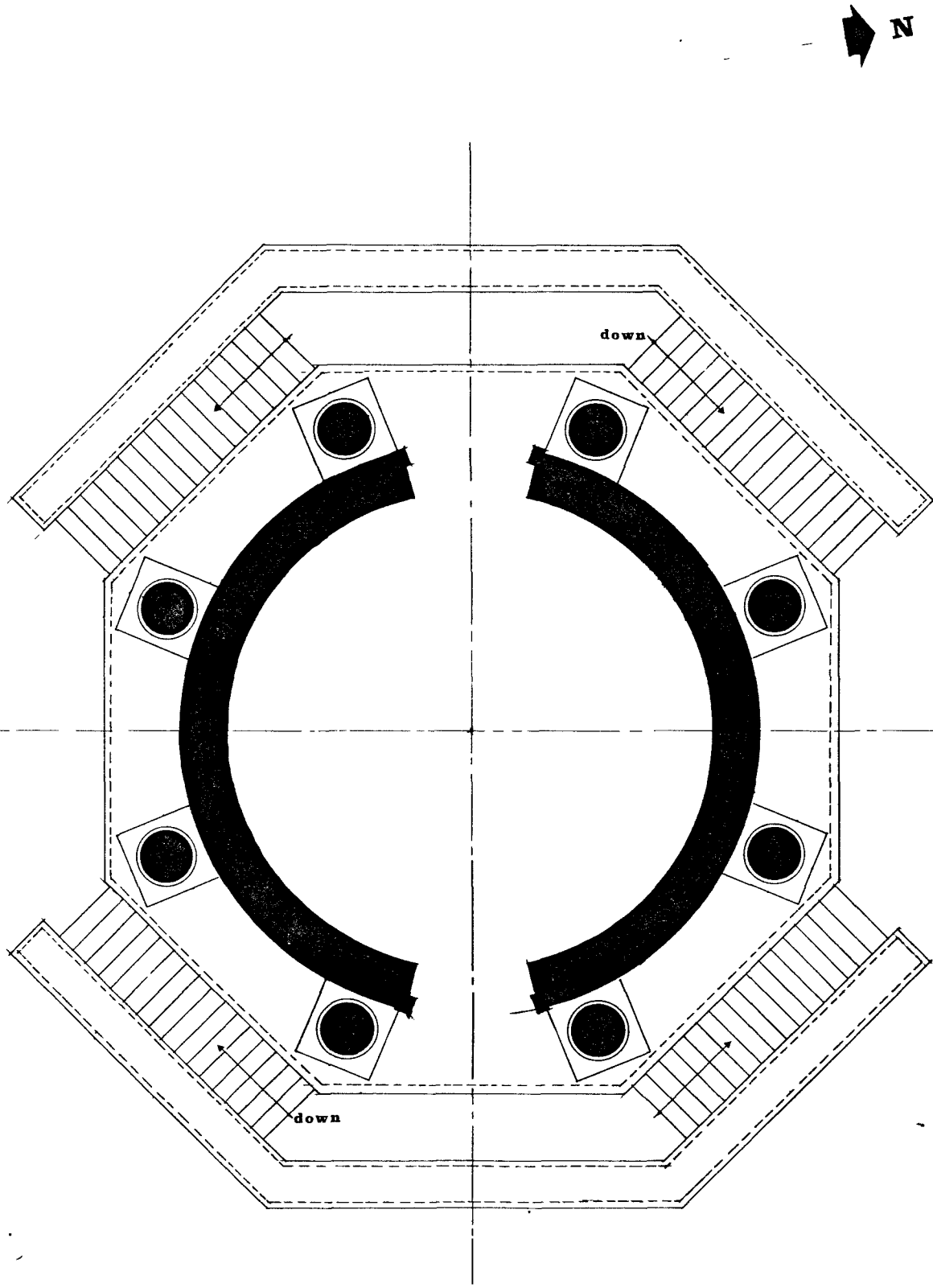
FIG. 7a

SIGNAL TOWE

FOUNDATION

0 1 2 3 4 m

khk



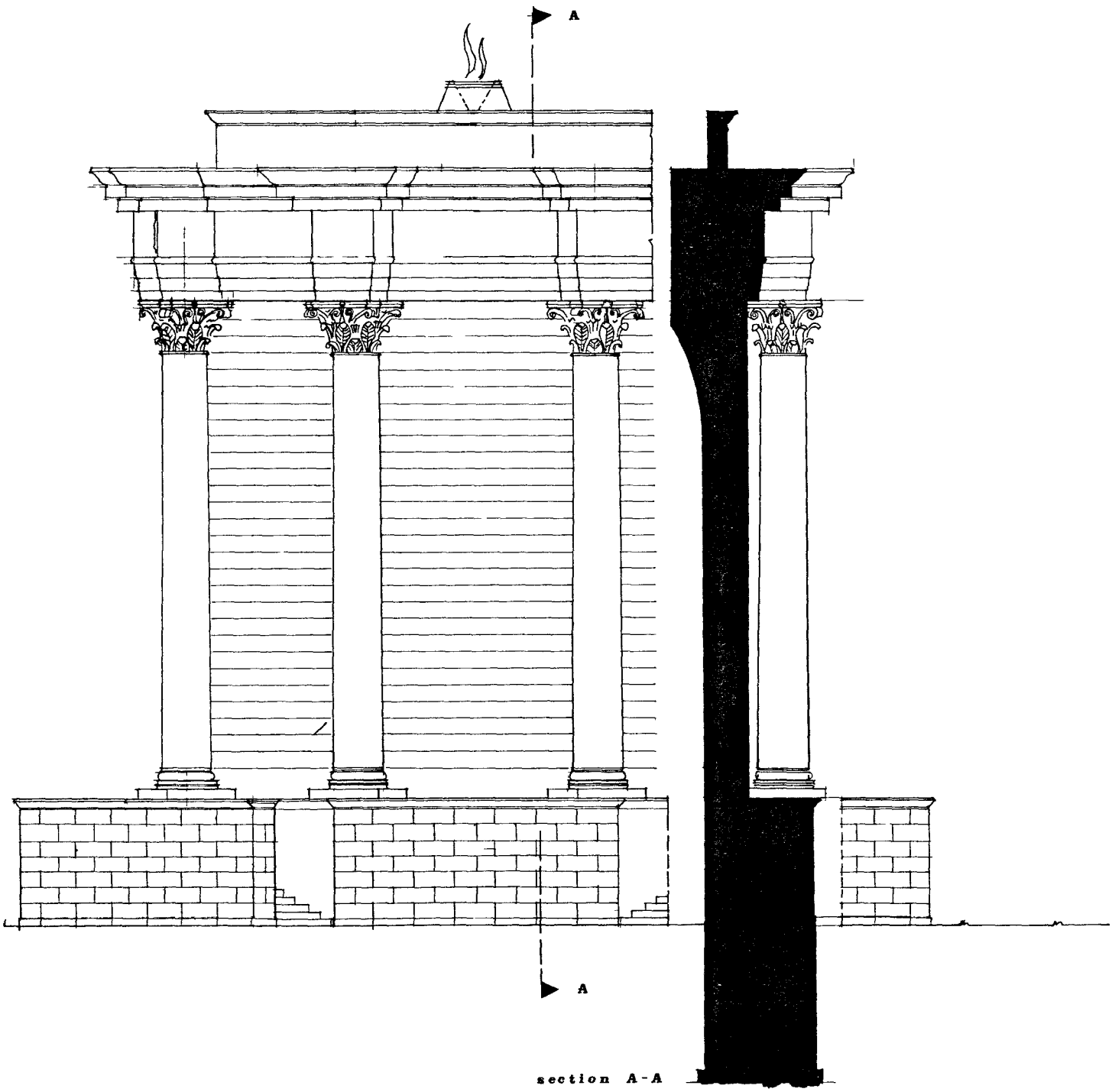
SIGNAL TOWER

PLAN

0 1 2 3 4 m

khk

FIG. 7b



SIGNAL TOWER

ELEVATION

0 1 2 3 4 m

khk

FIG. 7c

Assuming that the inner height of the cella from floor to coffered ceiling would have measured 5.80 m, it follows that the aperture for the doorway was 4.15 m in height and 1.90 m in width at the bottom of the doors, diminishing to 1.80 at the top.

The door jambs have been calculated to be 0.40 m wide at the bottom and diminishing to 0.37 m at the top, based on Vitruvius, Ch.VI, 2-6.

A lintel, fascia cymatium and cornices are placed across the aperture measuring 0.82 m high in total.

Building III (Signal Tower) (Fig. 7a,b,c)

The perimeter of the excavated mortar rubble foundations forms an octagonal shape, all sides having an equal 5.25 m length. The inner edge is circular, 8.30 m in diameter, resulting in minimum foundation thickness of 2.00 m.[8]

This massive substructure, founded on bedrock, appears to be capable of supporting a large superstructure.

The octagon is centred on the major north-south axis of the harbour which bisects two octagonal sides (north and south) at the midpoint. The northerly 5.25 m long side is nearly parallel to the east-west axis of Temple II and 7.20 m away from

the southern face of the temple podium.

Parallel to the three most westerly sides of the octagon, as well as the three most easterly sides, foundations for two 0.60 m wide wing walls were located. These wing walls are conjectured to be about 19 m long and follow at a constant distance of 2.00 m from the three easterly and three westerly sides of the main octagonal foundations.

Similar to the podium foundations of Temple II, the outer face of the octagon foundations and the external faces of each wing wall were left unfinished, to a height of 2.10 m, which suggests that the walls were placed below the surrounding ground level (precinct surface), again placing the superstructure at a level of about 2.80 m above sea level.

These octagonal foundations are interpreted as belonging to a podium on which a relatively high superstructure was built. The two sets of wing walls on the east and west sides are seen to support two sets each of ascending stair runs, thus providing access to the podium from two directions at each of the two entrances.

These postulated multiple stair arrangements are the main reason for suggesting Building III to be a secular superstructure.[9] The building's alignment with the north-south axis of the harbour on the harbour entrance side of the

island also appears to designate a functional importance to the building in the harbour's conceptional layout. Its size, height and location suggest that it was a signal tower, serving as a guide for ships entering the rectangular basin and the circular basin. Calculations to establish a conjectured height of the superstructure have been made on the basis of the bearing capacity of the soil (bedrock) which was made on the following assumptions:

a) permissible bearing load of virgin soil under the footings, consisting of stiff sandy clay to be 4.0 Kg/cm^2 (similar to the existing bedrock); (Huette, I, pp. 776)

b) the area of footings to support the superstructure is 76 m^2 in size;

c) gross weight of reconstructed building, including foundations as proposed in Figure 7 b and c, is calculated to be 2400 metric tons.(Height from bottom of footings to top parapet is shown as 17.75 m = 18.00 m and the volume of masonry, concrete and stone material used is computed to be approximately 1000 m^3.)

On the basis of the above assumed data, calculations show that the excavated footings are capable of supporting a building (tower) of masonry, concrete and stone to a maximum height of 24.0 m. Taking into consideration that exact data are unavailable,however, it appears reasonable to allow for a margin of error of 30%. A reconstructed height of 18.00 m, based on Vitruvian proportions is, therefore, likely.

By placing the 4 runs of ascending stairs between the wing walls and the octagonal podium, a horizontal run of about 5.00 m is created. It is here suggested that it would be appropriate to use a tread width not exceeding 0.35 m for those relatively (1.40 m) narrow stairs. Each stair accommodates 14 treads and 15 risers, one riser being 0.20 m. The podium platform is thus placed 3.00 m above the precinct, grade level, or 5.80 m above sea level.

In the course of the 1974 excavations, five column shaft fragments were located at the building remains or immediately adjacent to them. Hurst commented in his report[10] as follows: "All were in positions they could only have reached after the earlier excavations, so that it is not possible to be sure they were associated with the building". However, Beule's plan suggests that the largest of the column fragments was found very close to its present position.[11] Two columns of similar construction and dimensions were removed from the present site and are standing in the gardens of the police barracks in Salammbo. The shaft diameter is 0.90 m at the base and tapers to 0.75 m. The excavations uncovered marble fragments of architectural mouldings and veneer.

A Tholos-type building is proposed. The assumption is made that on the octogonal stylobate, a flat topped cupola supported the podium floor. The building consisted of an inner

screen wall and 8 outer columns placed on the points of the octagon.

The wide spacing of the columns prohibited the use of a continuous free spanning entablature. It is, therefore, suggested that the entablature was engaged and built as part of the inner screen wall and the vaulted cupola roof. The result would be a partly free standing column arrangement tied in by the engaged entablature. In this way the columns would act as structural reinforcement adding to the stability of the screen wall. A like arrangement of interacting columns and engaged entablature is found at the temple of Venus at Baalbeck. (See Figure 7c)

There is insufficient excavated evidence on which to base a selection of entablature and order or capitals. For the purpose of graphic reconstruction, the Corinthian order has been chosen and the rules of Proportion and Symmetry by Vitruvius have been applied.

Thus the height of a column, including base, shaft and capital is ten times its lower shaft diameter, or 9.00 m. The entablature from the underside of architrave to the top of Corona is about 2.50 m...A low parapet of 1.00 has been added to crown the otherwise flat roof surface bringing the total height of the tower from bottom of foundation to the upper surface of the parapet to 17.80 m, or about 18.00 m, a feasible height based on the carrying capacity of soil and foundations.

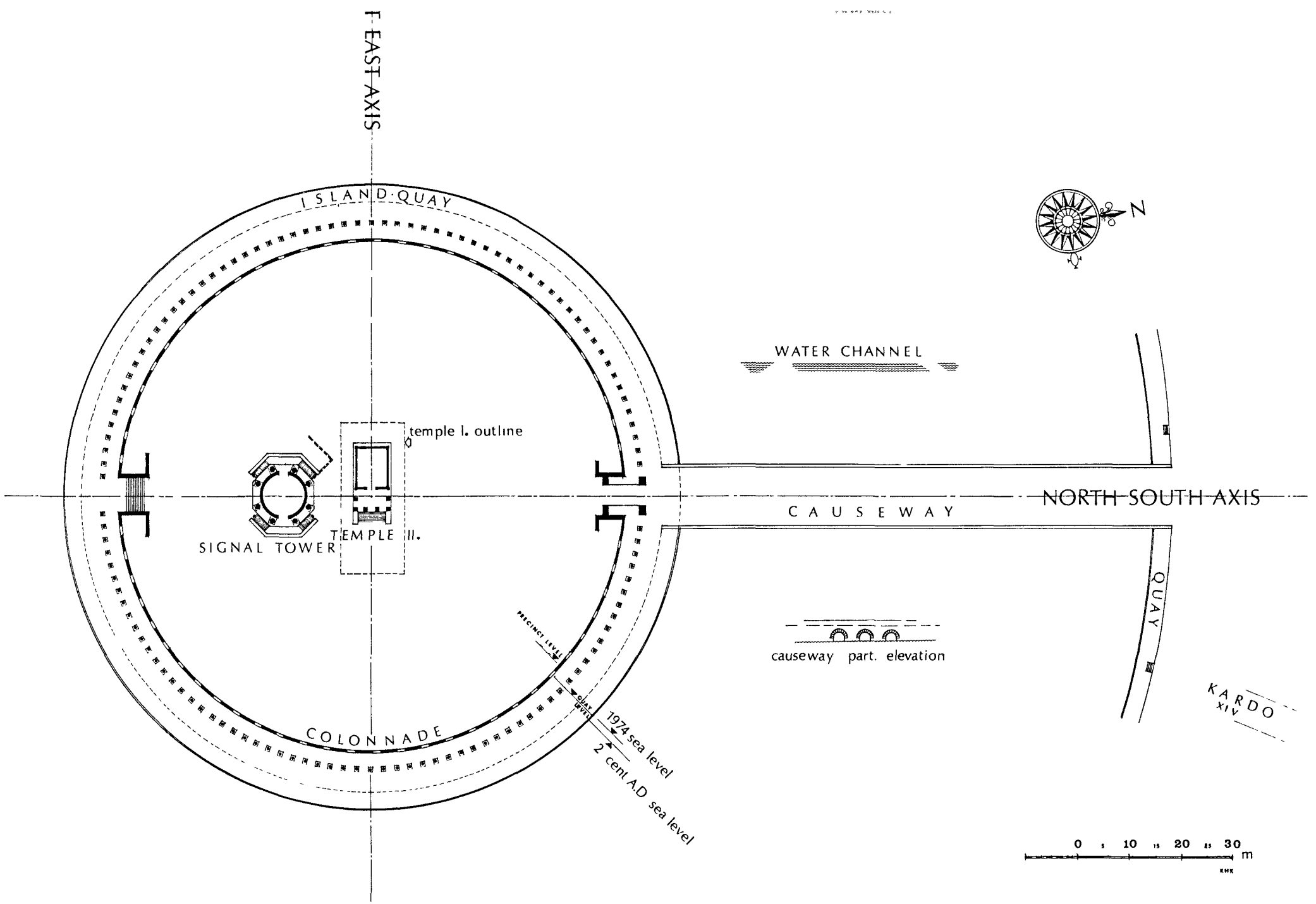

EAST AXIS
ISLAND QUAY
N
WATER CHANNEL
temple I. outline
NORTH SOUTH AXIS
CAUSEWAY
SIGNAL TOWER
TEMPLE II.
QUAY
causeway part. elevation
KARDO XIV
PRECINCT LEVEL
QUAY LEVEL
1974 sea level
2 cent A.D sea level
COLONNADE
0 5 10 15 20 25 30 m

FIG. 5

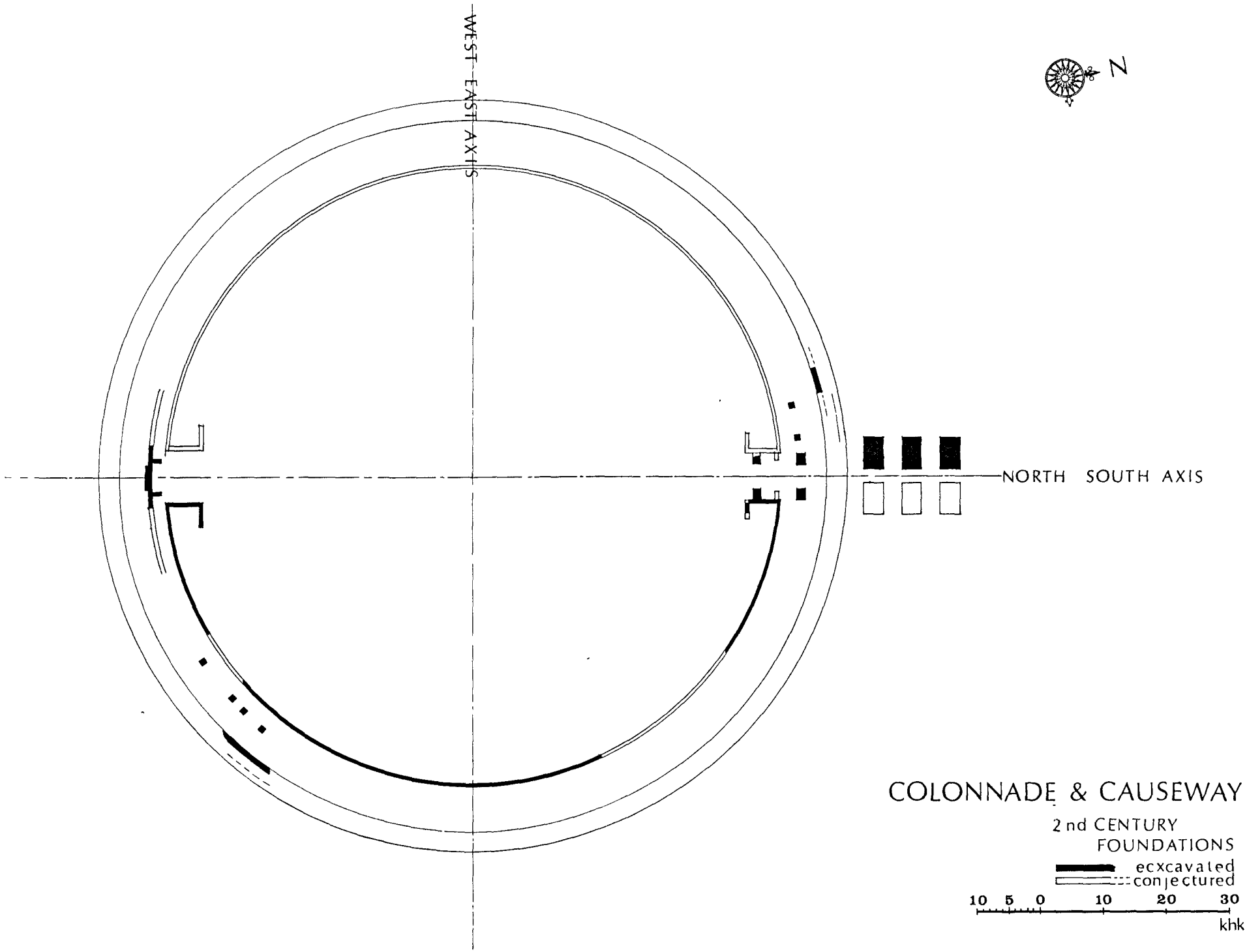
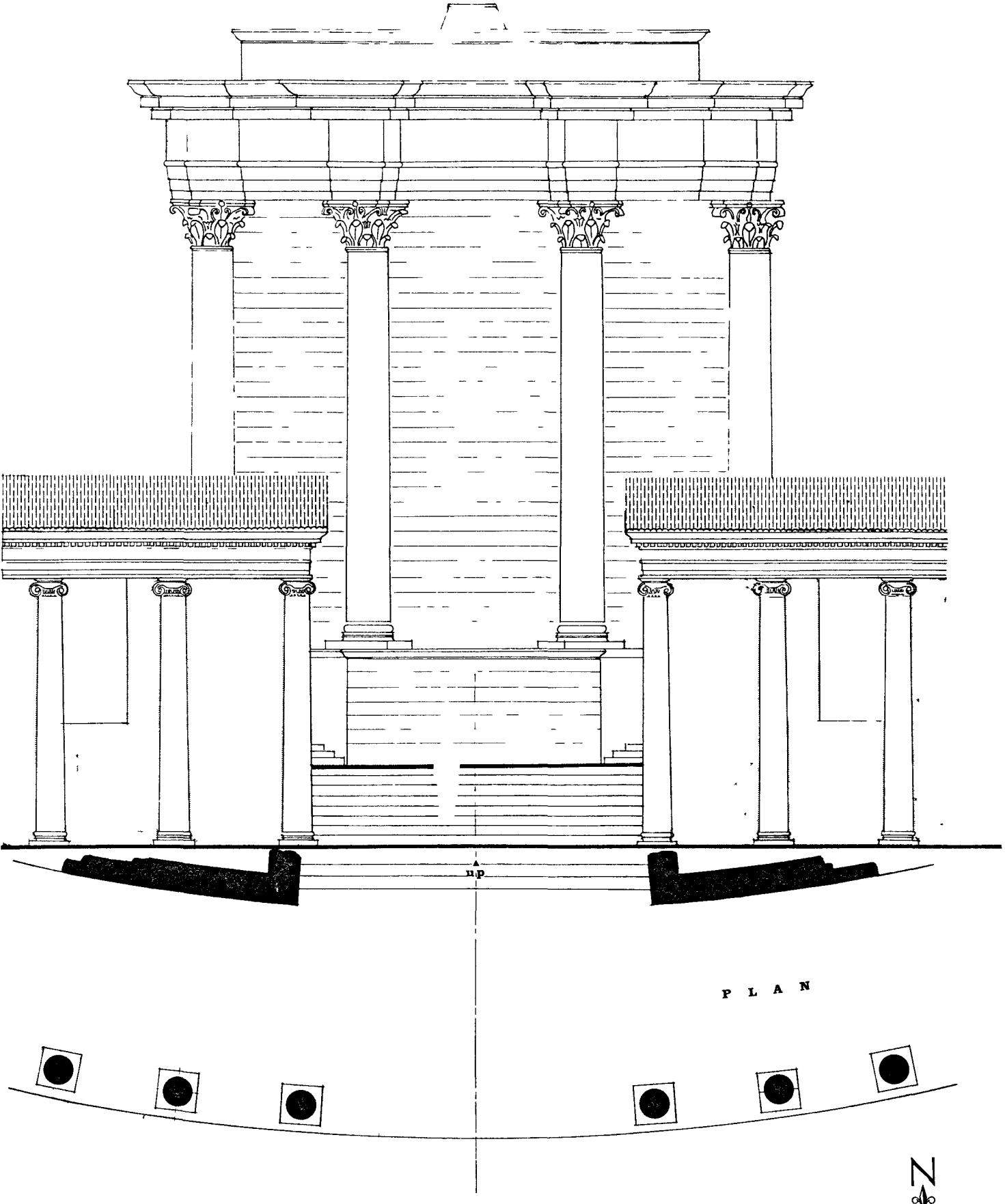

WEST EAST AXIS
N
NORTH SOUTH AXIS
COLONNADE & CAUSEWAY
2 nd CENTURY
FOUNDATIONS
excavated
conjectured
10 5 0 10 20 30
khk

FIG. 8a



N

COLONNADE

PLAN & ELEVATION

0 1 2 3 4 m

FIG. 8b

kb

Circular Colonnade (Fig. 5, 8a,b)

The excavated foundations are shown in Figure 8a and are described as follows:

A continuous inner ring of foundation walls, 0.80 m thick, is centred on the "north-south axis" along which the "Hellenistic" harbour plan was developed. The inner diameter of the circle made by the "ring" measures 98.00 metres with an east-west axis dividing the circular island into 4 quadrants.

A second outer ring of double foundations forms a circle with a diameter of 120.0 metres, centred on the same axial cross, making it concentric with the inner ring. The double foundations form the coffered quay-wall consisting of 2 parallel walls each 0.90 m in thickness set against a core of stone and clay 1.60 - 0.90 m wide.

Sections of walls were excavated in the south-east quadrant, as well as in the north-west quadrant. Surface traces of the wall are in evidence at various positions along the actual island perimeter, forming its border.[12]

The two concentric walls form the inner and outer edge of an 11.00 m wide quay surrounding an inner precinct. Both make up the centre island known as ILOT DE L'AMIRAUTE.

The island quay is separated from the inner precinct by a surface level difference and the transition of levels is made architecturally by the placement of a circular colonnade between the two.

Access from the lower level quay to the higher precinct was provided by two entrances, both centred on the north-south axis and the tangent of the inner circle wall foundation. The north entrance forms the south end of a 12.0 m wide CAUSEWAY connecting the island to the landside quays of the circular harbour channel. The south entrance is facing the entrance water channel which connect both the circular and the rectangular harbour basins.

Evidence for the colonnaded structure was excavated in two locations: one at the south-east quadrant, where four individual footing foundations, for individual column bases, each approximately 1.0 m square, were found. The other was excavated at the north-west quadrant where two foundations of similar size and placement are located. All individual column foundations are placed parallel to the circumference of the inner ring wall at a constant 2.20 m away from the wall. At the south entrance, another entrance feature must have existed as foundations, 0.80 m wide, with a 1.20 m wide thickening and 4.0 m long, as well as two short perpendicular wing walls projecting north indicate. They are centred on the entrance and follow the continuation of the path made by the colonnade footings for a distance of 10.0 m.

The evidence substantiating the existence of the colonnade and monumental entrances is summarized as follows:

a) continuous circular wall foundations supporting the rear wall of a roof covered colonnade;
b) circular path of individual column footings forming the colonnaded front;
c) two monumental entrances featured as part of the colonnade and providing access to the precinct.

The difference of levels between the quay-surface and the level of the precinct-grade, surrounding the temple podium and the signal tower, appears to be 1.55 m and is based on the following assumptions and observations:

Extensive studies on the subject of the ancient sea levels in the Western Mediterranean and sedimentation have been published by Fleming, York and Little, G. Evans[13] and, combined with site excavation reports, lead to the conclusion that harbour piers, quays and floor surfaces were generally placed at a minimum of 1.00 - 1.25 m above the contemporary sea level. Therefore, the seaward edge of the island quay is assumed to have been located a minimum of 1.00 m above sea level. The transition to the floor-level under the colonnade which has been raised to 1.25 m above sea level is made by a slope in the floor.

The surrounding grade level at the Signal Tower and Temple II is calculated to be 2.80 m above sea level. It is further assumed that the precinct floor level was largely covered with stone pavement under which a drainage system existed. Evidence to substantiate the existence of such a drainage system emptying into the harbour basin has been excavated at the north entrance, as well as in the south-east quadrant. Though evidence for the existence of the specific drainage channels has not been excavated, it can be deduced that the precinct surface was flat. The vertical rise between the two levels at both entrances, therefore, appears to be approximately 1.55 m.

A system of stairs or a ramp would have been needed to bridge the difference. Based on the excavated footings, a ramp appears as the likely access at the north entrance facing the causeway, thereby permitting access to the precinct by both rider and vehicle. At the south entrance, foundations permit the suggestion of an 8.00 m wide stair with flanking sidewalls. Foundations for returning wing walls have been excavated at both entrances. On the east side of the north-south axis, the walls stop short at a distance of 4.00 m from the central axis, turn 90 degrees toward the centre of the island for approximately 6.00 m and change to an easterly direction forming another 90 degree angle and run for a distance of 4.00 m. Identical foundations probably existed on the westerly side of the entrance axis.

It is also suggested, with respect to the south entrance, that the two ends of the roofed colonnade terminated,

respectively, on the east and west sides of the entrance separated one from the other for a distance of 8.00 m, thus forming two individual semi-circular colonnades. The result is an 8.00 m wide opening permitting an uninterrupted line of sight opposite the channel entrance to the harbour.

The foundation arrangements for the north entrance with returning wing walls are similar to the ones described for the south entrance. In addition, however, 4 large pier foundations (1.00 x 1.80 m each) are located there. They suggest the existence of a monumental entrance feature, possibly in the form of an arch against which both ends of the circular colonnade abutted.[14]

The previously described individual foundations located in the south-east quadrant and the north-west quadrant have been interpreted as being part of two semi-circular colonnaded fronts facing the circular water basin.

Proceeding from the south entrance in counter-clockwise direction, the measured distance between the individual piers is as follows:

axis to pier No. 1 = 28.00 m
pier 1 to pier 2 = 2.80 m
pier 2 to pier 3 = 4.80 m
(centre pier to centre pier).

Measuring from the north entrance going in westerly direction, the distances are as follows:

axis to westerly face of pier 1	=	3.00 m
pier 1 (westerly face) to centre of pier 2	=	5.00 m
pier 2 to centre of pier 3	=	2.60 m.

To arrive at a probable system of intercolumnation for the colonnade, the above column spacings have been analysed and a probable spacing of approximately 1.90 - 2.00 m is proposed.

Fragments of column shafts, believed to belong to the colonnaded structure, were found on the island. They suggest a column diameter of about 0.60 m.

The previously described individual square footings are located on a conjectured centre line which forms two semi-circles, beginning at both sides of the north entrance, parallel to the inner ring foundation on both sides toward the south entrance. Each semi-circle has a calculated length of 155.40 m. When the columns are placed at intervals of 2.50 m, a total of 124 are required to form the two semi-circular colonnades enclosing the precinct and separating its surface level from that of the harbour quay.

The rear of the colonnade is formed by a continuous circular enclosure wall. It is proposed that vertical openings

perforated the rear wall at regular intervals. Such openings are an essential design element to the architectural concept, as they link the quay with the precinct visually.

It may be assumed that the openings are placed at each second centre of intercolumnation, and follow the module of proportion integral to the colonnade.

There is no evidence or findings to link any particular capital order to the structure. Therefore, intuitively the Ionic order has been chosen for the purpose of graphic reconstruction. Following Vitruvius, the measurement from the stylobate to the underside of the architrave was calculated to be 5.90 m to which the height of the entablature, assumed to have a plain frieze, of 0.80 is added. The result is a frontal height of 6.20 m.

Lacking evidence, it is conjectured that sloping wooden rafters supported a tiled roof. The rise of the roof toward the rear of the colonnade, using the common slope of 15 degrees for this type of roof construction, adds 1.20 m to the height of the structure, which required the supporting rear wall on the precinct side to be 5.85 m high. (See figure 7c.)

NOTES FOR CHAPTER III

1 There is insufficient excavated evidence to designate a selection of entablatur and order of capitals for each building. Therefore, for the purpose of a graphic reconstruction, it is essential to select a stylistic architectural system whose rules and proportions can be applied to build a successful reconstruction model.

Such architectural system, applicable to architecture of the early Empire is available in the works of Vitruvius Mamurra, known as VITRUVIUS, "The Ten Books of Architecture," particularly in the content of Books III and IV.

Vitruvian influence on architectural writing from the early to the late empire was present and doubtless governed many period building projects.

For example, in the design of the Capital at Dougga, which was built in the 2nd century A.D., the stylistic system of Vitruvius, as layed down in Books III and IV, was used. The writings of Vitruvius were the most complete and convenient, perhaps the only written sources available to builders and architects of that period.

Based on the Dougga example, it appears appropriate and reasonable to use Vitruvius, Books III and IV, as underlaying reconstruction model for the 2nd century buildings at the Ilot de l'Amiraute.

2 Appian's Roman History, (96) p. 567.
In describing the Punic ship sheds: "Two Ionic columns stood in front of each dock, giving the appearance of a continuous portico to both the harbour and the island." The continuous circular colonnade visually replaces the punic portico described by Appian.

3 C f. description of archaeological remains associated with Temple II, in previous chapter.

4 Excavated by H. Hurst, Antiquaries Journal, Excavations at Carthage 1974: First Interim Report.

Figures 7, 8, 9, 10 - page 25.

5 The temple faces east, which is the traditional direction of entrances to Greek and Roman temples.

c f. Vitruvius.

6 Vitruvius, Book III, Ch. IV:3

7 Vitruvius, Book III, Ch. V

8 c f. Chapter II for further description of archeological remains associated with Building III.

9 No evidence of a temple having more than a single entrance with a single set of stairs has yet been found.

10 Hurst, H., Antiquaries Journal, 56 - p. 27.

11 Ibid., pl. IV and P. 105.

12 For piers and harbour construction see Vitruvius, Book V, Chapter XII (c.f. Appendix ' ')

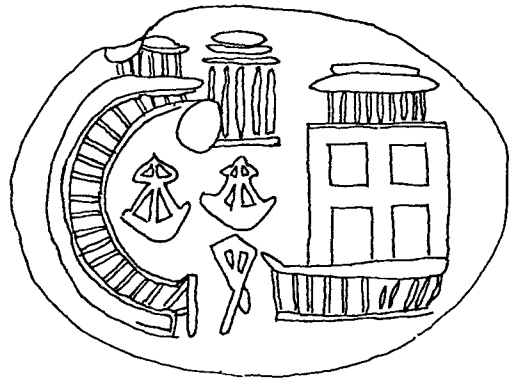
13 Flemming: Archaeological Evidence for Eustatic Changes of Sea Level and Earth Movements in the Western Mediterranean, pp. 58, 63, 66

York and Little, Offshore Survey at Carthage, 1973, p.91.

Evans, G., Marine Archaeology: Coastal Sedimentation, pp. 90-109.

14 Current excavations will undoubtedly shed light on this important entrance feature. No specific proposal as to its nature is, therefore, being made at this time.

15 P. Cintas, le Port de Carthage, pp. 44



The above sketch is the line-representation of an engraved flat intaglio which is in the possession of the Bardo Museum. It is of green jasper stone, measuring 1.5 x 1.1 cm. The lines of the engraving depict a schematic representation of a sea port surrounded by buildings. Inside of the crescent-shaped basin sail two boats in profile. The end of the basin is flanked by breakwaters of which one ends in a round tower, the other with two spikes in masonry striking out into the sea. A semi-circular portico borders the pier.

Behind that, but not far from the tower, stands a building with pediment supported by six columns. In front of the crescent-shaped basin, resting on a projecting construction, one sees a hollow square separated into four compartments by a crossbar, two small and two larger and surmounted by a second building with columns and pediment is indicated by a boat seen face on; it is situated opposite a round tower and protected by two breakwaters of which one is slightly incurved.

This gem was donated to the Bardo Museum as part of a private collection of artifacts and art. The museum catalogue gives its provenience as Carthage. P. Cintas says, concerning the dating of the gem: "This intaglio we are concerned with and of which we see a representation as given by R. Lantier and in which I see personally the exact sketch of what could have been the first inland port of ancient Carthage. However, it is not possible to determine the date of fabrication without very serious hesitation.

Comparing the exact sketch with Appian's and Strabos' description of the harbour is difficult, but the semi-circular wharf is surrounded with a colonnaded structure. The building to the north could be the representative of the Signal Tower located on the island. As for the drawing to the right, two interpretations are offered which the sketch represents: the plan of the rectangular basin with a colonnaded wharf at the bottom and a porticoed building elevation opposite. In this view the relationship shown of both basins to each other is seen simply as the artist's prerogative. The second interpretation would be to see in the sketch to the right, not the rectangular basin, but the off-shore pier (Choma) labelled as Falbe's quadrilateral completed with buildings on two sides.

Two similar engraved intaglios exist in the care of a Berlin Museum. Both show representation of a harbour resembling the Carthage intaglio. Because of this resemblance, one could be tempted to endorse the opinion that the gem cutters used a conventional image to represent a port, and consequently the image found at Carthage would be of limited interest to a reconstructed vision of the harbour, be it Punic or Roman. Though in reality, if the design of the intaglio or other small monuments of the same sort representing ports offer analogies, it is precisely for this reason that all ancient ports are of necessity resembling each other.

APPENDIX 'A'

The following are selected quotations from translations of ancient authors:

Appian's Roman History, translated by H. White

"Appian XIV, 95: The city lay in a recess of a great gulf and was in the form of a peninsula. It was separated from the mainland by an isthmus about three miles in width. From this isthmus, a narrow and longish tongue of land, about 300 feet wide, extended towards the West between a lake and the sea, (on the sea side) where the city faced a cliff (precipice), it was protected by a single wall. Toward the South and the mainland, where the city of Byrsa which stood on the isthmus, there was a triple wall. The height of each wall was forty-five feet, not taking account of the parapets and the towers, which were placed all round at intervals of 200 feet, each having four storeys, while their depth was thirty feet.....

Ibid. 121: Scipio's ships were blockading Carthage... thus the ships of Bithya (a Carthaginian general who was sent out to procure dwindling food supplies).....watching for a strong wind from the sea, spread their sails and ran the blockade.....Scipio, perceiving this, decided to close the entrance to their harbour, which looked towards the West, and stood a little way out from the land, so he built a long mole in the sea, beginning from the strip of land, which being between the lake and the sea, was called the tongue, and extending it

toward the open sea, straight across the entrance....(and the Carthaginians thereupon) excavated a second entrance on the other side of the harbour, opening direct on to the open sea.....

Ibid. 127: Scipio made an attack on Byrsa, and on that one of the harbours was called the Cothon.....When the wall encircling the Cothon had been taken, Scipio seized the market-place, which was near by.....

Ibid. 128: Scipio's real objective was the Byrsa, for it was the stronghold of the city.....There were three approaches to it from the market-place, lined with dense rows of six storied houses.

Ibid. 130: The temple of Eshmun (Asclepius) was in the citadel and was the most notable and richest of all temples .....The remnant took refuge in the temple of Eshmun.....whence they could fight easily, though they were but few, because of the height and precipitous nature of the enclosure, which had to be approached even in peaceful times by a flight of sixty steps.....

Livy, Books XXXVIII-XXXIX, Translated by E. T. Sage

Livy 11, epitome: Carthage was twenty-three Roman (i.e. twenty-one English) miles in circumference.....

Cicero, M. Tulli Ciceronis, Orationes de Lege Agraria Contra Rullum; Albertus Curtis Clark

Cicero, (de Lege Agraria) 11.32.87: Carthage was surrounded by ports.....

Orosius, The Seven Books of History Against the Pagans, Translated by Roy J. Deferrari

Orosius, IV.22: Its 22 Roman (20 English) miles were completely surrounded with a wall and the greater part of it also by the sea, except for three miles across an isthmus. There the wall was 30 feet wide and 45 feet high, and built of squared stone. The citadel, which was called Byrsa, had a circumference of a little more than two Roman miles. On one side, the wall of the city and of Byrsa was one and the same: here Byrsa overhung an arm of the sea which was called Stagnun (i.e. pond) because it was calm, being protected by a tongue of land.

Virgil, Aeneida 1-VI, Translated by H. Rushton Fairclough

Virgil, Aeneida, 1.427: Some of them (i.e. the new colonists) excavate the harbours.....

Strabo, Geography, Translated by Leonard H. Jones

Strabo, XVII. 3.14: Carthage was situated on a peninsula, and had an enclosing wall of about forty-one miles, of which seven were on the isthmus, reaching from sea to sea.... the acropolis, which they called Byrsa, a brow of considerable height, was in the middle of the city, with houses around about it. On its crest was the temple of Asclepius (i.e. Eshmuna)... below the acropolis were the harbours, the Cothon, a circular island, encompassed by a channel with dockyards on each bank...

Ibid., 441, 446: There was a grove in the middle of the City.....here Dido founded a mighty temple to Juno.....

APPENDIX 'B'

VITRUVIUS MARMURRA was born in 84 B.C. He served under Caesar as Prefectus Fabrum in Gaul, Spain and North Africa. We know that he travelled widely, visited many places important to the history of architecture such as Athens, Olympia, Ephesus A.O. Building plans executed under him were bridges over the Rhein, the basilica at Farum, and we understand from Pliny that he was also involved in the building of the Therma of Agrippa at Rome in 20 B.C. He also apparently held an official position in the rebuilding of Rome under Augustus.[1]

His fame however, then and now, is not based on architectural achievements, but on his writing works: "THE TEN BOOKS OF ARCHITECTURE," a textbook in which he collected and compiled over a period of thirty years, principles and rules to govern the design and building practises applied in the erection of public building projects of the early empire, all based on careful observations and personal knowledge. The preface of the work was dedicated to Augustus.

Evidence for the relevance of the Vitruvian textbooks in the architectural literature of the Empire is found by examining the works of:

a) M. Cetius Faventinus, who wrote a building compendium which is dated by Plommer to the early 4th century A.D., titled DE DIVERSIS FEBRICIS ARCHITECTONICAE.

b) PALLADIUS,
FIFTEEN BOOKS ON ARCHITECTURE, an architectural guide manual for the owners of large estates and is relevant for private architecture. The work is dated by Plommer as belonging to the late 4th century A.D.

In both literary works many statements from the books of Vitruvius are abreviated, used and partly rewritten. Both writers are intelligent men who extensively rearranged the material at their command to meet the practical needs of their readers. "The spirit of Vitruvius is apparent throughout all its rearrangements." (Plommer)

1. The biographical details given in this paragraph are debatable, but their possible inaccuracies do not affect the architectural arguments which follow.

The following passages from the works of VITRUVIUS, are selected quotations from the Ten Books on Architecture, but are the most important rules governing proportions and harmony imbedded in the construction of temples and public buildings in the early Roman Empire.

Vitruvius - Book III, Chapter I

1. The design of a temple (as well as other public buildings) depends on symmetry, the principle of which must be carefully observed by architects. They are due to proportion.....

Proportion is a correspondence among the measures of the members of an entire work and of the whole to a certain part selected as standard. From this results the principles of symmetry. Without symmetry and proportion there would be no principles in the design.....if there is no precise relation between its members, as in the case of those of a well shaped man. .....

3. Similarly, in the members of a temple (or other public buildings) there ought to be the greatest harmony in the symmetrical relations of the different parts to the general magnitude of the whole.....

4. Therefore, since nature has designed the human body so that its members are duly proportioned to the frame as a whole, it appears that the ancients had good reason for their rule; that in perfect buildings the different members must be in exact symmetrical relations to the whole general scheme.....

5. Further, it was from the members of the body that they derived the fundamental ideas of the measures which are obviously necessary in all works, as the finger, palm, foot and cubit. These they apportioned so as to form the perfect number .....and as the perfect number the ancients fixed upon ten .....

Chapter II

3. The Prostyle is in all respects like the temple in antis, except that at the corners opposite the antae it has two columns and that is has architraves not only in front, as in the case of the temple in antis, but also one to the right and one to the left in the wings.

Chapter III

1. There are five classes of temples, designated as follows: Pygnostyle, with the columns close together;

Systyle, with the intercolumnation a little wider; Diastyle, more open still; Araeostyle, farther apart than they ought to be; Enstyle, with the intervals apportioned just right.....

4. The construction will be Diastyle when we can insert the thickness of three columns in an intercolumnation ..... This arrangement involves the danger that the architraves may break on account of the great width of the intervals.

10. ..... In the Diastyle, the height of the column shall be measured off into eight and a half parts, and the thickness of the column fixed at one end of these parts.

12. Moreover, the diminution in the top of a column of the necking seems to be regulated on the following principles: if a column is fifteen feet or wider, let the thickness at the bottom be divided into six parts, and let five of those parts form the thickness at the top. If it is from fifteen to twenty feet, let the bottom of the shaft be divided into six and half parts, and let five and a half of those parts be the upper thickness of the column.....

Chapter IV

1. The foundations of these works should be dug out of the solid ground..... Above ground, let walls be laid under the columns, thicker by one half than the columns are to

be, so that the lower may be stronger than the higher .....

2. ..... The foundations having been brought up to the level, the Stylobates are next to be put in place.

3. The columns are then to be distributed over the Stylobates in the manner above described:..... in peripterals the columns should be so placed that there are twice as many intercolumnations on the sides as there are in front; for thus the length of the work will be twice its breadth.....

4. The steps in front must be arranged so that there shall always be an odd number of them.....the rise of steps should be limited to not more than ten, not less than nine inches.....the treads of the steps ought to be made not less than a foot and a half, and not more than two feet deep.....

5. But if a podium is to be built on three sides round, it should be so constructed that its plinths, bases, dies, coronae and cymatrumare appropriate to the actual Stylobate which is to be under the bases of the column.

Chapter V

1. This finished, let the base of the columns be set in place and constructed in such proportion that their height, including the plinth, may be half the thickness of a column

and their projection the same. Thus, in both length and breadth it will be one and one half thickness of a column.

If the base is to Attic style, let its height be so divided that the upper part shall be one third part of the thickness of the column, and the rest left for the plinth. Then, excluding the plinth, let the rest be divided into four parts, and of these, let one fourth constitute the upper forms and let the other three be divided equally, one part composing the lower torus, and the other, with its fillets, the scolia.....

3. But if Doric bases are to be built.....the base may be equal in breadth to the thickness of a column plus three-eighths of the thickness, its height that of the Attic base and so too, its plinth, excluding the plinth let the rest.... be divided into seven parts. Three of these parts constitute the torus at the top and the other four are to be divided equally, one part constituting the upper trochilus, with its astragals and overhang, the other left for the lower trochilus .....the astrogals must be one-eighth of the trochilus. The projection of the base will be three-sixteenths of the thickness of a column.

5. The shafts of the columns having been erected, the rule for the capitals (Doric) will be as follows:.....the abacus is in length and breadth equivalent to the thickness of the shaft at its bottom plus one-eighteenth thereof, and

the height of the capital, including the volutes, one-half of that amount. Then the height of the capital is to be divided into nine and a half parts, and down along the abacus on the four sides of the valutes, down along the fillet at the edge of the abacus, lines called "catheti" are to be let fall. Then, of the nine and half parts, let one and a half be reserved for the height of the abacus, and let the other eight be used for the volutes.*

8. .....The rule for the architraves is to be as follows: If the columns are at least twelve feet and not more than fifteen feet high, let the architrave be equal to half the thickness of a column at the bottom. If they are from fifteen feet to twenty, let the height of a column be measured off into thirteen parts and let one of these be the height of the architrave.....

9. .....The depth of the architrave and its underside just above the capital, is to be equivalent to the thickness of the top of the column just under the capital, and on its uppermost side equivalent to the foot of the shaft.

10. The cymatium (moulding) of the architrave should be one-seventh of the height of the whole architrave and its projection the same. Omitting the cymatium, the rest of the architrave is to be divided into twelve parts, and three of these will form the lowest fascia, four the next, and five

(*For method of describing volutes, see Chapter V, 6 & 8, pp.92.)

the highest fascia. The frieze, above the architrave, is one-fourth less high than the architrave, but if there are to be reliefs upon it, it is one-fourth higher than the architrave, so that the sculptures may be more imposing. Its cymatium is one-seventh of the whole height of the frieze and the projection of the cymatium is the same as its height.

11. Over the frieze comes the line of dentils, made of the same height as the middle fascia of the architrave and with a projection equal to their height. The intersection is apportioned so that the face of each dentil is half as wide as its height and the cavity of each intersection two-thirds of the face in width. The cymatium here is one-sixth of the whole height of this part. The coronae with its cymatium, but not including the sima, has the height of the middle fascia of the architrave and the total projection of the coronae and dentils should be equal to the height from the frieze to the cymatium at the top of the coronae (means in fact to be a 45 degree angle).....

12. The height of the tympanium, which is in the pediment, is to be obtained thus: Let the front of the corona, from the two ends of its cymatium, be measured off into nine parts and let one part be set up in the middle of the peak of the tympanium, taking care that it is perpendicular to the entablature and the neckings of the columns. The coronae

over the tympaniums are to be made of equal size with the coronae under it, not including the sima. Above the coronae are the sima which should be made one-eighth higher than the height of coronae.....

14. Each column (when fluted) should have twenty-four flutes.....the breadth of the flutes is to be equivalent to the enlargement in the middle of the column, which will be found in the figure.

Book IV - Chapter I

1. Corinthian columns are, except in their capitals, of the same proportions in all respects as Ionic.....while the height of the Corinthian (capital) is the entire thickness of the shaft.....

2. The other members which are placed above the column (entablature) are for Corinthian columns composed either of the Doric proportions or according to the Forric usages; for the Corinthian order never had any scheme peculiar to itself.....

11. The proportions of the capital should be fixed as follows: Let the height of the capital, including its abacus, be equivalent to the thickness of the base of a column. Let

the breadth of the abacus be proportioned so that diagonals drawn from one corner of it to the other shall be twice the height of the capitals.....the height of the abacus is one-seventh of the height of the capital.

12. Omitting the height of the abacus, let the rest be divided into three parts of which one should be given the lowest leaf. Let the second leaf occupy the middle part of the height. Of the same height should be the stalks, out of which grow leaves projected so as to support the volutes which proceed from the stalks and run out to the utmost corners of the abacus; the smaller spirals between them should be carved just under the flower which is on the abacus. The flowers on the four sides are to be made as large as the height of the abacus.....

APPENDIX 'C'

The following passages from the works of Vitruvius, are selected from the Ten Books on Architecture, Book V, Chapter IX, intended to describe the rules governing architectural proportions, style and construction of Colonnades.

3. The approved way of building them requires that they be doubled and have Doric columns on the outside, with architraves and their ornaments finished according to the law of modular proportions.....

2. The columns will not be subject to the same rules of symmetry and proportion which are prescribed in the case of sanctuaries; for the dignity which ought to be their quality in temples of the gods is one thing, but their elegance in colonnades and other public works is quite another. Hence, if the columns are to be of the Doric order, let their height, including the capital, be measured off into fifteen parts. Of these parts, let one be fixed upon to form the module and, in accordance with this module, the whole work is to be developed. Let the thickness of the columns at the bottom be two modules; an inter-columnation five and a half modules; the height of a column, excluding the capital, fourteen modules; the capital, one module in height and two and one-sixth modules in breadth.

Let the modular proportions of the rest of the work be carried out as written in the fourth book in the case of the temples.

4. But if the columns are to be Ionic, let the shaft, excluding base and capital, be divided into eight and one-half parts, and let one of these be assigned to the thickness of a column. Let the base including the plinth, be fixed at half the thickness and let the proportions of the capital be as shown in the third book. If the column is to be Corinthian, let it's shaft and base be proportioned as in the Ionic, but its capital, as has been written in the fourth book.

In the stylobates, let the increase made there by means of the "scamilli impares" be taken from the description written above in the third book. Let the architraves, coronae and all the rest be developed in proportion to the columns, from what has been written in the foregoing books.....

CONCERNING THE TREATMENT OF OPEN SPACES ENCLOSED BY COLONNADES

7. That they may be always dry and not muddy, the following is to be done: Let them be dug down and cleared out to the lowest possible depth. At the right and left construct covered drains and in their walls, which are directed toward the walks, lay earthen pipes with their lower ends inclined into the drains. Having finished these, fill up the place with charcoal, and then strew sand over the walks and level them off. Hence, on account of the porous nature of the

charcoal and the insertion of the pipes into the drains, quantities of water will be conducted away, and the walks will thus be rendered perfectly dry and without moisture.

APPENDIX 'D'

The following passages from the works of Vitruvius, are selected from the Ten Books on Architecture, Book V, Chapter XII, intended to describe the rules governing the construction of HARBOURS, BREAKWATERS AND SHIPYARDS.

1. The subject of the usefulness of harbours is one which I must not omit, but must explain by what means ships are sheltered in them from storms. If their situation has natural advantages, with projecting capes or promontories, such harbours are obviously of the greatest service. Round them, of course, colonnades or shipyards must be built, or passages from the colonnades to the business quarters and towers must be set up on both sides from which chains can be drawn across by machinery.

2. But if we have a situation without natural advantages and unfit to shelter ships from storms, it is obvious that we must proceed as follows:.....

Walls which are to be under water should be constructed as follows: Take the powder (*1) which comes from the country extending from Cumae to the promontory of Minerva, and mix it into the mortar trough in the proportion of two to one.

*1 Volcanic earth, Pozzolana used as hydraulic cement found in thick strata in and around Rome and in the district of Naples.

3. Then, in the place previously determined, a cofferdam, with its sides formed of oaken stakes with ties between them is to be driven down into the water and firmly propped there; then the lower surface inside, under water, must be levelled off and dredged, working from beams laid across; and finally, concrete from the mortar trough must be heaped up until the empty space which was within the cofferdam is filled up by the wall.....But if by reason of currents or the assaults of the open sea, the props cannot hold the cofferdam together, then let a platform of the greatest possible strength be constructed, beginning on the ground itself or on a substructure; and let the platform be constructed with a level surface for less than half its extent, while the rest, which is close to the beach, slopes down and out.

4. Then, on the water's edge and at the sides of the platform, let marginal walls be constructed, about one and one-half feet thick and brought up to a level with the surface above mentioned; next let the sloping part be filled with mud and levelled off with the marginal wall and the surface of the platform. Then, upon this level surface construct a block as large as is required and when it is finished leave it for not less than two months to dry. Then, cut away the marginal wall which supports the sand. Thus, the sand will be undermined by the waves and this will cause the block to fall into the sea. By this method, repeated as often as necessary,

an advance into the water can be made.

5. But in places where this powder is not found, the following method must be employed. A cofferdam with double sides composed of charred stakes fastened with ties, should be constructed in the appointed place and clay wicker baskets made of swamp rushes should be packed in among the props. After this has been well packed down, and filled in as close as possible, set up your water-screws, wheels and drums and let the space now bounded by the enclosure be emptied and dried. Then dig out the bottom within the enclosure.....and then fill in with masonry consisting of rubble, lime and sand.

6. Finally, build the wall of dimension stone, with the bond stone as long as possible, so that particularly the stones in the middle may be held together by the joints. Then, fill the inside of the wall with broken stones or masonry. It will thus be possible for even a tower to be built upon it.

7. .....the general rule for shipyards will be to build them facing the north. Southern exposures..... produce rot.....and these buildings must by no means be constructed of wood, for fear of fire. As for their size, no definite limit need be set, but they must be built to suit the largest type of ship.

APPENDIX 'E'

Selected Glossary of Architectural Terms

Abacus	(Lat. tablet) A slab forming the crowning member of a capital.
Abutment	Solid masonry which resists lateral pressure.
Acroteria	(Gk. Summits or extremities) Blocks resting on the vertex and lower extremities of the pediment to support statuary or ornaments.
Anta	(plural antae) A pilaster terminating the side wall of a greek temple.
Antefixa	Ornamental blocks, fixed at regular intervals, vertically, along the lower edge of the roof.
Architrave	(Gk., main beam) The beam or lowest division of the entablature, extruding from column to column.
Ashlar	Masonry of smooth squared stones in regular courses.
Base	The lower portion of any structure or architectural feature.
Capital	(Lat. caput = head) The crowning feature of a column or pilaster.
Cella	The major room of a temple, where the image of a god stood.
Coffers	Sunk panels, formed in ceilings, vaults and domes.
Colonnade	A range of columns.
Column	(Lat. - post) A vertical support, generally consisting of a base, circular shaft and spreading capital.
Cornice	The crowning or upper portion of the entablature.

Corona	The square projection in the upper part of the cornice.
Cymatium	(Lat. cyma = wave) Crowning moulding of a cornice.
Dentils	(Lat. - teeth) Tooth-like blocks in Ionic and Corinthian cornices.
Diastyle	A term used when the space between columns is three column diameters.
Engaged Column	Columns attached to a wall with part of their circumference.
Entablature	The upper part of an order of architecture, comprising architrave, frieze and cornice, supported by columns.
Exedra	(Gr. - outdoor seat) A recess or alcove, circular or semi-circular.
Frieze	The middle division of the classical entablature.
Gable or Pediment	The triangular portion of a wall between the enclosing lines of a sloping roof.
Interaxial	Measurement from centre line to centre line of column.
Intercolumnation	Space, measured between column faces.
Jambs	The sides of doors and windows.
Plinth	The lowest square member of a base.
Podium	A continuous pedestal, or raised platform.
Scotia	(Gk. - darkness) The concave mouldings in the base of a column.
Shaft	The portion of a column between the base and capital.
Soffit	The ceiling or underside of any architectural member.
Stylobate, Stereobate	The upper step or foundation wall, forming a platform on which a row of columns is placed.
Tholos	A circular building or dome.

Vault	An arched covering in stone or brick over any building.
Volute	(Lat. scroll) The scroll or spiral occurring in Ionic or Corinthian capitals.

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