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Swimming Pools and Water Management in the Eastern Mediterranean World of the 4th to 1st Century BC

Summary

While it is debated in scholarship whether the Greeks conceptualized swimming as a sport and leisure activity, the archaeological evidence of swimming pools in the Eastern Mediterranean from the 4th to 1st century BC speaks for the existence of such a concept. This paper argues that challenges of water management are a major reason why the Greeks did not systematically build swimming pools as an urban standard for the physical education and pleasure of broader parts of the population. By examining 13 pools, it is shown that their water management required specific topographical conditions, notably, a location close to a river or a spring, and the appropriate socio-economic conditions, notably, patrons with sufficient financial means, access to technological know-how, and cultural appreciation of swimming.

Keywords: swimming pools; athletics; water management; Panhellenic sanctuaries; Hellenistic palaces

In der Forschung ist umstritten, ob die Griechen Schwimmen als Sport- und Freizeitaktivität konzipierten. Die archäologischen Befunde von Schwimmbecken im östlichen Mittelmeer aus dem 4.–1. Jh. v. Chr. belegen aber eindeutig, dass ein solches Konzept existierte. Dieser Beitrag zeigt, dass die erheblichen Anforderungen an das Wassermanagement vermutlich der wichtigste Grund waren, warum die Griechen nicht systematisch eigene Schwimmbecken als urbanen Standard für Sport und Vergnügen der breiten Bevölkerung bereitstellen konnten. Mit der Untersuchung von 13 Schwimmbecken wird dargelegt, dass ihr Wassermanagement besondere Bedingungen erforderte: die Nähe zu Flüssen und Quellen, wohlhabende Bauherren, Zugang zu technologischem Knowhow und eine kulturelle Wertschätzung des Schwimmens.

Keywords: Schwimmbecken; Sport; Wassermanagement; panhellenistische Heiligtümer; hellenistische Paläste

Jonas Berking (ed.) | Water Management in Ancient Civilizations | (ISBN 978-3-9818369-6-7; ISSN (Print) 2366-6641; ISSN (Online) 2366-665X; DOI 10.17171/3-53) | www.edition-topoi.org

First of all, I would like to thank the conference organizers for inviting me to this very stimulating conference. Earlier versions of this paper were presented at the Annual Meeting of the Archaeological Institute of America in 2012 and the conference *Cura Aquarum* in Greece, held in Athens in 2015, and I am much indebted to the audiences for the discussions and advice they shared.

There is a strong notion in scholarship that Greeks would not have known and enjoyed swimming as a leisure and athletic-competitive activity, although Greece was surrounded by the sea and provided abundant natural waters.¹ While there is archaeological evidence, namely images of people swimming and remains of pools, that challenges this notion, it is by no means abundant. Furthermore, this evidence suggests that swimming from about the 6th to the 1st century BC was a privilege of the urban elite and royal households. Since swimming is today a prime athletic activity and one of the most popular sports, one wonders why the Greeks, with their strong focus on athletic-military training and shaping the body, would not have embraced swimming more systematically for training the youth.

Efficient systematic swim training and swim competitions need, ideally, relatively safe and reliable settings, notably, waters without strong currents, waves, winds, unpredictable depths, and other obstacles. Such conditions are best met by purposely-built swimming pools that require not only an appropriate setting (indoors or outdoors) and certain efforts to be made for their construction, but, above all, constant maintenance. Most challenging is the water management, particularly providing a steady supply of water, but also maintaining the quality and purity of the water and its drainage. This paper argues that the challenges of water management are a major, if not the main reason why the Greeks did not systematically build swimming pools as an urban standard for the physical education and pleasure of broader parts of the population. By examining 13 selected pools from six sites in the Eastern Mediterranean from the 4th to 1st centuries BC in a chronological order, it is shown that the water management of these pools required specific topographical conditions, notably, a location close to a river or spring, and socio-economic conditions, notably, patrons with sufficient financial means, access to technological knowhow, and cultural appreciation of swimming as an athletic and leisure activity. The selected pools are located in, or closely connected to, four Panhellenic sanctuaries in Olympia, Isthmia, Nemea, and Delphi, as well as two royal palace

1 Most strongly Auberger 1996, but also Elitzur 2008; Handy 2008.

areas in Aï Khanoum and Jericho.² Only when cities were increasingly provided with aqueducts from the late 1st century BC onwards, did cold water pools become more common, and even standard within public baths.

Due to the restrictions of space, the focus in the following is entirely on water management of swimming pools, whereas other key features such as the size and design, architectural-urban context, dates, possible functions, users, and socio-cultural significance of the pools cannot be discussed in detail. Since there is no comprehensive study of ancient swimming pools, let alone their water management, and since most pools have not been sufficiently explored and some are no longer visible today, this paper can only offer preliminary considerations and not final answers to all of the questions.³

1 Olympia

The Panhellenic sanctuary of Zeus was probably the first to be provided with a pool, most likely in the first half of the 4th century BC. This pool is located in the area between the sanctuary proper (Altis) and the Kladeos River, which was used to accommodate visitors in temporary structures and was gradually provided with permanent buildings for the convenience of visitors in the 4th century BC (Fig. 1). Based on the remains of waterproof pebble cement floors discovered at two different levels, the pool is reconstructed as an open-air facility with a rectangular shape, at a size of 24×16 m at the bottom and a maximum depth of 1.60 m, as well as including five steps (0.32 m deep and high) and a paved walkway of about 2.50 m width on all four sides (Fig. 2).⁴ Thus, the maximum capacity would have been about 614 000 liters.

Remains of a large drainage channel (0.50 m wide, 0.75 m high) were found under the later Roman Kladeos Baths, at a distance of about 5 m from the bottom of the pool

2 More pools are known from Late Classical and Hellenistic sites in the Eastern Mediterranean that cannot be discussed here: Pella, Palace, peristyle-complex V, pool 7.5×5 m, 1.65 m deep, end of 4th/early 3rd century BC (Chrysostomou 1996, 114–119); Samos, *Gymnasion*, central courtyard with *stoai*, pool 15.70 by 14.80 m, 1.26–1.66 m deep, mid-3rd century BC (Martini 1984, 23–25); pools of the late 1st c BC and early 1st c AD are also excluded, among them pools in the palaces of Herod the Great (Netzer 1986; Netzer 2001a; Netzer 2001b); and a pool in the area of the *gymnasion* of Corinth (10.32×11 –12 m, at least 1.58 m deep; 1st century

AD; Wiseman 1972, 18–22).

3 11 of the 13 pools discussed here became only known after René Ginouvès had published his study on the Greek bathing culture; Ginouvès 1962. There is also no monograph on the much more numerous swimming pools of the Roman Imperial period; however, for a summary of their water management, see Garbrecht and Manderscheid 1994, 21–23, 59–60, 70–76.

4 Schleif 1943, 17–18; Kunze and Schleif 1944, 40–46, 80–96; Mallwitz 1958, 23–24. – In more detail for this pool, Trümper 2017.

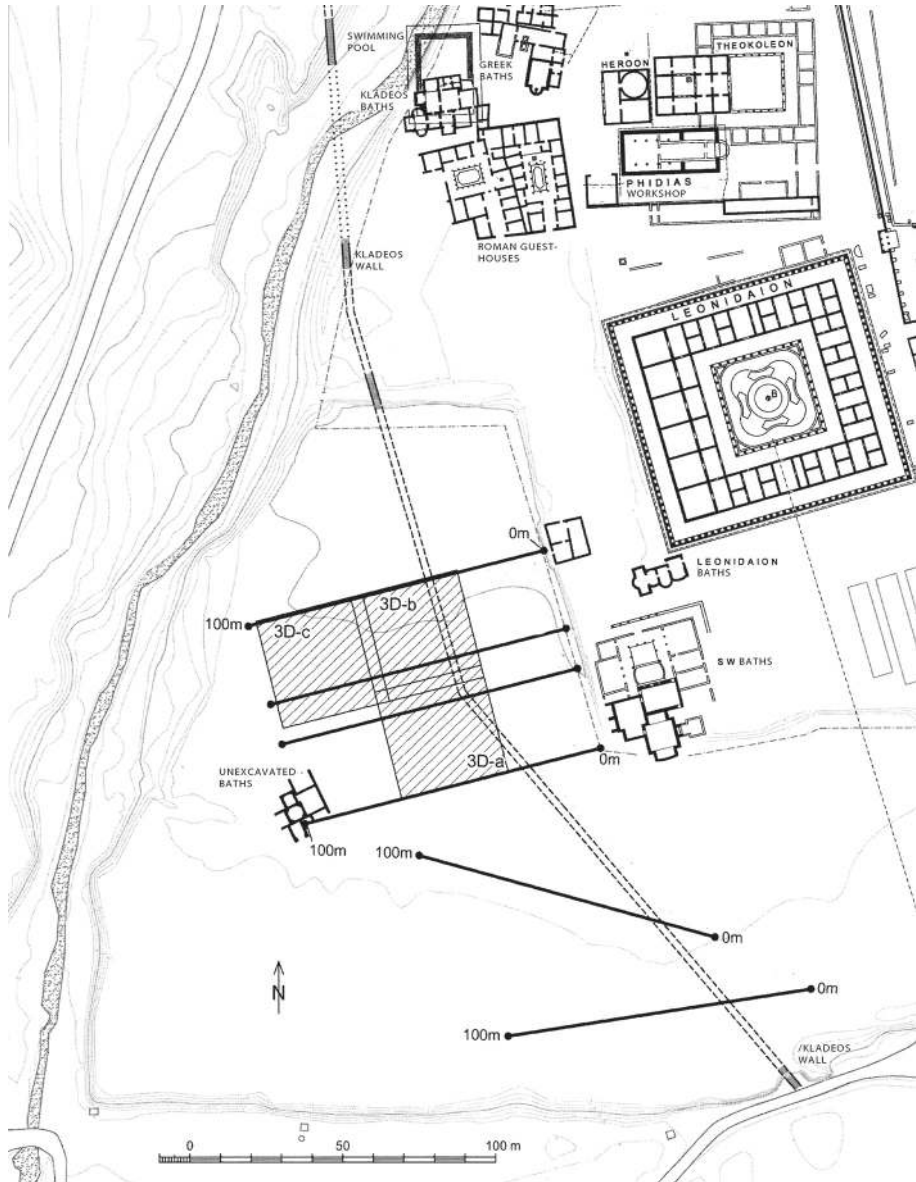


Fig. 1 Olympia, Sanctuary of Zeus, plan of the western section.

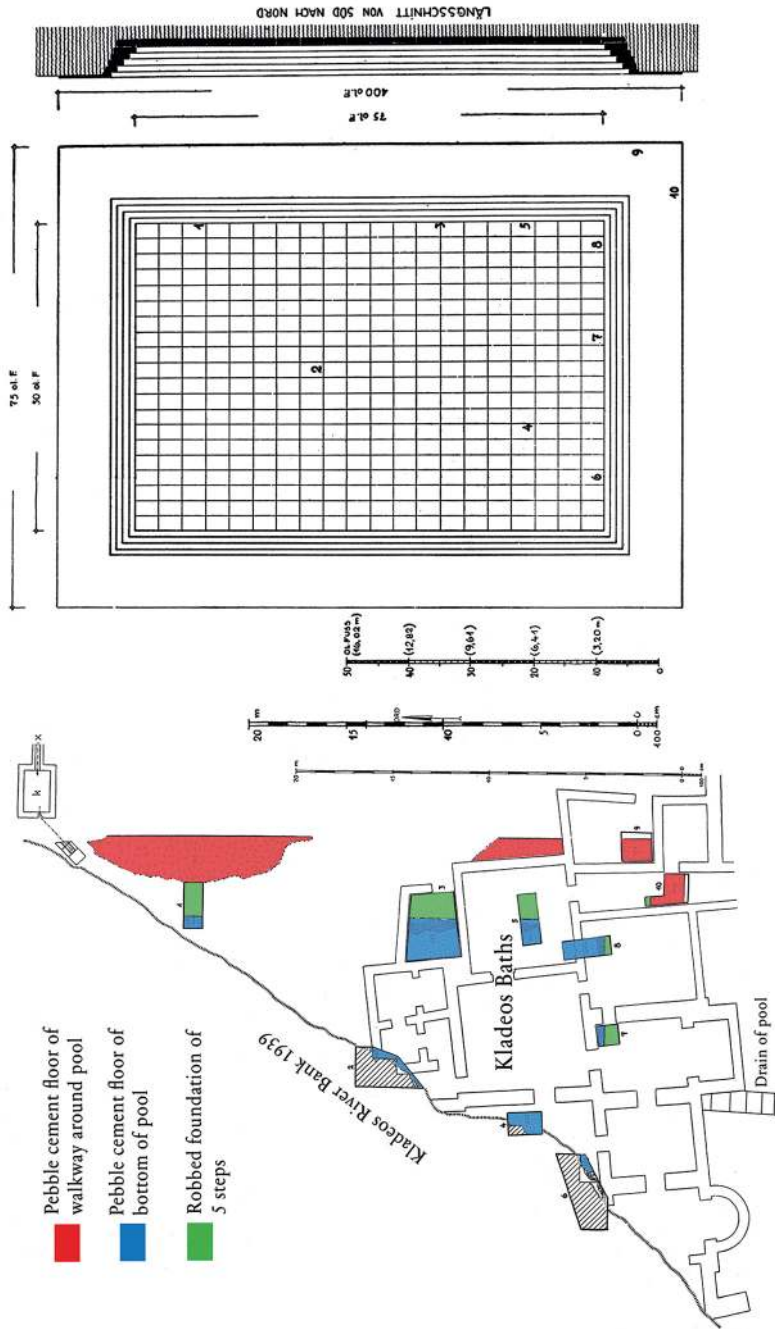


Fig. 2 Olympia, Sanctuary of Zeus, reconstruction of the swimming pool.

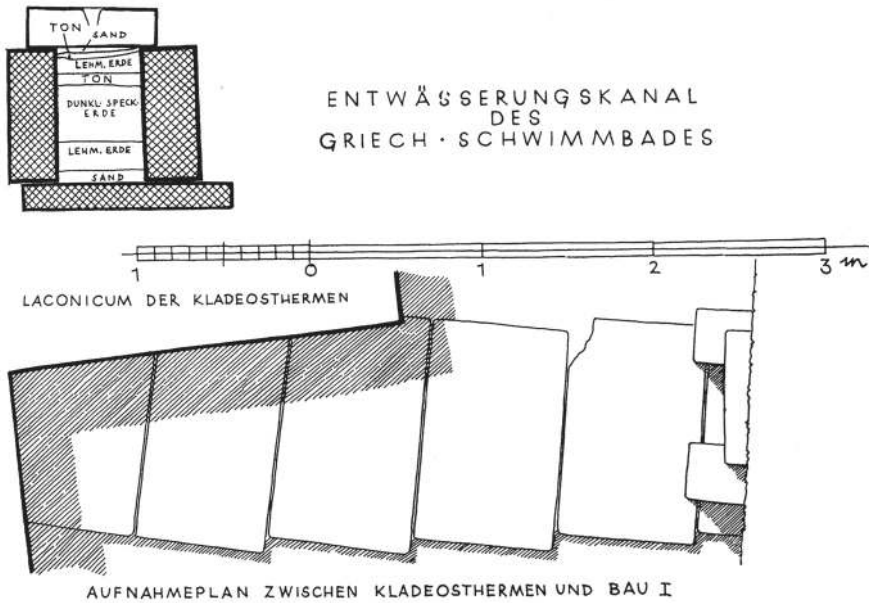


Fig. 3 Olympia, Sanctuary of Zeus, drainage channel of the swimming pool.

and, thus, without any direct connection with the remains of the pool (Fig. 3).⁵ Alfred Mallwitz assumed that this channel led from the bottom of the pool, through its steps, to the adjacent Kladeos River, and that drainage to the south, instead of more directly to the west, would have been chosen in order to avoid backwater during the rain-laden winter months.⁶ While it is questionable that the pool would have been used in the winter, they may still have tried to keep it as clean as possible, to avoid flooding year-round. Where exactly the drainage channel would have traversed the embankment wall of the Kladeos and reached the Kladeos, remains unknown.⁷

Reconstruction of the crucial water supply is problematic. Close to the reconstructed northeast corner of the pool, a basin (K) was found, whose size and depth are

5 Cf. Kunze and Schleif 1944, pl. 15 and Mallwitz 1958, pl. 2, who does not indicate any elevations for this channel; pl. 3 shows the pool in a section of trench 3 that was carried out in the Roman guest-houses with an elevation of -500, in a distance of about 15.25 m from the bottom of the pool. Mallwitz 1958, 23, claimed that he had seen the beginning of the drainage channel of the pool in the northwest corner of the Tepidarium of the Kladeos Baths, but this is questionable; see in detail Trümper

2017, 223 n. 23.

6 Mallwitz 1958, 23–24: on his reconstructed plan, pl. 4, the channel leads slightly to the southeast, but the remains as shown on pl. 2 suggest that it ran straight to the south.

7 Recent research on this embankment wall did not yield any evidence of this channel: Kyrieleis and Herrmann 2003, 43–45; Herrmann et al. 2013, esp. 401.

nowhere mentioned.⁸ This was presumably fed by the open channel X that, according to Hans Schleif, was constructed later than the pool itself.⁹ A channel leads from the basin to the southwest, widening from 10 to 28 cm, but after 3 m runs against a square block (60 × 60 cm), which is located in the northeast corner of the reconstructed paved walkway of the pool. While Schleif used these structures mainly for a reconstruction of the pool, their function was not discussed. A basin with an inlet, but no obvious outlet is hard to explain. If the basin had a connection to the pool, which seems most likely, if currently unprovable,¹⁰ it could have served as a settling basin from where cleaned water would have been led into the pool. In this case, it remains to be assessed in more detail how exactly this shallow open channel would have been supplied and whether it could have sufficed to fill the entire pool. If these structures did not belong to the pool, from the beginning or at a later period, water supply must have been granted altogether differently: the easiest option seems to be a channel from the Kladeos River to the northern border of the pool, of which no evidence for this has ever been found, however. This channels would have also had to cross the Kladeos embankment wall; the latter was located 27 m from the pool. The supply channel would have had to start at a sufficient distance upstream, in order to provide an appropriate slope down to the pool.¹¹

Whether water would have flowed continuously from the river to the pool and back into the river, depending on the season and water level of the river, must remain open, but seems an attractive possibility.

8 While the size can be taken from the plans, ca. 2.2 × 1.40 m, the depth must remain unknown.

9 Kunze and Schleif 1944, 43–44. The water management of the entire sanctuary has not been studied comprehensively; recent excavations to the northwest of the Philippeion yielded remains of five successive water supply systems that were dated from the 5th to the 2nd century BC; it is unclear, however, whether any of these and which would have supplied the basin k; Kyrieleis and Herrmann 2013, 20–25.

10 See in detail Trümper 2017, 229 n. 30.

11 There is no agreement in literature, when exactly the Kladeos ran where in relation to the embankment wall: Knauss 2004, 67 fig. 10, suggests that the

river ran to the west of the wall, once the wall had been built; Herrmann et al. 2013, 400, argue, based on recent excavations, that the Kladeos partially returned to its old riverbed to the east of the northern part of the wall, but it would have been diverted back to the west of the wall further south, e.g. at the height of the workshop of Pheidias. In this case, the Kladeos could have run immediately to the west of the pool, without any embankment wall between pool and river. Since the precise chronology of these changes remains unknown, however, they currently cannot be assessed with view to the (changing?) water supply of the pool. Cf. also Mallwitz 1981, 370–382; Matzanas 2012.

2 Isthmia

The Panhellenic sanctuary of Poseidon was provided with a pool around the mid-4th century BC, when the sanctuary saw a major remodeling and monumentalization.¹² Located about 100 m to the north of the temple and next to the theater, the pool can be reconstructed from substantial remains of different waterproof pavements and walls found under a Roman bath building from the 2nd century AD (Fig. 4). The open-air pool measured 30 × 30 m and was about 1.2 m deep, thus providing a capacity of 1 080 000 liters (Fig. 5).¹³ At least in the east, it was flanked by a paved walkway of 2.1 m in width and an adjacent wall; this pavement included a water line with seven oval basins that may have served as foot washbasins for swimmers or as drainage basins for a roofed structure.

Two drains leading from the center of the north wall of the pool to the north (and probably northeast) were found. One of them was safely connected to an outlet at the bottom of the pool that had a diameter of 0.12–0.18 m, which was presumably fitted with a bronze pipe, and led to a well-made drainage channel of 0.51–0.56 m in width.¹⁴ Of the other drain, only a channel to the north of the pool survives, which was made of large blocks and covered with waterproof cement, and reused in the later Roman bath.¹⁵ It cannot be determined whether both drains were used at the same time, presumably for granting smooth evacuation of large amounts of water, or whether they were built and operated consecutively. Immediately north of the pool, the water line branched to the east and west, but it is unclear where exactly the branches ended in the use period of the pool. They most likely emptied conveniently into the adjacent ravine, like other drains coming from the sanctuary.¹⁶

In contrast, no evidence of the central water inlet and supply has been securely identified. Possible remains of a channel to the southwest of the pool suggest, however, that water was supplied somewhere from this direction.¹⁷ Water sources seem to concentrate in this area, in the ancient and modern periods, because there is still a functioning spring, a large ravine (the ‘Northwest Gully’), and a network of channels and reservoirs from the Greek and Roman periods to the sanctuary. While the narrow water channels and the large reservoir found in the area of the temple do not

12 Gregory 1995, 303–312; Reinhard 2005, 9–10.

13 The pool is actually 1.40 m deep, but provided with curving cap stones, which indicated the height of the water.

14 Gregory 1995, 308.

15 The size of this drainage channel is not indicated in

Gregory 1995.

16 Gregory 1993, 9–10.

17 Gregory 1995, 308 mentions a small trench, RB 76–22, to the southwest of room XIV of the Roman bath building, in which a cutting in hardpan with several stones in situ were found.

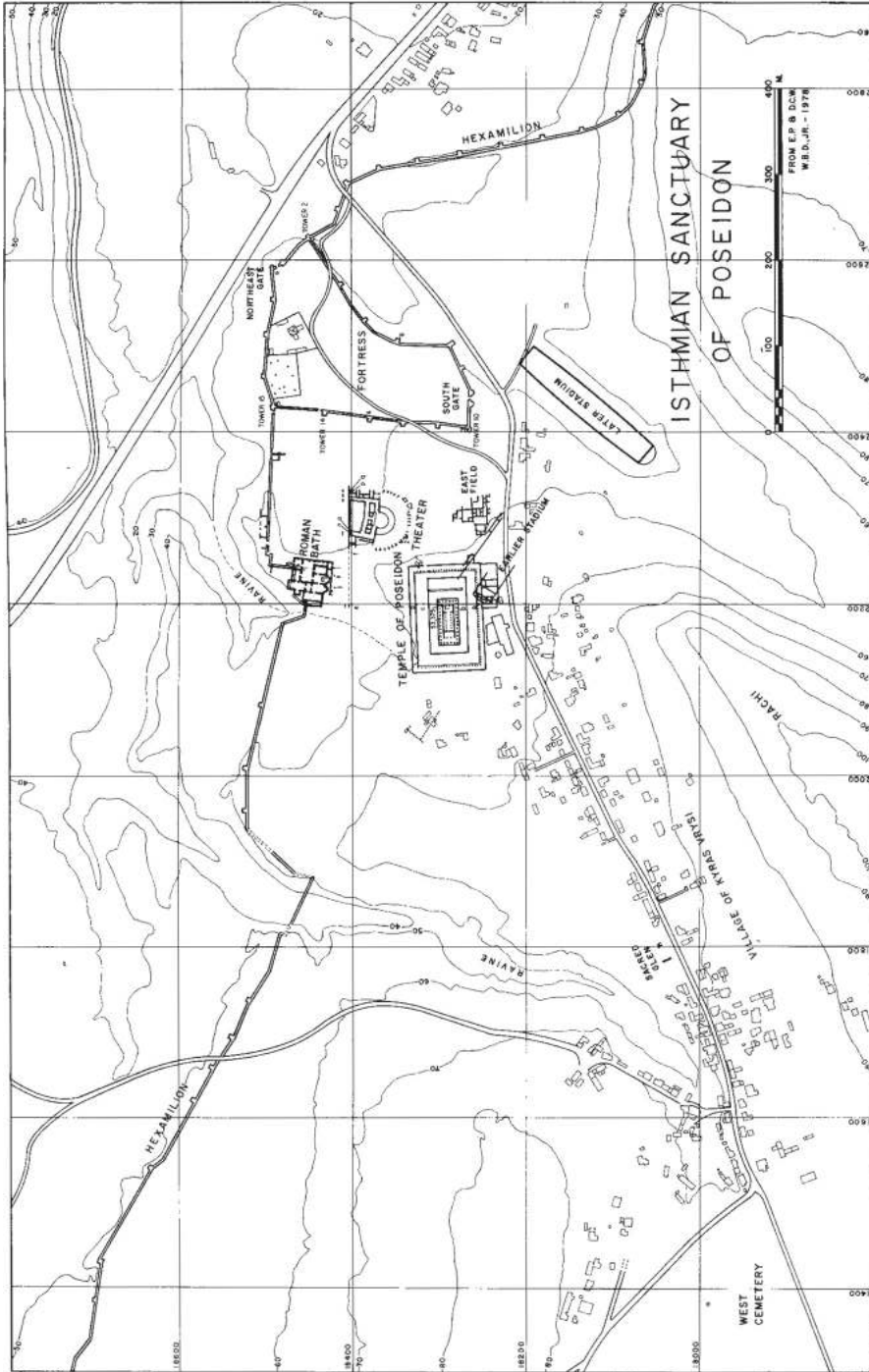


Fig. 4 Isthmia, Sanctuary of Poseidon, plan.

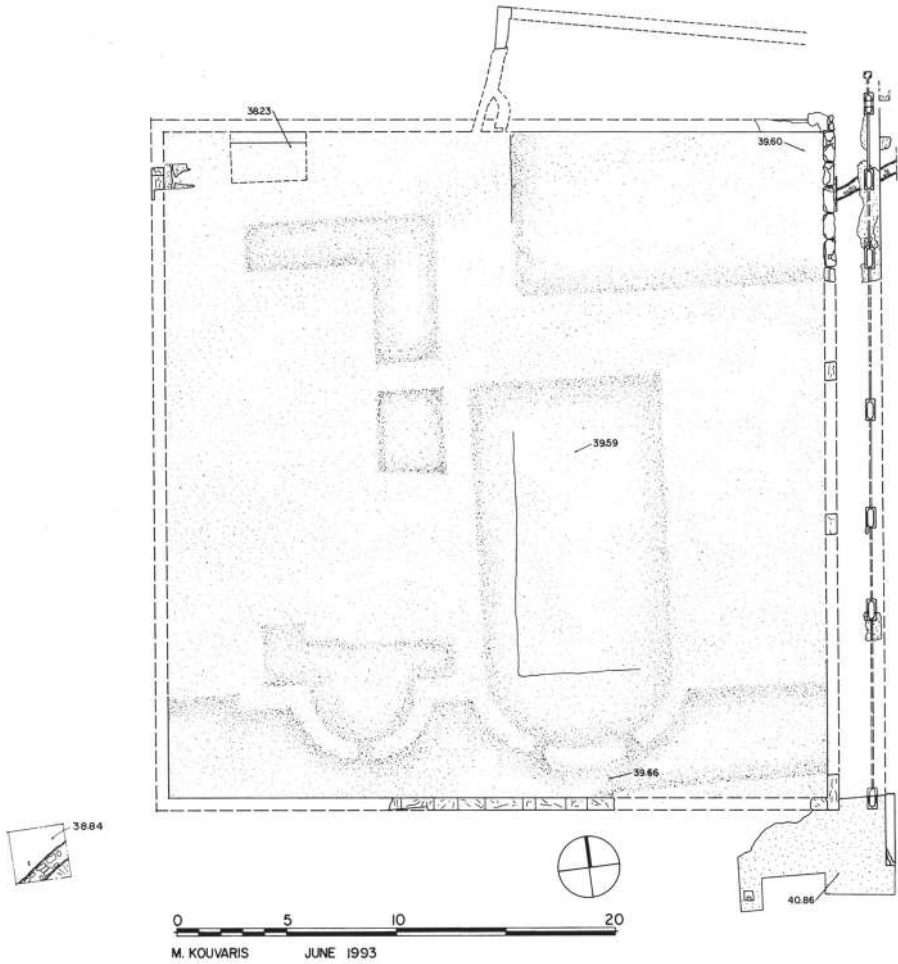


Fig. 5 Isthmia, Sanctuary of Poseidon, reconstruction of the swimming pool.

seem sufficient to supply the large pool,¹⁸ a system of large rock-cut tunnels (0.80 m wide, 2 m high) found close to the western ravine seems more appropriate for this purpose (Figs. 6 and 7). These have barely been explored, however, and their date, exact

18 Broneer 1973, 24–27: channels I–III (for example, channel I is 0.14 m wide at the bottom and 0.07 m deep); the largest reservoir, the northwest reservoir,

had only a capacity of 110 m³, and water was drawn by hand via three manholes.



Fig. 6 Isthmia, Sanctuary of Poseidon, rock-cut water tunnel at the eastern border of the ravine ('North-west Gully').



Fig. 7 Isthmia, Sanctuary of Poseidon, rock-cut water tunnel at the eastern border of the ravine ('North-west Gully').

course, and function cannot safely be determined.¹⁹ It is unknown whether this large pool could have been supplied continuously with fresh water, but the potential double drainage system may reflect a high use of water.²⁰

19 Jenkins and Megaw 1931–1932, 85–89, have briefly explored these features; they found the rock-cut tunnels covered with excellently preserved cement and filled with debris that included sherds from the Geometric to Roman periods. They argue that the cement would indicate a date in the 6th or 5th century BC. The tunnels ran into a barely preserved cistern. The opening of the main tunnel was found about 8–10 m below the top of the ravine (in the early 1930s), but earthquakes seem to have considerably altered the landscape in the area of the sanctuary of Poseidon over the centuries; Gregory 1993, 9. – Similar rock-cut tunnel systems for water supply, built from the Archaic period onwards, are known from

other sites, among them nearby Corinth, Megara, Nemea, and Samos; for Corinth, Hill 1964; Landon 2003; Robinson 2011, 11–17; for Megara, Avgerinou 2015; for Nemea, see below; and for Samos, Kienast 1995.

20 Recent research in the area of the Roman bath has yielded evidence that has cautiously been identified as remains of a bath building with a *hypocaust* system in the north, a large complex of stoa (*gymnasion?*) in the east, and another stoa (*palaistra?*) in the south. While these remains date to the Roman Imperial period, there are some indications of earlier phases, not yet fully explored, however (Frey and Gregory 2016), ongoing research in these areas may

3 Nemea

The Panhellenic sanctuary of Zeus was provided with a separate bath complex when the Nemean games were revived and the sanctuary experienced a building boom in the years of ca. 330 to 270 BC. The completely roofed bathing facility was located to the south of the temple, between a guesthouse (Xenon) and the Nemea River (Fig. 8). It included a central pool flanked by two rooms, each with four tubs on high feet for washing with cold water. Measuring 8.20 by 3.90 m at the bottom, the pool was at most 1.30 m deep and accessible by a monumental staircase with four steps that stretched across the entire northern side of the pool. Its maximum capacity has been calculated at 43.56 m³ (Figs. 9, 10).²¹

The pool was drained through a small hole at the bottom of the northwest corner into a shallow open U-shaped tile channel; this channel ran hidden under the lowest entrance step of the pool and collected water from both tub rooms and the pool, exiting through the west wall of the West Tub Room. All water from the bath complex was drained into a rubble-lined drain, which was covered with reused starting blocks of an early stadium.²²

Reconstructing the water supply is again more challenging, although there are substantial remains of the supply system. Both the tubs and the pool were fed with water from a system of reservoirs along and outside the southern wall of the building, which in turn, was most likely fed by a spring located 650 m to the east of the bath building. While no continuous channel from the spring to the bath complex was found, several sections were explored that may have belonged to different phases:

1. At the spring, a rock-cut tunnel (1.97 m high, 0.48 m wide, preserved for a length of about 16.40 m);
2. About 100 m west of the spring, a series of blocks that originally formed a rather monumental triangular shaped closed channel and that show heavy lime encrustations;²³

shed more light on the water supply, context, and function of the pool.

21 Miller 1992.

22 Miller 1992, 212–213; no measures for the outlet hole are given; the tiles of the channel had an interior width of 0.08 m at the small end, and an interior height of 0.14 m at the small end and 0.21 m at the large end. Miller 1992, 216 had still assumed that water was drained into the adjacent Nemea River. In Miller 2004, 67 and Miller 2015, 279–280,

the river is identified as a wide, deep, artificially made drainage channel that was only created at the end of the 4th century AD in order to convert the once swampy valley into arable land.

23 Miller 1992, 225–227: the blocks are about 0.29 m thick, 0.89–0.9 m high, and 1.02 m long. Since the technique of these reused blocks is strongly reminiscent of that on blocks of the Temple of Zeus, the aqueduct would be too late for the bath building.

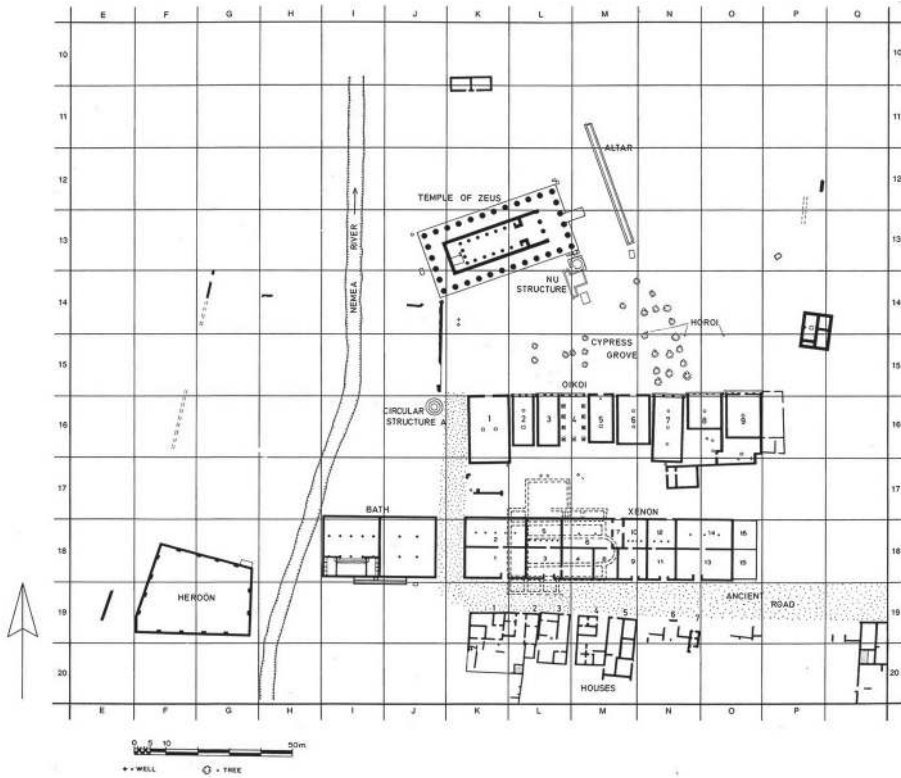


Fig. 8 Nemea, Sanctuary of Zeus, plan.

3. A covered small aqueduct line found to the south of the Xenon; this channel was traced for about 80 m, was made with shallow U-shaped terracotta tiles at the bottom, and may have supplied the reservoir system of the bath complex, even if no immediate connection between these structures was found. For this stretch, Stephen Miller calculated a steady slope of 0.9 m over every 100 m of distance traversed;²⁴
4. An aqueduct located directly south of, and largely parallel to, the reservoirs of the bath complex, which is constructed of small stones and tile fragments. Since it was cut by the reservoirs, it may originally have supplied the bath building with water.²⁵

24 Miller 1992, 227, 300: the U-shaped tiles are 0.107 m wide and 0.201 m high; the area was covered with Corinthian cover tiles, Lakonian ridge cover tiles, and broken Corinthian pan tiles.

25 Miller 1992, 231: followed for about 19 m, 0.1 m

wide and 0.3 m deep. It is lined with hydraulic cement and notable for its lack of heavy lime accretions; its bottom is with 332.839 partially on a lower level than that of the reservoirs with 332.740 to 332.995; cf. Miller 1992, Fig. 259*.

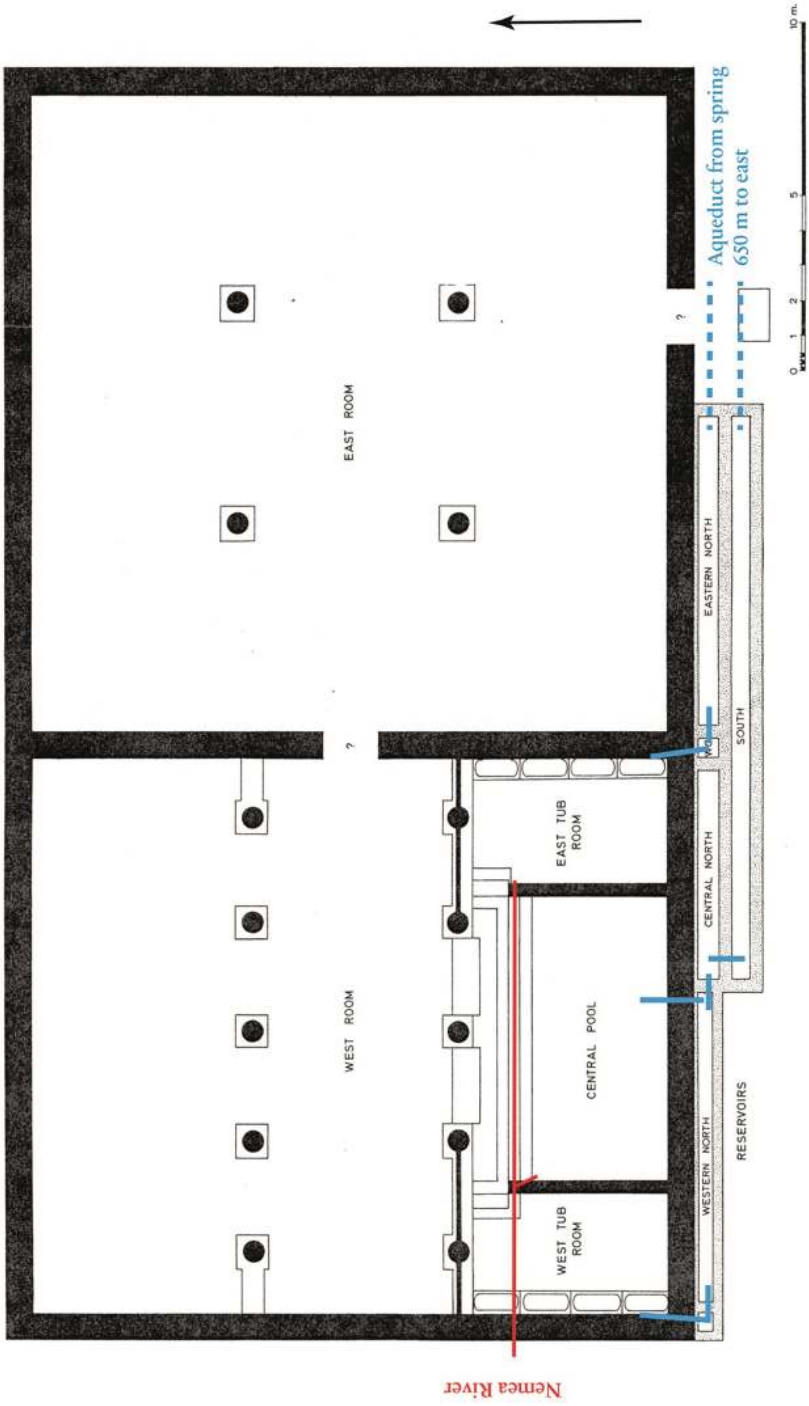


Fig. 9 Nemea, Sanctuary of Zeus, reconstructed plan of the bath building with water management (blue: supply – red: drain).

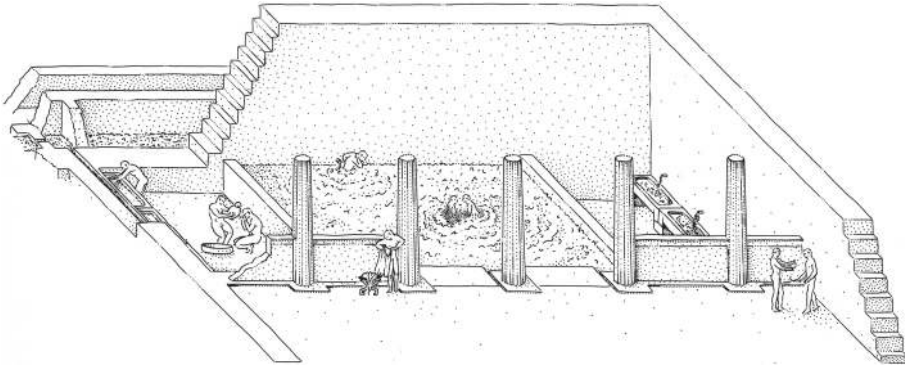


Fig. 10 Nemea, Sanctuary of Zeus, reconstruction of the bathing rooms.

Therefore, the intricate system of four reservoirs seems to belong to a later phase of the building when water supply was improved: either in order to better feed the existing pool and tubs, or to feed the newly built pool and tubs that replaced some unknown, presumably simpler bathing installations.²⁶ It is not at all clear, however, why the reservoir system was established and how exactly it worked. There were presumably two connections between the aqueduct and the reservoir system: one to the eastern north reservoir that was connected with the ‘water closet’ to its west and fed the East Tub Room.²⁷ The other must have filled the south reservoir, which supplied the central north reservoir, from where water ran into the western north reservoir; the latter fed both the pool, most likely with a pipe of less than 0.1 m diameter from its eastern end, and probably also the West Tub Room via a water closet system from its western end. Since the capacity of these three interconnected reservoirs has been calculated to be 12.34 m³, it would have required 3.5 fillings of all three reservoirs to fill the pool. Thus, one wonders whether the reservoirs did not primarily function as settling basins, rather than storage facilities, at least with the view of supplying the pool.²⁸

Miller assumed that the bath building was operated and supplied with water at intervals, and not continuously throughout the day.²⁹ Alternatively, the aqueduct could

26 Miller 1992, 237–239.

27 Miller 1992, 219, does actually not discuss at all how this reservoir was supplied, but states that the eastern north reservoir and the closet “served the hydraulic needs of the East Tub Room exclusively”; since the water closet is only connected with this reservoir and since the south reservoir with its slope from east to west has an outlet at the very western end, it seems most likely that the eastern north reservoir and the south reservoir were not

connected.

28 Note, however, that the aqueduct was presumably fully covered and the pool was also roofed, whereas the reservoirs were left open.

29 Miller 1992, 216–220; Miller 2004, 120–122, reconstructs a kind of flushing system for the tub rooms which would not have received constantly flowing water, but would have been filled periodically; one closet filling would have sufficed to fill all four tubs

have provided a steadily running supply for the bath building where the tub rooms were fed intermittently, via the closet system, and the pool permanently, serving as a kind of ‘flow-through’ pool. Outlet and inlet were correspondingly small in this pool, suggesting a modest, if possibly still permanent flow or trickle of water.

If the bath building was not supplied continuously with water, however, the aqueduct must have been shut off regularly somewhere between the spring and the bath complex, and it must have led water to other destinations, probably on a more permanent basis. One such destination could have been a large tripartite reservoir (112.72 m³ capacity) which has recently been discovered to the west of the bath complex. Miller suggested that excess water of the aqueduct was channeled to this large reservoir once the needs of the bath were satisfied. The elevation of the inlet and outlet of the bath complex and the inlet of the large reservoir show that the reservoir could only have been supplied with fresh water from the aqueduct, which must have been split at the height of the bath complex to feed both the bath and the reservoir.³⁰ Since the reservoir was only constructed in the late 4th or early 3rd century BC, it could have been conceived when the water supply of the bath was remodeled and improved; some contemporaneously established intricate system may have regulated distribution of spring water to the small bath reservoirs and the large reservoir. The latter presumably served to supply horses that ran in the nearby Hippodrome;³¹ therefore, in theory, it could also have received wastewater from the bath. The drain from the bath lies on a slightly lower level (0.07 m), however, than the inlet of the large reservoir, and could hardly have led water over a distance of about 80 m from the bath to the reservoir. Thus, it must remain open for now, where exactly the wastewater from the bath was drained to.

3.1 Delphi

The *gymnasion* complex at Delphi was located in close vicinity to the Panhellenic sanctuary of Apollo. Its *palaistra* was built in the third quarter of the 4th century BC and later enlarged, probably in the second quarter of the 3rd century BC, to include race tracks (*xystos* and *paradromis*) and a separate bathing complex (*loutron*) (Fig. 11). The different components of the *gymnasion* were organized on two long, north-south oriented terraces,

once. The pool would have been drained and re-filled perhaps only once per day. Miller 2004, 122: “the pool was probably completely filled and emptied at relatively lengthy intervals.” Cf. also Manderscheid 2000, 483–484.

30 Miller 2004, 134; Miller 2015, 335–344; the inlet of this reservoir is at 331.65; the bottom of the west-

ern north reservoir of the bath is at 332.740; the drainage outlet of the bath complex (in the north-western corner of the West Tub Room) is, according to Miller 1992, 216 note 611, at 331.582.

31 As suggested by Miller 2004, 92–93, fig. 60, 135; Miller 2015, 344–348.

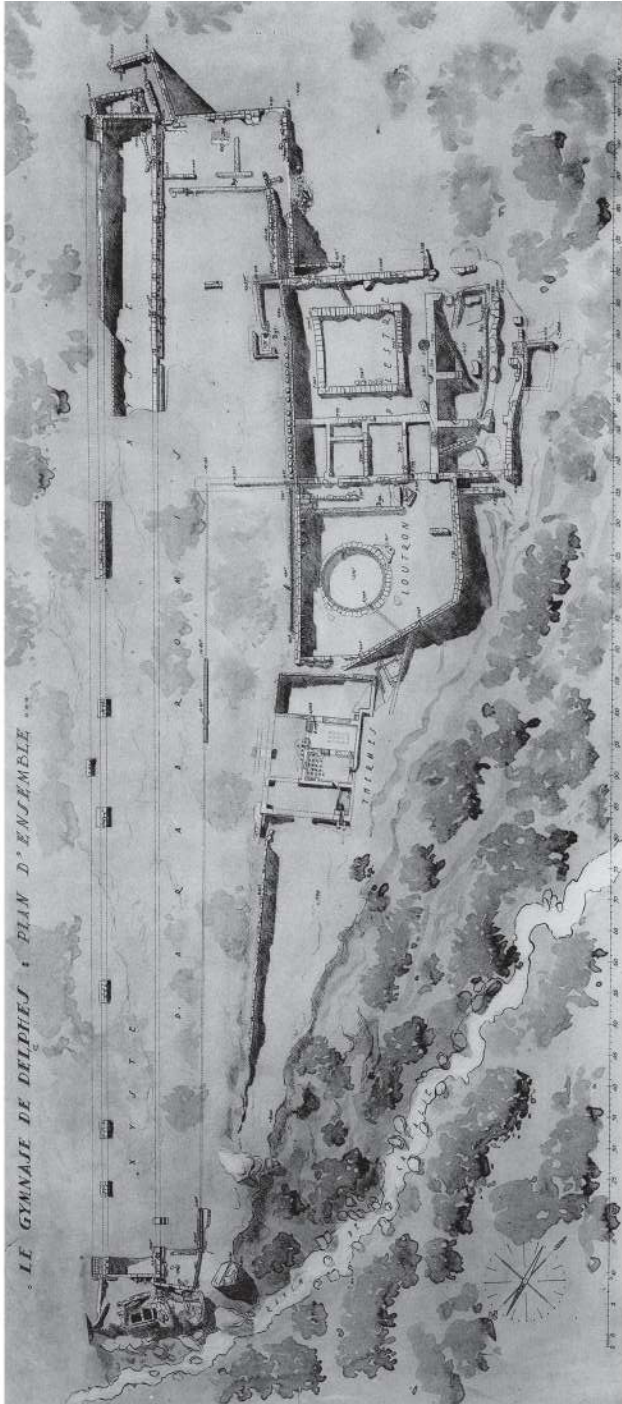


Fig. 11 Delphi, *Gymnasium*, state plan.

the bathing complex and *palaistra* on the lower terrace being complemented by the race tracks on the upper terrace. The *loutron* occupied an open-air paved terrain to the north of the *palaistra* and included ten basins for cold water ablutions along its eastern wall, and a centrally placed round pool (Fig. 12). The pool may even have been mentioned in an inscription that refers to a *kolymbethra*.³² The latter has a diameter of 8.6 m at the bottom and 9.7 m at the top and originally had a depth of 1.9 m, being provided with four steps all around. Thus, its maximum capacity was about 98 000 liters.

The pool was drained through an outlet that was installed at the bottom of its northwestern wall and had a diameter of 0.16 m. This was connected to a built covered drainage channel (0.69 m high, 0.5 m wide) that ran to the northwest with a steep decline and emptied into the adjacent Castilian ravine.³³

The pool was fed presumably by running water from the nearby Castilian spring that first supplied a channel system on the upper terrace (Fig. 13); an open channel made of limestone blocks (interior width of 0.95 m and depth of 0.115 m) and provided with settling basins was found in the middle of the terrace, running in a north-south direction parallel to the *xystos* and *paradromis*. While the beginning of this channel has been excavated at the northern end of the *paradromis*, it is unclear how this channel received water from the ravine below. Published plans show a system of terrace walls and two reservoirs in the embankment between the ravine and the *paradromis* that could have served to supply the channel, with possible temporary storage facilities.³⁴ On the terrace, the channel descends with a steady slope.³⁵ This channel, or a branch extending from it, must have turned west, roughly at the height of the pool, and descended quite steeply in order to feed a covered channel that ran behind the east wall of the *loutron*; the connecting channel ended in a settling basin from which water must have flown to the north and south.³⁶

32 Jannoray 1953, 53–63; Wacker 1996, 195–207. – For the inscription, accounts written under the archon Dion II (247–246 BC), see Pouilloux 1977.

33 Jannoray 1953, 62.

34 Jannoray 1953 does not discuss these structures, but his state plans, pl. I and III (here Figs. 11, 13), clearly show them. The channel starts at an elevation of 12,027, the bottom of the two interconnected reservoirs seems to have been at 12,70, and their top borders at 13,51. The elevation of the ravine is not indicated, but it seems to be significantly lower than that of the reservoirs; thus, a channel must have led from some point upstream down to the reservoirs.

35 Jannoray 1953, pl. I: from 12,027 in the north to 10,85 at the height of the northeast corner of the *loutron* terrace. When Pentazos and Trouki 1994, 433–434, reexcavated part of the upper terrace they

did not find any evidence that would safely date this channel to the 3rd century BC, however; their investigations showed that the terrace was used until late antiquity and that some of the water management structures (esp. terracotta pipes) certainly belonged to late phases of use.

36 Jannoray 1953, pl. I: this connecting channel had to descend from 10,85 down to 9,84. Jannoray 1953, 63, assumed that a terracotta pipe running from the open channel west to the southeast corner of the *loutron* would have supplied the *loutron* channel; recent excavations showed, however, that this terracotta pipe, made of reused elements, went to the northeast corner of the *palaistra* and served as a drain; Pentazos and Trouki 1994, 428–433, also found the location of the original supply channel

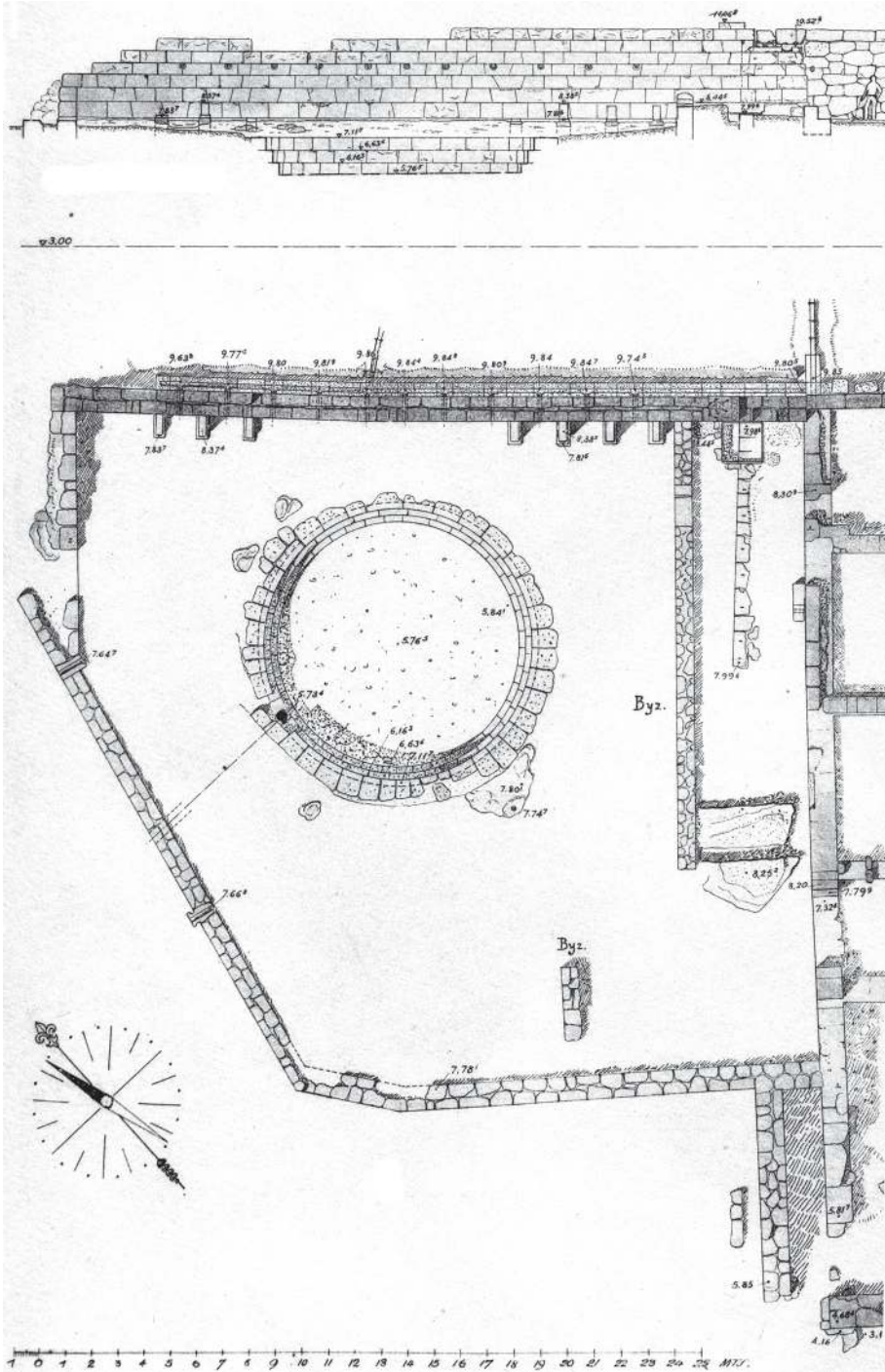


Fig. 12 Delphi, *Gymnasion*, state plan and north-south section of the bath complex (*loutron*).

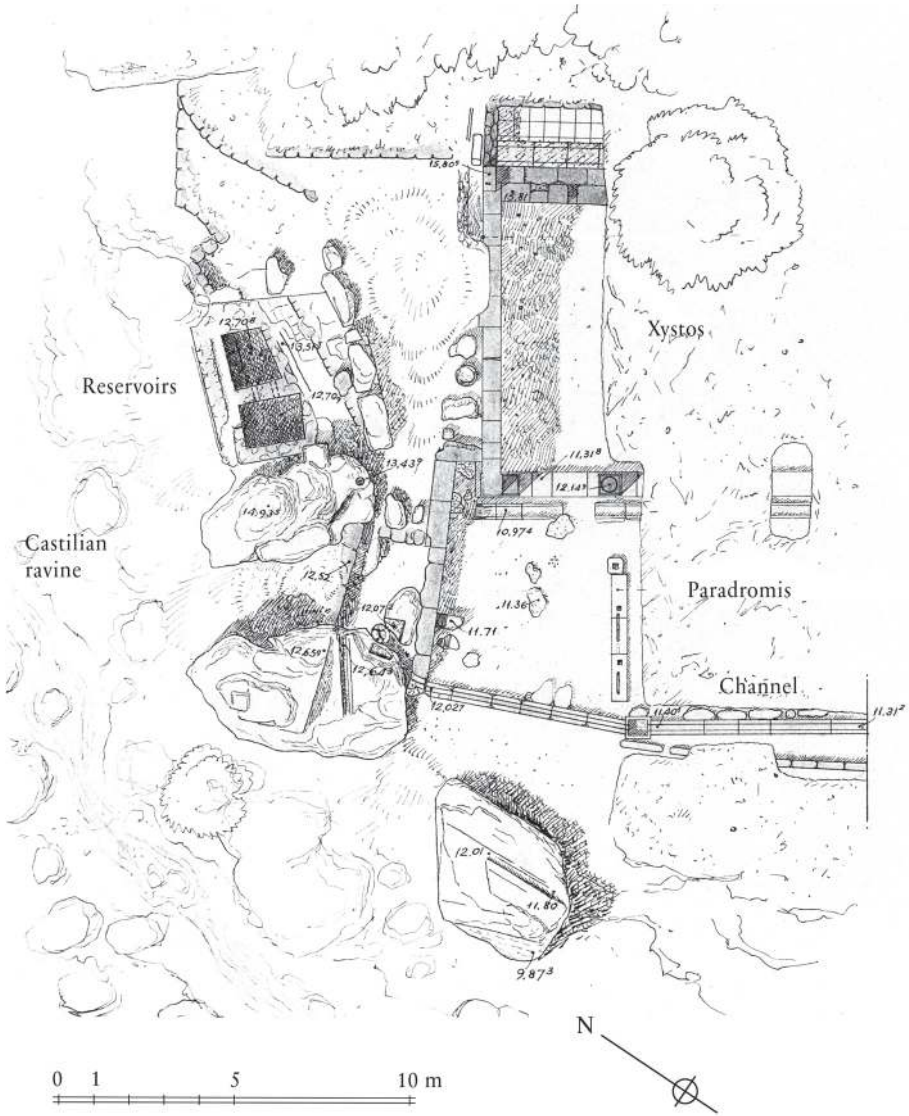


Fig. 13 Delphi, *Gymnasion*, state plan of the northern upper terrace.

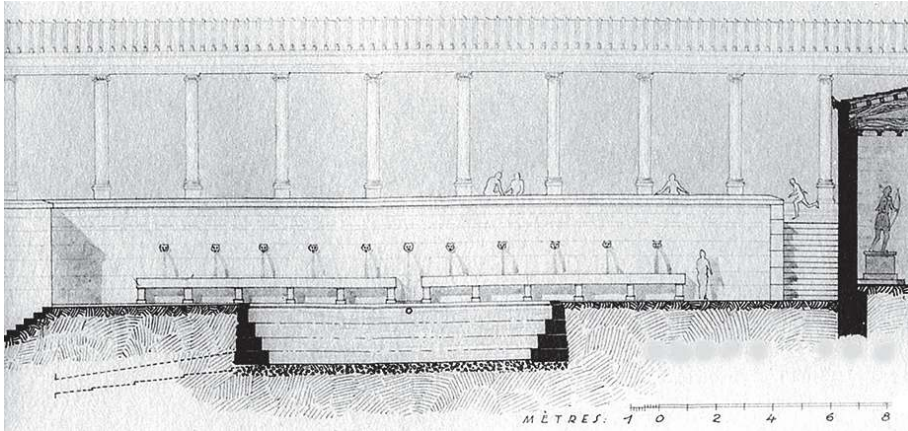


Fig. 14 Delphi, *Gymnasion*, reconstruction of the *loutron*.

The *loutron* channel supplied 11 water spouts that fed the ten above-mentioned basins, and presumably the pool. It must be emphasized, however, that no traces remained of the necessary connecting (open or closed?) channel between the central water spout, which was larger than the ten flanking spouts, and the pool; the precise location and size of the inlet of the pool remain unknown.³⁷ While obvious care was taken to supply the basins with relatively clean water, this was maybe not the case for the pool. Since no channel was found that would have drained waste and spilled water from the basins, Jannoray assumed that this water was led to the pool, via the central connecting channel between the central water spout and the pool; the basins would have been interconnected, water flowing from the northernmost and southernmost basins to the center (Fig. 14). Thus, the pool would have received more water, but presumably partially wastewater. The whole argumentation is flawed, however, because Jannoray misinterpreted the only evidence for his reconstruction, the only relatively well-preserved basin.³⁸ This basin has a groove or overflow channel on its left short border and a drainage hole in its left front corner; today, the right border is not sufficiently preserved to exclude the existence of a groove.³⁹ In any case, the hole in the bottom clearly suggests that water was drained onto the floor, at least at certain intervals, and not (solely) via the lateral grooves into a channel.

with its settling basin; this is not shown on the plan of their trenches on the upper terrace, 429 Fig. 5, however, which also does not include any elevations.

37 Jannoray 1953, pl. XI, 2 (here Fig. 14), reconstructs a small circular inlet (pipe?) at the top of the highest

step.

38 This basin has a length of 1.82 m and, according to Jannoray 1953, 39, would have an overflow outlet at the top right border; Jannoray 1953, 59 n. 1, argued that this basin could only have been set up as the fifth basin from north (with the direction of flow

In sum, it seems most likely that water from the basins simply ran over the paved floor of the terrace and via two outlets in its northwest terrace wall into the Castilian ravine. The pool could have been protected from this run-off water if its upper fourth step was slightly raised above the pavement of the open terrace; since the pavement of the open area and the highest step are not preserved in situ, however, their relationship cannot be safely determined.

While the supply from the Castilian spring, in theory, could have been shut off and the *loutron* fed only at intervals, when needed, water could also have run permanently, adding fresh and cold water to the 'flow-through' pool.

4 Aï Khanoum

The palace complex of Aï Khanoum in Bactria was located on a terrace next to the large Oxus River (Fig. 15). It was provided with a pool shortly before the destruction of the city in 145 BC. Located between the palace in the south and a complex identified as a *gymnasion* in the north, the pool was built in a large open-air courtyard⁴⁰ that was possibly planted with trees and most likely surrounded by a precinct wall on all sides (Figs. 16, 17). The pool is reconstructed from remains of its pebble pavement with a size of 41.5 × 44 m and a maximum depth of 2.1 m in the center; the pavement sloped slightly from all sides to the center. No evidence of access facilities (ramp or stairs), of a paved area around the pool, or of water management was found in the cross-shaped large trench that revealed the center of the pool and scanty remains of its borders (Fig. 16).

It is assumed that drainage would have been unnecessary because the pavement of the pool, made of two thick layers of pebbles, was most likely not entirely waterproof but would have allowed for seeping. It is unclear, however, how this would have worked and how quickly water would have disappeared: if too quickly, this would have required a significant steady inflow of water in order to keep a certain level in the pool, and, if not quickly enough, it may have hindered the regular exchange of water and caused flooding. In theory, water could have been drained to the west or southwest, into the nearby Oxus River, but two facts challenge this idea. First, the drain would have had to cross the precinct wall of the pool area, as well as the fortification along the Oxus River.

from the north to the center), next to the central outlet, or as the tenth basin from north (with direction of the flow from the center to the south); it would have been too short, however, to have served as the tenth and last basin in the row.

39 With a single groove, this basin could have been the tenth basin from the north (with direction of the

flow from the south to the center), or the fifth basin from the north (with the direction of the flow from the center to the north).

40 Veuve 1987, 39–41, 97, 103–106 Taf. IV, VI: precinct with a north-south extension of 152.8 m and an unknown east-west extension (at least 88 m).



Fig. 15 Ai Khanoum, Plan of the city.

Second, and more crucially, the inclination of the floor to the center of the pool would have prevented efficient drainage to one side.

More difficult is, again, the question of water supply, which is not addressed in the publication. Given the maximum capacity of the pool of about 3 800 000 liters, its water supply must have been a major challenge. In theory, the Oxus would have been an appropriate supply, but the embankment of the river is very steep and the entire

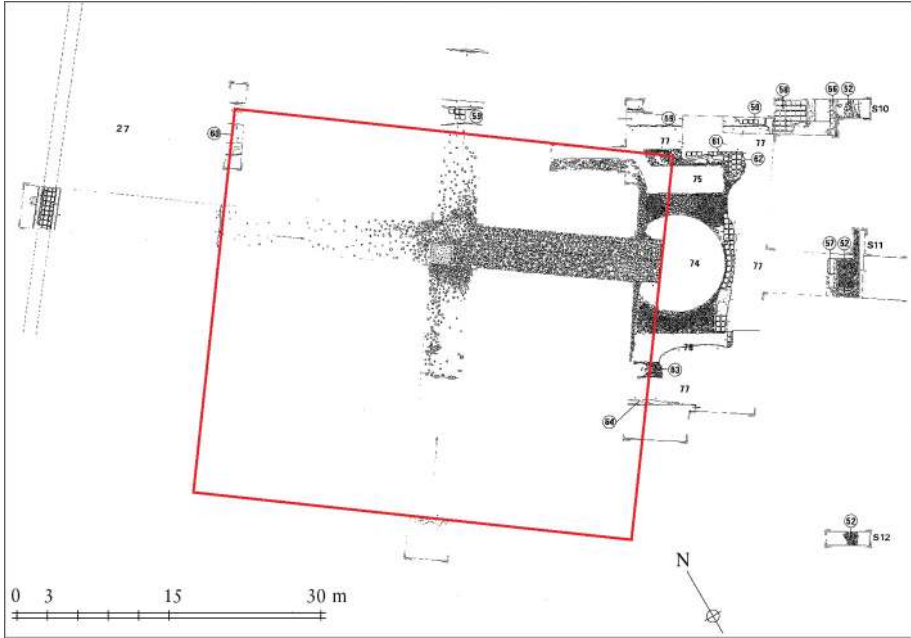


Fig. 16 Ai Khanoum, Pool area, state plan.

palace area is built on a terrace about 20 m above the river.⁴¹ The water supply of the city and the palace area has not been studied comprehensively, but it is generally stated that the city was supplied by a network of open-air channels,⁴² and it is emphasized that water-supply and water-drainage networks were highly developed.⁴³ The high number of bathing installations in the palace area and in private houses confirms that water must have been available in significant abundance.⁴⁴ A main channel brought water into the city from the north, flowing between the main north-south street and the foot of the eastern acropolis hill (upper city); but whether this channel also supplied the palace

41 This is clearly visible in the sections at the area of the fountain house and fortification, located to the north of the *palaistra*; Leriche 1986, pl. 8 fig. 11; cf. also the plan in Veuve 1987, pl. 2 with levels: the pool area is almost 10 m (+436.7) above the lowest point of the embankment (+427.8); no levels are indicated for the Oxus and its immediate border. A fountain house that was built between the Oxus River and the fortification, to the north of the *palais*-*tra*, was supplied by its own spring from the east;

Leriche 1986, 32–41. Cf. also the recent 3D reconstruction of the city, Martínez-Sève 2014, 271 fig. 3.

42 Bernard 1981, 110: “l’approvisionnement en eau étant normalement assuré, comme partout en Asie Centrale, par des canaux à ciel ouvert, branchés sur le système d’irrigation de la plaine.”; cf. also Francfort et al. 2014, 21, 64, 84, 96.

43 Martínez-Sève 2014, 273–274, 279.

44 Bernard 1981, 118.

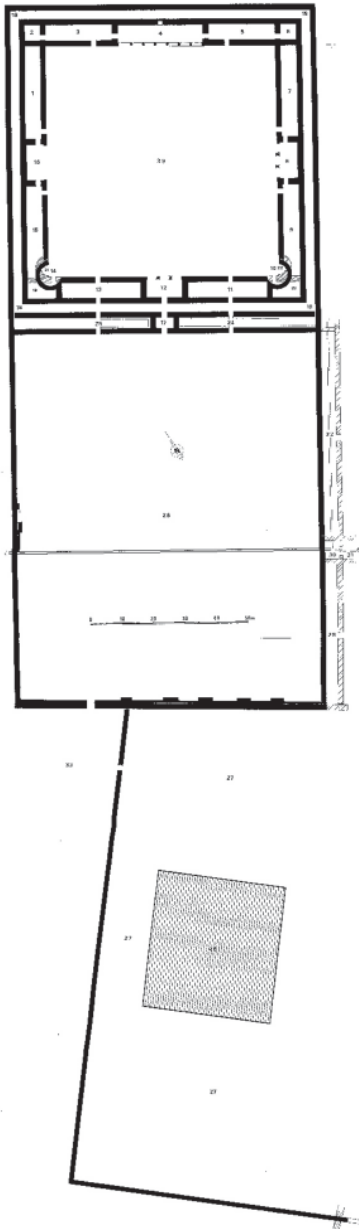


Fig. 17 Ai Khanoum, Reconstructed plan of the *gymnasion* and pool area.

and pool area, currently cannot be determined.⁴⁵

It cannot be safely determined whether this pool ever functioned, and how precisely. It must be emphasized that its identification as a pool has been challenged, in favor of a park for horses with a drinking trough.⁴⁶

5 Jericho

The Hasmonean royal family seems to have been very interested in installing swimming pools. Between 125 and 63 BC they built a large palace complex at Jericho that included eight large open-air pools (Fig. 18). Jericho is located in a desert area with an arid climate that was mild and agreeable in winter. The palace complex itself was laid out between a Wadi, Wadi Qelt, and the royal estate, an irrigated terrain of 45 ha surface that was surrounded by a wall and used to grow date palms and balsam shrubs. While Ehud Netzer reconstructed the development of the Hasmonean Palace complex in seven phases, swimming pools were only installed in phases 2–6.⁴⁷ Almost all of these pools were used contemporaneously until the destruction of the palace complex by an earthquake in 31 BC, and four of them were even reused by Herod the Great in his second palace at the site, built after 31 BC. The eight pools are very similar in design and function: they are rectangular and fall into two different size groups, namely 8 × 8 m and 13 × 18–20 m; they are 3–3.8 m deep, have benches built along the top of the side walls and a staircase leading to the bottom of the pool in one corner. Their capacity ranged from about 220 000 liters to 819 000 liters. All pools were open air, surrounded by paved areas and gardens with various banqueting facilities, and presumably also by high walls that granted privacy.⁴⁸

The drainage system of the pools is known in a general outline, even if its full functioning and final destination cannot always be clearly determined. The pools were commonly provided with outlets at the top of the side walls, a position that is common for overflow drainage.⁴⁹ For example, two narrow open channels emerge from the southwest corner of pool A(C)94, one coming presumably from the pool itself, and the other from the outer edge, although no immediate connection was found in either case

45 Martinez-Sève 2014, 269 Fig. 2; the 3D model developed by G. Lecuyot and O. Ishizawa, <https://www.youtube.com/watch?v=oyap-dAjj6M> (visited on 25/05/2018), does not include a clearly visible network of channels in the city.

46 Francfort et al. 2014, 63: “une vaste enceinte abritait une ‘piscine’, à ciel ouvert, espace que l’on a plutôt identifié à un parc à chevaux avec abreuvoir.”

47 Netzer 2001a, 1–7.

48 Netzer 1986; Netzer 2001b; Netzer 2001a. – Stacey 2006 challenged the function of the pools as recreational facilities and identified them as fishponds; Regev 2013, 246 n. 85, refers to an unpublished reply by Netzer who emphasized the lavish character of the garden areas with pools. Netzer’s interpretation is followed here.

49 Netzer 1986, 7.

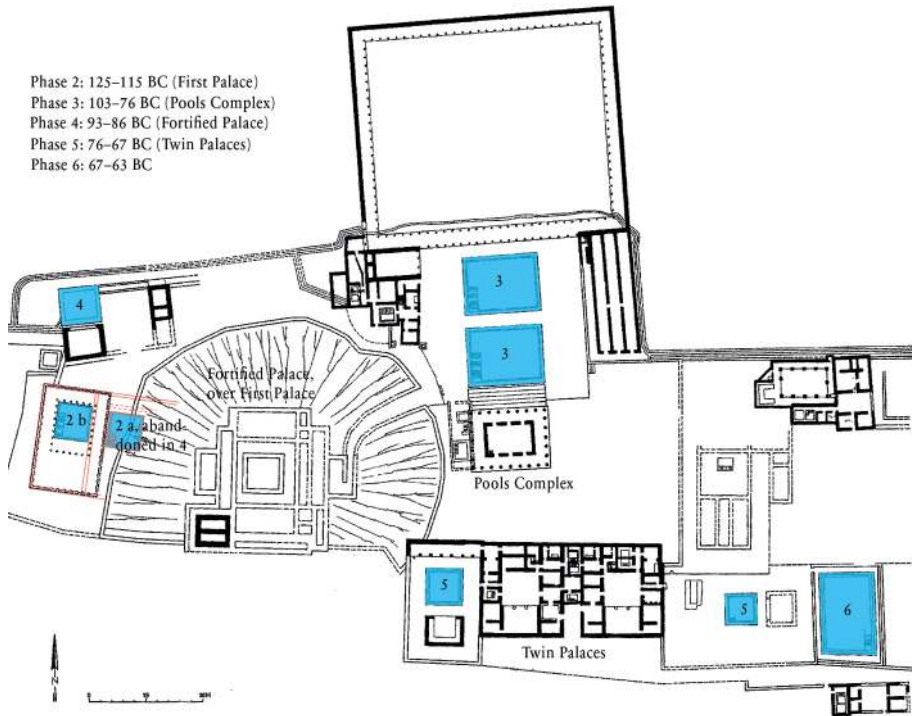


Fig. 18 Jericho, Hasmonean winter palaces with pools.

(Fig. 19). With elevations at 102.88 and 102.84, the bottom of these channels is located far above the bottom of the pool at 99.45 and even above the level of the bench of the pool with 102.71. The channels merged before passing through the precinct wall of the pool area; although the channel was not found to the west of this wall, it is assumed that it would have continued further west and irrigated the fields of the adjacent royal estate.⁵⁰ Similarly, none of the other many pools of the palace that are identified as ritual baths and reservoirs included drainage holes at their bottom; they were presumably either bailed out by hand with the help of buckets and jars, or also included pipes and channels at their upper border that drained overflow water.⁵¹

50 Netzer 2001a, 60 fig. 88: While no measures (width, depth) of these channels are given in the text, the state plan and published photos suggest that these were no more than 0.1–0.2 m wide, shallow, and found without cover. Similarly for the adjacent pool AC44, the bottom of the narrow shallow drainage channel was found 102.68 close to the southwestern

edge of the pool, 8 cm above the bench, and could be followed for 20 m, sloping down to 102.31 at a point when it apparently continued underground; this channel became broader and deeper towards its western end and was found partially covered with simple slabs (Netzer 2001a, 60).

51 Netzer 2001a, 119, 122, 131, 153, 157, 160, 167, 194.

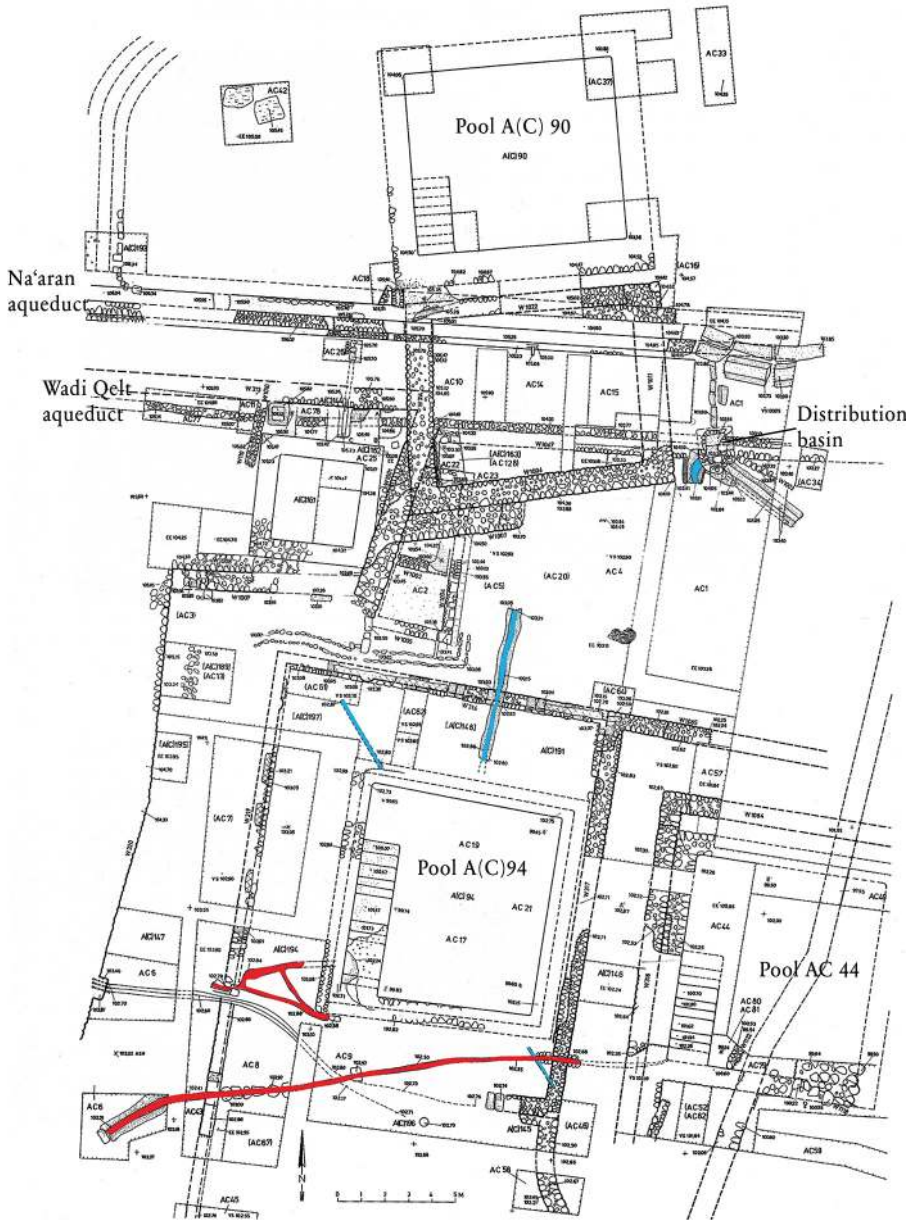


Fig. 19 Jericho, Hasmonean winter palaces: state plan of area AC, water management (blue: supply – red: drain).

The water supply of the royal estate and palace area has been comprehensively studied.⁵² Two main phases can be distinguished: When John Hyrcanus I built the royal estate and palace with the first two swimming pools around 125 BC, they were supplied by three springs in the Wadi Qelt, whose water was combined in one large open aqueduct channel. From this channel, a terracotta pipe with a diameter of 12 cm, buried 40 cm under the ancient surface, branched off to supply the palace, and probably also the first two pools. At the end of the 2nd century BC, the successor, Alexander Jannaeus, enlarged the estate and palace, building the two largest swimming pools (Pools Complex) and improving the water supply: water from three more springs, which were partially located much farther away in the Na'aran Valley and provided more water more reliably year-round, was channeled to the palace area.⁵³ While the Wadi Qelt aqueduct mainly supplied the royal estate, the Na'aran aqueduct fed first and foremost the palace and an adjacent industrial complex. The latter ran right through the palace area from west to east, but its course was changed several times in the Hasmonean Era.⁵⁴ While many remains of hydraulic installations were found in the palace area, connections between the different elements were often missing, so that coherent supply and drainage circulation patterns could rarely be reconstructed. Furthermore, in correspondence with the aqueducts, the sophisticated water management in the palace area itself saw many changes that also regarded the various pools.⁵⁵

For example, pool A(C)94, one of the earliest in the palace area, provides evidence of three different supply systems that belonged to at least two different phases (Fig. 19): 1. a terracotta pipe leading water from a roof in the east to the southeastern corner of the pool, but no inlet was found there;⁵⁶ 2. a terracotta pipe was found in the northern wall of the pool, close to the northwest corner; it could be followed for 3.3 m to the northwest, and originally most likely branched off of the Wadi Qelt aqueduct;⁵⁷ 3. this pipe was cut when the Na'aran aqueduct was built, which fed, among others, a distribution basin to the northeast of the pool. One of the three channels emerging from this

52 Garbrecht and Netzer 1991.

53 The farthest spring, Ein Auja, was located 11 km northwest of Jericho; Garbrecht and Netzer 1991, pl. 5, 1; the aqueduct was at least 18.73 km long; the aqueduct coming from the Wadi Qelt was around 8 km long.

54 While the aqueduct originally ran as a covered channel between the two large swimming pools of the Pools Complex, it was later relocated several times, bypassing the Pools Complex (Netzer 2001a, 92–100, plans 17–22).

55 Netzer 1986, 3; Netzer 2001a. – The many changes cannot be discussed in detail here for all eight swim-

ming pools. In addition, there are many other pools and basins in the palace area, identified as reservoirs, distribution basins, and ritual baths, which cannot be taken into account here.

56 Netzer 2001a, 60, plan 13: no elevation and no date are indicated for this pipe.

57 Netzer 2001a, 57, plan 13: this pipe slopes from 102.87 to 102.80 and must have ended at the very top of the pool; the bench below the inlet is at 102.73. The top of the Wadi Qelt aqueduct (underground pipe set into casing made of fieldstones) is at 104.77–105.14 to the northwest of the pool.

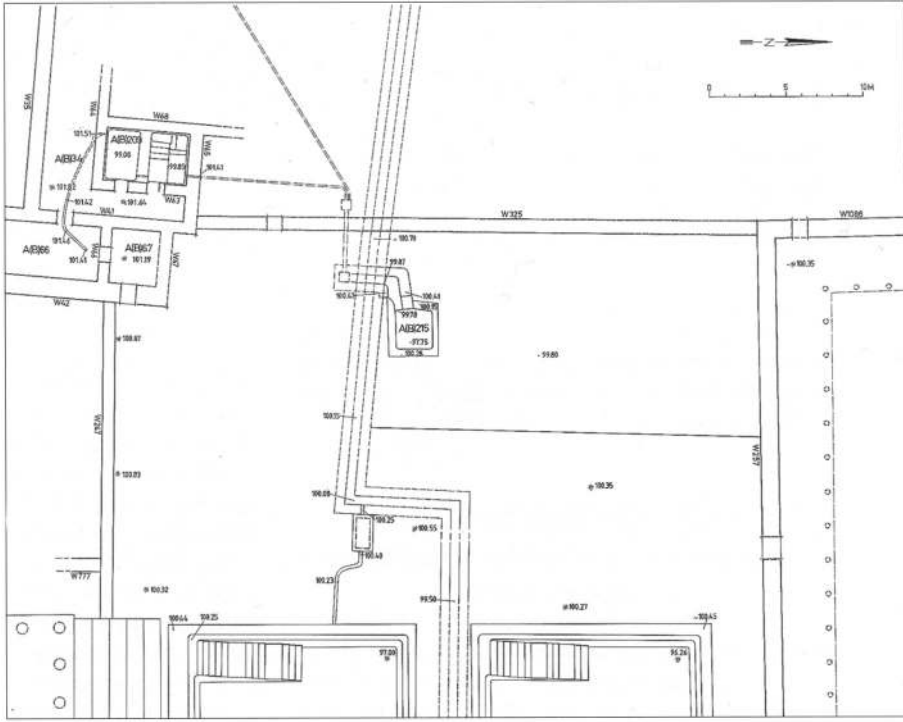


Fig. 20 Jericho, Hasmonean winter palaces: reconstructed plan of phase 3 of the Pools Complex.

basin supplied the pool; while part of this open channel was found to the north of the center of the pool, its connection with the pool did not survive.⁵⁸

The development of the water supply is even more complicated for the Pools Complex with its two large swimming pools. Apparently, the builders of the first Na'aran Aqueduct miscalculated the slope required for supplying both pools directly from the main branch that ran between both pools (Figs. 20–22).⁵⁹ Therefore, a separate channel with some distributive installation was built further west at a higher level, which presumably fed the south pool that, in turn, supplied the north pool via a connecting pipe. At a later point, the north pool was supplied with its own channel that branched off of the Na'aran Aqueduct. In a third phase, when the course of the Na'aran Aqueduct was significantly changed to bypass the Pools Complex, a separate settling basin was built to

58 Netzer 2001a, 54–55, 57, plan 13: bottom of Na'aran channel at 104.40; bottom of distribution basin at 103.54; bottom of the channel to the north of the pool at 102.80.

59 Netzer 2001a, 79: The aqueduct should have been about 0.60 m higher than actually built, which is a significant miscalculation.

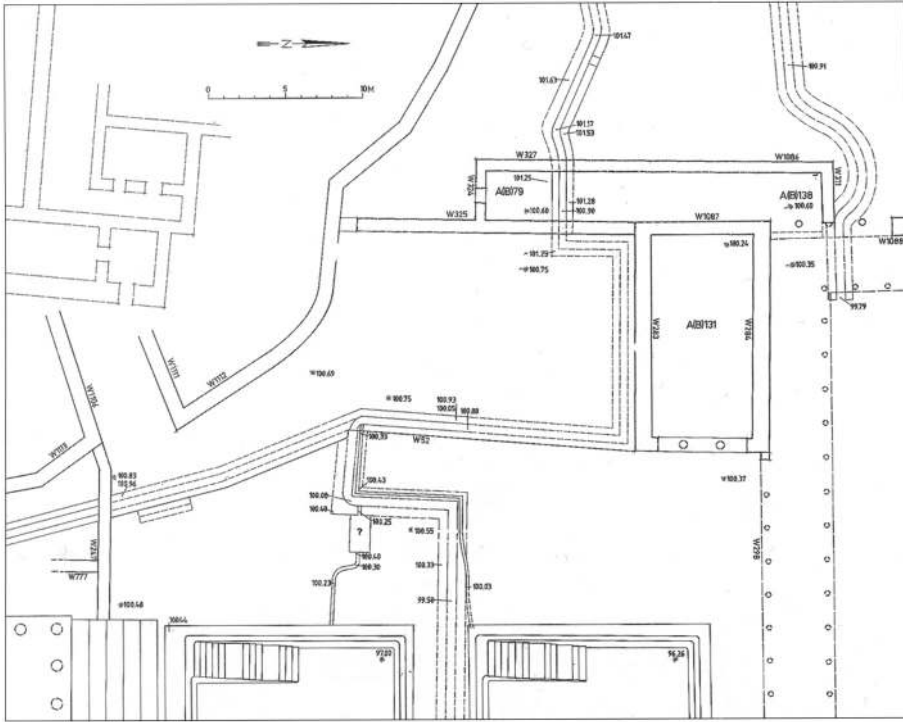


Fig. 21 Jericho, Hasmonean winter palaces: reconstructed plan of phase 5 of the Pools Complex.

the west of the pools that supplied both pools via two channels.⁶⁰ Due to substantial remodeling of the Pools Complex under Herod the Great, no original inlet to either pool and no connecting pipe between the pools were preserved. It must be emphasized, however, that the frequent changes in the water management of the Pools Complex clearly reflect the concern to grant, maintain, and improve the functioning of the pools.⁶¹

It is assumed that water was running constantly in the aqueducts and that the pools were supplied permanently, serving as flow-through pools on the way to the final destination, the gardens and cultivated fields. Cleaning these pools must have been challenging or impossible, however, because they could never be conveniently fully emptied, except by hand or by letting the water fully evaporate and dry out.

That these pools were really used for swimming and all kinds of entertainment, however, and not just as reservoirs, is confirmed by Flavius Josephus, who describes a

60 Netzer 2001a, 74–84, plans 14, 17–21.

61 For the water management of the other pools,

AC44, A(C)90, AE103, A(L)255, A(L)330: Netzer 2001a, 50–216.

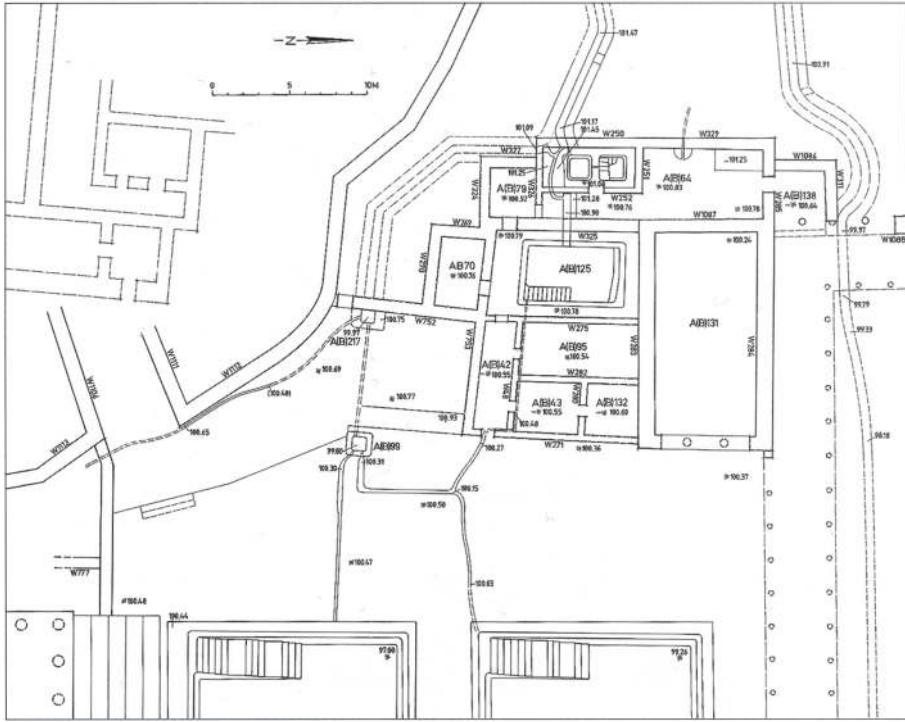


Fig. 22 Jericho, Hasmonean winter palaces: reconstructed plan of phase 6 of the Pools Complex.

political murder in the mid-30s BC that took place in one of the palace’s several large pools (*kolybethrai*).⁶²

5.1 Conclusion

For none of the 13 swimming pools discussed here, can the water management be fully reconstructed in all of its different aspects. There is evidence, however, that all pools were used and must have functioned, except for the example of Ai Khanoum.⁶³ Combining the data from various pools, the following picture emerges.

- Construction, topography: Swimming pools were commonly dug into the ground and lined with walls and some waterproof material. In two sites, evidence was found

62 Flavius Josephus, *Jewish Antiquities* 15.3.3.

63 Evidence includes a renewal of cement on floors and walls, and changes of the water management, not mentioned in detail here for the pools; in contrast,

calcareous concretions are not specifically mentioned for any of the pools. – For the questionable identification of the pool in Ai Khanoum, see Francfort et al. 2014. 63.

that the flanking walls were built as freestanding walls.⁶⁴ In all of the other cases, the area outside the pool walls was not sufficiently excavated in order to determine the construction technique and process. Where known, the top of the pools was commonly more or less at the level of the surrounding area; while this facilitated access, simply stepping down from walking level into the pool, it must have had consequences for the water management and water quality. From a practical point of view, ideal operation would have been to have inlets coming in at the top of the pool and outlets going out at the bottom; thus, drainage channels would have been on a significantly lower level than supply channels. How these differences in levels were negotiated, can only be assessed for the pools in Nemea and Delphi. The complex in Delphi, with its placement on terraces, provided the most convenient setting for water management. In Nemea, and presumably the other cases that do not provide evidence of extensive terracing or sloping terrain, slopes of supply and drainage channels must have been carefully calculated.⁶⁵ Certainly not by chance, the most ambitious, particularly deep pools were certainly (Jericho), or presumably (Aï Khanoum), not provided with drainage channels at their bottoms.

- Water supply: The supply sources for the pools include nearby rivers in Delphi, and possibly also in Olympia and Isthmia. Spring water was tapped with a short aqueduct in Nemea (650 m) and by much more ambitious aqueducts in Jericho (8 and 18 km). The pool of Aï Khanoum may have been fed by a channel system of unknown provenance and length. How precisely water flow was regulated and controlled from the source to the inlet of the pool cannot be fully reconstructed for any of the pools. The evidence in Delphi, Nemea, and Jericho⁶⁶ suggests that there were intermediating structures between the source and the pool, namely basins and reservoirs. Their precise function – settling, storage, distribution, pressure compensation – is not clear, however, and certainly depended upon their size and location. For example, the features in Jericho are all far too small in comparison to the pools to have served any kind of significant storage function. Distribution and settling seem more likely functions, the latter in order to keep channels unclogged and clean,

64 Jericho, Pools Complex: walls tapering from 1.50 at the bottom to 1.20 at the top (Netzer 2001a, 73–74 fig. 104); Jericho, pool A(L)255: walls widening from 1.00 at the bottom to 1.20 at the top (Netzer 2001a, 198); Nemea, pool: the lateral walls served as partition walls between the tub rooms and the pool and were built up to a height of about 1.3 m. Aï Khanoum, pool: the relationship between the top level of the walls and the walking level of the

surrounding area is unknown.

65 In Nemea, some artificial terracing was required for the construction of the bath complex: Since the terrain sloped down to the west, it had to be raised about 2 m with debris from the destruction of the early temple of Zeus; Miller 2004, 124; Miller 2015, 302, 324–326.

66 Possibly also Olympia, if the basin k was ever connected with the pool.

rather than the large open-air pools. While there is no evidence for sophisticated metal valve systems similar to those that regulated flows in water pipe systems and baths of the Roman Imperial period, sluice systems could have been installed: this is possible in cases where supply channels branched off from rivers (Delphi) or central aqueducts (Jericho), or some distribution system (basin, reservoir) was constructed between the source and different users (Jericho, Olympia?, Isthmia?, and Nemea?).

- Inlets: The little surviving evidence suggests that inlets were rather small in size and possibly preferably round. So far, not a single rectangular inlet has been found. Special configurations of the inlet, notably water spouts and pipes projecting into the pool that would have provided special visual and acoustic murmuring and rippling effects, cannot be safely reconstructed. With the exception of one terracotta pipe,⁶⁷ no ceramic or metal appliances were found in situ. The *loutron* in Delphi was supplied with 11 decorative water spouts, of which imprints survive on the eastern terrace wall; but for the pool itself, no trace of a spout was found. The pool in Nemea may have been supplied by a lead pipe, but no evidence of any water spout survives and the inlet was not located centrally in the south wall of the pool.⁶⁸ Water spouts would have made incoming water clearly noticeable and possibly even suggested the notion of constantly running water.⁶⁹ Other special water effects like water cascading down over steps or water falls, known from baths of the Roman Imperial period, were certainly lacking in the swimming pools under discussion.
- Drainage, destination of wastewater: Water was certainly (Delphi) or most likely (Olympia, Isthmia) drained to adjacent or nearby rivers. In Aï Khanoum, water seems to have seeped away into the ground at an unknown speed. In contrast, wastewater from the pools in Jericho was obviously reused for the irrigation of the gardens of the palace and agricultural fields of the royal estate. Similarly, wastewater from the pool in Nemea may have fed a nearby reservoir used for supplying horses.
- Outlet, drainage channel: The size of the outlet holes and drainage channels is potentially important for calculating the flow of water. The known outlet holes (Isthmia, Delphi, and Nemea) are small, with diameters of 0.12 to 0.16 m. The drainage channels of three pools were significantly larger, however, with widths of about 0.5 m and depths of about 0.7 m (Olympia, Isthmia, and Delphi). In contrast, the

67 Jericho, Pool A(C)94; Netzer 2001a, 57.

68 While there is evidence that the outlet holes of the tubs were lined with lead, no traces of water spouts survive (Miller 1992, 207 n. 598; 213 n. 605).

69 For the multifaceted connotations of water spouts that splashed water permanently into pools of Roman Imperial baths, Garbrecht and Manderscheid 1994, 71.

small pool and the flanking tub rooms in Nemea, as well as the pools in Jericho, were drained with remarkably small and shallow channels.

Jannoray assumed that the outlet in Delphi was small in order to prevent water from draining too fast and to maintain a constant level of presumably permanently running water in the pool. This does not explain, however, the significant size of drainage channels and the possible double drainage system in Isthmia. Most relevant for granting constant levels of running water is the close correlation between the size of the inlet and that of the outlet. These seem to roughly match in Nemea and in some examples in Jericho, but cannot be assessed for the other pools.

The position of drainage outlets differs significantly, with a preference for the bottom in most sites (Olympia, Isthmia, Delphi, and Nemea) and the unusual location at the top in the pools of Jericho. Since both positions would have granted a continuous flow through of water with matching inlets and outlets, the main difference regards maintenance and the quality of the water. Pools with drainage at the bottom could be conveniently emptied and cleaned, whereas the pools in Jericho would have required emptying by hand, which is hardly feasible for pools with fillings of up to 820 000 liters of water. Providing inlets and outlets at different levels may have facilitated complete, efficient exchange of the water. Modern swimming pools, in which water is circulated and cleaned with the help of electrical pumps, are commonly built with inlets at the top and the main drain at the bottom in order to grant complete circulation and filtering of the water. While in these pools the pump sucks in the water, in the ancient pools the floors needed to slope consistently to the point of the outlet. Such a continuously sloping floor is indeed evidenced by the pools in Olympia, Nemea, and Delphi, and must also have been present in the pool of Isthmia.

- Quantity and quality of water: The crucial question of whether water was constantly running through the pools, day and night and in all seasons alike, cannot be safely answered for any of the pools. The availability of water may have changed in different seasons, and none of the pools are located in a climate where swimming in cold water would have been particularly agreeable year-round.⁷⁰ Constantly running water is neither compelling nor excluded for any of the pools, with the possible exception of the example in Aï Khanoum, whose ‘outlet’ was possibly not blocked, but the inlets and outlets, supply and drainage, could have been blocked in all cases,

70 Note, however, that the Hasmonean Palaces at Jericho are commonly identified as winter palaces. Aristobulos III was murdered in one of the pools in 36 or 35 BC, shortly after Sukkot, the Feast of Taberna-

cles celebrated between the end of September and the end of October. The nature of this place, however, was hotter than usual (Flavius Josephus, *Jewish Antiquities* 15.3.3).

even if no evidence survives of the practice. None of the pools provided an outlet at the bottom and an overflow outlet higher up in the wall, which, according to Günther Garbrecht and Hubertus Manderscheid, would have clearly suggested permanently running water.⁷¹

The quality of water must have depended upon exchange rates. Furthermore, all open-air pools (all except for the pool in Nemea) were also filled with rain water, which was most relevant in the rainy winter months, and were susceptible to flooding, evaporation, and pollution. While the areas around the pools seem, in general, to have been paved, it is unclear whether pavements were laid out in such a way that dirty run-off water would not have flown into the pools. Some pools had decorative curbed borders (Isthmia and Delphi), but with the curb inside the pool; thus, the borders were not necessarily raised above the level of the paved areas in order to prevent the contamination of the pool water.

- Patronage: All pools were ambitious costly enterprises, in terms of construction, operation, and maintenance. Differences in water management, particularly with a view to the water supply may reflect certain technological developments between the 4th and 1st centuries BC, but also, if not primarily, reflect the interests and socio-economic power of their patrons. The largest pool of the examples discussed here was built in the palace complex of Aï Khanoum, which is known for its impressive monumental building projects and corresponding royal pretensions; even if this never served as swimming pool, but was a watering horses of the royal stables,⁷² it would still have been an awe-inspiring water installation. A similar, if not even more daring conspicuous consumption of water can be reconstructed for the palaces of the Hasmoneans, which transported water from considerable distances to feed its many pools in an arid climate. Impressive water works were regularly praised as a hallmark and major achievement of powerful rulers in ancient literature. The range of works is broad, but large reservoirs and pools played a particularly important role. For example, the Emmenides in Agrigento were intimately connected with an artificially made *kolybethra* that was built in the city after the victory of Himera in 480 BC, and that has been identified as a public reservoir for water supply and various pleasures.⁷³ Another impressive case is the immense artificial basin that the emperor Augustus built in 2 BC on the right side of the Tiber

71 Garbrecht and Manderscheid 1994, 72. – A hole in the third step of the pool in Delphi is identified as a late addition, and not as an original overflow drainage hole; Jannoray 1953, 62 n. 2.

72 See above, n. 46. – The ‘idiosyncrasies’ of this pool in comparison with the other pools discussed here

challenges indeed its identification as a purpose-built swimming pool.

73 Bouffier 2000: with a perimeter of 12501.250 m and a depth of 9 m this reservoir had a capacity of ca. 12 000 m³ or 12 000 000 liters.

River in Rome for a Naumachia, the spectacle of a sea battle; this basin was supplied by its own aqueduct and served to demonstrate Roman sea power and engineering skills.⁷⁴ The swimming pools of the royal families in Ai Khanoum and Jericho can certainly be counted among the monumental hydraulic masterworks of powerful rulers.

The Patrons and the significance of the other pools discussed here are more difficult to assess, but it is certainly not by chance that they adorned the major Panhellenic sanctuaries. The pools in Olympia and Isthmia were the earliest of the examples discussed here, and may well have served as prominent models and benchmarks. In Delphi, the *gymnasion* and its swimming pool were included in accounts of the Amphictyonic League from the mid-3rd century BC, which enumerated expenses for preparing the important festival of the Pythia. While the Amphictyonic League that controlled the sanctuary of Apollo may not necessarily have been responsible for constructing the swimming pool, they were at least interested in granting its proper functionality for Apollo's main festival.⁷⁵ Thus, one may conclude that swimming pools as an extravagant novelty and technological masterpiece conveyed the importance and prestige of the sanctuaries, no less than those in royal palaces.

Most of the pools discussed here were no longer used by the end of the 1st century BC.⁷⁶ While the royal pools went out of use when the palaces were destroyed, abandonment of the sanctuary pools (esp. Olympia and Isthmia) may have been motivated by challenges of water management, as well as the changing fashions of bathing culture. The idea of swimming pools did not die with these pools, however, instead, cold water pools of different sizes became an integral part of public bath buildings from the 1st century AD onwards, when water management could be efficiently, reliably, and abundantly provided via aqueducts. This is vividly illustrated by the swimming pool in Delphi: this was the only one of the examples discussed here that was obviously used continuously until late antiquity, and it only seems to have survived because it could

74 Sueton, *Augustus* 23; Cariou 2009; Baltrusch 2016: this reservoir had an extension of 1800 × 1200 Roman feet, ca. 533 × 355 m, thus a perimeter of 1776 m, whereas the depth is not known.

75 Pouilloux 1977; the nature of the works (repairs, cleaning and the like) performed for the pool is unknown, however, because the inscribed *stèle* is broken right at the point where the *kolymbethra* is mentioned.

76 The pool in Isthmia was abandoned in 146 BC, but probably reused from AD 50 until the Hadrianic period, when it was replaced by a Roman-style bath building. For the pool in Olympia, an aban-

donment around 100 BC is commonly identified, but without conclusive evidence; later abandonment cannot be excluded, but the pool was replaced by AD 100 by a Roman-style bath building. The pool in Nemea was most likely abandoned when the sanctuary declined after 270 BC. The pool of Ai Khanoum was abandoned when the city and palace were destroyed in about 145 BC. The pools in Jericho were only partially reused after an earthquake in 31 BC in the palaces of Herod the Great, but Herod's palaces were, in turn, destroyed by an earthquake in AD 48, at the latest.

conveniently be integrated into a new fashionable bath building in the Roman Imperial period, now serving as the canonical frigidarium pool. This smooth transition was certainly facilitated, if not inspired by, the well-designed water management of this pool.⁷⁷ In contrast, the much larger pools in Olympia and Isthmia were completely overbuilt with modern bath buildings in the same period.

77 The bath complex of the Roman Imperial period is barely discussed by Jannoray 1953, 78–79, who assumed, however, that it was supplied in a similar

way as the *loutron* of the 3rd century BC, by channels coming from the Castilian Ravine.

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1 M. Trümper after Herrmann et al. 2013, 406 fig. 5. 2 M. Trümper after Kunze and Schleif 1944, pl. 15. 3 Mallwitz 1958, 23 fig. 11. 4 Gregory 1995, 280 fig. 1. 5 Gregory 1995, 304 fig. 11. 6–7 Jenkins and Megaw 1931–1932, 87 fig. 11. 8 Miller 2015, 278 fig. 1. 9 M. Trümper after Miller 1992, fig. 260*. 10 Miller 1992, 233 fig. 331. 11 Jannoray 1953, pl. I. 12 Jannoray

1953, pl. II. 13 M. Trümper after Jannoray 1953, pl. III. 14 Jannoray 1953, pl. VI. 15 Veuve 1987, pl. I. 16 M. Trümper after Veuve 1987, pl. III. 17 Veuve 1987, pl. IV. 18 M. Trümper after Netzer 2001a, 6 fig. 8. 19 M. Trümper after Netzer 2001a, pl. 13. 20 Netzer 2001b, 93 plan 17. 21 Netzer 2001b, 96 plan 19. 22 Netzer 2001b, 7 plan 20.

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