

# PRELIMINARY REPORT ON THE ARCHAEOLOGICAL COMPONENT OF THE WĀDĪ MŪSĀ WATER SUPPLY AND WASTEWATER PROJECT (1998-2000)

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## Introduction

The "Wādī Mūsā Water Supply and Wastewater Project" is a development project of the Ministry of Water and Irrigation aimed at improving the existing infrastructure in the urban areas surrounding Petra. In addition to the Jordanian contribution, several components of the project were funded through American, French and German aid programs to Jordan. The archaeological component of the project was carried out by a team from the Department of Antiquities, through a contract signed between the Petra National Trust (PNT) and Camp Dresser and McKee International (CDM), the engineering consultants to the project, with funding from USAID. Middle East Engineering Management (MeeM) was sub-contracted by PNT for the general management of the archaeological component.

The archaeological component of the project was carried out in two phases. The first phase (23 October to 16 November 1996) involved the initial survey of the project area. A report was submitted to the engineering consultants on 10 December 1996 which included the archaeological report and detailed recommendations for the protection of the archaeological sites during the implementation of the project ('Amr *et al.* 1996, a summary of this report excluding the recommendations was published in 'Amr *et al.* 1998).

The second phase (20 June 1998 to 31 August 2000) commenced after the engineering contractors mobilized to the work sites. Due to its large scale, the engineering project was divided up into nine sub-projects, two of which were carried out along with the construction of the new Wādī Mūsā – aṭ-Ṭayyiba road and therefore did not form part of the second phase of the archaeological component of the project. Other than the recommendations given by the first phase of the archaeological component, two of the first phase team members (Khairieh 'Amr and Hani Falahat) gave specific recommendations for the protection of the archaeological sites during the road construction, which were

followed up by the Ma'ān Antiquities Office. There are four recorded archaeological sites along this section (Sites Tayyiba 3-6, see 'Amr *et al.* 1998: 530, 532-533) which were protected during the road construction and the excavation for the water and wastewater pipelines between Wādī Mūsā and aṭ-Ṭayyiba.

As the main purpose of the archaeological component of the project was the protection of archaeological remains, this preliminary report — similar to the first phase report, 'Amr *et al.* 1998 — is heavily "site oriented". A more synthetic approach is reserved for the planned final publication.

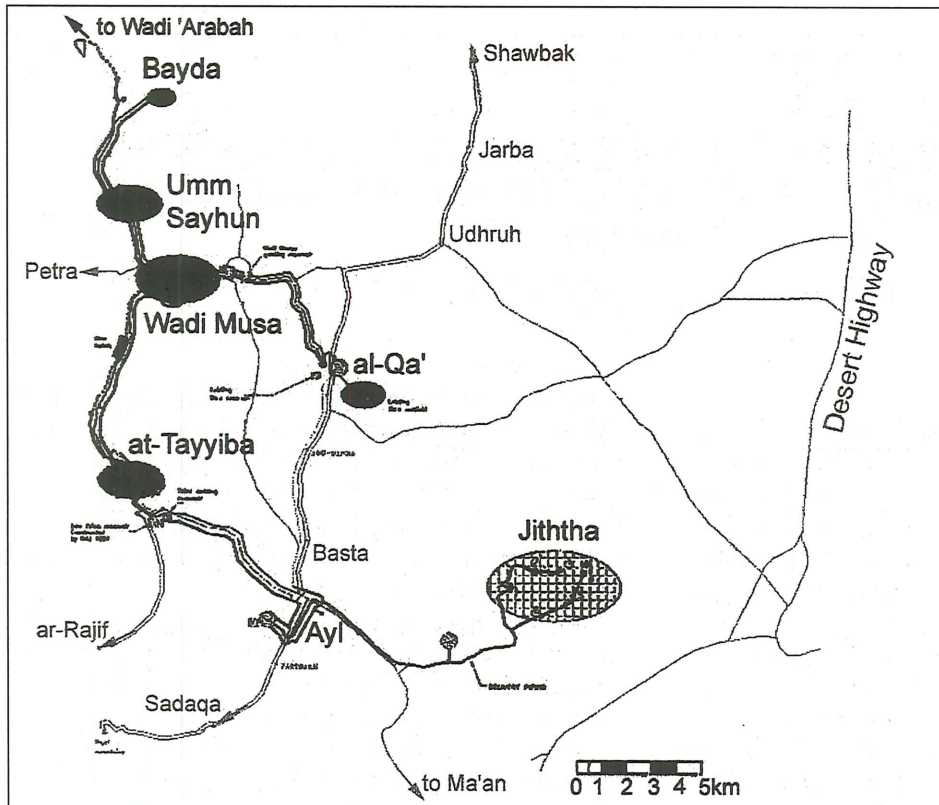
## Area of the Project

The area of the project has a linear length of approximately 60km, extending from the tip of the escarpment overlooking Wādī 'Arabah in the northwest (along the Bayḍā - Wādī 'Arabah road), through the towns of Bayḍā (بيضا), Umm Ṣayḥūn (أم صيحون), Wādī Mūsā (وادي موسى), aṭ-Ṭayyiba (الطيبة), Ayl (أيل) and then on to the area of Jiththa (جثه/جيثا) in the desert to the southwest. Additionally, there is a branch connecting Wādī Mūsā with al-Qā', now called Ḍāhiyat al-Amīr Rāshid (القاع/ضاحية الأمير راشد) (Fig. 1, note that the section between Wādī Mūsā and aṭ-Ṭayyiba was done separately, see above). The northern Bayḍā section, the connection between Ayl and Jiththa, and the Jiththa well-fields were added to the project in 1998, therefore they were not included in the 1996 survey.

Other than the pipelines connecting the sectors of the project, the project involved pipe networks in the towns of Bayḍā, Umm Ṣayḥūn, Wādī Mūsā and aṭ-Ṭayyiba, resulting in over 300km of piping, i.e. 300km of mechanically excavated trenches cutting through the area.

## Nature of the Second Phase of the Archaeological Component of the Project

The core archaeological team during the second



1. Schematic plan of the Wādī Mūsā Water Supply and Wastewater Project area (courtesy of CDM/ ACE).

phase of the project consisted of the authors, who were primarily responsible for carrying out the recommendations given by the first phase in 1996. They were also responsible for the completion of the survey to include the extensions added to the area after 1996 and the re-alignments of the pipelines, the excavation of soundings at suspected sites, and the recording of archaeological remains at sites where the pipelines could not be re-aligned (mainly inside the urban areas).

The work was made possible through constant coordination with the engineering consultants and contractors. Vital as well was the constant coordination and support of the Ma'ān Antiquities Office. Seven sub-projects meant seven contractors with several sub-contractors and teams each, all excavating at different locations at the same time, all of whom had to be visited and supervised by archaeologists. We are deeply grateful for the field assistance offered by Nazih Fino, Qais Tweissi, Sa'ad Tweissi, Sami Al-Nawafleh, Naif Al-Nawafleh, Hani Falahat and Samia Falahat. Antiquities Inspector of the Ma'ān District, Suleiman Farajat, gave us much important on-site logistic support. Mohammad Nasarat was our part-time driver at times when the extent and nature of work got beyond our capabilities.

All the non-metal artifacts, including mosaics and frescoes, were conserved on-site by Qais

Tweissi, the resident DoA conservator in Petra. The metal artifacts were cleaned and conserved in 'Ammān by Fatma Marii, Adel Towshan and Basma Sallam, except for a lead water pipe which was conserved on-site by Tawfiq Huneiti.

Hannan 'Azar registered most of the artifacts, Rula Qussous recorded the photographic material and was assisted by Hanan Abu 'Ali. Object drawings were done by Qais Tweissi, Ahmed al-Momani, Hala Suyuf and Sofinaz Kabaja.

General management and coordination between the team in the field and engineering offices in 'Ammān were carried out by Eng. Munthir Kharruf, Eng. Ma'an Huneidi, and Ibrahim Sayed (MeeM).

#### *Coordination with the Engineering Teams*

Due to the nature of the project, continual coordination with the engineering teams was carried out through regular meetings and direct communication with the contractors' representatives on site. This served to find out the exact locations and timing of the excavations. Daily site visits were also conducted by the archaeological team to all locations within the project area, in order to ascertain that recommendations are being carried out whenever possible and to check for new developments, be they re-alignments of pipelines or the discovery of deeply buried archaeological remains that could

not be detected on the surface. Whenever excavations were taking place at an archaeological site that could not be avoided, or at a newly discovered site, the archaeological team accompanied the excavation at all time in order to record the information, and if necessary, ask for a temporary halt to the excavation work.

At the outset of the project, we tried to coordinate excavation so that no more than one line, or a maximum of two, be excavated simultaneously through known archaeological sites, as the team consisted of only two archaeologists. Later on, however, this proved impractical and we had to face the situation where up to five lines were being excavated simultaneously through archaeological sites. This is where help from the local Antiquities Office proved to be of the utmost importance.

We soon also realised that there was a major gap between our way of thinking as archaeologists and the thinking of the engineers. Whereas the priority of the engineer was to accomplish as much work in as little time at as little cost as possible, our priority was the protection of the archaeological remains and the recording of the finds as accurately as possible. To help bridge this gap, we continually provided the consultants with summary reports on all the finds and recommendations for the next steps along the line, and discussed with the contractors on site the best ways they could help us to protect the sites with minimal effect on their work. We also found ourselves having to continually explain what we were doing, and the importance of what we were trying to protect, record, and recover.

#### *Method of Documentation*

During the first phase of archaeological work on the project, we managed to avoid disturbance to most archaeological sites outside the built-up areas by coordinating with the designers for shifting the pipelines where necessary. This could not be done in the built-up areas, where people now live and have the right to benefit from the project. In these areas, we could not practically excavate beforehand, as the pipelines were to be under modern streets that are in constant use. We also found out that we could not benefit from the scientific ground-penetrating techniques as the modern structures and amenities created too much noise for the techniques to be efficient.

The team, therefore, had to face excavation by mechanical means — done by none archaeologists — through kilometres of archaeological deposits. The shock of this happening right before us was overcome, to an extent, by our regarding the pro-

ject as a rare opportunity to get a 300km long sounding through areas that could not otherwise be excavated, as most of them were under modern streets and thick modern deposits.

For the purpose of recording the archaeological finds, we used the same grids as the engineering projects, using each pipeline as a unit. Architectural features (walls, basins, floors, etc.) within the pipelines were given consecutive numbers, and strata were tied in with the features. Each feature was given three-dimensional coordinates, the "X" being its distance from the nearest pipeline junction (Centre of Manhole — MH — for the wastewater and Station for the water pipelines), the "Y" its location under the modern surface, and the "Z" its location relative to the sides of the pipeline trench. We also recorded the orientations (by hand-held compass), building materials and dimensions of all features. The collected small finds (sherds, flints and objects) were tied in with these features and associated strata.

The recording was done inside the pipeline trenches, the widest of which was under 2m wide and could go as deep as 5m (Fig. 2). This was done concurrently with the contractors' excavations, and had to be timed so as not to delay the engineering work (as any delay meant compensation money). As most lines were excavated, pipes laid, and back-filled within a day (and sometimes within hours), we had to do our recording and collection of finds as fast as possible. We therefore decided to drop the drawing of all features which we initially started doing, and be content with photographs (black and white prints, and colour slides). Additionally, as we had to deal with limited space and time, we could not be choosy about the right angle and correct lighting for the photography. In general, however, the results were satisfactory for documentation purposes.

We also decided to keep the divisions of the project into the sectors already adopted during the



2. Recording of the archaeological remains in a wastewater trench.

first phase ('Amr *et al.* 1998: 503), adding to them the Jiththa sector, thus ending up with seven sectors: Bayḍā, Umm Ṣayḥūn, Wādī Mūsā, aṭ-Ṭayyiba, Ayl, Jiththa and al-Qā' (see Fig. 1).

### The Bayḍā Sector **بيضا**

The area of this sector was extended northward twice during this phase of the project, due to the extension of the area of the wastewater treatment plant at Siq Umm al-Ḥirān (سويق أم الحيران), and then due to the planning and construction of a 2km long irrigation pipeline to serve plots of land further north (Fig. 3). The sector now runs roughly alongside the road from Umm Ṣayḥūn to Bayḍā, includes the modern village of Bayḍā, and on to Wādī 'Arabah (starting from the Petra junction at the western end of Umm Ṣayḥūn, and going northward until the steep drop in the road going down to Wādī 'Arabah, with a length of around 10km). All the area to the west of the modern road (roughly west of the pipeline in Fig. 3), is within the Petra National Park.

Thirty archaeological sites — or rather outstanding archaeological features, as the whole area is considered a continuous archaeological site — were recorded in this sector in 1996 ('Amr *et al.* 1998: 504-515). Nine additional sites were recorded in 1998-2000, all resulting from survey work, thus bringing up the total to 39 sites. Details of these sites, as well as of the previously recorded sites that were affected by the implementation of the project and the recommendations for their protection, and daily records of the work progress are in 'Amr and al-Momani 2000.

#### Survey of the Bayḍā Sector

The survey of the Bayḍā sector in 1998-2000 included four new areas:

1. The top of Jabal al-Qirā' (جبل القراع), the highest mountain in the Bayḍā sector at 1243m asl. The slopes close to the summit were proposed for the location of a telecommunications tower to serve the wastewater treatment plant. A group of corrals and dry rough stone walls with associated Nabataean and Late Roman pottery sherds were recorded at the summit (*Site Bayda 31*).
2. The northern extension of the wastewater treatment plant, for the location of temporary facilities, access routes and dumping areas. Four sites were recorded in this extension. *Site Bayda 32* is a complex structure with associated Nabataean and Late Islamic sherds; *Site Bayda 33* were the remains of a Nabataean wine press; *Site Bayda 34* are wall lines of a Nabataean

structure associated with Bayda 33, part of which was used as foundation for a modern traditional house; *Site Bayda 35* is a group of Nabataean rock-cut features and badly preserved wall lines. The outstanding natural phenomenon associated with Sites Bayda 33, 34 and 35 is their bad state of preservation and the unusual deterioration of the remains. Graffiti as late as 1990 at Bayda 35 were already so badly eroded that they are hardly visible any more.

3. The construction of a 2km long irrigation pipeline to serve land north of the wastewater treatment plant. Three sites were recorded along this line. *Site Bayda 36* is an extensive area of terraces and field walls with associated unidentified flints, and Nabataean and Late Islamic sherds; *Site Bayda 37* is a complex site comprising a substantial Nabataean structure, several wadi barriers, and a recently (1990) reused small Nabataean cistern; *Site Bayda 38* is a modern Bedouin cemetery.
4. Clearance of Wādī Umm al-Ḥirān (وادي أم الحيران) by the contractor for the protection of the road leading to the wastewater treatment plant necessitated a re-survey of the eastern bank of the wadi. One site was added to the record: *Bayda 39*, a group of terrace walls and wadi barriers along a small side wadi.

#### Soundings at Site Bayda 1

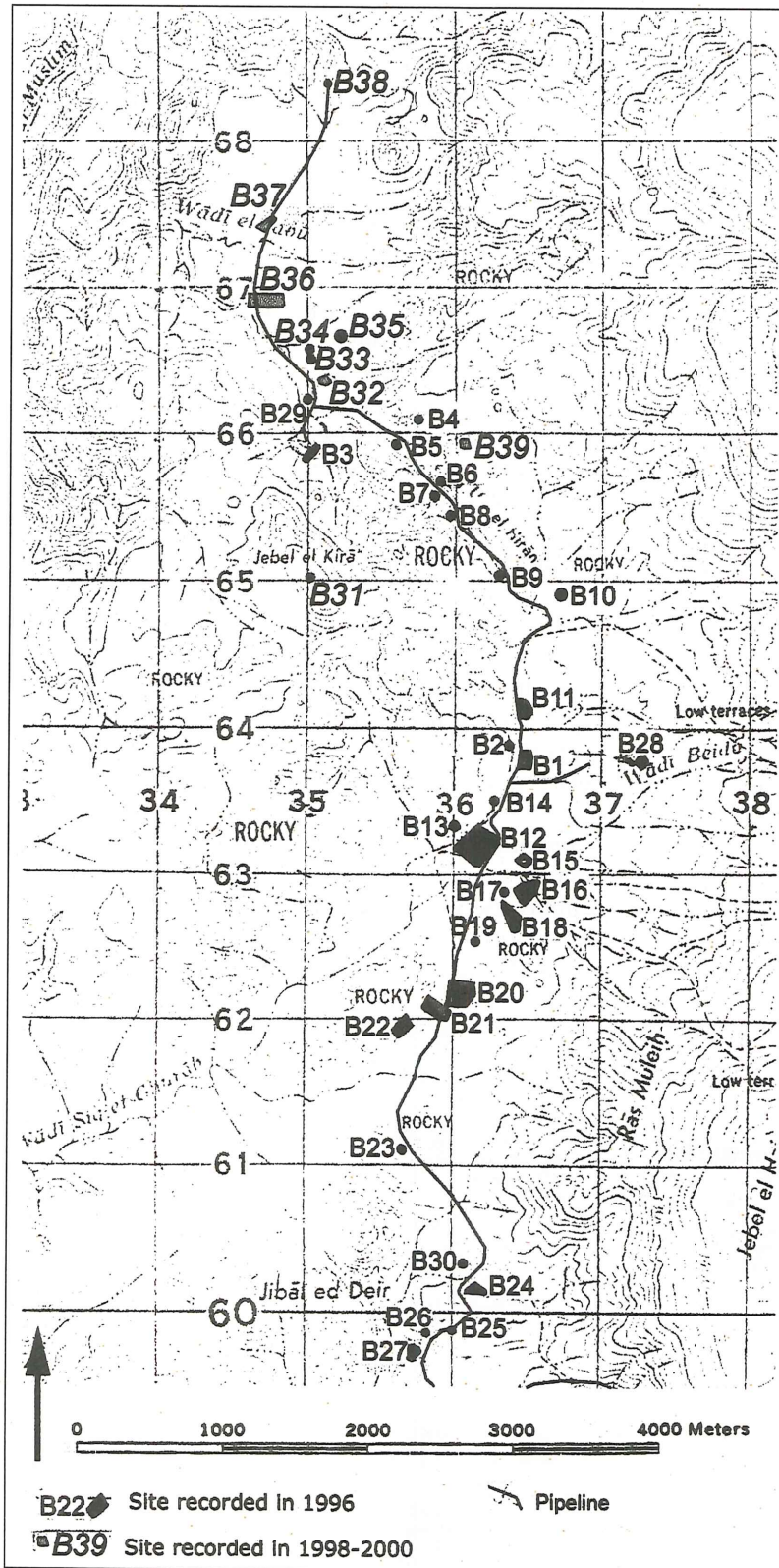
The Bayḍā Pumping Station was designed on the low ground directly to the north of the archaeological Site Bayda 1 ('Amr *et al.* 1998: 504, 505). We soon learnt that all pumping stations should have access all around them as well as a fence with deep foundations. As it was difficult to determine the exact extent of Site Bayda 1 from surface features, we excavated two 3 x 3m soundings on the northern slope of the hill on which the site is located prior to any construction work. These soundings revealed the total absence of any architectural remains or stratigraphy, and contained only wash layers. To our surprise, however, we recovered an almost intact Nabataean cooking pot (reg. no. WMS98.003) that was washed down from the site in one of the soundings.

#### Sites Affected by the Implementation of the Project

The impact of the project on the archaeological sites in the Bayḍā sector was limited (except for Site Bayda 33, see below), and no new sites were revealed by the excavation of the trenches. This was mainly due to the fact that in most cases, both the water lines (running along the eastern side of the main road), and the wastewater lines (running along

the western side) could be shifted to an extent. Also as this sector runs at the border of the Petra National Park, aesthetics were considered of prime importance. The contractors had to adhere strictly to

areas designated by the archaeologists for all their activities, including the locations of materials, dumps and machinery. Movements of machinery were also highly restricted in this sector.



3. Recorded archaeological sites in the Baydā sector (ref. map Jordan 1:50,000 Petra 30501 K737).

*Bayda 20:* An area of rock-cut installations and wall lines ('Amr *et al.* 1998: 511-512). Although the pipelines were shifted at this site, the movement of machinery disturbed one wall line (one course in height).

*Bayda 21:* An extensive site with many structures ('Amr *et al.* 1998: 512). The excavation trenches revealed the presence of an ash layer and ceramic water channel fragments. It also revealed that the wall lines next to the road do not exceed one course in height.

*Bayda 25:* A rock-cut channel, already cut by the main road, and wadi barrier ('Amr *et al.* 1998: 514). Heavy machinery scratched the channel.

*Bayda 33:* A small rock-cut wine press. This site could only be protected through major re-design of the northwestern part of the wastewater treatment plant. Due to its bad state of preservation (**Fig. 4**), and after consultation with the Ma'ān Antiquities Office, we decided to completely excavate and record the wine press. The Antiquities Inspector for the Ma'ān District then gave permission to the contractors for its removal (Site Bayda 32 was protected inside the premises of the wastewater treatment plant).

*Bayda 35:* A group of rock-cut features and wall lines. Dumping and the movement of machinery destroyed parts of the walls.

*Bayda 36:* A series of terraces and field walls. The irrigation pipeline cut through two terrace walls. No dating evidence was found in the trench.

*Bayda 37:* A Nabataean structure and hydraulic installations. Despite the realignment of the irrigation pipeline in the vicinity of this site, it still cut through two wadi barriers that were not evident at the surface.

#### The Umm Şayhūn Sector أم صيحون

No extensions were added to this sector ('Amr *et al.* 1998: 515). The archaeological sites recorded along the Umm Şayhūn – Wādī Mūsā road were not affected by the implementation of the project.

Within the village of Umm Şayhūn, however, clearance by the contractor revealed the opening to the tunnel *Site Umm Sayhun 3* at the northern cut of the main road across the village. The clearance also revealed two other openings to the tunnel at around 22.50m to the west of the main opening.

In the southeastern part of the village, three cemeteries with no traces at the surface were discovered by the excavations for the pipelines, bringing the total number of sites recorded in this sector up to six (**Fig. 5**). Details of these sites are in 'Amr and al-Momani 2000.

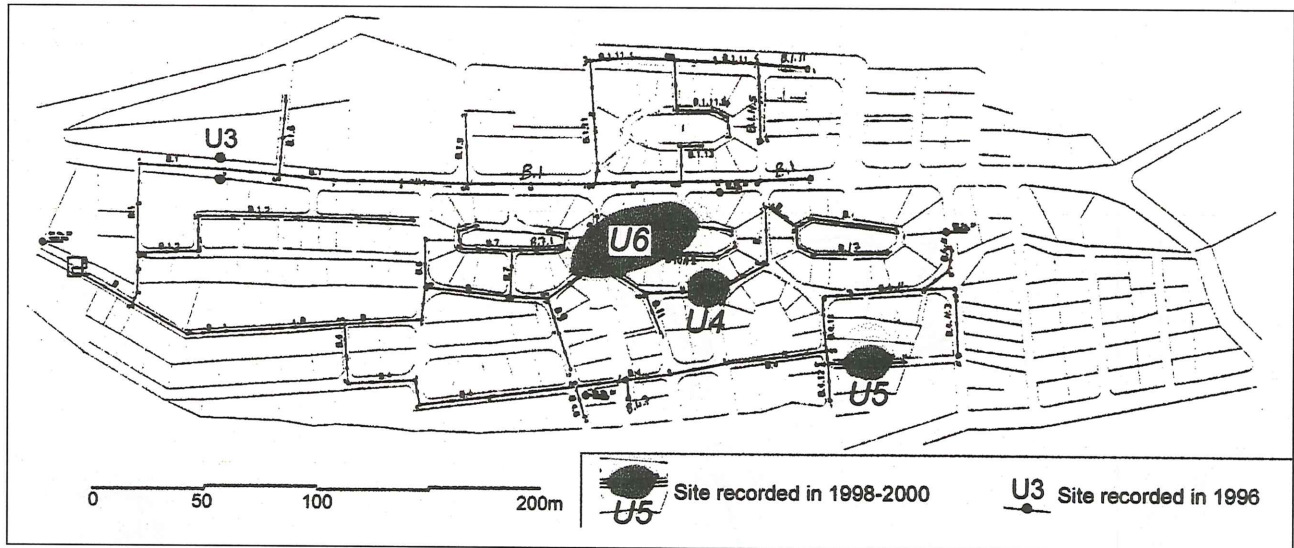
#### Sites Discovered during the Excavation for the Pipelines

Although the three sites are cemeteries that share several features, it was decided to keep them separate because the excavation for the pipelines in between did not reveal the presence of any burials.

*Umm Sayhun 4:* Five burials were recorded in this cemetery, all within stone-lined pits oriented roughly N-S. No dating material could be found but the orientations of the burials indicate that they are not Islamic.



4. Site Bayda 33, view from the north.



5. Recorded archaeological sites in the town of Umm Şayhūn (base map courtesy of CDM/ ACE).

*Umm Sayhun 5:* Eight burials were recorded in this cemetery, all within simple pits dug in the virgin soil, of varying orientations. Nabataean pottery of the first to early second centuries AD, including a complete plain bowl and jug (reg. nos. WMS99.004 and .079), were recovered from the burials.

*Umm Sayhun 6:* Six burials were recorded in this cemetery, all within simple pits dug in the virgin soil, of varying orientations. Nabataean pottery sherds of the first century AD were recovered from the burials.

The nature of the burials in these cemeteries, and the paucity of funerary goods, indicate that we are dealing with “the cemeteries of the poorest” of the Nabataean society, which stand in stark contrast to the monumental burials of Petra.

#### The Wādī Mūsā Sector **وادي موسى**

This sector basically covers the modern town of Wādī Mūsā, and proved to require most of the attention of the archaeological team due to the density of the pipelines as well as the density of archaeological sites. Twenty-four sites were recorded in Wādī Mūsā during the first phase of the project ('Amr *et al.* 1998: 516-526). By the end of the second stage, the number of recorded archaeological sites in the town went up to 33 (Fig. 6). Two of these sites were discovered after the first phase but prior to the commencement of the second phase of the project (Sites Wadi Musa 25 and 26); six sites that had no indications at the surface were discovered during the excavations for the pipelines (Sites Wadi Musa 27, 28, 29, 31, 32 and 33); while

Site Wadi Musa 30 (al-Muzayr'ā المزيرعة) was outside the project area but we decided to record it due to its obvious significance and proximity to the built-up areas, as well as the fact that we could not find any archaeological record of it except for its recent inclusion in the Jabal ash-Sharāh Survey where it is mentioned as Khirbat al-Qarāra خربة القرارة (Tholbecq 2001: 402).

Details of all the newly recorded sites, as well as the sites affected by the excavation for the pipelines and daily records of work progress are in 'Amr and al-Momani 2000.

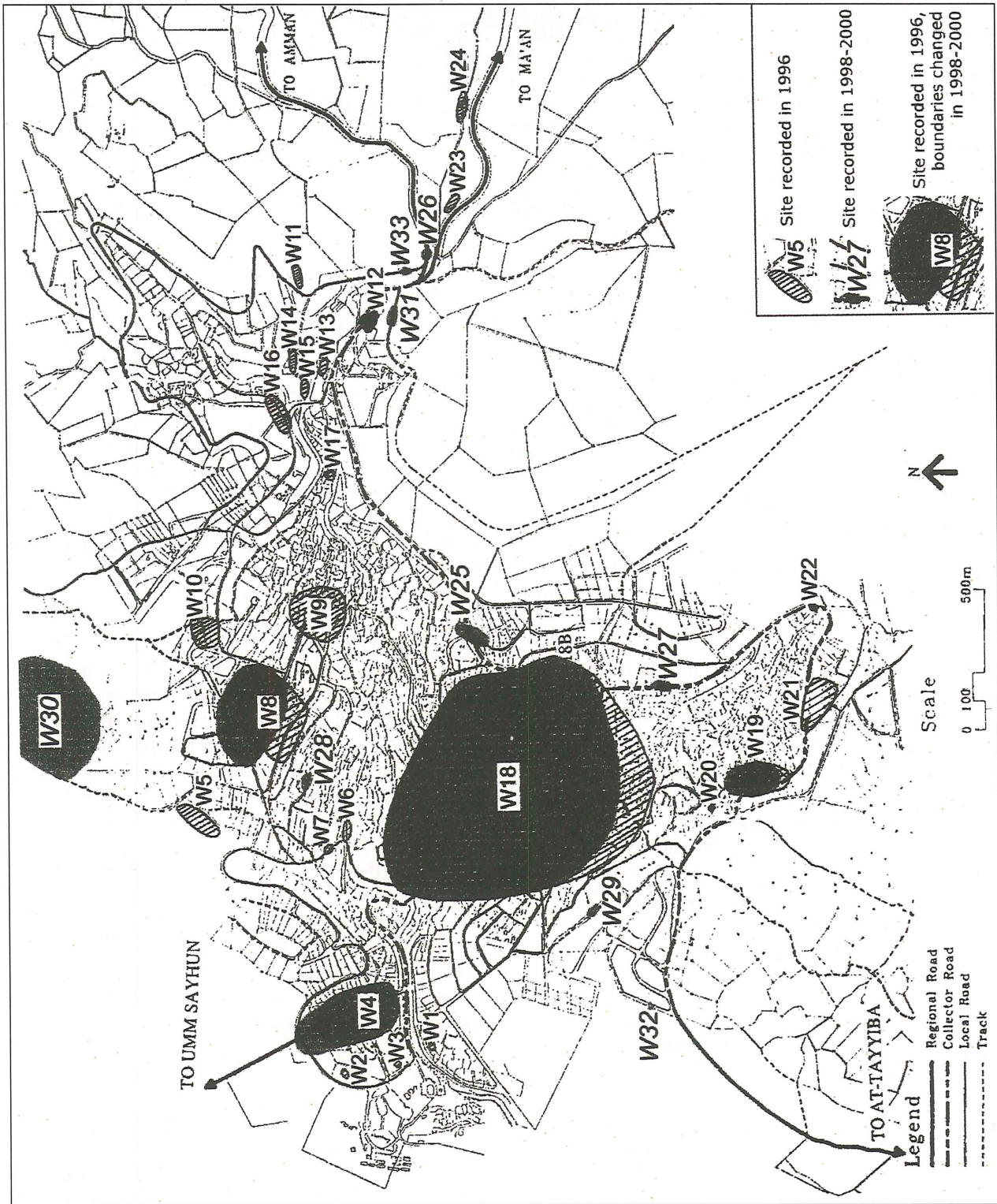
#### *Soundings at Site Wadi Musa 1 (ad-Dāra الدارة)*

Nine soundings (2 x 4m) were excavated at this site near the entrance to Petra, which was chosen for the location of the Wādī Mūsā Pumping Station. The soundings revealed the presence of ancient agricultural fields, mostly from the Nabataean period, under around 1m of modern deposits. The only feature found in the soundings was a modern *tābūn*.

During the excavations for the pipelines, however, part of a ceramic water channel of ca. 17cm diameter was discovered to the north of the sounded area, at 1.40m below the surface (reg. no. WMS99.096). Its orientation suggests that it brought water from one of the southern Wādī Mūsā springs to Petra (through as-Siq?).

#### *Previously Recorded Sites Affected by the Implementation of the Project*

The main recorded sites that were avoided by the project are Sites Wadi Musa 23 and 24, which are to the east of the built-up area, and Site Wadi Musa 9 (Khirbat an-Nawāfla خربة النوافله) which is



6. Recorded archaeological sites in the town of Wadi Mūsā (base map courtesy of PRPC, now PRA).

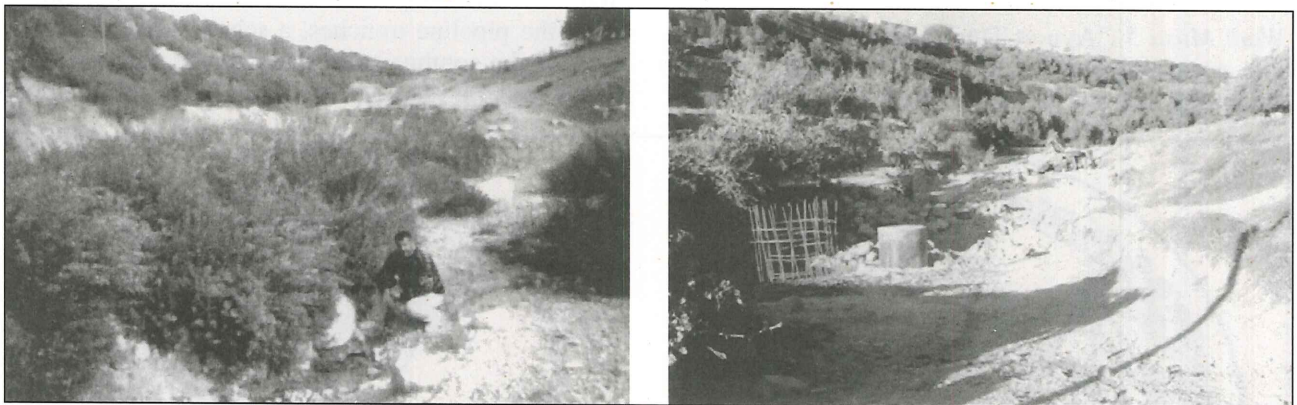


now converted into a tourist village and was excavated by the Department of Antiquities ('Amr *et al.* 2000). Sites Wadi Musa 2 (Birkat az-Zurrāba بركة الزرابة) and Wadi Musa 3 (al-Quff القف) are owned by the Department of Antiquities and are therefore protected. Sites Wadi Musa 6 (al-'Udmal العدمل), 11, 13 (Ṭāhūnat al-'Alāyā العلايا العلايا), 14 (Khīrbat al-Muḥaylla خربة المحيلة), 15 and 16 are along wastewater pipelines that were postponed to a later stage. Site Wadi Musa 6 along the southern bank of Wādī Khalīl/al-Madarr (وادي خليل/المدن), however, was affected in the spring of 2001, when during the excavation for the wastewater pipeline along the wadi — coordinated with the Ma'an Antiquities Office — a flash flood swept rubble, machinery and concrete manholes. This resulted in the total burial of 'Ayn as-Sayl (عين السيل), as well as covering a significant portion of the 6m previously exposed archaeological deposits ('Amr *et al.* 1998: 518-519, see Fig. 7). This same flood almost had a catastrophic effect on the Nabataean bridge below

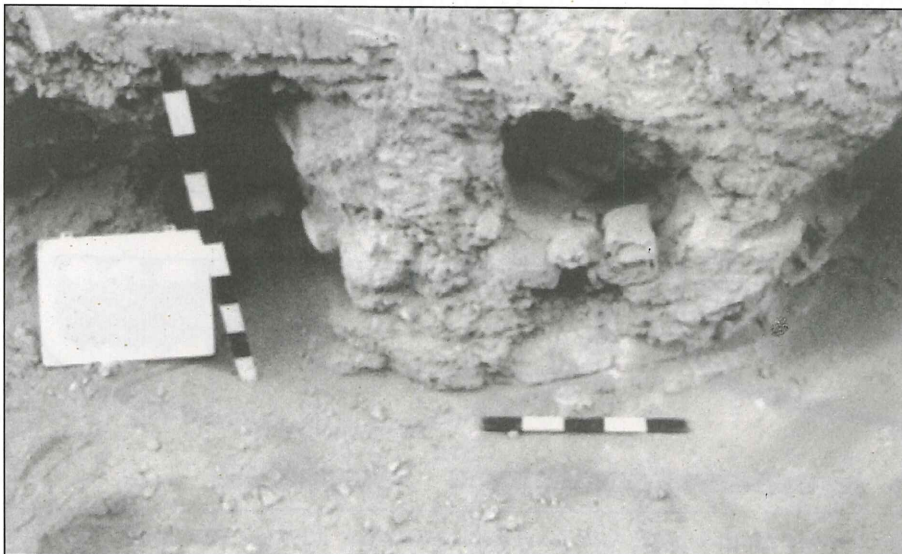
Khīrbat an-Nawāfla (Wadi Musa 9, 'Amr *et al.* 2000: 238 and fig. 8), which had just been fully exposed, recorded and — luckily — its consolidation accomplished by the Ma'an Antiquities Office on the day the flood occurred (2 May 2001, see Falahat *et al.* 2001a). The main reason for the bridge project was its protection during the excavation for the wastewater pipeline along the wadi.

The double water mill of Site Wadi Musa 17, and the cistern Site Wadi Musa 20 ('Ayn Ridān عين ريدان) were protected by their positions in private allotments that were not crossed by pipelines. Site Wadi Musa 22 (Ṭāhūnat 'Ayn aṣ-Ṣadr عين طاحونة الصدر) was not disturbed by the project, but was nevertheless destroyed for other land uses.

*Wadi Musa 4* (az-Zurrāba الزرابة): The excavation for the pipelines at this ceramic production centre revealed the presence of five pottery kilns under the main street crossing the site, thus bringing the total number of kilns recorded there up to 12 (Fig. 8. For



7. Site Wadi Musa 6: The picture to the left shows 'Ayn as-Sayl as recorded in November 1996; the one to the right is the same area after the flash flood of 2 May 2001.



8. Kiln XII at az-Zurrāba (W4), dated to the Nabataean period (mid first century AD). The strata it was dug into contained pottery of the first century BC and early first century AD.

previous excavations at az-Zurrāba see Zayadine 1981: 350-351; 1982: 380-393; 1986; 'Amr 1991; 'Amr and al-Momani 1999). All these kilns are again of the simple updraught type. They date to the mid first, late second-early third, mid fourth and sixth centuries AD.

The pipeline trenches also exposed parts of several workshops and work basins with hydraulic mortar, as well as four ceramic water channels of the Nabataean and Late Roman periods, probably associated with Birkat az-Zurrāba (Site Wadi Musa 2). We recovered 62 museum objects from the site, mostly various forms of pottery objects including superb wasters of large numbers of cooking pots and jugs melted together in one mass, as well as a number of painted Nabataean vessels (Fig. 9).

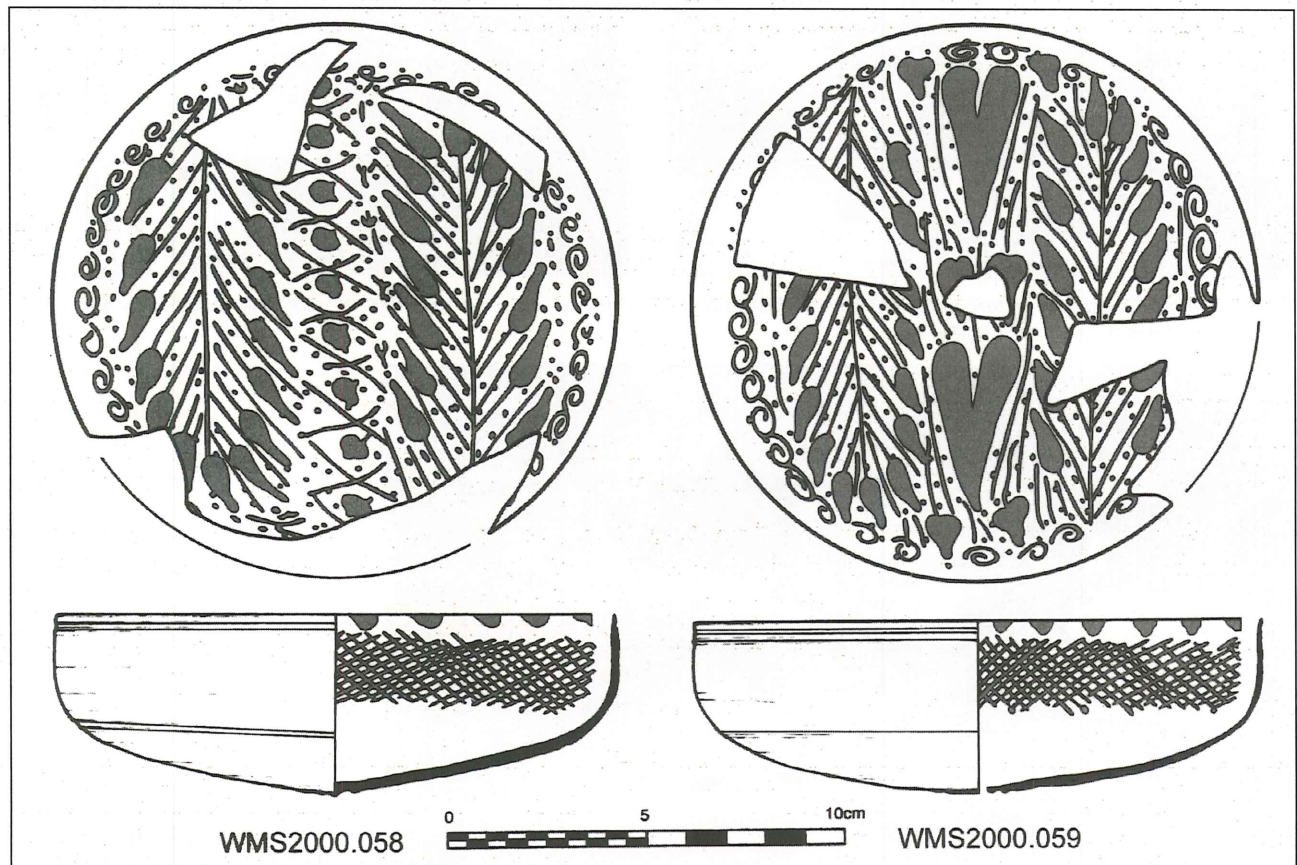
The pipeline excavations showed that the site of az-Zurrāba extends much further north than we anticipated in 1996 (by more than 50m, see Fig. 6). It reaches as far as the modern crossroads at the beginning of the main road to Umm Şayḥūn.

*Wadi Musa 5* ('Ayn at-Ṭinah العين الطينة): The pipeline excavations along the wadi revealed that the structures in the southeastern wadi cut do not con-

tinue any further than that cut. The "clay mine" pit, however, was partially obliterated by the dumping of excavated material from this and other projects in town (for recorded features at the site see 'Amr 1997).

*Wadi Musa 7*: The pipeline excavations revealed only soil deposits extending under the modern street, devoid of any dating evidence for this site.

*Wadi Musa 8* (al-Basiṭ البسيط): Excavation for the pipelines revealed a large Pre-Pottery Neolithic village covering most of this site. The 12 metres at the eastern edge of the site, however, are occupied by the remains of Ayyubid/Mamluk structures (Fig. 10) and Nabataean and Edomite fields associated with the nearby Sites Wadi Musa 9 (Khirbat an-Nawāfla) and 10 (Ṭawilān). The three sites form an important archaeological triangle within the area known as Ḥayy az-Zaytūna حي الزيتون (the district of the olive) in Wādī Mūsā, which is still the most intensely cultivated area of town. Other than the pipeline trenches, a school was built over part of the southeastern sector of the site in 1999-2000, and we recorded the discoveries revealed by



9. Two painted mid first century AD Nabataean bowls from inside Kiln XII at az-Zurrāba (W4). WMS2000.058: ware 2.5YR 5.5/8 light red/red, paint 10R 5/6 red; WMS2000.059: ware 2.5YR 5.5/6 light red/red, paint 2.5YR 4/6 red (drawing: Qais Tweisssi).



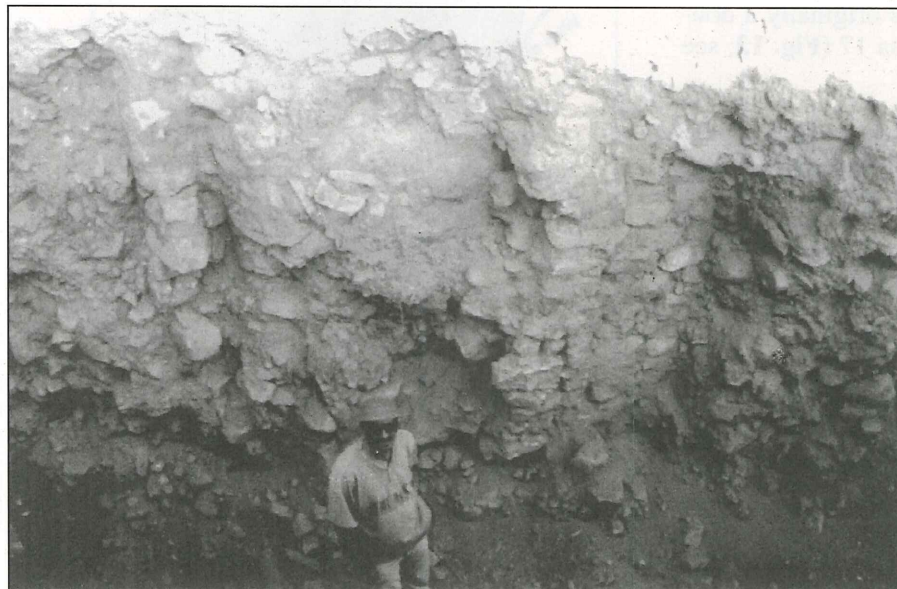
10. An Ayyubid/Mamluk structure cut by a pipeline trench at the eastern edge of al-Basīṭ (W8).

its foundation trenches along with those of our project. Salvage excavations carried out by the Department of Antiquities (Fino 1997; 1998) preceded the building of the school. The pipeline trenches showed, however, that Fino had excavated at the edge of the PPNB village and thus only revealed the latest and least preserved phase of its occupation.

The preserved remains of the Neolithic village surpassed all our expectations. We could discern at least three phases of Pre-Pottery Neolithic structures, as well as several Pottery Neolithic structures and a lime pit at part of the northwestern section of the site. Al-Basīṭ now forms a link with the other major PPN villages of the Petra area (Baṣṭa, Bayḍā and Ba'ja, see for example Bienert *et al.* 2000; Kirkbride 1968; Nissen *et al.* 1991 and pre-

vious seasons cited in these reports). The architecture revealed at al-Basīṭ resembles finds from these other sites, with complex structures of small rooms, many with red-painted plaster floors and channels underneath the walls. Most of the walls are well built with two faces of small rough rectangular blocks and mud mortar, and some that well exceed 2m in height may belong to two-storey buildings (Fig. 11).

At the northwestern edge of the site, a pipeline trench revealed a “standing stone” over a metre high, surrounded and supported by a circle of smaller stones, within a room approximately 3.30m wide (Fig. 12). Taking into consideration that we are only dealing with sections in this project, this feature is reminiscent of the “PPNB Temples” reported at 'Ayn Ghazāl (Rollefson and Kafafi 1997:



11. Neolithic structure at the centre of al-Basīṭ (W8).



12. "Standing stone" feature at the northwestern edge of al-Basit (W8).

28-30, 33-35; 2000: 95, 97).

We recovered 116 museum objects from the site, mostly consisting of flint tools, grinding stones and stone bowls. All the Neolithic objects from the site are currently under study by Gary O. Rollefson.

**Wadi Musa 10** (Ṭawilān طويلان): The Department of Antiquities owns most of this site, which is famous for its Iron Age remains (Bennett and Bienkowski 1995). Pipeline excavations at the southern edge of the site revealed only thick ash layers with pottery sherds. The one recovered object from Ṭawilān is the only Umayyad bronze coin from the whole project (reg. no. WMS2000.031), which was a surface find.

**Wadi Musa 12** (Ṭāhūnat 'Ayn Mūsā طاحونة عين موسى): Excavation for the pipelines going down the main street through town revealed that this water mill — which can still be seen by the side of the road opposite 'Ayn Mūsā — was originally a double mill similar to Site Wadi Musa 17 (Fig. 13; see 'Amr *et al.* 1998: 521-522).

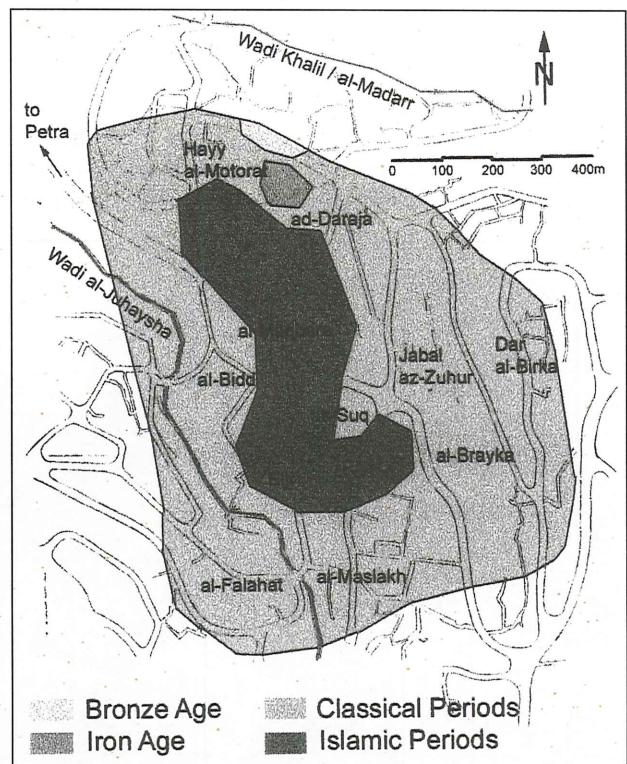


13. The lower water mill tower of Ṭāhūnat 'Ayn Mūsā (W12), now covered by the modern main road.

**Wadi Musa 16:** The pipeline trenches revealed part of a structure (two walls and an arch springer) under the modern street junction. The associated pottery may be dated to the Early Ottoman period.

**Wadi Musa 18** (Gaia): The ancient city that extends with a diameter of around 1km below the centre of modern Wādi Mūsā is the largest site in this sector, and the site cut by the largest number of pipeline trenches as it is also the site with the highest density of modern habitation. The excavations revealed habitation in this city dating back to the Middle Bronze Age, Iron Age II, and the Nabataean, Roman, Byzantine and Islamic periods.

The Middle Bronze Age (MB II?) was revealed in a small area at the northern edge of the site (Fig. 14). This is the only area within the project where Bronze Age remains were found. The features consisted of a group of sturdy walls and the remains of two lime kilns. As it is highly improbable that these installations were in isolation, we assume that a village must have existed in that area, most probably buried deep under Gaia. An Egyptian scarab seal purchased by the Department of Antiquities back in the early 1970s (Ward 1973) is said to have come from an area at the northern edge of Wādi Mūsā, but our locality is a more probable provenience especially that the locals re-



14. Distribution of the archaeological remains at Gaia (W18), according to general period.

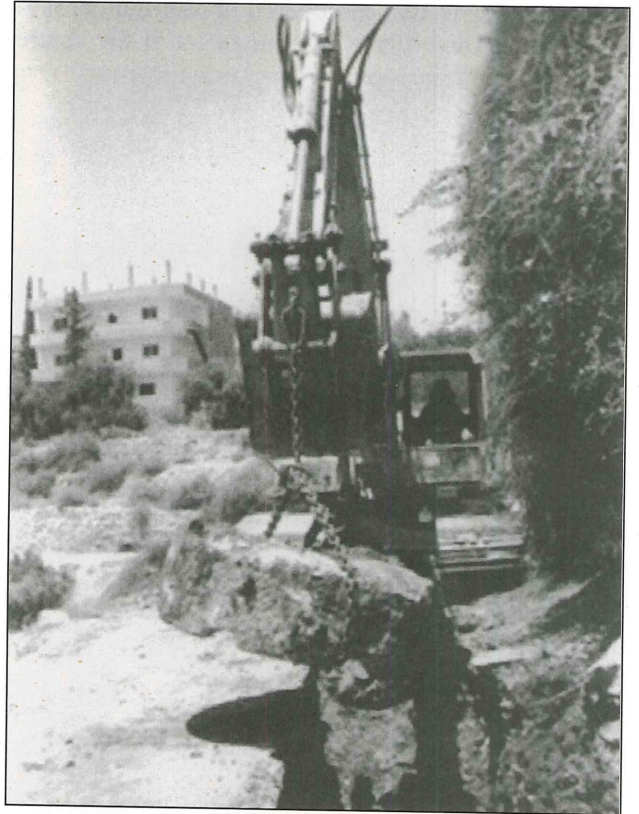
ported to us excavations that were carried out there in the early 1970s. It should also be noted, however, that stray MB II sherds were found at Khirbat an-Nawāfla (Site Wadi Musa 9), as well as the earlier Canaanian blades ('Amr *et al.* 2000: 231, 233), but this is again well south of the area reported as the locale for the scarab.

During the Nabataean period, Gaia reached its largest extent (excluding modern Wādī Mūsā). We recorded more than 20 complex Nabataean structures at various localities within the ancient city, in addition to a number of cisterns, lead water pipes (which seem to have spanned long distances, see Tweissi 2000), and stone-lined and ceramic water channels (see *Note on the Development of Ceramic Water Channels* below).

In accordance with the results of excavations at various Nabataean sites, Nabataean Gaia seems to have been established at the beginning of the first century BC (see Schmid 2001). Already at this early stage, the city was well defined by substantial boundary walls which we recorded along the main road going down to Petra, at al-Brayka (البريكة), and at the al-Falaḥāt (الفلاحات) sectors of town (Figs. 14, 15). Shortly after the establishment of the city, a monumental building was constructed at its centre, at the southeastern edge of the modern as-Sūq (السوق) area and more precisely below the modern Girls High School. Several statues and elaborate capitals were recovered from the school foundations in the 1970s, indicating the probability that a temple exists at the location. We recorded a substantial wall — very well built with headers and stretchers — directly to the south of the modern school, which could be the temenos wall for the presumed temple (?).

One of the most significant Nabataean dis-

coveries at Gaia was an olive press of the late first century AD, discovered at al-Bidd (البد, lit. the olive press, Fig. 16). The name of the district came from the discovery of olive pressing stones when the side street connecting the main road to Petra with the al-Falaḥāt district was constructed. This is the second Nabataean olive press recorded at Wādī Mūsā (see 'Amr *et al.* 2000: 239), and chronologically it links



16. Lifting of the massive Nabataean olive press basin from the pipeline trench at al-Bidd (W18). All the recovered olive press stones are currently on display in front of the Petra Visitors Centre.



15. The foundations of a massive first century BC boundary wall at the northwestern edge of Gaia (W18). It clearly separates the archaeological deposits to the east (left of the wall in the picture) from the natural clay soil to the west (right of the wall). This wall is currently under the main road going down to Petra, roughly below the middle of the large concrete retaining wall protecting the road under the as-Sūq area.

the Khirbat an-Nawāfla press with the presses from Khirbat adh-Dhariḥ (Villeneuve 1990).

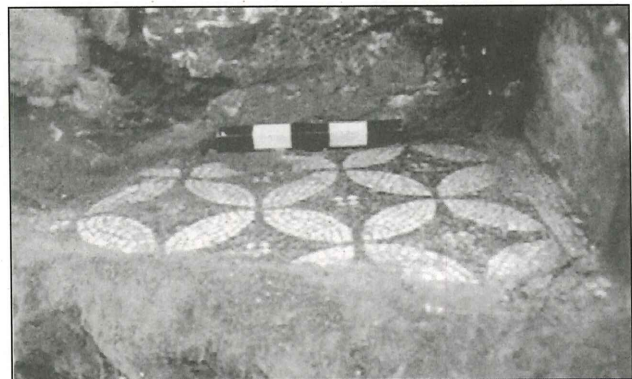
The best-preserved Nabataean remains were revealed at Dār al-Birka (دار البركة, Fig. 17), Jabal az-Zuhūr (جبل الزهور), as-Sūq, al-Maslakh (المسلخ), and al-Falahāt (see Fig. 14). The structures were all well-built, with flagstone pavements, plastered walls and arches supporting the roofs. Luxurious villas similar to that discovered during the excavation by the Department of Antiquities at the centre



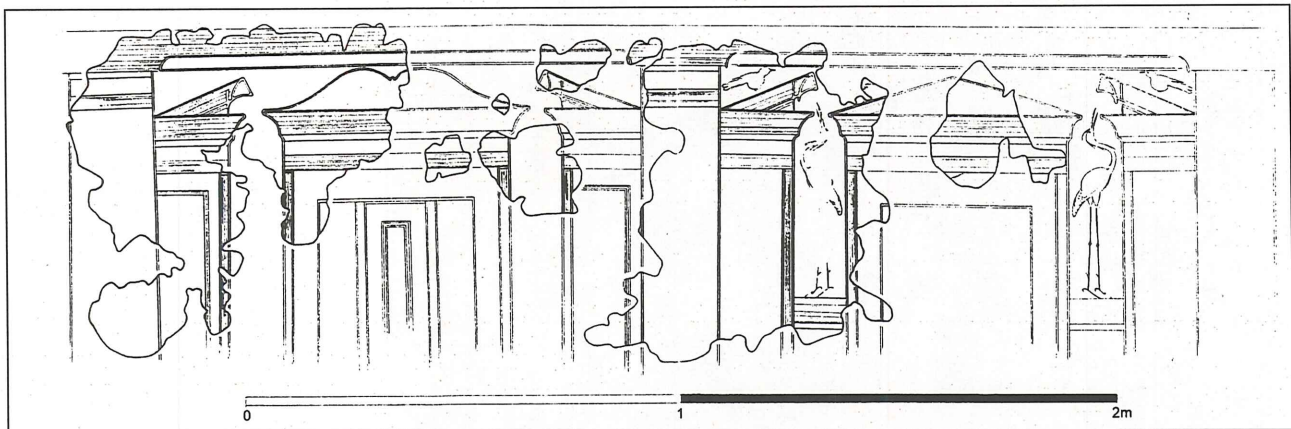
17. Completely preserved doorway connecting two rooms in a Nabataean villa at Dār al-Birka (W18).

of as-Sūq in 1996 ('Amr *et al.* 1997; Tweissi 2001) were found in all those areas. At a distance of less than 50m southeast of the "1996 villa", a neighbouring structure had a mosaic floor of black and white geometric designs dated to the mid first century AD (Fig. 18), which extends and should still be preserved underneath the foundations of what used to be the Yākhūr building (see 'Amr *et al.* 1998: 524). This is thus the second known *in situ* Nabataean mosaic floor (mosaic fragments of a similar date were discovered at az-Zanṭūr in Petra, Kolb 1998: 261-262). Between the two structures with the mosaics, the pipeline trenches revealed a Nabataean cistern adjacent to the cistern discovered during the 1996 excavation. Large "double" cisterns at the centres of towns are known from other Nabataean sites, e.g. at al-Ḥumayma (Oleson 1990: 288).

At around 100m to the north of the 1996 excavations, we recovered a fresco of the "Second Pompeiian Style" from another villa. Although similar to other frescos from Wādī Mūsā and Petra, it is unique in having representations of birds (a heron, a sparrow and a phoenix) among the architectural scene (Fig. 19). The inferior adherence of



18. Fragment of a Nabataean mosaic floor from the as-Sūq area (W18), now on display at the Petra Museum.



19. Reconstruction drawing of a Nabataean fresco from Jabal az-Zuhūr (W18), now restored and on display at the Petra Museum (by Qais Tweissi).

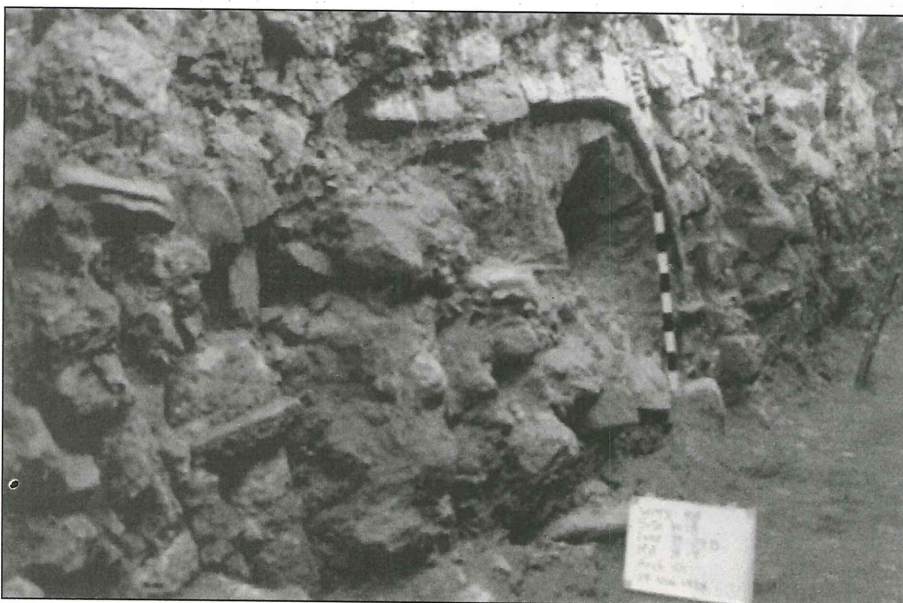
the painted bird figures indicates that they were a later addition to the scene.

Further south at al-Maslakh, the pipeline trenches cut through a villa with a private bath similar to that of the villa excavated in 1996 (structure mentioned at Site Wadi Musa 18F in 'Amr *et al.* 1998: 524, where we wrongly commented that the “ceramic channel” in fig. 13 “does not look like a flue pipe for a bath”). Other than being almost exact replicas of each other, the two baths are similarly situated at the western edges of their respective villas.

Most of the exposed Nabataean structures at Gaia had several periods of construction and/or reuse. Several continued into the Roman period, and some were partially reused, or their masonry reused in “new” constructions during the Late Roman/Early Byzantine period. This is especially evident at al-Falahāt where very well preserved fourth century AD structures are still standing under the modern streets (Fig. 20), as well as at Dār al-Birka (where we recovered two elaborate Nabataean capitals from a later wall, reg. nos. WMS98.038, .039). At Dār al-Birka, the pipeline excavations shed light on the date of construction of the *dār* (see 'Amr *et al.* 1998: 522), which had been postulated as “Ottoman” by several archaeologists. The structure was originally discovered and restored by local people in the early 20th century (according to information gathered by Hani Falahat of the Ma'ān Antiquities Office). By comparing its construction method and level with the neighbouring structures exposed by the pipeline trenches, we can now assume that it was originally constructed in the Nabataean period (first century

AD) and reused during the Late Roman/Early Byzantine period. The water spring, over which the *dār* is built, as well as its associated channel are still used for irrigating fruit orchards in the area.

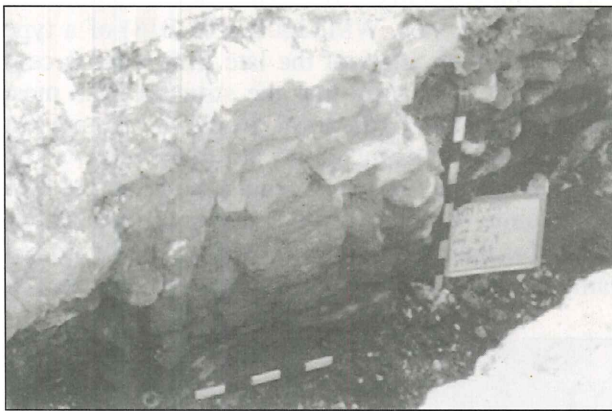
By the Late Byzantine and through the Early Islamic periods, the situation of Gaia looks similar to that of the area as a whole, where settlements seem to have got concentrated in small groupings rather than the spread-out extensions of the earlier periods. The residential space at Gaia decreased, and became mainly restricted to the city centre (as-Sūq and al-Jī/ Eljī الجي, for “controlled excavation” at al-Jī see Al-Nawafleh 2000), as well as a few remains near 'Ayn al-Baṣṣa عين البصة at the extreme southeast of al-Falahāt — an area which is mentioned in the Petra Church scrolls (Kaimo and Koinen 1997: 460). Thus this major city became even smaller than its “suburb” Khirbat an-Nawāfla (Site Wadi Musa 9, see 'Amr *et al.* 2000: 239 fig. 6c, 241). The decrease in size, however, did not preclude monumental and well-built structures. The pipeline trenches cut through a monumental Late Byzantine structure next to “al-Masjid al-'Umari” المسجد العمري in the town centre at the junction between as-Sūq and al-Jī. There we found fragments of columns, a large stone basin and a marble colonnette (reg. nos. WMS2000.010, .018) of a type used in church altars of the late fifth-seventh centuries AD, indicating that the structure was most probably a church (the local people say the present mosque was constructed on the foundations of an ancient mosque, hence its name). Some of the Early Islamic structures used the solid Nabataean walls for their foundations. The best preserved examples were revealed by the pipeline trenches at



20. Standing arch of a Late Roman/Early Byzantine structure, built with reused Nabataean elements, at al-Falahāt (W18). The circular “hole” next to the metre-stick is the result of prowlers as the pipeline trench was excavated late in the day and left open overnight.

the western edge of al-Ji (Fig. 21), which date from the Rashidun-Umayyad period. No indications were found for the settlement during the later Abbasid and Fatimid periods (in contrast to Khirbat an-Nawāfla, 'Amr *et al.* 2000: 241, 243-244). The few Fatimid sherds found by Al-Nawafleh (2000: 23) at al-Ji were not associated with any construction phase and probably came from other nearby sites (al-Ji is en-route between Khirbat an-Nawāfla and Khirbat Bani 'Aṭā, Sites Wadi Musa 9 and 19, see Fig. 6).

Again similar to the area as a whole, Gaia expanded during the Ayyubid and Mamluk periods when a large village was built (covering most of the area indicated in Fig. 14), but again it did not reach the size of the contemporary Khirbat an-Nawāfla ('Amr *et al.* 2000: 237 fig. 6d). The structures at both sites, however, are similar, with well-built stone houses having arches to support the roofs although the monumentality of the earlier structures is lacking. Also similar to Khirbat an-Nawāfla, Gaia had its own olive press at the period although we could not determine its extent due to modern disturbance (Fig. 22). This village continued in use during the Early Ottoman period,



21. Standing arch of an Early Islamic structure, blocked at a later phase, currently below the main road going down to Petra (W18).



22. Ayyubid/Mamluk olive press stones, north of the main road to Petra and directly below the as-Sūq area (W18).

from when we recorded several structures and stone water channels, thus forming the core of modern al-Ji.

Gaia produced more museum objects than any other site in the project. The 300+ recovered objects range in date from the PPNB (imported from al-Basīṭ?) to the Early Ottoman, and include a hoard of 116 bronze coins of the House of Constantine (reg. no. WMS2000.029), recovered from a villa at Jabal az-Zuhūr.

*Wadi Musa 19* (Khirbat Bani 'Aṭā خربة بني عطا): The pipeline trenches were comparatively shallow at this site (going down to a maximum of 2m). Thus they mostly revealed modern traditional buildings that were leveled for the construction of the streets, as well as the top of one archaeological wall (the date of which we could not determine). By going down to virgin soil in the south, and revealing ash deposits in the north, the trenches indicated that the site should be shifted ca. 30m to the north of where we anticipated in 1996 (see Fig. 6).

*Wadi Musa 21* (Khirbat Ṣubḥiyya خربة صبحية): The pipeline trenches cut through an Islamic "child cemetery" at the northern edge of the site (compare with the child cemetery at Khirbat an-Nawāfla, 'Amr *et al.* 2000: 246), and revealed an Early Ottoman structure at the southern edge.

#### *Sites Recorded after the 1996 Survey, and Sites Discovered during the Excavation for the Pipelines*

*Wadi Musa 25* (an-Naqla النقلة): This cemetery was discovered in 1997, when workers excavating foundations for a wall opposite the Wādī Mūsā Health Centre hit the top of a Nabataean (first century AD) family tomb that was excavated by the Ma'ān Antiquities Office (Mohammad Al-Marahla, publication in prep. See also 'Amr *et al.* 1998: 526). Pipeline trenches to the east revealed another similar tomb, with loculi built inside a natural cave. Three to four levels of the tomb were exposed, in which we recorded 15 burials. Between the two tombs — which contained only adult skeletons — the trenches cut through two child burials that were in simple pits with no funerary objects. This may be a reflection of the status of children in Nabataean society, probably akin to contemporary Roman beliefs that small children were not considered "full humans". Similar cemeteries seem to have extended to the north of Gaia, for example Site Wadi Musa 33 (below) at



the edge of the modern town, and "Site JSS 159" recorded by the ash-Sharāh survey outside of the modern town boundaries (Tholbecq 2001: 404).

*Wadi Musa 26:* Clearance of the section of the road from Wādī Mūsā to Baṣṭa in early 1998 revealed a previously unrecorded structure that was cut by the road above 'Ayn Mūsā, topped by the junction going up to Udhrūḥ and ash-Shawbak. This road cut is currently covered by the base for the new Wādī Mūsā – 'Unayza road, which is still under construction. Pipeline trenches in the vicinity revealed a well-built Nabataean structure of the late first-early second century AD, with a packed *ḥuwwar* floor and roof supported by columns (part of one was found *in situ*). This isolated structure is probably a farmstead.

*Wadi Musa 27:* This small site has no indications at the surface and was discovered by pipeline trenches along the road from the "Police Circle" to aṭ-Ṭayyiba. We recorded a Nabataean, first century AD, multi-room structure, and an adult burial in a simple pit with no associated burial goods. We could not determine the association of the burial with the structure, and the burial's orientation is not Islamic. At the top levels in the trench, we recorded a long Late Islamic terrace wall that was built over both the structure and burial.

*Wadi Musa 28:* An Islamic cemetery with no surface indications, revealed by the pipeline trenches at Ḥayy az-Zaytūna in the northern part of town, next to the al-Ḥasanāt Mosque. We recorded six single burials interred in stone-lined tombs. No dating evidence was found for the site, but the local people (of al-Ḥasanāt and al-Mashā'lah) who have been living in the area since the 19th century have no recollections or traditions associated with this

cemetery. It may therefore be associated with the earlier Islamic occupation of the nearby Khirbat an-Nawāfla (Site Wadi Musa 9).

*Wadi Musa 29:* Another old Islamic cemetery with no indications at the surface and no local traditions or recollections, in the southwestern sector of town (near the Wādī Mūsā Agricultural Directorate). The pipeline trenches cut through three single burials in pits lined with superbly hewn Nabataean blocks, probably from nearby Gaia (al-Falaḥāt sector).

*Wadi Musa 30* (al-Muzayr'a المزيرعة): A major site that the team members had been acquainted with for many years, but was not recorded in the 1996 survey due to its distance from the pipeline network (see 'Amr *et al.* 1998: 519). We decided to include it at this stage, however, due to its obvious importance and proximity to the built-up area. Although it is currently only used as agricultural fields for grain crops, land allotments at the site were recently officially registered, thus further threatening the site's integrity. Despite its obvious prominence, the site had only been recently recorded during the "ash-Sharāh Survey" as Site JSS 74 "Khirbat al-Qarāra" (Tholbecq 2001: 402).

Al-Muzayr'a is the fourth major archaeological site of the northern part of Wādī Mūsā, being on the same mountainside as al-Basīṭ, Khirbat an-Nawāfla and Ṭawilān (Sites Wadi Musa 8, 9 and 10). It is located on the eastern side of Wādī al-Yasala وادي اليسلة, a section of the large Wādī al-Qarāra وادي القرارة. Large structures built with big rough blocks dot the landscape. Some of the walls are still standing up to 4m above ground (Fig. 23). The site seems to have a boundary wall at its northern and western edges, while there is a massive natural cliff at the eastern edge. Most of the walls at the site are currently used as terraces for the ag-



23. Standing walls at the centre of al-Muzayr'a (W30).

ricultural fields.

Despite the impressive architectural, the surface pottery is scarce, probably due to the modern agricultural activities. We noted Iron II pottery all over the site, and Late Roman and Ayyubid/Mamluk sherds at its southeastern edge.

*Wadi Musa 31:* Another old Islamic cemetery opposite 'Ayn Mūsā with no traces at the surface, but local inhabitants informed us that graves were found when excavating for modern foundations at the site. We recorded 18 tombs in stone-lined pits.

*Wadi Musa 32:* A well-built structure with no traces at the surface, near the Petra Region Authority building. The pipeline trenches exposed only one corner of the structure, from which we recovered third century AD sherds.

*Wadi Musa 33:* A Nabataean tomb, of loculi built inside a natural cave, similar to those recorded at an-Naqla (Site Wadi Musa 25). Located at the eastern edge of Jilwākh جلاوخ and almost directly above 'Ayn Mūsā. The pipeline trenches exposed only the upper level of the tomb, where we recorded three burials that seem to have been robbed when the modern street was constructed.

#### *Note on the Development of Ceramic Water Channels at Wādī Mūsā*

We recorded a number of water channels exposed by the pipeline trenches at Wādī Mūsā. They were either lead pipes, ceramic pipes, or stone-lined conduits. Stone-lined channels seem to span all time periods from the Nabataean up the modern, while the ceramic channels we could date range from the early first century BC to the mid fourth century AD. Most of the ceramic channels were laid within shallow trenches excavated in the ground, some were within stone lined conduits, and a few had masonry infrastructures (to span uneven topography).

The ceramic pipes of the water channels were all wheel-made, and they show clear development with time (Fig. 24). In the first century BC, the pipes were plain and long, with one narrowing rim to fit inside the wider end of the next pipe, many of these pipes had vertical trimming marks on the exterior. By the early to mid first century AD the pipes developed "collar rims" with curving pronounced shoulders, making for a variety of internal diameters along the length of the channel. Early second century AD pipes had more angular shoulders and uniform body diameters. During the third century, the shoulders got smaller and sharper, thus

making for a smaller difference between the diameters of the two ends of the pipe. Finally the early-mid fourth century AD pipes had much better fitting joins and, for the first time, "waisted" bodies. As for the wares, the potters seem to have paid less attention to the quality of the finish with time, however they produced harder and stronger fabrics. The general impression is that, with time, pipes seem to have developed in order to withstand increased pressure. Could this be an indication of increased water supply, perhaps resulting from climatic changes? Further study on the subject is planned for the future.

#### **The at-Ṭayyiba Sector الطيبة**

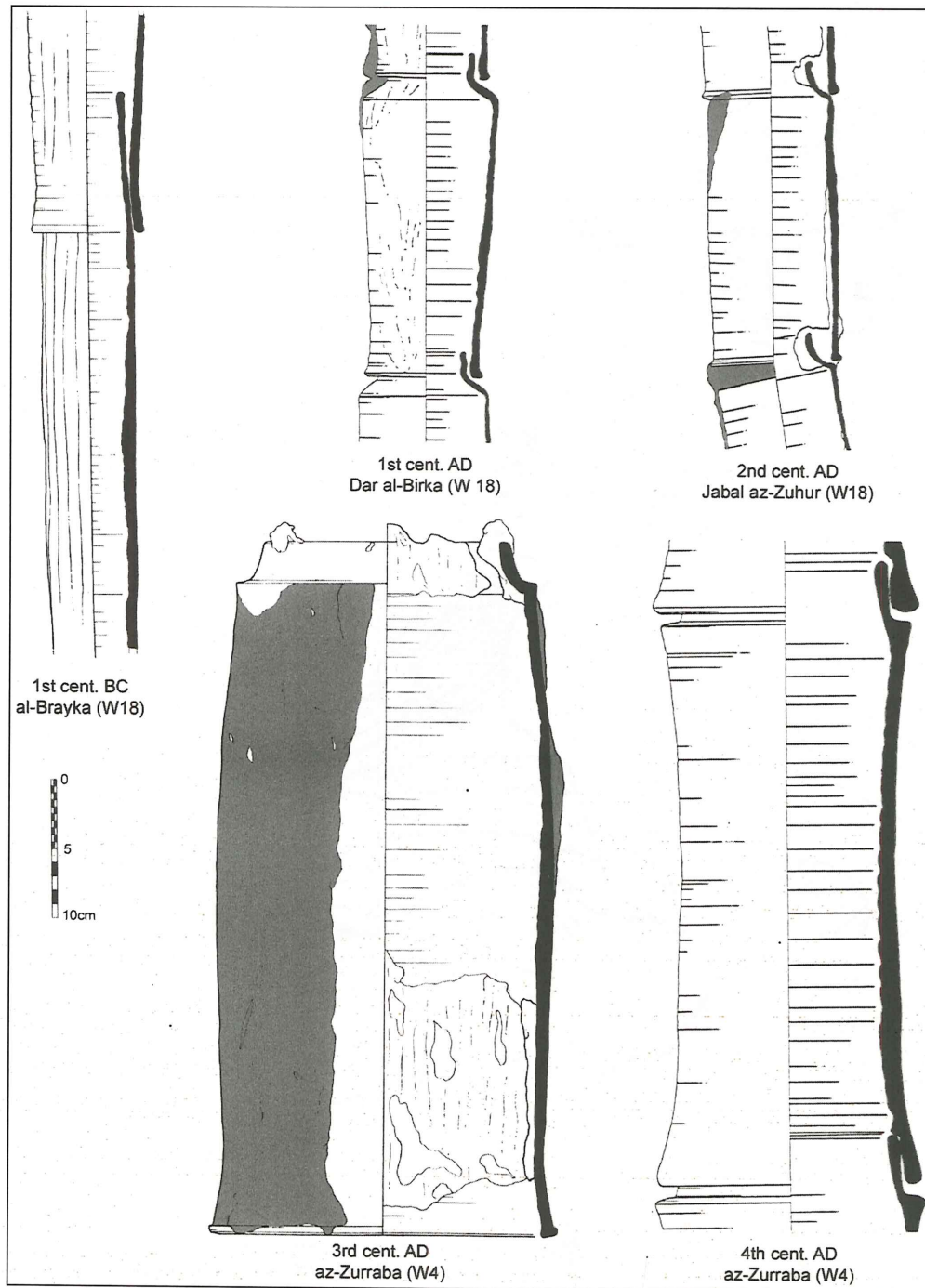
The at-Ṭayyiba sector is divided into three main sections, in which 12 sites were recorded during the first phase of the project ('Amr *et al.* 1998: 529-535):

1. The road between Wādī Mūsā and at-Ṭayyiba, which was done along with the construction of the new road as mentioned above. The only effect on the archaeological sites along this section was the partial burial of the edges of Sites Tayyiba 3 (Khīrbat Dubayl خربة دبيل) and Tayyiba 6 (Khīrbat Brāq خربة براق).
2. The road from at-Ṭayyiba to Ayl, up to the at-Ṭayyiba Water Reservoir. The single recorded site in this section (Tayyiba 2) was not affected during the project and no other sites were discovered by the pipeline excavations in this section.
3. Inside the town of at-Ṭayyiba, were the pipelines cut through four previously recorded sites, and revealed two sites that were previously unknown. Additionally, we decided to record a third site (Tayyiba 15, 'Ayn Ghazāl عين غزال). This site is directly to the northeast of the pipe networks and was not reached by the pipeline trenches (Fig. 25). It is, however, very close to the built-up area, and was greatly disturbed by bulldozing carried out by the then Petra Region Planning Council, during a project aimed at improving water resources in the region.

Full details of all the sites affected by the project, and the sites recorded during this phase, are in 'Amr and al-Momani 2000.

#### *Previously Recorded Sites Affected by the Implementation of the Project*

Due to the difficult topography of at-Ṭayyiba, habitation is concentrated at the mountain ridge along a main spine. Therefore sites Tayyiba 1, 10 (Khīrbat al-Ḥubays خربة الحبييس) and 11 (Khīrbat ar-Ruways خربة الرويس) could easily be avoided by the project. The same would have held true for Tayy-



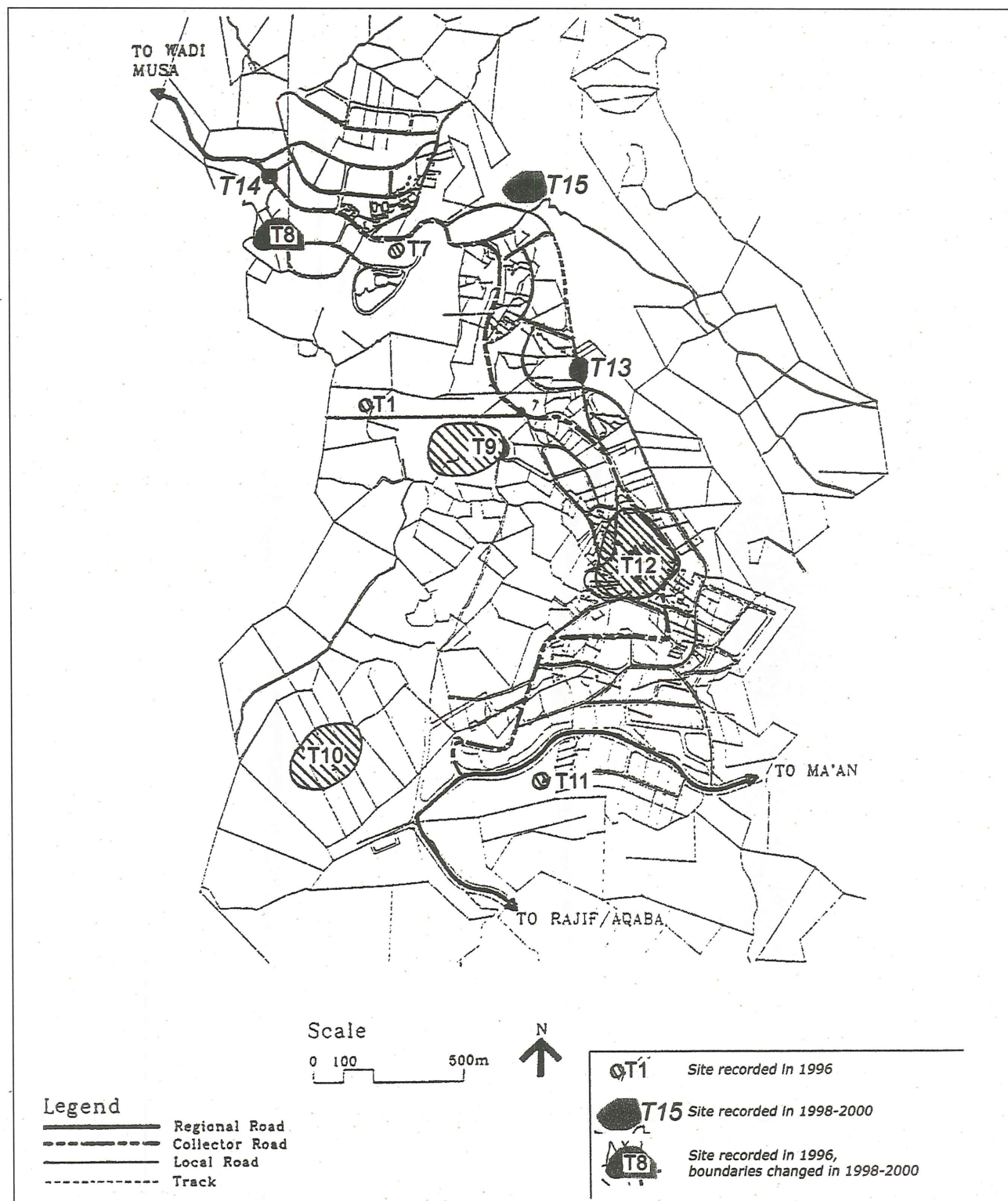
24. Representative examples of ceramic water pipes from Wādī Mūsā (drawings: Ahmed al-Momani and Qais Tweissi).

iba 9 (Khirbat al-Hāma خربة الهامة) had it not been for an unexpected cemetery (see below).

*Tayyiba 8:* Several of the previously recorded features belonging to this site ('Amr *et al.* 1998: 534) were not reached by the pipeline excavations during this phase due to technical difficulties. Excavation directly to the east of the features showing at the surface (along the northern street going down to "Taibet Zaman", next to the town's main Boys Preparatory School), however, revealed a sequence

of archaeological deposits over 1.50m thick. The trenches cut through fire places and stone formations that indicate a sequence of camps. No pottery and only a handful of flints were found in the trenches. The flints unfortunately proved non-diagnostic. These discoveries, however, showed that the site extends well beyond where we anticipated in 1996.

*Tayyiba 9* (Khirbat al-Hāma خربة الهامة): Pipeline excavations to the east of the site revealed the pres-



25. Recorded archaeological sites in the town of at-Tayyiba (base map courtesy of PRPC, now PRA).

ence of a cemetery that had no indications at the surface. We recorded 16 burials cut by the trench, all within stone-lined pits cut into the virgin soil, and oriented east-west, indicating that they are Islamic (Ayyubid/Mamluk?). No precise date could

be given due to the lack of dating evidence, but we recovered a bronze bracelet, two sets of beads and a pair of bronze-wire earrings (reg. nos. WMS99.028, .041-43) from the section of the trench (none of the burials discovered during the

project were excavated).

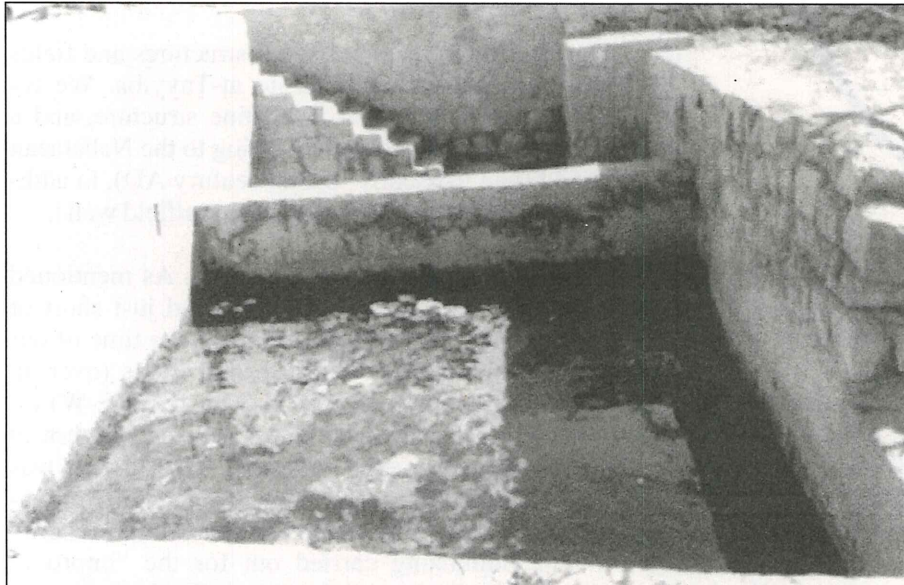
*Tayyiba 12* (Khirbat Dhbā' خربة ذباع): The main site at the at-Ṭayyiba town centre proved to have preserved remains beyond all our expectations. We recorded 14 structures, an alleyway, two water channels, a water well, an olive press, a *ṭābūn*, and 18 burials cut by the pipeline trenches. The recorded remains date to three major periods: Nabataean, Late Byzantine/Early Islamic and Late Islamic.

The earliest recorded period at the site, the Nabataean/Roman (first to early third centuries AD) is represented by a well-built structure in the northern section of the site, and a stone-lined water channel oriented towards a cistern that is still being used to irrigate fruit orchards near the site (Fig. 26).

The main and best-preserved period at the site

is the Late Byzantine/Early Islamic (seventh century AD). We recorded ten multi-room structures with several phases of use/construction, an alleyway between two structures (Fig. 27), a water well and a stone-lined channel from the period. One of the recorded structures seems to have been part of an olive press (a press stone was recovered from one of its corners). A nearby room contained large amounts of hand-made storage jar sherds (only one jar was restorable, Fig. 28). This may have been the storeroom for the press. The structures from this period were standing up to over 2m, with still preserved arch springers.

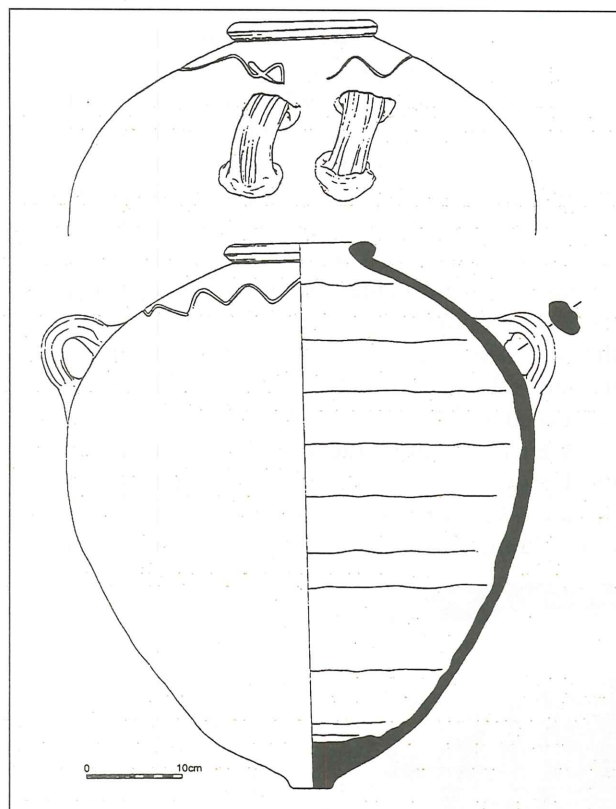
After the abandonment of the site at the end of the Umayyad or beginning of the Abbasid period, the area was used as a cemetery. During the Ayyubid/Mamluk and Early Ottoman periods, another



26. Water cistern still in use at Khirbat Dhbā' (T12). It seems this cistern was originally Nabataean and reused during the Rashidun/Umayyad period, as evidenced by water channels associated with it and revealed by the pipeline excavations.



27. A doorway, of two phases, opening onto an alleyway at the centre of Early Islamic Khirbat Dhbā' (T12).



28. Late Byzantine/Early Islamic four-handled storage jar from Khirbat Dhba' (T12). Reg. no. WMS98.079: hand-made body; wheel-thrown rim; height 58cm; ware 2.5YR 6/8 light red; exterior 5YR 6/6-6/7 reddish yellow (drawing: Ahmed al-Momani).

smaller village was established at the site and was later abandoned as well. The area was turned into a cemetery again, but this time only for children (the tradition of having separate cemeteries for children is known since the Ayyubid/Mamluk period at least, see 'Amr *et al.* 2000: 246).

Due to the exceptional discoveries at the site,



29. Nabataean dam and cistern at 'Ayn Ghazal (T15).

especially concerning the well-preserved architecture of the Late Byzantine/Early Islamic period which is rare in the area of Petra, an excavation project was started there in October 2000 by the Ma'an Antiquities Office with support from the then at-Ṭayyiba Municipality and the Ministry of Awqaf (see Falahat *et al.* 2001b).

#### *Sites Discovered during the Implementation of the Project*

*Tayyiba 13:* An old Islamic cemetery with no indications at the surface and no living memory or tradition, revealed by the pipeline trenches in the area of the at-Ṭayyiba Health Centre. We recorded 30 burials, all in stone-lined pits dug into the virgin soil, all oriented roughly east-west. No objects were found in the trench sections.

*Tayyiba 14:* Remains of small structures and fields near the northern entrance to at-Ṭayyiba. We recorded the corner of a Byzantine structure, and a *ṭābūn* within a stone shelter dating to the Nabataean period (late first-early second century AD), in addition to a number of Byzantine terrace/field walls.

*Tayyiba 15* ('Ayn Ghazal عین غزال): As mentioned above, the pipeline networks stopped just short of this site, but it was damaged during the time of our work on the project. Surface indications (over an area of approximately 60m N-S by 130m E-W) include several wall lines and a dam and cistern at the southwestern edge (Fig. 29). This cistern was fed by a tunnel from the 'ayn, located at the mountain slope some 20m to the northeast of the cistern.

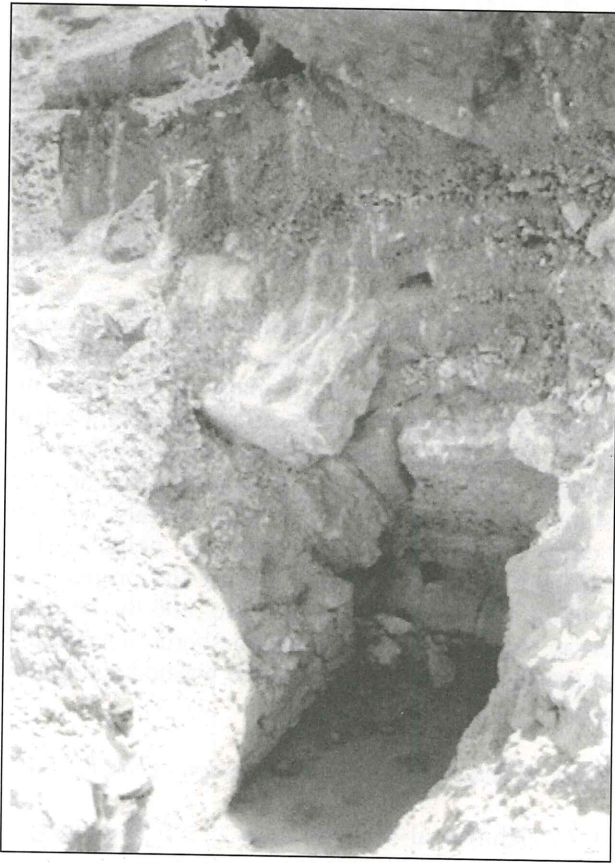
The bulldozing carried out for the "improvement of the water resource" completely destroyed

the tunnel, as well as several Nabataean walls at the site (Fig. 30). We recovered Nabataean and Late Islamic pottery sherds from the site, including a restorable Nabataean jug (reg. no. WMS99.093).

### The Ayl Sector **أيل**

Six sites were recorded in the Ayl sector during the first phase of the project ('Amr *et al.* 1998: 535-539). For the second phase, this sector was well expanded due to the inclusion of the Jiththa well-fields into the scope of work, therefore requiring further survey towards the southeast. The Ayl sector was accordingly considered as starting at the at-Ṭayyiba Water Reservoir in the northwest, going along the at-Ṭayyiba – Ayl road, across the town of Ayl, then along the Ayl – Ma'ān road until the Ayl Municipal Border in the southwest (at the Ma'ān - 'Uwhayda **أوهيدة** junction). At this extreme eastern point, there is a clear difference in the landscape and nature of the archaeological remains. It is the point at which the "sown" meets the "desert".

By the end of the second phase, the number of sites in the Ayl sector doubled to 12 (Fig. 31). Three sites (Ayl 7, 8, 9) were discovered during the



30. The water source at 'Ayn Ghazāl (T15), and adjoining Nabataean walls destroyed for the "improvement of the water resource".

survey of the extension area. One site (Ayl 10) was revealed by clearance of the road cut in the summer of 1998 and prior to the commencement of pipeline excavation. One site (Ayl 11) had no surface indication and was discovered by the pipeline excavation. Site Ayl 12 is at some distance from the pipeline but was revealed when the privately owned land was bulldozed for terracing. Details of all these sites, as well as sites affected during the implementation of the project, are in 'Amr and al-Momani 2000.

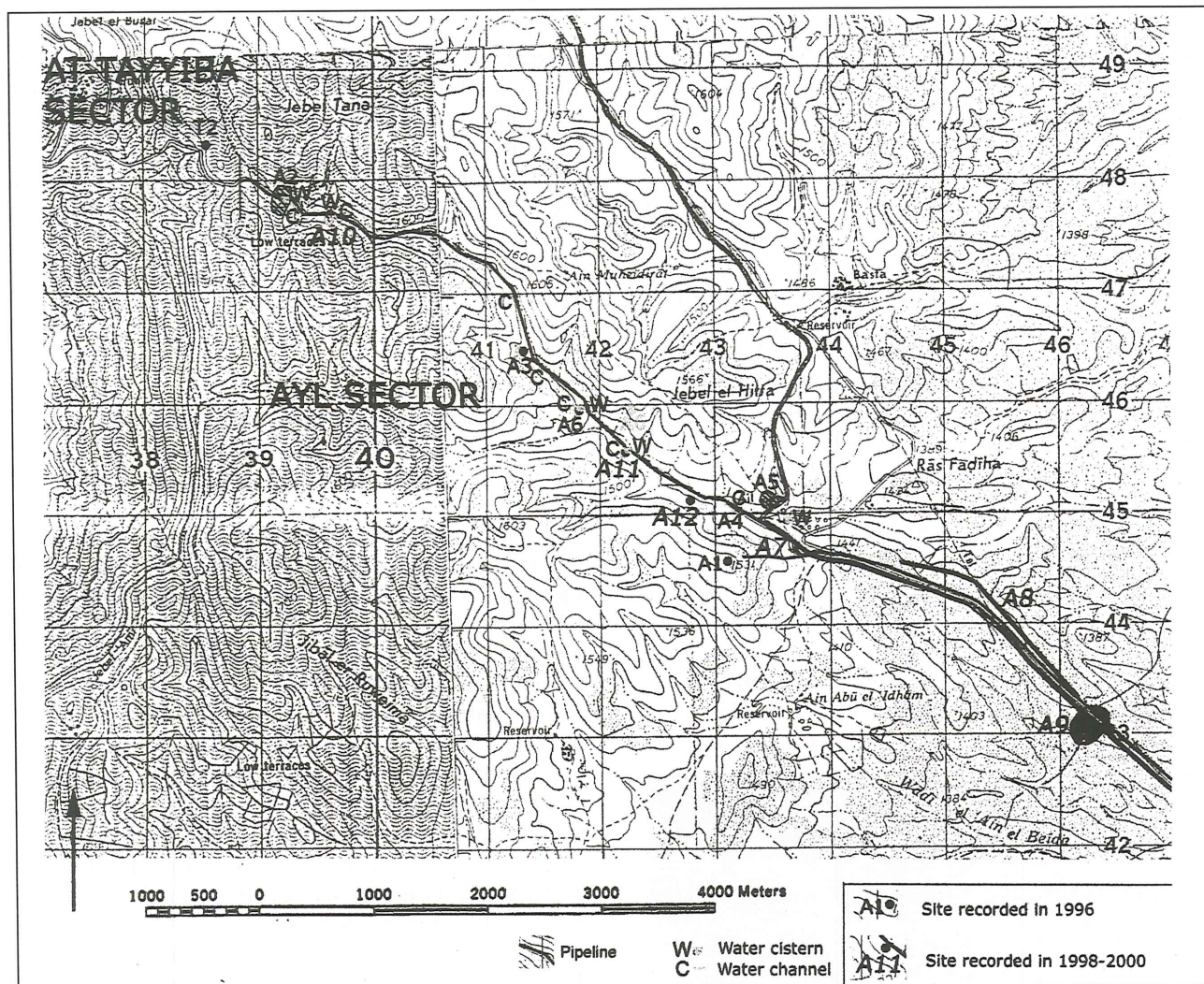
### Survey of the Eastern Ayl Sector

Three archaeological sites (two paved roads and a "cairn field") were recorded along the Ayl – Ma'ān road (A7, A8, and A9 in Fig. 31):

**Ayl 7:** A ca. 200m long stretch of a paved road at the northern end of the modern town of Ayl, above the main road through town and directly south of Khirbat Ayl **خربة أيل** (Site Ayl 5). Although not very well preserved, clearance of part of the surface revealed that the road is 6.30m wide, with curbstones and a central divide. The preserved area seems to include a junction with a branch heading southeast and another heading west. We located another short stretch around 300m to the west, approximately 100m north of the Ayl – Ṣadaqa **صدقه** road, and a Nabataean/Roman structure at a further 100m which could be associated with the road (we did not fully record these findings as they are well outside our area and do not seem to be threatened). The nature, dimensions and location of the road, added to the discovery of a reused Roman milestone directly below it (Graf 1995: 418), all indicate that this is a segment of the *Via Nova Traiana*.

Excavation for the pipelines at the streets adjoining the recorded stretch indicated that the road is not preserved below the modern streets.

**Ayl 8:** A ca. 2km long stretch of paved road with medium-sized curbstones, preserved from just east of the modern town. In the summer of 1998 only a small patch of cobbles was showing at the surface next to the last structure of the town (a small brick factory), indicating that the road is 3m wide. We could, however, trace the road alignment by a line of small bushes growing along it due to the moisture held by the cobblestones (Fig. 32). After ca. 2km the ancient road disappears under the modern asphalt road. It should be noted that Ayl 8 is not part of the old British Mandate road which could still be seen inside Ayl (below Ayl 7, near the main water cistern), and on which the present Ayl –



31. Recorded archaeological sites in the Ayl sector (ref. maps Jordan 1:50,000 Ras en-Naqb 3050II K737 and Ma'an 3150III K737).

Ma'an road is constructed, although the British road may have used the eastern part of Ayl 8 where the two roads meet.

By the summer of 2000 when the pipeline excavations were due in the vicinity, the bushes had disappeared due to two years of draught. We excavated six 0.50-0.60 x 3.50m soundings in the southeast next to the modern Ayl – Ma'an road in order to determine the exact alignment, which revealed that the paving is well-preserved at a depth of 20-50cm below the surface (except for the part right next to the modern road, see below). We could not find any dating evidence for the site, but it could be connected with Site Jiththa 2, a Nabataean watchtower? (see below).

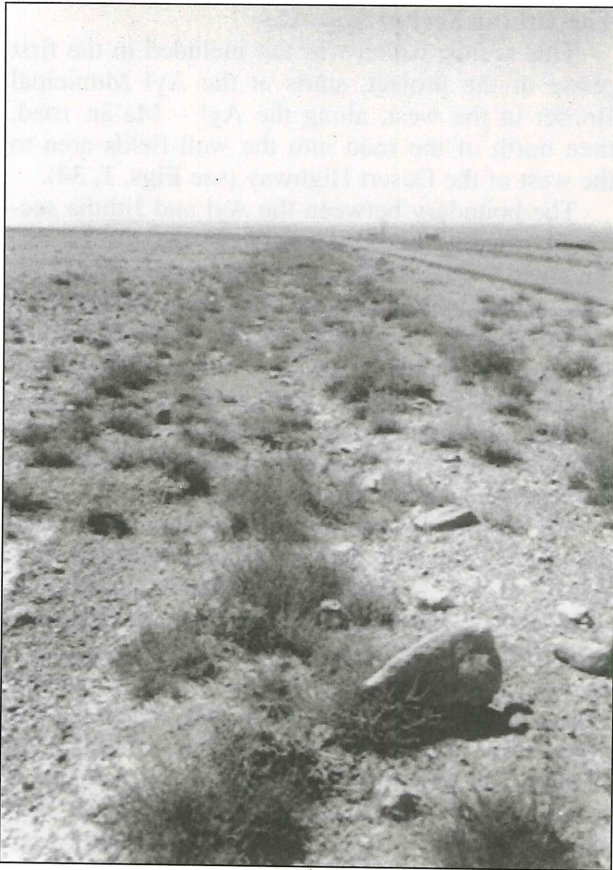
**Ayl 9:** Around a hundred small and medium-sized stone piles/cairns, and a number of field walls, spread over an elevated area of ca. 400m N-S x 700m E-W. The sizes and proximity of the piles

precludes their being the result of field clearance, while the presence of large numbers of ground snails among the stones of many of the piles indicates the presence of sub-surface cavities. Rodent holes also indicate the presence of ash below the surface. This points to the probability that at least some of the cairns may contain burials. Similar "cairn fields" are spread over the neighbouring hills but were not recorded during the project due to their distance from the pipelines and the built-up areas. A few Nabataean/Roman sherds were noted at the site, but they seemed to be washed and not *in situ*.

*Sites Affected by the Implementation of the Project*

**Ayl 2 (Khirbat al-Mabrak خربة المبرك):** The pipeline excavations did not reveal any archaeological remains belonging to the site. However, on 28 August 2000 (two days before the end of the project),

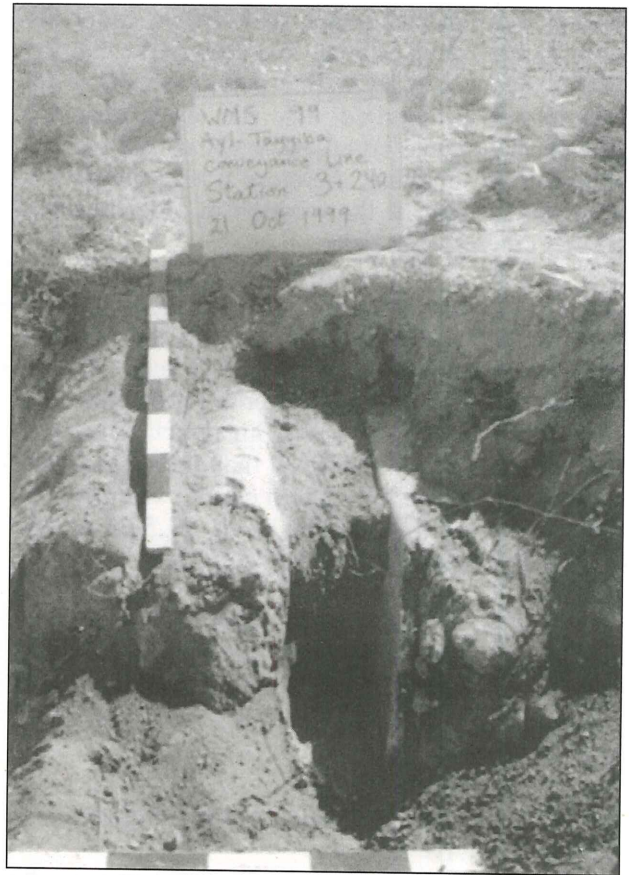




32. Line of small bushes growing on the road Site Ayl 8 in the summer of 1998. These bushes failed to grow in the summer of 2000 due to prolonged draught.

clearance in the vicinity revealed the presence of a water cistern and channel in the road cut to the east of the site. The cistern is well built and lined with hydraulic mortar, ca. 5.5m wide. The remains of the water channel are badly disturbed at around 10m to the east of the cistern, and could be seen for a length of ca. 10m along the road cut. We had previously recorded a well-preserved section of this channel between Sites Ayl 3 and Ayl 10, at a distance of around 1.5km from al-Mabrak (Fig. 33).

The present 'Ayn al-Mabrak عين المبرك is to the north of the main road. However, in the late summer of 2000 there was a large patch of green grasses growing at the surface to the south of the road between the main site and the cistern in the road cut, despite the prolonged draught of 1998-2000. This large green patch is quite higher than the present spring level, which indicates that the spring was originally at a higher level and went down with the water table like most springs in the area. Due to the local topography, a higher elevation would have meant the south of the road, nearer to the cistern in the road cut. The cistern was therefore most probably built to collect the water of



33. Cut in the Nabataean water channel that runs along the at-Ṭayyiba – Ayl road (section between Sites Ayl 3 and Ayl 10).

'Ayn al-Mabrak and consequently carry it eastward along the channel through sites Ayl 10, 6, 11 then all the way to Khirbat Ayl (see Note on the Hydraulic System below).

*Ayl 8:* Attempts to move the pipeline to the south of the Ayl – Ma'ān road, in order to avoid the site, failed due to technical and logistic difficulties. The pipeline was therefore re-aligned in order to minimize the damage, which was still over a ca. 180m length! This damage, however, was restricted to the area of the ancient road already badly disturbed by the movement of machinery when the modern road was built. Also, the pavement of the ancient road was only showing in the northern section of the pipeline trench, which means that destruction affected only the southern edge of it, up to a maximum width of 1m (out of the 3m total width).

#### *Sites Recorded during the Implementation of the Project*

*Ayl 10:* This site was discovered when clearance of the road section between at-Ṭayyiba and Ayl re-

vealed a number of walls, including a water cistern, along a 25m stretch. We collected a number of Nabataean and Byzantine pottery sherds at the location. We recorded this site more than six months before the commencement of the excavations for the pipeline, therefore it was possible to shift the pipeline at the location in order to avoid further damage to the site.

*Ayl 11:* Nabataean hydraulic installations with no surface indications, discovered in the pipeline trench along the at-Ṭayyiba – Ayl road. We recorded two neighbouring cisterns lined with thick hydraulic mortar along a 12.50m stretch. The western cistern is at a higher level than the eastern one, which implies that the eastern cistern was meant to catch the overflow. Walls at ca. 11.50m to the south may belong to a third cistern(?).

*Ayl 12:* This site was not reached by the pipeline, but was revealed when land there was bulldozed for agricultural purposes. The bulldozing revealed a natural cave with archaeological deposits, and a wall line further north.

#### *A Note on the Hydraulic System between at-Ṭayyiba and Ayl*

One of the most outstanding discoveries in the Ayl sector is the Nabataean hydraulic system comprised of a channel at least 5km long and several cisterns. The channel is built with small cut stones and stone slabs, and grey ashy mortar. It is 30cm wide and 70cm high on the outside, and its interior is covered with a thick layer of hydraulic mortar resulting in a conduit 14cm wide and 25cm deep (Fig. 33). We recorded its beginning at 'Ayn al-Mabrak (Site Ayl 2, see above), at an elevation of around 1650m asl. The channel slopes along the mountainsides between at-Ṭayyiba and Ayl, passing by the cisterns of Ayl 10 at an elevation of ca. 1590m asl, then the cistern at Ayl 6 (elevation ca. 1500m asl), down to the two cisterns of Ayl 11 (elevation ca. 1468m asl), on to the last recorded section at Ayl 4 (channel recorded in 1996, 'Amr *et al.* 1998: 538, at elevations of 1443.6 down to 1433.6m asl). This system may have ended at the cistern still being used below Khirbat Ayl (Site Ayl 5), which currently collects the water of the nearby 'Ayn Ayl.

The present at-Ṭayyiba – Ayl road, along which the pipelines were lain, follows a natural slope along the mountainsides. The recorded segments of the channel indicate that it ran roughly parallel to the road and was built along a slope 1-2.5m higher than the present road.

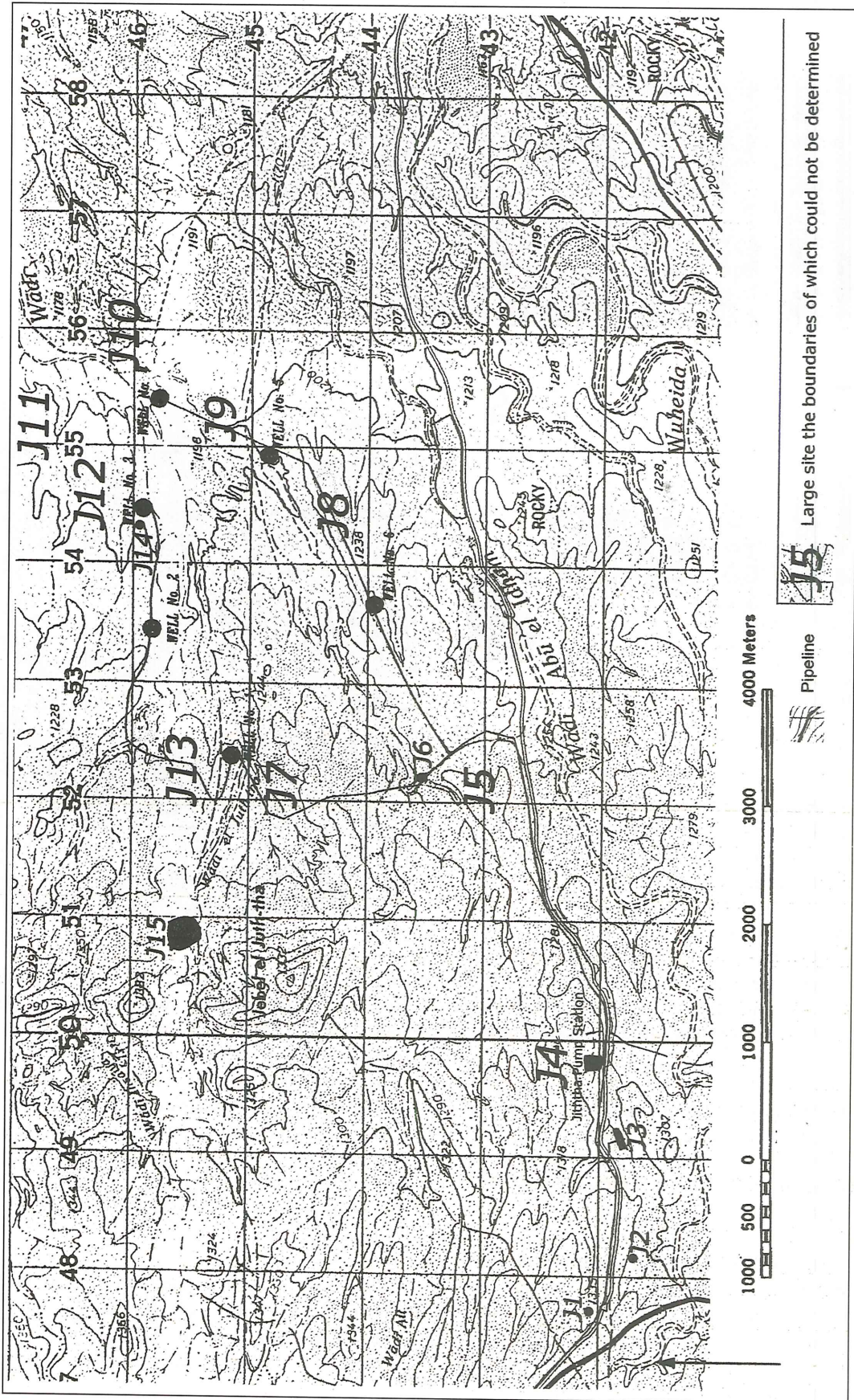
#### **The Jiththa Sector** جثه/جيثا

This sector, which was not included in the first phase of the project, starts at the Ayl Municipal Border in the west, along the Ayl – Ma'an road, then north of the road into the well-fields area to the west of the Desert Highway (see Figs. 1, 34).

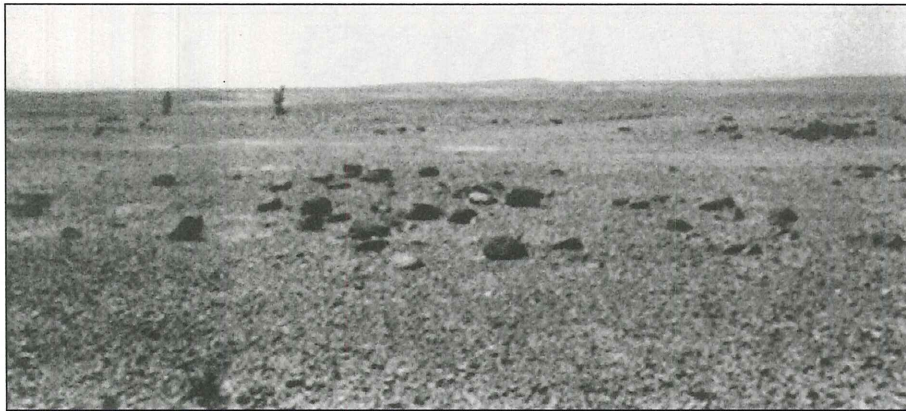
The boundary between the Ayl and Jiththa sectors is roughly the border between the "desert and the sown". This is obvious in the nature of the recorded archaeological sites. Nomadic camps have spread all over the Jiththa sector for thousands of years, and their low visibility and non-monumental nature created a major difficulty to us in convincing the machinery operators of their importance and the absolute necessity of restricting their movements in "the open desert".

We recorded 15 archaeological sites in the Jiththa sector (Fig. 34), nine of which (*Jiththa 4, Jiththa 5, Jiththa 7, Jiththa 8, Jiththa 9, Jiththa 10, Jiththa 11, Jiththa 12 and Jiththa 13*) are extensive areas over low rises covered with stone formations, mainly remains of multi-period nomadic camps, cairns and land boundary walls (Fig. 35). All these sites have significant flint scatters. Preliminary readings of the flint tools indicate the majority goes back to the Middle Palaeolithic and Epi-Palaeolithic (G.O. Rollefson and L. Quintero, pers. comm.). Maysoun Nahar of the Jordan University will be studying the chipped stone artifacts from Jiththa. Other chronological indicators are two Saffaitic inscriptions found at Sites Jiththa 5 and Jiththa 13, and an early Kufic inscription from Site Jiththa 8 (Fig. 36). This sector — even more so than the other sectors of the project — is still in dire need for a systematic comprehensive survey, as our survey was only intended for the identification and protection of archaeological remains during the project and there was not enough time or specialization among the team for the proper study that the area deserves.

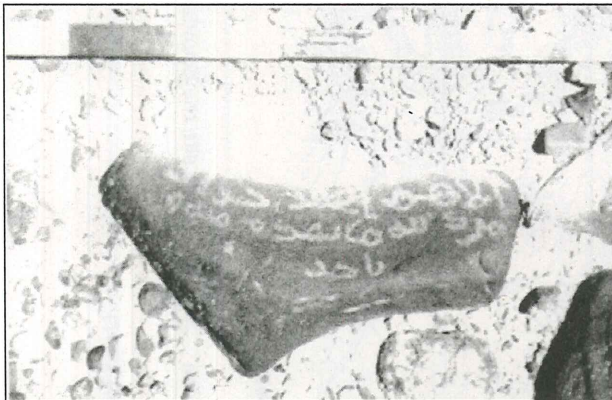
It was impossible to totally avoid the extensive sites of the Jiththa sector during the implementation of the project, we therefore concentrated on avoiding the individual features by shifting alignments and restricted all work, including movement of machinery and piling of excavated materials, to a minimal strip of 10m width. Additionally, as Site Jiththa 4 is located directly above the Jiththa Pump Station, we excavated two soundings there prior to the construction of the station which insured that there are no remains at the construction site and the flints recovered there were washed down the slope. Following are brief descriptions of the other sites recorded at Jiththa. Full details of all the sites are in 'Amr and al-Momani



34. Recorded archaeological sites in the Jiththa sector (ref. map Jordan 1:50,000 Ma'an 3150III K737).



35. General view of Site Jiththa 12.



36. Kufic inscription from Site Jiththa 8, which reads: O God forgive Ḥadād his late and preceding failing.

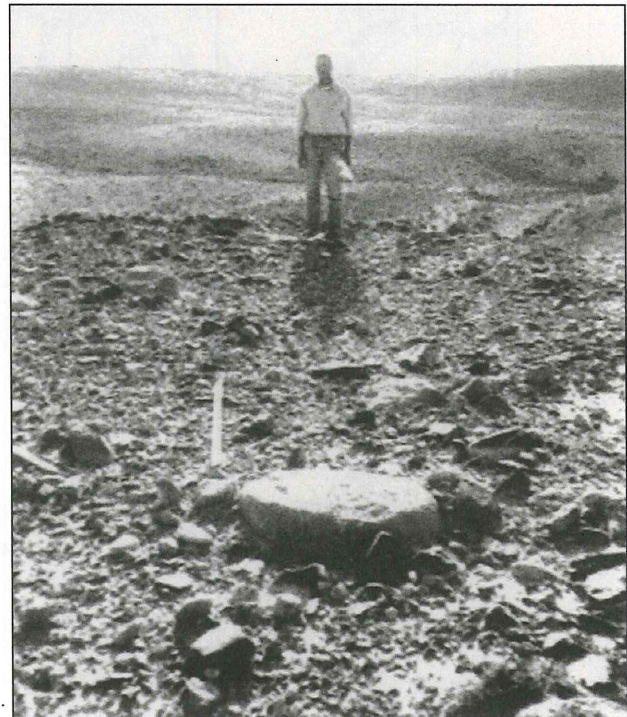
2000.

*Jiththa 1:* A small cemetery (ca. 50m N-S x 100m E-W) over a slight rise, at the Ayl Municipal Border. Oval piles of stones define the burials. No dating material was found at the surface.

*Jiththa 2:* A small structure (ca. 14 x 14m), built with rectangular blocks, approximately 100m to the south of the main road. Probably a watchtower for road Ayl 8. Abundant flint tools and Nabataean (first century AD) pottery sherds were found at the site.

*Jiththa 3:* Remains of a small nomadic campsite, composed of six stone circles (diameters 9-18m) and several stone features, at around 50m to the south of the main road. No dating evidence was found at the site.

*Jiththa 6:* A distinct structure measuring 14m N-S x 15m E-W. Some of the walls are around 1m wide. There are several flat round white stones that look like "column drums" in the interior (Fig. 37). This structure posed the greatest difficulty in the Jiththa sector as it is on a narrow ridge overlooking



37. Structure at Site Jiththa 6.

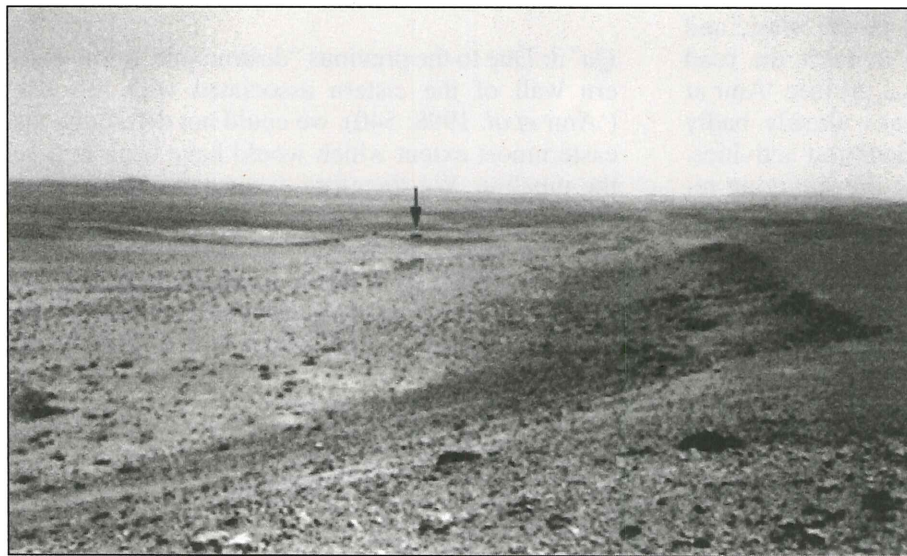
two deep wadis that was the only place where the pipeline connecting the two segments of the well-field could cross. The short time we had before the implementation of the project did not allow for a complete excavation of the site, therefore all work was restricted to the western part that was already partly destroyed by a dirt track. The pipeline excavation showed, as expected, that the walls did not exceed 30cm in preserved height. The abundant flint scatter at the site is peculiar and is still under study.

*Jiththa 14:* A large stone circle (29.50m N-S x 19.50m E-W), with several oval stone platforms inside. In addition to an abundant flint scatter, we recovered Chalcolithic and Nabataean pottery sherds from the site.

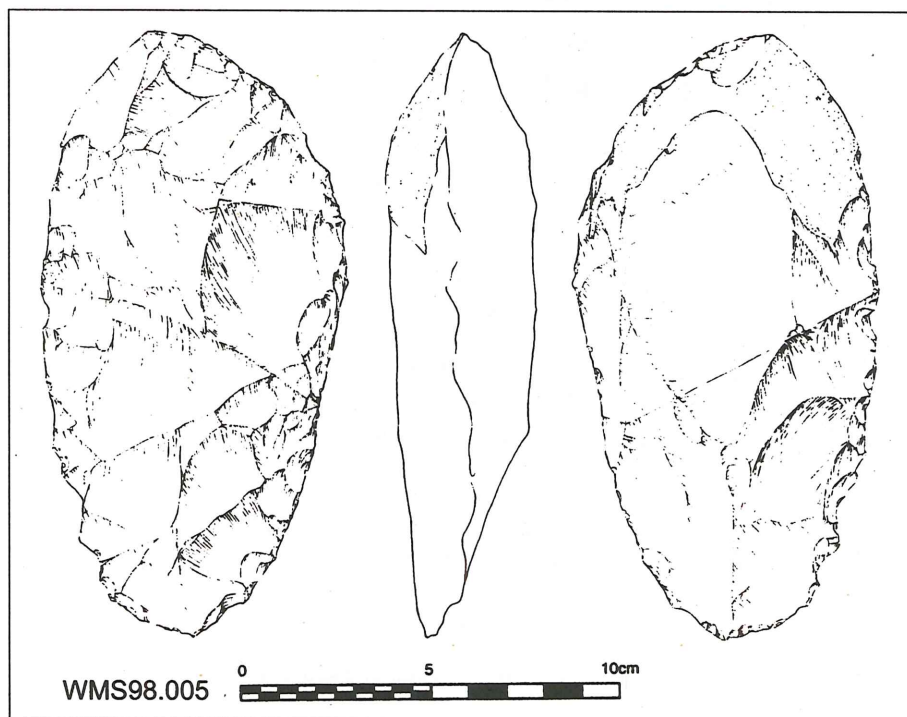
*Jiththa 15*: This site is well to the west of the well-fields (near a large modern quarry) but was included in the survey when an alternative route to the wells utilizing the quarry road was proposed. The site is unique in the area in having a large enclosure wall over an area of ca. 800m N-S x 300m E-W (Fig. 38). There are several well-built wall lines showing at the surface within the enclosure, and a lime kiln of ca. 5m diameter at the western edge. To the southwest of the enclosure there is a small *tall* with obvious structures (of inferior quality to those within the enclosure) and a number of Neolithic stone tools and querns scattered at sur-

face. Surprisingly, we found an Acheulean handaxe among the Neolithic implements (Fig. 39). The *tall* is partly destroyed by intrusion from the nearby quarry, which was stopped through the intervention of the Ma'ān Antiquities Office.

Abundant flint and pottery scatters were found at the site, dating from the Middle and Upper Palaeolithic, Pre-pottery Neolithic, Iron II (the date for the enclosure wall?), Nabataean, Late Byzantine and Early Islamic. The relationship between this varied history of *Jiththa 15* and the campsites of the *Jiththa* sector is a subject worthy of further investigation.



38. The western section of the great enclosure at Site *Jiththa 15*. The small rectangle in the background at the end of the arrow is our pickup truck.



39. Acheulean handaxe from the *tall* at Site *Jiththa 15* (drawing: Qais Tweissi).

**The al-Qā' Sector القاع**

The pipeline alignment in this sector was re-defined during this phase of the project, which meant a re-survey of the area and the recording of two additional sites to bring the total recorded at al-Qā' up to 12 (Fig. 40). Full details of archaeological work and sites are in 'Amr and al-Momani 2000.

*Sites Recorded during the Re-Survey*

**Qa' 11:** A 65m long section of a Nabataean/ Roman paved road, 4.20m in width, with curbstones. This road connects Site Qa' 6 (Umm at-Ṭirān) in the east to Qa' 9 (Bir al-Biṭār) in the west, and probably extended further west to meet the road junction Site Qa' 10 (ar-Raṣīf الرصيف) (see 'Amr *et al.* 1998: 541-543). The road was already badly disturbed by a dirt track and agricultural activities. To prevent further disturbance of the surviving remains, the pipeline alignment was shifted to the east in the vicinity of the site.

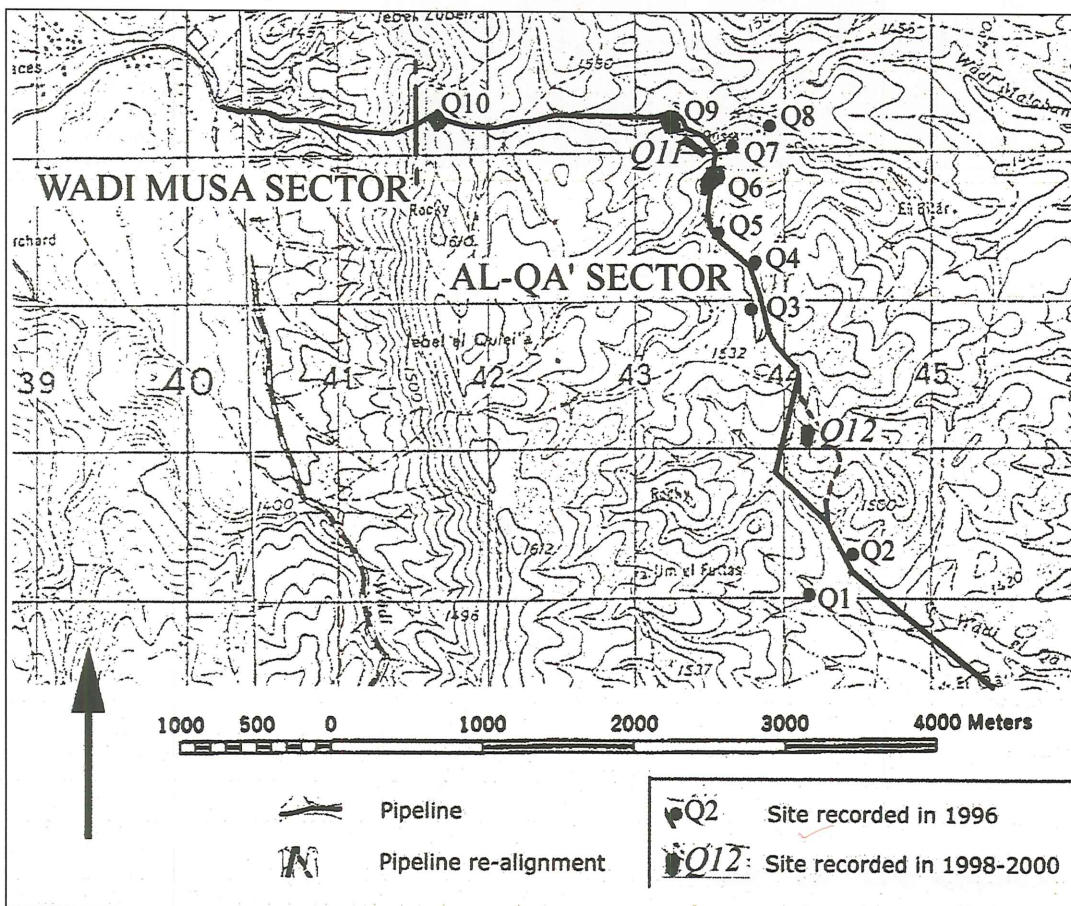
**Qa' 12:** A Nabataean/ Roman hamlet (first-third centuries AD), built with large chert blocks. Inter-

nal divisions can still be seen at the surface, and the outer walls are quite substantial (0.80m in width). There are two water cistern associated with the structure, one inside its southeastern corner — cut in the bedrock (Fig. 41), and the other at ca. 22m to the northwest — masonry built with a settling tank. The latter cistern had been recently cleared.

This hamlet and associated cisterns is well within the general “agricultural character” noted at the al-Qā' sector during the 1996 survey ('Amr *et al.* 1998: 539-543).

*Sites Affected by the Implementation of the Project*

**Qa' 3:** Due to the previous “destruction” of the eastern wall of the cistern associated with this site ('Amr *et al.* 1998: 540), we could not determine the easternmost extent which would have been next to the pipeline. We therefore excavated a 1-2m wide sounding along the expected edge, which revealed that one course of stones still survives above the carved bedrock, at a depth of 20-50cm below the present surface. The dimensions of the cistern were thus determined as 3.85-4.00m N-S x 4.50-4.70m



40. Recorded archaeological sites in the al-Qā' sector (ref. maps Jordan 1:50,000 Petra 3150I K737 and Bir Khadad 3150IV K737).



41. Opening of the rock-cut cistern at the southeastern corner of the structure, Site Qa' 12.

E-W. The internal hydraulic mortar was also seen as being well preserved. Due to the local topography, the pipeline could be shifted to a maximum of 2.50-2.70m to the east of the cistern, and our sounding was backfilled in order to protect the extant remains from the movement of machinery.

Qa' 6 (Khirbat Umm aṭ-Ṭirān خربة أم الطيران): The pipeline was shifted to pass between the concentrations forming the site (see 'Amr *et al.* 1998: 541-542). The pipeline trench therefore did not cut through any architectural remains, but revealed the presence of an ash layer 10m long and 0.60m deep with a few pottery sherds.

Qa' 9 (Bir al-Biṭār بئر البيطار): The pipeline went around the main mound forming this site ('Amr *et al.* 1998: 543), but did cut through thick deposits below the eastern and northern slopes, as well as four walls — two of which are modern terraces that were covered for the construction of the modern Bir al-Biṭār – Wādī Mūsā road.

### Concluding Remarks

The main purpose behind the archaeological work in the Wādī Mūsā Water Supply and Wastewater Project was the protection of the archaeological sites during the implementation of the engineering project, which involved mechanical excavations for a length of around 300km. This development project is unique in Jordan in that it involved archaeologists from the planning phase up to the end of the excavation work. Our involvement enabled the protection of most of the sites outside the built-up areas through adjustments to the designs not only on paper but also on the

ground, as well as alterations on the spot. Inside the built-up areas, however, these adjustments were not possible and the pipelines had to go through rich archaeological sites in order to serve existing communities who still live at these sites — a tradition in our part of the world that had been practiced throughout the millenia. Although seemingly unfortunate, this excavation through the now-urban-sites, especially in Wādī Mūsā and aṭ-Ṭayyiba, allowed us a glimpse of the richness that lies under the modern streets which could not have been otherwise known.

One of the most important outcomes of the project are accurate archaeological maps of Wādī Mūsā and aṭ-Ṭayyiba, the first such maps for Jordanian urban centres, which we plotted onto the 1:50 maps land allotment maps that are used for planning purposes. Copies of these maps were given to the Petra Region Planning Council (now the Petra Region Authority) so that they would be taken into consideration when development projects are planned for these two fast-growing towns. As for future archaeological work, the project allowed the identification of prime areas for investigation. Work at one site, Tayyiba 12 - Khirbat Dhbā', had already started (Falahat *et al.* 2001b) and there are proposals for Wadi Musa 8 (al-Basit) and certain locations within Wadi Musa 18 (Gaia), to name only a few possibilities.

By the end of the second phase of the archaeological component of the Wādī Mūsā Water Supply and Wastewater Project, we had registered 132 archaeological sites, most of which were recorded for the first time, and retrieved 627 museum objects, some of which are already on display for the public. As expected, the recovered amount of

data is enormous, and we are only at the beginning of the processing stages. In addition to the thousands of pottery sherds and chipped stones, we had recorded thousands of architectural features and tens of burials. Foremost, this project had enabled us to look at the varied terrains and climatic zones within the area as a unit, and to see the variety as well as the continuity of use of the different sectors throughout the periods (see for example 'Amr, in press).

Construction work on the Wādī Mūsā Water Supply and Wastewater Project is not complete yet. The northeastern section of the town of Wādī Mūsā is still not connected to the wastewater system due to technical difficulties, leaving a further 18km of pipeline trenches to be excavated. We had recorded six archaeological sites in that section in 1996: Sites Wadi Musa 11, 13 (Ṭāḥūnat al-'Alāyā), 14 (Khirbat al-Muḥaylla), 15, 16 and 17 ('Amr *et al.* 1998: 520-522). Judging by our experience during the second phase of archaeological work on the project, we expect these 18km to discover more sites in this section.

#### Acknowledgments

The major factor for the success of the archaeological component of the Wādī Mūsā Water Supply and Wastewater Project was the close and continuous coordination between the archaeologists and engineering teams. Our primary liaison was with the head consultant engineers, Bruce Duff and William MacDonnell of CDM, and Mazen Bader and Adnan Hamdan of ACE, as well as Husam Hamduni of the (then) PRPC. Work on the ground, however, would not have been possible without the enormous help we got from all members of the engineering teams, both on the consultant and the contractors sides. We are grateful to the site engineers with whom we consulted for hours on end to find solutions for difficult situations, the surveyors who accurately plotted sites to enable the designers to change alignments, the site supervisors who helped with a variety of on-the-spot situations, the machinery operators who "went easy" when requested to, the workers who continuously pointed out interesting features and objects to us. When we wrote down a list of the names, it was around one and a half pages long. We thank all of them. Our gratitude also to the people of the area, who despite their annoyance with the "mess" and inconveniences during the implementation of the project, showed genuine interest in the discoveries and extended their well-known generosity to us.

Finally, we would also like to thank the previous and present Directors-General of the De-

partment of Antiquities, Dr. Ghazi Bisheh and Dr. Fawwaz Al-Khraysheh, for allowing us extended leave from the office in 'Ammān to be able to carry out the fieldwork.

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