



# **The Early Islamic Aqueducts to Ramla and Hebron**

**15<sup>th</sup> International Conference**

**Water** in Antiquity

***Cura Aquarum* in Israel 14-20 October 2012**

**Amir Gorzalczany and David Amit  
Israel Antiquities Authority**

**October 15, 2012**



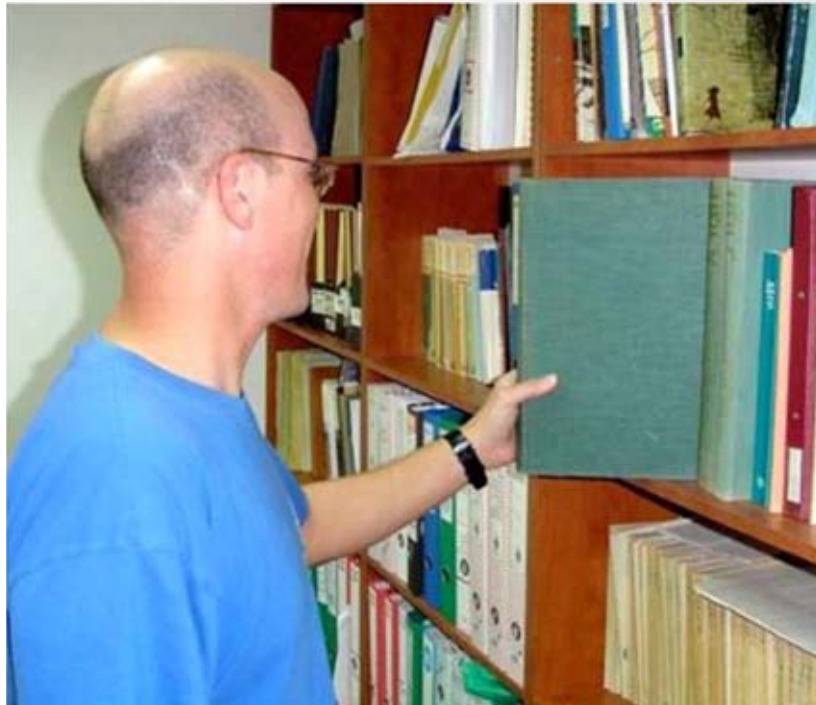
**Only two aqueducts were  
constructed in *Bilad a-Sham* during  
the Early Islamic Period:**

**The aqueduct to Ramla**

**The aqueduct to Hebron (*al-Khalil*)**



# Historical Sources for the Ramla Aqueduct and History of research



**Ahmed ibn Ychia el Baladouri**  
***(The conquest of the Lands)***

**ibn el Faqīh**

***(The Book of the Lands)***

**Yāqut**

**al–Ya’aqubi**

**Conder and Kitchener SWP**

**Sporadic finds in the fields**

**by farmers**

**Archaeological Excavations**

THE SURVEY  
OF  
WESTERN PALESTINE.

MEMOIRS  
OF THE  
TOPOGRAPHY, OROGRAPHY, HYDROGRAPHY,  
AND  
ARCHÆOLOGY.

BY  
LIEUT. C. R. CONDER, R.E., AND LIEUT. H. H. KITCHENER, R.E.

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SAMARIA.

EDITED WITH ADDITIONS BY  
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FOR  
THE COMMITTEE OF THE PALESTINE EXPLORATION FUND,  
1, ADAM STREET, ADELPHI, LONDON, W.C.  
1882.



rebuilt 35 A.D. by Galinius; bequeathed by Herod to Salome, and taken by Vespasian. It became the seat of a bishopric in the fourth century. Probably its decline followed the Moslem conquest. In the time of the Crusaders Ashdod was nothing but a small village.

El Hammâm (G u).—A domed building of rubble masonry, resembling those at Minet el Kûlâh, which see. There are two places of this name on the plan, not far apart.

Jisr Esdûd (F t).—A bridge with pointed arches, and apparently modern. Cisterns of rubble exist near it.

Kanât Bint el Kâfir.—Is said to be first traceable near Mr. Berghem's farm, and at the Bîr et Taiâsheh. Thence it is traced north of Nââneh to the Bîrket Bint el Kâfir, west of Ramleh. (Sheet XIII.) The bîrkeh, with several others near, appears to be most probably Saracenic work of the date of the building of Ramleh.

Khân Esdûd (F t).—A fine Khân, with small mosque attached. On the east, near the door of the mosque, is a large sarcophagus ornamented on the side with wreaths, now used as a watering-trough. The Khân has fallen into ruins within the present century.

Khûrâb Ibn Zeid (J u).—Two ruins close together; heaps of stones, caves, and cisterns exist at each.

Khûrbet el 'Ajjûri, or ed Deheisheh (H s).—Consists of traces only, with fragments of pottery and a ruined cistern of rubble.

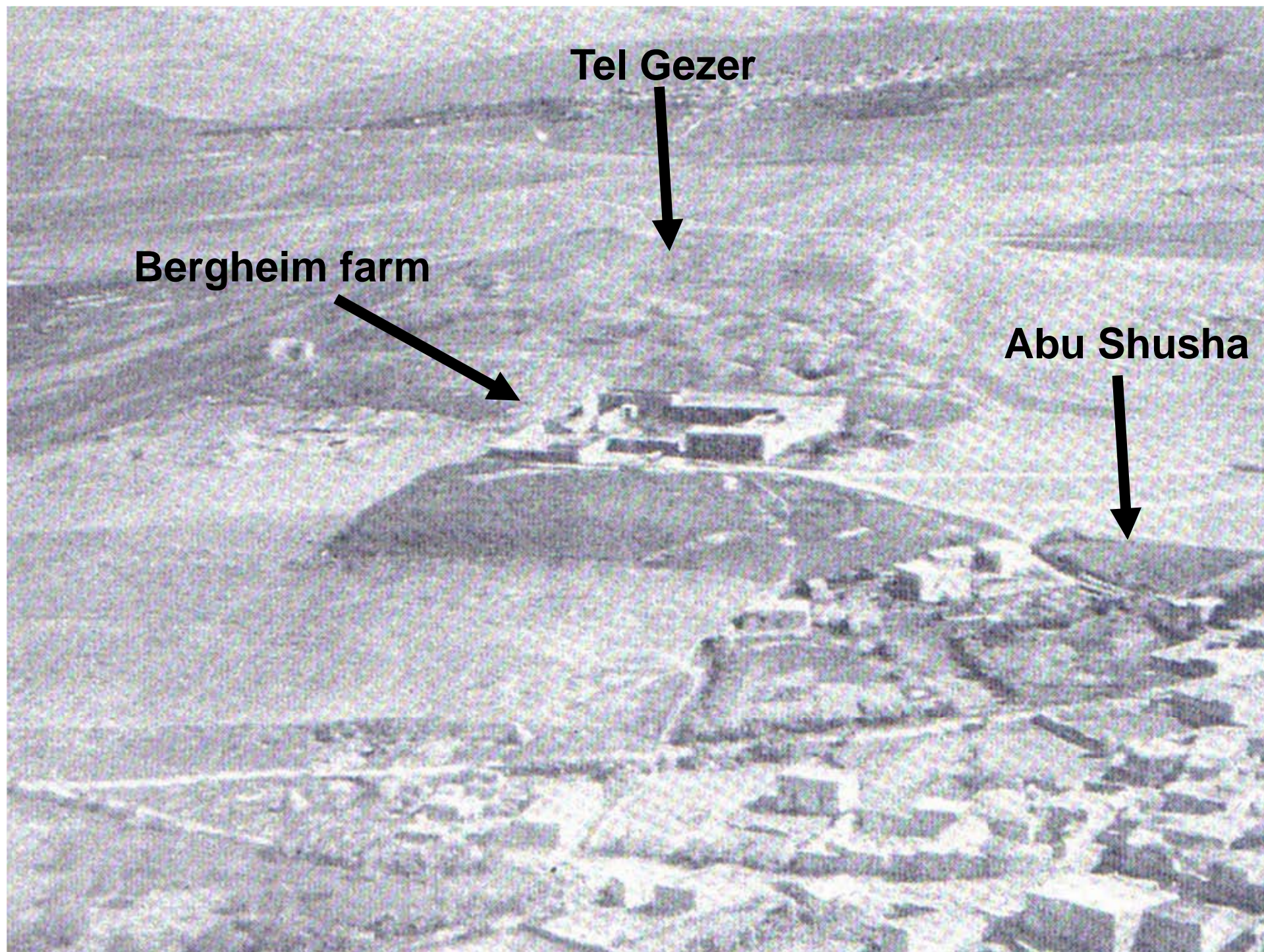
Khûrbet Abu 'Amîreh (I u).—Heaps of stones, foundations, caves, and cisterns cut in the rock.

Khûrbet 'Amîr (J u).—Resembles the last.

Khûrbet 'Ammûrieh (I u).—A ruined village on high ground. It is not improbably an ancient site. A tower of moderate masonry stands in the ruins, and there are vaults with pointed arches and foundations of houses, but nothing, apparently, of great antiquity. The place when visited was much overgrown.

Khûrbet 'Asfûrah, or Umm el Anseî (I u).—Consists of





**Tel Gezer**

**Bergheim farm**

**Abu Shusha**



**Abu Shusha**  
Intelligence information by the *Haganah*

**Tel Gezer**

**Ein Yardah spring**

**Bergheim farm**

**The question of the water sources**

**Topographic obstacle**

Abu Shushah  
Mocharet Hejjiah  
Sheikh Mohammed El Jezari  
Fort  
Farmhouse  
Well  
Cistern  
Quarry  
Tomb  
Winepress  
Olive press  
Spring well  
Khirbet Yerdeh  
Tomb  
Winepress  
Olive press

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WINEPRESS  
TOMB  
CISTERN  
QUARRY  
CAVE  
SHEIKH MOHAMMED EL JEZARI  
FARMHOUSE  
ABU SHUSHAH  
KHIRBET YERDEH  
MOCHARET HEJJIAH  
SHEIKH JOBAS

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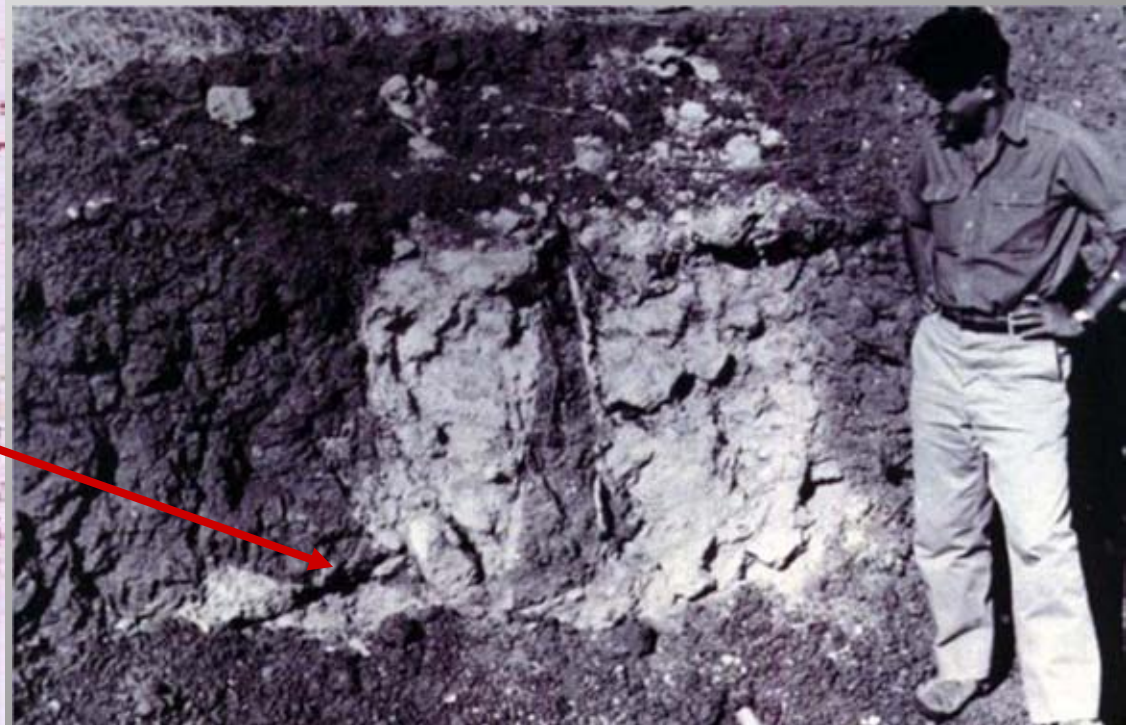
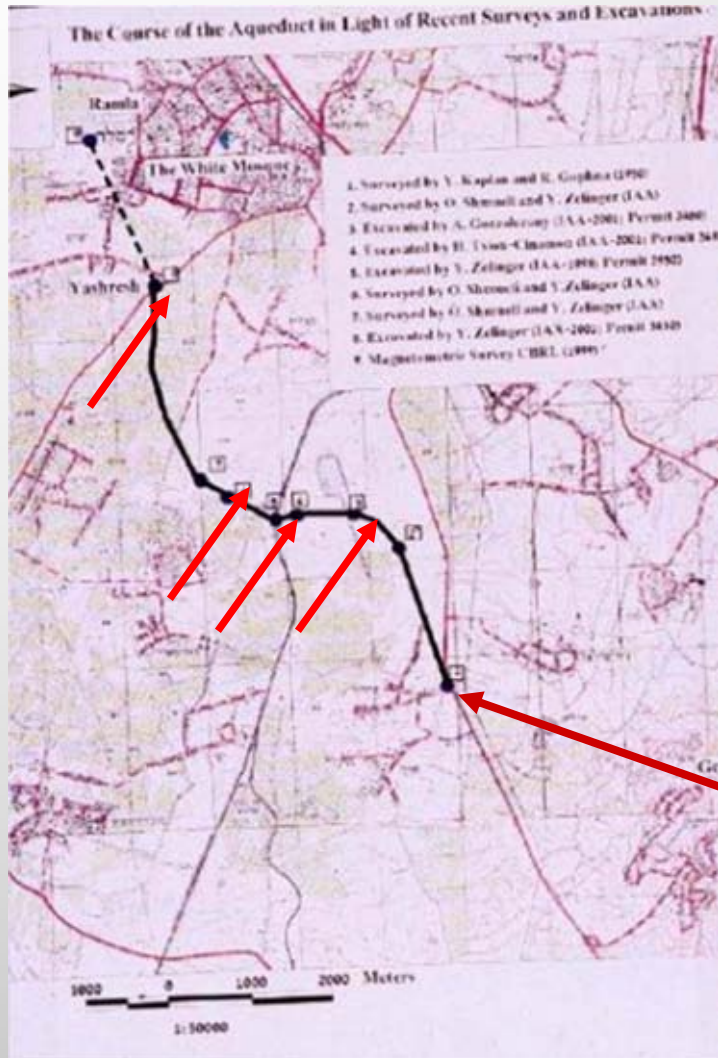
**Topographic obstacle**





**The first discovery in November  
1950 by Jacob Kaplan and his  
nephew Rami Kaplan**

**(AKA Prof. Ram Gophna)**





## **“Nesher” cement works**

**The 2001 excavations prior to the paving of the “Cross Israel” Road. General view of the aqueduct which is perpendicular to the road, looking East and North East**



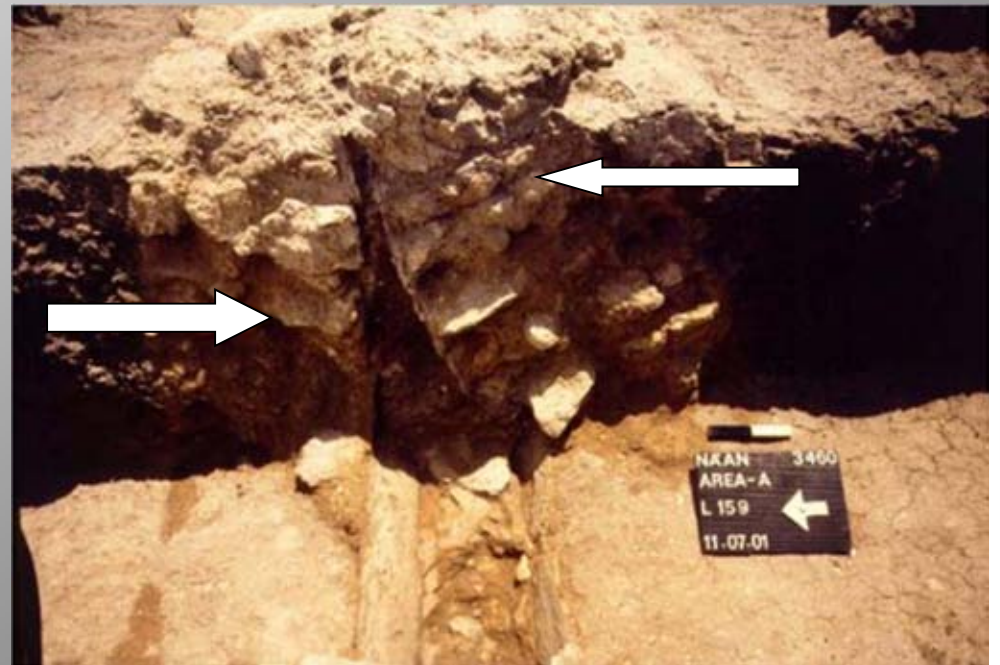


**Eastern area of the excavation,  
where the aqueduct collapsed**



**The collapse seems to be  
the result of the pressure  
caused by the alluvial soil**









Manhole

Sandy *hamra* soil





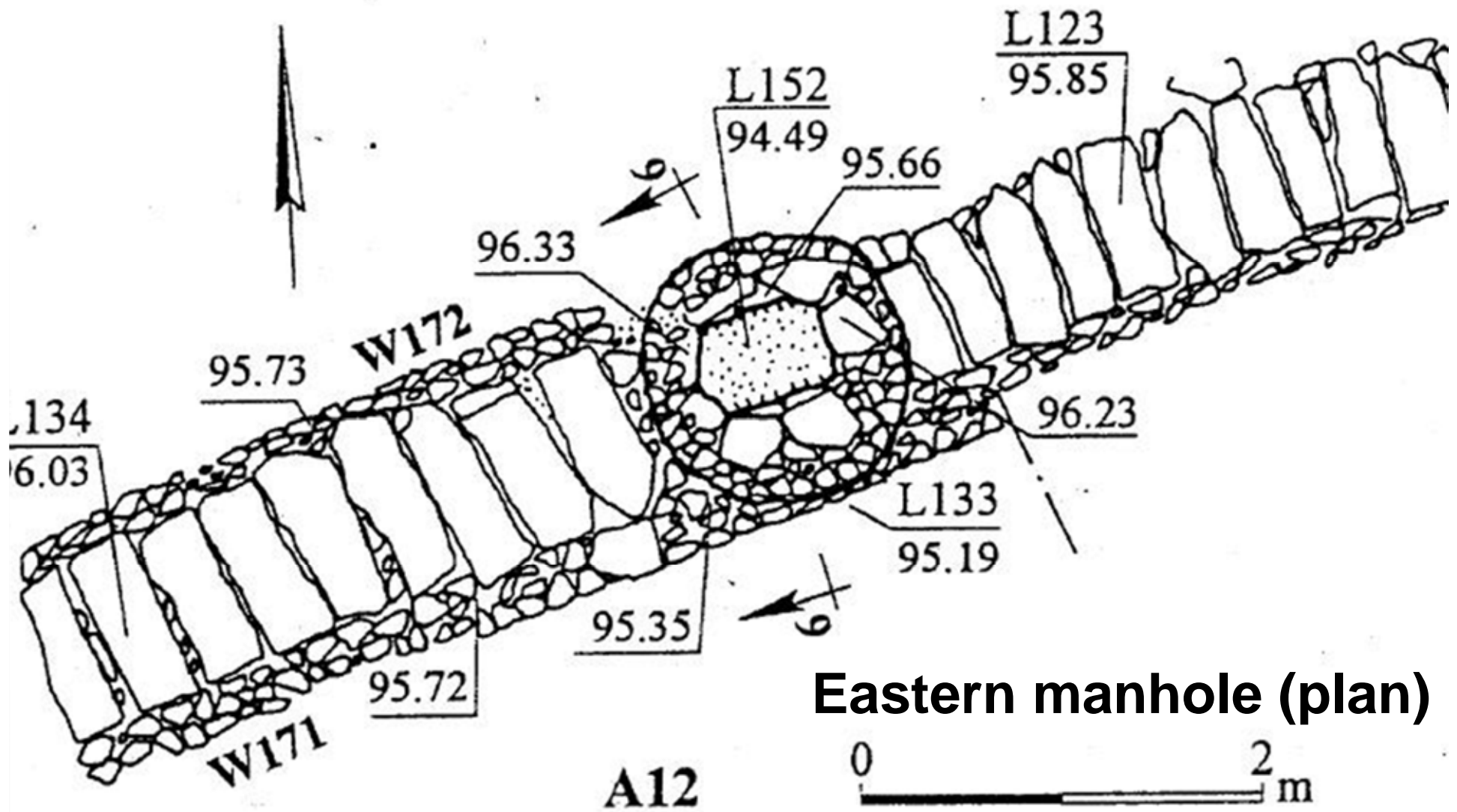


# Technology and measures according to Vitruvius (First Century B.C.)

(*De Architectura*; liber VIII)



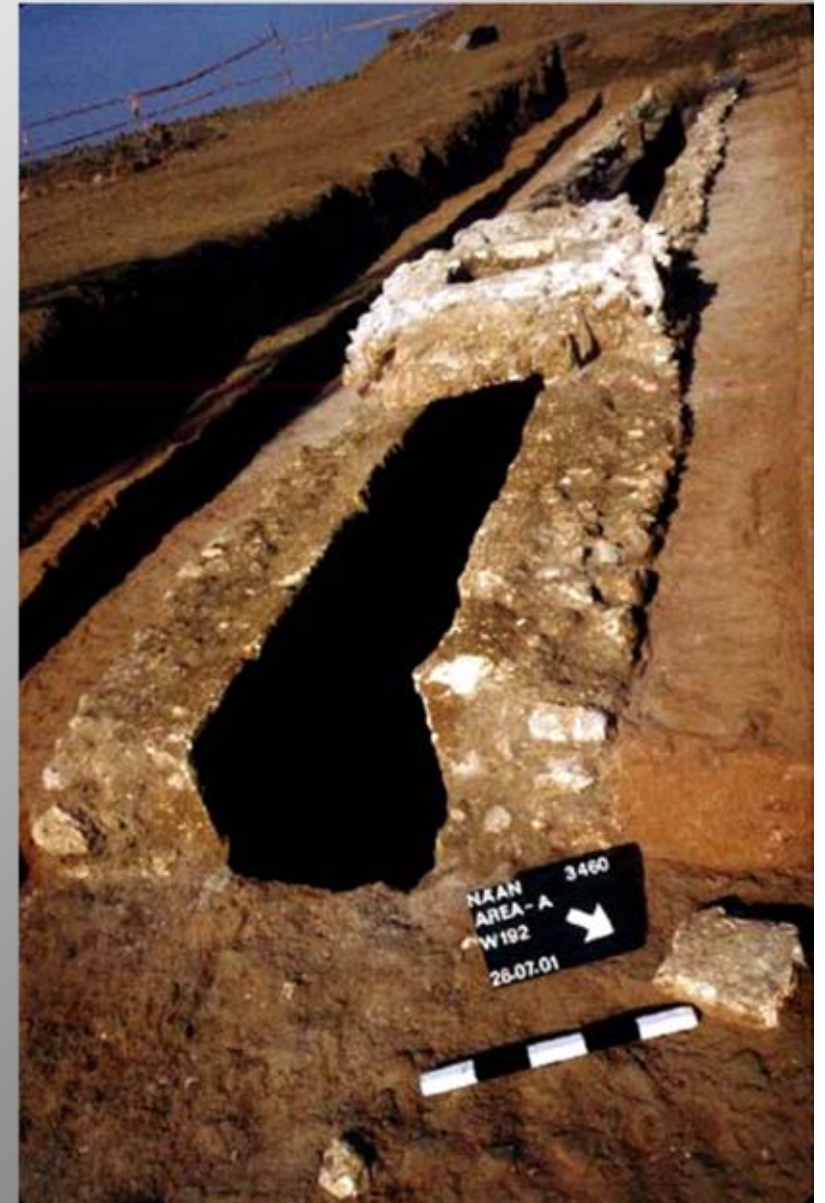
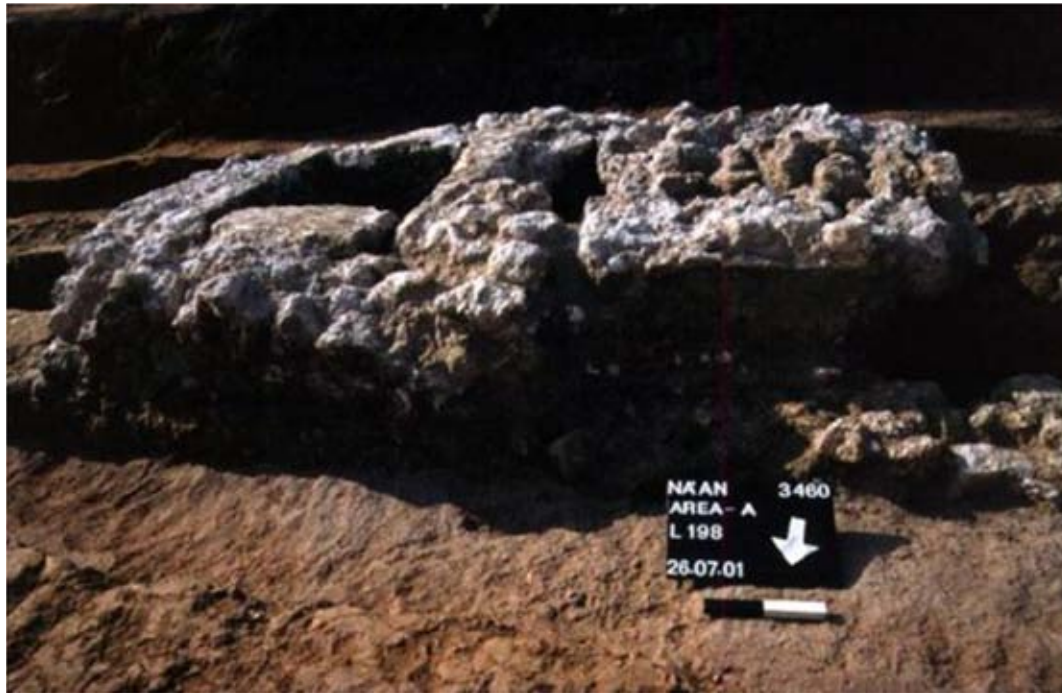




**Eastern manhole (plan)**



## Western manhole (partially preserved)







**Foundation and foundation  
trenches**





## Construction technique



Church related  
spolia in secondary  
use



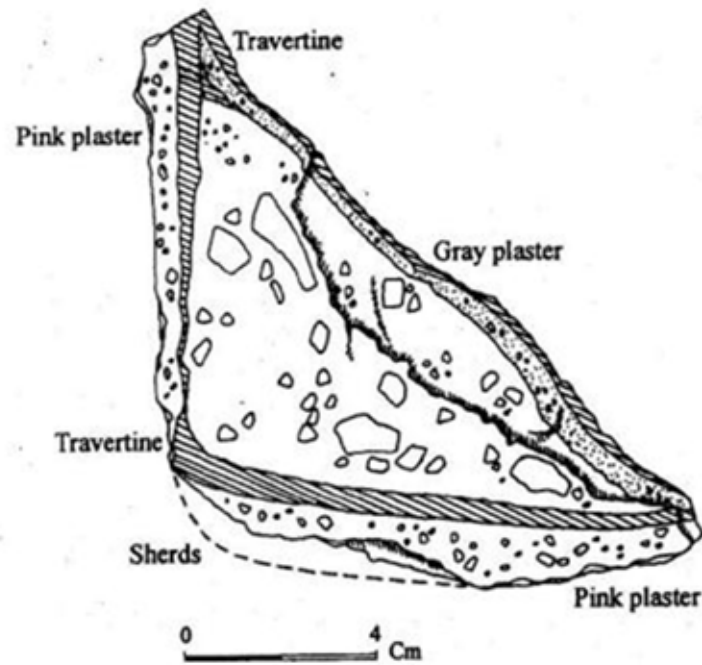




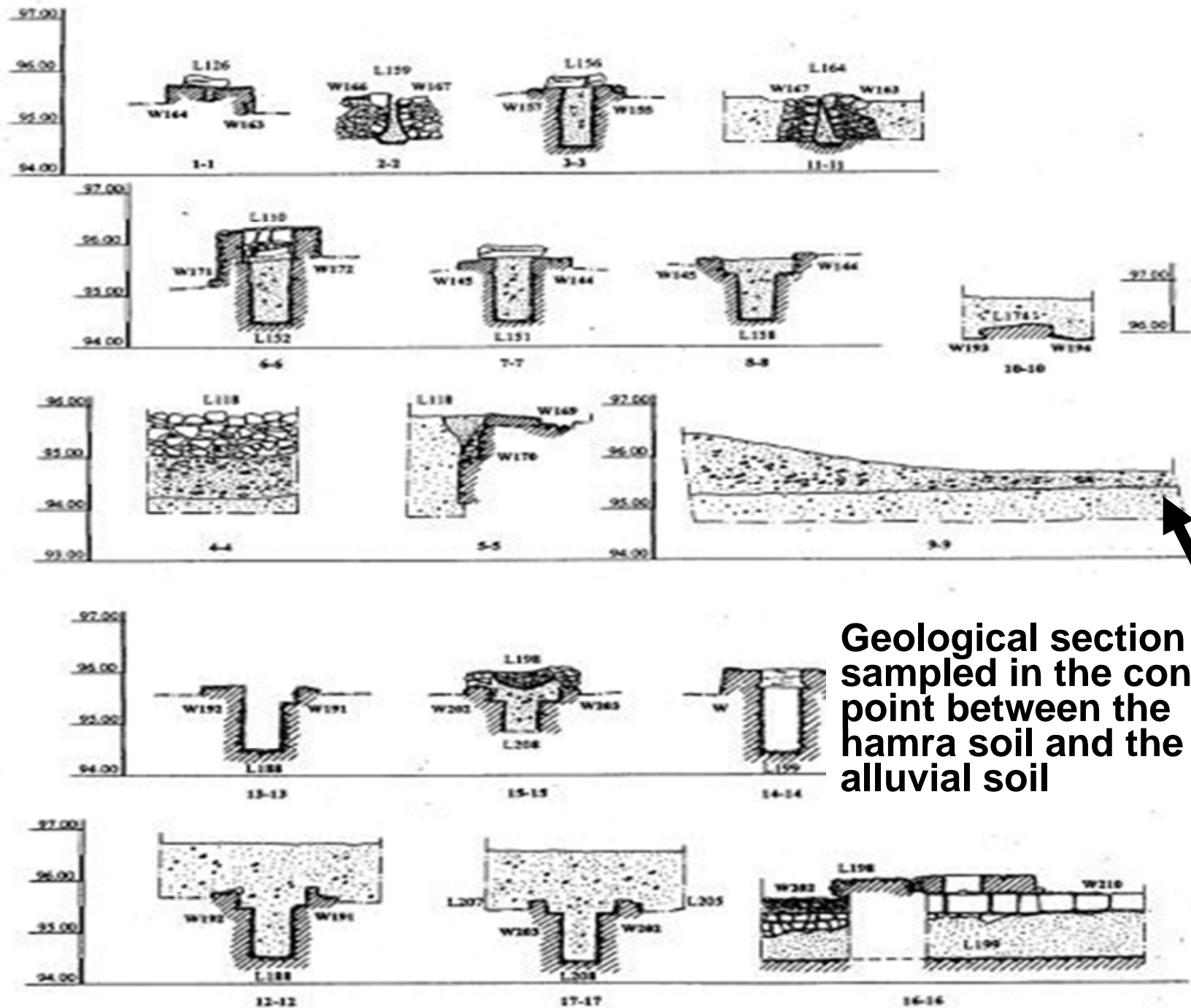
## Analysis of the hydraulic plaster



Later gray  
plaster



Original pink plaster



Geological section  
sampled in the contact  
point between the  
hamra soil and the  
alluvial soil



טבלה מס' 1: נוסחת Manning

$$V = K R^{2/3} S^{1/2} \text{ m/sec.}$$

$$Q = VA$$

Parameter	Explanation	
Q	Discharge	m <sup>3</sup> /s
V	Velocity	m/s
A	Cross sectional area	m <sup>2</sup>
R	Hydraulic radius	A/P
P	Wetted perimeter	2h + W
H	Height of flow	0.6
W	Width of flow	0.5
S	Slope	h <sub>1</sub> /1
L	Length	100 m
K	Roughness Coefficient	70 (Smooth plaster) 60 (Rough plaster with travertine)

Technical data and  
discharge calculation  
using Manning's  
Formula





# Technical data and calculations

(Two different calculations were performed with the kind assistance of Tzvika Tsuk and Yehuda Peleg)

Parameter	Calculation
A	$0.5 \times 0.6 = 0.3$
P	$0.6 + 0.6 + 0.5 = 1.7$
R	$0.3/0.7 = 0.1765$
S	$0.12/100 = 0.0012$
K	60
V	$60 \times 0.1765^{2/3} \times 0.112^{1/2} = 60 \times 0.3146 \times 0.346 = 0.6531$
Q	$0.6531 \times 0.3 = 0.1959 \text{ m}^3/\text{s} \times 3600 = 705 \text{ m}^3/\text{h}$



**8° deviation  
southwards**

**Robbery of  
covering  
flagstones**







**Robbery of covering  
flagstones performed  
In the past**







## The Course of the Aqueduct in Light of Recent Surveys and Excavations



**Highway 431**

**Site Ramla South (Matzliah)**  
excavated between 2004 and 2008  
(mostly industrial area)

**Bifurcation of the aqueduct**  
discovered in 2006

**Section discovered in 2001**

**Highway 6 "Cross Israel"**

**Tel Gezer area**



**Unexcavated continuation of  
the aqueduct penetrating the  
outskirts of modern Ramla**

**Aqueduct segment  
excavated in 2006**

**Modern wall**







## **General view and conservation plan**

**This section was removed, preserved and reconstructed close to its original location, adjacently to the highway. The site is now open to the public.**





# **The aqueduct to Hebron (*al-Khalil*)**

**(Never excavated, but thoroughly  
surveyed in several opportunities)**





# Islamic Sources

- al Muqaddassī (985 CE): Describes a short pipe in the Machpela Cave area
- Nāsir-i Kushraw (1047 CE) Describes springs used by pilgrims and city residents
- Mujir a-Din (1496 CE) adds information about a spring named *Ain el-Qana* (the spring of the aqueduct) on the Hebron – Beit Guvrin roadside



# 19<sup>th</sup> Century European scholars

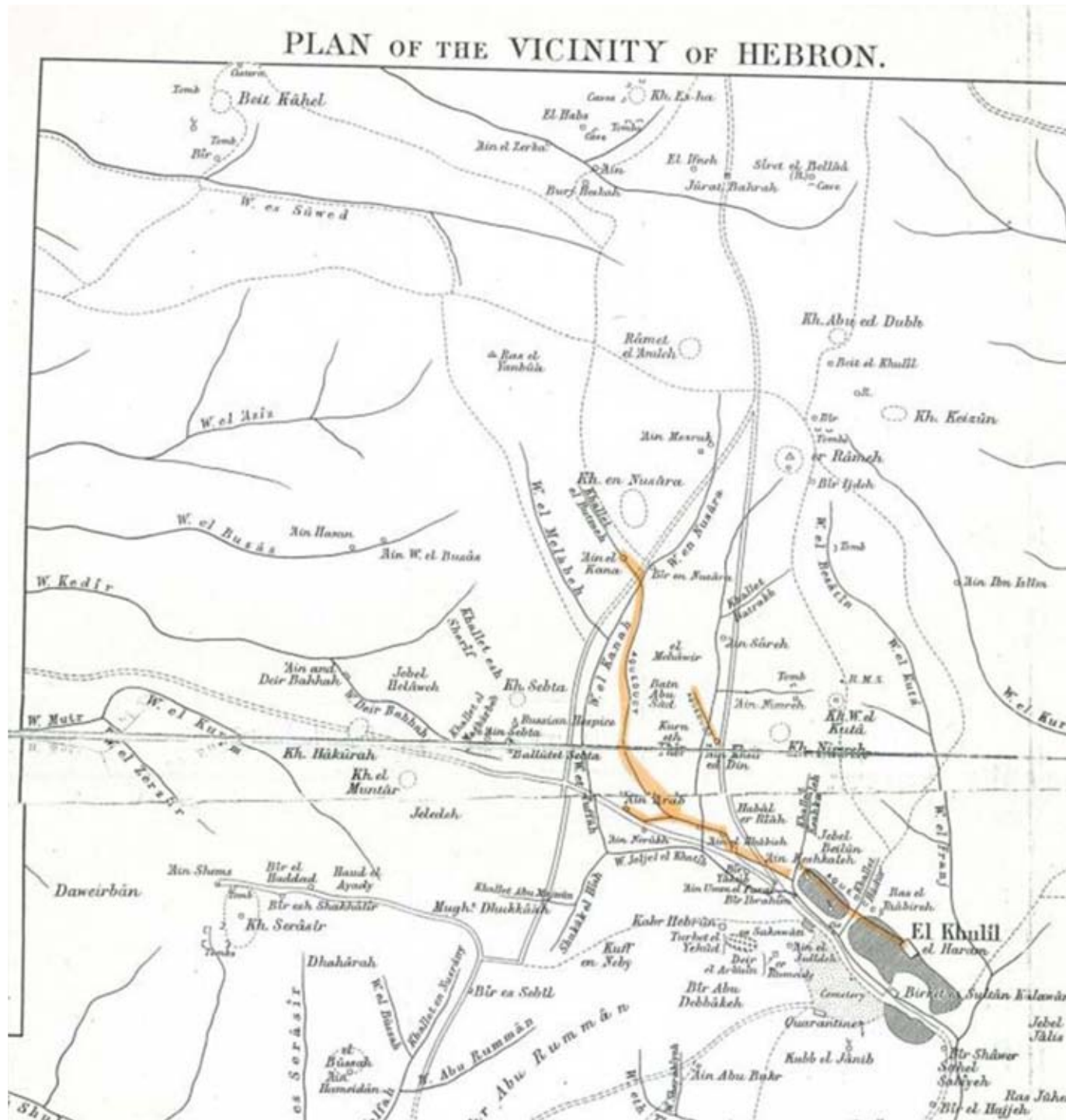
- G. Rosen (Prussian Consul in Jerusalem) visited Hebron in 1850 and published a paper in *ZDMG* XII: 477-513.
- V. Guerin, French researcher and traveler. *Judaea* (III)
- C.R. Conder and H.H. Kitchener 1883, on behalf of the Palestine Exploration Fund. *Survey of Western Palestine III. Judaea*
- C. Schick, 1898. Hebron and its Neighborhood. *PEFQ St.* 31: 232-238





Survey by  
C. Schick









# **New survey by David Amit**

- **Some 100 years later, based on previous documentation, a new attempt to locate remnants of the aqueduct has been carried out**
- **Hebron has greatly expanded in the 20<sup>th</sup> century and substantial segments of the aqueduct lie buried and covered by later construction**
- **It is still possible, however, to locate and distinguish some aqueduct sections especially the water source of *Ain al-Qana* and eastwards, in the remaining open spaces between buildings**



## **Remains of the aqueduct to Hebron**



**Ceramic pipes instead  
of open channel**





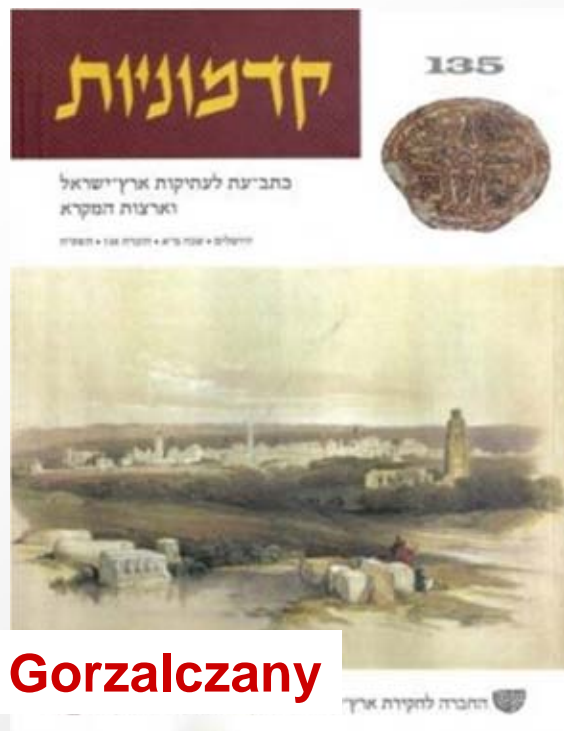


**Ceramic pipes  
*extra-situ***



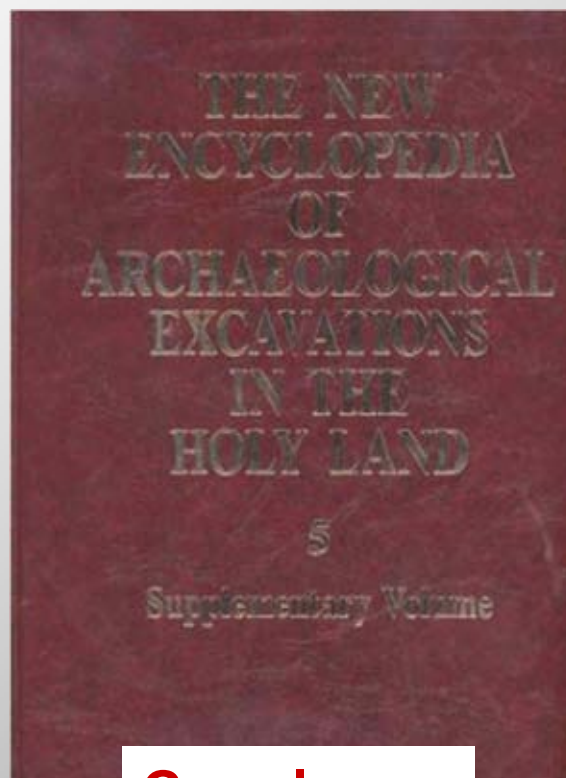
**Ceramic  
pipes *in-situ***



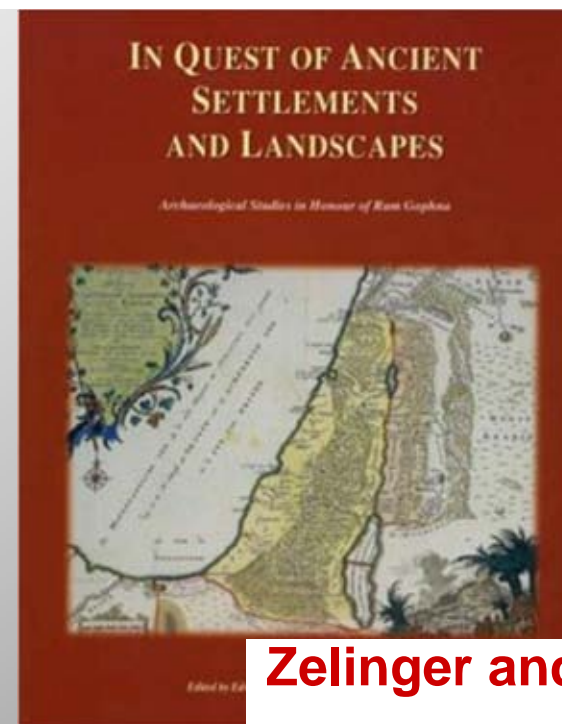


**Gorzalczany**

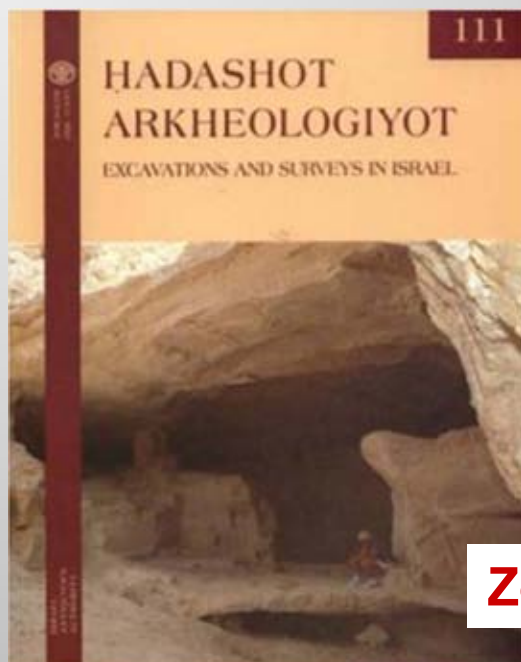
## PUBLICATIONS FOR RAMLA AQUEDUCT



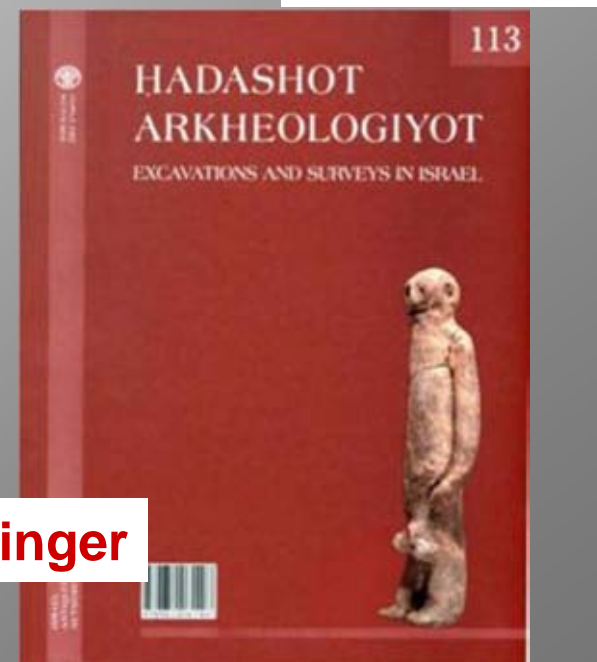
**Gorzalczany**



**Zelinger and  
Shmueli**



**Zelinger**



**Zelinger**



# Publications for the Ramla Aqueduct



**גורזלצני, א. חדשות ארכיאולוגיות באינטרנט 117 (2005)**

[http://www.hadashot-esi.org.il/report\\_detail\\_eng.asp?id=178&mag\\_id=110](http://www.hadashot-esi.org.il/report_detail_eng.asp?id=178&mag_id=110)

**ציון-צינמון, ח. חדשות ארכיאולוגיות באינטרנט 117 (2005)**

[http://www.hadashot-esi.org.il/report\\_detail.asp?id=140&mag\\_id=110](http://www.hadashot-esi.org.il/report_detail.asp?id=140&mag_id=110)

**גורזלצני, א. חדשות ארכיאולוגיות באינטרנט 120 (2008)**

[http://www.hadashot-esi.org.il/report\\_detail\\_eng.asp?id=794&mag\\_id=114](http://www.hadashot-esi.org.il/report_detail_eng.asp?id=794&mag_id=114)

**Gorzalczany A. 2011. The Umayyad Aqueduct to Ramla and other Finds near Kibbutz Na'an. *'Atiqot* 68:193-220.**

**Gorzalczany A. (forthcoming). A New Section of the Aqueduct from Gezer to Ramla and a Mamluk Period Cemetery near Yashersh. *'Atiqot*.**

**Gorzalczany A. (forthcoming). The Gezer Aqueduct to Umayyad Ramla. Chapter 7 in D. Pringle (ed.) *Ramla, City of Muslim Palestine ca. 715–1917; Studies in History, Archaeology and Architecture*. CBRL. Oxford University Press.**



# **Publication for the Hebron Aqueduct**

- **Amit, D. 1994. The Hebron Aqueduct. In  
Z. Erlich and Y. Eshel (eds.)  
*Proceedings of the 4<sup>th</sup> Annual Meeting  
- 1994. Judea and Samaria Research  
Studies*. Pp. 237-246**





## **Some comparative considerations...**

- **The construction of the aqueduct to Ramla should not surprise: the city lacked natural water resources**
- **However, why Hebron, a city of greater antiquity did not construct such an installation even during the Roman and Byzantine periods, when the needed technology was available?**
- **A possible explanation is that after the Islamic conquest, the symbolic meaning of Hebron increased substantially**



- **The traditions related to Abraham and the patriarchs encouraged an increase in the volume of visitors**
- **These visitors probably exhausted Hebron's water reserves and forced its residents to look for new water sources in the vicinity**
- **The construction of the aqueduct to Hebron during the Early Islamic period, and not before, can thus be explained in the framework of this historical scenario**



A man with a beard, wearing a red robe, is shown from the side, operating a large, complex mechanical device. The device has a horizontal beam with several vertical supports and pulleys. The man is holding a handle or lever. In the background, there is a landscape with a small building on a hill, bare trees, and a cloudy sky. The overall style is that of a vintage illustration or painting.

**Thank  
you**

