Ancient Water Systems In Israel
Guiding Principles

• Water - a source of life & people always need water
• Water use - private & public in ancient settlements
• Availability of water in antiquity - as large or larger than today
• Challenge - construct water systems & divert the water to the settlements
• Pumps not available & transportation of water was only by gravitation
Quantities of Water Per Capita Per Year

- Bedouins 1.5 CM = 1 gallon per day
- Biblical period 5 CM = 3.5 gallons per day
- Byzantine period 7 CM = 5 gallons per day
- Jerusalem during the 1948 siege - 1.5-2.5 gallons per day
- 1970 - 70 CM = 50 gallons per day
- Today - 120 CM = 82.5 gallons per day
Typology of Ancient Water Systems

1. Wells
2. Nearby springs (natural)
3. Cisterns
4. Reservoirs or pools collecting runoff
5. Reservoirs - beyond the city walls
6. Dams
7. Natural inner springs (w/in the city walls)
8. Underground - hewn down to the level of the water table
9. Aqueducts
Which are the most ancient water systems?

**Wells**

**Cisterns**
Cisterns

- Hewn in bedrock / stone construction
- Narrow opening and wide body
- Plastered from top to bottom
- Large storage capacity
- “Cannot export more water than it imports” (Avot de Rabbi Natan = Limited capacity)

Wells

- Dug / hewn to the water table level
- Vertical and narrow
- No plaster
- No need for storage capacity
- “Water that runs by itself” (Avot de Rabbi Natan = Unlimited quantity of water)
Wells

• Most ancient wells - Atlit-Yam, dated to 5900 BCE
• Deepest well - Tel Beer Sheba, 70 meters deep, dated to 1100 BCE
• Wells used throughout history until today
• Monumental water systems preferred in fortified cities
• Wells usually public, serving the entire community
Beer-Sheba Well
Southern Israel
Deepest Well
70 m; 230 Ft.
Cisterns

• Beginning use - 3000 BCE
• First cisterns - small, hewn out of chalk, unplastered
• First plastered cisterns - Hazor and Gezer, dating to 1800 BCE, bottle-shaped
• Plastered cisterns mainly bell-shaped
• Peak of cistern-use – Byzantine Period, 500 CE
• Used to this day
• Usually for private use
Cisterns from the Early Bronze to Iron age 2

Legend
- Iron Age 2
- Iron Age 1
- Late Bronze
- Middle Bronze
- Early Bronze

Km.

Mediterranean Sea

Hazor
Rosh Zeit
Sea of Galilee
Taanach
Yezrael
Mezer
HaAi
Gezer
Nasbeh
Radana
Dir e-Sir
Abu Twein
Buqeria
Ashdod
Bet Shemesh
El-Kich
Qumran
Dead Sea
Banat Bar
Qla
Margama
Shiloh
Tel Dalit
Tel Halif
Tel Ira
Uza
Negev Highland
Radum
Um el Bayara

Cisterns from the Early Bronze to Iron age 2
Reservoirs or Pools Collecting Runoff

- Reservoirs with a capacity greater than 150 cubic meters collecting runoff by channels (built or dug)
- Used in fortified cities during times of peace & siege
- First reservoirs (2500 BCE) at Arad & HaAi (Et-Tell) - mainly open, w/o plaster
- Hazor (Northern Israel) - a reservoir under the palace ca. 1300 BCE (LB Period)
- Well-known underground reservoirs, urban or royal (Judean Kingdom) - Tel Beer Sheba, Arad, Eitam, Bet Shemesh & Amman
Tel Arad
Central Reservoir
Beer Sheba Reservoir
# Typology of Water Shafts & Tunnels

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<tr>
<td>Shaft/Tunnel to Exterior Spring</td>
<td>Shaft/Tunnel to Water Table</td>
<td>Water Conducted to Bottom of Shaft/Tunnel</td>
<td>Feeding Tunnel &amp; Channels to Reservoirs</td>
<td>Exterior Approach to Water Source</td>
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Tunnels & Shafts to Inner Springs (w/in city walls)

- Used for a short period
- Fortified cities - built around a spring, ca. 1800 BCE = MB IIb
- Sites - Tel Dan, Kabri, Jericho
- Jerusalem - spring situated w/in the city walls & supplied by a hewn tunnel
- Inner springs - built by the government
Jerusalem

4 Parts:
1. Tunnel which was cut to direct water from the plentiful Gihon Spring
2. Stepped tunnel - cut downward from the street level behind the city’s defense wall
3. Almost horizontal tunnel ramp running out under the city wall to a point directly above the water chamber leading to #4
4. A shaft connected the end of this upper tunnel to the water chamber.
Underground Water Systems
Hewn Down to Level of Water Table

• First appearance - Tel Gezer and Tel Gerisa, ca. 3800 BCE
• Mainly 1000 BCE - Megiddo, Hazor, Gibeon, Yebleam, Jokneam and Lachish(?)
• Hewn inside fortified cities - in time of siege
• Built by the government
• Disappeared - end of the Judean Kingdom
Tel Gerisa
1800 BCE
Tel Aviv
Megiddo
1. Spring
2. Spring chamber
3. Pre-10th cent B.C. stairs to spring chamber
4. 9th cent B.C. blocking wall at entrance to chamber
5. 9th cent B.C. tunnel
6. 9th cent B.C. stepped shaft
7. 9th cent B.C. inset offset wall
8. Solomonic (10th cent B.C.) gallery
9. Solomonic (10th cent B.C.) covered stairway
Stepped Tunnel = Grade - 35°
L - 127 m, 416 ft.
1. Rock-hewn shaft with steps
2. Entrance structure
3. Stepped (or sloping) tunnel leading to water table
4. 9th cent B.C. 4-room Israelite house
5. 10th cent B.C. Solomonic casemate wall
6. Chamber on water table
7. Pool on water table
Stepped Tunnel =
Gradient - 29°
Length - 80 m, 262 ft.
1. Pre-10th cent B.C. “pool”
2. Stepped shaft to water table
3. Chamber at water table
4. City wall constructed in 12th–10th centuries B.C.
5. Spring
6. Feeder tunnel to increase flow of spring to water chamber
7. Water chamber
8. Outside entrance to water chamber
9. Stepped (or sloping) tunnel from inside city to water chamber
Gibeon Water Tunnel
Gradient = 43°
Length = 48 m, 157ft.

Water Chamber
Gezer
Middle Bronze Age
1800 BCE
28.80 m. below surface

Entrance – Keyhole shaped, 10.5 m. deep, w/ steps

Tunnel – Gradient = 39°
- Length 40m, 140 ft.,
- Height -7.5 m,
- Width - 4 m.
- Steps

Drawing by Vincent
Gezer Shaft/Tunnel

1. Rock-cut shaft
2. Stepped (or sloping) tunnel
3. Chamber on water table
4. Southern Gate in Middle Bronze wall
5. Middle or Late Bronze wall (initial phase built 2000-1500 BCE)
Gezer Tunnel
Architectural Features
Daily Operation
The Water System

A hewn passage to the ground water

You are now in Gezer’s ancient water system. The residents of the city dug it to reach ground water, which is about 40 meters below the surface. So far you have been going through the open part of the system. From this point, a 40-meter-long tunnel slopes downward; at the bottom is a cave and a basin to collect the water (from the water table).

The residents of the city would go down the water shaft to draw water from the basin in times of peace as well as war. A large portion of the tunnel is now stopped up due to numerous cave-ins since it was first excavated by Macalister in the early 1900s. Excavations are now being conducted to explore fully the water tunnel and cavern basin.
<table>
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<tr>
<th></th>
<th>PPNe 6000 BCE</th>
<th>NE 5000 BCE</th>
<th>CL 4000 BCE</th>
<th>EB 2500 BCE</th>
<th>MB 1800 BCE</th>
<th>LB 1400 BCE</th>
<th>Iron 1 1100 BCE</th>
<th>Iron 2 800 BCE</th>
<th>Hell. 200 BCE</th>
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1. Well
2. Nearby Spring
3. Cistern
4. Reserv. Pool Runoff
5. Dam
6. Inner Spring
7. Unde. Water System
8. Reser. Outer Source
9. Aqueduct
General Conclusions About Water Systems:

• Typology - gives only general picture on the subject in each region
• Certain developments can be traced throughout history
• Wells appeared first, leading to the development of underground, monumental water systems
• Cisterns next, leading to the development of underground reservoirs
• Research can be used for comparative analysis
• Research is just beginning and needs to be continued
www.nobts.edu/ArchaeologyCenter/
http://nobtsarchaeology.blogspot.com/