

# Engineering the Hanging Garden of Babylon



**Sean Brady** examines the remarkable engineering works that may have underpinned one of the Seven Wonders of the Ancient World.

## Introduction

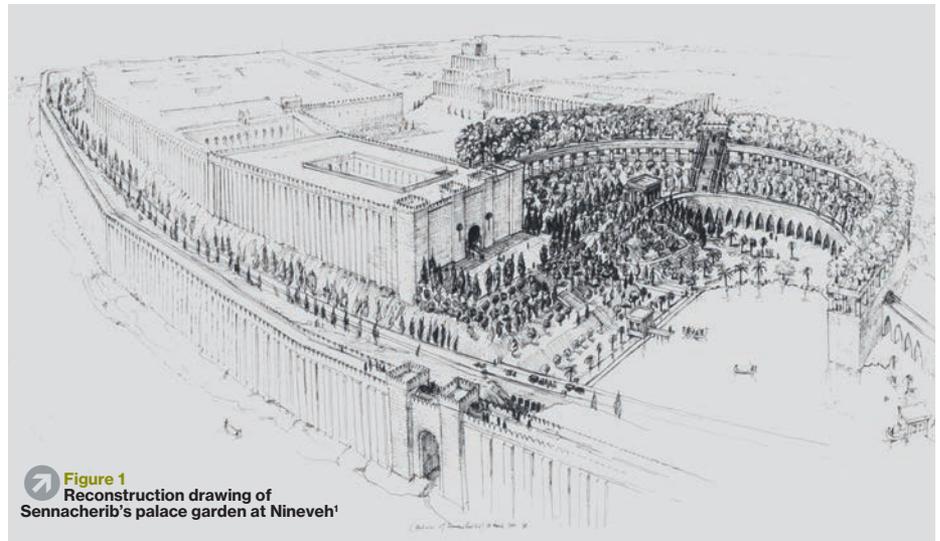
What would you do, hypothetically speaking, if you wanted to prove the existence of the Hanging Garden of Babylon? You could study the writings on the subject, identify the garden's likely location, then excavate to find physical proof. But what if there was a problem? What if, after decades of digging, you found nothing, not a single shred of evidence?

Would this mean the garden was a myth and never existed? Or would it mean you were just digging in the wrong place?

## Seven Wonders

The Seven Wonders of The Ancient World were compiled by Greek and Roman writers – a bucket list of must-see structures for intrepid travellers. While the Great Pyramid of Giza still stands, the remaining six were the Pharos Lighthouse in Alexandria, the Colossus of Rhodes, the statue of Zeus at Olympia, the Temple of Artemis at Ephesus, the Mausoleum at Halicarnassus, and a hanging garden located in the city of Babylon, just south of modern-day Baghdad. Physical evidence has confirmed the existence of all these wonders – all except for the Hanging Garden<sup>1</sup>.

This garden was constructed by Babylonian King, Nebuchadnezzar II, c.600BC as a gift for his Persian wife. It was not just a landscaped garden in the same way as, say, Versailles, because in addition to being visually stunning, it was also technically innovative – as was the case with all the Seven Wonders. The literature tells us it was approx. 120m × 120m in plan, built on man-made, multilevel stone terraces, like a Greek amphitheatre, at the foot of which was a lake. The trees planted on the upper levels



**Figure 1**  
Reconstruction drawing of Sennacherib's palace garden at Nineveh<sup>1</sup>

were above the water table and artificially moistened. It was lush all year round, a symbol of abundance and fertility – a true Garden of Eden in an arid land.

But there are problems with these descriptions. They are not first-hand accounts. They were provided by Greek and Roman writers who never actually saw the garden, written several centuries after its destruction. Then there are Nebuchadnezzar's writings. He was a prodigious documenter of his achievements, especially his building projects, but he never mentions a garden. Wouldn't you, if you'd built a world wonder? Finally, we come to physical proof. Babylon was excavated by Robert Koldewey between 1898 and 1917, and he looked for the location of the garden<sup>1</sup>. Yet he found nothing consistent with classical descriptions of the garden. And since then no one else has found anything either.

So, no first-hand eyewitness accounts, no mention of a garden in Nebuchadnezzar's writings, and no physical proof whatsoever. It's hardly surprising that some scholars have concluded that the garden never actually existed – that it was a myth.

## Jerwan

Let's leave the city of Babylon and travel more than 300km north, to the Assyrian kingdom. The year is 1932, and archaeologists Thorkild Jacobsen and Seton Lloyd are excavating

in the ancient city of Khorsabad<sup>2</sup>. One day Jacobsen is approached by a workman, Hussain Ali of Faddhilyah, who says that the previous summer he worked in a small village at the foot of the mountains. The village had 18 or so mud huts, and a number of them had been repaired using cut stones – stones that bore inscriptions. Jacobsen listens, but is sceptical. These claims were common, but not always genuine. However, he changes his mind when Ali shows him sketches of the writing – it's in cuneiform, the ancient language of both the Assyrians and Babylonians.

The next morning Jacobsen and Ali set off. By noon they reach their destination – a long, shallow valley bisected by a stream. They see the village of Jerwan in the distance, but the most spectacular sight is a large, 280m long stone wall that cuts straight across the valley. It's covered in grass, only recognisable by stones protruding in places through the turf.

They are met by the village elder (*mukhtar*), who shows them the mud huts containing the inscribed stones. Jacobsen examines the inscriptions and recognises the name Sennacherib, the ancient Assyrian king. These stones date back to 700BC. The *mukhtar* says the stones are taken from the grass-covered structure, which was a dam used in the past to capture flood waters. There are more inscriptions on the dam, and he can have villagers uncover them if Jacobsen is willing to wait.

Over a meal of curds, honey and crispbreads the men wait. Then they're shown the newly uncovered inscriptions, which are only partially legible, and Jacobsen realises he's made an astonishing discovery. The inscription details Sennacherib's building works, saying, "I spanned a bridge... [illegible words] I caused to pass over upon it". This wasn't a dam, it was a bridge. He guesses the illegible words are probably something like "armies or war chariots". Crucially, because it bears Sennacherib's name, it is the oldest bridge ever discovered – considerably older than the bridge discovered by Koldewey in Babylon.

### Excavation

In time it would transpire that Jacobsen was not the first archaeologist to notice the bridge, but no one at that stage had investigated it in detail. So the following year, he, along with his team, return to Iraq, where they base themselves in the village of Ain Sifni, 5km from Jerwan. His bridge theory, however, is about to be turned on its head.

Three or four days into excavation they're visited by a physician, Petros de Baz, who tells them an intriguing story he's heard from one of his patients. Long ago, two suitors vied for the hand in marriage of the king's daughter. The king promised her to the suitor who could supply the nearby village of Tell Kaif with water. The story then focuses on who won the daughter's hand, but it also describes how one suitor embarked on a major engineering project centred on Jerwan. Jacobsen is stunned. What if he's not excavating a bridge, but an aqueduct?

Two days later he gets his answer. They uncover a complete inscription at the north end of the structure, and rather than referring to "armies or war chariots" as Jacobsen assumed, it reads, "Those waters I caused to pass over upon it." Jacobsen is looking at an aqueduct – an aqueduct that predated the Romans by more than half a millennium.

The discovery has far reaching consequences: an aqueduct means a canal. They talk to the villagers, then to the surrounding villagers. They hear the same story of the king's daughter, but also start to hear stories about a canal system. They pass from village to village trying to plot its course. At Shifshirin, they uncover limestone blocks identical to those used in the Jerwan aqueduct. At Baqasrah they find similar stones, along with a terrace cut into the hillside. Outside Piran they also find a terrace, and villagers say these terraces can be seen at intervals throughout the countryside. Their trek leads them to Khinnis – a site well known to archaeologists – where the Gomel river was diverted into Sennacherib's canal.

It would take decades before the full extent of this engineering marvel would become known. (Interestingly, declassified imagery from the US CORONA intelligence satellite system was used by Jason Ur from Harvard University to help map the canal network's routes<sup>3</sup>. These images show changes in topography that are all but invisible at ground level.) From where water was diverted from the river at Khinnis, it would travel through a canal constructed more than 2700 years ago, crossing the Jerwan aqueduct and flowing more than 90km until it reached the ancient Assyrian capital city of Nineveh.

This infrastructure provided enormous benefits to Nineveh, among them clean drinking water and irrigation for surrounding farmland. But what if it had an altogether more glamorous role? Because if you were Sennacherib, and you wanted to build the most impressive garden in the world, you now had the single most important ingredient. Water.

### The prism

Is it possible that the Hanging Garden was in Nineveh, not Babylon? Could the Greek and Roman authors have got it wrong? This is the theory advanced by Dr Stephanie Dalley in her recent book *The mystery of the Hanging Garden of Babylon*<sup>1</sup>.

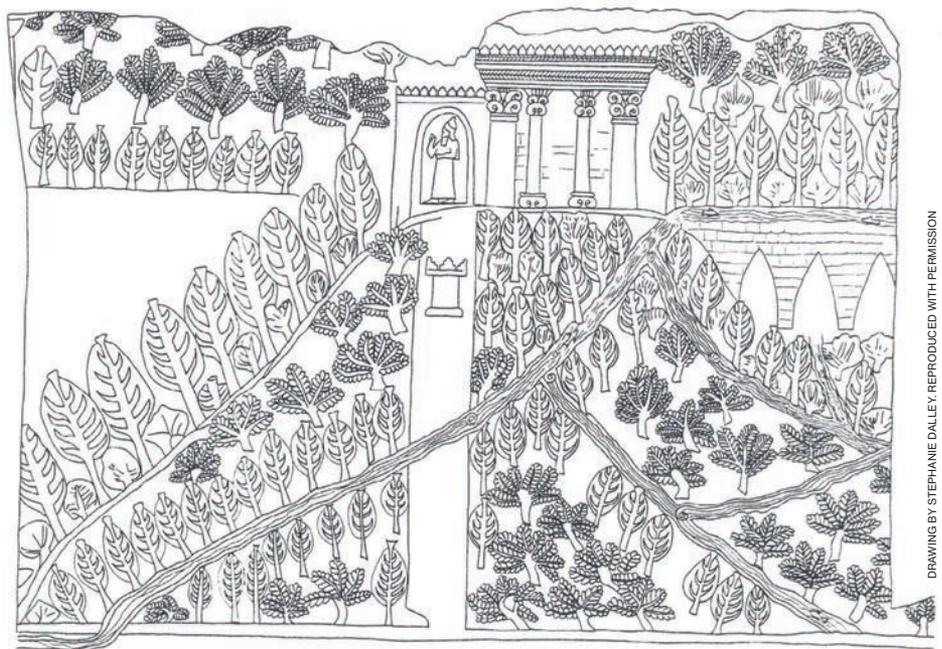
Dr Dalley is an academic at Oxford University and an Assyriologist. She is also one of a small group of people in the world that can read cuneiform text. She doesn't

subscribe to the view that the garden never existed – for her there is too much coherency between the various classical sources for it to be a myth. Instead, she believes we've been looking in the wrong place, and she provides a wide range of evidence to support this view in her fascinating book. We will limit ourselves to discussing only a few of her key points.

Dr Dalley's revelation came when she translated an Assyrian prism from the British Museum. This prism, 38cm long, with hexagonal sides – each full of cuneiform text – describes Sennacherib's palace and its surrounds in Nineveh (Figure 1). This method of "documenting" construction projects was common for the time. And these prisms were often buried in walls or foundations so that, when the building eventually collapsed, the prism – in what you could describe as a last gasp of egotism – served as a reminder of the king's past glories.

When Dr Dalley was deciphering the prism, she found a fascinating line of text: "I raised the height of the surroundings of the palace, to be a Wonder for All Peoples. I gave it the name 'Incomparable Palace'. A high garden imitating the Amanus mountains I laid out next to it, with all kinds of aromatic plants, orchard trees..." – a remarkably similar description to that of the Hanging Garden.

Another key piece of evidence came in the form of a bas relief (Figure 2) recovered from Sennacherib's palace in Nineveh – again stored in the British Museum. This relief depicts a garden that was not considered to



DRAWING BY STEPHANIE DALLEY, REPRODUCED WITH PERMISSION

**Figure 2**  
Part of garden at Nineveh, two generations after planting<sup>1</sup>

→ **Figure 3**  
Spiral, screw-like form of date palm

represent the Hanging Garden of Babylon because it was not found in Babylon – a strong reminder of the dangers of implicit assumption. It depicts a garden in Nineveh, but is this garden actually the world wonder? Dr Dalley believes it is – it is tiered with running water, again very similar to the classical descriptions.

Further, it ties into the discovery at Jerwan and the canal system. Looking at the right-hand side of the relief, about one-third of the way down, we see an arched structure. This depiction is almost identical to the design of the Jerwan aqueduct, specifically in the shape of its pointed arches. The presence of this similarly designed structure in the garden supports the view that the aqueduct was a part of a master-planned water and garden system.

And what a system it was, reminding us that with many great public achievements, the engineering required to make it possible often goes unheralded. Here in Nineveh engineers brought civilisation to one of the world's great ancient cities, and they did it more than half a millennium before we – as a profession – flourished under Roman rule.

There were four canal systems in all, each having reservoirs, dams and covered sluices to regulate flow. The Khinnis-to-Nineveh section was up to 100m wide and covered a distance of 90km, dropping by 1m per kilometre to ensure gentle flow. Experts estimate that this system could deliver 300t of water per day to the garden. Central to its successful operation was the Jerwan aqueduct: 280m long, 22m wide (not including its buttresses) and 9m high, built from more than 2M individual stones. For its time, it was unlike anything constructed in the West. Indeed, in 1935, Seton Lloyd took samples of a mortar between the stones and sent it to the Building Research Station of the British Department of Scientific and Industrial Research for analysis. It was concrete.

These engineering accomplishments demonstrate that engineering technology which we generally attribute to the Greeks and Romans was being used by the Assyrians many centuries earlier. But perhaps the most impressive innovation was something much smaller in scale, but no less indispensable if you wanted to build a hanging garden. What this invention is, however, depends on your interpretation of the word *alamittu*.



### Rising water

The canal system demonstrates that you can get water to the garden, but how do you transport it to the trees and plants on the upper tiered levels? One explanation can be found in the translation: "Instead of *shadufs* I let ... beams and *alamittu* stand over the wells." A *shaduf* is a bucket-levered system, but Sennacherib says he used beams and *alamittu* over his wells. The word "beams" could be retranslated as meaning cylinders, but what does *alamittu* mean?

*Alamittu* means "date palm", which may not initially appear very helpful. But Dr Dalley believes it doesn't refer to an actual date palm, it refers to something that *looks* like a date palm. So she tracked down a date palm in Oxford's Botanic Gardens and immediately understood the meaning of Sennacherib's inscription<sup>1</sup>. The branches of the date palm grow outwards from the trunk in a spiral fashion. The tree trunk looks like a screw (Figure 3). What Sennacherib meant by the word cylinder also becomes obvious: the screw sits inside the cylinder to form an Archimedes' screw.

This is how Dr Dalley believes water was transferred up the tiered garden – these screws rotate and draw water from the levels below. This means the use of the Archimedes' screw predates Archimedes himself by some 350 years. (In fact, many scholars agree that the screw was in use long before Archimedes discovered it. Dr Dalley's translation of the word *alamittu* also ties back nicely to the classical author Strabo's descriptions of the Hanging Garden of Babylon, which specifically mention the use of Archimedes' screws.) So, water began its journey over

90km away, was carried across northern Iraq, only to be lifted upwards by Archimedes screws – all to create a garden that was lush all year round, a garden that just may have been one of the great wonders of the ancient world.

### Physical proof

So, is this, in fact, the world wonder? Well, detailed physical investigation will have to wait. It hasn't been possible to launch an expedition to Nineveh, and such an expedition is unlikely to happen for some time. The ancient city of Nineveh lies across the River Tigris from modern-day Mosul and is a no-go area. In June 2014 it was overrun by one of the most brutal regimes of our time – Islamic State.

*Dr Sean Brady is the managing director of Brady Heywood. The firm provides forensic and investigative structural engineering services and specialises in determining the cause of engineering failure and non-performance.*

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