# Report on Architectural Recording and Archaeological Survey Undertaken at Nu'aija, Doha

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Origins of Doha Project

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## 1. Non Technical Summary

The *Origins of Doha Project* is a University College London Qatar based research project funded by **NPRP grant no. 5-421-6-010** from the Qatar National Research Fund (a member of Qatar Foundation). This project aims to explore the foundations and historic growth of Doha, its transformation to a modern city, and the lives and experiences of its people, through a combination of archaeological investigation, historical research and oral testimony.

In partnership with the Qatar Museums the *Origins of Doha Projec*t carried out an architectural and archaeological survey of an abandoned agriculture area at Nu'aija, located in the south of Doha. This area was also formerly one of the most important drinking water sources for the historic town of Doha. The work undertaken included recording a traditional *zajara* well, which would have been used to irrigate the agricultural land prior to the introduction of mechanical pumps. Several other buildings were recorded, as well as surviving elements of the agricultural area such as wells, tanks and irrigation channels. A surface collection of artefacts from the site, mostly ceramics, was also undertaken. As well as recording the site the work also provided a training element, in which members of QM participated in a short course on building recording at the site.

This report presents the results of the architectural and archaeological survey undertaken by the *Origins of Doha Project.* A brief history of site is given and the chronology and importance of the various structures on the site discussed. The traditional *zajara* well recorded on the site is possibly the only surviving example in the country. This type of type of structure would have been essential for irrigating crops prior to the introduction of mechanical pumps, and represents an important part of Doha's history.

## 2. Acknowledgements

This report was made possible by **NPRP grant no. 5-421-6-010** from the Qatar National Research Fund (a member of Qatar Foundation). The statements made herein are solely the responsibility of the authors. The excavation was undertaken in partnership with the Qatar Museums (QM) and the project was Directed by Professor Thomas Leisten of QM and Dr Robert Carter of UCL Qatar. The fieldwork, survey and photography were undertaken by a Daniel Eddisford, Tom Eley and Ruth Hatfield.

The authors would like to thank H.E. Sheikha Al-Mayassa bint Hamad Al-Thani and H.E. Sheikh Hassan bin Mohammed Al-Thani of QMA. Thanks are also due to, Professor Sultan Al-Muhesen, Dr. Ferhan Sakal and Dr. Alicia Bianchi, from QMA, and Mr Faisal Al-Naimi of the Department of Antiquities.

## 3. Introduction

An architectural and archaeological survey was conducted at an area of abandoned agriculture in the Nu'aija district of Doha. The site is located about 4km south of the historic core of the town, and this area was formerly one of the most important drinking water sources for town. The site was also used as an agricultural area, and a traditional *zajara* well on the site attests to the way in which the land was irrigated prior to the introduction of mechanical pumps. Other structures on the site consist of a *majlis* built of a mixture of traditional and more modern materials, with an unusual bath attached to it. A second building constructed of concrete blocks may have been a residential unit, and two buildings to the west were used as stables. Other elements of the site relate to its agricultural use, such as wells, tanks and irrigation channels. A surface scatter of artefacts collected across the site include an assemblage of 20th century ceramics as well as several metal artefacts.

The aims of the project were:

- To make a detailed record of architecture and features the Nu'aija site.
- To explore the history and significance of the site as a water supply through archaeological and historical techniques.
- To investigate the practice of traditional agriculture in Qatar.

The survey work was undertaken by a professional team of experienced archaeologists. The project also provided a training element, in which staff from Qatar Museums participated in a short course on building recording techniques.

Traditional local techniques of irrigation agriculture in Qatar are not well known or well recorded, indeed agriculture is frequently assumed not to have existed at all in the country prior to the introduction of diesel pumps (eg. Pike 1979: 80). The well and agricultural complex at Nu'aija, along with the traditional architecture on the site represents an important surviving element of the cities past. The site contains valuable information about the provision of drinking water to the inhabitants of Doha, as well as the practice of agriculture prior to the arrival of diesel pumps in the 1950s.

The traditional *zajara* well recorded on the site is possibly the only surviving example in the country. This type of type of structure would have been essential for irrigating crops prior to the introduction of mechanical pumps. Stone lined wells on the site relate to this early phase of use, while concrete block built tanks are associated with the introduction of mechanical water pumping in the second half of the 20th century. A *majlis* on the site was built in a traditional style, but also incorporated more modern building materials such as concrete blocks. This building probably dates from the mid 20th century and represents a traditional style of architecture, drawing on older construction methods but also incorporating more modern building materials. A domestic building and two stable blocks are possibly contemporary with the *majlis*, and also incorporate traditional building techniques such as their mud covered roofs.

The introduction of mechanical pumps in the mid 20th century, and their use to irrigate larger areas of the site, appears to have had a rapid and detrimental impact on the site. An examination of the hydrology of the area indicates that the aquifer accessible by shallow wells consists of a relatively fragile freshwater lens perched over a saline aquifer. The rapid increase in extraction from the upper freshwater lens that occurred in the mid 20th century resulted in saltwater up-coning from the underlying saline layer as well as saltwater intrusion from the coast. This resulted in the rapid salinization of the freshwater lens, and as a result the abandonment of the site as agriculture was no longer viable.

## 4. Site location

The area investigated during the survey is located in the Nu'aija district of Doha, approximately 4km south of the historic core of the town. Within Nu'aija two areas remain undeveloped, however archaeological features survive only on the larger southern site (ODQ24). Both sites are located directly to the south of the D ring road and to the southwest of the Al-Ahli Sports Club. Both sites are bounded to the west by Musaimeer Street (Figure 1).


**Figure 1: Aerial view of the Nu'aija sites ODQ 24 and ODQ 25 (Image from Google Earth).**

The main site, OOD 24, is centred on Qatar National Grid (QNG) 231835E 388440N. It measures 370m north-south and 320m east-west, covering an area of c. 9.5 hectares. The site consists of an area of abandoned agricultural land, that has been used to dump household and building waste. The ground cover consists of low shrubs, with patches of reeds around some former well locations, several larger trees are located around the edge of the site (Figure 2). The soil was wet and muddy in some areas during the survey work in February 2015, large lower lying areas of the site were covered with a thick saline crust, hinting at the reason for the site's eventual abandonment. The site contains a traditional *zajara* well, several abandoned buildings, stone and concrete brick lined wells, as well as other irrigation features such as tanks, channels and the remains of field systems. The site is partially walled off with an inner concrete block fence and an outer chain-link fence. The site is largely unused, although the northern area of the site is used as an informal parking area as well as for the storage of construction equipment.

**Figure 2: Overview of site ODQ 24.**

A smaller area to the northern, ODQ25 is centred on QN 231780E 388805N and consists of a rectangular are of ground measuring 50m north-south and 50m east-west (Figure 1). The ground cover consists of low shrubs and trees, similar to the area to the south. This site is unfenced and is currently being used as a depot for construction materials (Figure 3).

**Figure 3: Overview of site ODQ 25.**

## 5. Methodology

The initial stage of the fieldwork consisted of a detailed examination of the site to identify all structures and features that needed to be recorded. Each element of the site was individually numbered, photographed and described on standardized recording survey forms. A detailed building survey was conducted on the standing building on the site, consisting of drawn and photographic records, supplemented by a detailed written account. A systematic collection of surface artefacts was undertaken. All recording conformed to English Heritage (2002) guidelines for good recording practice.

*Mapping*

The features identified in the original site walkover were planned using a Leica Viva Differential GPS (DGPS). This survey data supplemented the more detailed annotated hand drawn records, giving a clear plan of the site. Elevation transects were recorded across the site using the DGPS in order to build a topographic model of the site. All data collected was tied to the Qatar National Grid.

*Written account*

Detailed written accounts of the features on the site were completed on standardized recording forms and included the precise location of each building, a summary of the building's form, layout, construction and sequence of development.

*Drawings*

Sets of measured plans and elevations were produced for each building, showing the form and location of structural features such as blocked doors, windows, masonry joints, ceiling beams and changes in floor and ceiling levels, as well as any evidence for fixtures of significance.

*Photography*

The drawn and written records were supplemented by a detailed digital photographic record. This consisted of a general view of all features on the site, giving an overall impression of their size and form. These were complimented by further detailed photographs of individual elements of the structures, the building materials used, evidence of rebuilding and repair, graffiti, or evidence of changes in use or function. In addition 3D digital photography was used to produce a 3D model of several of the structures in the site. The photographic archive is stored in an Adobe Lightroom catalogue, with appropriate metadata attached to each image.

*Surface collection of artefacts*

The site was divided into a number of collection areas, each of which was assigned a unique context number used to identify the finds collected. Limited collection of artefacts was undertaken from the northern area of the site as this area had been disturbed and significant quantities of rubbish dumped here. A methodical survey of each collection area was undertaken, with transects walked at approximately 3m intervals. All artefacts encountered in survey areas were collected, tagged with the appropriate context number, and are currently undergoing specialist analysis.

## 6. Historic Background

The city of Doha was almost entirely reliant on water drawn by hand from numerous wells, including those at Nu’aija, prior to the introduction of desalination technology in the 1950s. While households had private wells with which to conduct everyday cleaning activities, the water from these was brackish and unsuitable for drinking. Drinking water was obtained some distance from the town from several clusters of wells, and brought in by water-carriers (*kandari)*. In the early 20$^{th}$ century wells were located at Msheireb, Ain Walid Sa’id, Muntaza and Nu’aija. By the mid 20$^{th}$ century the main well clusters were said to have been in Msheireb, Muraikh and Nu'aija (Othman 1984: 8).

An 1864 account by Constable and Stiffe refers to “a tower near wells, with a little cultivation” one and a half miles southeast of Doha (Constable & Stiffe 1989: 105). Their map also shows a “tower near wells” about one and a half miles directly south of Doha, however they also note that “water is brought in skins from the desert, some distance from the town”. This reference to a separate and more distant water source is likely to relate to Nu'aija, which is ca. 4km to the south of Doha as it stood in the 1860s.

John Gordon Lorimer, the British Resident in the Persian Gulf, described the wells at Nuaija in 1908 (Lorimer 1908: 491):

> *“Dohah itself possesses only one well of brackish water, named Ain Walad Sa'id, which is ½ a mile to the south of the Dohah quarter, but there is a group of others called Mushairib, with fairly good water, at 1 mile to the west of the Dohah quarter. Three miles further inland is Bir-al-Jadidah, a large masonry well of indifferent water on which the town mainly depends for its supply. A mile beyond to the southwards are the wells of Na’aijah, from which the Shaikhs of the Al Thani, the other notables of Dohah town and the officers of the Turkish garrison obtain their drinking water. The best of the N’aijah wells is called ‘Asailah. The Turkish troops obtain most of their water from Mushairib, where there is a military outpost of 8 men in a tower to watch the wells. The soldiers have now a vegetable garden at this place; and scurvy, which was formerly common among the garrison, has disappeared.”*

Also relevant is early aerial imagery, particularly that of 1947, which shows three major clusters of wells to the south of Doha (there are other clusters at Msheireb and to the southeast of Doha):

1. One is about 0.6 miles (1 km) to the southwest of the old town around the junction of Rawdat Al-Khail and the B Ring Road. A small rectangular structure can be seen nearby in 1947, perhaps either a large well or a tower. This cluster could be Ain Walad Sa’id according to Lorimer’s distances. It may also equate to the wells with the tower according to Constable and Stiffe’s account, due to the rectangular feature and possible traces of walling which may be evidence of former cultivation, though the distances are wrong for this and a clear identification cannot be made.
2. Another cluster is found in the current area of Al Muntazah Park at the junction of Rawdat Al-Khail and the C Ring Road, ca. 1.5 miles south of the edge of the old town. No signs of agriculture or walling can be seen. This seems most likely to be the Bir Al-Jadida well, though no sign of a large masonry well can be seen and Lorimer’s distances would have to be

considered inaccurate: "three miles further inland" would locate Bir Al-Jadida some distance to the south of Nu'aija, which Lorimer then places a mile to the south of the former.

3. A third cluster of wells is found in the area known today as Nu'aija and must equate to Lorimer's wells at "Na'aijah". It is ca. 2.5 miles (4.0 km) south of the traditional limits of Doha, again illustrating the inaccuracy of Lorimer's distances, unless our understanding of the location of Nu'aija has changed radically since the early 20th century AD. The 1947 image reveals a dense cluster of circular wells, inside and outside walled agricultural plots (Figure 4). There is a northern concentration, outside the cultivated area, where more than 40 are visible. Around 8 more large wells can be seen in various former walled agricultural areas to the west, northwest and east of the main cluster, while the group of active agricultural plots contains at least 10 more large wells.

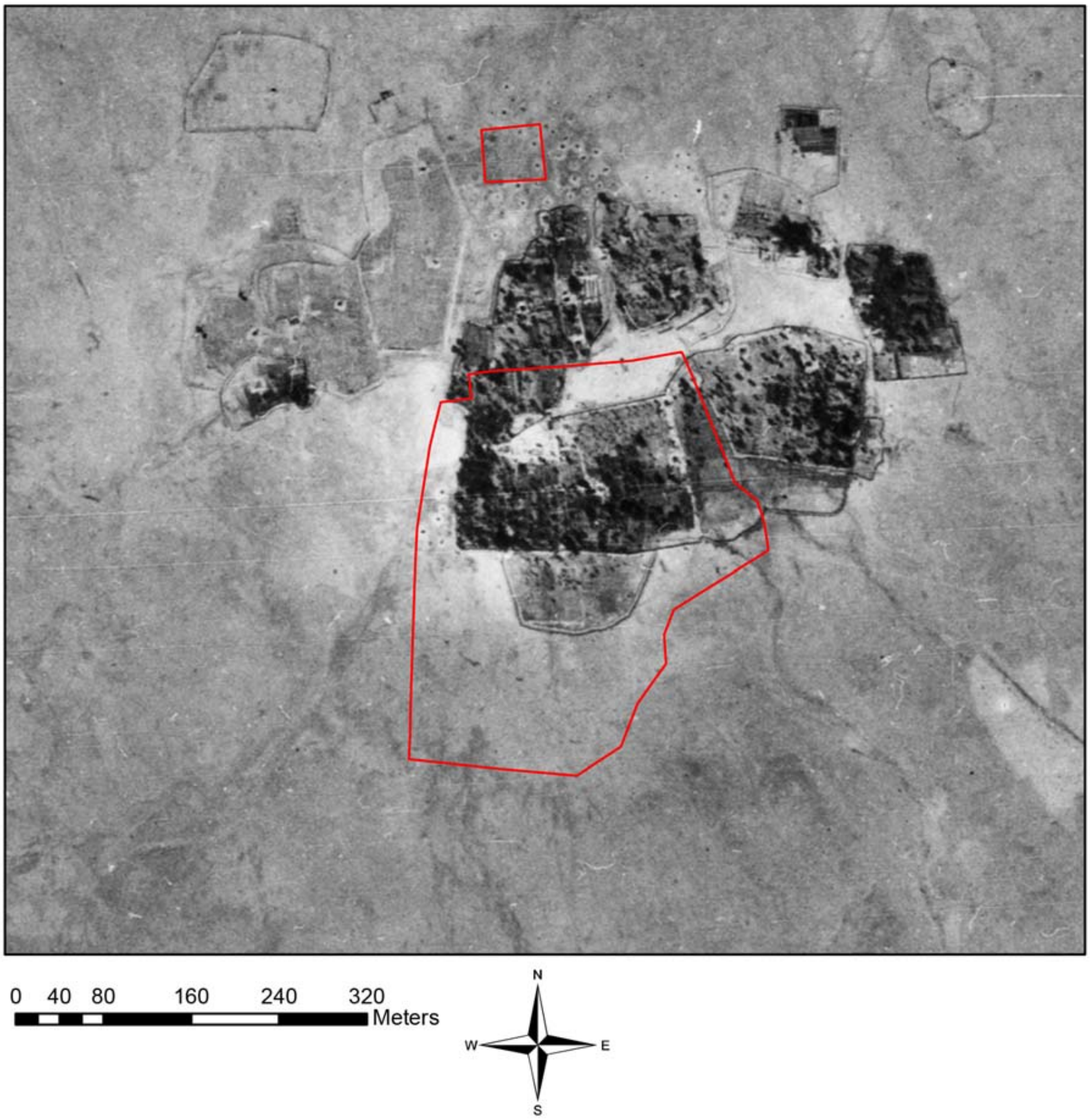


**Figure 4: Nu'aija agricultural area in 1947, with current sight boundaries shown in red.**

From these sources we can conclude that the best water was available from Nu'aija, hence its use by the Al Thani sheikhs, the Turkish officers and other Doha notables. Although it may not have been the most heavily-used public source (which honour goes to Bir Al-Jadida), the presence of numerous wells outside the walls of the cultivated area implies that its water was used by the wider community, or at least water-carriers transported the water into the town. The importance of Nu'aija to the inhabitants of Doha is also highlighted by the fact it is included on several sketch maps of Qatar produced in the 1930s (Tuson 1991: Volume 8, Maps 7-9).

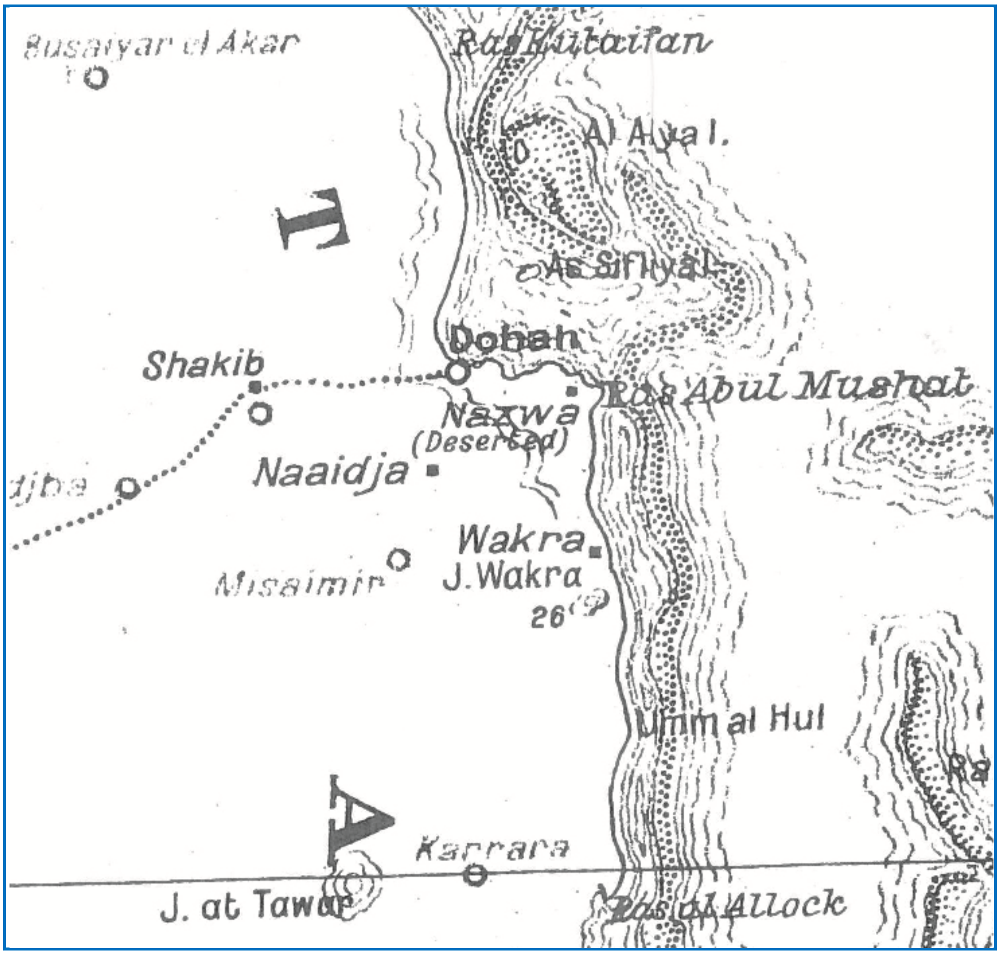


**Figure 5: Detail of a 1933 Map of Bahrain and Qatar, showing Naaidja [Nu'aija] to the south of Doha (Tuson 1991: Volume 8, Map 8).**

## 7. Results

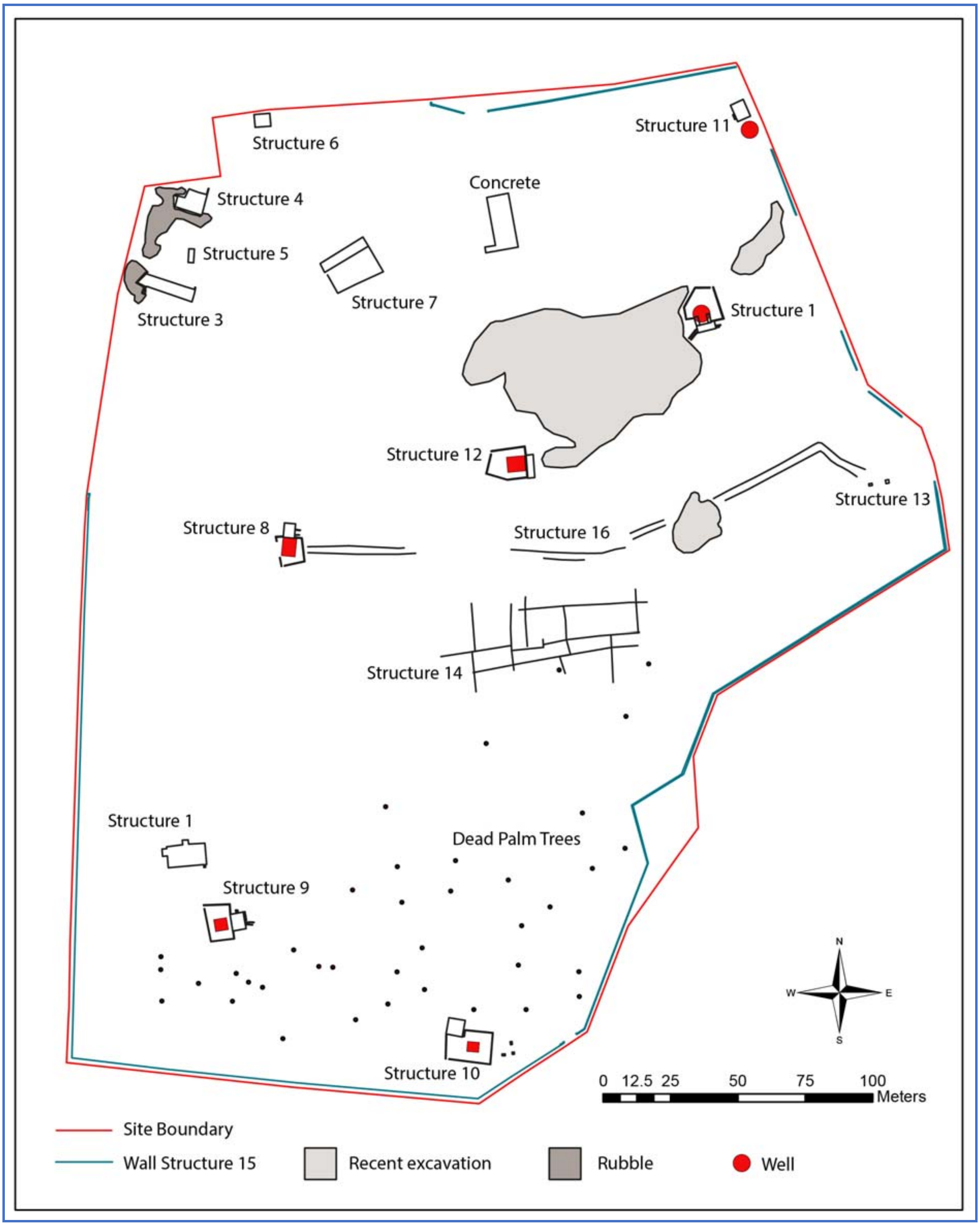


**Figure 6: Site Plan of Nu'aija site ODQ25.**

| | |
|---|---|
| Structure 1 | Traditional Zajara Well |
| Structure 2 | Majlis Building |
| Structure 3 | Stable Building |
| Structure 4 | Stable Building |
| Structure 5 | In-filled Water Trough or Tank |
| Structure 6 | Domestic Structure |
| Structure 7 | Concrete Water Tank |
| Structure 8 | Concrete Water Tank and Well |
| Structure 9 | Concrete Water Tank and Well |
| Structure 10 | Concrete Water Tank and Well |
| Structure 11 | Concrete Water Tank and Well |
| Structure 12 | Concrete Water Tank and Well |
| Structure 13 | Concrete Pump Bases |
| Structure 14 | Field System |
| Structure 15 | External Boundary Wall |
| Structure 16 | Water Channel |

**Table 1 : Summary of the features recorded on the site**

The main features recorded at ODQ 24 are illustrated above in Figure 6, and listed in Table 1. The north eastern are of the site has been recently levelled, and the ground level may have been raised slightly with imported material. This has created a level parking area, which is also used to store construction equipment (Figure 7). A rectangular area of concrete in the northern area of the site may represent the foundation of a temporary building.

**Figure 7: Levelled northern area of the site, with a volleyball court on it.**

Several large areas in the central and northern areas of the site have been excavated my machine to a depth of between 1m and 1.5m below the original ground level. The function of these depression is not clear, but they may have been dug in an attempt to retain rainwater and reverse the rapid salinization of the aquifer that occurred at the site.

The southern half of the site was not under cultivation in 1947 (see Figure 4 above) and was only turned over to agriculture in the second half of the 20th century, presumably after diesel pumped irrigation was introduced. A large number of dead palm trees are visible in this southern area (Figure 6), suggesting a relatively extensive area of palm plantation was established at this time.

## Structure 1 - Traditional *Zajara* Well

Probably the most important structure on the site is a traditional form of well that uses animal traction to lift water from the well, known in the Gulf as z*ajara* (Figure 8). This form of well was common across the Arab world until relatively recently, the distribution and a detailed description of the way in which this type of well operated is discussed in more detail in Chapter 9.

**Figure 8: The *Zajara* well, Structure 1, looking south.**

The well has a superstructure built of unfaced sub-angular limestone and consisting of two stepped elongated pillars or uprights (Figures 8 - 13). This stone superstructure would have supported horizontal wooden beams and a wheel, through which a rope ran to lift water from the well (see Figures 100 and 101). The upper part of the superstructure is covered with a very coarse brown render, the lower section with a smoother and light grey brown render. It is not clear if this relates to a repair to the structure, or if there is in fact a structural difference in the renders. For example the coarser upper render may be harder wearing, whereas the lower render may be more waterproof. Future analysis of samples taken from these renders may shed light on this aspect of the well. Other small patches of render appear to relate to repairs to the well.

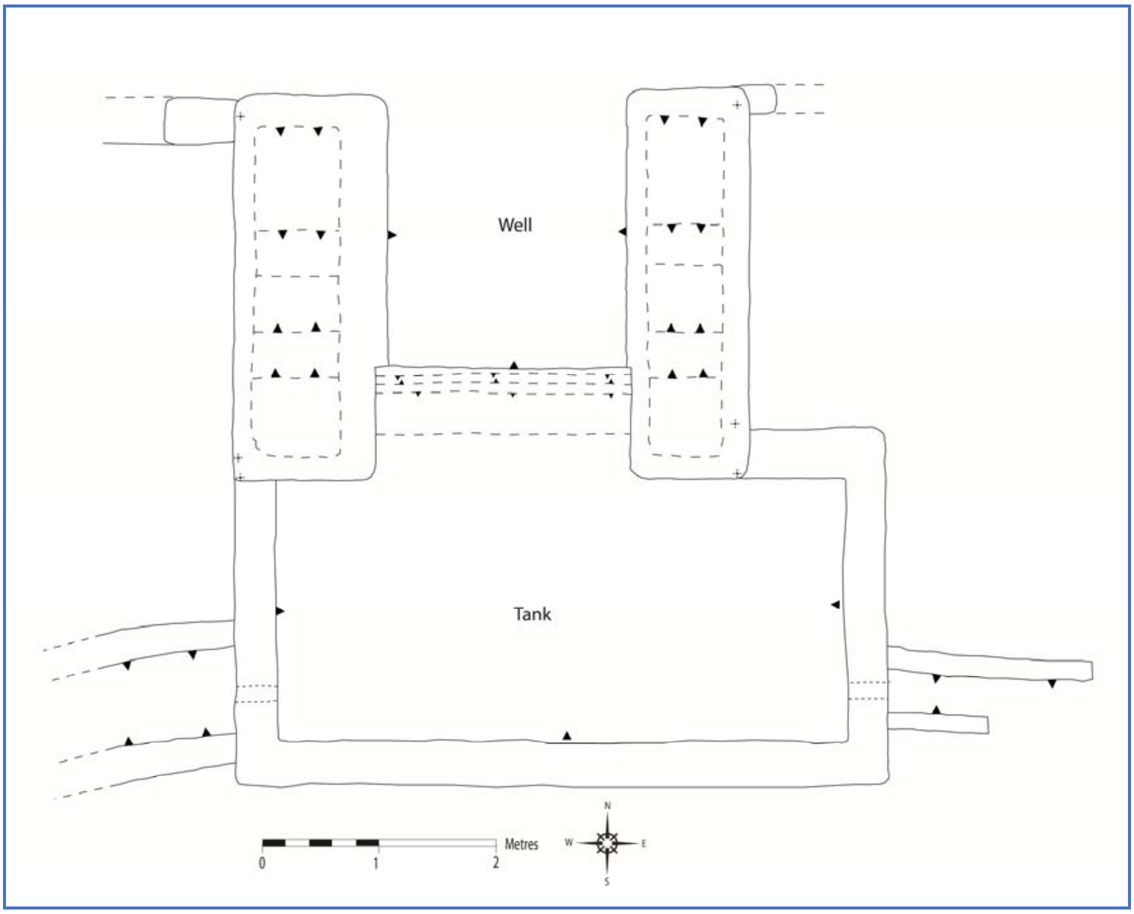


**Figure 9: Plan of well, Structure 1 without the later modern wall shown.**

**Figure 10: Photo of the west facing elevation of the well superstructure.**

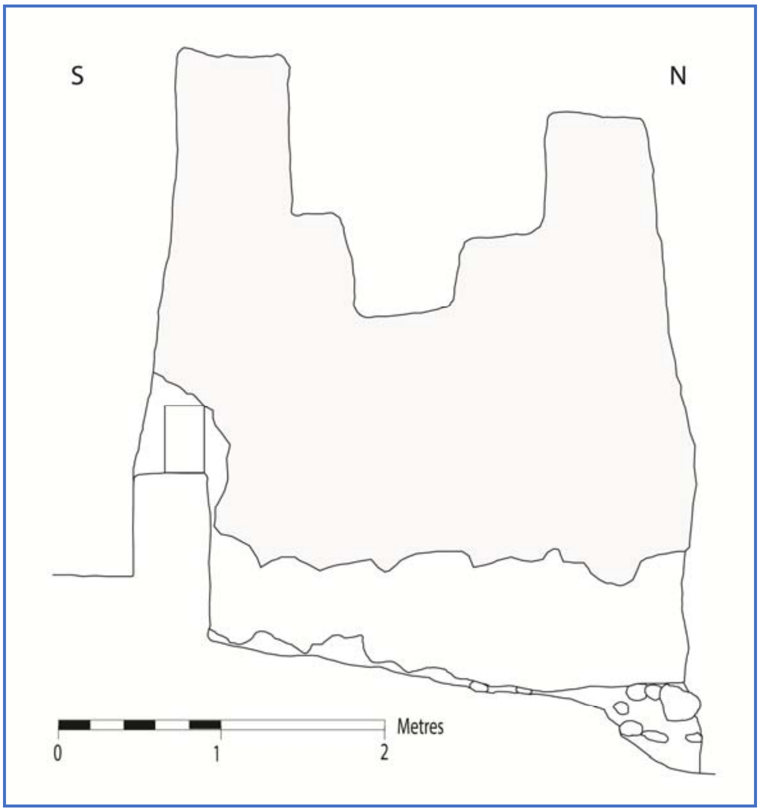


**Figure 11: East facing elevation of the well superstructure.**

**Figure 12: Photo of the east facing elevation of the well superstructure.**

**Figure 13: Construction of the well.**

**Figure 14: The well superstructure, looking northeast.**

The masonry superstructure for the lifting mechanism flank the well itself, which although contains some water is now largely backfilled (Figure 14). The well would probably have originally been rectangular in plan and lined with limestone. Water would have been lifted from the well in a leather bag, and poured into the sloping trough that runs between the two stone uprights (Figure 15). From here the water flowed into a rectangular tank on the southern side of the well (Figure 16). This tank had two phases of construction, the earliest core was built of limestone and covered in a thick brown render. A later phase of building raised the wall height of the tank with the addition of another course of limestone, which was covered with a finer hard grey render.

**Figure 15 : Trough to catch the water at the top of the well.**

**Figure 16: Water trough on the southern side of the well, the earlier phase of the trough is visible in the left foreground.**

Drainage holes in the eastern and western side of the tank fed into channels, built of limestone and a hard brown render (Figure 17). This constructing is similar in appearance to the earlier phase of the tank itself. These channels would have fed the water into a series of small canals, allowing the water to be diverted into the required area of the site to irrigate the crops.

**Figure 17: Channel leading from the water trough into the fields.**

All the other wells on the site that could be examined showed signs of later modification, with concrete block structures being added to facilitate water extraction with diesel pumps. This well does not seem to have been adapted for pumping however, and this is probably why the superstructure of the *Zajara* well survives. It is possible that at least some of the other wells on the site may originally have had similar structure associated with them.

The *Zajara* well has however been enclosed by a modern concrete block wall and chain-link fence, identical to those enclosing Structures 8, 9, 10 and 12. This modern wall also infills the space between the two uprights at the top of the well (Figures 18 and 19). This wall was clearly built after the well had fallen out of use, as the well cannot function with it in place. The modern wall appears to have been built to secure the well, possibly to make the site safer, and reduce the risk of accidentally falling into what originally would have been a fairly deep well.

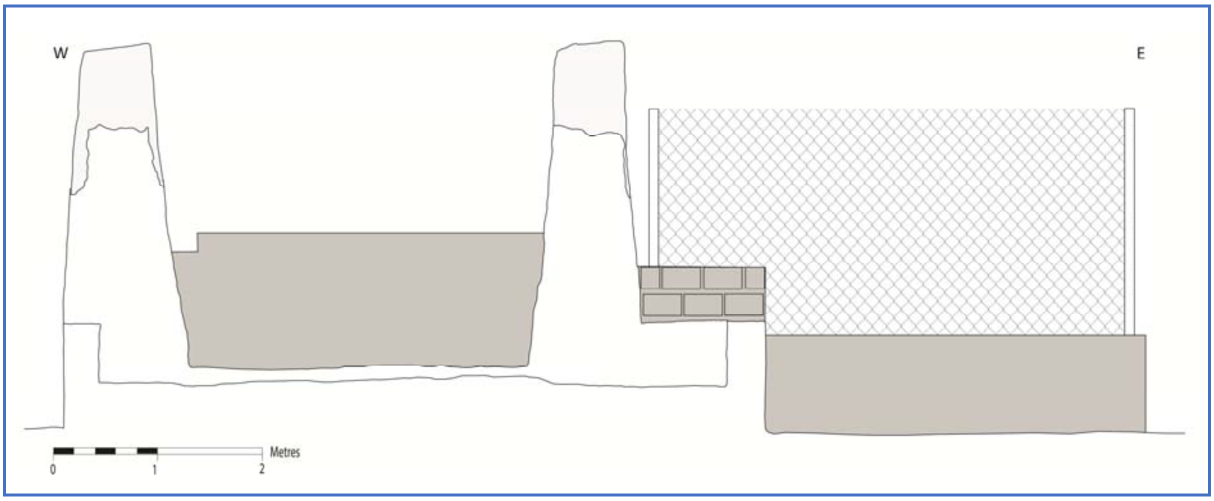


**Figure 18: Elevation of the south facing side of the well superstructure and trough.**

**Figure 19: The well superstructure and water trough, looking north**

## Structure 2 - Majlis Building

Structure 2 is a raised rectangular *majlis* with a open colonnaded veranda (*liwan)* running along its northern side (Figures 20 and 21). The building measures 14.85m by 7.75m in plan, and from the ground stands 4.90m high. The majlis is on a raised plinth, lifting its floors off the ground by 1.20m. Raising the building from the ground, combined with the large low windows in the structure, helps create a cooling breeze in the building. This form of natural cooling is a common feature of traditional architecture in the Gulf, and would have made the building a much more pleasant place to be during the heat of the summer months. Similar examples are known from Qatari houses dating from the 1930s and 1940s (Jaidah and Bourennane 2010). The building is divided into two rooms by an internal partition. The western space (Room 1) would have been a seating area, the smaller eastern space (Room 2) contains an unusual sunken bath. The building has a traditional appearance, and utilises many traditional construction techniques, however it also incorporated more modern building materials such as concrete blocks and square sawn timbers. Along with the bath instillation this suggests the building is a 'transitional' structure built as modern materials, and changes to the traditional way of life, were being introduced in Qatar in the mid 20th century.

**Figure 20: *Majlis* Structure 2 looking southeast.**

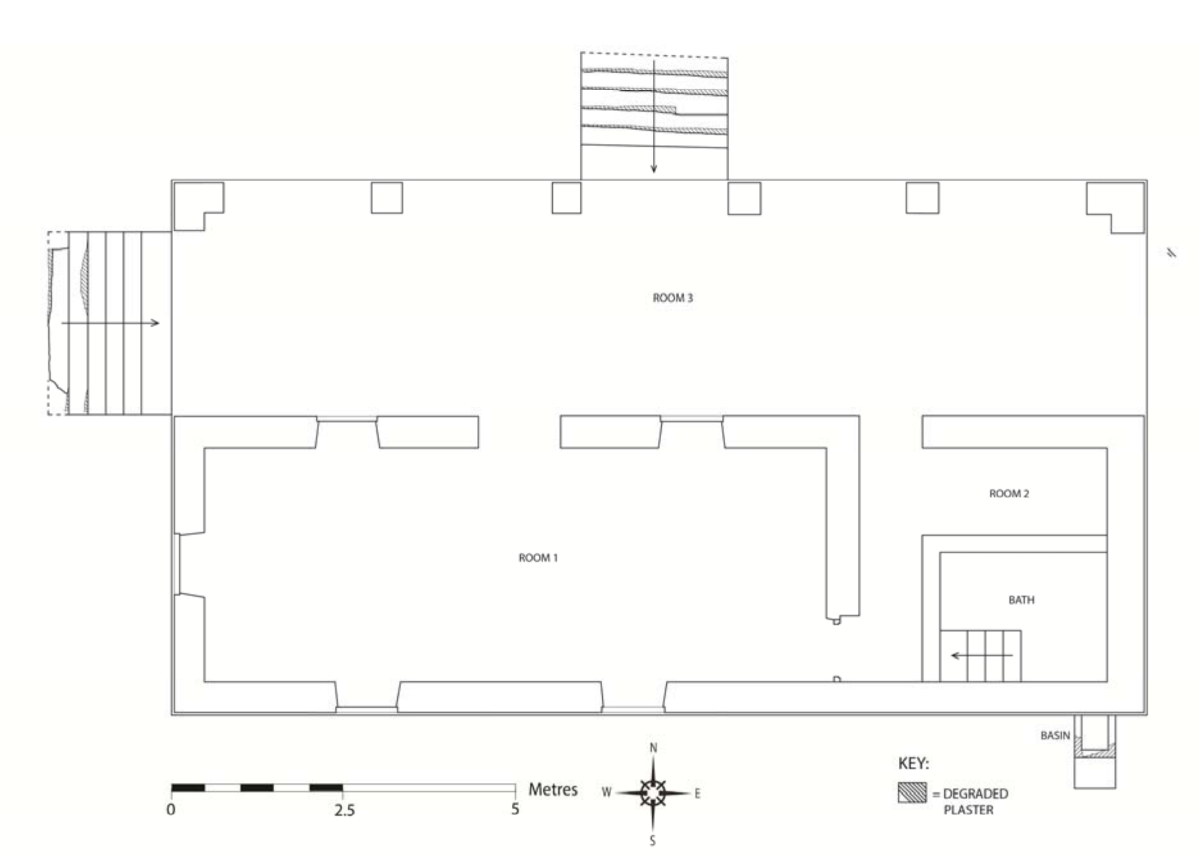


**Figure 21: Plan of the *majlis*, Structure 2.**

The majlis is built of concrete blocks, which contain a large amount of shell temper (Figure 22). These are identical in appearance to the shell tempered concrete blocks used to constructed the boundary wall (Structure 15), stables (Structures 3 and 4) and the large water tanks on the site (Structures 6, 8, 9, 10, 11 and 12). The building is covered in a hard brown render, and where this is missing the exposed concrete blocks are rapidly disintegrating Two sets of stairs give access to the *liwan* from the southern and western side (Figure 23).

**Figure 22: Shelly concrete block construction and external render**

**Figure 23: Stairs on the northern side of the *liwan.***

The *liwan* is constructed with six rectangular pillars along its northern side and utilises a simple horizontal trabeated construction with cross beams linking each pillar (Figures 34 and 36). The *liwan* creates a shaded area in from of the *majlis* as well as acting as a decorative element of the building. The pillars of the *liwan* are undecorated in this building, unlike more elaborated examples decorated with carved mouldings that common in higher status buildings.

A mixture of round *danshal* poles and square cut timber was used to build the *liwan*. Although it incorporates more modern cut timber the *liwan* was constructed in a traditional manner, the cross beams were bound with rope, and secured across the top of the pillars to create a horizontal beam (Figures 24 and 25). The rope binding prevents the mangrove from splitting, and also creates a surface onto which the render could be applied. A similar construction method was employed to create the lintels of doors and windows (Figures 29 - 32).

**Figure 24: Detail of the construction of the colonnade.**

**Figure 25: Detail of the construction of the colonnade.**

The ceilings of traditional Qatari houses afford protection from the elements, but also form an important decorative component to the internal spaces of the building. The flat roof of the majlis was constructed in a traditional manner. The rafters were laid directly on top of the walls and were overlaid with a layer of split bamboo, woven reed, and then a palm mat known as a *manghrour*. Finally, the roof was made watertight with the addition of several layers of well tamped down earth The roof in the *liwan* was made of round danshal beams, which typically would have been imported from East Africa (Figure 26). Inside the building the roof was built using the same method, but square cut timbers were used for the rafters (Figure 27). This suggests that a traditional appearance was required for the more visible external area of the *liwan.* However it appears that the less visible internal area of the house utilised cheaper or more easily available cut timber beams. Wooden water spots funnel rainwater from the roof away from the walls (Figure 28).

**Figure 26: Round *danshal* roof timbers in the external l*iwan area.***

**Figure 27: Square cut roof timbers in the internal space, Room 1.**

**Figure 28: Water spout on the roof of the majlis.**

The windows were located low to the ground, in order to create a breeze through the building. The lintels above the windows consist of round *danshal* poles bound with rope (Figures 29 - 31). Most of the window frames were missing, with only the plaster impressions of them left. Originally the windows would have had a wooden frame, and presumably shutters to keep out the rain and dust.

**Figure 29: Detail of the construction of the windows.**

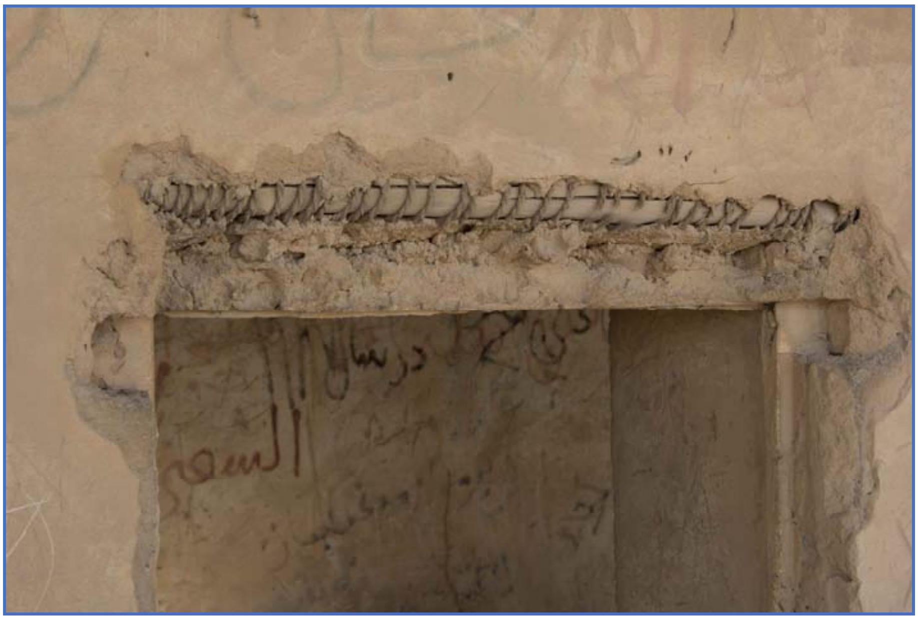

**Figure 30: Detail of the construction of the windows.**

**Figure 31: Window on the south side of the building**

The doorways were constructed in a similar style to the windows, with a lintel consisting of a round beam bound with rope (Figure 32). The doors themselves had been removed, but at least one of the doorways retained its original wooden doorframe and hinges (Figure 33).

**Figure 32: Doorway opening onto the liwan.**

**Figure 33: Detail of a surviving wooden doorframe and hinge.**

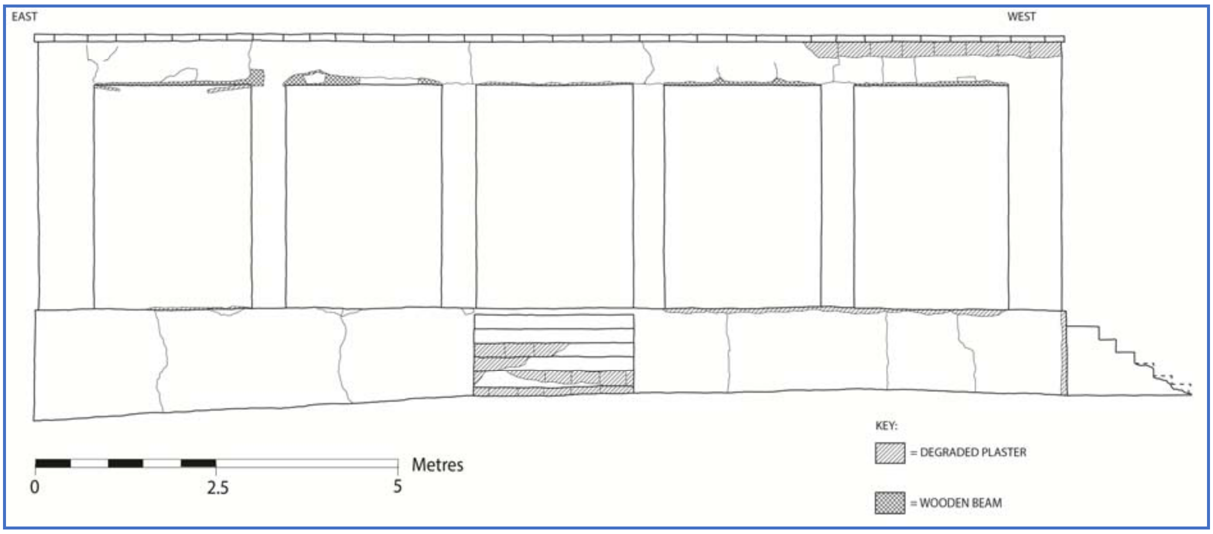


**Figure 34: North facing elevation of *Majlis* Structure 2 (External).**

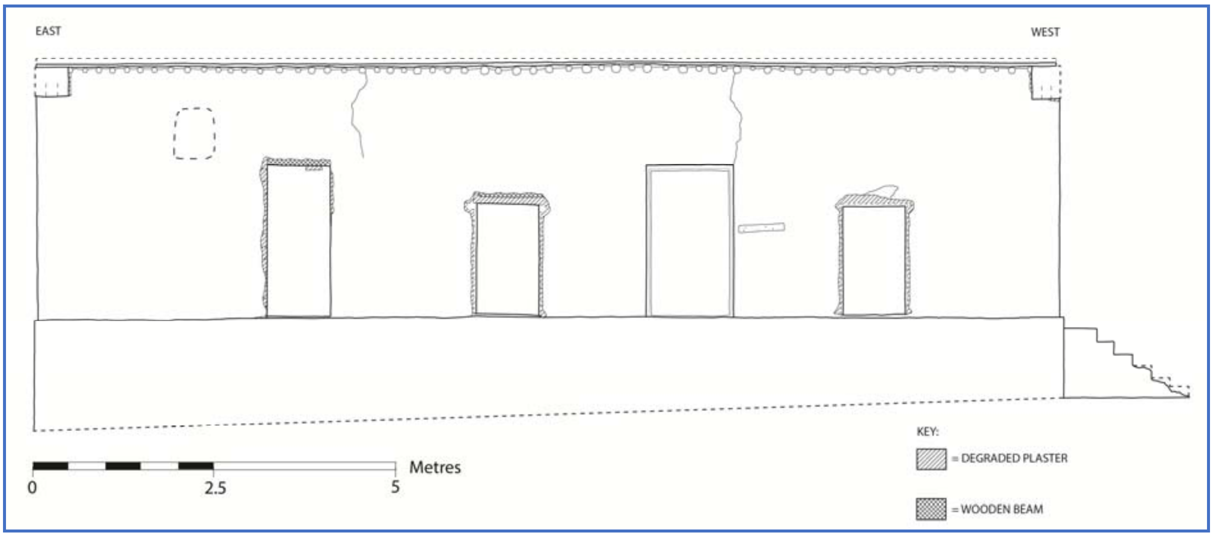


**Figure 35: North facing elevation of *Majlis* Structure 2 (Internal).**

**Figure 36: North facing elevation of *Majlis* Structure 2.**

Room 1 would have been used as a seating area, possibly to entertain guests (Figure 37). None of the original furniture remains, but it would presumably have contained rugs on the floor and low seating arranged around the walls. Room 2 contained a sunken bath, surrounded by a small lip and accessed by four concrete steps on its western side (Figure 38). A raised basin on the external face of the south wall of the building was linked by a pipe to the bath, and pumping water into the basin would therefore have filled the bath inside the building (Figure 39). The bath is not common feature of a *majlis*, and its function remains unclear. It has some similarities with a pair of sunken baths previously excavated in the Radwani House in the Msheireb area of the city (Carter and Eddisford 2013). Both baths are probably of a similar mid 20th century date, and so relate to a period when water was becoming more easily available in larger quantities as pumping and piped water was introduced.

**Figure 37: Internal view of Room 1, the door in the far wall opens into Room 2.**

**Figure 38: The sunken bath in Room 2.**

**Figure 39: External small trough with a pipe feeding through the wall and into the bath in Room 2.**

The building had clearly been abandoned for some time. The inside of the structure had a significant amount of spray painted graffiti in Arabic and English. Graffiti was also carved into the external render of the building in several places. The render was missing from several places on the external area of the building, and had almost entirely collapsed from the underside of colonnade. The roof of the *liwan* was mostly missing, with only the bear crossbeams surviving. The roof of the two internal spaces was intact, but the rafters were very rotten.

## Structure 3 - Stable Building

Structures 3 and 4 are both stable blocks, both are similar in appearance and construction, and both were probably built at the same time. Structure 3 measures 5.00m wide and survives to a length of 21.85m, a large pile of rubble is associated with the partially demolition of the western end of the building. The stable block consists of a single row of seven stalls, however as the western end of the building is partially demolished and it is likely there was originally at least one more stall (Figures 40 - 43).

**Figure 40: Ruth and Tom recording the stable block Structure 3, looking southwest.**

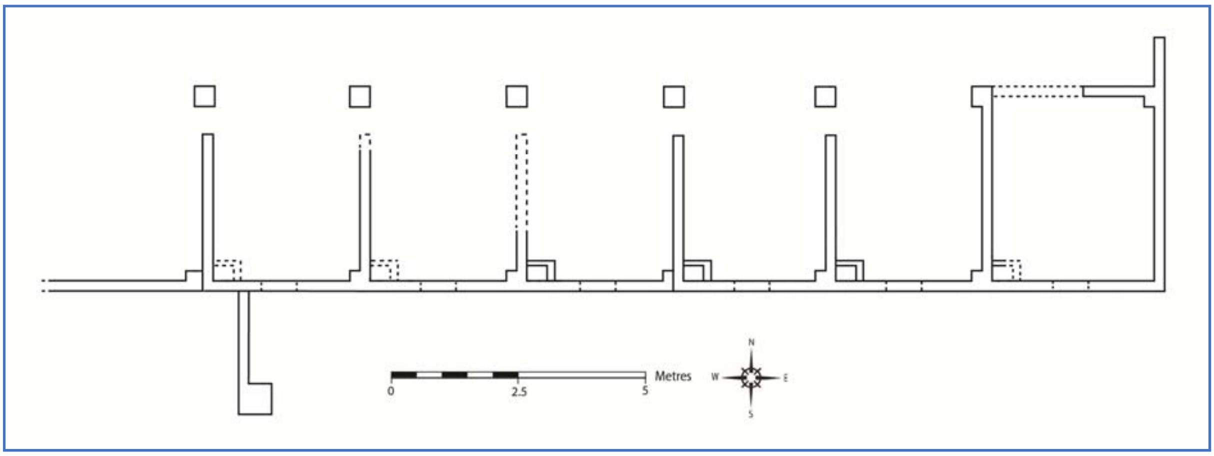


**Figure 41: Sketch plan of stable block Structure 3.**

**Figure 42: Photo of the north facing elevation of Structure 3.**

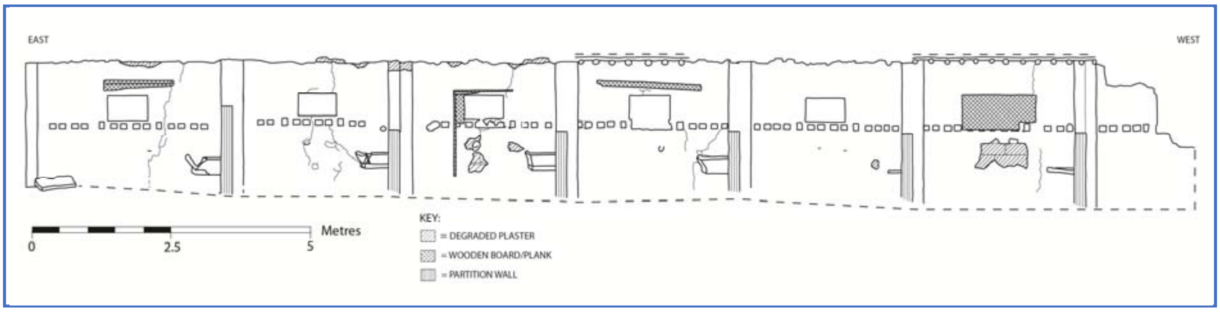


**Figure 43: Elevation drawing of the north facing elevation of Structure 3.**

The building is constructed of shell tempered concrete blocks, similar to those used in a number of other structures on the site, and covered in a hard grey render. Rows of air holes along the eastern and southern wall, as well as in the dividing walls between stables would have let a breeze blow through the structure and helped the horses keep cool during hotter months. A rectangular column of concrete blocks measures 0.60m by 0.60m in plan and stands 3.25m high. Attached to the building in its southwest corner by low wall this feature would presumably have held a water tank, providing gravity fed water to the stable block (Figure 44).

**Figure 44: The south side of Structure 3 and the water tank support, looking northwest**

Each of the stalls measured 3.85m deep, most were 2.90m wide, except for the stall at the eastern end which measured 3.20m wide. This eastern stall had the partially demolished remains of a wall enclosing its northern side (Figure 45). All the other stalls had no such wall, however circular holes in the pillars that formed the northern extent of the building indicate that removable horizontal wooden beams would have been used to keep the horses fenced in when necessary. The stalls were divided from each other by low sloping walls, again except for the larger eastern stall that was divided by a more robust taller wall (Figure 45). Each stall had an open rectangular window in its southern wall, although one of these had been bricked in. Holes in the southern wall of the building allowed further ventilation. A metal ring in the centre of the southern wall of each stall could have been used to tether the horses (Figure 46). Each stall also had a small manager in its southwest corner, used to hold food or water for the horses (Figure 47).

**Figure 45: The slightly larger eastern stall, looking south.**

**Figure 46: A typical stall, looking south.**

**Figure 47: Manger in the southwest corner of a stall.**

**Figure 48: Photo of the west facing elevation of Structure 3.**

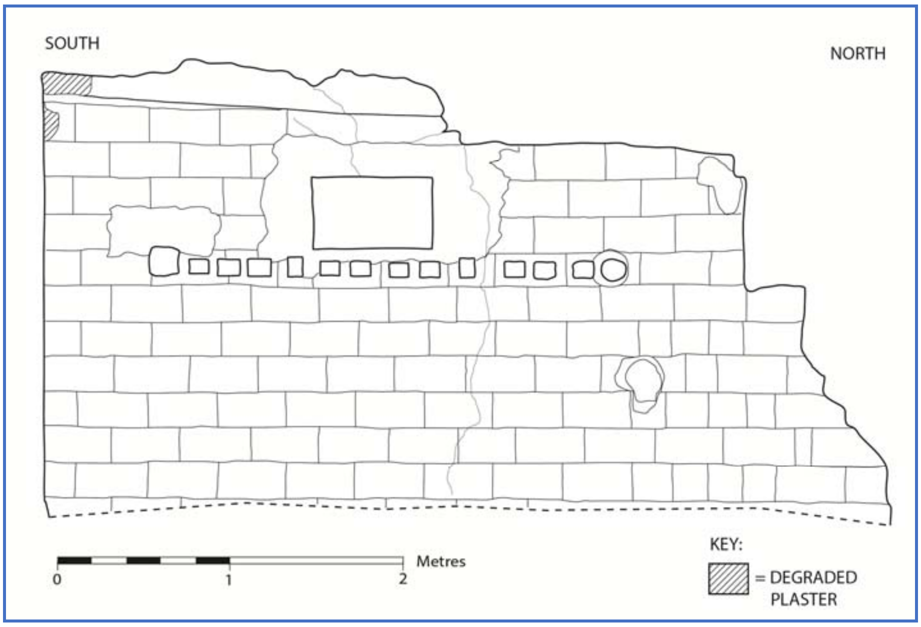


**Figure 49: Elevation drawing of the west facing elevation of Structure 3.**

The stable block was covered with a traditional style roof, consisting of round *danshal* beams laid directly on top of the walls and covered with a layer of split bamboo, and woven reeds or palm fronds. The roof was made watertight with the addition of a 0.10m thick layer of mud Figure 50). Although similar in appearance to the ceiling in the *majlis* building, Structure 1, the roofing style is not as elaborate as was often used in higher status buildings.

**Figure 50: Traditional roofing in Structure 3.**

## Structure 4 - Stable Building

Located directly to the north of Structure 3 a second stable block, Structure 4, has a slightly different layout but shares many features of the other stable (Figures 51 and 52). Both buildings were possibly built at the same time, and both would certainly have been in use at once. Structure 4 measures 10.10m by 10.25m in plan, although the western extent of the building has been demolished. To the west of the building a pile of rubble, similar to one directly to the west of Structure 3, contains demolition material associated with the stables. Structure 4 consists of a double row of stalls, with four stalls visible on each side and probably originally more stalls extending to the west.

**Figure 51: Stable block Structure 4, looking north west.**

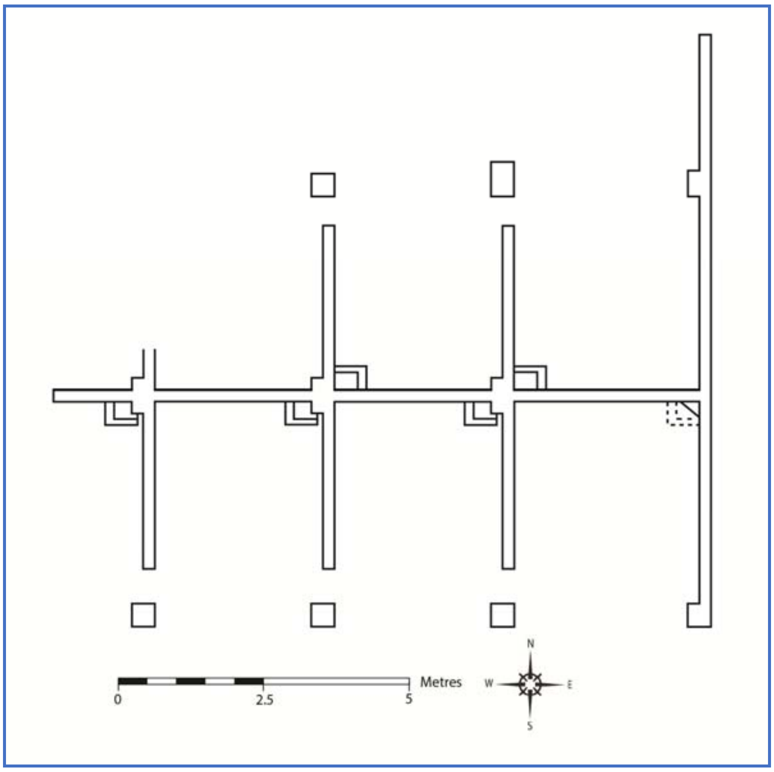


**Figure 52: Sketch plan of stable block Structure 4.**

Structure 4 was again built of shell tempered concrete blocks, covered in places with a hard grey render. Ventilation holes in the end walls provided a breeze. Although of a different configuration the stalls were of a similar size to those in Structure 3, measuring 2.80m - 3.00m wide. The stalls have very similar features with a window at one end and a manger in the corner of each stall (Figure 56). The building was also covered with a traditional roof, built of round danshal beams, split bamboo, reeds or palm fronds and packed mud (Figure 55).

**Figure 53: Photo of the west facing elevation of Structure 4.**

**Figure 54: Stable block Structure 4, looking southwest.**

**Figure 55: Traditional roofing in Structure 4.**

**Figure 56: One of the stalls in Structure 4.**

**Figure 57: Structural beams, resting on a pillar, over the open end of a stall.**

## Structure 5 - In-filled Water Trough or Tank

Located in-between stable buildings Structure 3 and Structure 4 was a rectangular infilled water trough or tank measuring 5.10m x 2.00m and standing 0.85m high (Figure 58). This trough, Structure 5, was built of hollow concrete blocks, tempered with shells and gravel. The trough is covered with a hard grey render. The lowest course of concrete blocks form a slightly wider foundation. Overall the construction of this feature is very similar to the tanks associated with wells Structures 8 - 12, and is likely to have been constructed at a similar point in time. However the elongated shape of this feature, and the fact it is located to a stable block as opposed to a well, suggest it was used to hold water for horses as opposed to being used as part of the irrigation of the agricultural element of the site.

**Figure 58: In-filled water trough, Structure 5, looking northeast.**

## Structure 6 - Domestic Structure

Structure 6 is an east-west aligned rectangular building, measuring 3.80m wide and 18.60m long (Figures 59 and 60). It contains four separate rooms, each accessed through a separate door in the southern side of the building. The building represents a domestic structure, the three western rooms represent bedrooms or living spaces, where as the smaller eastern room appears to have been a kitchen. A rectangular courtyard, located to the south of the building, was enclosed by a tall wooden fence, which survived along part of its eastern extent. This fence would have provided privacy and protection from the wind, creating a courtyard that may have been the focus of many of the household activities. The courtyard is today filled with rubbish, some of this material is clearly associated with the occupation of Structure 6, however much of the material appears to have been dumped in this area from elsewhere.

**Figure 69: Photo of the south facing elevation of Structure 6.**

Structure 2 was built of shell tempered concrete blocks and covered with a traditional style roof, that sloped down from south to north (Figure 61). The building measures is 3.70m high and 3.80m wide, the width being dictated by the length of the *danshal* beams used as rafters (Figures 62 and 63). A thin pale grey render covered the building, helping to protect the relatively soft shell tempered blocks used in the construction.

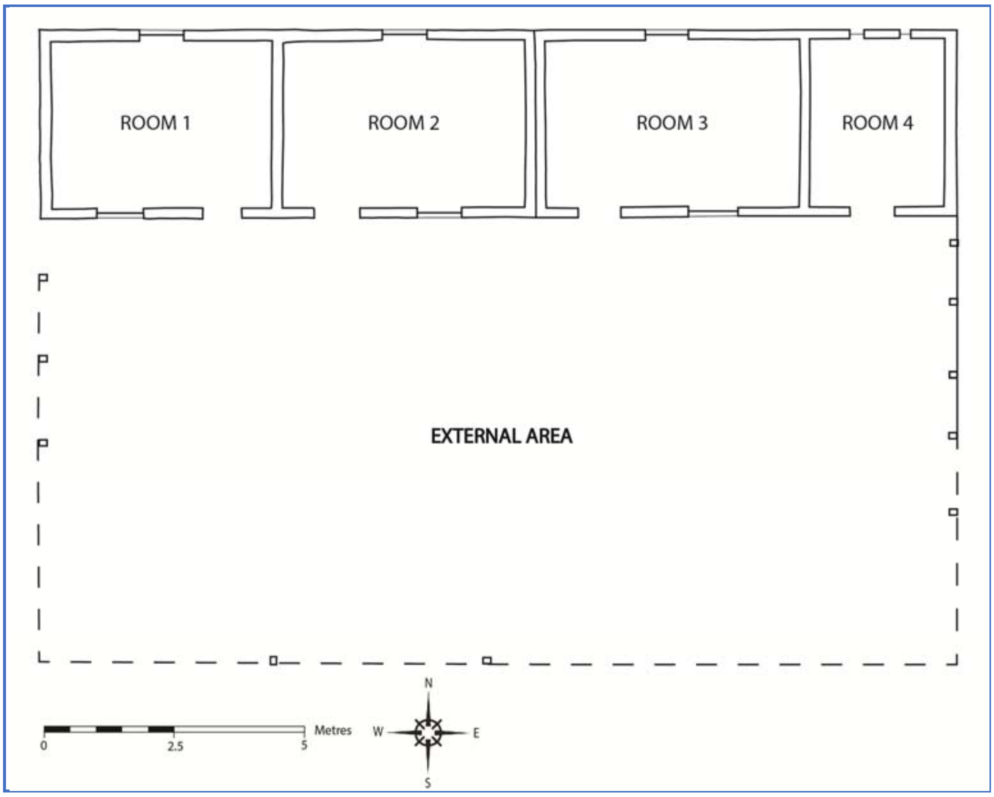


**Figure 60: Sketch plan of Structure 6.**

**Figure 61: Photo of the west facing elevation of Structure 6.**

**Figure 62: Ceiling and roofing timbers inside Structure 6.**

**Figure 63: *Danshal* roof timbers extending beyond the north wall.**

Structure 6 was covered with a traditional style roof, consisting of round *danshal* beams overlaid with split bamboo, palm matting and a thick layer of packed mud (Figure 62). The windows and doors both had lintels made from large square machine cut timber (Figures 64 and 65). The windows were set fairly low in the wall and had metal external bars and an internal wooden shutter (Figure 64). Fragments of glass in the wooden window frame indicate the windows were originally glazed. Wooden door frames contained simple softwood doors (Figure 65).

**Figure 64: Window in the north wall of Structure 6.**

**Figure 65: Door in the south wall of Structure 6.**

Rooms 1 and 2 are roughly the same size, measuring c.4.5m across. Room 3 was larger, measuring 5.20m across and Room 4 significantly smaller, measuring only 2.70m across. Room 1 contained a metal bed frame and Room 2 contained a sofa. Rooms 1, 2 and 3 all appear to have been used as bedrooms or living spaces, all now also contain significant amounts of dumped rubbish. Room 4, at the eastern end of the building, has two circular air vents in the northern wall and was probably used as a kitchen (Figure 66).

A courtyard area to the south of Structure 6 was enclosed by a tall wooden and corrugated iron fence, surviving at its eastern side (Figure 67). This open area would have probably been the focus of much of the activity in the summer months and may have contained an outdoor kitchen area. Roughly built tables were located at the eastern and western ends of the courtyard. A great deal of modern rubbish has been dumped in the courtyard area (Figure 69).

**Figure 66: Ventilation holes in the kitchen, Room 4.**

**Figure 67: Structure 6 and part of the surviving wooden fence enclosing the courtyard, looking west.**

## Structure 7 - Concrete Water Tank

Located against the northern boundary of the site Structure 7 consists of a raised rectangular water tank measuring 5.90m x 4.80m and standing 1.45m high (Figures 68 - 69). The tank was built of hollow shell rich concrete blocks, covered with a hard grey render. The lowest course of concrete blocks form a slightly wider foundation. The base of the tank was elevated above ground level by about 0.70m, which would have allowed any water contained to flow down into the surrounding agricultural area. The appearance and construction of this feature is very similar to the tanks associated with wells Structures 8 - 12. The tank is likely to have been associated originally with a now infilled well close by.

**Figure 68: Concrete tank, Structure 7, looking northeast.**

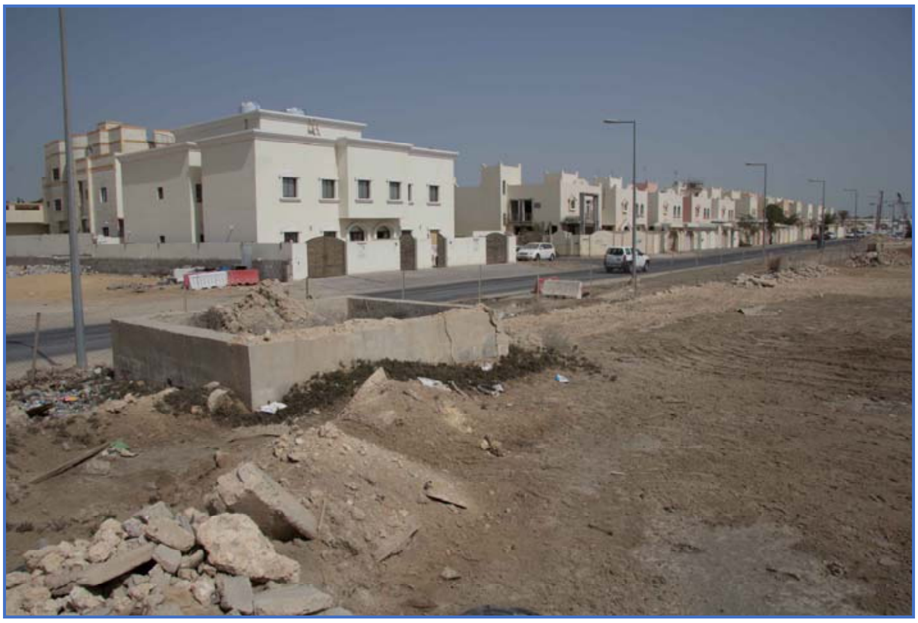

**Figure 69: Concrete tank, Structure 7, looking northeast.**

## Structure 8 - Concrete Water Tank and Well

Structure 8 consists of a partially infilled well with a raised water tank located on its northern side. The well is enclosed by a later modern concrete enclosure and chain-link fence, with an entrance in the southwest corner; this wall is partially collapsed in places (Figure 70). This feature is very similar in appearance, use, and life history to Structures 9, 10 and 12.

**Figure 70: Well, enclosed my modern wall, and raised tank to the right (Structure 8).**

The earliest visible element of the well appears to be parts of a stone lined box well, visible where parts of the later structure have collapsed (Figure 71). Any other elements of this early phase of use have been removed.

A later phase of use is associated with a rectangular raised tank and alterations to the well itself, all built in shelly concrete block (Figures 71 and 72). The alterations to the well appear to have enlarged it and possibly created a pump setting at the southern side of the well. On the northern side of the well a rectangular raised tank was added, measuring 5.40m north-south and 4.05m east-west (Figure 72). The shelly concrete blocks suggest a construction date in the mid 20th century. At this time diesel pumps were first introduced, and the existing wells were adapted for them. Water would have been pumped from the well into a raised tank, located directly to the north. This tank is raised off the ground by 0.50m, allowing the water to flow first into a small brick tank to the east, and then down into a raised concrete brick lined channel. From this channel the water could have been diverted through smaller channels to the areas of the site requiring irrigation.

**Figure 71: Partially infilled well, Structure 8. Note older stone lining to well visible in places.**

**Figure 72: Raised tank located on north side of well Structure 8.**

The latest phase of construction consists of a wall and associated chain-link fence that enclose the well (Figure 73). The concrete blocks used in this wall are of higher quality and contain gravel temper as opposed to shell. Although partially collapsed this wall is probably a relatively recent addition, possibly added after the well had fallen out of use.

**Figure 73: Partially collapsed modern wall and fence around well, Structure 8.**

## Structure 9 - Concrete Water Tank and Well

Structure 9 consists of an overgrown well with a raised water tank, accessed by steps, on its eastern side. The well is enclosed by a later wall and chain-link fence (Figure 74). This feature is very similar in appearance, use, and life history to Structures 8, 10 and 12.

**Figure 74: Steps leading up to the raised water tank with enclosed well behind, looking west.**

The well associated with Structure 9 was heavily overgrown, making a detailed examination impossible. A raised tank on the eastern side of the well measured 6.30m north-south and 5.10m east-west and was 0.70m deep. The base of the tank was raised off the ground by 0.80m and it was accessed by a set of steps in the north east corner. The tank was built of shell tempered concrete blocks and covered in a thin grey render. Metal pipes drained the water from the tank into three separate brick edged raised water channels on the north, east and west sides (Figure 75). These poorly preserved channels would have fed the water into the surrounding fields to irrigate the area.

**Figure 75: Channel leading from the east side of the raised tank of Structure 9.**

A wall and chain-link fence enclosed the well, harder built of gravel tempered concrete blocks. This fence was a later addition to well, and abutted the earlier raised water tank described above. The enclosure wall had a gate in its northwest corner, and was partially collapsed in the southwest corner (Figure 76)

**Figure 76: Partially collapsed wall, enclosing overgrown well, Structure 9, looking north.**

## Structure 10 - Concrete Water Tank and Well

Structure 10 also consists of an overgrown well with a raised water tank, accessed by steps, on its eastern side. Three concrete bases, located directly to the east of Structure 10 supported pumping equipment, with one pump still in-situ. The well is again enclosed by a later wall and chain-link fence.

**Figure 77: Overgrown well with raised tank to the right, Structure 10 looking southwest.**

The well was so overgrown with pampas grass was not possible to examine it, however as this plant thrives in wet conditions it seems likely the well continues to contain at least some water. The water tank, located to the north of the well, measured 6.30m north-south and 6.20m east-west (Figure 78). The base of the tank was raised off the ground by 1.70m, the extra height presumably required as it was located in a low lying area of the site. The tank was built of shell tempered concrete blocks, identical to those used to build the other similar tanks on the site. A Drain in the northern side of the tank fed into a very poorly preserved raised channel, running north towards the main agricultural area. The tank was accessed by a set of steps located on the southeastern side of the feature.

**Figure 78: Internal view of raised tank associated with Structure 10**

Located to the east of the well three rectangular concrete bases were associated with pumping water from the well. Two of the bases still had equipment in place (Figure 79). The southern base contained a pipe setting, that possibly act as a regulator valve. The northern base supported an English made pump or possibly a pump engine Figure 80).

**Figure 79: Pump setting in foreground with enclosed overgrown well behind, Structure 10, looking west.**

**Figure 80: In-situ pump associated with Structure 10.**

The pump still retains its makers plaque, it is partially corroded and hard to make out, but appears to read:

**JOHN ROBSON (SHIPLEY) LTD.**
**SHIPLEY YORKS, ENGLAND**
**ENGINE No 65432 TYPE RB**
**BRITISH STANDARD RATING**
**BHP 11'3 RPM 900 / 1100**
**OVERLOAD RATING**
**BHP 14 RPM 1100**

A second plaque details the importer's name in Arabic and in English:

**Agents in Qatar**
**Abdulrehmen Bin Abdullah Obaiden**
**Fakhroo and Sons**

The business records of John Robson are held at West Yorkshire Archive Service in Bradford (Reference: 19D91) and include the companies correspondence, sale notes and contracts for sale. The company was trading until 1he 1980s, and an examination of these records may shed light on when and how the pumps were exported to Qatar.

The overgrown well is enclosed by a later gravel tempered concrete block wall and chain-link fence. This enclosure is accessed by a gate in the southwest corner and abuts the earlier raised tank.

## Structure 11 - Concrete Water Tank and Well

Structure 11 is a raised rectangular water tank, measuring 6.70m north south by 5.3-m east-west and accessed by a set of steps on its western side (figure 81). The tank is again constructed of shell tempered concrete blocks and is raised off the current ground level by only about 50mm. A drain in the southwest corner would have lead into the irrigation channels of the farm, these do not survive in this area of the site and it is likely the ground level has been raised here. No evidence of pump settings are visible, again possibly these were buried as the ground level was raised or are buried under the rubbish and building debris that are dumped around, and within, the tank

**Figure 81: Overview of tank Structure 11, looking northeast. Shrubs on the right are growing in the partially infilled well**

Directly to the south of the tank a partially infilled and heavily overgrown well measures 7.00m in diameter and is roughly circular in plan. No associated lining of structural elements of the well are visible, but it seems likely the well was originally rectangular in plan, and similar to the other wells visible on the site, prior to being infilled.

## Structure 12 - Concrete Water Tank and Well

Structure 12 consists of a well with a shallow rectangular tank on its eastern side and an concrete block and chain-link fence enclosing it (Figure 82). The earliest element of Structure 12 consists of the remains of a stone lined rectangular box well, similar to one associated with Structure 8, visible in the eastern side of the well (Figure 83).

**Figure 82: Water tank in foreground and enclosed well behind, Structure 12, looking southwest.**

**Figure 83: Earlier stone well lining, below later concrete additions associated with Structure 12, looking east.**

The earlier stone lined well has been altered and expanded to the west (Figure 84). The modifications to the well are constructed of shell tempered concrete blocks, and include a level area n the western side of the well which probably housed a pump. A rectangular tank measured 8.60m north-south and 2.60m east-west and was 0.50m deep (Figure 84). A drain in northern side of the tank would have allowed water to flow into the surrounding irrigation system. A later gravel tempered concrete block wall and chain-link fence enclosed the well and was built directly on top of the earlier tank (Figure 83).

**Figure 84: Concrete block lined well, associated with Structure 12, looking southeast.**

**Figure 85: Water tank with enclosed well behind, Structure 12, looking southwest.**

## Structure 13 - Concrete Pump Bases

Two rectangular concrete bases were recorded, each with metal fixings to secure machinery. They measured 1.20m by 0.80m and 1.20m by 1.30m respectively and stood a maximum of 0.15m above ground level (Figure 86). Two discarded diesel pumps lay beside one of the bases (Figures 87 and 88), and would certainly have originally been housed on these features, similar to those recorded in-situ adjacent to well and tank Structure 10.

No well or tank was visible in this part of the site, unlike with the other pumps and pump settings seen on the site. It is possible there was originally a well in this area and it has since been filled in. It is also possible there was a bore hole drilled at this location, although again no evidence of this was recorded. It is also worth nothing that a stone canal, Structure 16, that crossed the centre of the site on an east-west orientation appears to have originated near these pumps. This may suggest that the pumps may have been associated with pumping water into this channel.

**Figure 86: Pump bases Structure 13, with discarded pumps visible behind, looking southeast.**

**Figure 87: Pump base Structure 13, with discarded pumps to the left, looking south.**

**Figure 88: Discarded pumps associated with Structure 13.**

## Structure 14 - Field System

The remains of a field system, visible in the centre of the site, consists of a series of low mounds of soil enclosing small rectangular fields (Figure 89). Water channels would have fed into these plots, allowing them to be irrigated. Glazed ceramic pipes visible within some of the raised field boundaries (Figure 90) are probably a later addition allowing the water flow to be managed more easily.

**Figure 89: One of the low banks defining the edge of a field.**

**Figure 90: A ceramic pipe, visible within a low banks defining the edge of a field.**

## Structure 15 - External Boundary Wall

The earliest visible boundary wall for the site was built of shell rich concrete blocks on a single foundation course of unfaced limestone. The wall was 1.80 m high and enclosed much of the site. In several places the addition of later gateways had truncated the wall. The wall was missing from the northwest corner of the site, here it would have originally extended beyond the current boundaries of the site, indicating the site was once larger than its current extent.

The wall was constructed of hollow shell rich concrete blocks measuring 400mm x 200mm x 200m, bonded with a hard grey render, and capped with a concrete lintel. The wall was 200mm wide, consisting of a single row of bricks with 400mm x 400mm brick uprights every c. 7.5m.

The building material and construction suggest the boundary wall is contemporary with many of the irrigation tanks on the site. The wall may be associated with a more intensive use the site following the introduction of diesel pumps. As the land was presumably more valuable due to better irrigation it may have been felt necessary to protect, or stake a more visible claim to the site by enclosing it with a relatively substantial wall. This presumably would have occurred within a process of changes in land ownership, in which access to resources shifted from communal or tribal control to control by an increasingly powerful if nascent state apparatus dominated by a few elite groups.

**Figure 91: External wall, Structure 15.**

## Structure 16 - Water Channel

Structure 16 consisted of a water channel or canal built of unfaced limestone and running across the centre of the site on an east-west orientation. This feature survived as a low mound, in sides of which the edges of the stone lined channel were visible. This feature is located at the southern extent of the area of agriculture visible on the 1947 aerial photograph of the site (Figure 4). It is therefore possible that this raised canal would have fed into the agricultural area to the north, prior to the site being enlarged in the second half of the 20th century.

**Figure 92: Stone edged irrigation channel Structure 16, looking west.**

**Figure 93: Stone edged irrigation channel Structure 16, looking east.**

**Figure 94: Stone edged irrigation channel Structure 16, looking east.**

## Surface Collection of Artefacts

A walkover survey of the site was conducted as part of the survey, and each area of the site that was examined was assigned a separate context number (Figure 95). Contexts 17 - 20 were focused on the surviving fields and agricultural area in the southern half of the site. As extensive disturbance and dumping had occurred in the northern half of the site limited surface survey was undertaken here. Context 21 was focused on the traditional well, Structure 1. Context 22 was focused on collecting artefacts from around Structure 6.

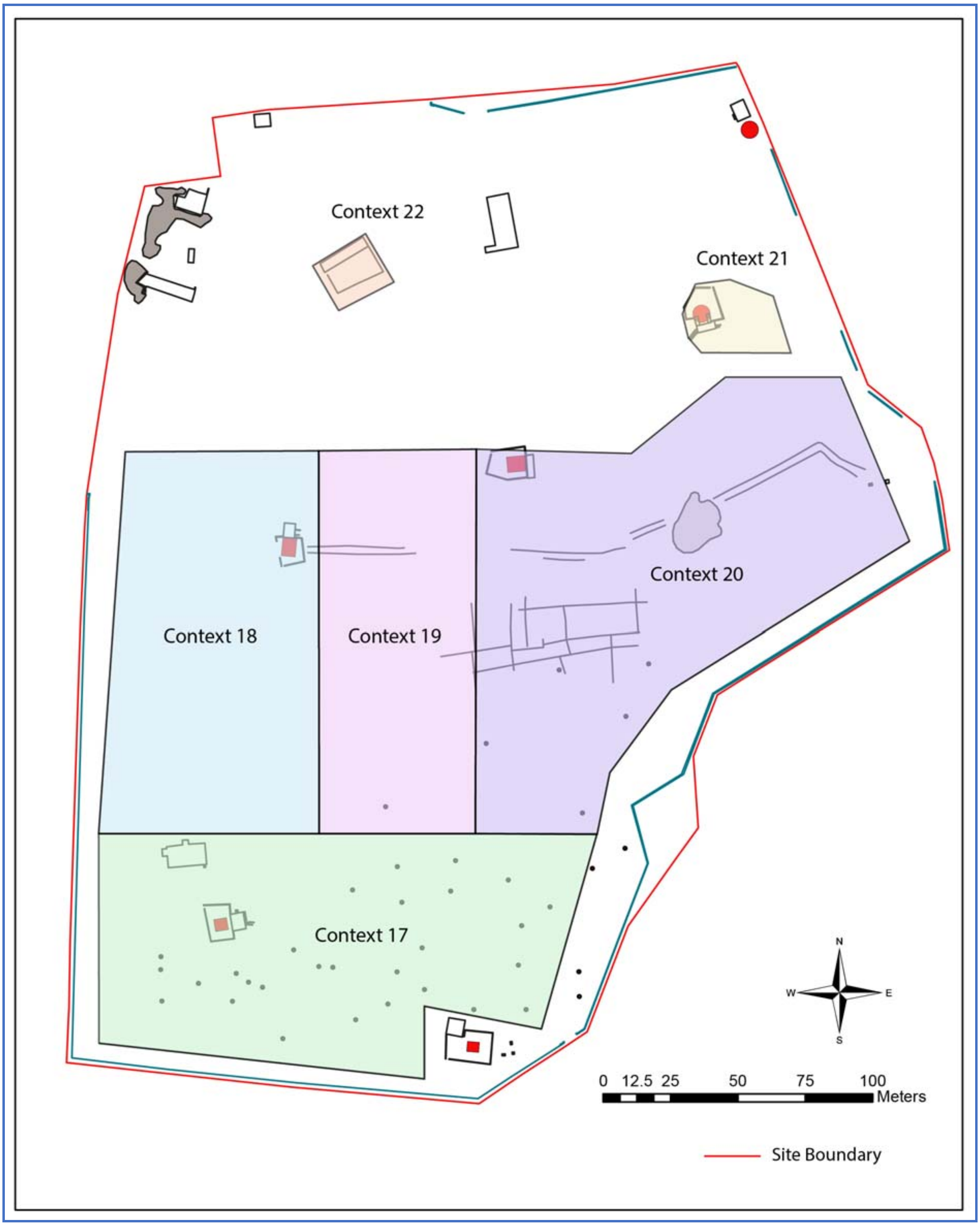


**Figure 95: Location of the surface collection areas.**

The artefacts collected during the walkover survey include a range of mid 20th century ceramics sherds, bullet cases, and several metal artefacts. The artefacts collected are summarised in Table 2 below. The assemblage is currently undergoing specialist analysis.

| Context | Pot | Glass | Cu. alloy | Metal | Plastic | Alabaster | Flint | Small Finds |
|---|---|---|---|---|---|---|---|---|
| 17 | Y | Y | Y | Y | Y | — | — | SF4 - Coin with hole; SF5 - Coin with hole |
| 18 | Y | Y | Y | — | — | — | — | SF1 - Cu. Button (?); SF2 - Decorative Cu. Pin; SF3 - Cu. Small plate |
| 19 | Y | Y | Y | — | Y | Y | Y | SF6 - coin |
| 20 | Y | — | Y | — | — | — | — | |
| 21 | Y | — | — | — | — | — | — | SF 7 - Cu. Object |
| 22 | Y | Y | — | — | — | — | — | |

**Table 2: Artefacts collected from the surface of the site.**

## Site ODQ 25

The smaller undeveloped area of Nu'aija, ODQ25, is located about c. 100m to the north of the larger area described above (see Figure 1). Early aerial photography of the area suggests this site was located in an unwalled area of wells, probably representing wells that were less restricted and therefore a location where the water-carriers or ordinary citizens of Doha drew their drinking water (Figure 2).

The site is currently in use as a storage area for building materials, it is also very overgrown, making access to the site difficult. No evidence of archaeological features were observed on the site. Any wells that once existed here appear to have been backfilled. Although at least one small hole was observed, measuring c. 0.50m in diameter, this was as likely to be a recent disturbance as an older feature.

No evidence of structures were visible on the site, and it is likely that the more public wells in this area of Nu'aija were less substantial than those at the enclosed agricultural areas. No buildings were present in this area. It seems likely that any more ephemeral features such, as field boundaries or tracks, would have been buried under the large amounts of material dumped on the eastern side of the site or disturbed by modern activity in this area.

## 8. Hydrology, Agriculture and Water Use in Qatar

Qatar's has experienced an arid to hyper-arid climate from the end of end of the monsoonal mid Holocene Climatic Optimum in the 6th millennium BC. From this period the low lying Qatar peninsula would have lacked perennial surface water, making human life reliant on hand dug wells in order to access groundwater from a shallow freshwater aquifer (Macumber 2011). Average annual rainfall in Qatar is low, highly variable and unpredictable, averaging only 82mm a year between 1990 and 2008 (Tables 3 an 4). The low level of annual rainfall means rain fed agriculture is not viable in Qatar, while a lack of perennial surface water makes *falaj* type irrigation that is common elsewhere in Arabia impossible. Rainfall in Qatar normally occurs in winter months, resulting from winter westerly winds, and during storm events recharges into the Tertiary limestone aquifer system.

| Year | Annual Rainfall in mm |
|---|---|
| 1990 | 34 |
| 1991 | 54 |
| 1992 | 117 |
| 1993 | 109 |
| 1994 | 44 |
| 1995 | 277 |
| 1996 | 124 |
| 1997 | 203 |
| 1998 | 57 |
| 1999 | 57 |
| 2000 | 76 |
| 2001 | 5 |
| 2002 | 39 |
| 2003 | 70 |
| 2004 | 42 |
| 2005 | 53 |
| 2006 | 128 |
| 2007 | 37 |
| 2008 | 34 |
| | |
| Average | 82 |

**Table 3: Annual rainfall in (northern?) Qatar for the period 1990 - 2008 (Darwish and Mohtar 2013: 3; Fig.2)**

| Year | Mean Depth of Rainfall | | |
|---|---|---|---|
| | North | South | Total Qatar |
| 1971/72 | 49.9 | 27.4 | 37.0 |
| 1972/73 | 17.8 | 18.6 | 18.2 |
| 1973/74 | 42.9 | 54.9 | 49.9 |
| 1974/75 | 58.4 | 63.6 | 61.4 |
| 1975/76 | 132.4 | 113.5 | 121.3 |
| 1976/77 | 114.1 | 75.0 | 91.7 |
| 1977/78 | 32.8 | 52.2 | 31.2 |
| 1978/79 | 59.5 | 46.3 | 51.9 |
| 1979/80 | 68.5 | 68.2 | 64.7 |

**Table 4: Annual rainfall in northern and southern Qatar for the period 1971 - 2080 (Lloyd et al 1987: 245; Fig 2)**

Pike (1979: 71) provides a useful summery of the underlying geology of the Qatar peninsula. "The geological succession in Qatar is composed of Tertiary limestones and dolomites with interbedded clays, marls and shales covered in places by a series of Quaternary and Recent superficial deposits. The oldest strata exposed are the limestones and dolomites of the Rus formation of lower Eocene age, containing beds of gypsum and anhydrite that have been subjected to considerable sub-surface erosion by solution and the subsequent development of depressions on the surface. The most widespread outcrop are the dolomites and crystalling chalky limestones of the Upper Dammam formation of middle Eocene age. The Tertiary succession is mainly of marine origin but a change to continental conditions during the Upper Miocene-Lower Pliocene led to the widespread deposition of gravels, sands and conglomerates, brought down by erosion of the Arabian pre-Cambrian shield. The Quaternary superficial deposits include pseudo-oolitic and conglomeratic limestones, beach gravels calcareous sands of marine origin, continental gravels, silts and muds, and aeolian sands and sabkhah deposits of marine origin."

This geological sequence is summarised below in Table 5.

| **Age** | **Formation** | **Thickness range (m)** | **Lithology** |
|---|---|---|---|
| Pleistocene-Holocene | - | 0-20 | Sand dunes, beach deposits, sabkha deposits |
| Miocene | Hofuf | 0-10 | Residual gravels |
| Miocene | Dam | 0-30 | Marls, chalks and limestones |
| Eocene | Dammam | 0-75 | Chalky and dolomitic limestones and marls |
| Eocene | Rus | 10-120 | Chalky limestones, anhydrites, marls and shales |
| Palaeocene | Umm er Rhaduma | 270-370 | Limestones and dolomites with silicious and marly zones; basal shales |
| Upper Cretaceous | Aruma | - | Dolomites and shales |

**Table 5: Summary of the geological succession of the Qatar penninsula.**

Hydrogeological conditions in Qatar are dominated by dissolution induced permeability in the upper part of the Umm er Rhaduma Formation and the Rus Formation. Throughout the Qatar peninsula groundwater occurs as a freshwater lens overlying saline water in both these strata (Figure 96). The situation is somewhat complicated in northern Qatar as a carbonate facies at the interface of the Rus Formation and the Umm er Radhuma Formation forms a hydraulic continuity between these two formations, creating a single complex aquifer system (Lloyd et al. 1987). The freshest groundwater occurs in the north of Qatar, associated with the carbonate facies of the Rus Formation, in the area of the country which experiences greater rainfall (Macumber 2009).

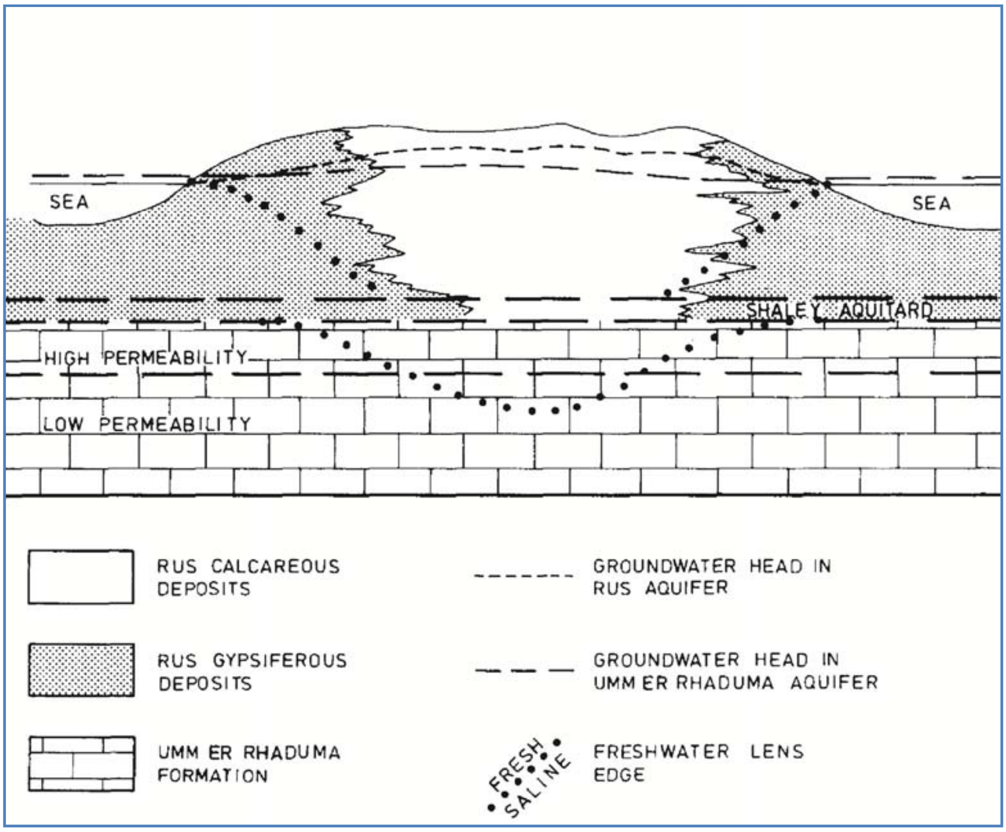


**Figure 96: Reconstructed cross section of the hydrological conditions in the Qatar peninsular.**

As well as creating permeability in the major aquifers of Qatar gypsum dissolution has also created the large shallow depressions that are seen across the peninsula and range in size from a few metres across up to 60 ha in size. These depressions collect the sparse rainfall that the peninsula experiences, and are a major factor in creating recharge for the underlying aquifers. In addition these depressions collect what little soil that develop, creating the best locations for agriculture. In Qatar these relatively soil rich areas are referred to as *rawdah* (Lloyd et al. 1987).

Currently 75% of water extracted from the aquifers below Qatar is used for agriculture. Today all the water is drawn from the deeper and more substantial aquifer associated with the Umm er Rhaduma formation. There are two main basins of groundwater in Qatar: the Northern Groundwater Basin (NGW) and Southern Groundwater Basin (SGW). There are in addition three secondary basins Abu Samra, Doha, and the Aruma deep Groundwater Basins. However the Doha basin is of very recent origin, being formed from excess irrigation, leaking water pipes, rainfall run off and leaking septic tanks from the greater Doha area (Amer et al 2008). Today the NGW basin is the most important groundwater source, covering about 19% of the total land area, and located at 10–40m below ground. The SGW Basin extends to about half of the land and water levels are mostly at least 30m below the surface. The Aruma aquifer in southwest Qatar is composed of approximately 130 meters of granular limestone belonging to the Aruma Formation, although containing relatively good quality water this is obtained at depths of 450–650m from the surface (Darwish and Mohatar 2013).

Before the introduction of drilled bore holes and pumped water agriculture in Qatar would have been reliant on the shallower aquifer associated with the Rus formation. Fresh water was obtained from this aquifer from hand dug wells, concentrated close to the coast, where the freshwater table is shallowest. In northern Qatar settlement was concentrated on an Eemian terrace at between 3 and 6 m above sea level, where water was most easily accessed and better-quality soils formed over more permeable marine sediments (Macumber 2011). The precise hydrology of the Doha area needs more detailed examination, including what impact the Wadi Sail has on the localised accessibility of water (Figure 98). However, it seems likely a broadly similar pattern may have existed in Doha, although the available water resources may have been more limited in comparison to those in the north of the peninsula.


**Figure 98: Wadi Sail in flood in the 1970s, prior to the wadi being managed with dams above Doha this was a relatively common occurrence in the winter months.**

Until the late 1950s a state of equilibrium existed, in which inflow into the aquifers of Qatar was balanced by outflow, including the water extracted via wells. From the end of the 1950s there was a very rapid increase in abstraction (Table 6), that quickly outstripped the rate of inflow into the aquifer, resulting in a drop in the water table across the country (Lloyd et al 1987).

| Year | No. of active farms | No. of working wells | Total abstraction for agricultural use (MCM) | Total abstraction (MCM) |
|---|---|---|---|---|
| 1959/60 | N.A. | N.A. | 3.0 | 4.0 |
| 1964/65 | N.A. | N.A. | 22.0 | 23.2 |
| 1969/70 | N.A. | N.A. | 36.0 | 38.0 |
| 1975/76 | 259 | 660 | 51.2 | 56.5 |
| 1979/80 | 337 | 806 | 67.0 | 68.5 |
| 1990/91 | 780 | 2496 | 142.5 | 145.0 |
| 1995/96 | 899 | 2769 | 234.4 | 237.0 |
| 2000/01 | 908 | 3340 | 234.6 | 236.9 |
| 2003/04 | 909 | 2981 | 218.4 | 220.8 |

**Table 6: Groundwater withdrawal from the northern and southern basins (Amer 2008, 30, Fig.3.1)**

Large scale extraction of fresh water from the aquifer with diesel pumps had a dramatic effect on the water table, and the groundwater level beneath central northern Qatar had fallen by up to 7m by 1980. As the fresh water level falls the seawater-fresh water interface rises under the Ghyben-Herzberg principle, meaning a fall in groundwater level of 1 m causes a rise in the fresh water-saltwater interface of 40 m (Macumber 2011). This would cause significant up-coning of the underlying saline water at borehole locations. Combined with an associated intrusion of seawater into the coastal aquifers this could rapidly lead to the salinization of the freshwater lens, and was responsible for large scale abandonment of coastal settlements in the north of Qatar in the 1960s and 1970s (Macumber 2009). The smaller and less robust upper fresh water lens would have been presumably been particularly susceptible to this process of salinization, especially in the south of Qatar where rainfall is more limited.

**Figure 99: Modern electric pumps extracting water from the lower freshwater aquifer in Rayyan in 2013. The fields are still irrigate using small canals in a traditional manner.**

This process of large scale fresh water extraction is still an issue for the Qatar today. "The average annual groundwater recharge from rainfall is estimated internally at 55.9 $Mm^3$/y. In addition, there is an inflow of groundwater from Saudi Arabia estimated at 2.2 $Mm^3$/y, making the average total renewable groundwater resources 58.1$Mm^3$/y for the period 1972–2005. Extraction of groundwater from both the NGW and SGW basins was about 220.2 $Mm^3$ in 2004–2005. This resulted in water abstraction rate several times the natural groundwater recharge rate. Continued overexploitation of the fossil groundwater reserves threatens to endanger the remaining reserves from saltwater intrusion, while overuse of groundwater for agriculture has resulted in soil salinization and desertification" (Darwish and Mohatar 2013, 3-4).

## 9. Traditional *Zajara* wells

The traditional *zajara* well recorded at Nu'aija is of some considerable importance as it represents possibly the only surviving example of this type of well in the country. Little is known of the traditional forms of agriculture in Qatar prior to the introduction of modern irrigation techniques. However, the *zajara* form of animal powered water lifting well was probably a common feature of traditional agriculture in a country with no ground water and limited rainfall. This kind of traditional well is known from elsewhere in eastern Arabia and many other parts of the Middle East. The construction varies, reflecting the materials available locally, as does the draft animals used to power the mechanism.

More elaborate channel or *falaj* type irrigation methods receive considerable more attention in the published literature, however simpler methods utilising human or animal traction would have been an important element of agriculture in the arid regions of the Arab world from at least the Bronze Age. Although none of these wells have ever been formally recorded in Qatar an undated photograph of an unidentified example in Qatar show an identical structure to one recorded at Nu'aija (Figure 100). This well appears to have has two separate water lifting mechanisms, powered by donkeys.

**Figure 100: A traditional *Zajara* well in operation in Qatar, probably in the early 20th century.**

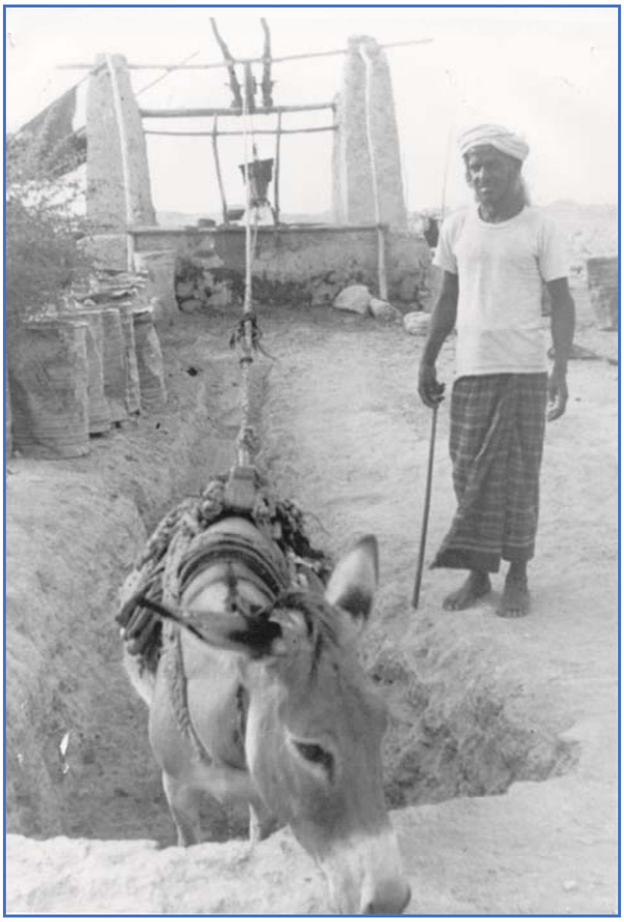

**Figure 101: A traditional *Zajara* well in operation in Qatar, probably in the early 20th century.**

Paulo Costa (1991: 246-48) provides a informative summary of how a traditional *Zajara* well operated, based on his based on field work conducted in 1982 at Tawi Sa'id, on the Batinah coast of Oman.

> "A well may have one or more wooden wheels (*manjūr*) on which the rope is pulled to lift the water. The well mouth, round or rectangular in section, is normally unlined, except for the last two or three metres near the top. The method of construction of the well depends however on the nature of the soil in which the well is sunk; the rectangular section is normally used for wells with two or more wheels. The well can have heavy upright posts connected by a wooden scaffold. The structure can be partly or totally replaced by masonry. The height of the scaffolding is determined by two factors:
>
> 1) the necessary space for ropes and bags with extended *kanān*, between the *manjūr* and the well mouth
>
> 2) the required level of the discharge basin/s to create enough water-head in relation to the levels of the distributary system.
>
> In some instances a large tree may also be used to support the wheel axle; in the studied case the axle was set on two wooden posts (*māhajlīn*) supported by two beams (*qāsiya*) of which the lower one was supported by tree branches. Normally the wheel runs on an

axle (*jabha*) attached to the scaffold or set on masonry pillars. The wheel is formed by a turned wooden hub from which radiate two rows of spokes. Boards mortised two-three inches from the spoke ends and tied to them by strips of leather or coconut fibre ropes form the circumference of the pulley on which the main rope runs into the well. The well end of the main rope (*karr*) is attached by a special knob (*qurba*) to a wooden cross with arms of uneven length from which a large leather bag (*dalw*) is suspended). The bag which has a reinforced border (*dafīr*) has a capacity of 10 to 40 litres and runs into a narrow spout in the shape of a long sleeve (*kanān*) to which an auxiliary rope (*rasa*) is attached. The man holds the two ropes by means of a wooden handle (*ma'laqa*). The bag has a weight in the form of a stone (*mīzān al-dalw*) attached at the end of the short arms of the cross, opposite the spout.

**Figure 102: Detail of the leather bucket used to lift water.**

A draft animal is attached to the end of both ropes by means of a breast harness or wooden yoke (*luīlj*) supported by a soft harness (*ĝabt*) if the animal is a humped bull. A runway (*habb*) beginning at the well head descends at an angle of about 20˚. The animal is secured by a short rope ending with a ring (*hazzāma*) to a long rope running along the runway, close to the ground (zīj)"

*Description of the Operation*

When the animal walks up the runway the bag is let into the well; the auxiliary rope being a little shorter that the main rope lifts the spout up and holds it shut while the bag falls into the well. Both ropes run over a guide roller (*dawwāra*) which rotate on two wooden blocks (*rabiyyāt*). While the bag fills with water the man lifts the animal's yoke and turns it round the animal's neck in a position against the bull's hump. He then drives the animal down the slope, thus lifting the full bag from the well. When the bag has reached the surface the auxiliary rope drives the spout over a shallow plastered basin (*gamīla*) in front of the well and the bag empties itself into it. To avoid splashes and consequent loss of water the basin is covered by branches of date clusters, dried shrubs or branches of a tree called *sidr*. At the end of the basin there is either a wooden beam (*tab'*) or a second roller to guide the ropes. From the basin the water runs into a water tank (most common *lajīl* but also *jābiya* or *birka*) or directly through a network of channels (*sāqiya*) to the plots to be irrigated. While the bag empties the animal is allowed to eat a little hay or grass placed at the end of the runway. The man turns the yoke 90˚ round the animal's neck and guides the bull up the slope. Since the weight of the falling bag and ropes would draw the harness over the animal's head, the man takes over a small harness that runs from his shoulder (or waist) to the rope end. Leaning back the man walks up with the animal to the well head where they turn round again while the bag fills for the next turn. To keep count of the hauled bags, at each descent the man places a small pebble into a cavity next to the manger, at the end of the runway. Depending on the well's depth a day work may produce 2 to 3 hundred bags of water (for an average capacity of 25 litres this means a total of about 25 to 30 thousand litres a day)."

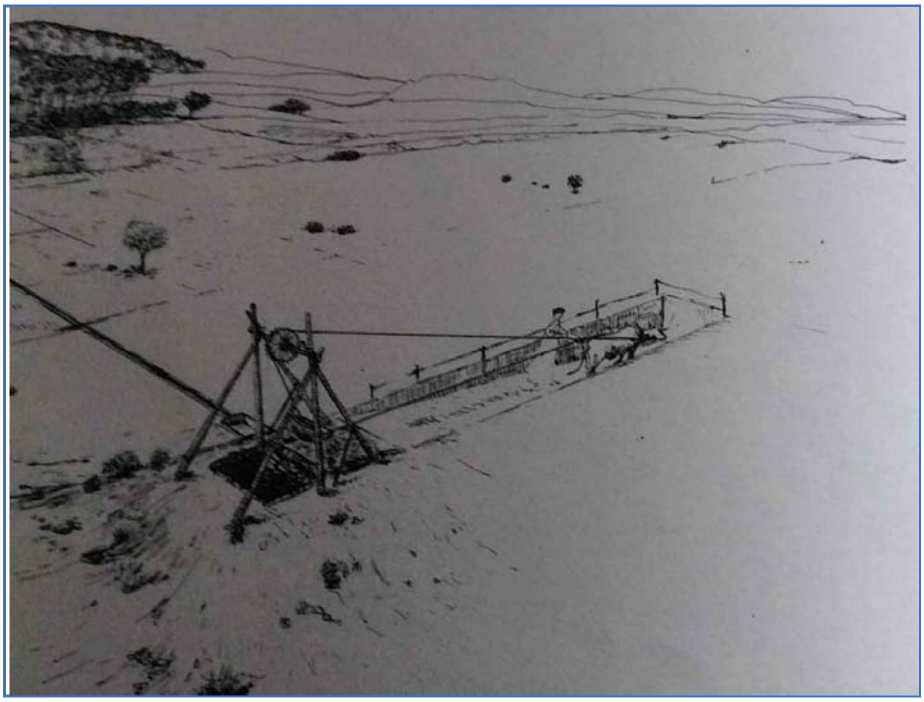

**Figure 103: An illustration of a wooden *Zajara* well in use on the coastal Batinah plain in Oman (Costa and Wilkinson 1987, 40, Fig. 6)**

An earlier account by Julius Euting describes a similar well, referred to as a *Samah* well, at the outskirts of the town of Ha'il in the northern Nejd in 1883 (Ward 1983: 528).

> "Situated on the south side of the city, the *Samah* well is quite a compact system. It consists of :
> l) the actual well, with a shaft 25 m deep and 4 m in diameter in the granite rock, up which the water is drawn in leather buckets; 2) a 35-metre long walled walkway along which two camels pass backwards and forwards pulling up and letting down the leather buckets over the wooden pulleys; 3) a long narrow building, with a room on the first floor, from which one can look over the well, the adjoining garden, and the square beyond the wall. At one end, stairs lead up to a slender tower. All these three sections are secured by doors."

**Figure 104: A wooden framed *Zajara* well on Batinah plain in Oman in 2015.**

Wooden examples of *zajara* wells survive on the Batinah plain of Oman (Figure 104), as well stone built examples in the interior. I stone built well, similar to the one at Nu'aija, was visited by the author near Nizwa in Oman in 2015. Ragette (2003: 66) illustrates a donkey powered *Zajara* well in M'zab (Ghardaïa Province, Algeria) that is also very similar to the one recorded at Nu'aija (Figure 105). Other similar types of well include an example utilising oxen in central Iran (Figure 106) and a simple well used to lift water with a camel in Turkmenistan in 1870 (Figure 107).

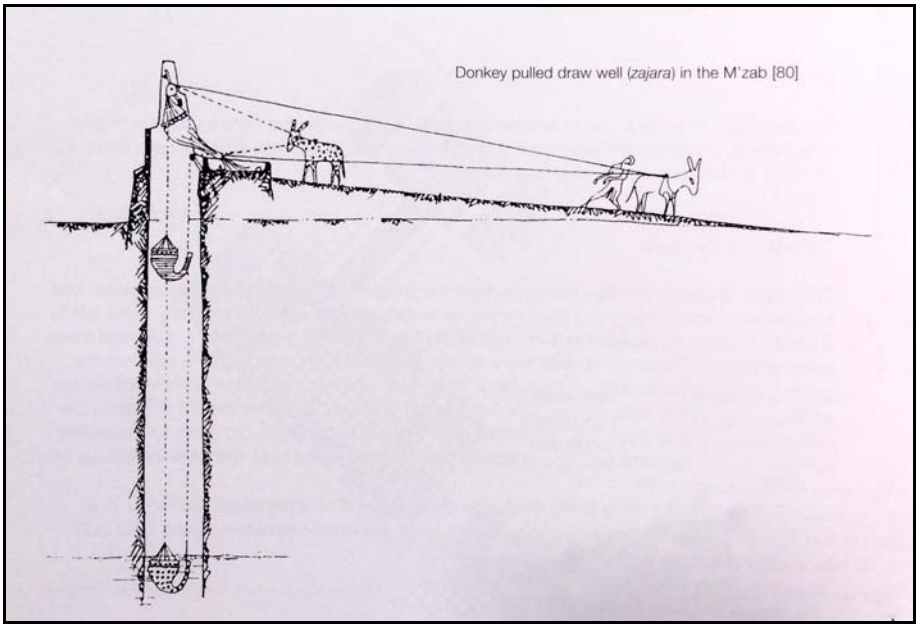


**Figure 105: A reconstructed cross section through a *Zajara* well in M'zab (Ragette 2003: 66).**

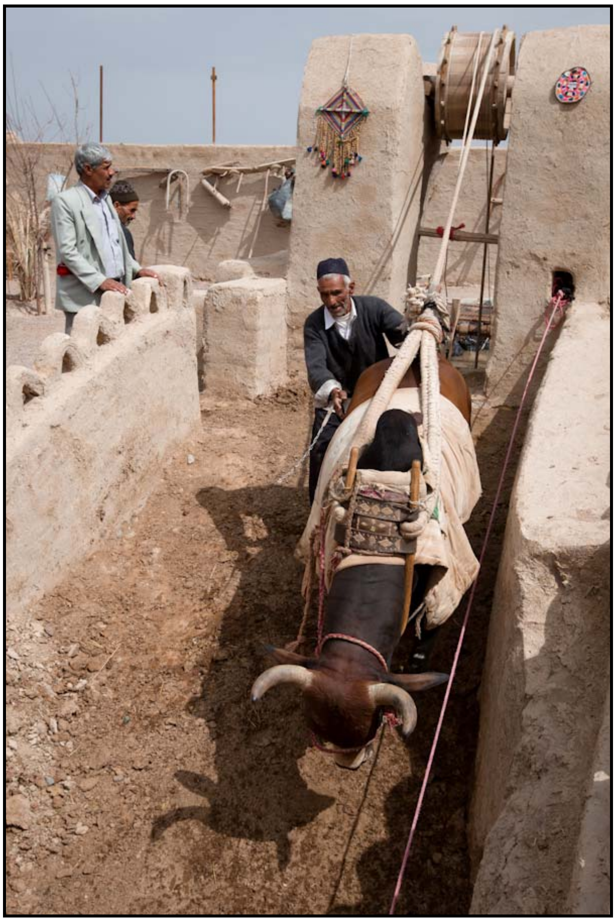

**Figure 106: Water being lifted from a *Zajara* well using oxen in central Iran**

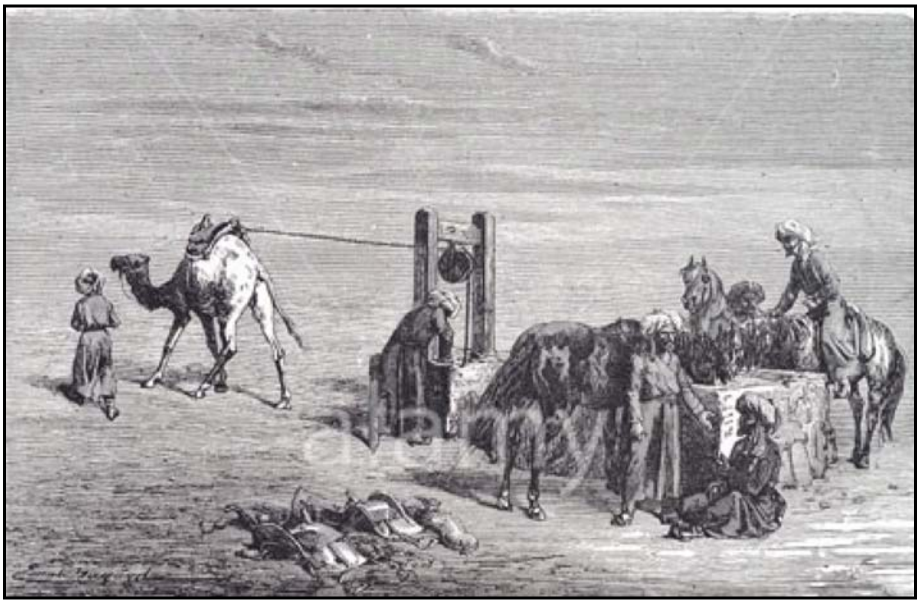

**Figure 107: Water being lifted from a traditional well using camel in Turkmenistan in the 1870s.**

## 10. Discussion

The standing architecture and archaeological features visible on the surface at Nu'aija represent an important part of the cultural heritage of Doha, showing a significant aspect of the way in which the city survived in an arid region prior to the introduction of diesel pumps and desalination plants. Along with historical sources, such as early written accounts and historic photographs of the city, the Nu'aija survey provides a unique insight into how the inhabitants of Doha obtained drinking water and farmed in the desert in the 19th and early 20th century. The site also illustrates how technological advances, introduced as Doha become more wealthy following the discovery of oil on the peninsula, impacted on the way agriculture was undertaken and the unintentional affect this had on the hydrology of the country.

The history of the site is summarised below in three phases, relating to the way in which the site has been utilised over time. Phase 1 relates to the traditional methods of water abstraction and agriculture undertaken until the middle of the 20th century. Phase 2 is associated with changes to the site, and the expansion of the area irrigated, following the introduction of diesel pumps. Phase 3 includes the way in which the site has been altered most recently, probably representing changes undertaken after site fell out of use following the rapid salinization of the upper freshwater aquifer.

### Phase 1 - Early wells using animal power and manpower

The earliest evidence of use of the site appears to predate both mechanical pumps and the use of concrete as a construction material. This phase of use is associated with the stone lining visible in some of the box wells and with the single surviving *zajara* well on the site (Structure 1). This phase of use probably dates to the later 19th century through to the mid 20th century.

In an aerial photo of the site in 1947 (figure 4) the northern half of site ODQ25 is in use as an agricultural area, presumably in private ownership, and evidence of this can be seen in the Phase 1 activity such as the *zajara* well. At his time site ODQ24 contains of a number of apparently unfenced wells, possibly used by the wider population. Sadly no evidence of these more ephemeral features survives today

Lorimer (1908: 491; see section 6) states that the Al Thani Sheikhs, officers of the Turkish garrison and other notable inhabitants of Doha obtain their water from the Nu'aija wells; suggesting that access to the better quality drinking water from these wells might have been restricted. Lorimer also tells us that the Turkish garrison had a watch tower at Nu'aija. The presence of fortified inland well and agricultural sites is common in northern Qatar, and highlights the value of these sites to coastal towns which lacked clean drinking water. The Turkish fortification at Nu'aija do not appear to have survived, presumably demolished by the extensive development of the area. Finally Lorimer states that the Turkish troops have a vegetable garden at Nu'aija, where they grow citrus (probably limes) that prevented scurvy among the troops. As the agricultural are located at the northern half of ODQ25 represents one of the larger farmed areas at Nu'aija it seems likely it may have belonged to the Ottoman garrison, or a wealthy family such as the Al Thani.

## Phase 2 - Irrigation with mechanical pumps

The first oil strike in the Qatar oil fields was made by Petroleum Development (Qatar) Ltd in October 1939. However, the outbreak of World War II meant that the commercial exploitation of Qatar's hydrocarbon deposits did not begin until almost a decade later. The wealth created by the this new industry resulted in rapid and far reaching changes to many aspects of Qatari society.

Powerful Qatari families had established claims to many of the best water sources in the peninsula, and with the money from oil exports they began to modernise these assets. At Nu'aija this can be seen in the adaptation of earlier wells to allow water to be pumped from them, as well as the expansion of the agricultural areas to the south. Concrete was first introduced in Qatar as a building material in the late 1950s, initially used to make shell tempered concrete blocks. These concrete blocks were probably produced locally and were made with a type of shell sand very rich in small gastropods that is readily available along the coast of Qatar. These shell tempered concrete blocks were used to line the new wells and to build raised tanks and irrigation channels. Imported British pumps were used at Nu'aija to lift water from open wells into the large tanks built next to them. From here gravity fed irrigation would have allowed the water to flow down in to channels and be directed to different parts of the agricultural area. The expanded agricultural area included a large date palm plantation. These attempts to irrigate the desert were not a success. The rapid increase in water extraction appears to have quickly resulted in saline water from the underlying saline aquifer and from the coast being introduced into the shallow freshwater aquifer. The wells and soil would have become salinated and the crops and palms would have rapidly died. Attempts to trap rainwater by building check dams or excavating depressions were sometimes undertaken, but with no success. Elsewhere in Qatar boreholes were drilled to access the lower freshwater aquifer, however this does not seem to have occurred at Nu'aija. Possibly the lower aquifer is poor in this area, or maybe the soil became so salty that it was no longer viable to farm this area.

Along with the intensification of the agriculture at the ODQ25 several structures were built, utilising the same shell tempered concrete blocks used in the wells and tanks. Structure 6 represents a fairly simple accommodation block, possibly to house workers who maintained the farm. These workmen could also have looked after the apparently large number of horses stables in two blocks to the west (Structure 3 and Structure 4). A raised *majlis* (Structure 2) is built in a traditional style with a *liwan* along its northern side, however an unusual sunken bath in the structure and the use of less traditional building materials hint at the changes that were occurring at this time. This *majlis* does not appear to be part of a residence, there is no evidence of associated structures or the enclosing wall that define traditional houses. It seems likely that this building functioned as a kind of a private pavilion, a place where the owner could spend time close to his farm and stables.

## Phase 3 - Modern use and alterations

The final phase of site use is related to activity after the agricultural use of the site was abandoned, possibly as early as the 1970s. Most of the wells on the site are enclosed by a modern concrete block wall and chain-link fence. These enclosures appear to have been built after the wells are abandoned, as there is no obvious way to extract water once they are in place. A similar chain-link fence encloses the current boundaries of ODQ25. The buildings on the site are possibly abandoned at the same time as the agriculture fails.

A number of other alterations are made to the site after it was abandoned. Several large shallow holes are mechanically excavated, possibly to promote recharge of the aquifer. Hardcore is laid across the northern area of the site to create a level parking area; this is used for storage and as a communal area, a makeshift volleyball court is set up here. the northern and western extent of the ODQ25 agricultural area is built over and the western extent of the stable blocks truncated, creating current site boundaries.

The future of the site is uncertain. The rapid development of Doha continues, and it seems likely there will be pressure to develop the site in the near future. Further historic research may reveal much about the sites ownership and history. However, unless steps are taken to preserve elements of the site it is likely another tangible aspect of Doha's past will disappear.

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