

The *aflaj* irrigation system (Oman)

No 1207

1. BASIC DATA

State Party: The Sultanate of Oman

Name of property: The *aflaj* irrigation system of Oman

Location: Dakhiliya, Sharqiya and Batinah Regions

Date received by the World Heritage Centre: 29 June 2004

Included in the Tentative List: 4 July 1998

International Assistance from the World Heritage Fund for preparing the nomination: No

Category of property:

In terms of the categories of cultural property set out in Article 1 of the 1972 World Heritage Convention, this is serial nomination of five *sites*.

Brief description:

The collection systems of five *aflaj* irrigation systems represent some 3,000 still functioning systems in Oman. Water from underground water sources or springs is tapped and conducted by gravity, often over many kilometres, to support agriculture and permanent settlements in extremely arid desert lands. Ancient engineering technologies demonstrate long standing sustainable development.

The fair and effective management and sharing of water in villages and towns is still underpinned by mutual dependence and communal values and guided by astronomical observations. Numerous watchtowers built to defend the water systems reflect the former total dependence of communities on the *aflaj* system.

2. ACTIONS

Background: This is a new nomination.

Date of the Technical Evaluation Mission: 12-16 November 2005

Dates of request for additional information and of receipt from State Party: ICOMOS sent a request to the State Party on 29 November 2005 for them to consider the implications of extending the nomination to include more of the *aflaj* systems. On 20 February 2006, a revised nomination was submitted by the State Party which extended the nominated area of all five *aflaj* systems to include the agricultural demand area and key buildings within surrounding settlements.

Consultations: ICOMOS has consulted its International Scientific Committees on Archaeological Heritage Management and on Historic Gardens – Cultural Landscapes.

Literature: Wilkinson, J C, *Water and Tribal Settlement in South-East Arabia: A study of the Aflaj of Oman*, Oxford, 1977. Al Shaqsi, Saif bin Rashid, *Aflaj Management in the Sultanate of Oman*, PhD dissertation, University of Wales, Bangor, 1996.

Date of evaluation approval by ICOMOS: 10 April 2006

3. THE PROPERTY

Description:

The five nominated sites have been chosen to represent the sophistication and technological achievements of the total remaining working irrigation systems in Oman. Four of the sites lie around the Western Hajar mountains. The fifth site is in the southern end of the Eastern Hajar mountains.

The word *falaj* (plural *aflaj*) is used to refer to a complete irrigation system for a settlement. In classical Arabic *falaj* means to divide into shares. Applied to water, it has come to mean a physical and social structure for the sharing of water among those who have a right to it.

In physical terms, the *aflaj* system of irrigation consists of tapping substantial underground water resources, springs or surface water and conducting the water by gravity alone often over long distances, to towns and villages where it is distributed to domestic and agricultural users.

Relatively constant supplies of water are ensured by the *aflaj* system for large areas of desert throughout the year, and this in turn has led to the growth of permanent urban settlements based on an assured agricultural production and water resources for both people and livestock.

The areas nominated cover the collection and part of the distribution sections of five *aflaj* systems. This includes the underground channels which run between the mother well, spring or *wadi* (surface water) where the water is tapped, to the *shari'a* the start of the distribution network around the settlements, together with part of the above ground distribution channels around the plantations within settlements, and the associated buildings, such as mosques, watchtowers, houses, sundials, and water auction buildings.

For the underground section, the boundaries are drawn to protect the sources and channels and consist of the main channels overlaid by a strip approximately 250 metres wide.

Within the settlements and water 'demand' area, the boundaries enclose the agricultural area irrigated by the water system, and associated buildings.

Each system is further protected by a wide buffer zone, but this does not extend around the settlement and demand areas, apart from at Al-Jeela.

The areas are:

Areas in square kilometres

	<i>Upstream</i>	<i>Buffer</i>	<i>Settlement</i>
Falaj Al-Khatmeen	1.35028	17.564	1.004
Falaj Al-Malki	6.000	42.5571	1.572

Falaj Daris	3.89468	33.701	2.383
Falaj Al-Jeela	0.309522	38.3946	0.140
Falaj Al-Muyassar	3.00501	31.8266	1.134

The constructions in Oman are one of the largest concentrations of irrigation systems of this kind anywhere in the world: over four thousand systems have been identified in a large-scale survey completed in 2001. Around 3,000 of these systems are still functioning and these reflect a restoration programme carried out by the Ministry of Water Resources over the past 25 years. This in turn demonstrates the crucial significance of the water systems as a major national resource that still underpins agricultural systems across a large area of the country.

The precise dating of most of the underground channels is not known. The present network appears to result from several building campaigns, the earliest of which could be around 500 AD or even earlier. Recent archaeological evidence is suggesting that irrigation systems existed in the area as early as 2,500 BC, but when the first deep channels were mined and faced is not clear (see below).

In the settlements, water is still distributed through a traditional system of time-sharing, organised on a community basis.

Three types of *aflaj* are recognized in Oman:

i. *Ghaili*: This form is based on the perennial flow in a *wadi*. Water, diverted by means of a partial dam from the *wadi*, is conveyed in covered or open channels to settlements. In cases where the water flow is small or intermittent, reserves are stored in holding tanks for distribution in periods of drought. 48% of all system are *ghaili*.

ii. *Aini*: The sources of water are perennial mountain springs. They never dry up completely, but their water flow is not constant, varying according to the season and the climatic conditions in any given year. In form they are similar to *ghaili aflaj*. *Aini* account for 28% of systems.

iii. *Daoudi*: This type of *falaj* taps into underground water sources at the foot of mountains. Deep 'mother' wells are sunk to tap into the source of water and this is then conveyed to settlements on the plains through underground channels often over very long distances. 24% of systems use underground channels. The *Daoudi* is by far the most complex. Its construction relies on sophisticated engineering expertise and must also have demanded considerable labour forces and organisational capacity.

In constructing a *daoudi* system, a mother well is first dug at a point as near as possible to where the underground water system or aquifer emerges from the mountains. Finding this point demands traditional knowledge of the mountains and their geology. The mother well may need to be up to 60 m deep.

The sides of the well are lined with stone set in a mortar. This is made from cakes of clay burnt with palm tree wood, which, when needed for use, are ground to a powder and mixed with water to form the mortar. This mortar when set is water-resistant and appears to be very stable and long lasting. It is still produced by traditional methods.

From the mother well, a tunnel is constructed to the *shari'a* distribution point in the settlement. This tunnel may be many kilometres long - up to 14.8 km as at Falaj Al-Malki, and have remarkably shallow gradients as little as 1:2500.

Some tunnels have a network of side braches, like the veins of a leaf. One now dead system had 37 branches; the maximum number in a working system is 17. Where the tunnel goes thorough rock no lining is needed, but in soft rock support is provided either through stone faced walls supporting stone vaults or slabs, or through palm tree logs supporting stone slabs.

At regular points inspection shafts are constructed along the channels to allow dredging on a regular basis. In the long journey from the mother well to settlements, the water sometimes has to pass over *wadis* or other obstacles. To achieve this, the water is channelled through inverted siphons - two helical channels connected by a small aqueduct.

Shari'a and distribution channels in settlements

Such is the significance of the water distribution systems that the open channels are at the heart of the settlements.

The water emerges in the settlement at the *shari'a* which usually has a stepped access and is often next to a fort or watch-tower, a circular mud-brick structure. From there it is dispersed in a network of over ground channels to the cultivated fields which grow date palms as the main crop and also lemons, fodder grasses and a variety of seasonal food crops. The sluices are made of rock slabs, mud or rags.

Next to the *shari'a* water can be taken for drinking and cooking. The next stretch is reserved for ablutions. It then passes by the mosque and fort to places for washing clothes. Only after these uses have been satisfied, is the water diverted to palm plantations and to other crops through dividing the main channel into equal subsidiary channels which are regulated between shareholders.

Aflaj distribution system

The success of the *alfaj* systems depends on the social and economic structures which underpin it and have done for centuries. These are rooted in local communities and guarantee fair shares to stakeholders. The system is not based on any form of written or statute law, but rather on a traditional system of time-sharing that is passed from one generation to the next.

The executive authority in each system is the *falaj* agent, or *wakeel*, appointed by the local sheikh in consultation with the stakeholders and advised by a technical expert, *arreif*. The *wakeel* is responsible for the overall management of the *falaj*: his duties include responsibility for the funds, regulation of the sale and rental of individual shares, and day-to-day overseeing of the operation of the system. His subordinates, known as *areefs* (of which there may be a number, especially at the larger *aflaj*), are responsible for distributing water shares. Individual shareholders have an obligation to respect the quantity of water assigned to them and the periods when it becomes available.

The time distribution system for the water may be based on either a seven or ten day cycle. The units allocated to

shareholders vary from between 12 hours down to as little as 1.25 minutes.

Such a system demands an accurate way of measuring volumes of water by flow over time. In the day time this was traditionally done by shadows from a tall stick falling on rows of small stones set into the ground. At night measurement was based on the movement of stars, a system that involved close observation of a total of 24 stars. Several settlements still preserve their sun-dials. Some also have small buildings where auctions of the water shares are held.

The nominated sites include underground channels between the mother well and the *shari'a*, and open channels within the settlements together with watch-towers, ablutions block, mosques, forts, sun-dials and the distribution system around the plantations.

Falaj Al Khatmeen

This *daoudi falaj* is fed from the Wadi Al Meadin, which is notable for its abundant flow during periods of rain and its continuous (though not constant) flow throughout the year. The total length from mother well to *shari'a* is 2.4 km, and it irrigates a cultivated area of some 723,124 m². For most of its length the channel runs underground.

The open channel in the settlement passes beneath Bait Al-Redadah Fort (not included in the nomination), which was built during the Yaruba Imamates (1649–1711). At the entrance to the town, the channel is split into three equal sections, one of which irrigates the holdings of the local people and the other two the agricultural land belonging to the State Treasury (*Bait Al Mal*). The water for each of the three users is accurately controlled: if three balls of the same size and weight are thrown into the channel before it splits into three, each will run automatically into a separate branch channel.

The demand area covers abandoned traditional houses facing the water channels, two watchtowers strategically sited to over look the channels, and a mosque.

Falaj Al-Malki

This *daoudi falaj* is one of the largest *aflaj* in the Sultanate: its total length from mother well to *shari'a* (including all its 17 branches) is some 14.8 km. The demand area covers 1,572,730 m². The *falaj* splits into two branches, supplying the towns of Nazar and Al-Yaman.

Recent intensive building activity has reduced the flow of this system.

The demand area includes a watchtower located on a hill above the plantations and the remains of two others together with a few scattered traditional houses.

Falaj Daris

This *daoudi falaj* is thought to be the oldest in the Sultanate. The total length of its three channels is 7,990 m. Most of the water derives from the Wadi Al-Abiyadh. The cultivated area of the town of Nizwa that it supplies is 1,715,502 m².

The *shari'a* is surrounded by a small park.

The demand area includes a mosque, fort and a few old mudbrick houses.

Falaj Al-Muyassar

Another *daoudi falaj*, Falaj Al-Muyassar originates from a mother well 50 m deep. Including its branches, the *falaj* is 5.8 km in length, and it irrigates a cultivated area of 1,133,698 m² by means of two main branches.

Its *shari'a* is next to a watchtower and a cluster of mud brick houses now abandoned. The attractive village has many mud brick houses either side of the open water channels and a sundial and auction building.

Falaj Al-Jeela

This *aini falaj* is located in a very small village in the remote and barren mountainous area of Wilayat Sur. The water comes from a spring of the Wadi Shab high above the settlement and is conveyed over 1.6 km by means of open channels and a small aqueduct to a collection tank in the settlement. From there the water is distributed to palm and pomegranate plantations. The total demand area is about 14,000 m².

Falaj Al-Jeela maintains a stable flow rate throughout the year and is barely affected by rises and falls in groundwater levels.

The demand area is tightly constrained by the surrounding mountains. It includes a small mosque, and some traditional houses.

History

The histories of the five *aflaj* in the nomination are unknown, since no written records survive. By virtue of its size and complexity, and the importance of the town of Izki that it supplies, a case could be made for Falaj Al-Malki as being one of the earliest in Oman. There are similar indications that Falaj Daris, with its links to the town of Nizwa, could be considerable antiquity. The relationship of Falaj Al-Khatmeen to the Bait Al-Redadah fort, known to have been built during the Yaruba Imamates, suggests that this *falaj* originated in the 17th century.

It would be helpful if more information could be assembled from both technical and archival sources and excavations to allow clearer indication to emerge of the chronology of *daoudi aflaj* construction.

Protection and Management

Legal provision:

The *aflaj* systems are owned by the individual shareholders, with certain shares allocated to the mosque. The legal title to shares is recorded in the form of a registration document (*sukk*); ownership of these shares is absolute, and they can be inherited. Only rarely are the entire shares owned by a single individual. Details of ownership and all transactions are recorded by the *wakeel*. Certain shares are owned communally by all the shareholders in the *falaj*, and these are available for rent through weekly auctions.

At Falaj Al Khatmeen, the demand area is owned by the Government state treasury. In the other nominated areas,

the plantations, watchtowers, mosques and houses are privately owned.

There is no protection for the visual setting of the *aflaj* or for the open channels and their associated structures, watch-towers, mosques and traditional houses, within settlements. Local municipalities can however restrict the removal of palm plantations in order to build houses.

The underground sections of the *aflaj* system are well protected. The key protection measure is the Water Wealth Protection Law, which was promulgated by Royal Decree No. 29/2000. This ensures that *aflaj* owners and agents need to obtain a permit from the Department of Water resources before carrying out any enlargement, repairs or maintenance on their *aflaj* from the mother well to the *shari'a*. Furthermore no work shall be undertaken which might affect the aquifers, or their water quality. Further protective measures were set in place by the Ministry after their survey (see below). Under this, no new wells shall be dug within 3.5 km of mother wells, and for any new development protection zones must be provided either side of the *falaj* route.

Management structure:

Although there are no formal management plans in force for the nominated areas as a whole, there are complex and detailed traditional management systems for the management of the water and the water channels. This system is supplemented by repairs carried out by the Ministry of Water Resources. Each *aflaj* system is managed by the *wakeel*, using the traditional form of management, in close collaboration with shareholders and the local community.

The nominated areas are said to be the best examples of co-operative water management in Oman.

Traditionally, *aflaj* have been financed entirely by their shareholders. However, the high costs of manpower and materials, as well as the deteriorating condition, made it increasingly difficult in the 1970s for shareholders to maintain their *aflaj* adequately. As a result, the Government of Oman assumed responsibility for *falaj* maintenance in the Second Five-Year Plan (1981–85) in the form of an extensive drilling and rehabilitation programme. This responsibility continues.

Justification of the Outstanding Universal Value by the State Party (summary)

- Without the existence of the *aflaj*, there would be no more than impoverished settlement in the Gulf Region (or other desert regions);
- The *aflaj* technology has been brought to a high level in Oman and has been functioning successfully for more than two millennia;
- The organisation of the water distribution systems is an outstanding example of a traditional structure at least a thousand years old which continues to play a vital role in society;

- The combined *aflaj* systems in Oman are one of the largest irrigation systems anywhere in the world.

4. EVALUATION

Conservation

Conservation history:

Since the Ministry assumed responsibility for the maintenance of the main underground *aflaj* channels in 1981, many hundreds of kilometres of channels have been restored.

The Ministry of Regional Municipalities, Environment, and Water Resources created an inventory of *aflaj* between 1997 and 1998, published in 2001. The inventory includes the following data:

- Location and depth of mother wells;
- The routes of *aflaj* channels;
- Measurement of flow rates;
- Data on water quality;
- Definition and measurement of planted and demand areas;
- Data on state of conservation of channels and the nature of the flows.

Each inventoried *falaj* has been assigned a registration number and a registration plate has been placed at the *shari'a*. The project was undertaken by 134 Ministry staff members.

By contrast, the conservation of the cultural properties in the demand areas has not so far been given high priority and no grant aid has been given for these structures.

State of conservation:

Much of the restoration of the channels, particularly those underground, is carried out under the supervision of the Ministry of Regional Municipalities, Environment, and Water Resources. *Falaj* communities carry out regular monitoring of their systems and submit requests for assistance in maintenance or conservation whenever their structural or hydrological structures are affected. Upon receipt of these requests, the Ministry prepares technical specifications and drawings and supervises the maintenance work.

In some cases this has involved sinking new inspection shafts and rebuilding sections of collapsed channels. Some of this has been done using concrete. Cement has also been used for the surface of some channels where they emerge near the *shari'a*. For instance at *Falaj Daris* in the park near the *shahr'ia*, many of the open channels have been refinished in cement mortar. In some places this cement facing is showing sign of becoming detached from the underlying traditional mortars.

Workshops where the traditional mud mortars are made still exist and ICOMOS considers that it would be desirable if traditional materials could be used as these

seen from the evidence of old channels to be exceedingly effective.

The mud forts watchtowers and traditional houses are mostly neglected and abandoned. Some are in a parlous state – but retrievable. The work however is beyond the resources of traditional owners. It is stated in the nomination that these are amongst monuments to be renovated by the Ministry of Heritage.

Protection and Management:

The water channels are very effectively managed by a combination of traditional management and support for large-scale construction projects from the Ministry of Water Resources. There is, however, no coordinated management of the surroundings or settings to the underground channels or of the demand areas. It is suggested that the *falaj* committees could form the basis for local management committees for the wider area working in collaboration with the relevant ministries and their regional offices.

Many of the traditional mud-built buildings such as watch-towers, forts, and houses which are adjacent to the water channels in the settlements are suffering from lack of maintenance and management and there is considerable re-building in some of the larger settlements.

If the integrity of the wider *aflaj* system is to be sustained in its relationship with the settlements, greater protection is needed for the surroundings of the underground water channels and for the demand areas. This should not mean turning them into museums – but managing change to respect the qualities of the places and ensuring that the key elements of the system survive.

Risk analysis:

- Development

The last few decades has seen rapid development in Oman including the smaller towns and villages. This had compromised some of the settings of the *aflaj* system, particularly when traditional mud brick buildings, including watch-towers are left to decay and palm plantations have been replaced by new houses.

Road construction has also affected the water channels and some new roads cut across the underground channels or are built next to open channels.

- Water demand

Increased development has led to increased demand for water which has resulted in the drilling of large deep wells. This in turn has affected the level of underground water supplies and made some *aflaj* that were formerly reliable throughout the year become intermittent. For instance:

Falaj Al-Malki: Recent intensive building in the area has resulted in severe pressure on the aquifer and this effect, coupled with a scarcity of rain has led to a decrease in the water flow of the *falaj*, especially in periods of drought.

Falaj Daris: The water flow has been affected as a result of development pressures and the flow rate falls during periods of drought.

- Climate change

Lack of rainfall in the Gulf Region over the past two decades has seriously lowered the water table – a process exacerbated by the drilling of new wells.

At *Falaj Al-Jeela*, the area has suffered a drought over the past 14 years and at some point this will impact on the water flow from the perennial spring. All the *daoudi aflaj* are to some extent affected.

Unexpected flash floods when rain does occur, have led to surges of water and this has also been damaging to channels. There are no disaster plans in place to deal with floods. Damage to the channels is made good through government intervention.

- Visitors

Currently it seems that very few visitors visit these sites. It is very difficult to appreciate the underground sections of the *aflaj*, and at three of the sites the overground sections are intertwined with roads and some new development. If visitors are to appreciate the scope and extent of these systems, an access strategy will need to be developed to provide information and access compatible with traditional uses.

Authenticity and Integrity

Authenticity:

The basic layout of the nominated *aflaj* is wholly authentic. There are some modern interventions such as the use of concrete for lining shafts, and cement for reinforcing the tops of the mother wells and access shafts, at some of the *shari'a*, and in the distribution channels to individual agricultural plots, and new building around the settlements.

The authenticity of the management of the *aflaj* is incontrovertible. The traditional system of ownership and management functions efficiently and is complemented by the administrative, technical and financial support from the Ministry of Water Resources.

Integrity:

Initially, only a portion of each *aflaj* system was nominated – from the mother well to the *shari'a*. Those parts of the system in the settlements, serving the needs of the community through the provision of water for cooking, washing, and agriculture, have now been added to the nomination and the nominated areas now reflect the integrity of the whole *aflaj* system.

Comparative evaluation

There is some uncertainty about where and when the *daoudi falaj* type of irrigation originated. It is known in Iran, Armenia, in large parts of Central Asia and western China, in Chile and Peru in South America, as well as in Oman and neighbouring United Arab Emirates, Egypt, Morocco, and Spain.

Also called *qanats*, the technique is known from the Iron Age in Persia, now Iran. It has been assumed that it arrived in Persia from the Caspian region at the end of the 2nd millennium BC and that the Assyrian ruler Sargon II, who

reigned at the end of the 8th century BC, and his successor Sennacherib built a number of *aflaj*. Recent finds however in Oman and at El Ain, United Arab Emirates, have led to the suggestion that technology could have been transferred in the reverse direction.

Daoudi aflaj dated to the Iron Age have been excavated in El Ain and its surrounding areas of Hili, Bida Bin Saoud, Jebbeb and Al Madam, near the border with Oman. Two old *aflaj* have also been reported in Maiyser and Raki in Oman dating back to around 1,500 BC and recent excavations at Bahla Fort in Oman have reported ancient irrigations systems possibly dated to 2,500BC but confirmation of their type and precise date is still awaited.

Underground water channels began to be diffused more widely during the Achaemenid period in Persia, from the mid-6th to the mid-4th centuries BC. This was a period of Persian expansion, especially during the reign of Cyrus the Great. Much of Oman came under Achaemenid rule in the mid-6th century BC, and from AD 226 it formed part of the Sassanian Empire of Persia, until the Sassanians were finally driven out with the coming of Islam in the 7th century AD. Historical records indicate that there was a period of *falaj* construction in Oman during the Yaruba Imamates in the second half of the 17th century, when the Portuguese were finally expelled from Oman, and it became the first independent state in the Arab world.

There are close similarities between the *aflaj* in Iran and those in Oman. There are said to be 20,000 *qanats* are still in use in Iran.

In the Roman age, the first *falaj* appeared in Syria and Egypt. The technique spread along the Silk to Parthia, Bactria and Sogdia and later into Xinjiang. Underground water systems also still flourish in Chile and Peru.

Irrigation based on springs is even more widespread than the *daoudi aflaj* type. No comparative analysis is given for spring irrigation – which is found in perhaps as many as forty countries around the world. Particularly impressive examples can be found in the Himalayas for example where water is channelled for many kilometres to villages in the plains below. The one example nominated, although impressive because of its dramatic setting, cannot be said to represent this type of system.

Considering just *daoudi falaj* or *qanats*, without further research into what remains in Iran and Central Asia in particular, both in terms of construction and chronology, it is difficult to say with certainty where the structures in Oman fit into the wider picture of technology transfer for the system of tapping underground water sources for irrigation, or whether they are more technically sophisticated than other examples. It would therefore not be possible to say that the systems in Oman have high value purely on technical grounds or because they represent early uses of this technology.

However the systems in Oman are still functioning as integral and essential aspects of the production systems of villages and towns, and are still managed by long-standing traditional systems within the communities they serve. They have a value as part of a distinct and living cultural landscape and reflect particular social systems that developed in this region. Out of the 3,000 functioning systems, 627 are *daoudi aflaj*.

Outstanding Universal Value

Evaluation of criteria:

The sites are nominated on the basis of criteria ii, iv and v.

Criterion ii: This criterion is justified on the grounds that the *aflaj* system in Oman is an outstanding example of ‘considerable antiquity’ which survives intact and is if socio-economic benefit. More specific information is needed to demonstrate the antiquity of the parts nominated. ICOMOS considers that this criterion might be justified on the basis of further detailed information.

Criterion iv: This criterion is justified through suggesting irrigation underpinned settlement which in turn underpinned a successful state that influenced its region. Although this is true it is also true for many other parts of the neighbouring regions. It does not justify why the five nominated areas can reflect this larger picture. ICOMOS considers that, with the available information, this criterion cannot be properly assessed at this stage.

Criterion v: The nomination justifies this criterion on the grounds that the sites are threatened from the lowering of the water-table, which they are, and that the sites are an exceptionally well preserved form of land-use. ICOMOS considers that the property meets this criterion.

5. RECOMMENDATIONS

Recommendations

The current nomination is for part of four *daoudi aflaj* system and one *aini aflaj* system. Systems based on springs are widespread around the world and the one nominated *aini aflaj* site is not exceptional.

The original nomination was submitted by the Ministry of Water Resources and included those aspects of the system over which it has control. The State Party is to be congratulated on extending the nominated areas to include the wider landscape created by the *aflaj* irrigation system to include the demand areas in settlements and thus reflect social and community involvement.

The wider nomination should be considered as a collection of cultural landscapes representing distinctive, long-standing, sustainable and living ways of managing water resources.

The underground parts of the nomination and main water channels through the settlements are very effectively managed through traditional practices supported by repair work carried out by the Ministry of Water Resources. The one aspect however that could be improved is the use of materials: there is a need to re-introduce the use of traditional mortar.

The landscape within settlements has so far received less attention and is not subject to an agreed approach. There is a need to consider how the wider landscape can be managed through the development of a management process involving local communities and perhaps based, as suggested in the nomination, on an extension of the traditional *falaj* committees and supported by the Ministry of Heritage and Culture.

As many of the traditional buildings are in a state of considerable decay, there is also a need to create a short-

term action plan to address how these buildings can be stabilised and where appropriate be given viable uses.

A management plan is needed to articulate these approaches and to address the need for control of new development, access for tourists and presentation of the *aflaj* systems.

Currently the underground channels have legal protection but the nominated areas in the settlements are not protected. Consideration needs to be given as to how the settlement patterns and key structures can be protected.

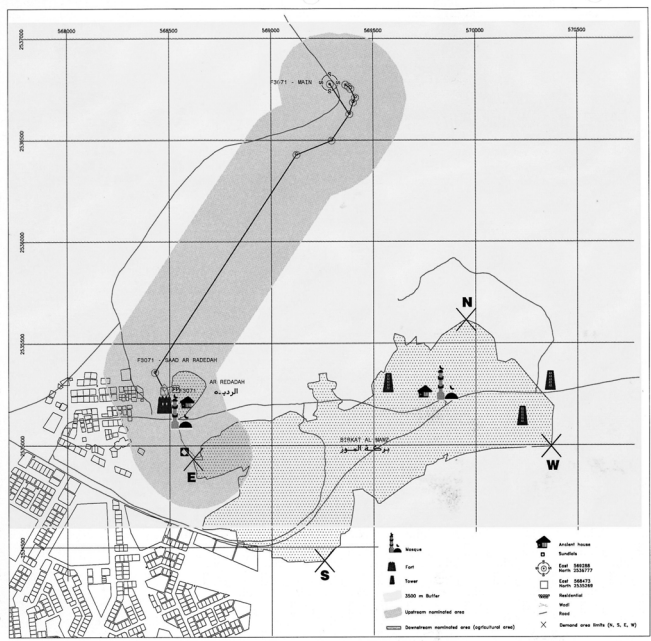
Recommendation with respect to inscription

ICOMOS recommends that the *aflaj* irrigation system of Oman, be ***referred back*** to the State Party of the Sultanate of Oman to allow them to consider how:

- The enlarged areas can be given adequate protection;
- Further information can be provided in support of the proposed criteria;
- A management plan or system can be developed for the settlement areas, to complement traditional management arrangements, which addresses the restoration, and conservation of the traditional structures such as mosques, watchtowers, forts, houses, and wash places, the re-introduction of traditional mortars, the control of development, the management of visitors, and the presentation of the *aflaj*.

ICOMOS, April 2006

Falaj Al-Khatmeen : Topographical map showing boundaries of nominated property and buffer zone



سلطنة عمان
وزارة البلديات الإقليمية والبيئة
وموارد المياه
دائرة التخطيط
مشروع حصر الأفلاج

SULTANATE OF OMAN
Ministry of Regional
Municipalities, Environment
& Water Resources
Planning Department
FALAJ INVENTORY PROJECT

Falaj System	S3071	نظام الأفلاج	S3071
Falaj No.	F3071	رقم الأفلاج	F3071
Falaj Name	AL KHATMEEN	الاسم	الختمين
Wadi	AL KHAYDIN	الوادي	الحيدان
Village	BEHAT AL HAKZ	القرية	بحات الحوز
Wilayat	NIZWA	الولاية	نزوى

LEGEND

Underground channel
 Covered surface channel
 Open surface channel - wet
 Open surface channel - dry
 Open surface channel - uncertain
 Agricultural channel area
 Agricultural channel area
 Well
 Pump
 Dam
 Reservoir
 Road
 Railway
 Demarcated area (IMR) (N, S, E, W)

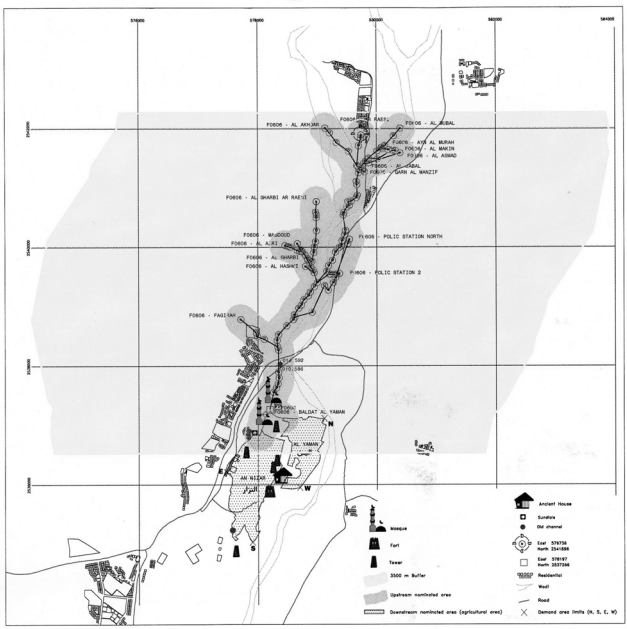
Pond location fixed by "Trimble" GPS
 Pond location fixed by 3 minute "Trimble" GPS
 Pond location fixed by "Single fix" GPS
 Supporter well
 Location of IMR inventory point
 Section - Unknown type
 Measurement / amount point
 GPS fix (as indicated on the map and in the legend) of the IMR location fixed by using a location of support well subject to a maximum of 300m (nominally) from the station.

Datum : WGS 84 Projection : Transverse Mercator
 Map compiled by MRCR GIS & RS section
 M/0174/30001-13-05-06 0844

S3071

Map showing the revised boundaries of Falaj Al-Khatmeen

Falaj Al-Malki : Topographical map showing boundaries of nominated property and buffer zone



سلطنة عمان
وزارة البلديات الإقليمية والبيئة
وموارد المياه
دائرة التخطيط
مشروع حصر الأفلاج

SULTANATE OF OMAN
Ministry of Regional
Municipalities, Environment
& Water Resources
Planning Department
FALAJ INVENTORY PROJECT

Falaj System	S0606	نظام الأفلاج	S0606
Falaj No.	F0606	رقم الأفلاج	F0606
Falaj Name	AL MALIKI	الاسم	الملكي
Wadi	MAKFIN - IMR	الوادي	حطين المكن
Village	AN-NIZWA - AL YAHIR	القرية	النزوى
Wilayat	IZKI	الولاية	إزكي

LEGEND

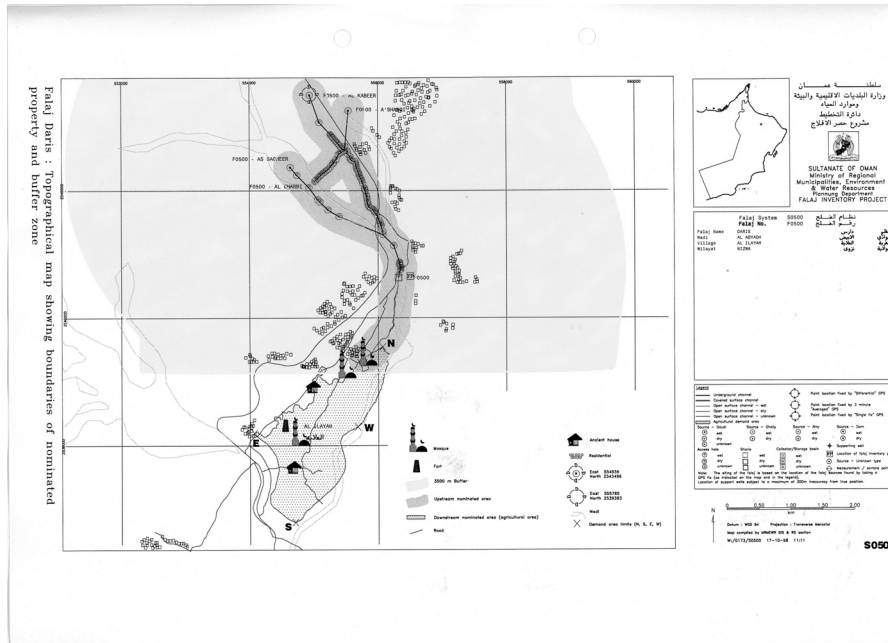
Underground channel
 Covered surface channel
 Open surface channel - wet
 Open surface channel - dry
 Open surface channel - uncertain
 Agricultural channel area
 Agricultural channel area
 Well
 Pump
 Dam
 Reservoir
 Road
 Railway
 Demarcated area (IMR) (N, S, E, W)

Pond location fixed by "Trimble" GPS
 Pond location fixed by 3 minute "Trimble" GPS
 Pond location fixed by "Single fix" GPS
 Supporter well
 Location of IMR inventory point
 Section - Unknown type
 Measurement / amount point
 GPS fix (as indicated on the map and in the legend) of the IMR location fixed by using a location of support well subject to a maximum of 300m (nominally) from the station.

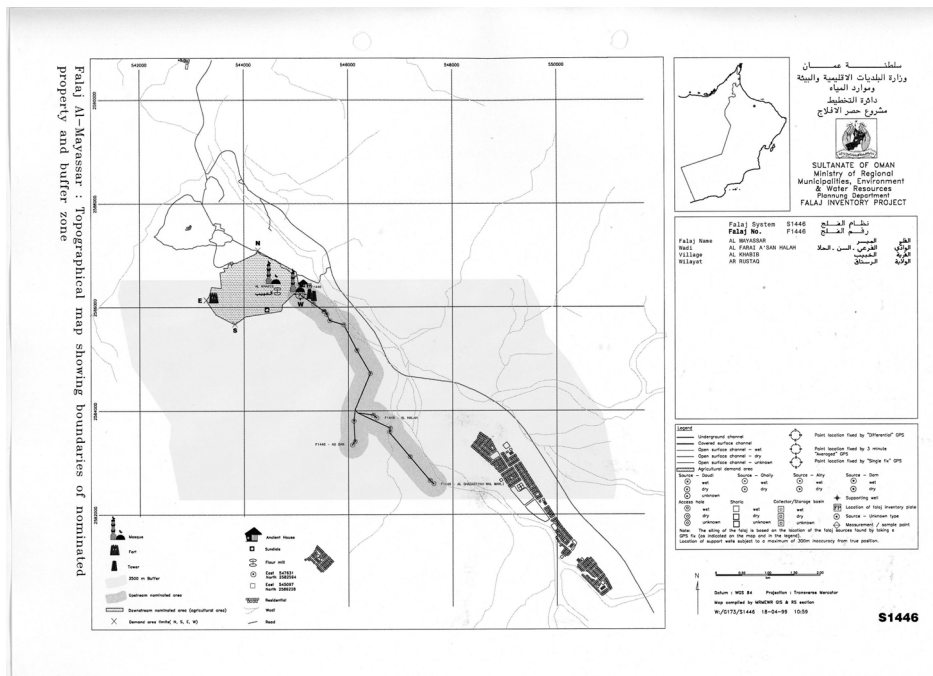
Datum : WGS 84 Projection : Transverse Mercator
 Map compiled by MRCR GIS & RS section
 M/0174/30006-17-05-06 0844

S0606

Map showing the revised boundaries of Falaj Al-Malki

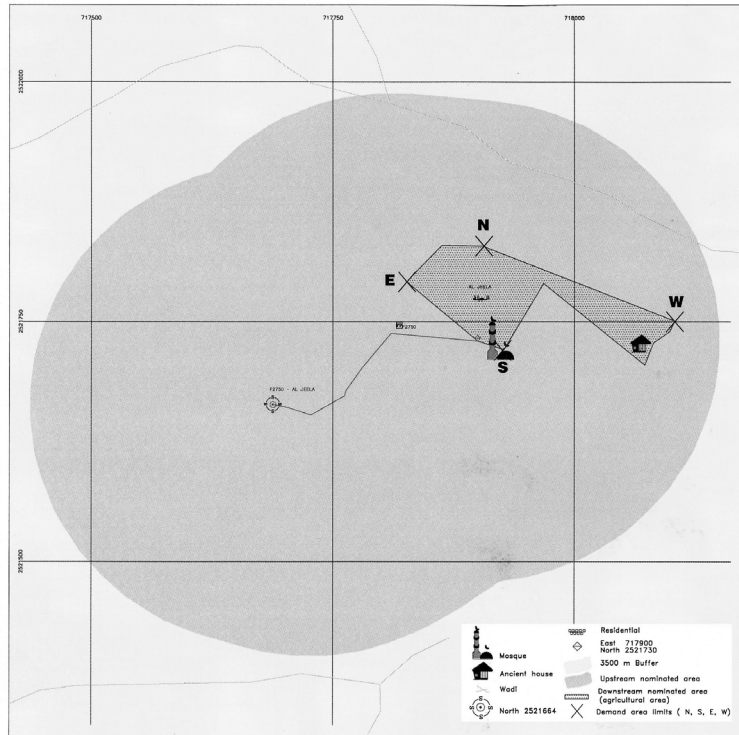


Map showing the revised boundaries of Falaj Daris



Map showing the revised boundaries of Falaj Al-Mayassar

Falaj Al-Jeela : Topographical map showing boundaries of nominated property and buffer zone



سلطنة عمان
وزارة البلديات الإقليمية والبيئة
وموارد المياه
دائرة التخطيط
مشروع حصر الأفلج

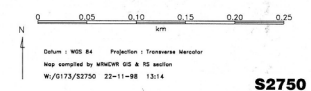
SULTANATE OF OMAN
Ministry of Regional
Municipalities, Environment
& Water Resources
Planning Department
FALAJ INVENTORY PROJECT

Falaj System	S2750	رقم النظام الأفلج	
Falaj No.	F2750	رقم النقطة	
Falaj Name	AL JEELA	الاسم البلدي	
Wadi	ASH SHAB	الوادي	
Village	AL JEELA	القرية	
Wilayat	SUR	الولاية	

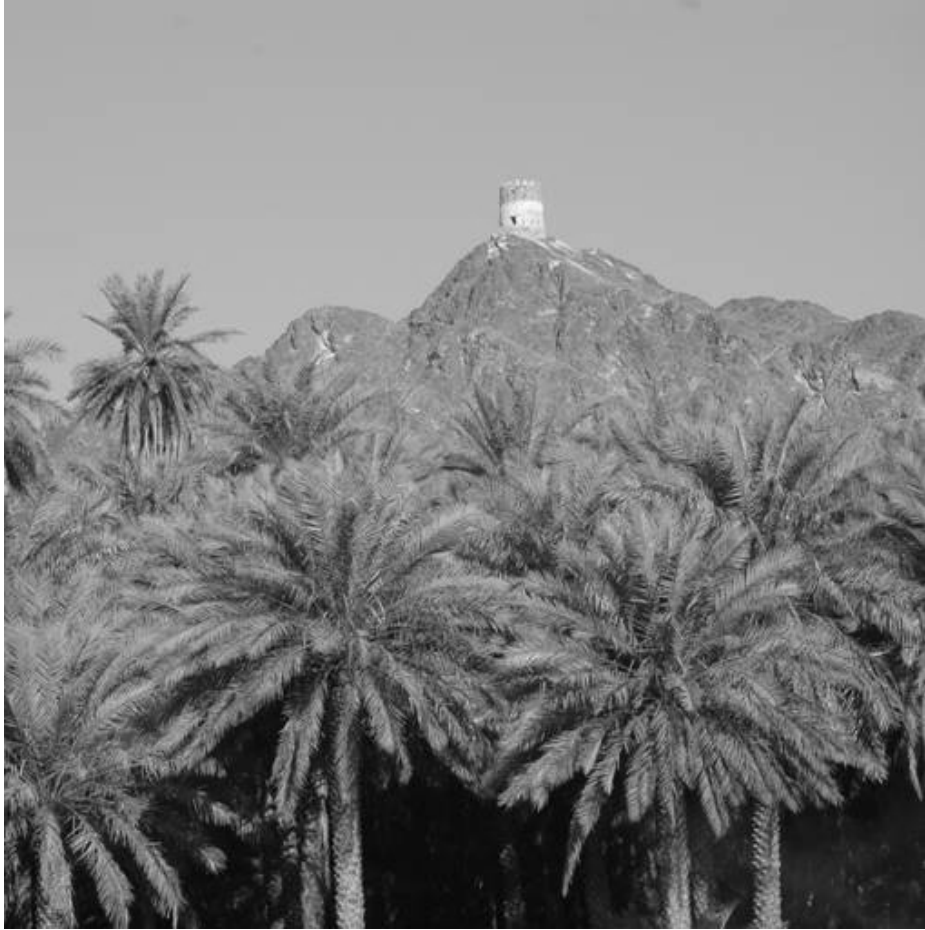
LEGEND

Underground channel	Point location fixed by "Differential" GPS		
Covered surface channel	Point location fixed by 3 minute "averaged" GPS		
Open surface channel - wet	Point location fixed by "Single fix" GPS		
Open surface channel - dry			
Open surface channel - unknown			
Agricultural demand area			
Source - Sand	Source - Shaly	Source - Any	Source - Dam
wet	wet	wet	wet
dry	dry	dry	dry
unknown	unknown	unknown	unknown
Storage	Collector/Storage basin	Supporting well	
well	well	well	
dry	dry	dry	
unknown	unknown	unknown	
			Location of falaj inventory point
			Source - Unknown type
			Measurement / sample point

Note: The points of the falaj are based on the location of the falaj sources found by taking a GPS fix (as indicated on the map and in the legend).
Location of support wells subject to a maximum of 300m inaccuracy from true position.



Map showing the revised boundaries of Falaj Al-Jeela



Watch Tower



Underground channel



Shari'a



Distribution Point