
Jodrell Bank Observatory

(United Kingdom of Great Britain and Northern Ireland)

No 1594

Official name as proposed by the State Party

Jodrell Bank Observatory

Location

England (Cheshire East administrative authority)
United Kingdom

Brief description

Located in a rural area of Cheshire East in northwest England, the Jodrell Bank Observatory is one of the earliest radio astronomy observatories in the world. Still in existence, the Observatory played a pioneering role in human understanding of the Universe. Part of the University of Manchester, the site encompasses a number of radio telescopes and supporting functional buildings, and is surrounded by open countryside, free from radio interference.

Jodrell Bank Observatory is now the hub of the United Kingdom's national wide array of up to seven radio telescopes (e-MERLIN) including the Lovell and Mark II Telescopes. The signals from all seven telescopes are combined at Jodrell Bank.

Category of property

In terms of categories of cultural property set out in Article I of the 1972 World Heritage Convention, this is a *group of buildings*.

1 Basic data

Included in the Tentative List

27 January 2012

Background

This is a new nomination.

Consultations and Technical Evaluation Mission

Desk reviews have been provided by ICOMOS International Scientific Committees, members and independent experts.

An ICOMOS technical evaluation mission visited the property from 1 to 4 October 2018.

Additional information received by ICOMOS

A letter was sent to the State Party on 10 October 2018 requesting further information about mapping, the comparative analysis, proposed justification of Outstanding Universal Value, integrity, authenticity and management.

Additional information was received from the State Party on 7 November 2018 and has been incorporated into the relevant sections of this evaluation report.

An Interim Report was provided to the State Party on 21 December 2018 summarising the issues identified by the ICOMOS World Heritage Panel.

Further information was requested in the Interim Report including: about the legibility of the boundary, inclusion of all attributes, conservation, smaller historical items and indicators.

Additional information was received from the State Party on 28 February 2019 and has been incorporated into the relevant sections below.

Date of ICOMOS approval of this report

13 March 2019

2 Description of the property

Note: The nomination dossier and additional information contain detailed descriptions of this property, its history and its state of conservation. Due to limitations on the length of evaluation reports, this report only provides a short summary of the most relevant aspects.

Description and history

Jodrell Bank Observatory is located in a rural area of Cheshire East in northwest England. The site has evidence of every stage of the history of radio astronomy, from its emergence as a new science to the present day.

The configuration of the site is largely determined by the evolution of the Observatory. At the beginning of its use in 1945, the only structures on the site were the Botany Huts, located at the southern edge. These two buildings were used by the research team as their base. Both huts are presently disused. From that time activity has moved to the north across the site with many new instruments developed and then abandoned. While much of the early scientific equipment was demolished or re-used in subsequent instruments, some above or below ground remnants survive.

A road through this southern area provides an entrance route for staff and leads to the Green, the area at the heart of the property, where a wide range of experiments were set up. It comprises mainly a square area of grassland, around which circles an access road, providing access to largely dating back to the early days of the Observatory, like the Park Royal Building (used originally as the control room for the Transit Telescope and later the Mark II Telescope), the Electric Workshop (originally used as the main office for the Observatory) and the Cosmic Noise Hut (used as a control and receiving room for the adjacent 30-Foot telescope, which no longer exists).

The Green is also the location of the Mark II Telescope, the third largest telescope in the United Kingdom and the first telescope of any kind in the world to be controlled by a digital computer. This telescope was built on the site of the former Transit Telescope and only archaeological traces of its existence remain. To the north of the Green, the site is dominated by the 76 metre diameter Lovell Telescope which sits in a working compound containing a number of engineering sheds and its Control Building. This building has been extended on a number of occasions since first completed in 1955 but it still retains its original control room and two wings.

To the northwest of the property, set around the Lovell Telescope, there are spaces open to the general public which include visitor facilities, and part of the Discovery Centre. The rest of the visitor facilities and gardens, including an Arboretum, sit just outside the property to the northeast.

The basic layout and form of the Observatory has not changed since the mid-1960s. However, as a working research facility, there has been periodic adaptation and improvement over the years. A number of smaller telescopes have been erected at the Observatory since that time, and many subsequently relocated away from the site.

The original permanent buildings at the Observatory all survive. The site otherwise includes a network of roads, carparks, open grass and wooded areas, and several water bodies. Along part of the western border but just outside the property, is the International Headquarters for the Square Kilometre Array Organisation (SKAO), the international project planning the next generation large telescope.

The Jodrell Bank Observatory is one of the earliest planned sites for radio astronomy in the world.

The site was first used for radio astronomy in 1945 when Bernard Lovell moved his research from a city location at the University of Manchester in order to undertake experiments in radar without interference from radio transmissions.

The development of radar arose during World War II. After the war, scientists like Lovell who had worked on radar returned to their peacetime research. Lovell was involved in research on cosmic rays and was interested in the possibility of detecting radar echoes from cosmic rays. He borrowed a radar system from the Army for this research. Lovell considered a property owned by the University in rural Cheshire as a site which might be free from interference. The Jodrell Bank Experimental Grounds had previously been used for botanical research. The radar system was set up at Jodrell Bank and Lovell began to use this equipment in December 1945. The first experiments produced important but unexpected results.

The Jodrell Bank team collected large amounts of ex-military apparatus which was invaluable for their research. One important item was a searchlight loaned from the Army and used as the steerable mount for an array of aerials

designed to investigate meteors. This was the first purpose-built scientific instrument at Jodrell Bank. The remnants of the mount are still at the property.

In December 1946, Lovell presented the results of the meteor research. In response, the President of the Royal Astronomical Society announced the arrival of '*an entirely new field of astronomical research*'.

Also in 1946, Lovell was planning a much larger aerial array for his cosmic ray research. While partly built, it was never completed as proposed. Instead, the framework was used for a fixed giant dish-type reflector, known as the Transit Telescope. Completed in 1947 it was 66 metres in diameter, making it the largest in the world at the time. However, the telescope was not successful in cosmic ray research. However, it was crucial in a much wider field of research related to the study of extra-terrestrial radio waves, which became known as radio astronomy.

The Transit Telescope also played an important role in the development of long baseline interferometry – an essential part of modern day astronomy. The telescope was later dismantled, to make way for the Mark II Telescope, however traces of it remain.

By 1948, permanent buildings were being erected for the Observatory. Several of the early buildings still remain. Through this time a range of instruments were constructed, some of which were used for only a short time while others remained for years.

Optical interferometry was also developed at Jodrell Bank in the mid-1950s.

The Lovell Telescope, originally called the Mark I Telescope, was first conceived in 1948 in order to build upon the success of the fixed-dish Transit Telescope, by adding the capability of being able to steer the telescope to any part of the sky. The engineer Charles Husband was responsible for the structural design. Its design involved considerable technical difficulties.

Construction of the 76 metre diameter telescope began in 1952 and it was completed in 1957. One of the early public successes of this telescope was its use to track the carrier rocket for Sputnik 1, the world's first artificial satellite launched by the USSR. Jodrell Bank continued to play a role through the 1960s in tracking both American and Soviet spacecraft.

The construction of the iconic Lovell Telescope generated huge public interest which led to the construction of a visitor centre in 1966. This building was extended a number of times over the years until it was finally demolished and replaced by the Discovery Centre.

Deterioration of the Lovell Telescope was noted by the mid-1960s, and in the early 1970s modifications were undertaken. Significant repairs were also undertaken in the early 2000s, and further work is currently underway.

The Mark II Telescope was designed in the light of issues with the Lovell Telescope. Funding was provided in 1961 and it was completed by 1964, on the site of the former Transit Telescope. Upgrade work was undertaken in 1987 and the late 1990s.

Jodrell Bank has had a substantial impact in science on subjects including the emergence of radio astronomy, meteors and moon studies, the development of very large paraboloidal telescopes, detection of the Andromeda Galaxy, the study of the distribution of hydrogen in the Milky Way and other galaxies, long baseline interferometry, the discovery of quasars, quantum optics, optical interferometry, space tracking, pulsar research, and research into gravitational lensing.

Work on long baseline interferometry started at the Observatory in the 1950s and became an increasingly important focus for its research. This work was fundamental to understanding radio sources such as quasars.

The Observatory has a long history of public engagement with science and its role has fostered public interest in science and radio astronomy.

Boundaries

The nominated property has an area of 17.38 ha, and a buffer zone of 18,569.22 ha.

The property boundary has been drawn to incorporate a minimal area, nonetheless it has been defined so as to include all the attributes that belong to and represent the history of Jodrell Bank as a property of Outstanding Universal Value for its role in history of science.

The proposed buffer zone corresponds to an existing and legally-based Consultation Zone established in 1973 to protect Jodrell Bank from radio emissions in its vicinity. This zone is essential for the effective operation of the telescopes. Since it is quite large, it has proven over many decades to be very effective in protecting the Observatory from radio interference.

ICOMOS requested additional information in its interim report on how the proposed boundary is identifiable on site, as it does not correspond to the whole Observatory boundary site. The State Party replied on 28 February 2019 and advised that the proposed property boundary mostly coincides with the Observatory site boundary, and otherwise is marked by a fence line or by an appropriate signage on site.

State of conservation

The structures at the Observatory have been subject to modifications, repairs and upgrade works since the 1960s. This has included modifications to the Lovell Telescope in the 1970s, as well as repairs in the early 2000s and currently. This work included adding a new reflecting surface with a shallower curve above the original dish, subsequently replaced, and a large new wheel girder system supported by a second inner circular railway track. Later work involved replacement of the drive system, the

outer railway track, original wheels and gear racks. Work is currently underway to restore the original but corroded 1957 surface of the dish.

In the case of the Mark II Telescope, upgrades were undertaken in 1987 and the late 1990s.

For many decades, the main priority for the Jodrell Bank Observatory was research, rather than conservation of its heritage. The first heritage designation at Jodrell Bank occurred in 1988 with the Lovell Telescope. However, it was not until the World Heritage nomination process that conservation of the property's heritage became an explicit part of management.

Based on the information provided by the State Party and the observations of the ICOMOS technical evaluation mission, ICOMOS considers that the state of conservation is generally good.

As noted in the site gazetteer of 2014, the steel elements and load-bearing structure of the Lovell Telescope show signs of ageing and corrosion in spite of regular maintenance.

The buildings and huts while often quite basic in their fabric, generally retain all their original fabric and fittings, and are very well looked after. Most of them show signs of recent repair and upkeep. Some additions and extensions from the 1970s and 1980s look rather worn, partly because of the inferior materials used in their construction.

The Telescope Workshop and the adjoining Dormitory Block are the subject of current repairs. The two Botany Huts (and Blackett's Hut which is not an attribute) from the earliest period have suffered from neglect and disuse over the years, and show signs of serious structural problems. Restoration work is planned.

The property throughout its history has prioritised scientific research over providing well-built structures that would last in the long-term. With the possible exception of the original Control Building, other buildings on the site have a generally quite primitive character and all of them have often been extended or modified. This character is part of the property history which should be carefully considered in management.

Factors affecting the property

Based on the information provided by the State Party and the observations of the ICOMOS technical evaluation mission, ICOMOS considers that the main factors affecting the property are development within the property or in the area surrounding it, and maintenance of the large steel structure of the Lovell Telescope. However, there are generally few factors that might pose a threat to the property and its proposed Outstanding Universal Value.

The property and its setting are well protected against undesirable development. The property and much of its surrounding area are owned by the University of Manchester which is committed to the protection of the

property. Surrounding areas are mostly used for agricultural purposes and significant changes are unlikely. The strict rules for the Consultation Zone controls development within the buffer zone.

It is possible that additional working space may be needed by researchers at the Observatory. Similarly, it is possible that the Square Kilometre Array building in the buffer zone may at some future time need to be extended. Masterplanning for the property and buffer zone may be desirable to anticipate future development needs.

With regard to the Lovell Telescope, the steel structure is subject to an impressive monitoring regime, and maintenance and repairs are regularly undertaken. A major repair and renovation project is currently underway.

3 Proposed justification for inscription

Proposed justification

The nominated property is considered by the State Party to be of Outstanding Universal Value as a cultural property for the following reasons:

- The Observatory is an outstanding example of supreme scientific and technical achievement, which revolutionised the understanding of the Universe.
- The Observatory has physical evidence of the international exchange of ideas as the new science of radio astronomy and the space age developed during the 1940s – 1960s. The property was at the heart of an important flowering of international cooperation and exchange of values and ideas regarding astronomy and other fields of scientific endeavour.
- The technological and landscape ensemble of the Observatory exemplifies through surviving physical evidence the transition from optical astronomy to modern multi-wavelength astrophysics that took place after World War II. This stage in history saw a radical change in the understanding of the Universe. This is also the era of 'Big Science' which is characterised by a dramatic increase in the scale of scientific projects.
- The Jodrell Bank Observatory is inextricably linked to the fundamental and radical concept underpinning modern astronomy related to the scale and nature of the Universe. The Observatory is closely linked to the discovery of this larger Universe and the scientific techniques for its exploration.

Comparative analysis

The comparative analysis is presented in three parts: a discussion of astronomy and World Heritage which considers sites on the World Heritage List, on Tentative Lists, and other sites related to radio astronomy, a discussion of the values for comparison, and finally a section which presents specific sites for comparison. The comparison is made with other sites which have the combination of proposed Outstanding Universal Value and attributes.

The comparison relies upon the two-part ICOMOS-IAU thematic study, *Heritage Sites of Astronomy and Archaeoastronomy in the context of the UNESCO World Heritage Convention: A Thematic Study* (Ruggles and Cotte 2010 and 2017). This study identifies sites on the World Heritage List with possible connections to astronomy, noting that the majority of the sites listed are not related to modern scientific astronomy or its history. The second part of the study further notes that '*there are very few historical observatories on the World Heritage List and no observatories from the 20th century*'. Current properties on the World Heritage List with connections to astronomy are concerned either with pre-scientific cultural interactions with astronomical phenomena or with traditional visible-light astronomy. There are no sites associated with the development of radio astronomy.

The only site on a Tentative List arises in the case of the Astronomical Observatories of the Ukraine which includes the Crimean Astrophysical Observatory which operates a 22 metre radio telescope.

The thematic study looks beyond these lists to consider other possible sites related to radio astronomy. This has been used to derive a list of sites for comparison, which are considered in the nomination. This list has been supplemented with information from *Cosmic Noise: A History of Early Radio Astronomy* (Sullivan 2009) and other sources (eg. Leamington 2017).

The analysis identifies five values to be used for the comparison. These are: site as an operational radio astronomy observatory, pioneering role in the emergence of radio astronomy, period over which site carried out radio astronomy research, extent of remaining physical evidence of contribution to radio astronomy, and presence of one or more iconic radio telescopes.

The analysis then presents several tables comparing the size of various types of telescopes, including transit telescopes, fully steerable dishes, and single dish telescopes. The remainder of the analysis presents information about 19 comparable sites across the world, in a format broadly structured according to the values noted above.

Sites include those associated with the earliest phase of radio astronomy (eg. Bell Telephone laboratories, United States of America, 1931–34 and Wheaton, United States of America, 1937–47), early sites dating from after World War II (eg. Richmond Park, United Kingdom, 1945–48, Jodrell Bank, and the Sydney Field Stations, Australia, 1945–98) through to a very recent and large telescope (FAST, China, 2016–present). Some sites now contain no physical evidence, while many include steerable and/or fixed telescopes of various sizes, from 15 to 500 metres in diameter.

The analysis concludes that the Jodrell Bank Observatory is the earliest radio astronomy observatory in the world that is still in existence and carrying out world-leading research. It is still a working observatory compared to other sites from

the pioneering phase of radio astronomy. The Observatory also contains superior evidence dating from the emergence of radio astronomy. The site includes two major telescopes, of which one, the Lovell Telescope, is iconic, being the first very large steerable telescope in the world, and for a period it remained the largest steerable telescope in the world. The Jodrell Bank Observatory contains the record of the story of the emergence of radio astronomy and its development to maturity, continuing to the present day.

ICOMOS considers that two of the sites identified in the analysis are also iconic, and the scientific research at these sites is at least equally important to that undertaken at Jodrell Bank. These are the Green Bank (United States of America) and Arecibo (Puerto Rico) sites. These sites however did not have the same pioneering role as Jodrell Bank, as they were developed later and they have also changed considerably over time. The Effelsberg site (Germany) might also be considered iconic but was only developed in the 1970s.

There are other sites not considered in the analysis, such as the Mauna Kea Observatory in Hawaii, the Very Large Array in New Mexico, Atacama telescopes in Chile, and the RATAN-600 radio telescope in Russia. However, all of these examples do not relate to the early pioneering phase of radio astronomy, and they would not compare with Jodrell Bank in its range of values.

Accordingly, it is considered that the absence of these properties from the analysis does not detract from the overall conclusion.

ICOMOS considers that the comparative analysis justifies consideration of this property for the World Heritage List.

Criteria under which inscription is proposed

The property is nominated on the basis of cultural criteria (i), (ii), (iv) and (vi).

Criterion (i): represent a masterpiece of human creative genius;

This criterion is justified by the State Party on the grounds that the Observatory is an outstanding example of supreme scientific and technical achievement, which revolutionised the understanding of the Universe.

ICOMOS considers that Jodrell Bank Observatory is a masterpiece of human creative genius related to its scientific and technical achievements. The adaptation and development of radar and radio frequency reflectivity to develop radically new equipment, such as the Transit Telescope and Lovell Telescope, were a key part in the development of entirely new fields of scientific research and led to a dramatic change in the understanding of the Universe. The Observatory was important in the pioneering phase and later evolution of radio astronomy.

ICOMOS considers that this criterion has been met.

Criterion (ii): exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;

This criterion is justified by the State Party on the grounds that the Observatory has physical evidence of the international exchange of ideas as the new science of radio astronomy and the space age developed during the 1940s – 1960s. The property was at the heart of an important flowering of international cooperation and exchange of ideas and scientific findings regarding astronomy and other fields of scientific endeavour.

ICOMOS considers that the Observatory does represent an important interchange of human values over a span of time and on a global scale on developments in technology related to radio astronomy. The scientific work at Jodrell Bank was at the heart of a global collaborative network. In particular, several important technological developments such as very large paraboloidal dish telescopes and interferometer were developed at the Observatory, and were later influential in scientific endeavours in many parts of the world.

ICOMOS considers that this criterion has been met.

Criterion (iv): be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;

This criterion is justified by the State Party on the grounds that the technological and landscape ensemble of the Observatory exemplifies through surviving physical evidence the transition from optical astronomy to modern multi-wavelength astrophysics that took place after World War II. This stage in history saw a radical change in the understanding of the Universe. This is also the era of 'Big Science' which is characterised by a dramatic increase in the scale of scientific projects.

ICOMOS considers that Jodrell Bank represents an outstanding example of a technological ensemble which illustrates a significant stage in human history – the transition from traditional optical astronomy to radio astronomy and the associated consequence for the understanding of the Universe through multi-wavelength astrophysics. The property is also associated with the peacetime development of 'Big Science' as a major change in the way in which scientific research was supported and undertaken. The surviving evidence at the property related to the evolutionary development of radio astronomy from the post-war pioneering phase through to sophisticated, large scale research activity in the field makes Jodrell Bank an outstanding example of such a technological ensemble.

ICOMOS considers that this criterion has been met.

Criterion (vi): *be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance;*

This criterion is justified by the State Party on the grounds that the Jodrell Bank Observatory is inextricably linked to the fundamental and radical concept underpinning modern astronomy related to the scale and nature of the Universe. The Observatory is closely linked to the discovery of this larger Universe and the scientific techniques for its exploration.

ICOMOS considers that Jodrell Bank is directly and tangibly associated with events and ideas of outstanding universal significance. The development of the new field of radio astronomy at the property led to a revolutionary understanding of the Universe which was only possible through research beyond the possibilities of traditional optical astronomy to explore the electromagnetic spectrum beyond visible light. Understanding of the nature and scale of the Universe has been dramatically changed by research in radio astronomy at the Observatory.

ICOMOS considers that this criterion has been met.

ICOMOS considers that the nominated property meets criteria (i), (ii), (iv) and (vi).

Integrity and authenticity

Integrity

The integrity of the nominated property is based on the technological and landscape ensemble of the Observatory with its evidence related to the evolution and conduct of radio astronomy from the period after 1945.

ICOMOS considers that the Observatory retains all attributes that reflect the proposed Outstanding Universal Value of the property. The boundaries encompass all the attributes that document the development of the property as a site of pioneering astronomical research. Practically all stages of development from the very beginning, with improvised, re-used or borrowed equipment, onwards are represented by buildings, physical remains or in some cases archaeological remnants. Some important stages, such as represented by the large Transit Telescope, have not survived intact although traces remain. The later, large scale and far more ambitious instruments are still present at the property. This includes the iconic Lovell Telescope with its Control Building. The property also retains many quite modest structures which are, none the less, important for their research use, or which otherwise supported the work of the Observatory. At the heart of the property is an area called the Green which is the location of the Mark II Telescope, and it is bounded by modest research buildings which were the location for much of the early scientific work at the Observatory. This area gathers many elements identified as attributes of the nominated property.

The buffer zone of the proposed property corresponds to the existing and legally-based Consultation Zone established in 1973 to protect Jodrell Bank from radio emissions in its vicinity. This zone is essential for the effective operation of the telescopes, and provides an adequate protection of the integrity of the nominated property.

The buffer zone protects the scientific capabilities of the Observatory from radio emissions in its vicinity.

In general, all the structures are well preserved and the property continues to be dominated by the large scale Lovell Telescope and Mark II Telescope. However, two wooden buildings from the first phase have suffered from neglect and dis-use over the years. Their restoration is to be undertaken. The grounds of the Observatory are well cared for. Recent buildings in the property are constructed in contemporary materials and have a simple and subdued character, making them clearly recognisable as new but without detracting from the overall character of the property.

Authenticity

The authenticity of the nominated property is based on its attributes of Outstanding Universal Value which include the location and setting for the Observatory, its form and design reflecting the development of the property as a research facility, materials and substance of the property including the large scale structures of the two main telescopes, and the ongoing scientific use of Jodrell Bank.

ICOMOS considers that the property is authentic in terms of the potential Outstanding Universal Value. The location has continued unchanged, and the largely agricultural setting is essentially unchanged apart from the construction of the Square Kilometre Array building as part of the ongoing scientific use of the Observatory. The form and design has evolved through time reflecting the important development history of the property. This includes the somewhat improvised character of many structures indicative of the priority given to scientific research rather than the quality of buildings. Materials and substance have been mostly retained although there has been some replacement of deteriorated materials over time. The property retains its ongoing scientific use.

ICOMOS considers that the requirements of integrity and authenticity have been met.

Evaluation of the proposed justification for inscription

ICOMOS considers that the comparative analysis justifies consideration of this property for the World Heritage List.

ICOMOS also considers that the nominated property meets criteria (i), (ii), (iv) and (vi), and that the requirements of integrity and authenticity have been met.

Attributes

The attributes of the property are all related to the central theme of the property and its Outstanding Universal Value – it is a technological and landscape ensemble reflecting the pioneer phase and later development of the science of radio astronomy.

The isolated location in an agricultural setting mostly devoid of other developments provides context for the scientific research which required an absence of radio interference. The built elements, notably the two dominating and major radio telescopes, control buildings, research and support facilities, as well as the archaeological traces of early research instruments embody the evidence of the important history of the Observatory and its role in radio astronomy.

The ongoing scientific use of the Observatory is an important attribute reflecting the continuity of research.

4 Conservation measures and monitoring

Conservation measures

As noted above, a comprehensive conservation approach to the property only formally began with the process to develop the World Heritage nomination. Prior to this, maintenance of facilities was undertaken in the context of the continuing scientific research priorities at the Observatory. Examples of previous work include installation of a new working surface on the Mark II Telescope in 1987, and replacement of the Lovell Telescope wheel bogies in 2007.

Following the revised priorities for the Observatory which included the recognition of heritage values, funding for a major conservation and restoration project was secured from various sources starting in 2014, including from the University budget and the Heritage Lottery Fund. This project includes work to the Lovell Telescope, Control Building and buildings associated with the Green in the centre of the property. The overall project is due for completion in 2021.

Work to the Lovell Telescope is under way, and a program of repairs to the Telescope Workshop and the adjoining Dormitory Block has commenced. In the case of the two Botany Huts which are in poor condition, a restoration project is to be undertaken.

Maintenance and conservation of the Observatory is overseen by highly professional facilities staff, and the maintenance and conservation work is of a high standard. The facilities staff have a clear overview of the state of the buildings and structures, following a five-year cycle of review and maintenance. The conservation work undertaken at the property is of a high standard.

One of the potential challenges for the conservation of the Observatory is to respect and portray the historical character of the buildings and site development. This character often includes relatively primitive buildings,

sometimes with additions undertaken with little regard to aesthetics or quality construction.

The current conservation management plan appears to contemplate the removal of some features of high significance, but which are in poor condition (eg. the Searchlight Aerial). In this case, the plan presumes preservation in situ but also refers to preservation by record if necessary. ICOMOS requested further information on the conservation approach for all attributes in its interim report. The State Party advised, in the additional information submitted in February 2019, that significant structures will be conserved as required, that the Searchlight Aerial will definitely be preserved in situ, Heritage Impact Assessment will be undertaken when any conservation work is considered on the property, and this conservation approach will be reflected in the revised Conservation Management Plan due in July 2019.

Monitoring

A suite of key indicators for monitoring the property has been developed. This includes the timeframe for monitoring. Indicators are linked to the property attributes.

For example, the telescopes are inspected and maintained regularly. Both major telescopes are inspected daily during operational periods by specialised staff. This is critical to prevent damage. More detailed inspections are carried out weekly. Buildings are inspected on a continuing basis. Trees on site are inspected by the University's Arboricultural Team. A condition survey for the whole property will be commissioned every five years and be undertaken by external consultants.

While there is a moderately long list of indicators, which have been developed, what appears to be missing are indicators of the actual condition of attributes, or changes in condition. ICOMOS requested further information on monitoring state of conservation in its interim report. The State Party provided useful additional information on February 2019 summarising the monitoring approach, stressing the use of condition surveys, and proposing to revise the indicators by July 2019 so that they relate more explicitly to the maintenance of attributes in good condition.

ICOMOS considers the conservation measures are generally adequate. Ongoing care will be needed to respect and portray the historical character of the buildings and site development, recognising the relatively primitive character of some buildings and the historical changes undertaken with little regard to aesthetics or quality construction. The revised Conservation Management Plan and associated Gazetteer should be provided, when completed, to the World Heritage Centre and ICOMOS.

In addition, ICOMOS considers the monitoring approach to be generally satisfactory, and that revised indicators will be included by July 2019.

5 Protection and management

Documentation

The most recent records for the property are contained in the Jodrell Bank Observatory Site Conservation Management Plan (2016) and the Site Gazetteer (2014) which contains data sheets on all property features. As noted above, in response to a request for further information from ICOMOS in its interim report, the State Party provided additional information in February 2019, and has advised that the Conservation Management Plan and Site Gazetteer are being revised. These should be completed in July 2019.

An archival survey was also completed in 2017. Primary sources of documentation include scientific and technical papers, citations of papers, an engineering archive which includes documentation about changes to the major telescopes and other instruments, papers and images related to scientific work, the Jodrell Bank National Archive which includes papers written at all stages of the site's development, Sir Bernard Lovell's personal papers, national records of and objects related to the development of Jodrell Bank, media records, as well as books by many of the scientists and engineers who worked at the Observatory. This survey project is continuing.

Legal protection

The various components of the property have all been carefully evaluated by Historic England, the national government conservation body, and most of them have been listed under the *Planning (Listed Buildings and Conservation Areas) Act 1990*. The two major telescopes have been listed in the highest category, Grade 1. There are some components which have no listing at the present time, although they are managed for their heritage values as part of the property.

In addition, World Heritage inscription would mean that all components within the property would enjoy a protection status equivalent to the highest level or Grade 1, in accordance with the *National Planning Policy Framework* (2012) and the spatial planning system which operates through several pieces of legislation, including the *Town and Country Planning Act 1990*.

Any changes to listed buildings require listed building consent, a process that is normally managed by the county conservation officer. When needed, conservation staff from Historic England are involved in this process.

University staff are well aware of the heritage status of the property, the legal requirements for conservation, and their role and responsibilities within the system.

It is noted that the buffer zone, based on a pre-existing *Jodrell Bank Radio Telescope Consultation Zone* for the Observatory, has operated effectively to protect Jodrell Bank for many decades. It was established by the *Town and Country Planning (Jodrell Bank Radio Telescope) Direction 1973*.

Management system

The property is under the management of the University of Manchester with a committee, the Jodrell Bank Site Governance Group responsible for coordination. This committee includes key internal stakeholders such as the three main site user groups. Each of the site user groups has its own well-developed and independent management and operational structures. Roles managing the heritage of the Observatory are integrated to the daily work of the Jodrell Bank Centre for Astrophysics, responsible for scientific and engineering research, telescope operations and engineering, and the Jodrell Bank Discovery Centre which is responsible for visitor management and heritage coordination. These user groups are supported by other management groups within the University.

The third site user group is the Square Kilometre Array Organisation, located just outside the property within the buffer zone but within the overall Observatory.

The future management of the property will be based on the existing University structures, augmented by a World Heritage Site Steering Committee which will have oversight of the property and undertake coordination between the University, users and external stakeholders.

The Conservation Management Plan (2016) is a concise document, which provides an overview of the instruments and procedures for the effective management of the property. The plan is supplemented by an extensive Site Gazetteer, which includes considerable detail including issues and recommendations for site elements. As noted above, these documents are being revised and completed by July 2019.

The Observatory staff comprises about 30 technicians, engineers and astronomers who work directly on or with the major telescopes. They are directly involved in the maintenance and conservation of the structures. The property has a dedicated heritage officer.

Significant repairs to the Lovell Telescope are normally carried out by external specialist engineers, and all painting of the telescope is undertaken by an external project team. Archaeological advice for the property is also obtained externally.

Most of the funds for the management, operation and maintenance of the Observatory come from research budgets expended at the property. These research funds come from a variety of national and other sources, and the University. In addition, the University makes an additional contribution towards the heritage costs of the property. Funding for visitor facilities and engagement is partly funded by the University and otherwise by the operation of the Discovery Centre as a not-for-profit business.

Visitor management

The Observatory has a long experience with managing visitors to the property, commencing in the 1950s. In 2011, a new visitor facility was opened supported by a visitor strategy and financial support plan. There is a current

tourism management plan and enhanced presentation of the property is intended through a new gallery building and exhibition focused on Outstanding Universal Value, new guided tours, new interpretation points at the property and a new website.

Community involvement

The Observatory is located in a rural setting with a very small community in the surrounding area. Nonetheless, the local community considers the Observatory as a much-respected and cherished element, and a landmark in the countryside. The activities of the Observatory, including visitor programs, are much appreciated and supported by the local community.

Representatives of the local community have been consulted about the World Heritage nomination, and there is an ongoing dialogue about the proposal. The local community will also be represented on the proposed World Heritage Site Committee.

Evaluation of the Effectiveness of the Protection and Management of nominated property

The protection and management of the property is generally good, including the existing documentation and archive, legal protection, the management system and visitor management. Community involvement is also satisfactory, noting this will be enhanced if the property is inscribed on the World Heritage List.

ICOMOS considers that requirements for protection and management are adequate.

6 Conclusion

ICOMOS considers the comparative analysis for the Jodrell Bank Observatory justifies consideration of this property for the World Heritage List, and that the nominated property meets criteria (i), (ii), (iv) and (vi). The requirements of integrity and authenticity have been met. The requirements for protection and management have also been met, and the proposed boundaries and buffer zone are adequate.

The state of conservation is generally good, and a current major conservation project is currently underway. Ongoing care will be needed to respect and portray the historical character of the buildings and site development, recognising the relatively primitive character of some structures and the historical changes undertaken with little regard to aesthetics or quality construction.

The main factors affecting the property are development within the property or in the area surrounding it, and maintenance of a large steel structure of the Lovell Telescope. Development within the property is closely controlled through the management system and the buffer zone has proven to be very effective in controlling development around the property. The Conservation Management Plan and associated Gazetteer will be revised by July 2019, together with the monitoring indicators.

7 Recommendations

Recommendations with respect to inscription

ICOMOS recommends that the Jodrell Bank Observatory, United Kingdom of Great Britain and Northern Ireland, be inscribed on the World Heritage List on the basis of **criteria (i), (ii), (iv) and (vi)**.

Recommended Statement of Outstanding Universal Value

Brief synthesis

Jodrell Bank Observatory was important in the pioneering phase and later evolution of radio astronomy. It reflects scientific and technical achievements and interchanges related to the development of entirely new fields of scientific research. This led to a revolutionary understanding of the nature and scale of the Universe. The site has evidence of every stage of the history of radio astronomy, from its emergence as a new science to the present day.

Jodrell Bank Observatory is located in a rural area in northwest England. Originally, scientific activity was located at the southern end of the site, and from that time activity has moved to the north across the site with many new instruments developed and then abandoned. Remnants of early scientific instruments survive.

At the south end of the site is the location of the Mark II Telescope and it is bounded by an ensemble of modest research buildings in which much of the early work of the Observatory took place.

To the north of the Green, the site is dominated by the 76 metre diameter Lovell Telescope which sits in a working compound containing a number of engineering sheds and the Control Building. There are spaces open to the general public which include visitor facilities set around the Lovell Telescope. Other visitor facilities are outside the property to the northeast.

Jodrell Bank Observatory is the hub of the UK's national wide array of up to seven radio telescopes (e-MERLIN) including the Lovell and Mark II Telescopes.

Criterion (i): Jodrell Bank Observatory is a masterpiece of human creative genius related to its scientific and technical achievements. The adaptation and development of radar and radio frequency reflectivity to develop radically new equipment, such as the Transit Telescope and Lovell Telescope, were a key part in the development of entirely new fields of scientific research and led to a dramatic change in the understanding of the Universe. The Observatory was important in the pioneering phase and later evolution of radio astronomy.

Criterion (ii): Jodrell Bank Observatory represents an important interchange of human values over a span of time and on a global scale on developments in technology related to radio astronomy. The scientific work at Jodrell

Bank was at the heart of a global collaborative network. In particular, several important technological developments such as very large paraboloidal dish telescopes and interferometer were developed at the Observatory, and were later influential in scientific endeavours in many parts of the world.

Criterion (iv): Jodrell Bank Observatory represents an outstanding example of a technological ensemble which illustrates a significant stage in human history (1940s-1960s) – the transition from optical astronomy to radio astronomy and the associated consequence for the understanding of the Universe through multi-wavelength astrophysics. The property is also associated with the peacetime development of ‘Big Science’ as a major change in the way in which scientific research was supported and undertaken. The surviving evidence at the property related to the evolutionary development of radio astronomy from the post-war pioneering phase through to sophisticated, large scale research activity in the field makes Jodrell Bank an outstanding example of such a technological ensemble.

Criterion (vi): Jodrell Bank Observatory is directly and tangibly associated with events and ideas of outstanding universal significance. The development of the new field of radio astronomy at the property lead to a revolutionary understanding of the Universe which was only possible through research beyond the possibilities of optical astronomy to explore the electromagnetic spectrum beyond visible light. Understanding of the nature and scale of the Universe has been dramatically changed by research in radio astronomy at the Observatory.

Integrity

The property retains all attributes that document its development as a site of pioneering astronomical research. Practically all stages of development from the very beginning, with improvised, re-used or borrowed equipment, onwards are represented by buildings, physical remains or in some cases archaeological remnants. Some important stages, such as represented by the large Transit Telescope, have not survived intact although traces remain. The later, large scale and far more ambitious instruments are still present at the property. This includes the iconic Lovell Telescope with its Control Building. The property also retains many quite modest structures which are, none the less, important for their research use, or which otherwise supported the work of the Observatory.

In general, all the structures are very well preserved and the property continues to be dominated by the large scale Lovell Telescope and Mark II Telescope. However, several early wooden buildings have suffered from neglect and dis-use. Their restoration is to be undertaken. The grounds are well cared for. Recent buildings have a simple and subdued character, which do not detract from the overall appreciation of the property.

The Consultation zone, buffer zone of the property, protects the scientific capabilities of the Observatory from radio emissions in its vicinity, contributing to maintenance of the functional integrity of the property.

Authenticity

The location of the property has continued unchanged, and the largely agricultural setting is essentially identical apart from the construction of the Square Kilometre Array building as part of the ongoing scientific use of the Observatory. The form and design has evolved through time reflecting the important development history of the property. This includes the somewhat improvised character of many structures indicative of the priority given to scientific research rather than the quality of buildings. Materials and substance have been mostly retained although there has been some replacement of deteriorated materials over time. The property retains its ongoing scientific use.

Protection and management requirements

Most of the attributes of Jodrell Bank Observatory have been listed under the *Planning (Listed Buildings and Conservation Areas) Act 1990*. The two major telescopes have been listed in the highest category, Grade 1. There are some elements which have no listing at the present time, although they are managed for their heritage values as part of the property.

In addition, World Heritage inscription affords all attributes a protection status equivalent to the highest level or Grade 1, in accordance with the *National Planning Policy Framework* (2012) and the spatial planning system which operates through several pieces of legislation, including the *Town and Country Planning Act 1990*. Any changes to listed buildings require approval.

The buffer zone is based on the *Jodrell Bank Radio Telescope Consultation Zone* which has operated effectively to protect the Observatory for many decades. It was established by the *Town and Country Planning (Jodrell Bank Radio Telescope) Direction 1973*.

The property is managed by the University of Manchester with a committee, the Jodrell Bank Site Governance Group responsible for coordination. This committee includes key internal stakeholders such as the three main site user groups. Each of the site user groups has its own well-developed and independent management and operational structures. Roles managing the heritage of the Observatory are integrated with the daily work of the Jodrell Bank Centre for Astrophysics, responsible for scientific and engineering research, telescope operations and engineering, and the Jodrell Bank Discovery Centre which is responsible for visitor management and heritage coordination. These user groups are supported by other management groups within the University. The third site user group is the Square Kilometre Array Organisation, located just outside the property within the buffer zone but within the overall Observatory.

The management of the property is based on existing University structures, to be augmented by a World Heritage Site Steering Committee which will have oversight of the property and undertake coordination between the University, users and external stakeholders. The Conservation Management Plan (2016) provides an overview of the instruments and procedures for the effective management of the property. The plan, supplemented by an extensive Site Gazetteer, is currently being updated.

The Observatory has a long experience with managing visitors. There is a current tourism management plan and enhanced presentation of the property is ongoing.

Additional recommendations

ICOMOS further recommends that the State Party give consideration to the following:

- a) Providing a summary end of project report following completion of the current major conservation project,
- b) Confirming the timeframe for the conservation of the two Botany Huts,
- c) Continuing to respect and portray the historical character of the buildings and site development. This character often includes relatively primitive buildings, often with additions undertaken with little regard to aesthetics or quality construction,
- d) Providing the revised Conservation Management Plan and associated Site Gazetteer when completed, to the World Heritage Centre, and to ICOMOS,
- e) Considering masterplanning for the property and buffer zone to anticipate possible future development needs;

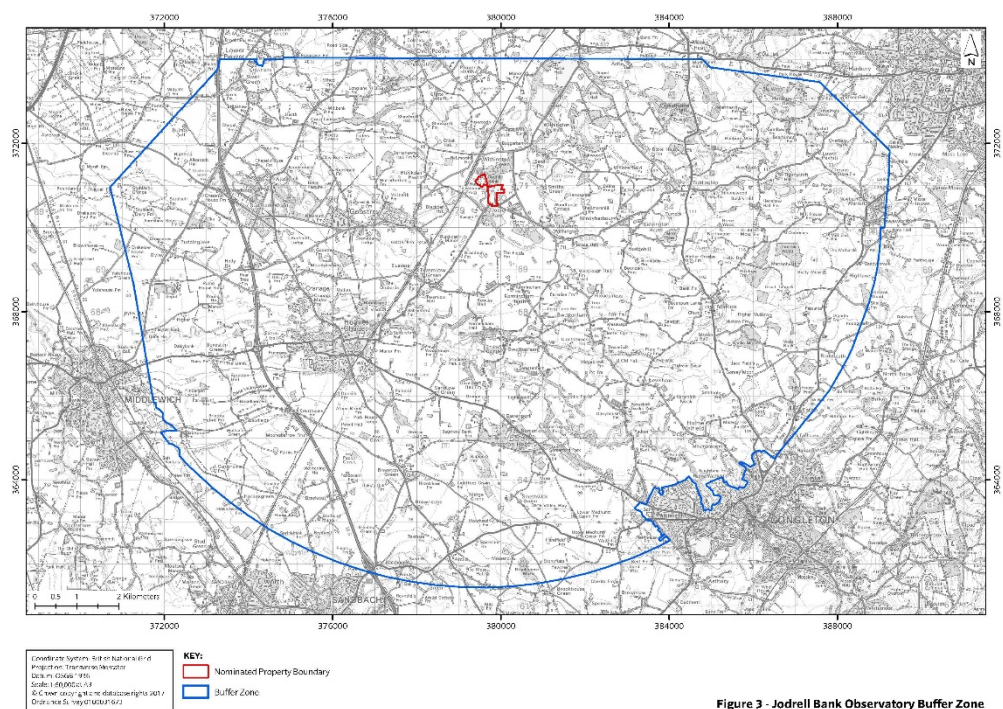
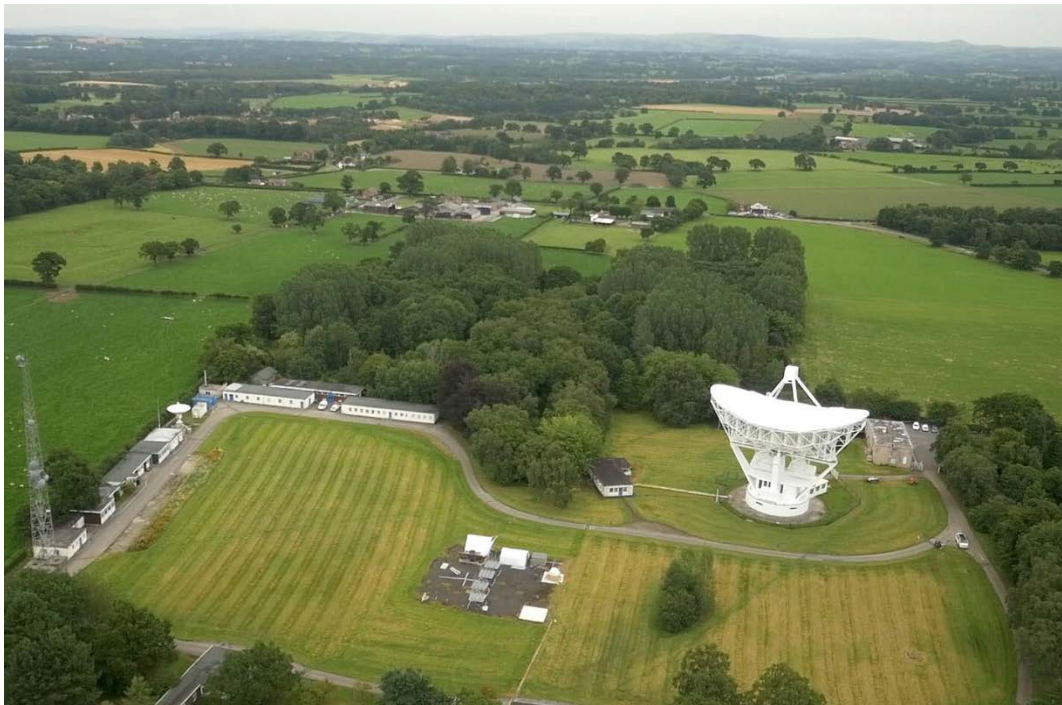


Figure 3 - Jodrell Bank Observatory Buffer Zone

Map showing the boundaries of the nominated property



The Lovell Telescope



The Green and Mark II Telescope



The Mark II and Lovell Telescopes



The Control Building