Water Management System of Augsburg (Germany) No 1580

Official name as proposed by the State Party
Water Management System of Augsburg

Location
City of Augsburg, Region of Swabia, State of Bavaria, Germany

Brief description
The Water Management System of Augsburg is a sustainable system of water management evolved in successive phases through the city's application of innovative hydraulic engineering, demonstrating an exemplary use of water resources over the course of more than seven centuries to the present day.

Water and Augsburg's strategic location at the crossroads of important trade routes in south-central Germany were key foundations of the growth and prosperity of the city, its population, and its status as a flourishing trading metropolis. The architectural and technological monuments in the nominated property preserve successive socio-technical ensembles that are vivid testimonies to the city's continuous and successful urban administration and management of water.

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* constituted by 22 elements.

1 Basic data

Included in the Tentative List
15 January 2015

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 8 to 13 July 2018.

Additional information received by ICOMOS
A letter was sent to the State Party on 18 October 2018 requesting further information about the documentation, selection of component elements, proposed justification for Outstanding Universal Value, comparative analysis, integrity, authenticity and protection.

Additional information was received from the State Party on 12 November 2018 and has been incorporated into the relevant sections of this evaluation report.

Further information was requested in the Interim Report including: how the water management system worked as a whole, to better demonstrate the technical role of each individual element in the overall system; justification for criterion (ii); continuity of use nowadays, especially regarding traditional water management; boundaries of the nominated property, particularly in Rotes Tor; the 5 m legal protection and the fact that 8 elements were not fully covered by the buffer zone; the city forest integration in the buffer zone; and projects for a new tram track and bicycle paths.

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

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
The Bavarian city of Augsburg lies in the north of a glacial gravel deposit formed during the Ice Age that spreads between two Alpine rivers, the Lech and the Wertach, as they converge at the mouth of a great drainage basin. This large aquifer formation produces purified groundwater that emerges in Augsburg in a series of springs that feed streams and water canals.

Some of these water canals were mentioned for the first time in 1276, as water was canalised in the Lochbach and brought to the city to provide water for the mills, tanneries, textile producers and goldsmiths. Since 1346, water was derived at the Hochablass. Later, in 1416, the water power was used for the domestic hydraulic system. By 1545 a strict separation between drinking and process water was being kept throughout the system of watercourses.

A water management system based on pumping and water towers was developed continuously until 1879, when research on hygiene and the first mapping of the groundwater resulted in new waterworks, a turbine pumping station at the Hochablass built to modern standards. In 1883, a diversion of the Wertach was laid out for a planned power plant on the Fabrikkanal, located about 700 m downstream. The last phase of the evolution of this industrial hydraulic system was the construction of a canal

about 18 km long parallel to the Lech, in the north of Augsburg. This canal was built to supply three large power plants.

The Water Management System of Augsburg is comprised of a series of 22 elements categorised into six typologies: one canal complex and one water course system; four drinking waterworks structures; two water engineering structures; three monumental fountains adorned with bronze sculptures; one water-cooled hall; and ten hydraulic power stations.

Canals and watercourses
The first typology comprises a network of canals known as Lech canals, which date from at least 1276, and are still in use today: *Vorderer Lech* (Western Lech), Schwallech, *Mittlerer Lech* (Middle Lech), *Hinterer Lech* (Eastern Lech), *Stadtgraben* (City Moat), *Innerer Stadtgraben* (Inner City Moat), Stadtbach canal, and Brunnenbach/ Brunnenmeisterbach canal. The first typology also includes a complex of watercourses known as the Eiskanal, dating from 1879, renovated in 1972 to become a canoe course and still in use today.

Drinking waterworks
The second typology, drinking waterworks, was in use from the 15th to the 19th centuries. These waterworks housed pumping machinery initially driven by water wheels and later by turbines to counter the abrupt topographical change presented by the plateau that hosts the city centre of Augsburg. Potable water was lifted to expansion basins on top of the towers, from which it could flow by gravity through wooden pipes to consumers. The first of the four drinking waterworks elements is the waterworks at the *Rotes Tor*, known also as Red Gate (from 1416 to 1879), which is comprised of the Box Tower, the Upper Fountain and Lower Fountain Master's Houses, the Small and Large Water Tower (the latter with its notable well-conserved double-helix stairway) and the Aqueduct. The second element in this typology is the *Unterer Brunnenturm*, also known as the Lower Waterworks (from 1502 to 1879), comprising the Lower Water Tower, the Pumphouse/hall and the Zirbelnuss canal bridge. The third element is the *Vogeltor* or Bird Gate (from 1776 to 1879). The last element is a turbine pumping station at Hochablass (from 1879 to 1973), still with its original machinery. This last element represented modern cutting-edge hydraulic engineering of the late 19th century.

Water engineering structures
The third typology is constituted by the Hochablass weir (from 1911/1912 to today), which has its original machinery; and the ancient Galgenablass culvert for water flow (documented from 1545 to today).

Monumental fountains
The fourth typology, a system of three monumental fountains of extraordinary artistic quality are the Augustus Fountain (from 1594 to today), Mercury Fountain (from 1599 to today) and Hercules Fountain (from 1602 to today).

Water-cooled hall
The fifth typology is a water-cooled butcher's hall from the early 17th century. It is a rare example of a large proto-industrial food processing structure, constituted by the city's central meat cutting, processing and marketing facility, known as *Stadtmetzg* (in use from 1609 to 1930). The water flowed through a vaulted basement tunnel beneath the building to cool the butcher's workshops.

Hydraulic power stations
The sixth typology includes some of the first examples of hydraulic power stations from the 19th century, addressing the use of hydro power to generate energy. Ten power plants constitute this typology: Fabrikkanal (from 1885 to today), composed of the power plant and a rope pulley, still presenting pulley rope transmission; Singold (from 1886 to today), with an extant bevel wheel transmission dating from 1886; Stadtbach (from 1873 to today), with machinery dating from 1907; Wolfzahnau (from 1901/1902 to today), comprising a transformer substation, a power plant with a generator whose flywheel dates from 1913, and the power plant keeper's house; Proviantbach (from 1922 to today), with machinery from 1922; Senkelbach/Riedinger (from 1840 to today), with machinery dating from 1923; Wertachkanal (from 1921 to today), with machinery dating from 1921; Gersthofen (from 1901 to today), with machinery dating from 1963; Langweid (from 1907 to today), with machinery dating from 1907 and 1938; and Meitingen (from 1922 to today), with its original equipment. The three last power plants are evidence of the continued development of the Augsburg system to supply hydroelectricity. All ten power plants are still used for their original purpose. Their settings with relation to the canals have been maintained, continuing to provide sustainable power in the 21st century.

Boundaries
The nominated property has an area of 112.83 ha, and a buffer zone of 3,204.23 ha. The boundaries of the nominated property are defined by the limits of the canal system chosen to represent the Water Management System of Augsburg. In the south, the canal system comprises canals and the city forest *(Stadtwald)* where drinking water is collected; in the east, diversion canals bordering the western bank of the Lech River; in the west, canals bordering the eastern bank of the Wertach River; and in the north, the Lechkanal west of the Lech River and running parallel to it.

The boundaries of the nominated property are widened at the area of the fountains, on Maximilianstraße and in the *Lechviertel*. Underground canals and water supply pipes connect all the elements that are part of the Water Management System of Augsburg. Around the canals, there is a tight buffer zone, constituted by 5 m of legal protection.

Upon ICOMOS request, the whole *Rotes Tor* element was totally included in the nominated property, as the State Party had originally considered only the building façades of this element.

Upon ICOMOS request, the State Party also included the city forest, source of the groundwater, in the buffer zone.

A lack of buffer zones regarding some of the 22 elements that constitute the nominated property was also identified by ICOMOS. Subsequently, the State Party established a complete buffer zone around the waterworks of Hochablass, Hochablass weir, power plant of Fabrikkanal, power plant of Wolfzahnau, power plant of Proviantbach, power plant of Wertachkanal, power plant of Gersthofen, power plant of Langweid and power plant of Meitingen. Adequate buffer zones are now implemented in all the 22 elements.

State of conservation

Augsburg suffered considerable destruction during the Second World War, but none of the elements in the nominated property suffered extensive damage, and therefore were not subjected to reconstruction. The only structure that was bombed was the power plant of Senkelbach/Riedinger, which in 1945 had its roof rebuilt and the generation of electricity recommenced. The *Stadtmetzg* butcher's building dating from 1609 was renovated in 1939 to become a Social Security office. During the Second World War a fire affected the south part of the building. The interior of the building was then largely reconstructed to look like the original 1609 building.

In general, all the elements that are part of the Water Management System of Augsburg are in a good state of conservation. This is the case for the watercourses and canals, the drinking waterworks, the water engineering structures, the water-cooled butcher's hall and the power plants.

After the Second World War, to avoid environmental impacts, the original bronze sculptures on the monumental fountains were replaced with bronze replicas; their urban spatial relationship was respected too. The 16th century bronze figures were removed to a museum. Notices inform the public of this change and direct them to where the original sculptures can be visited.

It was noticed recently that some of the historical buildings exhibit some damage. Repairs have been undertaken, following the conservation guidelines associated with the Management Plan. There was also some vandalism that occurred in the fountains, which was reversed. Furthermore, the stonework of the *Stadtmetzg* has been affected by humidity, especially in the area of the formal canal course; this situation is being monitored. The building's facade is currently being rehabilitated according to the Management Plan's heritage conservation guidelines.

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, in general, appropriate.

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 pressures including transport infrastructure; environment pressures; natural disasters; possible rise in the number of visitors; and number of inhabitants in the buffer zone.

Regarding development pressures, the challenges identified were technical advancements and changes in the norms that can affect elements, such as the power plants, integration of transport infrastructure, such as tram and bicycle lanes, and protection of important visual axes.

Concerning environmental pressures, the major challenges identified were water shortage and flooding. The degradation of rivers and the flood plains near them mean that retention areas can be lost. The draining of marshland also leads to a reduced water uptake capacity of the soil. The climate change impact results in an increase in heavy rainfall and flooding events that can seriously affect Augsburg's water management system.

Natural disasters such as lightning, fire and flooding can affect the nominated property. Under extremely adverse conditions, lightning and fire could damage the buildings and structures, although this is unlikely due to established protective measures. Flooding will be a more common occurrence, as mentioned under the environmental pressures in the preceding paragraph. As a result, risk preparedness procedures should be addressed.

A high number of visitors can also be a relevant factor. Several elements are particularly sensitive to excessive use. This is the case with the water towers, especially the Small and Large Water Towers as well as the Box Tower at *Rotes Tor.* Their highly sophisticated and valuable wooden constructions have been damaged in recent years due to excessive use. As a result, access is already limited to 14 people ascending the *Rotes Tor* at a time.

The city forest (*Stadtwald*), including its network of watercourses, constitutes a highly sensitive ecosystem as a nature reserve and a protected area for water resources. The use of buses or other types of transport in the city can also be a pressure to consider, in the event of a large numbers of visitors.

The estimated population living in the nominated property is 15 permanent inhabitants, which is not considered a threat. However, the number of inhabitants in the buffer zone is 2,905. An increase in this number could put pressure on existing measures to protect the nominated property's buffer zone.

Projects for a new tram track and for bicycle paths are being planned near the canals. ICOMOS underlined the need for Heritage Impact Assessments regarding the potential impacts of the tram tracks and the bicycle paths on the nominated World Heritage property. According to the State Party, an approximately 500 m section of the

new tram track will be located near the Wertach canal. In this area, the planning has already reached a concrete stage. The State Party mentioned in the additional information that in the context of the necessary planning approval procedure for the tram track, an Environmental Impact Assessment will be carried out, as required by law.

The State Party provided in the additional information, a mobility plan detail of Augsburg. In particular, detailed drawings regarding the cross of Wertachkanal were delivered. The impact of the tram bridge that crosses the canal reveals the importance and the need to address an Heritage Impact Assessment regarding the tram tracks.

Regarding the possibility of the bicycle path to affect the property, the State Party mentions in the additional information, that a plan is in place to take the bicycle path across the Holzbach canal, using a steel girder construction that is part of the underpass structure. This will totally block the view of the canal when crossing the tunnel. As the bicycle path is intended to supplement the link between Rosenaustrasse and Badstrasse over a distance of 450 m, a detailed impact assessment should be addressed to better analyse its impact on the nominated property.

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 separation of drinking and process water in Augsburg was unique and provided Augsburg with a source of pure drinking water for more than 300 years.
- Innovative hydraulic engineering, developed mainly for power generating (first to drive waterwheels and also used for water pumping, and later for turbines and hydropower generating electricity), was possible as there was a continual adaption to new uses, which was unique to Augsburg.
- The continuous and exemplary use of water resources and the sustainable system of creative water management were developed through “good governance” to safeguard the water supply and impose standards for the city’s hygienic protection. This was developed for the interest of citizens and has been working for more than 700 years.

For several centuries, there was a continuous use of the water management system. However, the way this management is being carried out today, especially as compared to the historical management of the water was questioned. ICOMOS inquired if today’s continuity of use should be part of the justification for Outstanding Universal Value, as traditional management is no longer followed. In this regards, the State Party mentioned that the drinking water supply is managed, maintained and expanded by the municipal corporation *Stadtwerke Augsburg Wasser GmbH* (SWA). Their facilities also include the former drinking Waterworks on the Hochablass dam, which is partly used as a museum and partly, after its conversion, as an electric power station. Also, in the tradition of providing free water for the entire population, more than 20 drinking water wells are available throughout the city. Even if the water supply is free, the continuity of the traditional management of the water system is no longer in place.

Comparative analysis
The comparative analysis is presented by the State Party by means of a comparison with other World Heritage properties within Germany, including Mines of Rammelsberg, Historic Town of Goslar and Upper Harz Water Management System [1992, 2010, criteria (i), (ii), (iii) and (iv)], Maulbronn Monastery Complex [1993, criteria (ii) and (iv)], and Bergpark Wilhelmshöhe [2013, criteria (iii) and (iv)]; and the Tentative List property Mining Cultural Landscape Erzgebirge/Krušnohoří (Germany and Czechia). This was supplemented by an international comparison that includes World Heritage and Tentative List properties, as well as other properties throughout the world not on the List, all with a comparable combination of proposed Outstanding Universal Value and attributes.

The nomination dossier compares the Water Management System of Augsburg in an extensive way, addressing early water systems (Petra in Jordan, Qanat system and Shushtar in Iran, China, Oman, Pakistan); water systems from the Roman period (Spain, France, Italy, Lebanon, Greece, Tunisia, Turkey); water systems used in the mining industry (Bolivia, Germany, Czechia, Poland, Slovakia); water systems for the supply of cities and landscapes and for irrigation purposes (Brazil, Colombia, Philippines), rural water systems built by monks (Germany), urban water systems (Kuwait, Syria, Republic of Korea); inland navigation channels (Belgium, France, Canada, China, United Kingdom, Belarus, Poland, Colombia); water management and control; abundant water resources for parks and decorative fountains; and water for hydropower.

The comparative analysis also mentions properties not included in the World Heritage List that integrate artificial water management, canals and drinking water systems; early pumping facilities, compensation reservoirs and water towers; modern-day drinking water works and their driving technology; hydropower plants for the generation of energy for industry; and electricity generation on the basis of hydropower on an industrial scale.

ICOMOS considered that the comparative analysis would have benefitted from being focused on the originality and innovation of the system with similar European cities or properties, from 1545 onwards. A further comparative analysis was provided at the request of ICOMOS that addressed the innovative aspects of the Augsburg water system. This comparison addressed in particular Italian municipal water supply systems, but also canal systems, the piston pumps system and the use of water towers in cities north of the Alps, from Hungary, Czech Republic, France and Germany.

Italian engineers and craftsmen became experts for early water systems from the 11th century onwards until the 16th century, but Flemish and German engineers could take over after the technology was transferred to the north of the Alps. Due to the instalment of their own legal administrations, nearly all cities in the Po river plain Italian region, built their own systems, often a mixture of navigable canals and feeders for mills and process water. In the special geographical situation of Venice, a separation of the lagoons water distributed through the canals, which could become salty, and cleaner sweet water was necessary. Many towns north of the Alps also used canals following the Italian example, mostly called town brooks or creeks to transport water from higher level sources or rivers, as conserved in south-western Germany, and widespread also in northern France. These canal systems have often a smaller scale and do not separate drinking and process water. The large and long network of canals for drinking and process water in Augsburg, built up over centuries, has no direct comparison in Europe.

The raising of water onto a higher level, which was very important for Augsburg and many other cities, was first accomplished with the ancient technique of water wheel driven buckets, by Archimedes' screws and then to a larger extent, in the 16th century, by piston pumps, derived from mining experience. The special challenge was to transform the circular movement of the waterwheel into the linear motion needed to drive the piston pumps, which was first accomplished with rack and pinion drives, followed by the more efficient crankshafts and piston rods. The fountain masters of Augsburg played an important role in this development, as documented by Caspar Walters publications and his conserved authentic models.

From 1560 to 1617, Augsburg fountain masters and pump engineers exported Augsburg experience to Brussels (1602-03) in Belgium, Phalsbourg (1572) in France, Enns (1573), Steyr (1573) and Vienna (1568) in Austria, and several cities in Germany, such as Marburg/Lahn (1573), Frankenberg/Eder (1574), Stuttgart (1617), among others. In 1874, the methods developed in Augsburg were brought to Strasbourg, France, and fully developed there. In the same year, in Germany, Regensburg city requested for Augsburg to assist with the erection of drinking waterworks. Surveys to implement Augsburg system were also addressed in Kempten, in 1874, and in Munich, in 1876. The influence of Augsburg technology widespread and had a definitely impact, improving the water management system in several European cities.

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 (ii), (iv) and (vi).

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;*

The State Party justifies this criterion on the grounds that the Water Management System of Augsburg generated significant technological innovations, and that an international exchange of ideas regarding water supply and water generation evolved which, in turn, inspired local engineers in their drive for innovations, many of which were tested and implemented in Augsburg for the first time.

Brooks and artificial canals leading fresh water into the city grounds were documented for the first time in the City Law in 1276. This is the first document about a city's fresh water supply. A more outstanding fact is the continuous administration (and the expansion) of this water supply ever since, documented in the *Baumeisterbücher*, written documents which show the financing of the water system and are conserved in the city's archives – the first documented year is 1320.

Augsburg played an important role in the development of piston pumps since the 14th century and their techniques were constantly improved. The Augsburg water system became very well known all over Europe through the publications of the Fountain master Caspar Walter. In turn, the great number of expert visitors who travelled to Augsburg to see the technological improvements in its waterworks ensured that these improvements spread throughout Europe.

The strict separation between drinking and process water was introduced as early as 1545, long before research into hygiene matters established as a fact that impure water was the reason for many diseases. The Augsburg system of division was well known and recognized as a model, as descriptions in many manuals and travel books show.

This system lasted until 1879, when a new drinking water supply was developed, following new scientific knowledge about the influence of bacteria. The separation was probably unique and provided Augsburg with a source of very clean drinking water for more than 300 years.

Particularly the *Unteres Brunnenwerk* (Lower Waterworks) convincingly and credibly illustrates the technological development and achievement that has taken place in the area of water lifting. The transfer of know-how and the new technological developments of the time were documented in publications. The *Unteres Brunnenwerk* was pioneering a new technology, which came to be employed elsewhere only later.

ICOMOS considers that criterion (ii) has been justified.

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, as a technological and significant architectural ensemble, the Water Management System of Augsburg illustrates the use of water resources and the production of highly pure water as the basis for the continual growth of a city and its prosperity since the Middle Ages. Significant types of buildings, such as the canal complex system, the watercourses, the drinking waterworks, the water engineering structures, the monumental fountains, the water-cooled hall, and the hydraulic power stations, constituted the technological ensemble.

The elaborate canal system, which spans for over 28 km from south to north and has a combined length of more than 200 km, is the backbone of The Water Management System of Augsburg and directly connects its elements. The continuous use, extension and maintenance as well as the preservation of the whole System are testimony to pre-eminence in two significant stages in human history: the "water art" of the Renaissance, and the cutting-edge hydraulic technology of the Industrial Revolution.

The waterworks at the *Rotes Tor* consisting of the large and small water tower, the *Kastenturm* (box tower) and the upper and lower fountain master's house form together a functional unity. Waterworks are conceived of as technical installations and therefore are rarely given a highly artistic design like that in Augsburg. The ensemble of the three fountains, which is one of the characteristic features of Augsburg, is the only known triad of larger than life bronze sculptures in a public space north of the Alps. It is also an extraordinary example of the art of sculpture.

The hydraulic technological development was demonstrated by the water power plants and industrial canals that developed hydropower-based energy and electricity generation in Augsburg in all its phases throughout significant stages in human history. Together, the power plants form an outstanding technical ensemble whose diversity, multi-faceted character and state of preservation is unique.

All of the hydro-technical development stages present in Augsburg have been preserved and documented. Due to their high-value artistic design and execution, nearly all of the elements of The Water Management System of Augsburg represent exemplary models. They form an inter-related inseparable technical and artistic ensemble of extraordinary value.

ICOMOS considers that criterion (iv) has been justified.

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 Water Management System of Augsburg is directly and tangibly associated with the fundamental idea and concept of separating drinking and process water as a prerequisite for sustainable and social development. Many testimonies recognize Augsburg's leading position for water engineering over centuries, mentioned on the book *Hydraulica Augustana*, published by Caspar Walter in 1754, that became one of the early reference books for hydro-engineers. Also relevant is the collection of the so-called master builder's books gathered from 1320 to 1789 and archived from the very beginning, traditional records incorporated into the city's formal accounting system.

The role of the publication and circulation of Walter's *Hydraulica Augustana* book, as well as the ancient master builder's books kept by Augsburg municipality have been acknowledged in relation to the influence the Water Management System of Augsburg had beyond Germany and is better recognised through criterion (ii).

ICOMOS considers that the separation of drinking and process water and its relation with ideas, beliefs, artistic and literary works of outstanding universal significance has not been demonstrated.

ICOMOS considers that criterion (vi) has not been justified.

ICOMOS considers that the nominated property meets criterion (ii) and (iv), but criterion (vi) has not been demonstrated.

Integrity and authenticity

Integrity

The integrity of the nominated property is based on the functional unity and the wholeness of an integrated group of 22 mutually dependent elements, expressed in six typologies of structures that are a testimony to the city's long and continuous management of its water system. Furthermore, numerous sightlines have been identified and mapped to avoid negative visual impacts on the proposed Outstanding Universal Value of the nominated property.

The property has evolved over time and has undergone great transformations. From the various elements – brooks, canals, mills, weirs, water towers, etc. – a system gradually evolved, with interdependent and interactive elements, under the supervision and administration of the municipality. These elements were expanded, maintained, perfected and continually updated, and can still be seen and experienced today. The many canals extend from the rivers and the catchment area, branch out widely, flowing together again in watercourses. Numerous waterworks, hydro technical structures and power plants were preserved, including recent technical installations. The interrelation of parts of the system can be observed on the 22 elements that constitute the nominated property. The integrity of the Water Management System

of Augsburg refers to an asset that in its current state is the product of a long succession of adaptations, modifications and substitutions over more than 700 years.

ICOMOS noted that the former pumping and river catchment areas, as well as elements related to the downstream wastewater retreatment facilities were not part of the nominated property, nor of the buffer zone. The State Party clarified that the former river catchment areas were barely preserved. Regarding the wastewater treatment, while Augsburg had for centuries, a very advanced and high quality drinking water supply, the waste water system did not have the same pioneer character. The Mettlochkanal might have been very advanced for its time and the strict administration rules were very clear, but in comparison, the 19th century change to more modern systems came very late to Augsburg. There is only very small physical evidence of the early digs in archaeological sites.

The important role played by the *Stadtwald*, the city forest, was considered when assessing the integrity and wholeness of the nominated property, and following ICOMOS suggestion, the State Party included the city forest in the buffer zone.

Overall, the justification for inscription of the nominated property relies on the 22 individual elements, but also on the overall management of the water system. The additional information provided by the State Party enlightens how the water management system works as a whole (considering the groundwater collected from the city forest, the canals and waterworks, the monumental fountains, and the hydraulic power systems), but also the significance of the effective technical role of each individual element in the overall system: the network of canals, the complex of watercourses, the four drinking waterworks structures, the water-cooled butcher's hall, the two water engineering structures (weir and culvert), the three monumental fountains, and the ten hydraulic power stations.

The property is of adequate size to ensure the complete representation of the features and processes, which convey the property's significance.

Authenticity

The various elements are in a good state of structural and material repair and have retained a high degree of authenticity. Given the age of the property, there has been some considerable repair and reconstruction work (modern materials have extensively replaced earlier stonework in the canals, for example), but such work itself underpins some of the changing practices and technologies of water management, and documents the evolution of the system.

The city of Augsburg suffered considerable destruction from bombing during the Second World War, but its water management system was not destroyed and remained active. The greater impact was the destruction of the Senkelbach/Riedinger power plant's roof and the discontinuation of electricity generation. Its roof was reconstructed in 1945 and the production of electricity was reinitialized.

Most of the structures have kept their historic substance, form, use and materiality. Some of the structures saw their uses change in the 20th century, as was the case with the *Unteres Brunnenwerk* (Lower Waterworks), which ceased operation as a pumping station in 1879 and is now a restaurant.

The structure that is the most altered is the *Stadtmetzg*, which was fully renovated in 1939, to change its use from a butcher's facility to a Social Security office. While this means a partial loss of the building's historic fabric, it is still of great interest as a very rare example of a large pre-industrial meat-processing facility. The external design, the built volume and the urban relationship of the structure were kept, but the interior spaces and interior distribution were altered in 1939. A fire affected the south part of the building during the Second World War. In 2016, research revealed the original fabric from 1609 in the building's basement, resulting in an attempt to match the design intentions of the early 17th century on the exterior facade. The basement tunnel through which the water flowed to cool the butcher's workshops – now used as an archive – has been conserved, though it is no longer connected to the canals.

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

Evaluation of the proposed justification for inscription

ICOMOS considers that the comparative analysis for Water Management System of Augsburg warrants consideration of this property for the World Heritage List.

ICOMOS considers that the nominated property meets criterion (ii) and (iv), but that criterion (vi) has not been demonstrated.

The conditions of integrity and authenticity have been demonstrated.

Attributes

The attributes of the property are presented throughout the nomination dossier when addressing the description of the nominated property and the significance of each element. In general, the attributes are comprised of a network of canals and a complex of watercourses, drinking waterworks structures (pumping stations, water towers, houses, canal bridge), water engineering structures (weir and culvert), hydraulic power stations, monumental fountains and a water-cooled butcher's hall.

The Management Plan also introduces World Heritage attributes by defining key characteristics of the water system and specific features from each of the 22 elements, in order to define the protection of the assets. Augsburg has a great number of intangible, technical and physical features, which together define its special value.

In the Management Plan, attributes were also established to define the nominated elements and to relate, in each one of the structures, specific features to associated risks. The distribution of attributes and the conditions of authenticity and especially of integrity served as a foundation for the definition of the boundaries of the nominated property.

ICOMOS considers that the identified attributes contribute to the justification for inscription.

4 Conservation measures and monitoring

Conservation measures
Conservation of such a large system has been possible only through efforts made over many generations to preserve and safeguard the key elements of the system. For instance, conservation measures were carried out at the end of the 18th and the beginning of the 19th centuries on the pillars and basins of the fountains that are a characteristic feature of Augsburg's cityscape.

Presently, the World Heritage Office in Augsburg takes care of the regular review of the general state of conservation of the nominated property. In order to take a more sustainable and effective approach to conservation, the World Heritage Office established guiding principles and objectives in line with accepted conservation practice, which were included in the Management Plan currently being implemented. The Plan also includes an approach to nature conservation and protection measures.

A pro-active conservation approach has been established, supported by key indicators to measure the state of conservation of the property, thereby contributing to a more effective conservation of the different elements. A conservation strategy was defined for each of the 22 elements, establishing an expected response to the identified damages derived from the threats that jeopardise their state of conservation.

Monitoring
All 22 elements are monitored through regular assessment of their current state of conservation. The identification of damages, repair measures, and definition of conservation strategy for each element include heritage conservation, buffer zone, design guidelines and sustainable use. Detailed information on maintenance and conservation measures are also addressed in the Management Plan. The overall long-term conservation approach is observed in both state-owned and privately owned historic properties.

With regard to the monitoring of the state of conservation of the nominated property, it is suggested to correlate the attributes/features with the affecting factors as listed in the Third cycle of Periodic reporting, with a view to facilitate the link between monitoring at the property level with the periodic reporting wider exercise.

ICOMOS considers that the conservation measures and monitoring are adequate. The monitoring system in place for the protected architectural heritage appears well thought and tested. With regard to the ad-hoc indicators set up for the monitoring of the nominated property, it is suggested to correlate them with the attributes of the property and the affecting factors, taking into account those listed in the Third Cycle Periodic Reporting.

5 Protection and management

Documentation
The nomination dossier did not provide accurate and detailed maps of the 22 individual elements that constitute the nominated property. Upon request, the State Party presented as additional information on 12 November 2018 more precise information on each element, such as individual site plans, as well as Google aerial photographs.

Legal protection
An integrated protection regime appropriate for a property with the varied attributes of the Augsburg water system is detailed in the Management Plan. The regime rests on water pollution control (European Union Water Framework Directive) to protect water purity and the ecosystems dependent on it; nature conservancy laws (European Union Habitats Directive) relevant to the flora and fauna of the natural areas; Bavarian Heritage Protection Act *(BayDschG),* since monuments in Germany come under the sovereignty of the *Länder*; and building laws (Regional Planning Act), by which the city council controls town planning and development. These are the highest forms of protection available to the nominated property and its buffer zone, according to the State Party.

All the built elements are on the list of the Bavarian Heritage Protection Agency, including the *Eiskanal* canoe course, which the Agency promptly listed in preparation for this nomination to the World Heritage List. The nominated elements and their spatial relationships that lie within the former city walls are additionally protected by the area conservation scheme known as the *Ensemble Altstadt Augsburg* (Old Town Augsburg Ensemble).

The city has also elaborated two sets of planning guidelines relevant to the application for inscription on the World Heritage List, which the city expects will help safeguard the cultural and natural assets of the nominated property, and which was implemented with the Management Plan.

The 5.00 m wide legal protection zone on both sides of the canals acts as the buffer zone for most of the nominated property. The 5.00 m width is a traditional protective measure that has been used in Augsburg for hundreds of years. The State Party was requested to explain about the protective measures in place, to control urban development in the wider setting, which could affect the property. The State Party considers the existent protective mechanisms of the building code and Heritage Protection Act sufficient to protect the nominated

property, as they are beyond the proposed buffer zone. This is the case of the Federal Regional Planning (*ROG*), the State Development Programme *(LEP),* the Bavarian Heritage Protection Act *(BayDSchG)*, the Bavarian Building Regulation *(BayBO),* and the Federal Building Regulation *(BauGB)*. For the State Party these regulations provide a legally based protective mechanism that is applicable beyond the 5 m buffer zone canal protection. Also, for the State Party, Augsburg World Heritage coordination office would be in a position to influence urban developments and apply legal principles to guarantee protection of the nominated property.

ICOMOS considers that further exploring on how the buffer zone relates to the broader setting and what, if anything, needs protecting in the broader setting in order to protect the watercourses and the canals in an effective way from urban development and factors that could affect the site would be needed, as well as the implementation of subsequent measures.

Heritage Impact Assessments to assess the potential impacts on the property of any new projects or major restorations located in the buffer zone and its vicinity, should be undertaken.

Management system
A Management Plan was prepared for the nominated property and adopted by Augsburg City Council. The objective of the Management Plan is to safeguard the proposed Outstanding Universal Value of the nominated property. Measures for the sensitive sustainable development of the nominated property will be balanced with the conservation of the nominated property. In this context, the Management Plan serves as a strategic instrument to define objectives with regard to conservation and sustainable development, for evaluating the need for action, for pointing out areas of synergy and conflict, for coordinating existing measures and for defining high-priority projects.

The Management Plan explains in detail the coordination and management of the nominated property, and the proposed management system to protect the proposed Outstanding Universal Value of the nominated property. There is a World Heritage coordinator who is a key facilitator between different bodies, a number of which are established to help coordinate World Heritage-related initiatives. This is the case of the Advisory Council, as well as two Steering groups, one of which will advise on major restorations and new constructions pursuant to paragraph 172 of the *Operational Guidelines*. Notwithstanding, the State Party should previously inform the World Heritage Committee of any major restorations and new constructions, as required by paragraph 172.

To coordinate the Management Plan, the City of Augsburg established a World Heritage Office, which evaluates projects and planned constructions and verifies their compatibility with the World Heritage Convention and the *Operational Guidelines*. The Office also assesses the regular review of the general state of conservation of the nominated property.

Visitor management
An inscription on the World Heritage List would probably increase the number of visitors to Augsburg. As the nominated property extends over a considerable area, an increase in the number of visitors is not likely a problem, as they will not be concentrated in few places.

In order not to jeopardize the most fragile elements of the nominated property, some preventative measures have already been put in place to control the number of visitors. This is the case for accessing the medieval water tower in *Rotes Tor*, where only 14 persons are allowed to ascend at one time due to the fragile wooden stairways and ceilings. The Management Plan also has other measures that are being planned, such as accessing some elements only by means of guided tours.

Augsburg Tourism has an array of tourist communication merchandise about the elements in the nominated property. A World Heritage visitor and information centre is already under preparation in the city centre, which will provide information for both local citizens and visitors. Educational material is also being planned to guide visitors. A strategic signage and orientation scheme is being revised to produce a unified design and information system to ensure that people can experience the entirety of the water system and its diverse cultural elements.

Community involvement
There is a continuing community know-how related to a technical understanding of water management. A notable tradition of managing water resources for the benefit of the community can be traced back to fountain masters such as Caspar Walter and master builders such as Elias Holl, all the way to the artisans who created the Galgenablass culvert and the early canals, to the engineers that at present operate the hydraulic power plants and protect the city's natural sources, through to the designers of the canoe course and the *Maschinenfabrik-Augsburg-Nürnberg* (MAN) industrial manufacturing company. The local community has long been actively involved with the water management system of Augsburg, though its level of support for the nomination of the property is not clear in the nomination dossier.

Evaluation of the effectiveness of the protection and management of the nominated property
A fully detailed Management Plan explains in detail the current management of the nominated property. Noted are the usefulness of the comprehensive document, the balance between the experience and size of the management team, and the effectiveness of its management with related entities and the local community.

ICOMOS considers that the protective measures and building regulations currently in place for buildings and landscapes located near the 5 m canal buffer zone should be reinforced, as the canals could be vulnerable to urban development.

ICOMOS considers that the property's protection and proposed management is adequate. Further exploring on how the buffer zone relates to the broader setting and what, if anything, needs protecting in the broader setting in order to protect the watercourses and the canals in an effective way from urban development and factors that could affect the site would be needed, as well as the implementation of subsequent measures.

6 Conclusion

ICOMOS considers that the comparative analysis for Water Management System of Augsburg warrants consideration of this property for the World Heritage List. The Water Management System of Augsburg is of great importance with the canal network being mentioned for the first time in a written City Law document in 1276; and the waters for drinking and process water being separated, at least since 1545. ICOMOS considers that the nominated property meets criteria (ii) and (iv), but that criterion (vi) has not been demonstrated. The conditions of integrity and authenticity have been met.

The continue use of the water management system throughout seven centuries was demonstrated. However, it has not been established that today, the management is still being carried out in a traditional way, especially when compared to the historical management of the water.

The general protection and management of the nominated property are adequate. Reinforcement of protective measures around the canals to control urban development should be implemented.

The state of conservation is generally good, and the conservation measures and monitoring are adequate.

The main factors affecting the property are development pressures, environment pressures, natural disasters, possible rise in the number of visitors, and number of inhabitants in the buffer zone. An Heritage Impact Assessment for the project of a new tram track and a bicycle path planned near the canals should be undertaken.

With regard to monitoring, the overall approach is generally satisfactory.

7 Recommendations

Recommendations with respect to inscription

ICOMOS recommends that the Water Management System of Augsburg, Germany, be inscribed on the World Heritage List on the basis of **criteria (ii) and (iv)**.

Recommended Statement of Outstanding Universal Value

Brief synthesis

The Water Management System of Augsburg is a sustainable system of water management that evolved in successive phases through the City's application of innovative hydraulic engineering, demonstrating an exemplary use of water resources over the course of more than seven centuries.

It represents an urban water landscape that is unparalleled in terms of its surviving successive technical diversity. The system includes: the sources of both potable and process water (spring water and river water, respectively) and their network of canals and complex of watercourses that kept the two types of water in strict separation throughout the system; water towers from the 15th to 17th century that housed pumping machinery driven by water wheels and later by turbines to counter the abrupt topographical change presented by the plateau that hosts the historic city centre of Augsburg; a water-cooled butchers' hall from the early 17th century; a system of three monumental fountains of extraordinary artistic quality; Hochablass Waterworks that represents modern cutting-edge hydraulic engineering of the late-19th century; hydropower stations, and finally the hydroelectric power stations that continue to provide sustainable power.

Criterion (ii): The Water Management System of Augsburg has generated significant technological innovations, which sustained Augsburg's leading position as a pioneer in hydraulic engineering. The strict separation between drinking and process water was introduced as early as 1545, long before research into hygiene matters established as a fact that impure water was the reason for many diseases. An international exchange of ideas regarding water supply and water generation evolved which, in turn, inspired local engineers in their drive for innovations many of which were tested and implemented in Augsburg for the first time.

Criterion (iv): The Water Management System of Augsburg illustrates the use of water resources and the production of highly pure water as the basis for the continual growth of a city and its prosperity since the Middle Age. The architectural and technological monuments preserve successive socio-technical ensembles that are vivid testimony to the City's urban administration and management of water that brought pre-eminence in two key stages in human history: the water "art" of the Renaissance, and the Industrial Revolution.

Integrity

The integrity of the Water Management System of Augsburg is based on the functional unity and the wholeness of an integrated group of 22 mutually dependent elements, expressed in six typologies of structures that are a testimony to the city's long and

continuous management of its water system. The technical-architectural ensemble constituting the system is of adequate size and fully represents the features and processes, which lend the property its importance.

The integrity of the property refers to an asset that in its current state is the product of a long succession of adaptations, modifications and substitutions over more than 700 years.

Authenticity

The Water Management System of Augsburg is an exceptional preserved structures that document the development of an urban water management system since medieval times. The system function is based on the preserved ensemble of water management features such as canals, water courses, waterworks for the production of drinking water, hydro-technical structures and buildings, a triad of fountains of extraordinary artistic quality, a water-cooled meat cutting, processing and sales facility and a range of hydropower plants.

Management and protection requirements

All 22 elements of the Water Management System of Augsburg have been included in the Bavarian heritage list. They are protected by law in accordance with the Bavarian Heritage Protection Act. All the important upkeep or change measures and all construction interventions are to be coordinated with the Lower Heritage Protection Authority of the City of Augsburg and require approval in accordance with heritage protection law. Large parts of the property lie in conservation and FFH (Flora-Fauna-Habitats) areas or within the existing heritage protection areas 'Ensemble Old Town Augsburg' and 'Olympic Canoe Course'. This provides extra protection for the property, as strict regulations exist for water quality control and nature conservation in addition to building and heritage preservation. The protection, sustainable use, development and design quality of the property and its setting are also ensured by various ordinances, master plans and guidelines elaborated by the City of Augsburg. Buffer zones have been designated and mapped however protective measures in the wider setting of the property should be reinforced.

A World Heritage Office is responsible for coordinating and ensuring the preservation and proper management of the property. Among other responsibilities, it checks any projects and planned constructions against compatibility with the World Heritage standards and takes care of the regular review of the general state of conservation of the property. A Management Plan has been compiled to define the framework of the future management of the property.

Additional recommendations

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

a) Further exploring on how the buffer zone relates to the broader setting of the property and identify areas which would need to be protected, in order to reinforce the protection of watercourses and canals from urban development and factors that could affect the site, as well as implementing the subsequent measures,

b) Undertaking Heritage Impact Assessments to assess the potential impacts on the property of any current or planned projects, including the projects for a new tram track and bicycle paths near the canals;

Revised map showing the boundaries of the nominated property (November 2018)

Aerial view of Hochablass Waterworks

Wolfzahan power plant

City area canal - Hinterer and Mittlerer Lech

Hercules fountain