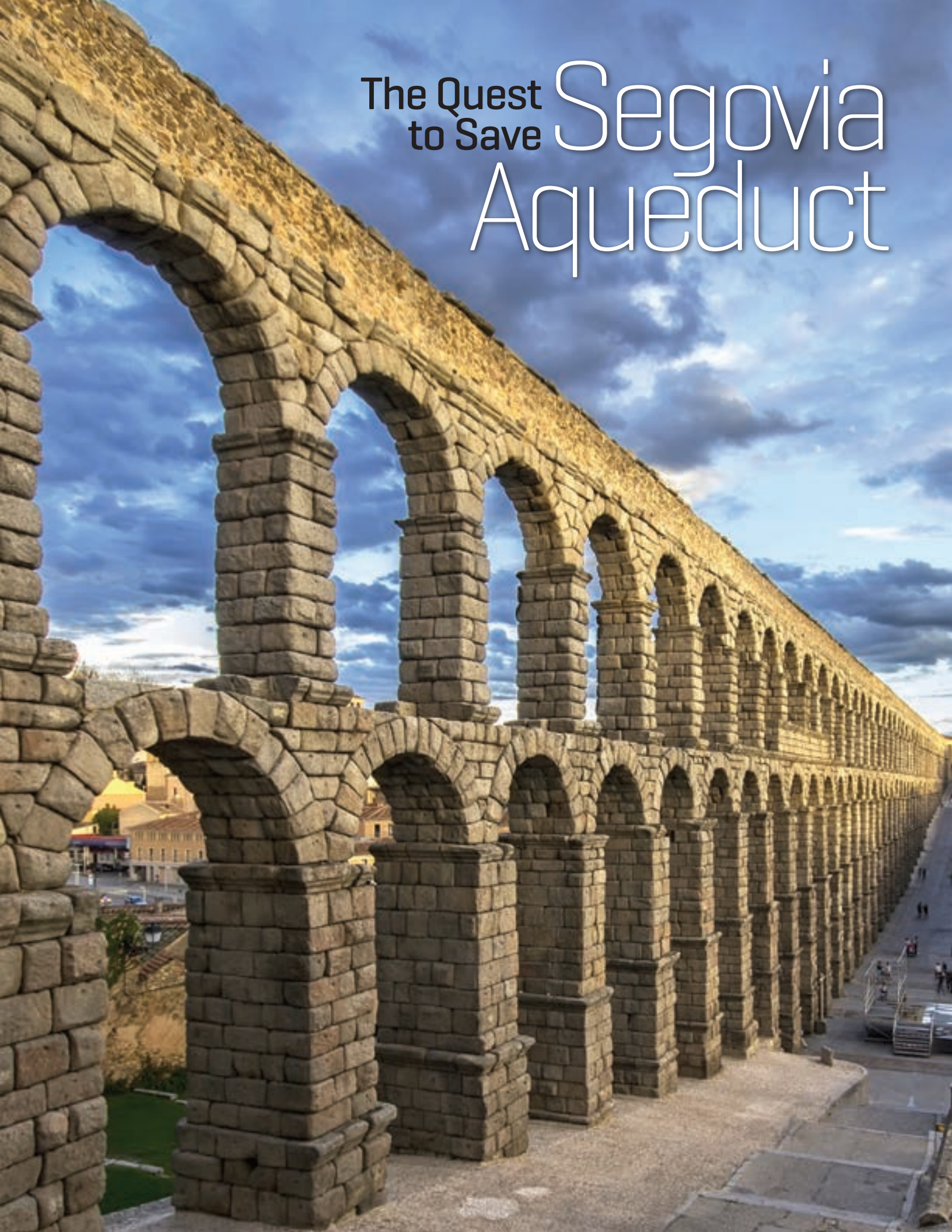

The Quest to Save Segovia Aqueduct

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WORLD MONUMENTS FUND

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Contents

Introduction

THE AQUEDUCT OF SEGOVIA presents a dramatic silhouette on the landscape and is immediately recognizable as something worthy of attention. It is a reminder of the vast reach of the Roman Empire across Europe in the first century and their legendary ability to harness water and other natural resources. Astonishingly, the Aqueduct of Segovia continued to transport water to the urban center well into the early decades of the twentieth century. The Aqueduct was placed on the 2006 World Monuments Watch to call attention to considerable conservation needs of the structure and the desirability to improve documentation of the structure and develop a comprehensive management plan to protect the site in the future, from its source at the Frío River to the hydraulic pipes under the City of Segovia.

The inclusion in the Watch created great media attention in Spain and a general outcry to protect this iconic monument, which remains one of the most intact Roman aqueducts in Europe. The Old Town and Aqueduct of Segovia was inscribed on the World Heritage list in 1985. Of note in the description of the Outstanding Universal Values of Segovia is the layered history that is evidenced in every aspect of Segovia from the streetscape to urban plan and individual buildings, which chronicle the history of settlement from antiquity to the thriving city that exists today. The Aqueduct of Segovia is one of the principal monuments giving shape to the city and there is no doubt that this marvel of engineering allowed the city to continue to flourish

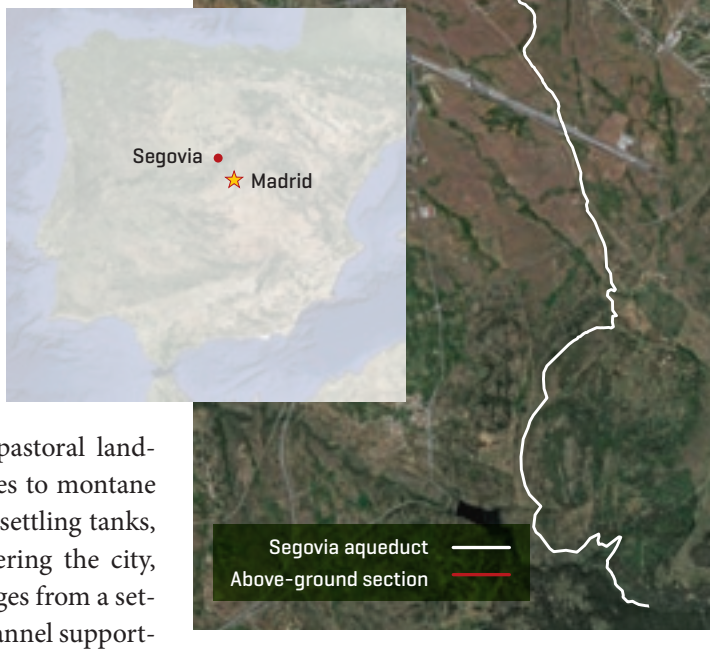
long after the Roman period. The great building campaigns of the medieval and Renaissance eras were made possible in part by the civil works achieved by the Romans. The Aqueduct of Segovia is prized for its endurance in such remarkable condition as only remnants of other great Roman aqueducts survived in Toledo, Seville, and other locations in Spain.

Through the generosity of American Express, WMF was able to capitalize on the attention gained through the 2006 World Monuments Watch and convene a workshop of all stakeholders at the national, municipal, and local level to review the proposed conservation plan and develop strategies to protect the monument to the fullest extent possible. In 2009, a technical workshop on the conservation program was held in Segovia in collaboration with the World Heritage Centre.

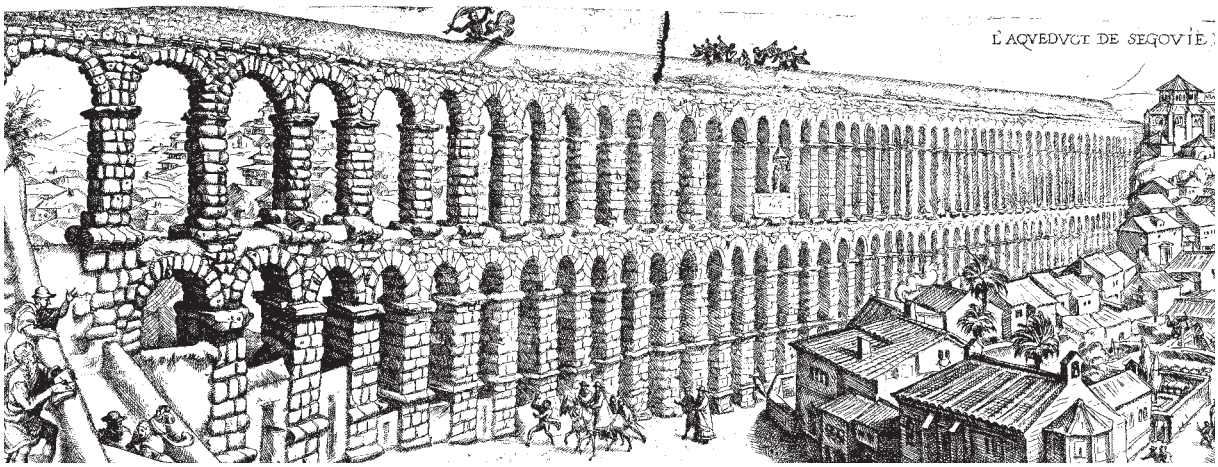
This publication, supported by American Express, represents the full breadth of discussions held and the materials developed as a result of these workshops. The intention to protect the Aqueduct of Segovia was always evident, but at the time of the 2006 World Monuments Watch, the need to look more critically at the long-term management strategy for the monument was a priority. As the essays in this publication illustrate, there is now a wealth of new information available about the Aqueduct's construction and materials. There is also stronger local attention on the need to continue to safeguard an ancient monument that continues to define the character of Segovia.

Anatomy of an Aqueduct

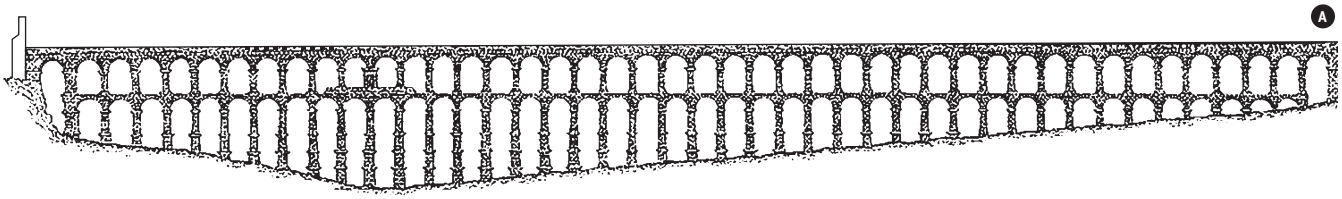
THERE ARE MONUMENTS that punctuate a landscape and those that come to define it. Such is the case with the Segovia Aqueduct, which is among the largest surviving Roman structures on the Iberian Peninsula and one of five sites built during the more than six centuries of Roman rule—from ca. 218 B.C. to A.D. 460—inscribed on UNESCO's World Heritage List. A masterpiece of engineering, the aqueduct supplied the Spanish city, 100 kilometers northwest of Madrid, with potable water for nearly two millennia. So synonymous are its iconic arches with Segovia that a rendering of the arcade has served as the central graphic element of the city's coat of arms since 1273.

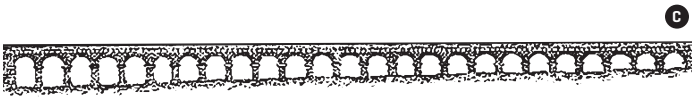


The hydraulic system stretches 16.2 kilometers, from its freshwater source, the Frío River, in the lush rolling hills of the Sierra de Guadarrama, to its terminus at the Alcázar, an early twelfth-century castle built on a precipice overlooking the junction of the Eresma and the Clamores valleys, which marks the northwest corner of the medieval walled city. For most of the route, its waters traversed a pastoral landscape—ranging from pine forests and oak copses to montane grasslands—coursing through a series of ducts, settling tanks, sluices, and underground channels. Upon entering the city, however, the aqueduct's U-shaped conduit emerges from a settling tank at the Calle los Cañuelos, the water channel supported by stunted arches that increase in height and then double as the terrain recedes in elevation. Only for its final stretch, where the water transport system must bridge a deep depression at the Plaza del Azoguejo, does it reach its full height of nearly 29 meters. Just beyond the plaza, the arcade vanishes some 40 meters inside southern wall of the old city, which was built atop a large outcrop of rock. From there, the hydraulic pipes continue underground for more than a kilometer.



One of the earliest known representations of Segovia's aqueduct is this engraving by Dutch Northern Renaissance artist Jan Cornelisz Vermeyen (1504–1559).





The aqueduct bridge, which represents a mere 5.5 percent of the total hydraulic system, is supported by 118 pillars and 119 arches, 42 of which are of double height, and has a lateral expanse of more than 800 meters. The raised structure is composed of some 25,000 ashlars—the majority of which are of *berroqueña*, a locally sourced, coarse-grained granite—originally held together without the aid of mortar or brackets.

An Aqueduct Through Time

WHILE THE AQUEDUCT is thought to have been commissioned by the Flavian emperor Domitian (r. A.D. 81–96), there is scant information about its construction sequence or the Roman settlement it originally served, save for disjointed finds that have come to light during municipal projects such as road construction and electrical installations or from limited archaeological investigations undertaken in concert with emergency repairs to the aqueduct bridge, namely during the restoration campaigns of 1970–74 and 1992–94, as well as some test excavations subsequently carried out in 1998.

What is known, however, is that the first major repairs to the aqueduct were undertaken during the reign of Trajan (r. A.D. 98–117), who boasted of his efforts to refurbish it in an inscription rendered in bronze letters on both to the east and west façades of the attic structure—above pillars 107, 108, and 109—at the point where the bridge reaches its maximum height in the Plaza del Azoguejo.

While the letters themselves have long since disappeared, holes for the anchors that once held them remain. In the Summer of 1992, noted Hungarian archaeologist Géza Alföldy and photographer Peter Witte of the Deutsches Archäologisches Institut (German Archaeological Institute) in Madrid—were lifted up to the attic in the basket of a crane to carry out a detailed photogrammetric survey and mapping of the hole-ridden panels on either side. Not long thereafter, Alföldy was able to render a reading:

Imp(eratoris) Nervae Traiani Caes(aris) Aug(usti), p(ontificis) m(aximi),
tr(ibunicia) p(otestate) II, co(n)s(ulis) II,
patris patriae iussu
P(ublius) Mummius Mummianus et P(ublius) Fabius Taurus II
viri munic(ipii) Fl(avii) Segoviensium aquam restituerunt.

"By order of Emperor Nerva Trajan Caesar Augustus, Pontifex Maximus,
holder of the tribunician power for the second time, consul for the second time,
father of the country,
Publius Mummius Mummianus and Publius Fabius Taurus, duumvirs [co-magistrates] of the Flavian municipality of the Segovians, restored the aqueduct."

Agencia EFE

Géza Alföldy and Peter Witte study the aqueduct.

Alföldy's interpretation of the aqueduct's inscription.

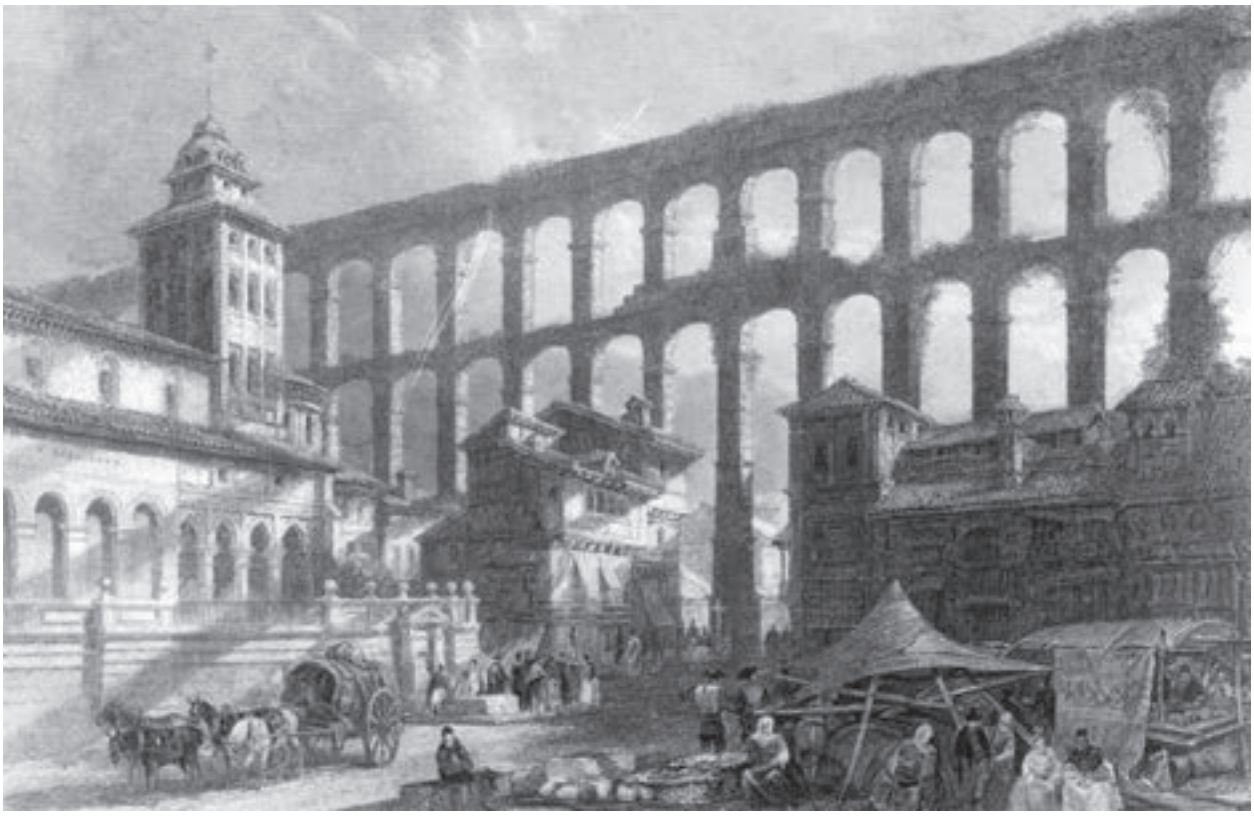
Given the integral nature of the attic structure within the overall design of the aqueduct bridge, and the fact that the inscriptions on either side seem not to overlay ones of greater antiquity, it is quite possible that Trajan's "restoration" was more likely a completion of the structure or perhaps entailed a substantial reconstruction or replacement of earlier architectural elements, rather than merely a maintenance exercise as the text would suggest. Such a notion may be underscored by archaeologist Germán Prieto Vázquez's discovery in 1998 of a Roman coin, a *sestertius* from the reign of Trajan along with abundant Roman ceramics in the fill near the foundations on the eastern side of arches 115 to 117 in the Plaza del Azoguejo.

In the centuries that followed, there is little information in the historical record about the monument or its condition, until the reign of Alfonso VI (ca. 1040–1109), who may have appropriated some of the aqueduct's granite ashlars to reinforce the walls of the medieval city, which along with the first 36 arches of the aqueduct, had suffered damage during an aggressive attempt by Al-Mamún of Toledo to bring Segovia under Moorish hegemony in 1072. Evidence suggests efforts to rebuild the city continued well into the twelfth century at which time the Alcázar was constructed, in all likelihood atop the remains of earlier Roman fortifications: the earliest references to the castle date to 1120.

According to archival documents, repairs to the aqueduct bridge itself may have begun as early as 1463, continuing in earnest with what was purported to be the 'faithful reconstruction' of the 36 arches and pillars damaged by the Moors, initiated by Isabella I of Castile y León in 1483 and carried out between 1484 and 1489 by Fray Juan de Escobedo under the aegis of Don Pedro de Mesa, prior of the Jerónimos del Parral Monastery. Repairs made at this time are evident in the slightly pointed arches (numbers 13 to 21) along the Calle los Cañuelos.

The pointed crowns of some arches indicate that they were part of a fifteenth-century restoration program.

It is clear from historical records that maintenance of the aqueduct continued throughout the sixteenth century and early seventeenth century, with much of the system—ducts, settling tanks, and masonry walls—restored by 1614. Subsurface



Casa Moreno. Archivo de Arte Español (1893–1953) / Fototeca del Instituto del Patrimonio Cultural de España, Ministerio de Educación, Cultura y Deporte.

An 1837 engraving by Scottish artist David Roberts shows the encroaching construction that once threatened the aqueduct.

remains, including waterlines within the city wall that lead to the Alcazar, appear to date to this period, and hint at the existence of a secondary water distribution network that may have been added at this time.

For the remainder of the seventeenth century and throughout the eighteenth century work continued piecemeal, including, in 1775, the paving over of an open portion of a canal leading into the city. It is also clear that during this period dwellings began to encroach on the structure. In 1803 and 1806, several houses and other assorted buildings erected in and around the arches were dismantled in the Plaza del Azoguejo. In 1820–21, D. Joaquín de Góngora undertook a structural study of two arches, which had begun to develop noticeable cracks. In the decades that followed, still more emergency repairs were carried out, including the shoring up of six arches on the Calle los Cañuelos, where the aqueduct emerges above ground, in 1868.

Collectively, these early efforts were aimed first and foremost at maintaining the city's vital water supply rather than preserving the structure as a historical and culturally significant monument until the aqueduct was declared a national treasure by royal decree in October 1884; in 1941, the aqueduct bridge was given the further distinction of being named a "Monumento Histórico Artístico de carácter nacional." Despite such recognition, it would be another three decades before the first major conservation campaign aimed at restoring the bridge structure was undertaken.

Between 1970 and 1974, in a lead-up to the city's "bi-millennium" celebrations, the Ministry of Public Works and the Ministry of Fine Arts charged engineers Carlos Fernández Casado and Aurelio Ramírez Gallardo with carrying out extensive repairs and consolidation of the aqueduct, which included the reinforcement of broken blocks; the stabilizing of arches exhibiting differential movement with the insertion of brass rods to restrict the motion of adjacent ash-

lars; and the filling in of voids, where the relatively porous stone had been lost to the corrosive effects of the elements, with cement mortars and resins. The bridge was also cleaned of pollutants and vegetation. In the wake of the restoration, traffic was allowed to pass beneath the aqueduct in the area of the Plaza del Azoguejo to ease congestion within the city. (At one point the Junta de Castilla y León, the regional government, even entertained the notion of removing one of the pillars to widen traffic lanes.)

On December 6, 1985, the aqueduct along with the historic center of Segovia, was inscribed on UNESCO's World Heritage List during its ninth session. While such international recognition dramatically increased the city's visibility as a tourism destination; it also brought with it increased international pressure on the Junta de Castilla y León to properly manage the monument and its environs.

Traffic through the aqueduct's arches is now prohibited.

By 1987, engineer Antonio Mas Guindal had determined that vibrations from the passing vehicular traffic were beginning to take their toll on the aqueduct bridge, calling into question its structural integrity and raising the alarming prospect that parts of it might even collapse. The media were quick to jump on the story, which prompted the Council of Europe to send a mission led by José María Ballester, who invited noted engineer Giorgio Croci—of Rome's La Sapienza University—to investigate the aqueduct's structural stability. While Croci determined

El Adelantado de Segovia

Prior to 1992, traffic passed through the aqueduct. At one point there was discussion of removing one of the pillars to ease congestion.

Early twentieth-century photographs of the aqueduct by German photographer Otto Wunderlich (1886–1975) illustrate its long importance as Segovia's center of trade and commerce.

Photos courtesy Fototeca del Instituto del Patrimonio Cultural de España, Ministerio de Educación, Cultura y Deporte.

that the structure was not in danger of immediate collapse, wind erosion, and more importantly, a dramatic spike in atmospheric pollution wrought by vehicular traffic were compromising the integrity of the individual blocks, evident in substantial stone deterioration and a visible reduction in the size of contact surfaces between ashlars, which increased the structural load on ever-weakening masonry blocks.

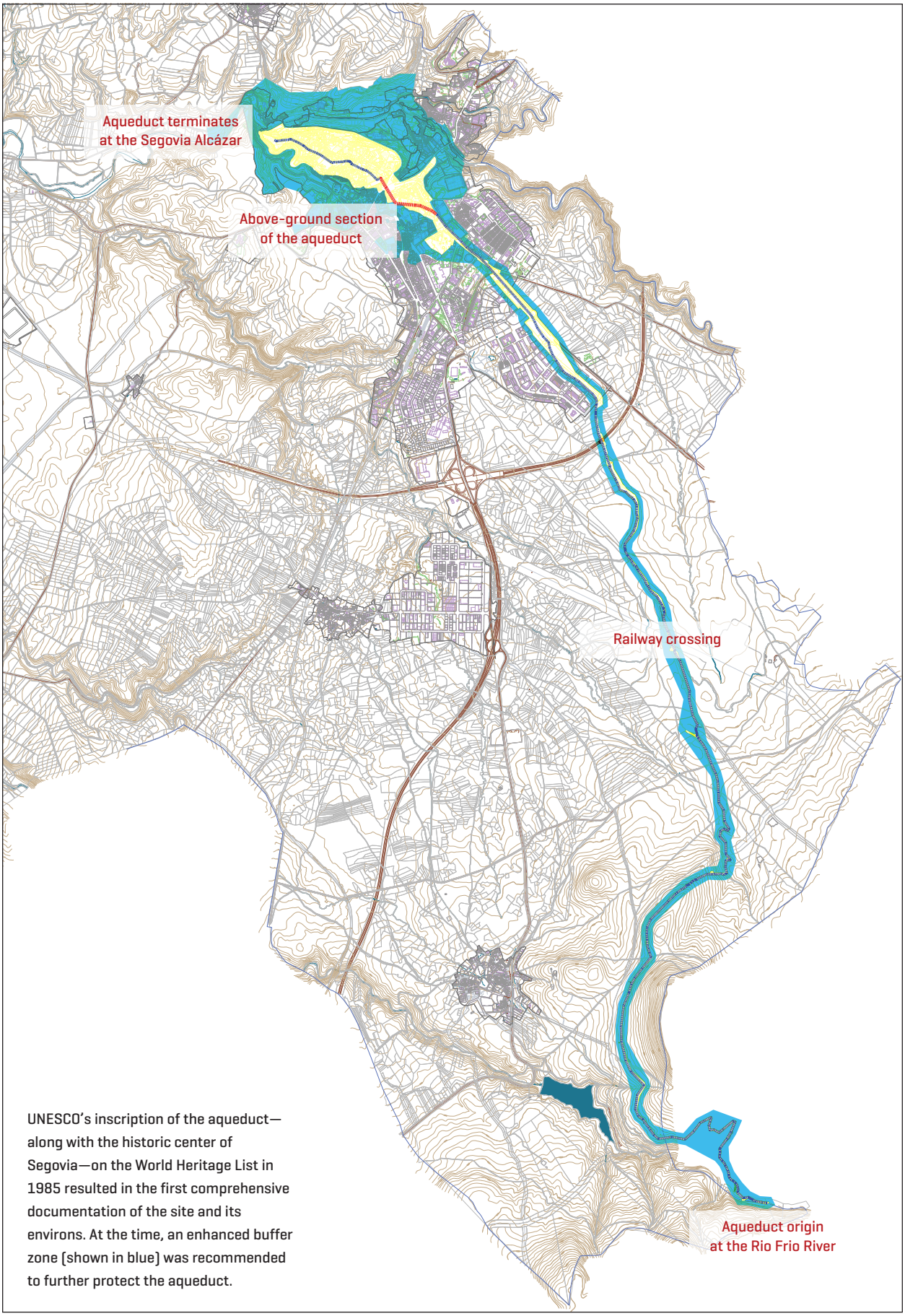
In 1992, traffic beneath the aqueduct bridge was eliminated and the Junta de Castilla y León embarked on a campaign to stabilize the structure, an effort underwritten in large part by Caja Madrid, one of Spain's leading banks. Far more aggressive than prior interventions, the conservation program—carried out under the direction of architects Francisco Jurado Jiménez and Marco Antonio Garcés—included sandblasting of the aqueduct's surface to remove deposits; reinforcement of architectural elements with stainless steel rods, as had been undertaken two decades earlier; the reshaping of contact surfaces to redistribute the structural loads; and consolidation of eroded ashlars and filling of fractures with a variety of acrylic and epoxy mortars and resins. At that time, the water channel atop the aqueduct bridge was also lined with lead in an attempt to prevent water seepage while an alcohol-based biocide was applied to stone surfaces to arrest biological growth. This in turn was followed by the application of a water repellent to limit the moisture absorption within the weakened stone. Although the aqueduct had ceased all function as a water transport system by this time, Jurado undertook the restoration of the silt settling house at the Calle los Cañuelos to increase visitor appeal.

Although many of the aqueduct's structural issues were addressed during the campaign, little could be done to halt the erosion of the masonry blocks themselves, which have continued to deteriorate. Within a decade, treatments aimed at mitigating biological growth and limiting water ingress had long since lost their efficacy. More disturbing, however, it seemed that several interventions carried out in 1992 actually exacerbated rather than remedied the aqueduct's structural problems, including sandblasting and the use of acrylic and epoxy mortars, which had started to discolor, despite the addition of particulate stone to disguise their placement, while the lead channel, installed to minimize water infiltration had largely disintegrated. In addition, few if any measures had

Erosion of the aqueduct's ashlars has rounded their corners and reduced the area of contact surfaces.

Inappropriate patchwork with concrete and a variety of acrylic and epoxy mortars and resins threatens the structure.

In 1992 the water channel atop the aqueduct bridge was lined with lead in an attempt to prevent water seepage.



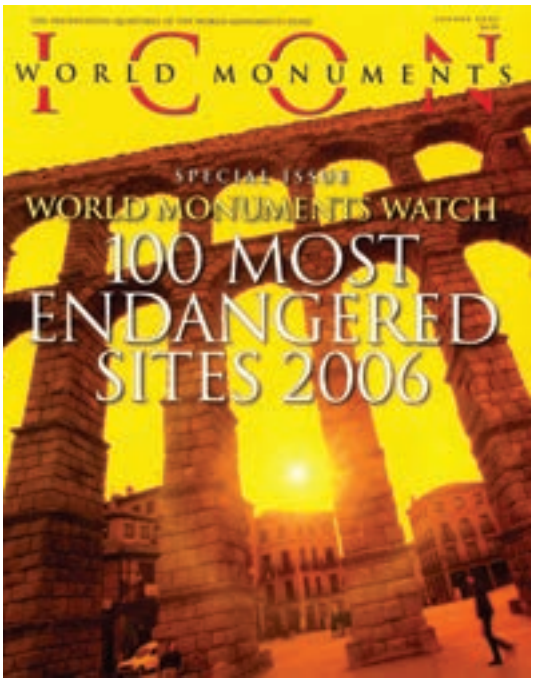
UNESCO's inscription of the aqueduct—along with the historic center of Segovia—on the World Heritage List in 1985 resulted in the first comprehensive documentation of the site and its environs. At the time, an enhanced buffer zone (shown in blue) was recommended to further protect the aqueduct.

Construction of a new rail line in 2000 destroyed a portion of the aqueduct's subterranean construction.

been taken to protect the subsurface portions of the water system. The location and conditions of some stretches outside the city limits remain undocumented to this day.

This lack of documentation and public awareness of the extent of the hydraulic system, some say, was to blame for the destruction of a subterranean portion of the aqueduct during construction of a new high-speed rail line between the city and the Sierra de Guadarrama in 2000–2001. At that time, contractors cut through some 14 meters of underground construction midway between the aqueduct's source and terminus at a locale known as the Casa de Aldeanueva. Perhaps more important, the destruction highlighted the questionable stewardship of the World Heritage site on the part of the Junta de Castilla y León and the need for aproper management plan, made all the more urgent with UNESCO's adoption of new guidelines outlined in its *Budapest Declaration* of 2002. Sites seeking World Heritage List inscription would be required to have a proper management plan in place as part of their dossiers; in 2004, the World Heritage Committee further mandated that sites already inscribed, including Segovia, which did not have a management plan in place, would be required to develop one.

The seemingly precarious state of preservation of the aqueduct and the damage caused by the rail-line construction, along with the pressing need to develop a proper management plan, prompted the Segovia's Councilor of Historic Heritage, Concepción Domínguez, to nominate the Roman wonder for inclusion on WMF's 2006 World Monuments Watch, a move that would anger the regional government, which had carried out the most recent restoration work and which was ultimately responsible for the management of local historic resources.



Publicity surrounding the aqueduct's inclusion on the 2006 World Monuments Watch prompted global action.

Quest to Save an Ancient Treasure

RARELY HAS THE WORLD MONUMENTS WATCH prompted as much controversy as when the Roman aqueduct of Segovia was included in 2006. The 2005 announced laid bare the problems that can arise when municipalities, regional governments, ministries of culture, and heritage organizations share jurisdiction over a country's cultural patrimony but have disparate notions of what is best for it. Such situations all too often result in a stalemate wherein sites at risk are left to deteriorate—the Segovia Aqueduct a case in point. Despite its chilly reception, the listing eventually galvanized support on the local, national, and international levels for a common goal, to save one of Iberia's most important and iconic monuments.

Following the aqueduct's inclusion on the Watch, long-time WMF corporate supporter American Express stepped forward with a grant of $125,000 to underwrite a series of workshops aimed at reaching a consensus on how best to manage the monument and to carry out pilot studies at both the micro and macro levels. Collectively, these efforts prompted the development of a comprehensive management plan for the site, a project that would take the Junta de Castilla y León more than six years to draft. Perhaps more important, the studies carried out in the wake of the listing underscore the fact that the aqueduct's greatest value in our time has yet to be realized, through an environmental reinterpretation of the totality of the hydraulic work, which connects the historic city to a bountiful natural preserve from which it originates.

At that time the 2006 Watch List was announced, the *consejera* (cultural advisor) of the Junta de Castilla y León, Silvia Cañadas, demanded that the aqueduct be withdrawn from the Watch List in exchange for a willingness of the regional government to make a commitment to the City Council of Segovia to jointly address the maintenance and upkeep of the monument. (It should be noted that monuments are not removed from WMF's Watch List but rather they may be omitted from subsequent lists, issued every two years, should efforts to address risks posed and/or conservation challenges be completed or well underway.)

At the international level, the listing prompted UNESCO to consider including the aqueduct on its list of "World Heritage in Danger." Hoping to avert such recognition, the Spanish Ministry of Culture through its Director General of Fine Arts, Julián Martínez, made an additional commitment of €100,000 annually toward the monument's conservation.

In February 2006, WMF-Spain convened its first meeting in Segovia. Among the international experts invited to participate were Isabel Rodá, a professor of archaeology at the Autonomous University of Barcelona; Alonso Zamora, director of the Museum of Segovia; historian Antonio Ruiz; noted structural engineer Giorgio Croci of Rome's «La Sapienza» University; and Lisbon-based geologist and structural engineer José Delgado, who served as an advisor to WMF. The meeting was held in collaboration with the Institute of Historic Heritage—its director, Álvaro Martínez Novillo, and its department head, Ramón de la Mata Gorostizaga, having actively supported Watch Listing. Collectively, they embarked on the task of charting a plan of action for the site that would prove to be as challenging politically as it would be technically.

Although UNESCO had stopped short of including the aqueduct on its manifest of sites at risk following Watch Listing, the organization emphasized the need for a holistic approach to the conservation of the site at its 30th session held in Vilnius, Lithuania, in July 2006, noting in the minutes that:

> **91.** ***Old Town of Segovia and its Aqueduct (Spain) (C 311 rev) Decision 30 COM 7B.91***
> *The World Heritage Committee, Having examined Document WHC-06/30.COM/7B, Recalling Decision* ***29 COM 7B.103****, adopted at its 29th session (Durban, 2005), Encourages the State Party to seek specific international expertise in the conservation of major classical monuments and to keep the Centre and ICOMOS informed on its outcome.*

EL ADELANTADO DE SEGOVIA

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SEGOVIA / 16
La Junta comenzará la próxima semana la vacunación contra la brucelosis bovina

SEGOVIA / 17
La DGT y la Guardia Civil de Tráfico conmemoran el 50 aniversario de su creación

SEGOVIA / 19
El Ayuntamiento de Cantalejo abrió ayer al público la piscina climatizada

PATRIMONIO

Ayuntamiento y Junta ven "necesario" un Plan de Gestión para el Acueducto

WORLD MONUMENTS FUND

José María Bellido coordina las jornadas

WMF–Spain's 2009 meeting was covered extensively in the local press.

Not long thereafter, the Directorate General of Heritage for the Junta de Castilla y León, which had so vehemently opposed Watch Listing of the aqueduct, finally agreed to participate in the meetings and collaborate on the development of a management plan through its Director General, Enrique Saiz, with additional technical input from José Luis Cortés, Ignacio Barroso, and Jesús del Val.

At that point, it seemed as though a much needed political breakthrough was on the horizon, yet it would be more than three years before representatives of the City Council and the Regional Government would finally meet face to face, at a three-day technical workshop in Segovia, sponsored by WMF with underwriting from American Express, and held in November 2009.

While the pending meeting was in its planning stages, WMF commissioned two important projects—one at the micro level, the other at the macro level—aimed at informing later workshop discussions.

The first was a pilot study to develop an effective means to documenting in detail the various forms of stone deterioration evident in the aqueduct's 25,000 granite ashlars. Such a study would be key to formulating protocols for future monitoring and conservation treatment of the aqueduct iconic support structure. The study was undertaken by José Delgado and a stone conservation team from Lisbon-based restoration firm Nova Conservação, with whom WMF had worked on the restoration of the extraordinary sixteenth-century Jerónimos Monastery in Lisbon, carried out between 1998 and 2002.

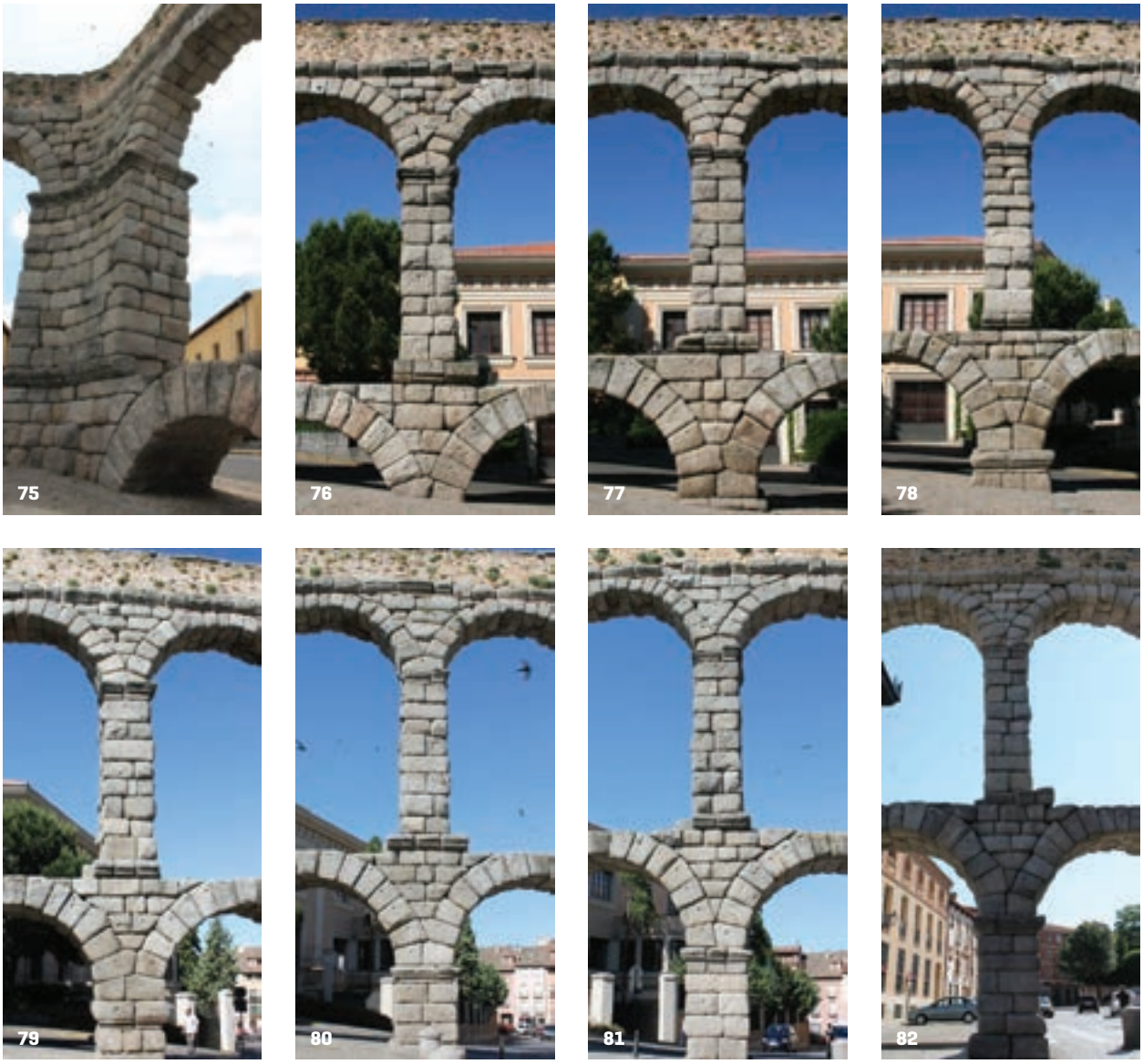
The second study was a landscape assessment of the whole of the 16.2-kilometer-long hydraulic system, from its origin at the dam on the Frío River to its terminus beneath the twelfth-century Alcázar, in order to formulate a conservation plan that addressed the totality of the monument, not just its majestic standing arcade currently covered by the World Heritage listing. Such a study had yet to be undertaken but would be critical for drafting measures to protect the site from damage and insensitive development such as the 2000–2001 construction of the high-speed rail line, which destroyed 14 meters of subterranean aqueduct. WMF entrusted this important environmental project to Rafael Mata Olmo, director of the Department of Regional Geographic Analysis at the Autonomous University of Madrid and a noted expert on landscape and urban-planning issues.

Both projects would provide data critical to formulating a long-term plan for the monument's preservation.

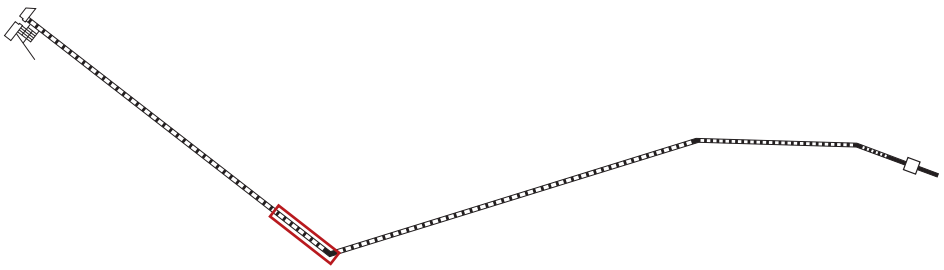
Messages in Stone

TO ASSESS THE CONDITION of the standing aqueduct structure, José Delgado and the stone conservation team from Nova Conservação selected a suite of pillars for study that bore a host of visible conservation pathologies—from natural erosion, degradation, and fractures, to damage wrought by prior inappropriate conservation interventions.

Numbered 75 to 82, the study pillars are located in the Plaza de Díez Sanz, where the arcade makes a 55° turn to the northeast and where the aqueduct bridge structure transitions from a single to a double arcade. There, the structural load on the individual supports increases dramatically—the pillar segment serving as an ideal sampling area for ascertaining the condition of the whole of the structure, and developing a prototype documentation methodology that, in



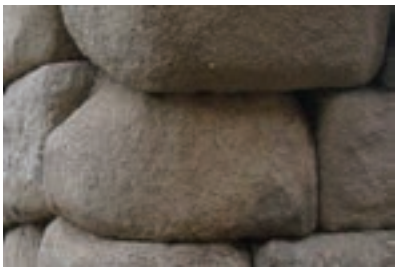
A suite of eight pillars (numbered 75 to 82, above) in the Plaza de Díez Sanz were selected to be the focus of the study.



Surface disintegration

Fractures not in stress concentration zones

Blocks showing chips scales



The overall shape of the block

Past interventions to repair block surfaces

Past interventions to reconstruct the blocks

Situations showing foundation problems

Situations with joints filled with mortar

Joints widened by dislocation of blocks

Joints eroded

Lacuna in the masonry

Blocks protruding from the surface

Twelve degradation forms were identified and ranked as part of the conditions assessment survey.

time, can be extended to the entire monument to assess each of its 25,000 granite ashlars—the pathologies they presented to be noted in a harmonized conservation code. The code details not only individual forms of degradation evident in the individual blocks but indicates its level of its severity, on a scale from 1 to 5, minor to severe. The aim of the detailed mapping of the structure was to twofold—to identify with certainty the most critical conservation concerns in terms of safety and to prioritize them for future work.

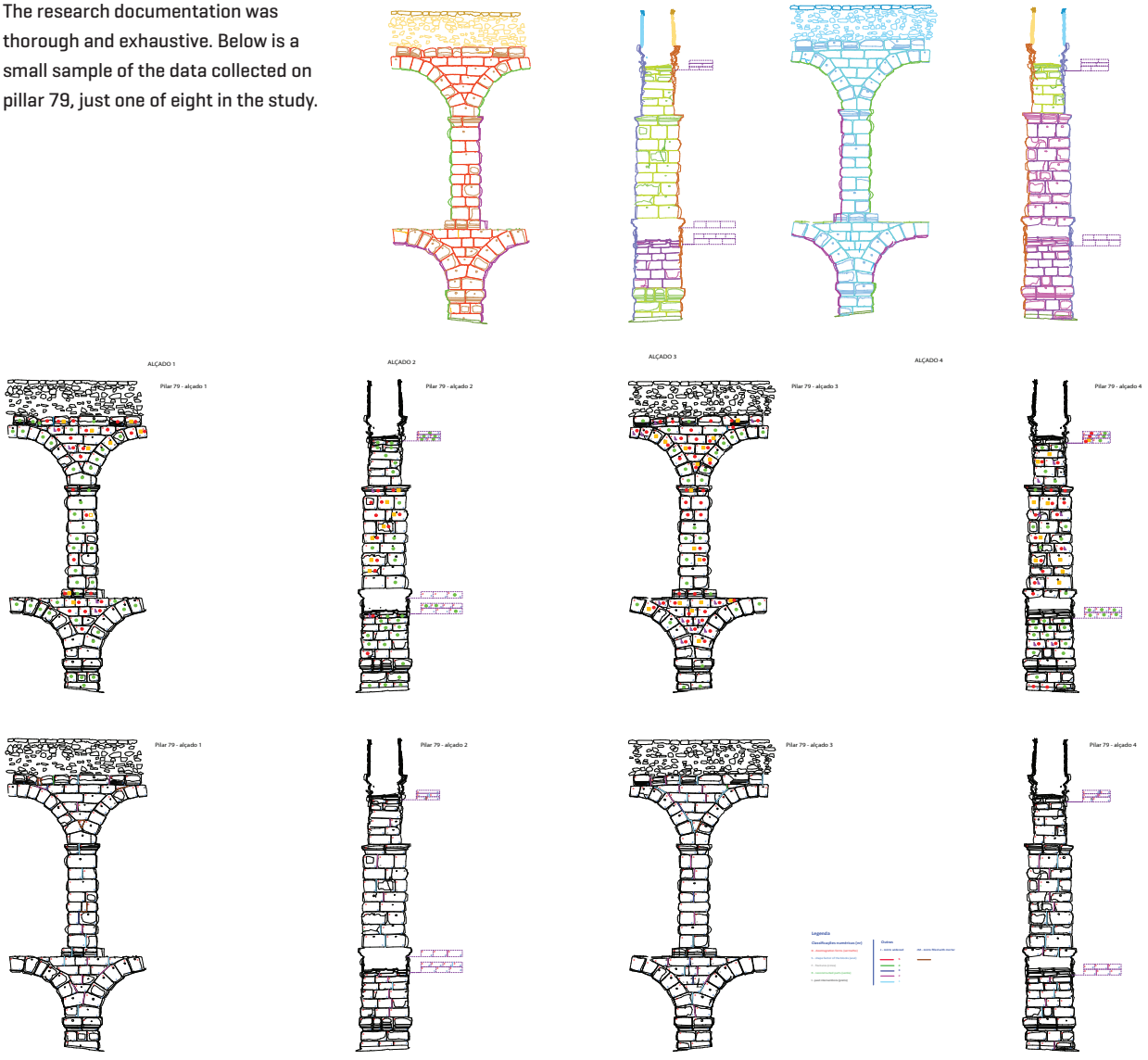
In concert with the ashlar documentation project, representative samples of the varieties of granite used in the construction of the aqueduct and gathered from the same local stone sources were subjected to a host of laboratory analyses to determine their porosity—which at high levels can contribute to swelling and the development of fissures—and to separate out natural geologic decay and materials transformation from deterioration attributable to anthropogenic activity.

Over the course of the study, the team analyzed four main varieties of granitic materials used in the aqueduct's construction—Ortigosa del Monte, La Granja, Magullo, and Sotillo. The first two being coarse-grained granites and the most abundant stone found in the structure, while the latter are fine to medium grained granites, respectively. And not surprisingly, each of the granite types has weathered differently over the centuries: the coarser the stone, the more water it retains, the increase in moisture eroding the granite from both inside and out. When such blocks are soaked their intense internal network of fine cracks serve as draining paths through which water can pass, eroding the cracks and resulting in fissures. Such erosion is compounded by seasonal variations in temperature and humidity.

Given the natural porosity of the construction material, it was clear that the semi-arid nature of the Segovia area, which receives a moderate annual rainfall of 464 mm (18 inches), had contributed to the longevity of the standing structure.

Collectively, the ashlars in the study area exhibited a range of conditions in terms of their structural state with the most widespread degradation coming as a result of sand erosion. Most, if not all, ashlars dating to the Roman period exhibited degradation of this type, which was evident in progressive mass loss at their corners and edges that has left once block-like forms visibly more rounded or spherical in nature. Such mass loss has no doubt compromised the

The research documentation was thorough and exhaustive. Below is a small sample of the data collected on pillar 79, just one of eight in the study.



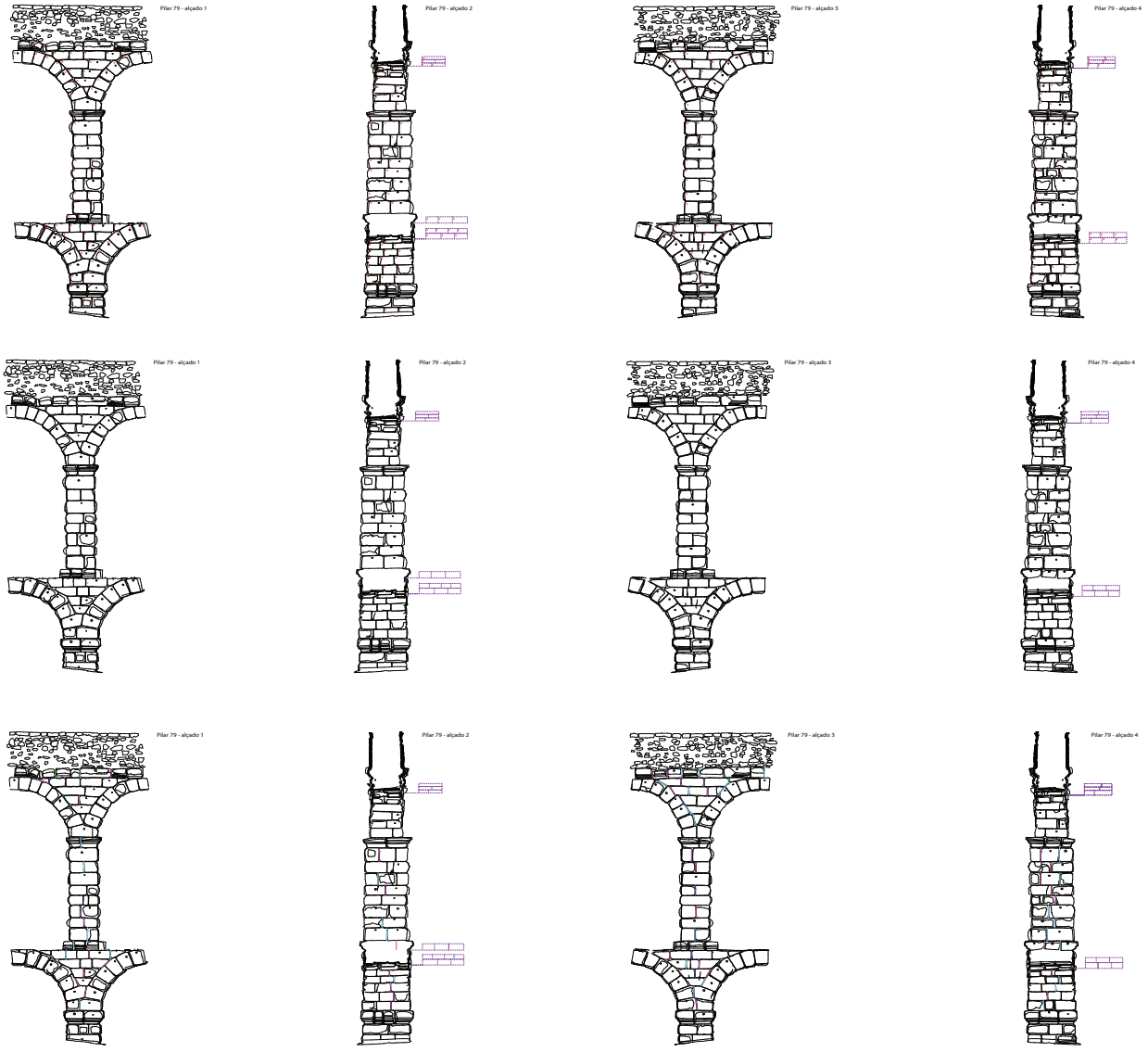
stability of the aqueduct with reduced contact areas between blocks to bear its structural load.

Numerous fissures and fractures in the ashlars were also identified. Conservators have yet to determine whether the fissures are the result of the aforementioned water ingress and seasonal changes in temperature and humidity, or whether they have been wrought by disparate strains placed on the ashlars as their mass has decreased and the load placed upon greater and more concentrated. They may find that the fissures have been caused by a combination of both factors.

It is evident in the pilot study that earlier efforts to reconstruct portions of the monument with masonry and mortar—rather than masonry alone—introduced new decay mechanisms, evident in the stones themselves. Over time, the setting mortar (originally lime-based) that stabilized the stones undergoes lixiviation, that is, as it dissolves, its discrete components break down and form incrustations. Moreover, the gradual disappearance of the supporting mortar acts like a vacuum, opening up new channels that allow for the ingress of erosive elements such as sand and water, hastening the mass loss.

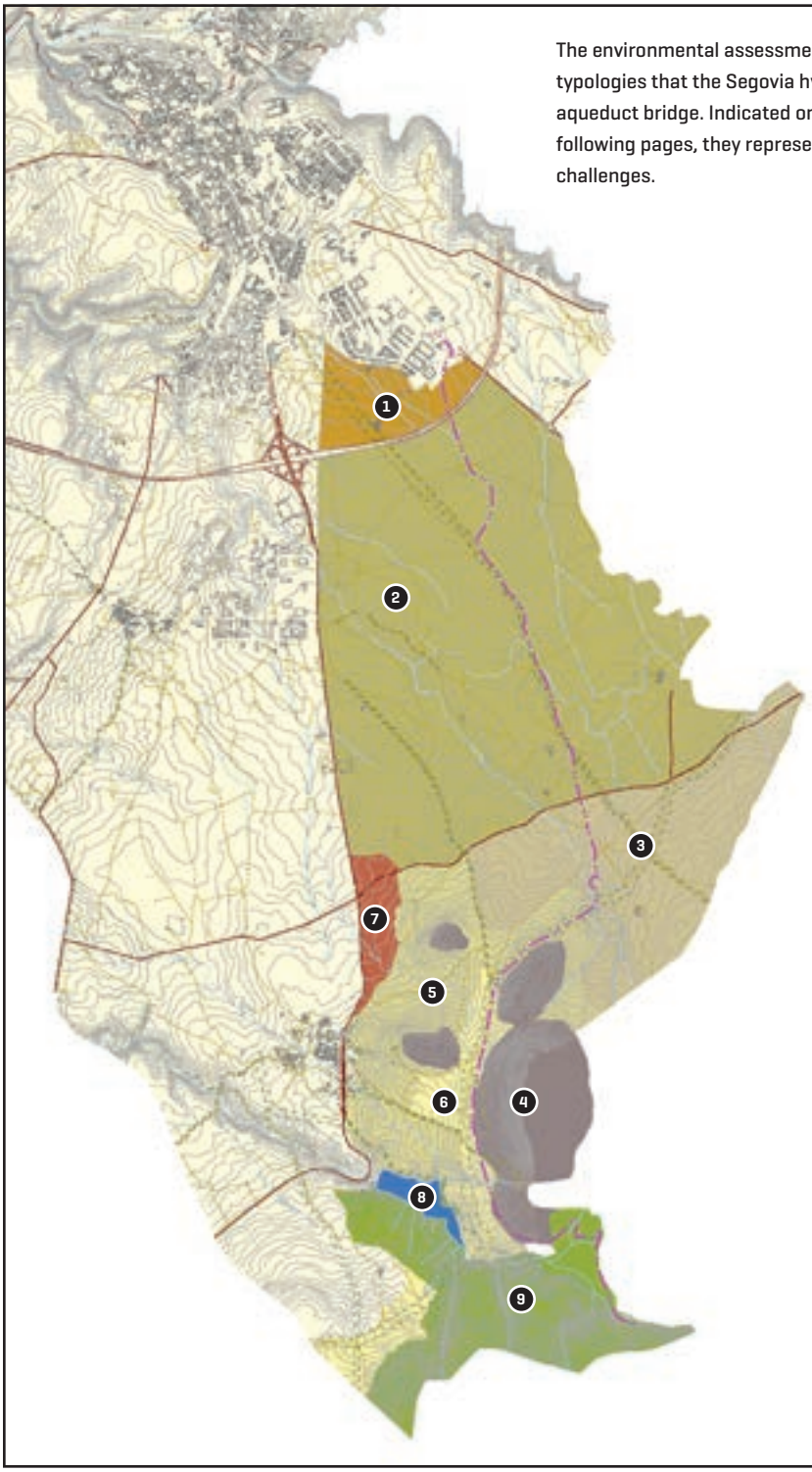
The pillars selected for the study exhibited most, if not all, of the conservation pathologies the team expects to find with the future mapping of the standing structure in its entirety.

The complete study (in Spanish) can be downloaded at wmf.org/publication/segovia-aqueduct-survey



Preserving an Ancient Landscape

ENVIRONMENTALLY SPEAKING, the Segovia Aqueduct is far more than the iconic standing structure we see today. And as such, plans for its preservation should include measures to address the totality of the 16.2-kilometer-long hydraulic system, from its origin at the dam on the Frío River in the foothills of the Sierra de Guadarrama to its terminus beneath the twelfth-century Alcázar. Such measures serve not only to ensure its protection from further destruction but to realize the untapped potential of the aqueduct landscape as a recreational destination for the citizens of Segovia and the thousands of visitors the city attracts, from day-trippers from Madrid



The environmental assessment survey identified nine distinct terrain typologies that the Segovia hydraulic system passes through en route to the aqueduct bridge. Indicated on the map below and briefly described in the following pages, they represent a broad array of formidable conservation challenges.

1. **Wasteland between New Segovia and the Southern detour of the highway**
2. **The pure grass pastures of Aldeanueva and Pradogrande**
3. **The cleared holm-oak woods of the Segovia slope**
4. **The Cabeza Grande, El Calvario and La Aldehuela Mountains**
5. **The Revenga Mountains and Los Hoyos**
6. **Pastures of the Royal Soriana Western Ravine**
7. **The ash tree pastures and enclosed fields of Revenga**
8. **The Surroundings of the Puente Alto Reservoir**
9. **Pinares de La Acebeda**

to the growing number of international travelers seeking an eco-tourism experience.

It is important to note that as of this writing, provisions to protect the ex-urban portions of the hydraulic system are still lacking in both the General Urban Development Plan of Segovia (PGOU) and the Guidelines for the Development of the Territory of Segovia and its Surroundings (DOTSE), which govern development at the local and regional levels. Perhaps more disturbing, the PGOU, which was approved in 2008, outlines plans for urban expansion into rural areas to the south of central Segovia in the vicinity of the high-speed rail station at Hontoria, 4 kilometers away. Without remediation, such urban expansion is sure to compromise surviving archaeological remains.

1. Wasteland between New Segovia and the Southern detour of the highway

This gently rolling landscape consists of rural land—although with little agricultural activity—adjacent to the urban developments in New Segovia and delimited to the south by the city's beltway. Although the area now has limited environmental and productive value, it was part of the pure grass pastures of the Segovia slope until recently. Interest of this landscape now lies in its strategic position at the doorstep of the consolidated town as a space with urbanization prospects and also for significant public use and pedestrian access to places like the Lomo and Prado Corral.

2. The pure grass pastures of Aldeanueva and Pradogrande

South of the road between La Granja de San Ildefonso and the Riaza Palace on either side of the Santillana route, lie large pastures with pure grass, commonly referred to as *prados* (meadows) in local terminology. These pastures also make up a slope that inclines toward the town of Segovia and the base-level Eresma River. One of the most defining characteristics of this landscape is the presence of large farms with perimeter fences and an almost total absence of tree cover, with a predominance of grass pastures due to the ancient and continuous process of plowing for livestock grazing land.

3. The cleared holm-oak woods of the Segovia slope

This landscape is unique to the town limits of Segovia and can be considered an excellent example of holm-oaks on a mountain slope, clearly marking the transition between the mountains of holm-oaks further south (the hills of Matabueyes, Cabeza Gatos o Carrera Blanca). This section of the slope currently has a clear dynamic of vegetal re-colonization, with an abundant presence of serial scrubland as well as prevalent new growth at the base of the oaks. This overall regrowth is the result of intentional livestock reduction to return the land to a more natural state.

To this end WMF commissioned an environmental assessment of the whole of hydraulic system, carried out by Rafael Mata Olmo, director of the Department of Regional Geographic Analysis at the Autonomous University of Madrid. The resulting study provides a visual analysis and characterization of the hydraulic system within the context of not only the urban fabric of Segovia but the ex-urban landscape it traverses.

Beyond its utility in drafting legislation to safeguard the site from further impacts, the survey revealed the untapped potential of the hydraulic system when viewed within the context of an imaginative ex-urban adaptive reuse scheme. By removing current visual clutter—such as inappropriate signage and derelict structures—and improving the quality of the landscape

4. The Cabeza Grande, el Calvario, and la Aldehuela Mountains
These modest elevations constitute a set of landmarks of great popularity as dominant elements of the landscape, contrasting with the Royal Soriana Western Ravine below. The hills have dense forest cover, mostly consisting of small holm oaks. The historical protection of these mountains against livestock foraging explains the abundant biomass, in contrast to the absence of woods along the livestock route, a grazing-ground for hundreds of years.

5. The Revenga Mountains and Los Hoyos
This discontinuous landscape is located west of the town of Revenga, its main boundary being the pastures associated with the Cañada Real Soriana Occidental, although it also reaches to the slope of Los Hoyos. The landscape is made up of clusters of oak, most being highly branched specimens of modest size. The hill does not have significant undergrowth, although it merits being highly valued for its unique geographical context and for its landscape diversity regarding the adjacent treeless land.

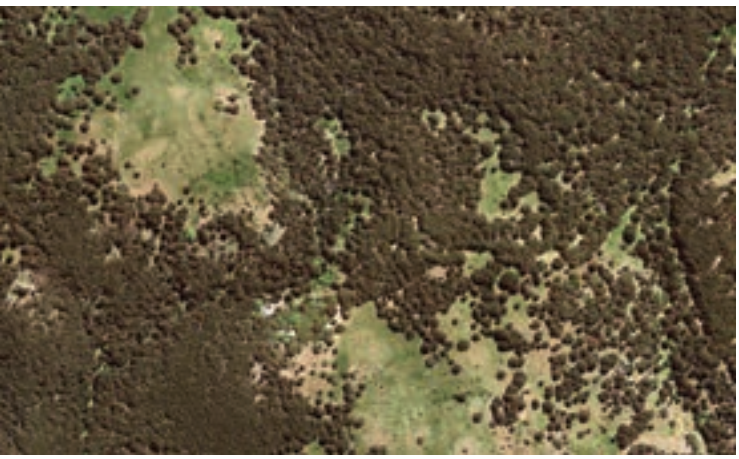
6. Pastures of the Royal Soriana Western Ravine
The Cañada Real and its adjacent land make up a homogeneous landscape, characterized by the absence of wooded vegetation and the dominance of pastures along the livestock route. This age-old livestock use presents a visual reality that contrasts with the nearby forests. Although the current livestock use of the route is largely symbolic, the area retains its cultural and environmental importance as a green route and recreational public-use place.

surrounding the waterworks, it is possible to enhance the archaeological, historical, and architectural quality of the monument, thereby encouraging heightened public recognition of its patrimonial significance. With its variety of nature trails and vistas, along with the archaeological interpretation of surviving Roman remains, such a plan would enable visitors to experience the whole of the aqueduct system, which courses through nine diverse and distinctive Castilian landscapes, each with its own ecology. Moreover, such a scheme would achieve the landscape quality objectives advocated by the European Landscape Convention (Council of Europe, 2000).

The complete study (in Spanish) can be downloaded at wmf.org/publication/segovia-aqueduct-study

7. The ash tree pastures and enclosed fields of Revenga
North of the town of Revenga, on land with high water retention capacity, this landscape unit is located furthest from the Aqueduct's course, but lies within its sightlines. It is characterized by the presence of so-called *sotos*, or riverside groves—flat or slightly concave areas on the mountain foothills, which traditionally provided support for the widespread forest grazing system unique to the region. The Soto of Revenga is an excellent example of an enclosed field landscape, with a dominant presence of ash trees and rich pastures, in which various grasses and a wide variety of spring perennials can be observed.

8. The Surroundings of the Puente Alto Reservoir
This body of water—near the Cañada Real Soriana Occidental on the El Sobornal path of the aqueduct's course—is a landscape unit in its own right, as well as an element of considerable environmental importance, despite being small and artificially created. Profuse vegetation colonizes the banks of the reservoir, with the presence of pines, holm oaks, and some Pyrenean oaks, complimenting the beauty of the reservoir itself.



9. Pinares de la Acebeda
The Pinares de la Acebeda are part of the historic group of forests of the Valsaín Mountains, extending through the towns of San Ildefonso, Segovia and La Granja. From the study's perspective, the high intrinsic value of this space from the geomorphological, ecological and landscape points of view—which have earned them a high level of protection—is because this unique landscape houses the aqueduct's dam and the first few kilometers of its route.

Summary

TOGETHER, THE STUDIES COMMISSIONED BY WORLD MONUMENTS FUND provided a foundation for fruitful workshop discourse. In addition to representatives from the regional and local authorities, participants included Giorgio Croci, José Delgado, Alonso Zamora, Rafael Mata Olmo, and Pablo F. Longoria. Held with support from UNESCO, through its representative for Spain, Kerstin Manz, the forum was hailed by the participants and the press alike as a watershed moment, the meeting being the first of its kind to take place in more than a decade.

Throughout the discussions, it was stressed that the monument must be addressed in its entirety and that obtaining legal protection for the hydraulic works that lay beyond Segovia city limits was of the utmost priority in light of potential pending development outlined in the PGOU. To this end, it was clear that limited archaeological investigations would be needed to ascertain what additional remains from the Roman period may have survived to supplement the detailed landscape assessment undertaken prior to the workshop. Such excavations to establish with certainty the locations of all of the elements of the hydraulic system will enable municipal and region officials to adopt necessary measures to protect the whole of the monument.

It was clear too that a GIS-based information system should be developed to aid in monitoring the site and enhance the capacity of conservators to address problems as they emerged, which was deemed preferable to carrying out a radical, and risky, restoration campaign as had been done in decades past. Topping the list of conservation priorities was the reversal of prior interventions that were known to be contributing to the continued degradation of the monument. Among these the removal of the lead liners within the aqueduct channel during the 1992 restoration, which had fostered a dramatic increase in biological growth. Recommended too was a further reduction of vehicular traffic in and around the monument.

During the meetings it was unilaterally recognized that a permanent on-site office needed to be established tasked with monitoring and managing various conservation activities. The office would to serve not only as a repository for historical resources and technical documentation related to the aqueduct project but also as an interpretive center for those visiting the ancient site.

At the close of the workshop, World Monuments Fund convened a meeting, attended by workshop participants, the Councilor for Planning of the City Council of Segovia, and the Director General of Fine Arts of Castilla y León, Enrique Saiz, accompanied by his staff. It was at this meeting that a management plan for the aqueduct was framed out, with architect Alberto García Gil, a polemic long involved in urban planning issues in Segovia, charged with drafting it in detail.

Since then, a 204-page Plan de Gestión has been completed and is pending approval from the Junta de Castilla y León prior to its being submitted to UNESCO World Heritage Committee. The draft lays out a multifaceted decade-long program that takes into account not only the immediate conservation concerns raised in the planning meetings leading up to its drafting but lays the groundwork for the longer-term development of the Segovia Aqueduct Landscape into a broader World Heritage property, fulfilling the mandate of the 2006 Watch Listing.

As with all sites included in the World Monuments Watch program, the goal is to bring greater public attention to historic places, their ongoing conservation needs, and their continuing relevance in our lives. In this instance, the Watch was catalytic in demonstrating the value of the Aqueduct of Segovia and its importance to the character of the region. The work supported by American Express allowed for a fuller exploration of the history of the site and its evolution across the centuries. We can all hope this investment has deepened public recognition for the site in the coming centuries.

Scholar Biographies

JOSÉ MARÍA BALLESTER is the director of the Department of Rural Development at the Botín Foundation. He is an international expert and art critic who has served on various committees and councils dedicated to the preservation of cultural heritage. He was a member of the juries for the Prince of Asturias Awards (1999 and 2000) and the first Queen Sofía International Prize for the Restoration of Monuments in Latin America. He was also a member and vice president of the European Union Awards for Cultural Heritage/Europa Nostra Competition, and was elected president in 2012. Ballester served as a consultant to the Holy See for the Cultural Heritage of the Church from 1996 to 2008.

GIORGIO CROCI graduated in civil engineering from La Sapienza University, Rome, in 1960. He has authored many books, as well as about a hundred publications—presented, for the most part, during international meetings—addressing the study of instabilities; the analysis of ancient masonry buildings; and the restoration, seismic adaptation, and design for consolidation interventions. He has been a professor of structure engineering since 1984, and has been on the engineering faculty at La Sapienza University, Rome, since 1995. Croci has also received several awards and commendations for his work safeguarding the world's architectural heritage.

JOSÉ DELGADO RODRIGUES received his degree in Geology at Coimbra University, Portugal, and his *Especialista* degree (PhD equivalent) at the National Laboratory of Civil Engineering, where he also became principal research officer, head of the geotechnical department, and president of the scientific council. He started his career in the field of engineering geology and hydrogeology and progressively moved to the field of conservation science, in which he has researched and taught for the last 40 years. Delgado has published over 170 papers for congresses and international reviews, and is currently reviewing papers for several international journals in the field of conservation of cultural heritage.

PABLO LONGORIA has been WMF's representative in Spain since 2001. He studied architecture in the Escuela Técnica Superior de Arquitectura de Madrid (1993). He worked in New York City for Frank Williams Architects and Beyer Blinder Belle Architects, and now holds his own architectural practice in Spain. He is a specialist in historic preservation, and has worked on restoration projects at the Alcázar and the Monastery of San Clemente in Toledo, and the mercury mines of Almadén. He is the author of the *Master Plan for the Historic Walls* in Segovia and the *Assessment Study for the Rehabilitation Works of the Calle and Plaza Mayor Area* for the Ayuntamiento de Madrid.

RAFAEL MATA OLMO is a professor of regional geographical analysis and the director of the department of geography at the Autonomous University of Madrid. He is a specialist in the study of rural and urban systems and landscapes, and in regional planning policies, landscape, and nature conservation in Spain and Latin America. He is the author and editor of more than 200 scientific publications, appearing in books, chapters of books, articles in scientific journals, and presentations at national and international conferences. Mata has won multiple awards for his work in landscape preservation, and participates in several international and national committees dedicated to the conservation of natural and cultural landscapes.

DR. JOSÉ ANTONIO RUIZ HERNANDO received his doctorate in history from the Universidad Complutense de Madrid and is currently a professor of art history and architecture at the university's school of architecture. He was Provincial Councilor of Fine Arts of Segovia from 1971 to 1979. He is a full academic member of the Real Academia de Historia y Arte of San Quirce and a corresponding member of the Real Academia de Bellas Artes of San Fernando, Madrid. He has been curator of the Alcazar of Segovia since 1990. Ruiz has published several articles and books on the art and architecture of Segovia—highlighting the cathedral and the city's Romanesque architecture. He also participated in the ERA project of the European Union.

CARLOS SANZ VELASCO graduated from Universidad Complutense de Madrid in 1990 with a degree in fine arts, specializing in conservation and restoration of cultural heritage. He is now a professional freelancer, focusing on conservation and restoration work on different materials—especially stone, wood, and mural paintings. Sanz also works on various studies, projects, and site management, mainly commissioned by the Spanish government.

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