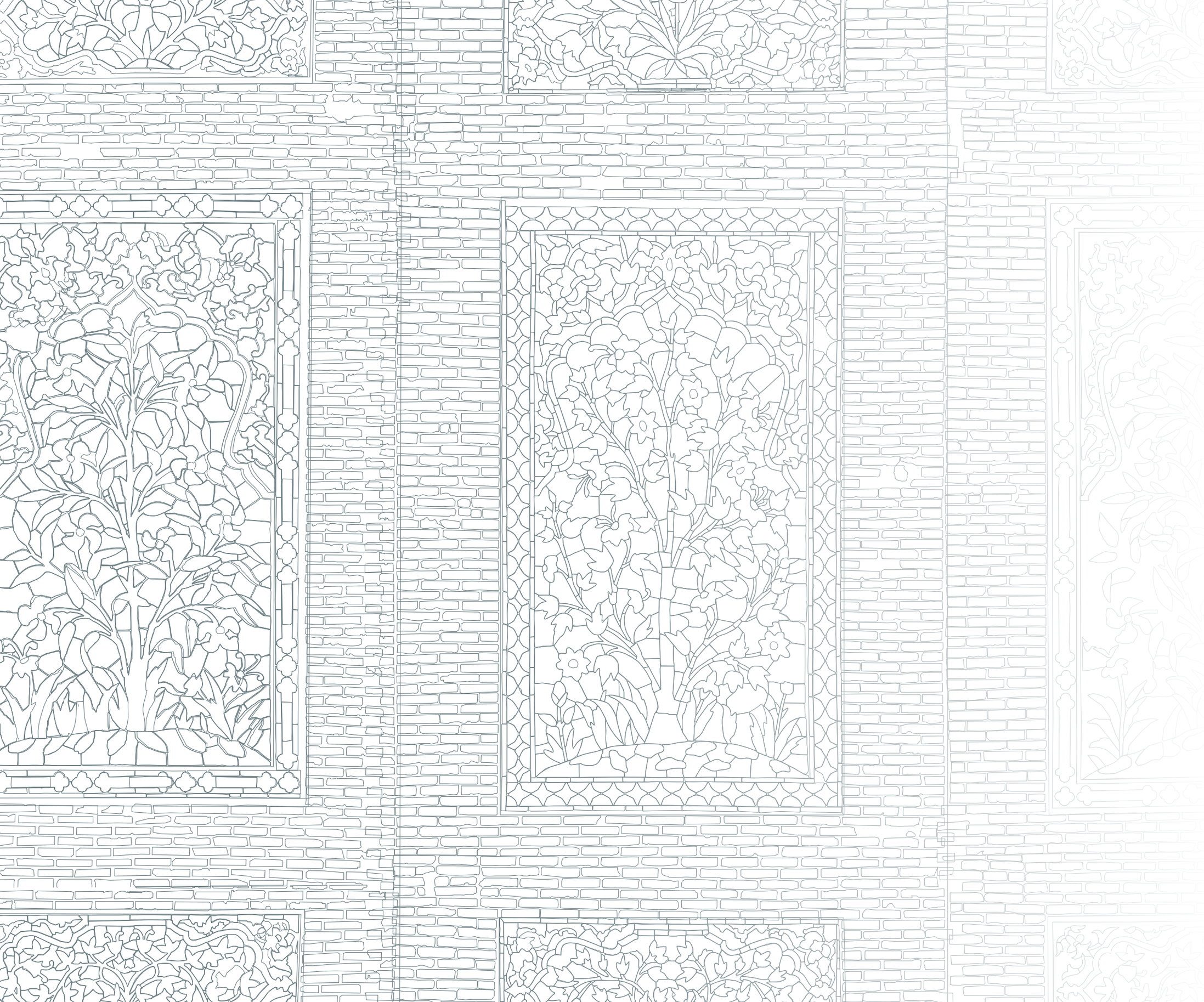
CONSERVATION OF THE WAZIR KHAN MOSQUE LAHORE

PRELIMINARY REPORT ON CONDITION AND RISK ASSESSMENT

AGA KHAN TRUST FOR CULTURE
AGA KHAN CULTURAL SERVICE - PAKISTAN



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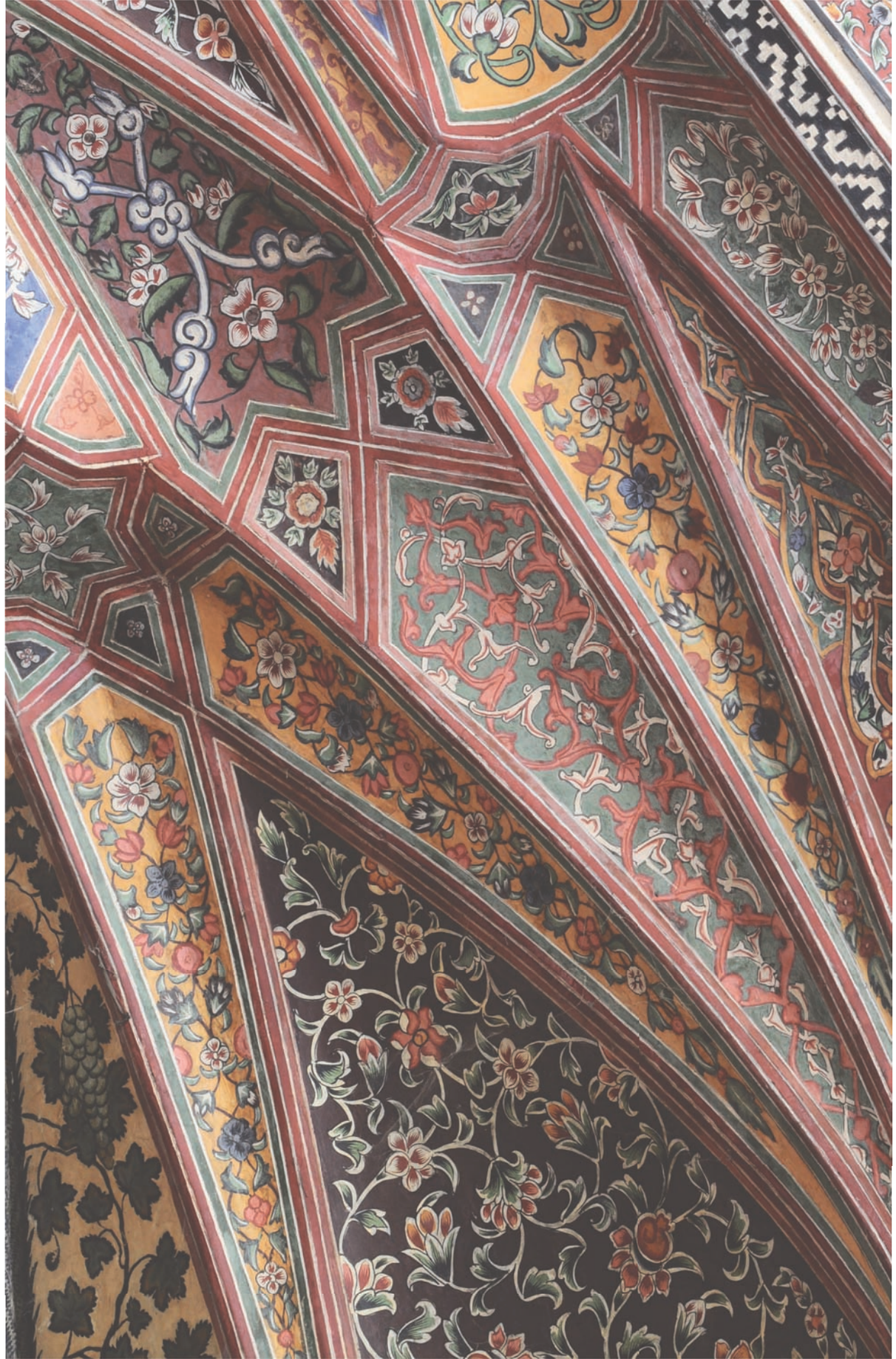

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KEY TERMS AND DEFINITIONS

Ahatta:	Open precinct.
Auqaf:	Department responsible for the care and maintenance of the religious properties in Pakistan.
Bannatkari:	Filigree work. A decorative technique executed with the combination of brick pieces and glazed tile work (*kashikari*).
Caravanserais:	Resting place for travellers, a roadside inn, usually along trading routes and highways.
Charsu:	A junction of three or more streets (bazaars) covered with a dome historically used in Central Asian architecture under Persian influence.
Chhatri:	Domed-shaped pavilion on top of a *minar* or building standing on a pillared structure.
Chowk:	Public square.
Chujjas:	Projected shade.
Dewrhi:	An entrance vestibule often associated with a 'bent' entranceway to a building.
Dori:	Decorated / braided moulding.
Gachkari:	One of the surface decorative techniques used in Mughal monuments and executed in relief calligraphy with lime plaster.
Gali:	A narrow lane.
Gharqis:	Soak wells.
Hadith:	Record of the sayings or actions of Prophet Muhammad (PBUH).
Hammam:	Public baths.
Hijri:	The Islamic lunar calendar; begins with the migration (Makkah to Madina) of Prophet Muhammad (PBUH).
Hujra:	A small room dedicated for meditation, reading and a resting place for teachers and students, normally arranged in a row facing a courtyard or a bazaar.
Iwan:	A big vaulted façade structure, walled on three sides, with one end entirely open.
Jalli:	Perforated piece of terracotta (also in marble and wood) arranged in different geometrical patterns and shapes.
Jharokha:	Projected balcony.
Jilau Khana:	A formal open urban space providing a locus of arrival and the first vision of an entrance façade.
Kashikari:	Glazed tile work typically arranged in floral and graphical patterns in addition to many forms of Islamic calligraphy.
Katra:	A gated *cul-de-sac* containing multiple residences.
Madrassa:	A school usually imparting traditional forms of education.
Mazaar:	Grave; it usually refers to the tombs of Islamic saints or famous people.
Minar:	An integral element of mosque architecture. A *minar* is divided into four major parts; the square base, the octagonal shaft and a balconied gallery which is roofed by a dome topped by a small finial.
Mujavir:	Shrine caretaker.
Muqarnas:	Geometric expression of transition in arcuated structures in Islamic architecture.

Mutawalli:	A caretaker of a mosque, shrine or similar religious establishment.
Naqqashi:	Fresco work.
Nastaliq:	One of the forms of Islamic calligraphy.
Pucca:	Permanent structure.
Qalibkari:	Stalactite (*muqarnas*) work.
Sahn:	Open courtyard.
Serai:	An establishment meant for the temporary residence of travelers, mostly with a quadrangular, formal typology.
Shahi Guzargah:	Royal trail.
Soffit:	The underside of any construction element.
Subedar:	A provincial governor during the Mughal era.
Takya:	A Sufi place of residence, instruction and religious education. A living *takya* could last for several generations and acquire an attached graveyard.
Tazakari:	Faux brickwork or brick imitation executed with the help of surface render. The process is carried out by applying a thin layer of lime plaster mixed heavily with red ochre on the wall surface and then scouring out thin grooves in the still wet plaster layer with a special instrument, thus exposing the underlying white lime backing in a pattern imitating fine brickwork.
Thuluth:	Style of calligraphy.
Waqf:	A gift of land or property made by a Muslim, intended for religious, educational, or charitable use.
Wazookhana:	Ablution space.

LIST OF ACRONYMS AND ABBREVIATIONS

AKTC:	Aga Khan Trust for Culture
AKCSP:	Aga Khan Cultural Service - Pakistan
CAD:	Computer Aided Design/Drafting
EDM:	Electromagnetic Distance Measurement
ICOMOS:	International Council of Monuments and Sites
LWC:	Lahore Walled City
REDM:	Reflectorless Electromagnetic Distance Measurement
ROW:	Right of Way
SDWCLP:	Sustainable Development of the Walled City of Lahore Project (Project Management Unit)
UNESCO:	United Nations Educational, Scientific and Cultural Organization
WB:	World Bank

PREFACE

The Walled City of Lahore is one of the most important historic cities in the subcontinent. Although much altered by recent development, it still retains considerable original character and heritage elements. Within the confines of the city are a number of important monuments, many of which are in urgent need of conservation.

With support from the World Bank (2006), the Punjab Government has recently begun implementation of an important new initiative to rehabilitate a part of the city's urban fabric and to improve its infrastructure while linking many monuments along a historic route starting from Delhi Gate and culminating at the royal palace in the Lahore Fort. This is likely to have been the path frequently used by Mughal royalty to approach the palace fort. The urban rehabilitation (or area development) project is being complemented by the projected conservation of a few key monuments that are part of this historic route. Of these, one of the most significant is the Wazir Khan Mosque. This large mosque was built in 1634 (1044 AH) and is one of the finest mosques of the city.

From 2007, under a partnership with the Punjab Government, the Aga Khan Trust for Culture (AKTC), through their Historic Cities Programme and its Pakistani affiliate, the Aga Khan Cultural Service - Pakistan (AKCSP), have been providing technical assistance in the design and implementation of this area development project. AKTC technical assistance includes detailed documention of baseline conditions as a necessary first step in the conservation of the Wazir Khan Mosque, as well as planning assistance towards the re-organization of the historic urban open space (Chowk Wazir Khan) in front of the mosque following the removal of commercial encroachments within the immediate proximity of the monument's principal façade. The initiative includes the rehabilitation of the surrounding urban fabric and Chowk Wazir Khan. It extends to Chowk Kotwali, on the north-western corner of the mosque. The objective is to improve the quality of the urban environment for both residents and visitors, relocate unsightly infrastructure underground and return the mosque as faithfully to its original urban setting as possible. The J.M. Kaplan Fund has provided funds for initial documentation and analysis of the monument fabric.

A programme for the conservation of the mosque is being evolved and will be implemented over several stages. In the first stage, which the present report describes, structural and architectural investigations were initiated in April of 2009. Geotechnical investigations of the foundation structure, necessitated by the noticeable inclination of the four *minars* of the mosque have revealed that the bearing soil strata are sound. A detailed electronic documentation of the building has been carried out and is being used to analyze the damage and to assess the quantum of structural interventions and conservation measures. The structural damage that has occurred will be rectified by repair and stitching together of the masonry fabric. Careful monitoring of the behaviour of the building will be mandated thereafter. Pilot restoration initiatives on the various kinds of surface decorations will be carried out first, before expanding these to a larger scale.

A substantial range of interventions must be made in the immediate urban environment of the mosque, in order to ensure that the mosque is not subject again to the adverse treatment it has suffered over the last two odd hundred years. The neighbourhood interventions being proposed include the clearing away of accretions built on the face of the building in order to ensure that it can be maintained. They also include major infrastructure works.

This document presents a brief account of the history of the mosque complex and a description of its key qualities, as exposed in a process of meticulous documentation of its architectural fabric carried out by AKCSP. It also presents an analysis of the major issues faced by the monumental complex in its survival and onward passage to future generations. A plan for the conservation of the mosque is presented as well as a preliminary estimate of the costs to be incurred in the launching of a conservation programme that may last several years.

We hope that going through this report will evoke interest and civic concern and will persuade individuals and groups, both within the country and outside it, to take active interest in the conservation of this priceless monumental heritage of Pakistan and to support that process with moral and material assistance.

October, 2011
Lahore

EXECUTIVE SUMMARY

1. HISTORICAL BACKGROUND

The Wazir Khan Mosque was built in 1634-35 AD (1044-45 AH), by Hakim 'Ali ud din* a governor of the Punjab in the early part of the reign of the Mughal emperor Shah Jahan. It was built on the remains of an old Sufi complex and the Sufi grave sites associated with it. The monument is protected under the federal Antiquities Act, and under the Punjab Special Premises Preservation Act. The responsibility for its conservation vests in the Punjab Archaeology Department. A mosque management committee looks after its day to day affairs. The mosque is a part of an urban ensemble put under an endowment established in 1641 whose trusteeship now vests in the Punjab Auqaf Department.

The Wazir Khan Mosque sat astride the historic route that the Mughal nobility would traverse as they entered the city and made way to the royal residence in the Lahore Fort. According to the *waqf* document as reproduced in Abdul Latif Lahori's book on Lahore's history (1892), the ensemble contained in addition to the mosque itself, a bazaar meant specifically for calligraphers and book-binders. Additional shops were built into the body of the monument meant to sustain it, and according to the document, the *waqf* included a *serai*, a *hammam*, several wells and pieces of open land. No specific mention has been made of the Wazir Khan Chowk, and from a comparative review of other Mughal period *serais*, the Chowk lends itself to the interpretation of having been a small *serai*, indeed possibly the one mentioned in the *waqf* deed.

This urban ensemble today includes the Wazir Khan Chowk, and its entrance from the east, the Chitta Gate, and other smaller monuments in the Chowk such as Dina Nath's Well and the shrine of Syed Suf. Both these smaller monuments were built in the mid nineteenth century. Syed Suf's Shrine comprised a dome almost identical to that over the Dina Nath Well, and partially obstructed the axial view of the mosque from Chitta Gate. With the enlargement of the shrine in 1990, and the doubling of the size of its dome, this view is now completely obstructed.

The shops built into the body of the mosque face the street-level on the eastern side onto the Chowk and the Kotwali Bazaar on the north. As the street-level has risen over four centuries, the shops are now lower than the street-level and new shops have been built against the historic structure along the Kotwali Bazaar. In addition houses that similarly abut the monument and actually rest on its historic wall have been built on the southern side, on land which was part of the historic endowment.

As described in this report in further detail, the mosque itself comprises a prayer chamber and a large courtyard. The latter is surrounded on its northern, southern and eastern sides with 28 *hujras* and two pavilions facing each other across the width of the courtyard. There are four *minars* marking the four corners of the courtyard. An important feature of the entrance system of the mosque is the Calligraphers' Bazaar that crosses the axis of entrance at a right angle, and is marked at this crossing with a large *dewhri* and a dome atop the same.

The mosque complex, in the form that it has survived, still has a singular outstanding attribute that places it in the frontline of the major monuments of the world - the exuberant architectural decorations that embellish its exterior and interior surfaces. In essence these are of two kinds - exterior surface decorations which are chiefly in the form of glazed ceramic tile murals; and interior decorations in the form of *naqqashi* wall painting - a semi-dry form of fresco (painting on fine lime plaster renders). Both these forms of embellishment have integral calligraphic components drawing on the Quran and the Hadith.

* In this report we have followed Abdullah Chaghatai (1975) quoting *Zakhira-tu'l Khawanin* of Shaykh Farid Bhakkari; the name is also recorded as Aleemuddin, or 'Ilmuddin in other sources which Chaghatai prefers not to follow.

2. DOCUMENTATION AND DAMAGE ANALYSIS

The definition of the range of problems and issues faced by the conservation and rehabilitation effort and the damage analysis contained in this report ensues from a comprehensive documentation of the monument carried out by a small technical team from AKTC-AKCSP. This documentation was carried out using laser electronic measurement and photo-orthorectification technologies coupled together, resulting in very accurate coverage of the mosque's present conditions. The documentation was carried out at a high standard of compliance with the relevant international legal and technical requirements, as embodied in the United Nations convention signed and ratified by Pakistan, and other relevant international charters.

The condition of the mosque as documented reflects decades of indifferent management, lack of technical and financial resources and the resulting inadequate conservation and upkeep. Moreover, the condition of the mosque has a direct relationship with the loss of municipal regulatory functions in the urban context in which this historic monument exists. This situation must be reversed if the mosque is not to deteriorate to an extent that its conservation becomes an impossible goal to achieve.

The existing conditions pertaining to the monumental complex can be described under several general groups of information, ranging from the overall context of the monument complex to a detailed analysis of the various forms of weathering and damage that the monument has sustained.

The Neighbourhood Context:

The neighbourhood of the mosque comprises the Chowk Wazir Khan, certain smaller protected buildings, and buildings not protected under any law but of a certain heritage value.
The neighbourhood context is one of:

a. buildings and activities encroaching illegally on public space;

b. buildings built unlawfully against the body of the monument and even bearing on the monument for structural support;

c. the undesirable state of the neighbourhood utility infrastructure in particular as the latter affects the monument itself; and

d. the inimical nature of the land use and commercial activities happening around the mosque and within those parts of its premises that open outwards into the neighbourhood.

The chief victims of this situation are:

a. the mosque building itself; access to large parts of its structure is eliminated because of the abutting buildings, and by the indifferent manner it is served with utility infrastructure;

b. the Chowk Wazir Khan, a precisely designed urban open space, which is now lost to the encroachments stated above and to a host of inimical activities taking place in it (inappropriate steel fabrication, parking, unnecessary construction and reconstruction around other historic elements etc.);

c. the citizenry who are deprived the full spiritual and aesthetic benefit of a high value monument from a religious as well as urban, architectural and art historical points of view.

The Condition of the Mosque Itself:

Apart from the effects of neglect and lack of maintenance and upkeep, the mosque suffers from several instances of structural failure. These are manifested in the leaning out of the four *minars*, in the resultant structural cracks induced in the structure of the prayer chamber, in cracks caused by subsidence of the southern flank of the courtyard due to water ingress from badly sited and maintained ablution and toilet facilities, and from the prevention of the egress of water from roof tops, particularly because of the houses built against and on top of the southern wall of the monument. These latter structural problems have also infested the buildings constituting the Calligraphers' Bazaar that bound the courtyard on its eastern flank.

In addition to the electronic documentation mentioned above, Dr. Fritz Wenzel, a senior structural engineer from the University of Karlsruhe with a long history of working with historic monuments in Europe and in Islamic countries has provided advice on the structural aspects of the mosque, and provided guidelines on investigations which were carried out on the geophysical aspects of the foundations of the mosque complex, with particular focus on the *minars* and the causes of their leaning outward. The resulting reports are attached at Appendices B1, B2 and C.

On the basis of the geophysical engineers' report, the structural analysis carried out by Dr. Wenzel describes the inclination of the *minars* to be within safe limits and attributes the visible inclination to the effect of seismic factors. The recommendation with respect to the structural issues suggests a methodology of "engineering reinforcement restricted to local strengthening of weak areas", continuous monitoring of movement by measuring cracks, and the planning and execution of local structural measures prior to the restoration process to be undertaken for surface elements and finishes.

Apart from the structural issues of the *minars,* on which the geophysical investigations and Dr. Wenzel's work focused, there are several instances of structural failure in the smaller buildings and the floor of the courtyard chiefly to do with soil conditions in the upper most strata (reaching down to about 6 to 7 metres depth) which are saturated with water from leaking infrastructure elements within or close to the monument. As a result, the south-eastern part of the courtyard floor, opened up for repairs by the Punjab Archaeology Department in April 2011, had subsided. Major subsidence is found in the buildings flanking the courtyard on the southern side.

Structural problems apart, the fabric of the building suffers from endemic failure of maintenance, from unfriendly use, from the manner in which elements of the utility infrastructure have been introduced, and from the effect of weathering decay. These are also reflected in numerous aspects that have to do with poor understanding of historic materials and the fact that repairs and interventions carried out have for at least three decades not been informed by a complete understanding of the historic materials that constitute the built fabric of the monument.

3. A FRAMEWORK FOR FURTHER ACTION

Strategic considerations for dealing with the array of problems and issues and a set of recommendations based on these have been proposed in Part III of the report. Four broad areas of consideration have been found relevant:

a. Problems and issues generally pertaining to the neighbourhood of the mosque complex;

b. Encroachment on public space, illegal construction, and the resulting lack of municipal control and regulation of a heritage site. This comprises at least two important aspects which need to be considered - the manner in which *waqf* properties have been allowed to be used as private or semi-private premises, as well as the manner in which lack of municipal control affects the functioning of the city in the immediate environs of the mosque;

c. Infrastructure issues;

d. Issues of conservation of the mosque complex per se.

The recommendations for how this project is to be proceeded with reflect the above considerations.

A. At the level of the neighbourhood the recommendations are as follows:

i. All later period constructions that abut the 17th century edifice should be removed to enable access for conservation activities from all sides. In particular, the properties owned by the Auqaf or by private owners, which have been erected against the monument on its southern side, should be removed and their occupants accommodated elsewhere;

ii. The full weight of current and future legislation relating to listed historic monuments must be brought to bear in a new regulatory regime to be imposed on the neighbourhood context;

iii. Existing institutional arrangements must be reviewed in depth, and new institutional structures should be established;

iv. The urban design and rehabilitation of Chowk Wazir Khan should be integrated with the conservation design of the mosque;

v. Appropriate measures should be taken to reduce the intensity of traffic and to regulate it in the vicinity of the monument;

vi. The 1990 structure of the *mazaar* and shrine of Syed Suf should be reduced to an appropriate size and style in order not to obstruct the axial view of the mosque entrance from Chitta Gate;

vii. The design of the Chowk prepared as part of the urban design components of the World Bank funded Pilot Urban Rehabilitation and Infrastructure Improvement project should be considered for full implementation;

viii. The heritage component of the Chowk itself, including Chitta Gate, and Dina Nath's Well should be appropriately conserved, rehabilitated and presented;

ix. Recently discovered fragments of what could be the original façade of the Chowk or its later modifications are embedded deep inside modern construction. These should be laid bare, conserved and appropriately displayed.

B. Recommendations to address various kinds of unregulated structures and uses affecting the quality of the urban environment:

i. Structures in the Chowk Wazir Khan which occupy public space in the open should be removed, including the shops on the diagonal path from Chitta Gate to Kotwali Gate. This is already being actively considered as part of the Government of Punjab Pilot Urban Rehabilitation and Infrastructure Improvement Project.

ii. Structures that have been erected against the monument's structure as well as built against or into the structures of Dina Nath's Well, Syed Suf Shrine, Chitta Gate and Kotwali Gate, should also be removed.

iii. Structures which have over time replaced the 17th century perimeter of the Chowk should at the very least be pushed back to the original perimeter as some of them intrude as much as 3.5 metres into the public space. The extent to which these structures will be either allowed to continue as at present, or be pushed back, or removed altogether up to the original ROW is contingent upon the precise urban design of the Chowk. It has been assumed in this report that these structures will be replaced by new structures that will recapitulate the original form of the Chowk.

iv. 19th and 20th century buildings which today constitute elements of historic importance and some degree of architectural merit should be conserved, if necessary after purchase and evacuation. These buildings would justify conservation in their own right. There are two properties that fit this description: H-1088 and H-687. Both these properties will lend value to the Chowk and the mosque if properly conserved, integrated into the design of the Chowk, and displayed. If not acquired outright under eminent domain, this may meet with resistance from the owners of other properties which are not being conserved or whose properties will be altered to one extent or another in order to bring them into the parameters of the law. This issue will need to be addressed and mitigated.

C. Recommendations to improve the modern services infrastructure are as follows:

i. The existing utility services, inadequately incorporated in the past in a piecemeal fashion and that have posed considerable threat to the structure and to the surface decorations, should be upgraded to the highest standards;

ii. A detailed infrastructure planning process should be started. This new infrastructure development plan should be integrated within the larger detailed design of infrastructure currently being undertaken by the Punjab Government for the Pilot Urban Rehabilitation and Infrastructure Improvement Project.

iii. Mechanical and electrical engineering consultants may be appointed for the design of the infrastructure and utility services of the monumental complex. These consultants will work in a fully coordinated manner with AKTC-AKCSP and move the conservation programme forward in full integration with the structural consolidation and architectural conservation of the monumental complex.

D. Proposals for structural and architectural interventions in the monument proper include:

i. In view of the need for organizational, human, technical and financial resources and the degree of collective responsibility and oversight necessary for the conservation of this important national monument and its urban neighbourhood, a high powered institutional framework based on public-private partnership principles should be created. This would make the best use of the resources that are currently available as well as those to be procured in the future through sustained capacity building measures;

ii. Appropriate legal and institutional measures are taken to clear the mosque of all illegal construction and encroachment. It may be kept in mind that a substantial financial outlay will be required for the purchase and demolition of those structures built against the body of the monument which have a history of half a century or more;

iii. For those parts of the complex that are not used for religious purposes and that were originally intended for generating revenue including those elements intended for supporting the livelihood of a certain class of craftsmen (calligraphers and bookbinders), a range of appropriate uses should be established. The proposed uses should not only be sensitive to the architectural fabric of the mosque but be integrated with the planning for the future of the neighbourhood surrounding the mosque;

iv. Necessary activities for the consolidation of the structure of the mosque should be commenced;

v. In conjunction with structural consolidation, the repair of the architectural fabric should also be commenced;

vi. The conservation and restoration of the ornamentation and surface decoration of the mosque in the interior as well as the exterior of the building should be commenced. For this purpose a portion of the ornamented part of the monument should be selected to start the conservation on a pilot scale, which could then be expanded on an accelerated schedule. It may be mentioned here that the detailed analysis of the damage to surface decoration of the mosque is still a slow, laborious ongoing process. It must be continued until all parts of the tile revetment and the interior frescoes have been documented. The interior frescoes have not been documented as yet. For both types of surface ornamentation and renders (tile mosaics and frescoes), it is proposed to undertake pilot conservation projects. The reason is that only through investigative and research processes aimed at developing, deploying and testing the appropriate materials and techniques can an effective and reliable conservation programme be undertaken.

vii. A well-designed, modern system of services infrastructure that is properly integrated into the schema of the architectural fabric and which does not pose hazards to the monument or its users, should be established. This should also include a modern public address system that should replace the existing technology of horn loudspeakers strapped on to the mosque;

viii. An appropriate and effective system of display should be designed and implemented including setting the building in its historic context, and exploiting the full potential of the magnificent architecture and its decorative features by effectively illuminating it at night;

ix. An appropriate information system should be established to provide the public and visitors the full breadth of information that is needed to gain an adequate understanding of the historic structure;

x. The valuable opportunity afforded by the conservation of the mosque for on-the-job training and development of conservation skills for both professionals and craftsmen should be fully exploited;

xi. All restoration programmes should be designed and carried out in such a way as to provide a strong basis for preventive conservation in the future.

The recommendations in Part III of the report also contain sections specifying the manner in which work should proceed with respect to the consolidation of the mosque's structure. This is dealt with under the sub-sections on the foundations and the *minars*, primary elements (external and internal walls, floors, stairs, roofs and domes) of the building fabric in general as well as the secondary elements and finishes (*tazakari*, *kashikari* and *naqqashi*).

4. PROVISIONAL COST ESTIMATES

Based on the documentation, investigations, analyses and recommendations contained in this report, a preliminary cost estimate has been arrived at. The present cost estimate relates to the actions to be undertaken for the following items of work:

a. Removal of the affects of neglect and indifferent repairs and management that the mosque has had to endure both at the level of the neighbourhood environment and at the level of the monument itself;

b. Structural consolidation of the monument including addressing those processes which have resulted in structural damage;

c. Repairs to the essential architectural fabric of the monument;

d. Undertaking a complete design of all infrastructure elements and implementing the same; and

e. Undertaking repairs to surface renders and decorations in coordination with the pilot tile mosaic conservation and fresco conservation programmes. Notional amounts for the continuation of the conservation of surface renders and decorative revetments beyond the pilot projects have been included and identified separately.

The estimate is intended to be used as a framework for arranging funds for the conservation programme. This would include the administrative and financial approvals, as well as the planning and execution of the overall conservation programme, which may take as much as five years of full blooded project activity. The estimate also includes certain major expenditure to be incurred for the rehabilitation of Wazir Khan Chowk.

Item	Description	PKR, million	USD, million
1	Acquisition of Property	139.55	1.64
2	Rehabilitation of the Neighbourhood Context	59.80	0.70
3	Conservation and Rehabilitation of the Monumental Complex	369.69	4.35
3.1	*Primary Elements*	*18.73*	
3.2	*Secondary Elements*	*71.90*	
3.3	*Installations*	*3.84*	
3.4	*Conservation of Surface Ornaments and Revetments*	*212.93*	
3.5	*Infrastructure*	*55.88*	
3.6	*Field Material Science Laboratory*	*6.42*	
	Total	569.04	6.69

At this stage, a total fund of Rs. 569.04 million (USD 6.69 million), is estimated to carry out the activities envisaged over a period of between three to five years. This amount includes Rs. 200.21 (USD 2.36 million) worth of work on *kashikari*, *naqqashi* and *tazakari* that will be continued on after the pilot stage, and Rs. 139.55 million (USD 1.64 million) for acquisition of property for demolition and clearance.

The cost estimate has been divided into three parts:

Item 1 (Rs. 139.55 million) covers **acquisitions of property** to clear the mosque and the Chowk of all encumbrances and encroachments that have arisen from at least a couple of hundred years of indifference and neglect.

Item 2 pertains to the actual **rehabilitation of the neighbourhood context**, which is estimated to cost Rs. 59.80 million.

Item 3, worth a total of Rs. 369.69 million of the estimated cost, covers the **conservation of the Wazir Khan Mosque** monument itself. This estimate includes the cost of the setting up of a **field material science laboratory** which is likely to benefit the agencies and individual conservation projects for other monuments to be undertaken in the medium term future in Lahore and beyond. In addition it includes the cost of a glazed tile production facility and the cost of pilot conservation projects for two important aspects of the decorative schema of the monument—glazed tile mosaic work (*kashikari*) and wall treatment/painting on both wet and semi-dry lime plaster renders (*tazakari* and *naqqashi*).

PART I: HISTORY AND BACKGROUND

1 HISTORICAL BACKGROUND

Masjid Wazir Khan was built in 1634 AD (1054 AH) by Hakim Aliuddin[1] (sometimes also referred to as Hakim Ilmuddin). At the time of its construction, half a century before the construction of the Badshahi Masjid, the mosque was considered the largest in Lahore, superseding the Begum Shahi Mosque constructed during the reign of Emperor Jahangir in 1614 (1023 AH). Hakim Aliuddin came from the town of Chiniot on the banks of the river Chenab, and had been employed as a court physician by prince Khurram (later Emperor Shah Jahan). His services during various campaigns earned the appreciation of the prince, earning him the title Wazir Khan,[2] and he remained one of Shah Jahan's most trusted aides in the earlier years of his reign. He was appointed *subedar* of the province of Lahore in 1632 and relinquished this position in 1639. It was Wazir Khan, along with Prince Shah Shuja, who was entrusted in 1632 with the task of bringing the body of the deceased queen Mumtaz Mahal from Burhanpur to Agra to be buried at the site of the Taj Mahal.

According to Abdullah Chaghatai, whose book *The Wazir Khan Mosque, Lahore*[3] is the main source for later publications on the subject, the mosque was built outside the limits of the old city wall[4] that existed prior to the new fortifications built during Emperor Akbar's reign (1556 - 1605). According to the author, the mosque is located on the site of an old *madrassa* previously established by Syed Ishaq Gazruni (d. 1384 AD, 786 AH). It is possible that by the 17th century the *madrassa* or Sufi *takya* had ceased to function and existed as a derelict site where the graves of Syed Ishaq Gazruni, Syed Suf and Syed Sarbuland lay within 100 metres of one another, as they continue to this day. In building the Wazir Khan Mosque, the grave of Syed Ishaq Gazruni was incorporated in the complex, and can be found in a chamber about 2.5 metres (7.87 feet) below the mosque's raised plinth, underneath the floor of its courtyard. Chaghatai further speculates on whether such a large undertaking on the site of a previously existing group of grave-shrines could have been intentional, aimed at re-sanctifying the site of the Sufi institution that had existed at the site three centuries earlier.

Much of the historical and contextual background to the mosque can be gleaned from the *waqf* document published in Latif's late nineteenth century book on the history of Lahore.[5] From the *waqf* we learn that the mosque was built together with a bazaar, a *hammam*, a "large" *serai*, some wells and *katras*. Chaghatai interprets the description in the *waqf* document to mean that all shops built on both sides of Delhi Gate Bazaar right up to the Delhi Gate were part of the buildings created together with the mosque. This interpretation first appears in a 1903 article by F. H. Andrews reprinted in the book. However, the *waqf* document just mentions "shops on either side of the road" without precisely identifying the road in question. It could just as well have been the road running along the mosque's northern side. Today there are no signs of a bazaar built as a single architectural project of the 17th century between Delhi Gate and the mosque.[6] The *waqf* mentions twenty shops (and their upper storeys) intended free of charge for calligraphers and book-binders as part of the endowment, which could also mean the shops forming the "bazaar" on the north and south of the mosque's entrance *dewrhi* (although these are only sixteen in number, unless we include the four niches built into four sides of the octagonal space which comprises the domed *dewrhi*). No traces remain of the *serai*, although the space of the Chowk or *jilau khana* of the mosque is typologically similar to the form of caravanserais as they were built during the Mughal era.

Chaghatai also reflects on the larger cultural role the mosque may have played over the centuries of its existence. His observation was keen enough to notice an inscription engraved on the plaster render (created in the 17th century) in the niche north of the prayer chamber. From this and from a comparative study of other sources, he concludes that certain parts of the mosque were used as a centre for intellectual discourse. Some of the *hujras* of the mosque were also used by persons belonging to specific building trades, of which he mentions the trade of the *naqqash* after which a specific *hujra* (the third from the east of the northern row of *hujras*) was named.

Opposite: View across Wazir Khan Chowk of the entrance iwan of the mosque. Photograph probably taken c.1970's.

2 INSTITUTIONAL FRAMEWORK FOR THE PROTECTION AND MANAGEMENT OF THE COMPLEX

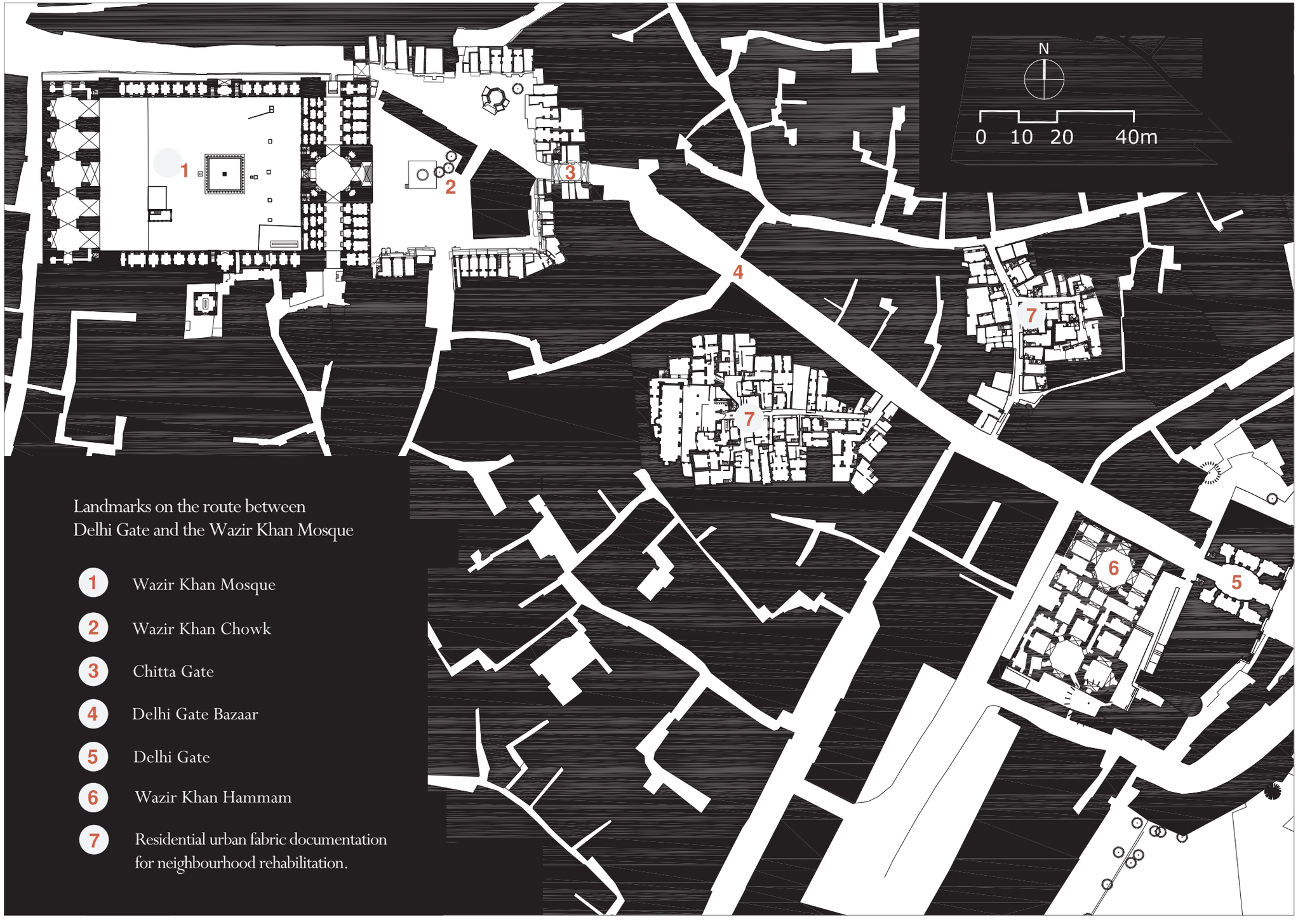
In 1924, the Wazir Khan Mosque and Badshahi Mosque were included in the list of monuments protected[7] under the Ancient Monuments Preservation Act of 1904 and were, at the time of Independence, among more than one hundred monuments and sites protected under that Act. The 1904 Act was replaced with the Ancient Monuments Preservation (Amendment) Ordinance in 1964. Six years later, a new legislation called the Antiquities Act 1968 was passed by parliament. It was further amended and finally replaced with the Antiquities Act 1975 which is currently the main legislation in Pakistan for heritage protection.[8]

Until the 1980's, the Federal Department of Archaeology and Museums was the only national organisation competent under law to declare "protected" any monument or ancient site. Since the mid-eighties the provincial governments have created their own laws[9] and departments of archaeology, and have been listing monuments as "special premises" in the Punjab and "protected heritage" in the province of Sindh. However, the Wazir Khan Mosque, Chitta Gate, the north-western gate of Chowk Wazir Khan and the well of Dina Nath remain protected monuments under the federal legislation.[10]

Most of the religious buildings in Pakistan are under the provincial *auqaf* departments for their maintenance, management and administration of daily affairs and the management of the Wazir Khan Mosque complex is therefore the responsibility of the Punjab Auqaf Department.[11] A manager and support staff are permanently stationed in the Auqaf office at the Wazir Khan Mosque. This office also serves as a base to manage the other religious monuments in the Walled City. The office manages activities related to rents, annual agreements and negotiations with the tenants of shops.

The conservation, restoration and major repair work of the mosque, however, are the responsibilities of the provincial Department of Archaeology. A mosque committee is responsible for the management of daily activities related to the prayers and also arranges the programmes on special religious days.

Opposite: Detail of floral and geometric fresco work on the western-facing wall in the prayer chamber.



Landmarks on the route between
Delhi Gate and the Wazir Khan Mosque

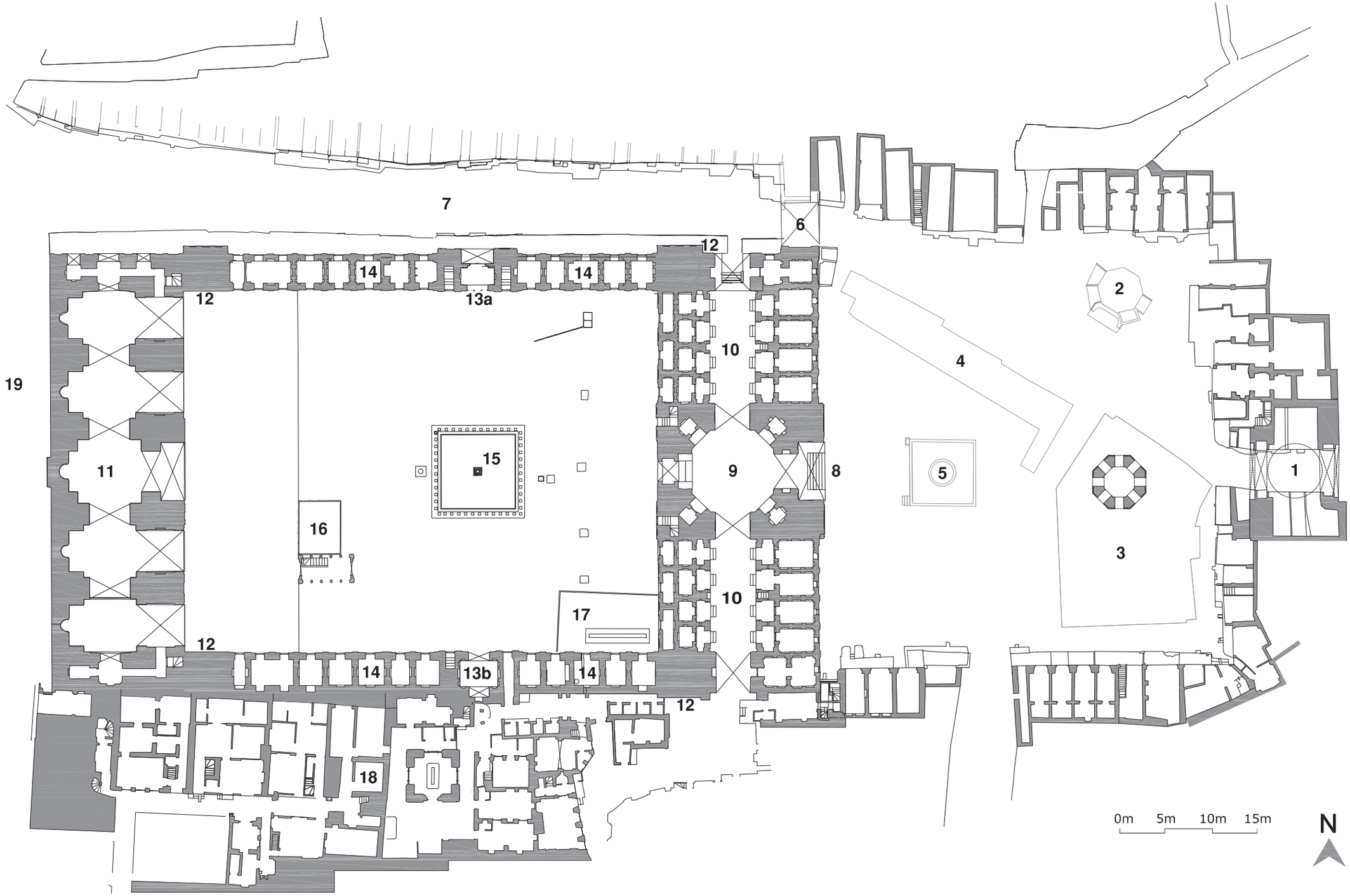
1. Wazir Khan Mosque
2. Wazir Khan Chowk
3. Chitta Gate
4. Delhi Gate Bazaar
5. Delhi Gate
6. Wazir Khan Hammam
7. Residential urban fabric documentation for neighbourhood rehabilitation.

3 THE URBAN CONTEXT

Historically, as part of the royal thoroughfare connecting Delhi Gate and the Lahore Fort, the Wazir Khan Mosque together with its square formed a singular and very important element punctuating the urban fabric of the Walled City. Located about 260 metres (853 feet) from Delhi Gate, and surrounded by the dense, organic, urban tissue of the Walled City, the Wazir Khan Mosque complex is the centre piece of an historic ensemble and represents urban design trends of the first half of the 17th century. This ensemble includes Chowk Wazir Khan (a formal, introductory urban open space), the mosque itself, the double row of shops integrated in the entrance system of the complex, and the shops at street-level built into the body of the monument on its eastern and northern sides. On the southern side the perimeter of the mosque is physically obstructed by houses built contiguous to the historic walls in the 20th century. An open street leading off the main throughfare forms the western limit of the complex.

Right: The Lahore Walled City, and the Shahi Guzargah route between Delhi Gate and Lahore Fort.

Below: Panoramic view looking east and south, of the Wazir Khan Mosque, Wazir Khan Chowk and the neighbourhood. Left of image is the north-eastern and eastern neighbourhood; left of centre is the Syed Suf Shrine with its green dome and Chitta Gate behind; the right half of the image shows the Wazir Khan Mosque complex in the foreground with the mosque's southern neighbourhood in the background.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4 THE MONUMENTAL COMPLEX

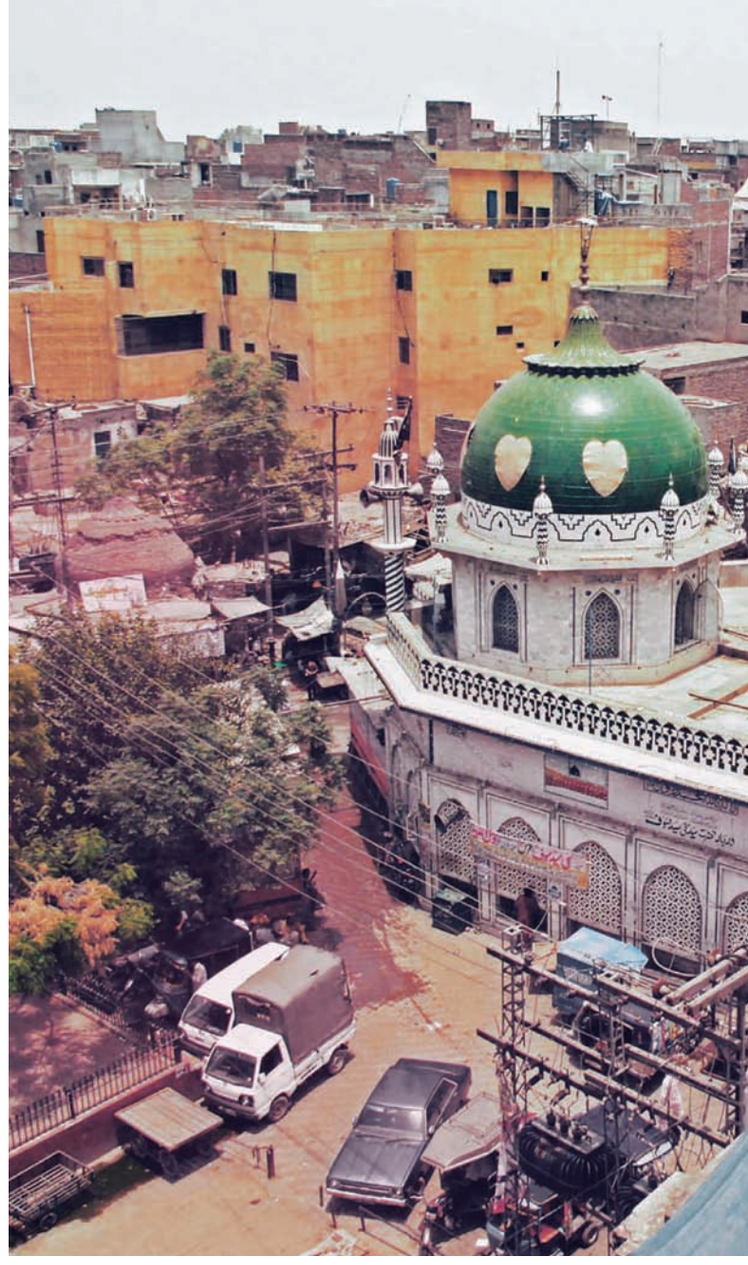
4.1 THE CHOWK

At the urban scale the complex comprising the mosque building and Chowk Wazir Khan is a significant example of urban design in the Shah Jahan era. The Chowk represents a typology of urban space described by the term '*jilau khana*', which signifies an introductory space of arrival and first sighting, and has its parallels in other great mosques and funerary monuments of the period. Historically, the shops lining the perimeter of the square would have played an important role in creating a formal urban ambience and in supporting commercial activities in the square. Even in its present deteriorated form, the Chowk contains some of its original formative elements which endow it considerable character: the Chitta Gate to the east and the gate in the north-western corner of the Chowk leading into the Kotwali Bazaar are sympathetic to the architecture of the mosque by virtue of their scale and stylistic attributes.

Once an open public square of the Walled City, Chowk Wazir Khan has now lost its original form and prime function. Shops that were built along with and integrated into the mosque building on its northern side have been expanded into the street with structures that shelter the current commercial activities. These shops pay rent to the Auqaf Department. Structures that constitute the perimeter of the Chowk have illegally occupied the space of the square to a dramatic degree, intruding into the latter by as much as 5.75 metres.

Vehicle and pedestrian access to the square is made possible through Chitta Gate sitting astride the main road connecting Delhi Gate and the Lahore Fort, on the Chowk's eastern side. Traffic conditions today are intense in their density and mixed modes (pedestrian, pedal bicycles, motor cycles and motorized passenger and goods vehicles, bullock and horse driven goods transports and push-carts). Much of this through traffic carries goods for warehousing and retail trade in the Azam Cloth Market, the Pakistan Cloth Market and the Kashmiri Bazaar situated in close proximity north and west of the mosque complex.

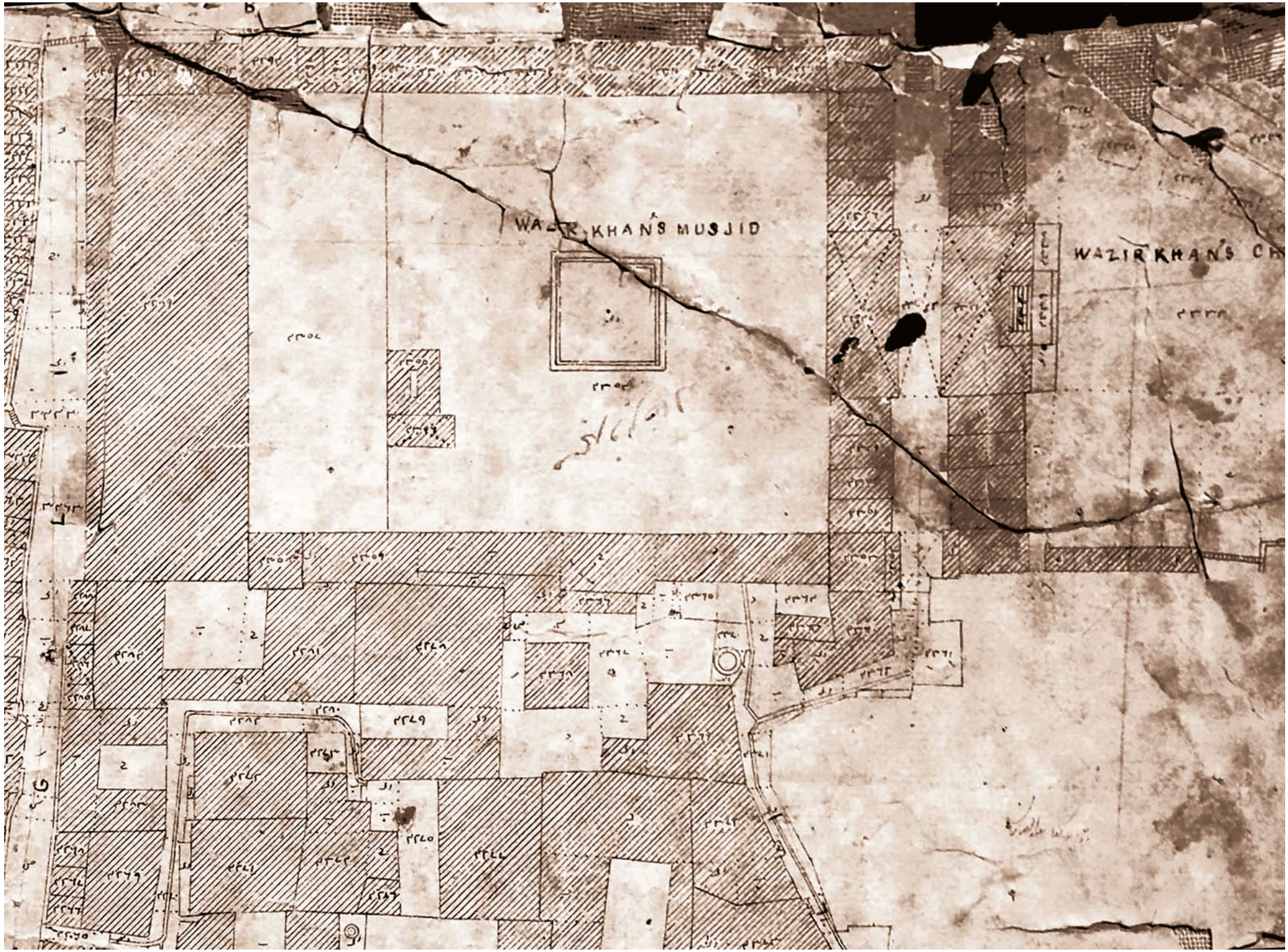
The form of the square is reminiscent of the typology of Mughal *serais* and the square could well have been the *serai* mentioned in the *waqf* deed (Latif op. cit). The cellular spaces lining the square, many of which contain present-day shops, could (in this interpretation) have been the residential cells of the *serai*.



Right: View of Wazir Khan Chowk, from the south-eastern minar. *In the foreground are parked vehicles, to the left is the dysfunctional fountain platform, to the right is the Syed Suf Shrine, and in the background is the mosque's north-eastern residential neighbourhood. The dome of Dina Nath's Well, a historic monument in the square, is barely visible (left of centre of the image).*

Opposite: The Main Elements of the Monumental Complex (see legend below).

1 Chitta Gate
2 Dina Nath's Well
3 Syed Suf Shrine
4 Encroaching shops on angular pathway across Chowk
5 Public tap / fountain
6 North-western Gate to Kotwali Bazaar
7 Kotwali Bazaar
8 Entrance *Iwan*
9 *Dewhri*
10 Calligraphers' Bazaar
11 Prayer Chamber
12 *Minar*
13a North Pavilion
13b South Pavilion
14 Row of *Hujras*
15 Ablution Pool
16 Syed Ishaq Gazruni Shrine and adjacent pavilion
17 Recently added ablution facilities
18 Residential neighbourhood on southern side
19 Street


WAZIR KHAN'S MUSJID
WAZIR KHAN'S CH

4.2 THE MOSQUE

Today, the monument itself is limited to the mosque building, the entrance portal of what used to be a "calligraphers' bazaar", the mosque courtyard, the prayer chamber, the *minars*, the *hujras*, a pair of two-storey pavilions on the central axis transversely crossing the courtyard, and the shops at street-level on the northern and eastern sides. These architectural elements are described in the following paragraphs.

For analytical purposes, the structure of the mosque can be divided into three horizontal planes. Level 0 corresponds to the street-level where the shops on the eastern and northern sides are located. The floor level inside these shops is now lower than the street-level. Level 1 corresponds to the podium on which the main ensemble of the mosque and the buildings that frame the courtyard are based, occupying the major proportion of the covered area of the complex. Level 2 corresponds to those spaces which can be accessed from Level 1 via staircases at different locations.

The layout of the mosque is rectangular in plan, measuring 86.17 m x 50.44 m (282.7 ft x 165.5 ft) on its extreme limits. The four imposing *minars* define the corners of the main courtyard. The prayer chamber, courtyard, *hujras*, vestibule and bazaar constitute the main elements of the mosque complex. Among the architectural elements and decorations of the Wazir Khan Mosque which represent influences from the pre-Mughal era and from neighbouring regions such as Persia and Central Asia, one special feature is the formal "bazaar" which constitutes a key element of the entrance system to the courtyard of the mosque. This bazaar comprises two rows of shops facing each other and traversing the entire width of the site. The shops forming the two legs of this bazaar arrangement could with some conjecture be said to be the shops intended free of rent for calligraphers and bookbinders of the Quran in the *waqf* deed included in Syed Muhammad Latif's book.[12] It is noteworthy that the principal entrance façade of the mosque is also the external façade of the outer layer of shops that form the Calligraphers' Bazaar,[13] and not of the enclosure of the mosque proper. Half way along its length, the linear axis of this bazaar crosses the axis of the entrance to the mosque. This crossing is marked by an octagonal dome. This is the first example in the subcontinent (and not widely emulated elsewhere), of a purpose built bazaar in an adaptation of a Central Asian *charsu*. However, in this ensemble only two bazaars lead off from the dome of the *charsu*, the remaining bazaars having been replaced by the axis of movement into the entrance of the mosque.[14]

Right: Waqf *deed of theWazir Khan Mosque, as translated in Latif, Syed Muhammad,* 'Lahore: Its History, Architectural Remains and Antiquities, with an Account of it Modern Institutions, Inhabitants, Their Trade, Customs, &C.' *(1892), Lahore.*

Opposite: 1907 cadastral map

"Praise be to God who enabled His servants to honour religious edifices, and benedictions and salutations to Mahomed, His Prophet, who persuaded people to spend money on charitable objects, and to his descendents and companions, the mine of virtues and the source of good, so long as there is duration to earth and skies.

Be it known that this is a writing to declare that I, the humble slave of the threshold of God, Hakim Ilm-ud-dín, alias Wazír Khán, son of Sheikh Abdul Latif, son of Sheikh Hisám-ud-dín, Ansári, have, while in full possession of my health and senses, and the enjoyment of my property, and all the privileges pertaining thereto, out of property exclusively owned and best earned by me, dedicated to pious uses the Chief Mosque, situated in the Lahore city, with all its lawful accessories and appendages;

And that in order to give permanency to this sacred Institution, I have endowed for its expenses all the shops situated on both sides of the road, together with the upper storeys, habitable quarters, the large serae, bath, two wells worked with Persian wheels, and several miscellaneous plots of ground, each of these properties just mentioned having known boundaries and manifest marks.

The legacy is valid, binding, certain, and imperative; it is not subject to sale, mortgage or dower; it is un-inheritable, and is under no circumstance or cause to become the property of anyone until the day when God shall assume heritage of all lands, for He is the best of the inheritors; and this is my final endowment to poor Mussalmans.

And the conditions in regard to the legacy before mentioned are these:—
The control and charge of the endowments, the dismissal and appointments of the servants of the mosque, &c., the disbursement and the apportionment of expenses, the increases therein and investments and divestments relating thereto, the location and ejectment of the tenants of the shop, will permanently for life be in the hands of the testator himself. After him the power shall rest with one of his lineal descendents, and Mahomed Sai'd Khán, after whom it shall rest with Mirza Mahomed Anwar; after him with the ablest of his male descendants, and the descendants of that descendant, progeny after progeny, and generation after generation, so long as their offspring shall last. Should none be left of his male descendants, then the power shall rest with his nearest of kin, in the order already mentioned.

Further, it is provided that there shall be one Imám (prelate) and preacher to the mosque, thoroughly skilled in the art of reading, and familiar with the rules of prayer, and one public crier to prayers who must be fully conversant with the death ceremonies.
Further, it is laid down that twenty shops outside the eastern gateway, together with their upper storeys, shall be for the exclusive use of the book-binders and book-sellers of the books of Islám, free of rent in perpetuity.

Further it is covenanted that there shall be two teachers for the said mosque for the purpose of giving instruction in theology.

The following are the provisions regarding the remuneration of the establishment attached to the endowment. The Imám and preacher to receive from one rupee to ten rupees per diem; the public crier to prayers four annas a day; each teacher one rupee.

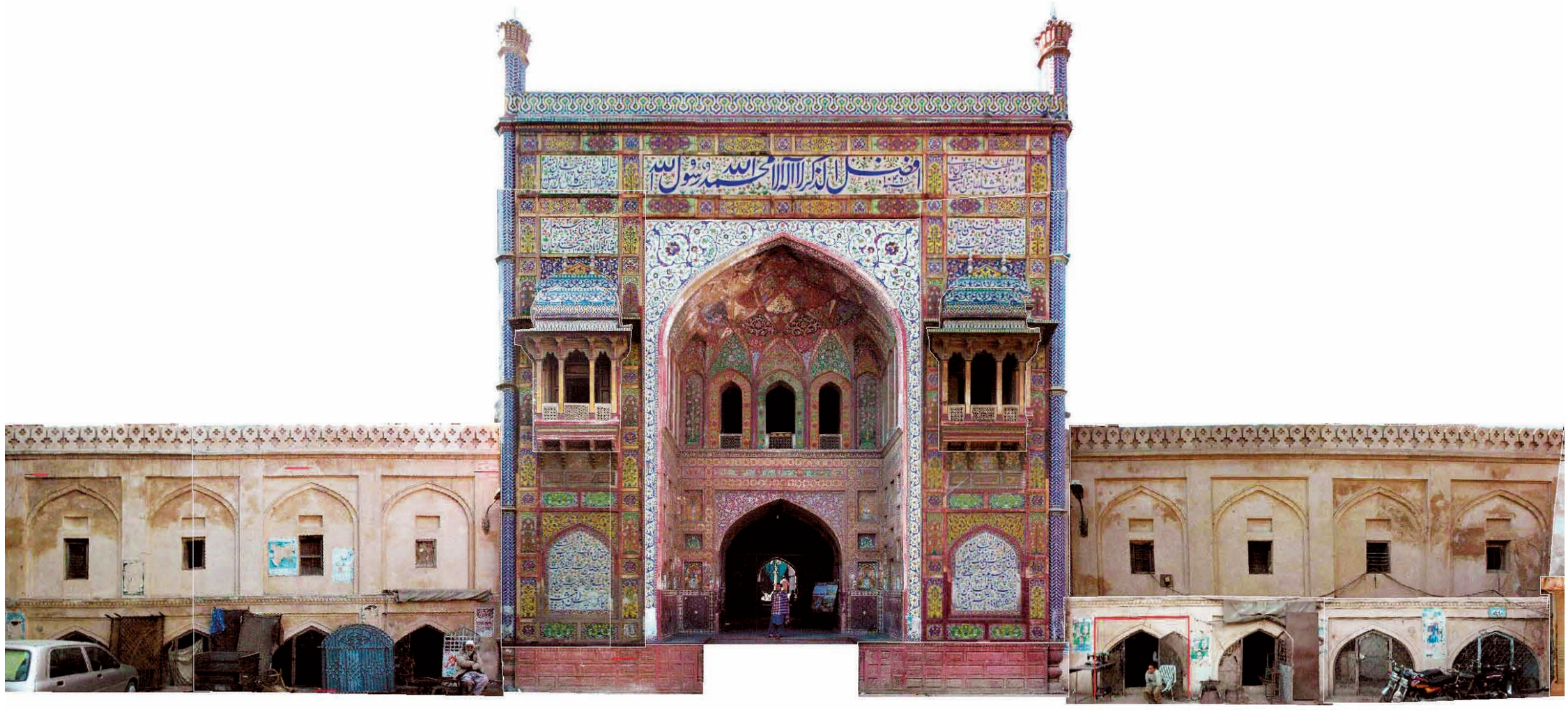
Any one of the descendants of the testator in charge of the legacy aforesaid, shall receive each month one-sixth of the income of the endowed property; and any one of his near relations who may be in charge shall receive a ninth share of the same and the share shall decrease according to the remoteness of consanguinity.

And whatever shall remain after defraying the expenses of building, the servants of the mosque and other necessary expenses, shall be spent in maintaining guests, providing for the carrier of fire-wood (for baths), and the chamberlain and other rightful persons attached to the mosque.

And in appointing the servants of the mosque, the Law of the Hanfi sect shall be taken as a guide.

And the rules above detailed have been framed by the testator himself. Any one who attempts to make a change in them after he has once heard them, shall be deemed a transgressor. This legacy has a binding force; and whatever I have herein written is attested as binding by the Qázi of the time, who has put his sacred seal on it in confirmation of the same.

Written on the first date of the holy Ramzan, in 1051 (1641 A.D.) of the sacred Hijri era."


افضل الذکر لا الٰہ الا اللہ محمد رسول اللہ

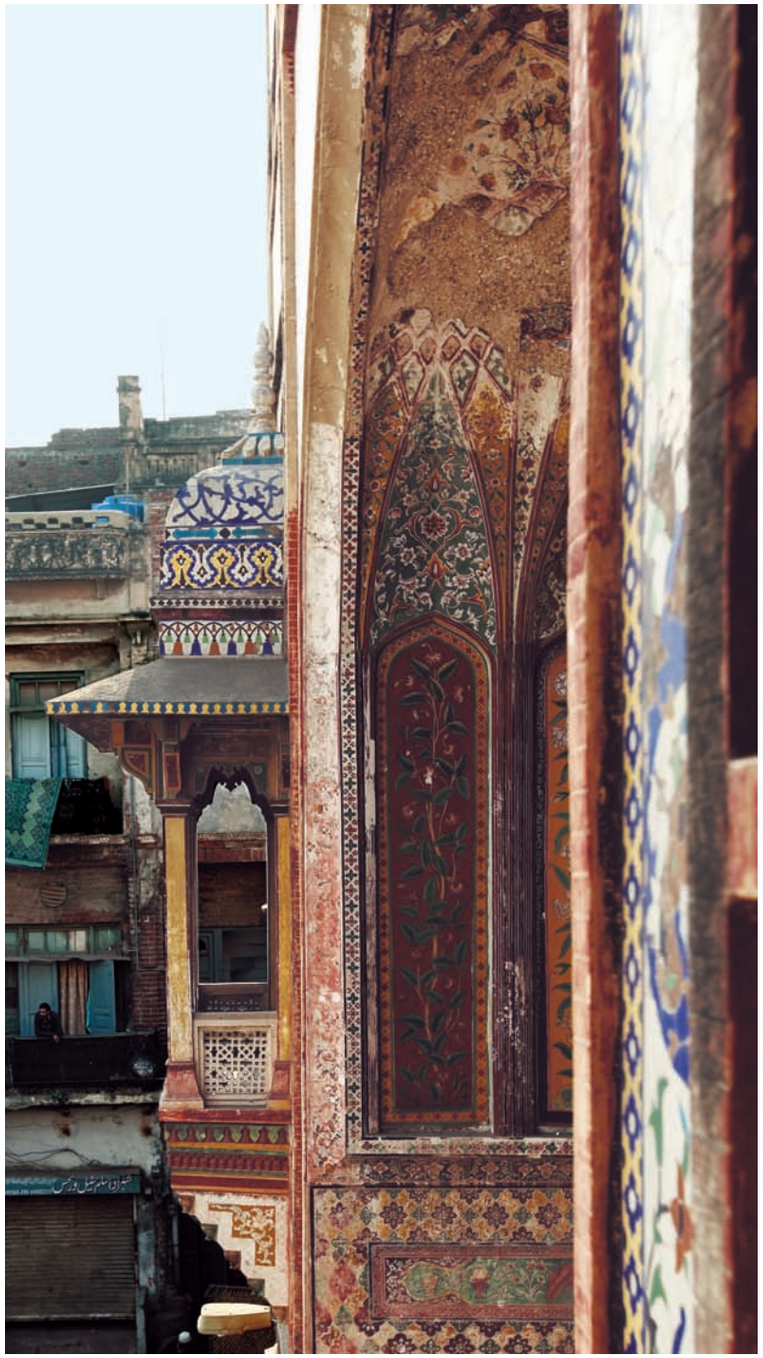
4.2.1 The Main Entrance

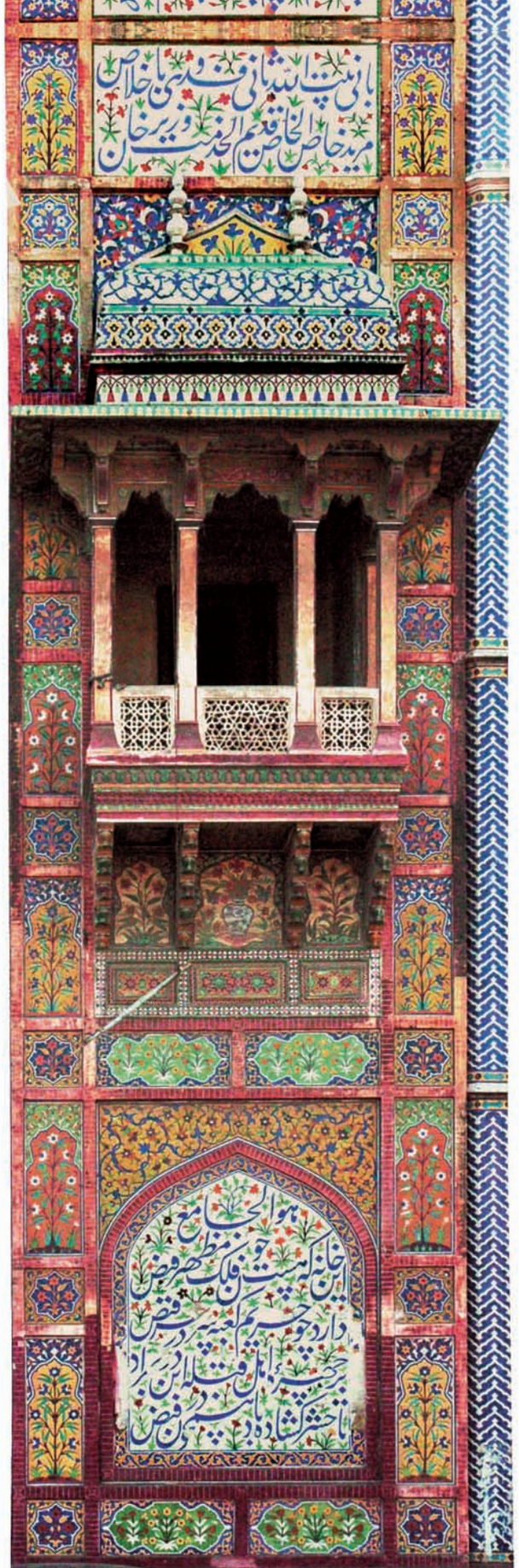
The central, double-storied mass of the main *iwan* represents an entrance system of some complexity. With a set of seven steps[15] from the Chowk one reaches the first plinth level of the mosque under the entrance dome. At this point the space leads off into three directions in addition to the direction from which one has entered. The two rows of shops for calligraphers and book binders on the north and south sides form passageways that are open to the sky. These passageways open out on the north side to the Kotwali Bazaar, while on the south side they would have formerly opened into the open land which was part of the endowment, but now comprises a residential neighbourhood. Movement in the third, western, direction is through a door after a set of three steps, and leads into the courtyard of the mosque. On the right and left before the doorway are platforms that are to this day used by persons looking after shoes that must be taken off prior to the entry into the courtyard.

The entire façade of the *iwan* on the eastern side is decorated with *kashikari*, of which a predominant component comprises calligraphic work, described in Section 5.2. A band of small squares and rectangles provides a boundary for larger rectangles containing calligraphy in *nastaliq* script in both Arabic and Persian.

The arched recess of the *iwan* is formed of *qalibkari* (*muqarnas* or stalactite work) and decorated with *naqqashi* (fresco work), the latter also on the *entrados* of the *iwan* arch. The recess also contains three oblong arched windows which open on to the Chowk from the Level 2 gallery looking into the entrance *dewrhi*. This whole eastern façade is well separated from the rest of the face by being projected outwards 0.586 metres (23.07 inches). It is distinguished by two small octagonal engaged minarets on either ends of the face of the *iwan,* each topped by a miniature *chhatri*.

An interesting feature on the façade is the presence of two projected balconies which mark the points at which the façade is fenestrated at the upper level (Level 2). This typological accent does not appear to be very common in Mughal *iwan* architecture in the region. The balconies enrich the façade of the *iwan* by bringing its decorative arrangement into high relief and establish a strong outward spatial engagement of the façade with the space of the Chowk. The balconies also characterize the architecture of the mosque as the late stage of a Lahori regional style, to be overshadowed by the architecture of the high Shahjahani period some years later.





Above and Right: Detail of the balcony on the east facing façade of the entrance iwan.

Opposite: Rectified photographs of the entrance iwan*, the adjacent Calligraphers' Bazaar at Level 1 and the shops at Level 0.*

DIAGONALLY OPPOSED VIEWS OF THE MOSQUE COMPLEX:

Panorama of the mosque complex and its northern and eastern residential neighbourhoods, photographed from the south-western minar.

In the background from left to right, are the western, northern, eastern and south-eastern residential and commercial neighbourhoods.

In the foreground, from left to right, is the prayer chamber, the north-western minar, *the northern row of* hujras *with central pavilion, the north-eastern* minar, *the entrance* dewrhi *flanked by the double row of the Calligraphers' Bazaar, the south-eastern* minar *with the roofs of the southern row of* hujras *and pavilion visible immediately in front.*

Within the courtyard, the ablution pool is in the centre with its service pipe from the southern pavilion visible. In the immediate foreground is the complex of the shrine and pavilion of Syed Ishaq Gazruni. To the north of this is a line of prayer mats laid out.

In the south-eastern corner of the courtyard, to the right of the entrance, there is the recently added ablution facility.

Panorama of the mosque complex and adjacent Kotwali Bazaar, photographed from the north-eastern minar.

In the background from left to right are the southern, western and northern residential and commercial neighbourhoods.

In the foreground from left to right, is the entrance dewrhi, *the minars of the entrance* dewrhi *and the south-eastern* minar, *the southern row of* hujras *and their central pavilion, the south-western* minar, *the prayer chamber, the north-western* minar *with the roofs of the northern row of* hujras *and pavilion visible immediately in front.*

To the right of the image is Kotwali Bazaar - immediately adjacent to the mosque on its northern side. The shop awnings clearly demarcate the road.

4.2.2 THE CALLIGRAPHERS' BAZAAR

The Calligraphers' Bazaar, used in the past to support the activities of calligraphers and book binders, is an integral part of the mosque complex. Arranged in two rows the total number of shops on the northern and southern sides of the *iwan* is 16. Each shop has a small portico in the front which serves as a transitional space. Shops on the western side are smaller than the shops on the eastern side. Currently four rooms on the north-eastern end are used by the Auqaf Department whilst the remaining rooms are used either as storage or are vacant.

4.2.3 THE COURTYARD

The large open courtyard, measuring 52.62 m x 40.02 m (172.64 ft x 131.29 ft), is paved in brick and divided in two parts by a small change in level. Each façade facing the courtyard is well decorated with *kashikari* and *tazakari* work. The lower portion of the courtyard has an ablution pond in the centre.

a. FLOOR

A variety of patterns executed in cut brick cover the entire surface of the courtyard. A major drain in the eastern part of the courtyard for storm and waste water from the courtyard and the ablution pond runs in a south to north direction.

b. *HUJRAS*

The north and south sides of the courtyard are formed by rows of small *hujras* (rooms for study and meditation) intended for the staff, teachers and students at the mosque, which open into the courtyard. These *hujras* stretch between the pair of *minars* on either of these sides. At the centre of each row of *hujras,* a double storey pavilion establishes a north - south axis and breaks the monotony of the linear mass. The pavilion structure on the south side has an old cascade recessed in its southern wall, clearly marking the point at which water was brought into the courtyard from the well on the other side of the wall in order to feed the ablution pond. This structure also has a small access way into the southern neighbourhood. The pavilion on the northern side contains an entrance into the courtyard from the Kotwali Bazaar. On the exterior this entrance is marked by a small *iwan* and steps leading up into the coutyard.

c. THE ISHAQ GAZRUNI SHRINE

The shrine of Ishaq Gazruni is situated in the south-western section of the courtyard and is marked by a cenotaph at the level of the courtyard. The grave itself is located in the basement which can be accessed from an adjacent pavilion containing a staircase.

Right Top: View through the Calligraphers' Bazaar from the southern side.

Right: Detail of brick flooring.

Below: North pavilion with the northern row of hujras.

Looking towards the northern end of the prayer chamber.

4.2.4 THE PRAYER CHAMBER

The prayer chamber is situated on the raised, western side of the courtyard and is marked by another small rise of about 60 mm (2.36 inches) in the floor level. It is the centre piece of the mosque complex, a large structure covering an area of 710 m² (7642 ft²). The area occupied by its massive walls is 273 m² (2938 ft²) which is about 39% of the total covered area. Other than the central space accessed through the central *iwan*, the chamber is divided into four equal bays, two on either side, and each accessible from the courtyard though a secondary arch.

Five massive domes cover the entire space of the prayer chamber. These are reported to be double domes. The central part of the chamber holds a relatively larger space with a higher and larger dome than the domes on either side. A local precedent of this type of arrangement is to be found in the Begum Shahi Mosque (also called Maryam Zamani Mosque) which was constructed in 1614 (1023 AH), some 20 years earlier than the Wazir Khan Mosque.

The impressive eastern façade of the prayer chamber has its *iwan* in the centre with recessed archway access into the prayer chamber. The entire façade is decorated with *kashikari* (glazed tile work) composed with calligraphic tablets and floral panel arrangements. The recessed portion of the central *iwan* and the whole interior is decorated with *naqqashi*, *qalibkari* and *gachkari*.

Above: View towards the prayer chamber from the roof of the entrance dewhri. *The present form of the central ablution pool is the result of Auqaf interventions made in the 1990's.*

Below: Naqqashi *work on the inside of the central dome of the prayer chamber.*

Right: Photograph of the north-eastern minar *as seen from the courtyard of the mosque, taken by an unknown photographer in the 1870s. Part of the* Bellew Collection of Architectural Views, *British Library Online Gallery.*

4.2.5 THE *MINARS*

The *minars* of the mosque are the most visible features at the urban scale, located on each corner of the courtyard. The square bases of the *minars* on the western side form part of the courtyard enclosure and are visible in it being set out from the body of the prayer chamber. On the contrary, the bases of the eastern *minars* are embedded within the assembly of architectural forms containing the *hujras* and the Calligraphers' Bazaar. The total height of a *minar* from the floor level of the courtyard is 30.5 metres (a little over 100 feet) while the height of the *minars* from the street-level on the northern side is 32.91 metres (107.97 feet). The form of each *minar* can be divided into four sections: the first is the square base with a height of 8.46 metres (27.75 feet); from this base, the octagonal shaft of the *minar* reaches a height of 11.37 metres (37.30 feet); the third section is the projected section of the *minar* which forms an open ambulatory. The fourth section is an octagonal pavilion (*chhatri*) formed of red sandstone base structure, in turn covered with a cupola with projected *chujjas*. One can access the ambulatory at the top of the *minar* through a spiral staircase in the octagonal shaft.

The square base and the octagonal section of the *minars* are decorated with *kashikari* composed in recessed rectangular panels. The upper most section of the octagonal shaft is also decorated with *kashikari* but in a more elaborate manner, forming a transition to accommodate the larger diameter of the projected ambulatory. This transition begins by a frieze of terracotta panels with interlaced geometric motifs in relief within which fine *kashikari* work is embedded. The frieze is topped by a piece of the *minar* shaft divided into 16 oblong panels of *kashikari* work, each panel comprising a distinct composition of arboreal motifs. 8 of the 16 panels are wrapped around the vertices of an expanded octagonal shaft. At the top of each of the 16 panels is an interlaced system of *qalibkari* that enables the diameter to curve out and expand once more to accommodate the span of the octagonal ambulatory surrounding the *chhatri*. The base of the ambulatory is decorated with another *kashikari* frieze. The walls of the ambulatory sit atop this final frieze and are separated from it by a decorated *kashikari* moulding. The existing fragments of glazed tile on the dome and the base of the *chhatri* suggest that the surface used to be covered with glazed tiles.

Above: View towards the courtyard with the south-eastern minar *in the foreground and the north-eastern* minar *in the background.*

Right: The north-western minar*, with the base clearly visible from the courtyard.*

4.2.6 CONSTRUCTION METHOD AND ARCHITECTURAL FABRIC

The entire complex is built in brick masonry laid in lime mortar. A significant construction device used for covering the relatively shorter roof spans is the 'flat dome'. Aside from the prayer chamber, the entrance portal and the cupolas, all but a couple of the roof and upper floors structures use the flat dome technique in spans of up to 4 metres. The construction, seen ubiquitously in the architecture of the period comprises brick placed on edge in concentric circles and embedded in thick lime mortar bed and cover. A slight curved rise in the underside of the dome enables the creation, with a thick plaster render, of a flat horizontal soffit which hides the arcuated construction of the flat dome. The supporting system devised for roof spans of more than 4 metres in the Level 2 courtyard pavilion on the south side is interesting. Here, the span is divided longitudinally into two by the introduction of a series of brick columns in the centre, thus turning the ordinarily square roof span into two oblong rectangles of unequal width, each spanned by the same flat arcuated system. The depth of the roof structure, including all renders, varies from 0.5 metres to 1.5 metres.

a. BRICK FLOORING

All the floors in the mosque are made of brick laid in a variety of geometrical patterns, particularly in the courtyard and the prayer chamber. The floor of the prayer chamber of the mosque is exclusively in fine bricks laid in interlacing patterns. The geometrical patterns in the lower, eastern, portion of the courtyard are a rather simple arrangement of octagons and squares, the latter created by alternate vertices of the octagons. The sides of the octagons are defined by bands of brick placed at 90° to the vertex. The brick floors in the upper level of the courtyard and the prayer chamber are delicately executed both in terms of their detailed geometrical patterns and the craftsmanship. Here, the major shapes formed due to the inter-connected octagons have a thin border of black brick. This type of brick flooring is also observed in the Lahore Fort and the Shalimar Gardens.

Above: The small waziri *brick and lime mortar used in the Wazir Khan Mosque. Photographed on the mosque's southern wall.*

Right: Detail of the underside of a flat dome.

Opposite: Restoration of the courtyard floor, showing in detail the design and geometric layout of bricks used extensively across the mosque's floors.

b. DECORATIVE SCHEME

Artistically, the mosque displays some of the best examples of regional Mughal architectural, ornamental and decorative techniques, surpassing others in its delicacy and comprehensive decorative scheme. Most of the other Shahjahani era monuments in Lahore - Dai Anga Mosque, Asif Khan Tomb, Gulabi Bagh entrance[16] also have a combination of *kashikari* (glazed tile work), *naqqashi* (frescoes) and *tazakari* (incised faux brickwork) as architectural décor but the enormous scale of these decorations in the Wazir Khan Mosque certainly makes this mosque conspicuous in its artistic worth.

On the exterior, the decoration chiefly comprises a combination of fine exposed brickwork or plaster render with a thin layer of incised faux brickwork framing panels of glazed cut tile *kashikari* mosaic. The dramatically coloured glazed tiles are found in floral and arboreal motifs as well as calligraphic verses in geometrically coordinated panels placed in recessed niches and surrounded by the brickwork or the faux-brickwork schema. This forms the overriding organisational basis for the façades. On the *minars*, the decorative features comprise glazed tiles, exposed brickwork and in the case of the south-eastern *minar*, *tazakari* work from the late 1970's.

The vividly displayed and superb glazed tile mural decoration and calligraphy has been ascribed a direct relationship with the calligraphy of the Safavid monuments in Esfahan (Iran), built only a few years before the Wazir Khan Mosque.[17] The artistic and technical ancestry, however, has also been linked to the tradition of calligraphic decoration to be found in Central Asian sites such as those in Samarkand and other Timurid sites in Iran, Turan and present day Afghanistan.

The superb calligraphy by master calligraphers contains verses from the Holy Quran, the Hadith, and Persian poetry in elegant forms of *nastaliq* and *thuluth*. Calligraphic work and geometrical and floral decoration in *kashikari* and *gachkari* (raised relief in lime plaster) along with large-scale fresco painting and *tazakari* decoration lends the Wazir Khan Mosque an exceptional and unique heritage status.

In the interior of the mosque, the chief architectural and artistic characteristic resides in its profuse fresco work, bordered occasionally by floral *tazakari* work. The original frescoes have been touched up or painted over throughout the centuries by successive attempts at 'restoration', so much so that it can be said with some certitude that no original work is now visible. Yet the interior of the mosque has a stunning chromatic richness in its collective ambience that provides an artistic balance to the tile mosaic on the exterior.

i. *KASHIKARI* (GLAZED TILES)

Kashikari or glazed tile-work predominates all other forms of surface decoration, at least in the exterior, and it could be said more in the Wazir Khan Mosque than any other Mughal monument in the region. The *kashikari* covers an area of approximately 1400 m², of which nearly 160 m² is missing.

Except on the *minars*, most of the *kashikari* was selectively restored during the restoration efforts in 1971-78. Later in 1984-85, the *kashikari* on the north-eastern *minar* was replaced with new materials using old techniques. This second phase of work could not be continued owing to a paucity of funds. The rest of the *minars* contain old *kashikari* work, possibly the original. To a certain extent the *kashikari* work restored in 1971-78 on the main façade of the prayer chamber, on the faces of the *hujra* walls and on the main façade of the entrance portal seems to be in a fair condition. The condition of *kashikari* on the north-eastern *minar* is generally good but the condition of *kashikari* on the other three *minars* and on the north façade of the mosque, which appears to be older than that on the eastern façade, is not in a good state of repair.

Part of the *kashikari* work in the mosque is executed as calligraphy. Together with the floral and arboreal motifs, the calligraphy is woven into the overall decorative scheme of the mosque, in a manner which gives it prominence without detracting from its integrated place in the larger decorative scheme.

Right: Detail of kashikari *work on the north-west* minar.

Opposite: Tazakari *and* kashikari *decorative techniques used in combination on the rows of* hujras *facing inward to the courtyard.*

ii. *TAZAKARI* (INCISED FAUX BRICKWORK)

In addition to *kashikari* most of the wall surfaces in the entrance bazaar and courtyard are covered with *tazakari* or incised faux brickwork. The process is carried out by applying a thin layer of lime plaster tinted dark with red ochre on a base of white lime render. While the red ochre layer is still wet, thin grooves which represent mortar joints are scoured out with a special instrument to expose the underlying white lime render in a pattern imitating fine brickwork.

Most of the *tazakari* surface in the elevations of the courtyard has changed colour due to its direct exposure to rain and sunlight. There is evidence of repeated restoration of *tazakari* work at several locations. Erosion and flaking of the surface are the other kinds of damages noticed during the documentation of surface finishes. The use of non-mineral colour additives to the plaster might result in the colour washing away with the rain, as mineral red ochre mixed and carbonated into the lime would not run but only lose its red pigmentation due to exposure to sunlight and slow chemical changes with the passage of time.

iii. *NAQQASHI* (WALL PAINTING)

A major part of the interior wall and domed surfaces are decorated with wall paintings (*naqqashi*). Calligraphy and the compositions of plants and curvilinear shapes are the main themes displayed in these paintings. Although the wall paintings appear to be applied *secco* work, the team has documented instances of earlier work with the pigment embedded in the lime. In this report, all wall paintings are referred to as fresco work.

Almost all fresco paintings have been repainted/restored several times during past restoration campaigns and are now left with very rare examples of original work. It is believed that during these restoration efforts the old and authentic paint surfaces have been removed before applying a new fresco layer. Most of the damages on fresco paintings are observed on the lower levels of walls and at the base of domes due to water ingress from the floor and roof. In several places the plaster render bearing the fresco is damaged at the base of walls where electrical outlets have been installed.

A certain proportion of the work on the wall also comprises the technique of engraved fresco, used mainly in framing borders and panels around ordinary fresco.

This page: Details of fresco work in the prayer chamber.

Opposite: Tazakari *work being executed during a previous restoration phase.*

iv. Glazed tiles interlaced with unglazed terracotta lattices:

This special form of glazed tile terracotta decoration is to be found in panels on the northern façade of the northern axial pavilion, and in bands encircling the top most part of the shafts in all four *minars* before the shaft begins to cantilever out to form the ambulatory around the *minar chhatris*. In general considerable damage is found in this kind of treatment.

v. Terracotta *jalli* work:

Terracotta *jalli* manufactured to a quality and mass rarely seen has been used, but sparingly, in the mosque. The size of each fired piece of terracotta was found to extend to as much as 900 mm x 500 mm x 70 mm thick. It is found in the following locations:

1. In the parapet / balustrade surrounding the *minar* ambulatory;

2. The ambulatory at Level 2 looking into the domed space of the *dewrhi*, as well as the railings looking out into the open areas at the end of the northern and southern pavilions of the Calligraphers' Bazaar.

3. As panels of screens in the upper register of the northern and southern axial pavilions.

Right top: Terracotta jalli *work in the balustrade surrounding the north-western* minar's *ambulatory.*

Right: Glazed tile work interlaced with unglazed terracotta lattices at the top of the south-eastern minar's *shaft.*

Opposite: Looking across the domed space of the dewrhi *at* jalli *panelling in the ambulatory at Level 2.*

ENDNOTES

1 Chaghatai, Abdullah, (1975) *Masjid Wazir Khan, Lahore: History and Architecture*, Lahore: Kitab Khana-i-Naurus. The author, relying on the manuscript Zakhiratul Khawaneen, prefers to use the name 'Ali-uddin', while both Latif and Kanhaiyya Lal prefer to use 'Ilmuddin'.

2 Hakim Aliuddin was granted the title of Wazir Khan in 1620. Wazir Khan was entrusted with the building of the Khwabgah and Hammam-e-Badshahi in Lahore Fort, just before Shah Jahan embarked on his journey from Lahore to Kashmir in the summer of 1634. He was also responsible for the construction of *havelis*, bazaars and bath houses, a surviving example of the latter is the Wazir Khan (or Shahi) Hammam just inside Delhi Gate.

3 Chaghatai, Abdullah, (1975) op.cit. This book is in the main in Urdu but includes a smaller section in English. The material here referenced to this work has borrowed on both the Urdu and the English text.

4 The reference is to the city wall that existed prior to the construction of the new fortification for an expanded city during the reign of Jalal ud Din Muhammad Akbar (1556-1602 AD). The present perimeter of the Walled City conforms to the Akbari walls, demolished in two stages by the British between 1859 and 1884.

5 Latif, Syed Muhammad, (1892) *Lahore, its History, Architectural Remains and Antiquities*, Lahore: New Imperial Press. The authenticity of the will is held by Chaghatai to be doubtful on account of the date of the *waqf* deed being a year later than the reputed date on which Wazir Khan is known to have died. Chaghatai also recounts a claim to the position of the *mutawalli* of the mosque contested in the court of an early British administrator.

6 As late as the mid 1980's the Delhi Gate Bazaar contained an assortment of Sikh or early British period buildings of considerable artistic worth. Of these only a handful have survived total demolition.

7 Chaghatai, Abdullah, (1975) op.cit.

8 Mughal, Rafique, (1996) *Protected Archaeological Sites and Monuments in Pakistan*, Pakistan Heritage Society, Peshawar-Lahore.

9 In the Punjab, the Punjab Special Premises (Preservation) Act 1985, was the precursor for similar legislation enacted in Sindh, Khyber-Pakhtoonkhwa and Balochistan.

10 Ibid. Under the 18th Amendment to the Constitution of Pakistan, passed by the Pakistani national parliament in April, 2010, a process which will result in the devolution of the subject of culture and heritage from the Federal to the Provincial level is currently under way. It is assumed that at some point during this process, the Federal Act will be repealed and its jurisdiction transferred to the Provincial Governments.

11 Qureshi, Muhammad Abdullah, (1962) *Masaajid: Ahd-e-Ghazvanvi se zamana - e - haal tak*. In Nuqoosh, Lahore Number, Lahore: Idara - e - Farogh - e - Urdu.

12 Latif, Syed Muhammad, (1892) op.cit.

13 In the remaining part of this report, these shops will be referred to as the Calligraphers' Bazaar.

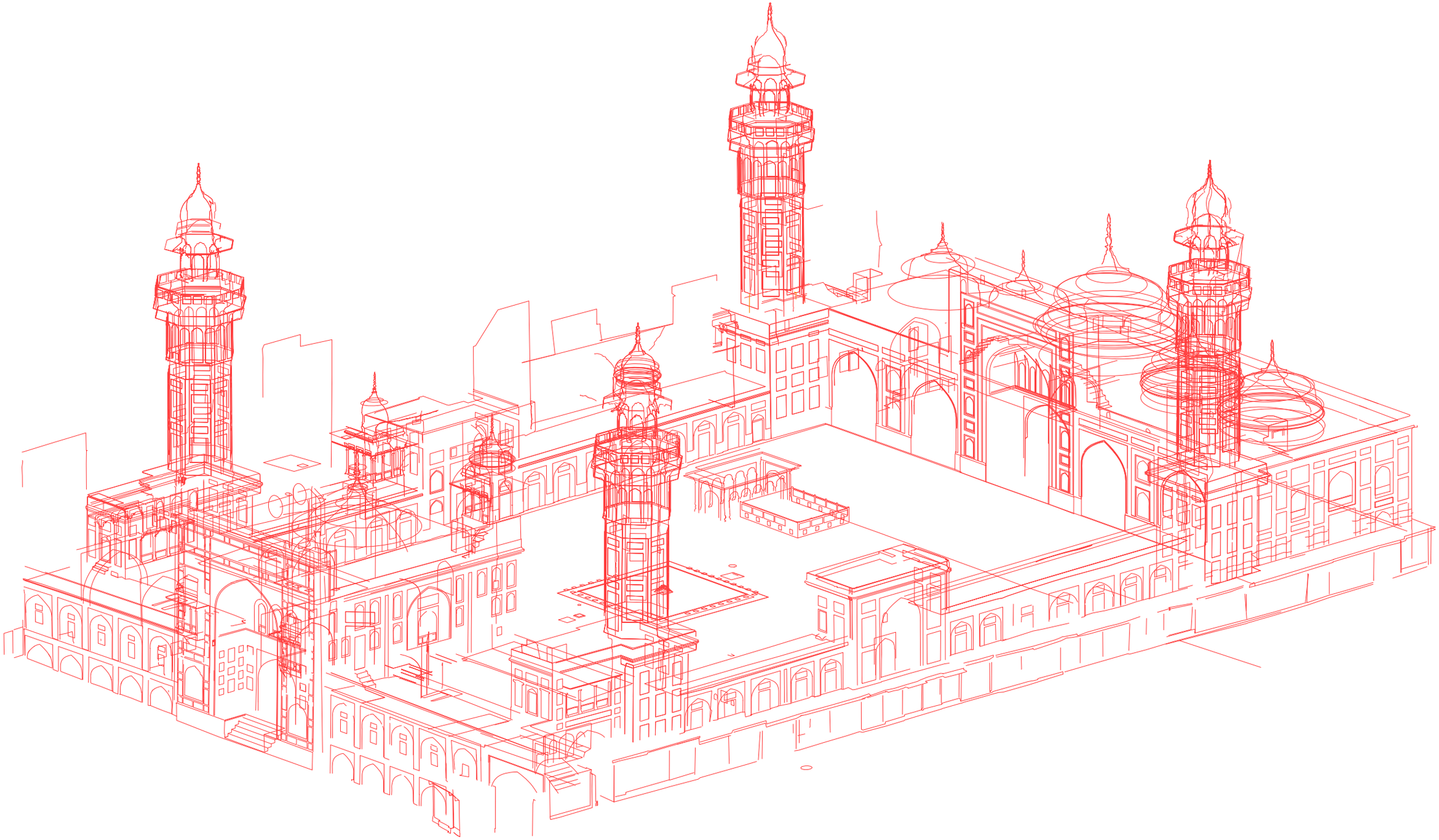
14 Kanhaiyya Lal mentions the term "*char soo*" for this arrangement at the Wazir Khan Mosque, in his *Tarikh-e-Lahore* (1884).

15 19th century illustrations depict at least two more steps. Since the original floor of the Chowk was a good 1.2 m below the present one, several more steps of the original configuration of the staircase could be concealed below the earth fill forming the present level of the Chowk.

16 Not to speak of the Masjid Mian Muhammad Saleh Kamboh and the now destroyed Chiniaan Wali Masjid within the Walled City itself.

17 Chaghatai, Abdullah, (1975) op. cit.

PART II: DOCUMENTATION AND DAMAGE ANALYSIS



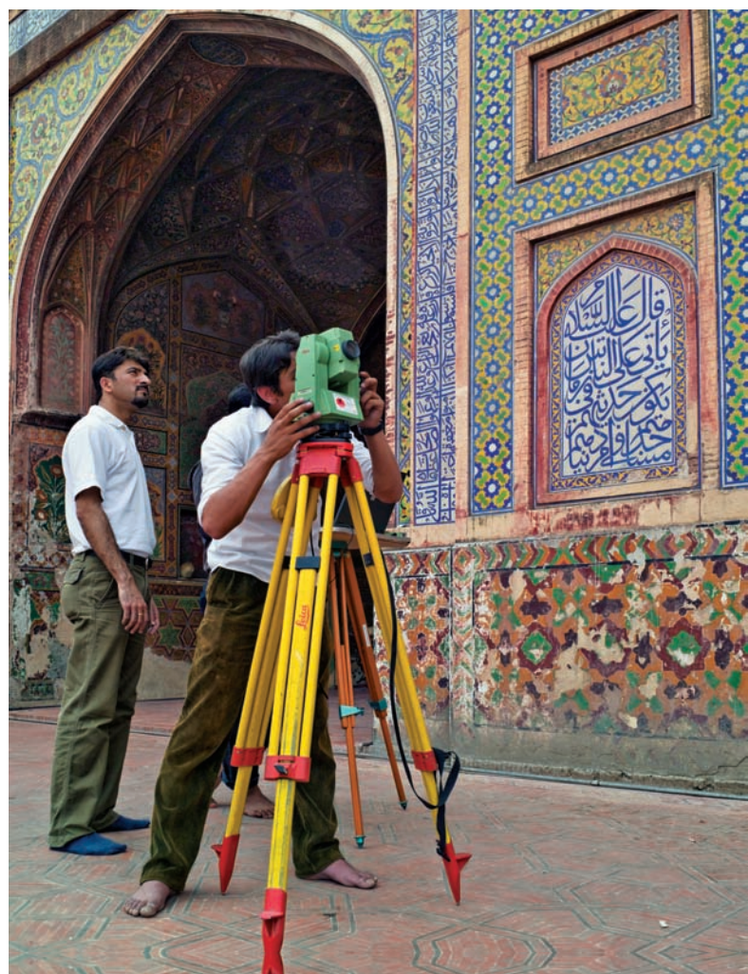
OVERVIEW: DOCUMENTATION AND DAMAGE ANALYSIS

For nearly two years, a small AKTC-AKCSP group of conservation architects and engineering staff has been examining the Wazir Khan Mosque and its neighbourhood context in some detail. The purpose has been to develop a comprehensive data base within the constraints of time and resources available. Such a data base and the analytical and problem solving processes that would ensue from it has never been attempted for a historic monument in Lahore up till the present time.[1] The process of documentation that has produced this data includes observations carried out at several planes, using various methodologies, and at several levels of resolution: archival research and research into administrative documents, simple observation of the situation on the ground, assessment of the institutional and administrative framework, collecting photographic evidence, detailed survey of the neighbourhood, detailed electronic documentation supplemented by orthorectified photographs of the monument itself, and a documentation of the structural issues the monument faces accompanied by analyses of the structure and the geophysical conditions of the monument. This documentation has for its own context the detailed baseline studies of the Walled City of Lahore carried out by AKTC-AKCSP, which includes a comprehensive topographical survey of the city, a socio-economic household quality-of-life survey, and a plot and building inventory that has given rise to a LWC geographical information system (GIS).

A preliminary review of the condition of the mosque leads us to the conclusion that its physical fabric has been inadequately protected from the elements and has been subject to unavoidable natural threats, such as earthquakes, causing certain structural impacts. However, it also appears glaringly evident that a significant amount of the present damage in the mosque is caused by human factors. The mosque has never been as exposed to the pressures of rapid development in its immediate surroundings as it is at present. These pressures range from the immediate and long term impacts of inappropriate activities and the building of unauthorized structures to contain them, to environmental factors like the pollution generated by vehicles in the cramped physical environment of the Walled City. Additionally, lack of sophistication in the appreciation of the heritage, of adequate technical and interpretive skills in the care and maintenance of the monument and the regulation of its use, and the deliberate vandalism of the structure are also main contributors to the damage.

The absence of a professionally qualified team and lack of regular maintenance procedures greatly threaten the mosque complex with further deterioration. The non-permanent and periodic interventions in both the structure and the building fabric in the past have contributed little to safeguarding the architectural fabric of the mosque and to enhancing the appeal of its decorative craft techniques. The absence of a permanent mechanism for maintenance during these past efforts has significantly contributed to damages sustained by the mosque complex.

Part II aims to present the existing conditions documented and describe in analytical terms the problems and issues they pose for the conservation and rehabilitation of the Wazir Khan Mosque and its context. The following chapters begin by briefly describing the methodology used in carrying out the documentation and the graphic content of the documentation spread over several pages. This is followed by an analytical section describing the existing conditions, problems and issues of the monumental complex. This includes a discussion of the neighbourhood context of the monument and the ways in which at least three centuries of urban social and political mayhem has resulted in the present conditions. This is followed by a description of the infrastructure conditions attending the monument and its context. A detailed description of the existing conditions of the monument as documented follows and is accompanied by an analysis of the processes of decay that it faces.



Right, Top: Crack monitoring in the prayer chamber, with the use of digital callipers.

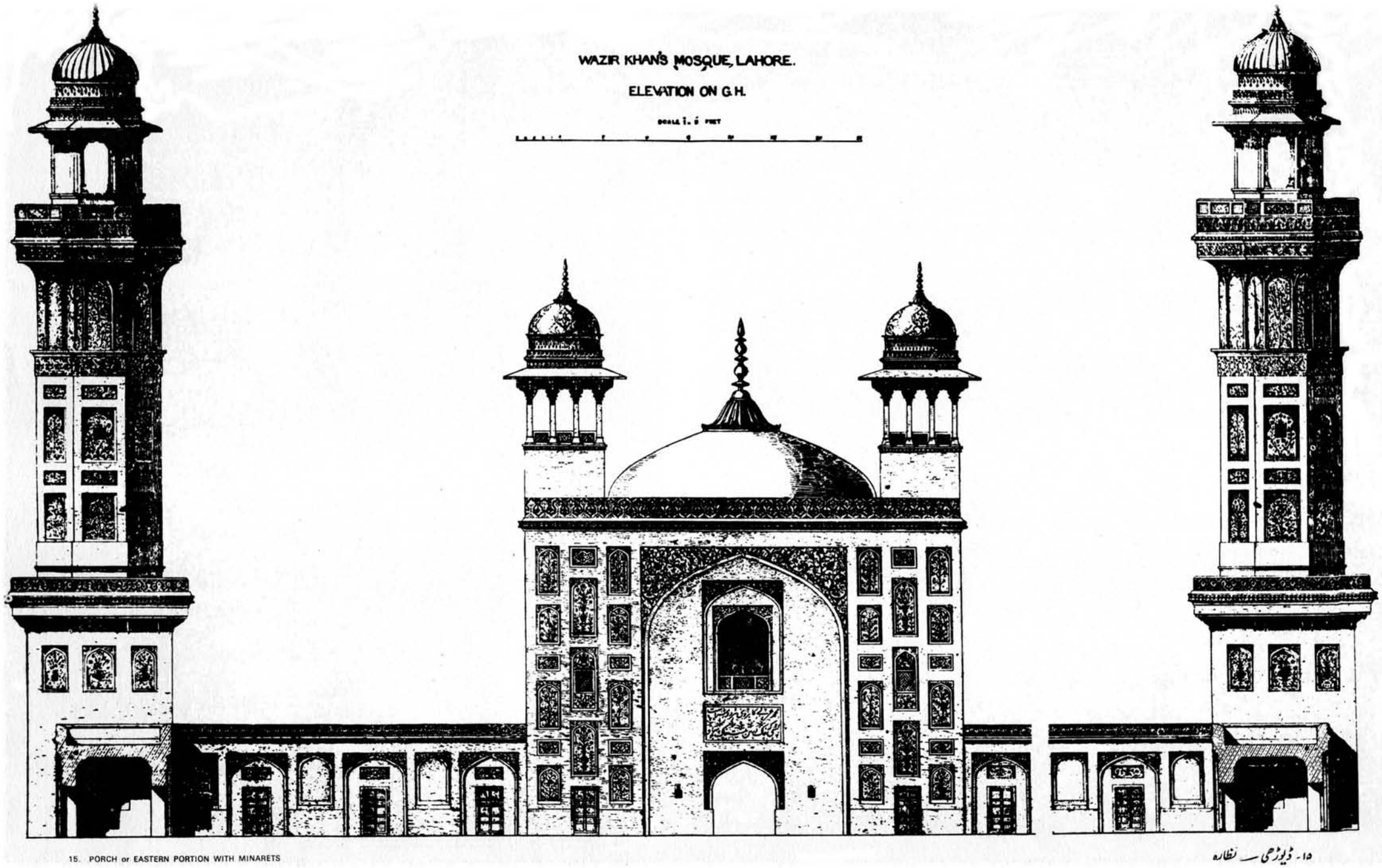
Right: REDM survey underway of the hujras *on the north side of the courtyard.*

Opposite: The 3D wire frame produced by AKCSP after 2 years of surveying and documentation.

WAZIR KHAN'S MOSQUE, LAHORE.

ELEVATION ON G.H.

SCALE 1. 6 FEET



15. PORCH or EASTERN PORTION WITH MINARETS

۱۵- ڈیوڑھی ــ نظارہ

5 DOCUMENTATION METHODOLOGY

Heritage documentation is an integral part of the conservation process and documentation of the appropriate intensity and detail is the means to arrive at an effective understanding of a given situation. It is essential because it provides the data for recording conditions, understanding, interpretation and action. This section explains the documentation process and is followed by an assessment of the different types of damage occurring in various sections of the mosque complex. It is important for the project to identify the various threats and map the weathering forms and damage to the structure both at a macro and micro scale.

The earliest available architectural documentation of the mosque was carried out in 1875 by Farid Baksh, a student of the Mayo School of Arts, Lahore.[2] The drawings prepared by him are said to be in the custody of the Federal Archaeology Department at the Lahore Fort. Reproduction of the drawings in certain publications[3] attests to their meticulous detail and idealization of form. However, it is unknown if they were accurate enough to meet the stringent requirements of objectivity that modern heritage conservation procedures require.

The current conservation project of the mosque aims to strive towards those requirements. Apart from careful observation of the physical conditions and the necessary background and archival research, a precise and detailed documentation programme of the mosque complex has been carried out to fulfil basic requirements of international charters and conventions of ICOMOS[4] and UNESCO,[5] and in order that a scientific record of its present condition is established for use in carrying out studies and conservation programmes. It is also very important for us to use this opportunity to attempt to demonstrate the highest possible standards of recording buildings. This would lay the precedence for a new trend in the conservation of monuments in urban settings in Pakistan.

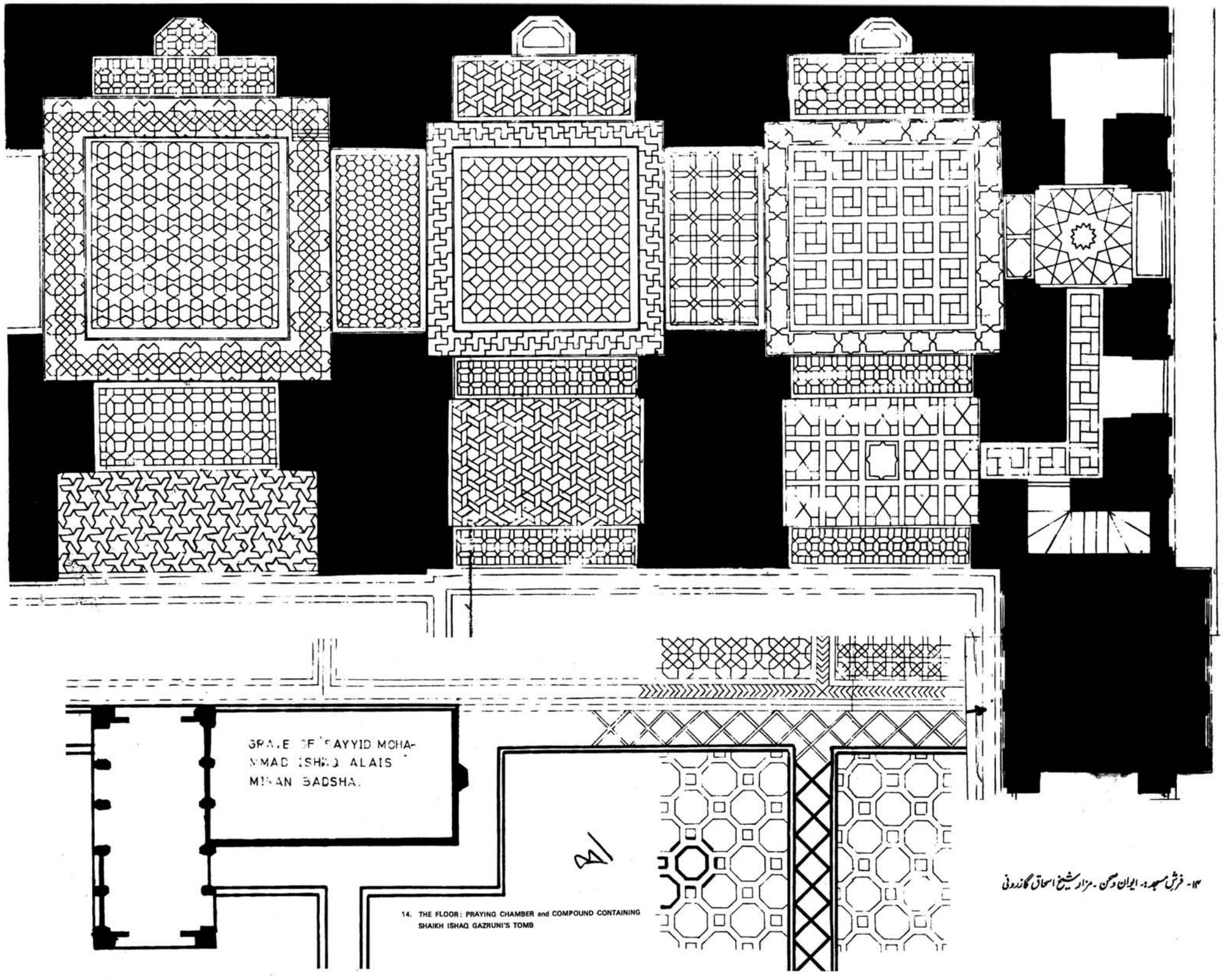
A basic component of the surveying technology and method used in this documentation - Reflector-less Electronic Distance Measuring - is identical to that used to carry out the Lahore Walled City topographic survey, conducted by AKCSP over roughly the same period as the documentation of the mosque. As a result, the physical documentation of the mosque complex is geographically embedded in the topographical survey of the entire Walled City at the same degree of dimensional tolerance.[6] This enables an effective assessment of the characteristics of the mosque complex in relation to the much more dynamic historical, transformational and present-day locational and dimensional characteristics of the urban fabric surrounding it.

The present project provides a suitable opportunity to begin the first thorough documentation effort of recent time. The documentation programme devised is an REDM survey with a Total Station, in combination with real time CAD software and image orthorectification software. The documentation process has the following objectives:

- To gather detailed information in respect of the Wazir Khan Mosque and its surroundings in the form of base drawings.
- To establish a detailed record of the as-found state of the monument to allow conservation measures to be proposed.
- To provide a strong investigation and monitoring tool for recording the extent of damage and structural deformations in different parts of the monument.
- To establish an architectural survey which would be available for researchers and experts for future studies.
- To use the documentation as the basis for management, monitoring and maintenance of the site and monument after the conservation process is over.
- To disseminate and build capacity in recording techniques with REDM.[7]

The documentation of the monumental complex commenced in March, 2008 after securing permission from the Auqaf Department. By January, 2009 enough basic documentation was carried out to enable the structural engineer, Dr. Wenzel, to make an initial assessment of the condition of the structure, and for him to establish the necessity of undertaking geotechnical investigations and to prepare specifications for the same. The documentation of the architectural fabric of the mosque continued apace until

Opposite: The earliest known architectural documentation of the Wazir Khan Mosque, undertaken by Farid Baksh in c.1875. This is the elevation of the eastern façade of the courtyard.
(From Chaghatai's The Wazir Khan Mosque, Lahore*).*



14. THE FLOOR: PRAYING CHAMBER and COMPOUND CONTAINING SHAIKH ISHAQ GAZRUNI'S TOMB

۱۴- فرش مسجد، ایوان و صحن ـ مزار شیخ اسحاق گازرونی

July, 2010 when the architectural form of the entire complex was documented. Thereafter a process to document in detail the surface ornamentation of the monument, and damage sustained by the monument by weathering and other factors such as human intervention and vandalism was continued. As of April, 2011 this process continues. The present report includes the extent to which such detailed documentation and its analysis has been completed.

5.1 THE RECORDING PROCESS

Before commencing the survey, station points were established securely on the courtyard floor. The electronic documentation of the building began as a series of traverses, using a laser based (reflector-less) electronic distance measuring total station. Each line on the survey comprises a collection of points recorded in 3-D with reference to the station point from where the survey was commenced. Each point recorded has a unique coordinate reading in the x, y and z axes, and is automatically converted to a vertex in a polyline system. At the end, this survey was integrated with the AKCSP LWC-wide topographic survey.

Using a real time CAD interface,[8] the process of documentation instantaneously created a CAD drawing on a laptop computer mounted on a light tripod, which moved along with the Total Station. The geometry of the monument is described at 4 primary planes - Level 0 (street-level), Level 1 (courtyard level), Level 2 (at the level of the upper gallery of the *dewrhi*) and Level 3 (cutting horizontally across the shaft of the *minars* and showing the roof in plan projection). The first of the traverses established the plan of the courtyard at Level 1. The plane was established at a datum of 1 metre at a point marked on the base of the north-west *minar*. The traverse then continued into the prayer chamber, then all the *hujras,* the northern and southern pavilions and the Calligraphers' Bazaar at Level 1.

Before carrying on to plan traverses at Level 0 and Level 2, several sections were first drawn. The sections also recorded the façades of the buildings nearest to the section plane. This aspect of the survey was accompanied by a photographic coverage of these façades, to be used in the development of orthorectified images using image rectifying software. Salient points on the façades were recorded using cross-hair targets, which also appear in the photographs. An image rectifying software[9] was used in conjunction with both the electronic position of the targets and their photographic versions. This enabled the insertion of orthorectified images, in their correct location, into the CAD drawing generated by the REDM survey and helped in the development of detailed drawings of the façade, leading to the appropriate level of analysis of its components. A time consuming manual "tracing over" of the details of elements in the photograph, such as tile work and the elements marking its decay, then commenced accompanied by an analysis of damage to these elements by weathering (including damage by biological causes) and other causes such as human vandalism, structural behaviour etc. This process is an ongoing one, and its speed is restricted by the meticulous nature of the work and the limitations of the size of the professional workforce involved.

Most sections drawn through the fabric of the mosque use a mirrored sectional plane, i.e., one that creates sections looking in both directions.

The first section was drawn through the north-western and south-western *minars*, looking west and east. The former included the façade elevation of the prayer chamber.

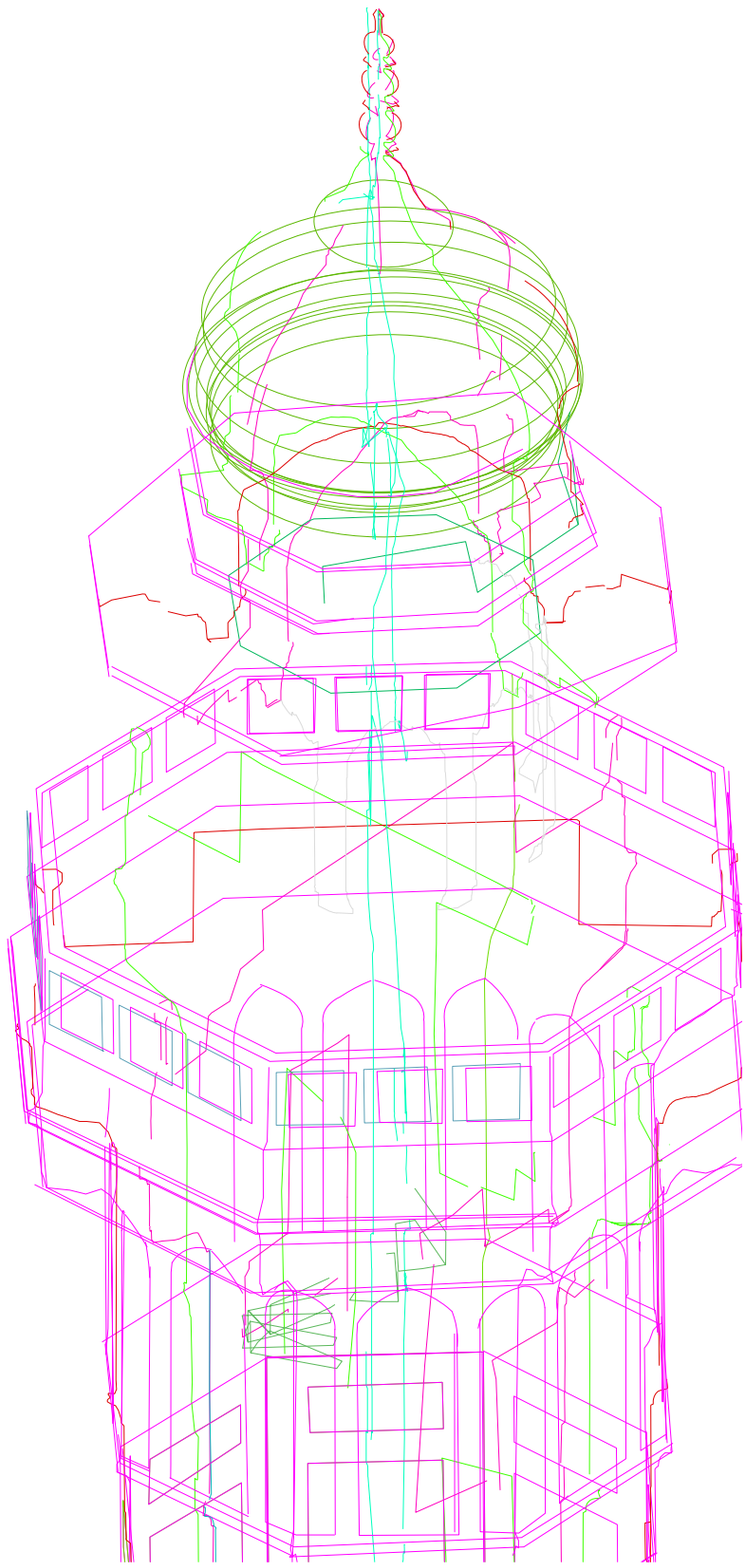
The sequence of work then established longitudinal sections AA (bi-directional), and AA' (looking south only—the only section plane that is projected in one direction) through the main courtyard, the prayer chamber, the *charsu* and its dome and the main *iwan* facing Wazir Khan Chowk. These sections include the façades of the northern and southern sides of the courtyard.

The next important section drawn was Section DD (bi-directional) whose plane slices the main chamber vertically and illustrates its features looking east and west.

Section EE is a section on a plane that runs north-south, through the centre of the second *hujra* from the east, on both the north and south wings flanking the courtyard. It faces east, illustrating the façade elevation of the eastern side of the courtyard, and the *hujras* on this side.

The fourth section in the chronological order used in the survey is Section CC which runs north-south along the centre line of the ambulatory in the Calligraphers' Bazaar, and comprises coverage

Opposite: The earliest known architectural documentation of the Wazir Khan Mosque, undertaken by Farid Baksh in c.1875. A documentation of the decorative brick flooring in the prayer chamber (from Chaghatai's The Wazir Khan Mosque, Lahore*). N.B. taken from Chaghatai's reproduction in which Baksh's original drawing has evidently been cropped to show only the main central and northern two chambers of the prayer chamber. Consequently, the Ishaq Gazruni shrine and pavilion have been shifted out of their actual context, so as to fit on Chaghatai's page layout.*



looking both east and west. Section FF runs in a plane parallel to the plane of section CC which runs through the building comprising the shops in the Calligraphers' Bazaar and parts of the main *iwan*.

The plane of section GG runs east to west and slices through Levels 0, 1 and 2 along the buildings of the north flank of the courtyard. Section HH runs longitudinally in similar fashion along the buildings that form the south flank of the courtyard.

All sectional planes that cut across the building at all three levels record spaces such as *hujras*, the (northern) pavilion and the shops at Level 0. Plans, sections and details are shown on the following pages.

More intense documentation was carried out on several different elements of the complex. Of these the most important documentation was that of the four *minars*, each of which was documented fully along its eight sides, and in addition four sections were prepared for each of the *minars*. Careful measurements were made of the inclinations of the *minars*. One set of these was made immediately after the earthquake of 28 October, 2009, (6.7 on the Richter scale) to observe any change of inclination caused by the earthquake.

5.1.1 DOCUMENTATION OF STRUCTURAL CRACKS

Structural cracks were documented in all important locations of the building. While some cracks are inert and have little or no increase or change, certain new cracks have appeared in some parts of the building indicating rapid and live movement of foundations, chiefly for reasons of poor drainage and saturation of the bearing soil. Both types of cracks were recorded on both the exterior and the interior of the buildings. In addition crack monitoring has been conducted by fixing tell-tales or by fixing crack monitoring studs and carrying out regular measurements (see also Section 9.1.3).

5.1.2 DOCUMENTATION OF THE FORMAL GEOMETRY OF THE BUILDINGS

In addition the geometry of transitions and *muqarnas*' was recorded carefully both inside and outside the prayer chamber and in the *charsu*, the *dewrhi* of the entrance system in the Calligraphers' Bazaar.

5.1.3 DOCUMENTATION OF INVESTIGATION PROCEDURES, EXPLORATORY PITS AND ONGOING INTERVENTIONS

a. Investigation procedures

Visible portions of the system of the mosque's courtyard were recorded, as these were crucial in determining the causes of the subsidence patterns that have prevailed. Some of these investigations led the documentation team into the rear of the shop under the third *hujra* from the east on the northern flank of the courtyard, into which the present water disposal drain appears to be flowing. This was properly documented.

b. Exploratory pits

A total of five exploratory pits were opened up to ascertain interventions and changes that have occurred in the parts of the monument below the existing floor or grade levels of the mosque and the Chowk Wazir Khan. Measurements were carefully made of the cultural strata and material found in these exploratory pits.

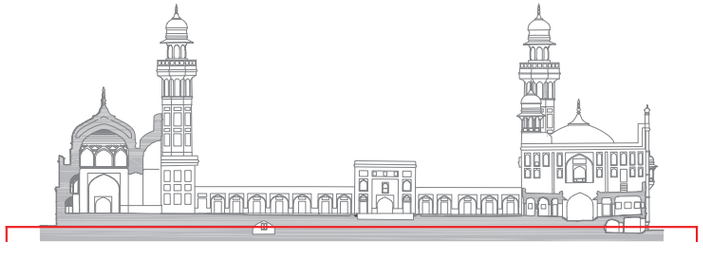
c. Ongoing intervention

The Punjab Archaeology Department, under a request from the Punjab Auqaf Department, have excavated a large part of the courtyard to address the issue of its subsidence in its south-eastern corner. The extent of this excavation and its depth at various locations were recorded. The historical material excavated was also photographed.

d. Documentation of existing use and critical locations of drainage and consequent structural damage

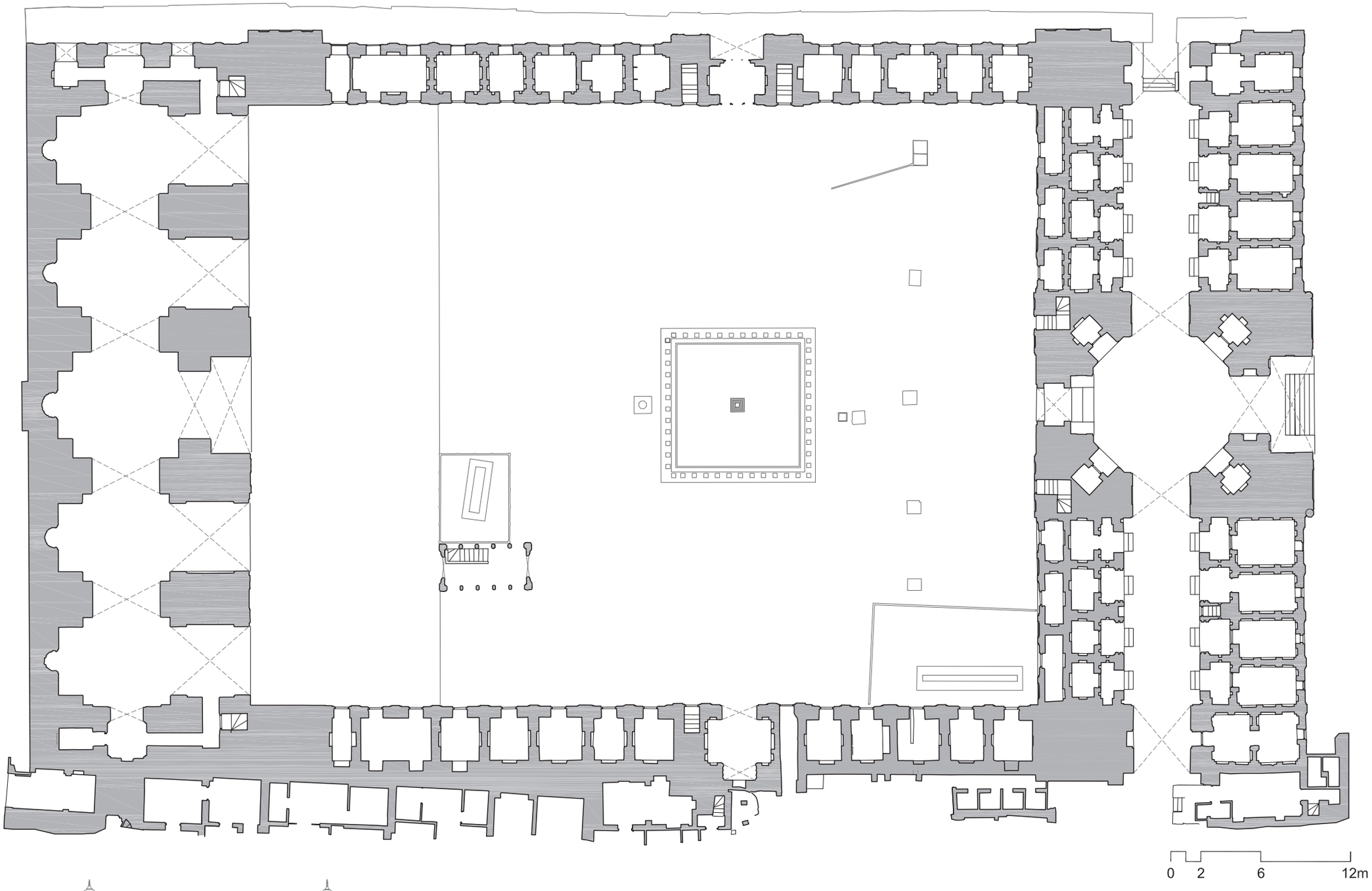
As described in the following pages, the mosque complex has suffered from a variety of inappropriate uses and abuses, as well as from unthoughtful interventions such as the construction of buildings that bear on the historic walls of the monument. These interventions and critical points at which they bear on the structural health of the monument were carefully recorded.

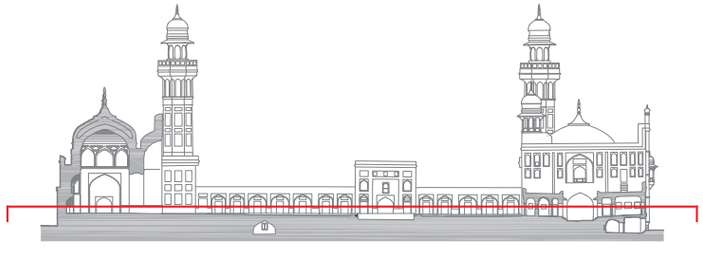
The four minars *of the monumental complex have conspicuous artistic merit and elegance, but also face structural issues—all four* minars *are inclining to one extent or the other. As such the team documented them particularly intensively, through the REDM equipment as well as using photo-orthorectification techniques. Shown on the page opposite is the north-east* minar, *with the wire frame documentation of its geometry. Shown on the right is the south-east* minar, *with its eight sided central shaft completed with orthorectified photographs of its tiled panels.*



PLAN AT LEVEL 0 OFTHE MOSQUE AND WAZIR KHAN CHOWK

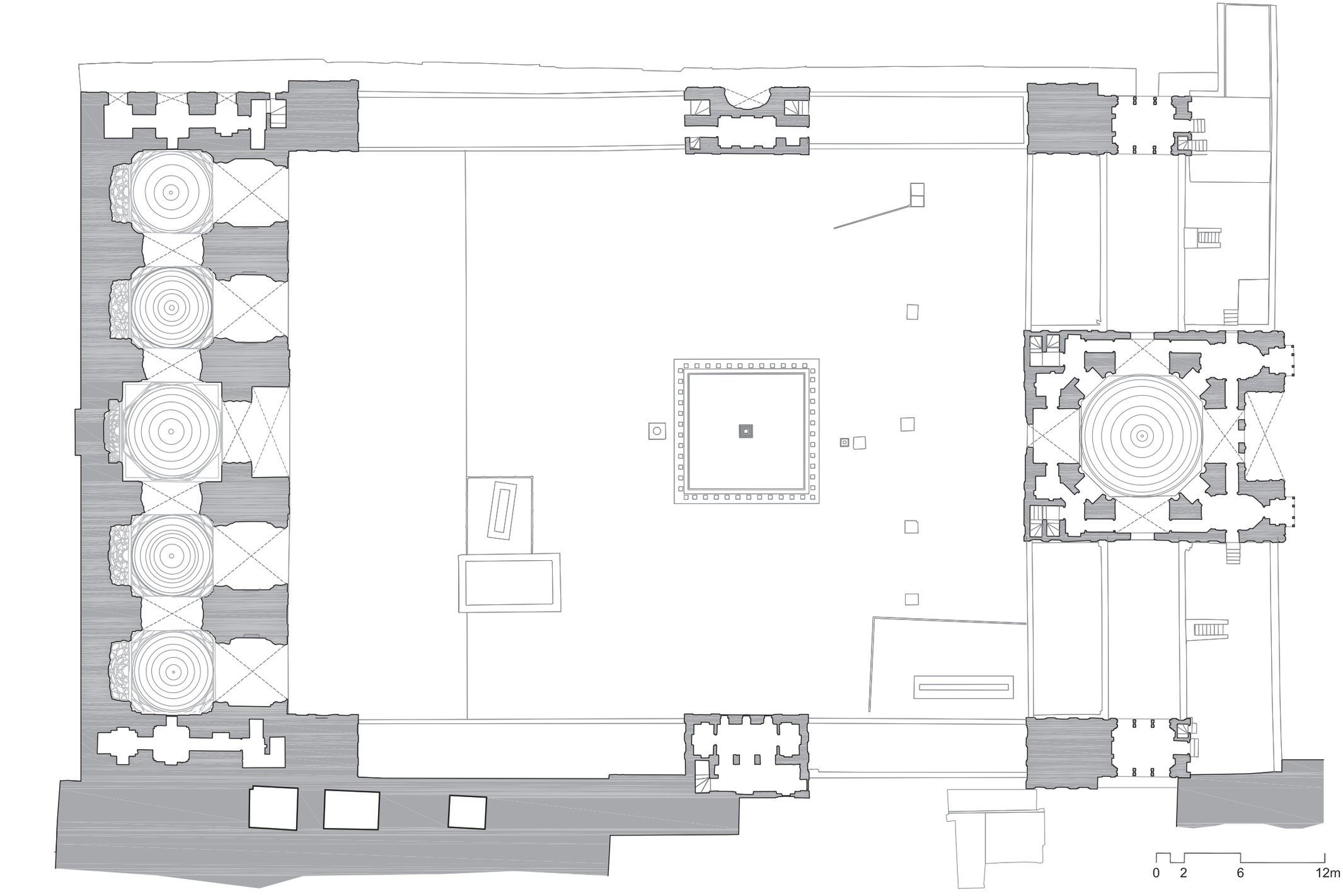
Showing the shops at street-level on the mosque's northern and eastern sides, and the Ishaq Gazruni shrine chamber under the level of the courtyard. The length of the shrine chamber is longer than the demarcation at courtyard level.

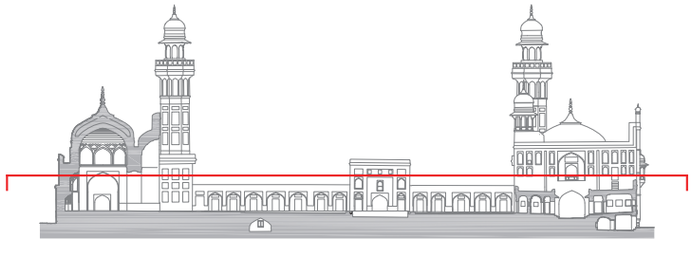




PLAN AT LEVEL 1

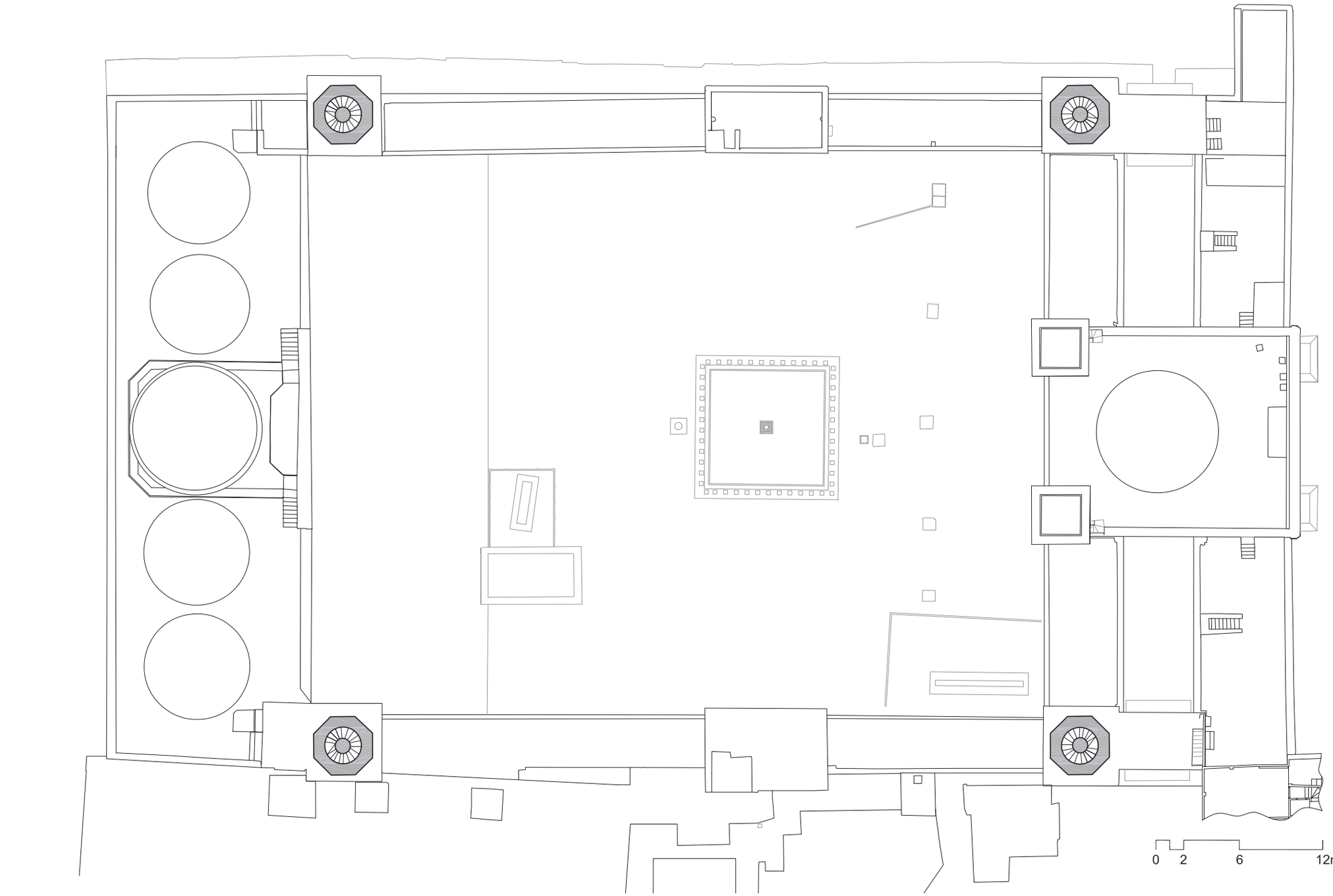
Showing the entrance dewrhi, *Calligraphers' Bazaar, courtyard, northern and southern rows of* hujras *with pavilions, the prayer chamber, all four* minar *bases, Ishaq Gazruni Shrine pavilion, central ablution pool, and recently added ablution facility in the south-eastern corner of the courtyard.*

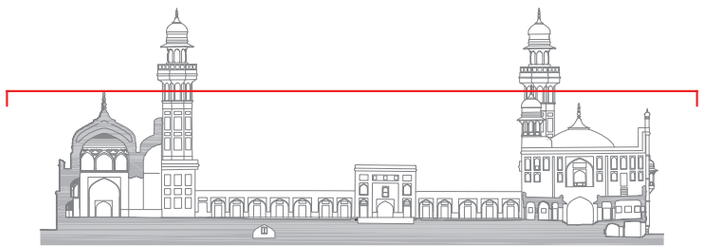




PLAN AT LEVEL 2

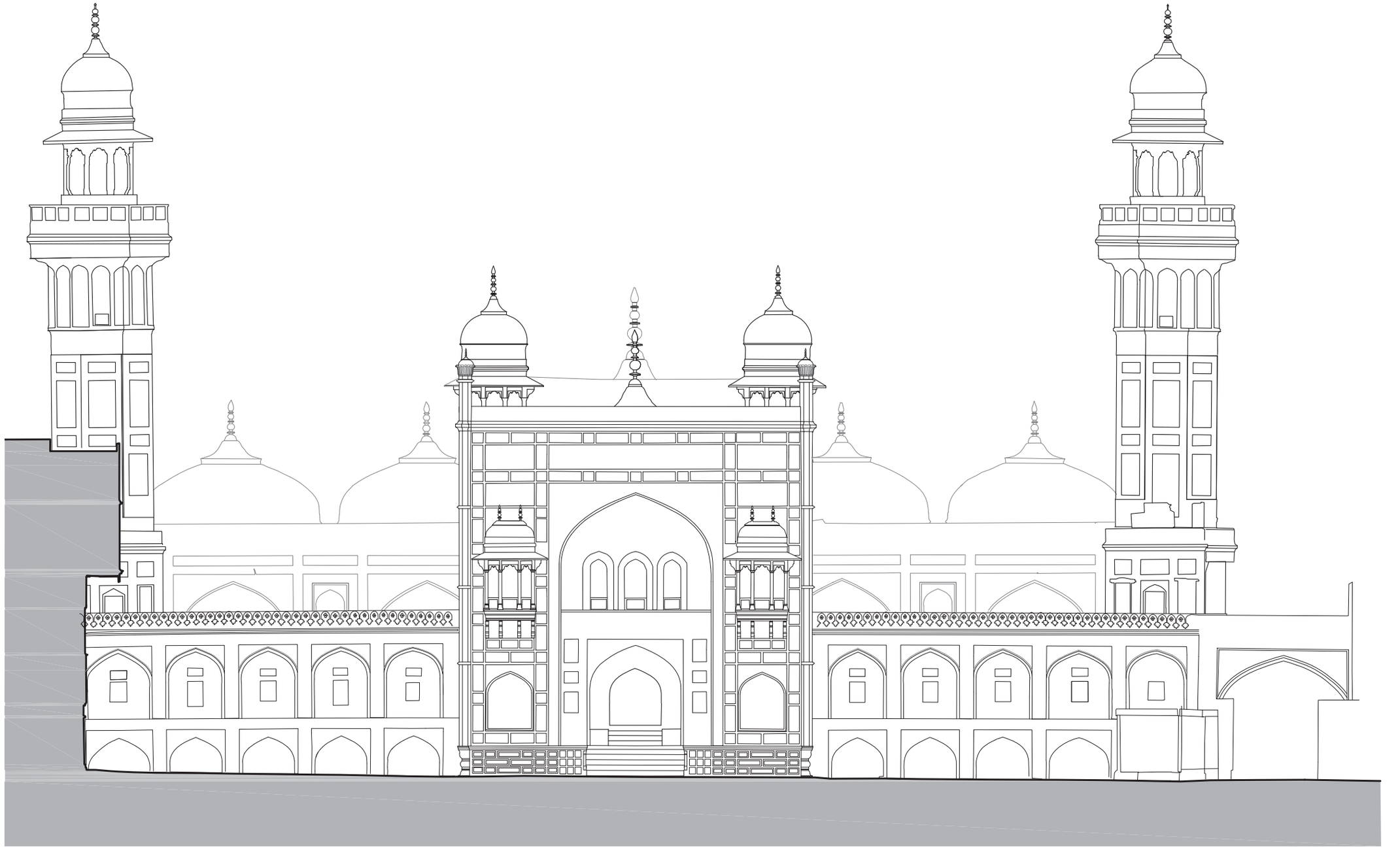
Showing all pavilions at Level 2 including those on the roofs of the Calligraphers' Bazaar, and the domes of the dewrhi *and the prayer chamber. Additionally, the built residential area of the mosque's southern side is included where the houses abut the mosque's southern wall.*

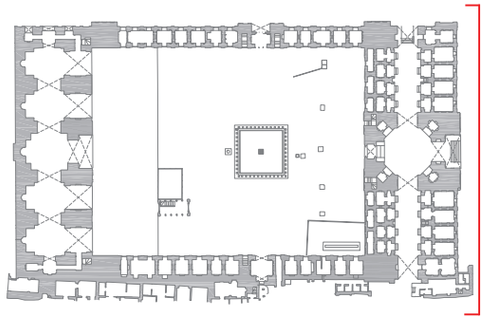




PLAN AT LEVEL 3

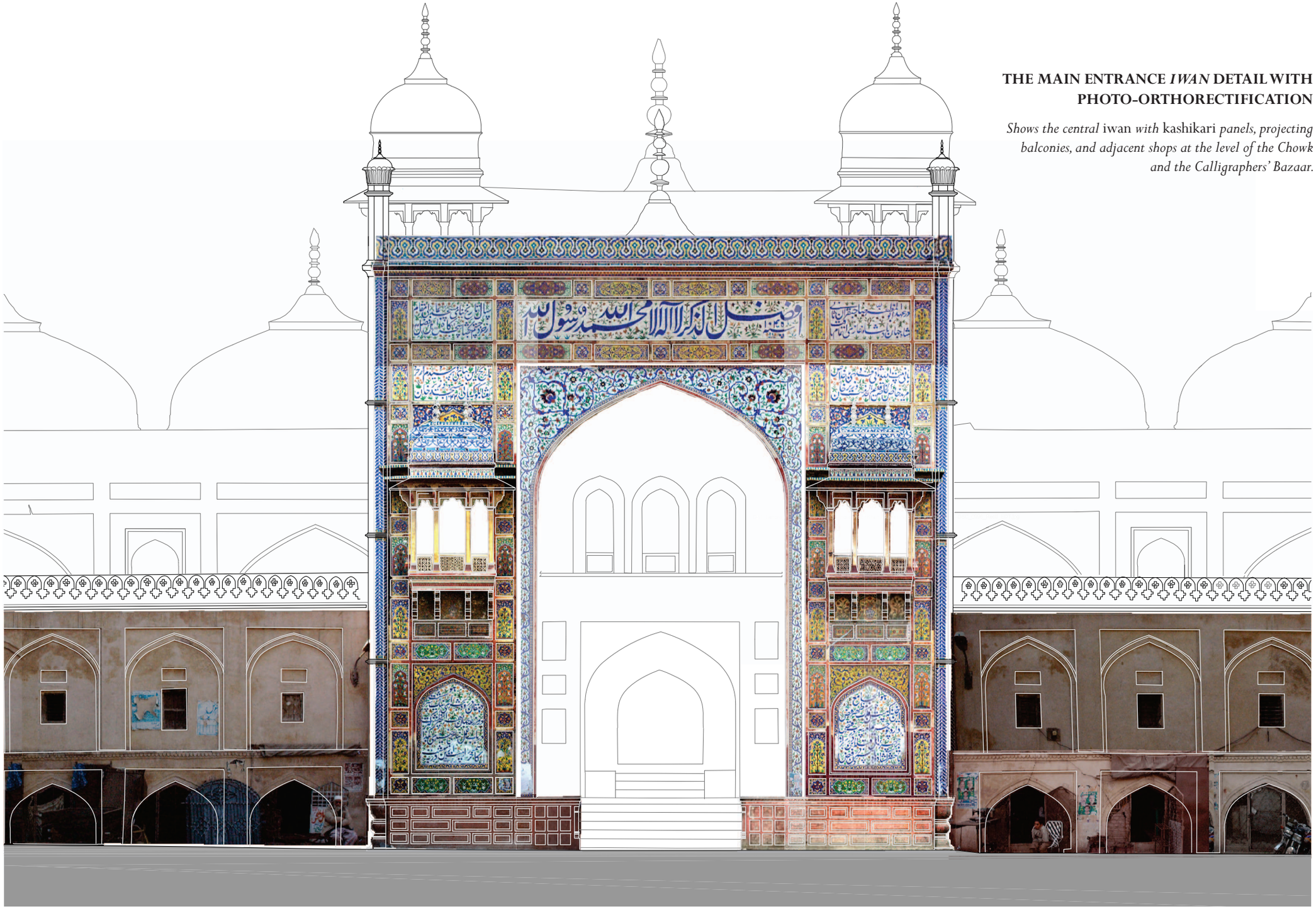
Showing the roof plans of all areas of the mosque and sections through the minars. *The roof plans of the houses on the southern side abutting the mosque's wall are also shown.*





THE EASTERN FAÇADE LOOKING OVER CHOWK WAZIR KHAN

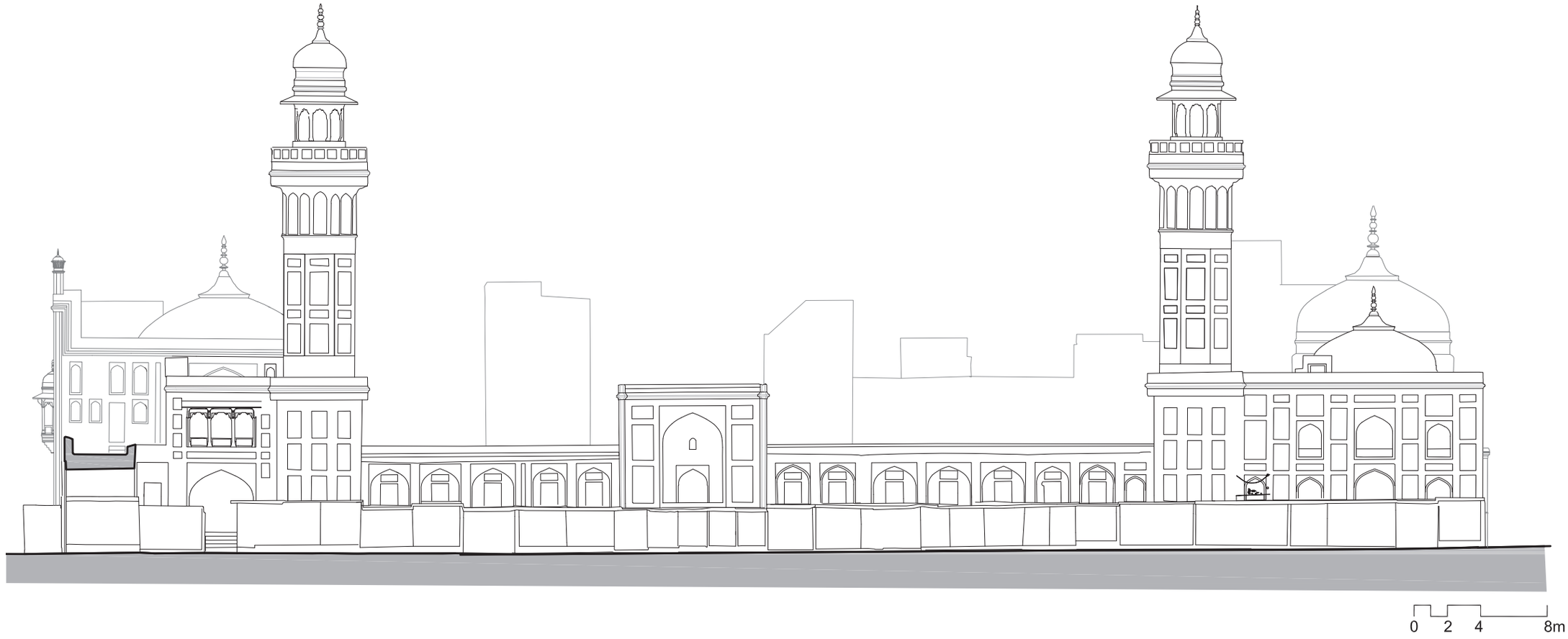
The external iwan *overlooking the Chowk is shown together with shops at the street-level partially obscured by the elevated floor of the Chowk. The windows of the shops of the Calligraphers' Bazaar, accessed from within, look over on to the Chowk. The relative height of the prayer chamber is shown behind. On the right is Kotwali Gate, the north-western gate leading from the Chowk to Kotwali Bazaar on the mosque's northern side, and on the left is an abutting residential property.*

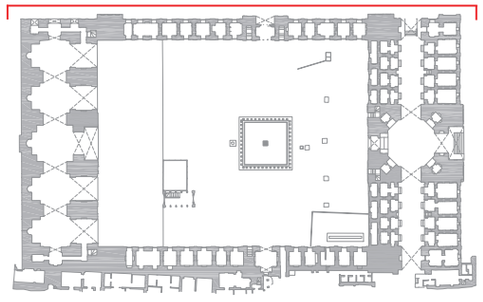


THE MAIN ENTRANCE *IWAN* DETAIL WITH PHOTO-ORTHORECTIFICATION

Shows the central iwan *with* kashikari *panels, projecting balconies, and adjacent shops at the level of the Chowk and the Calligraphers' Bazaar.*

0 1 2 4m



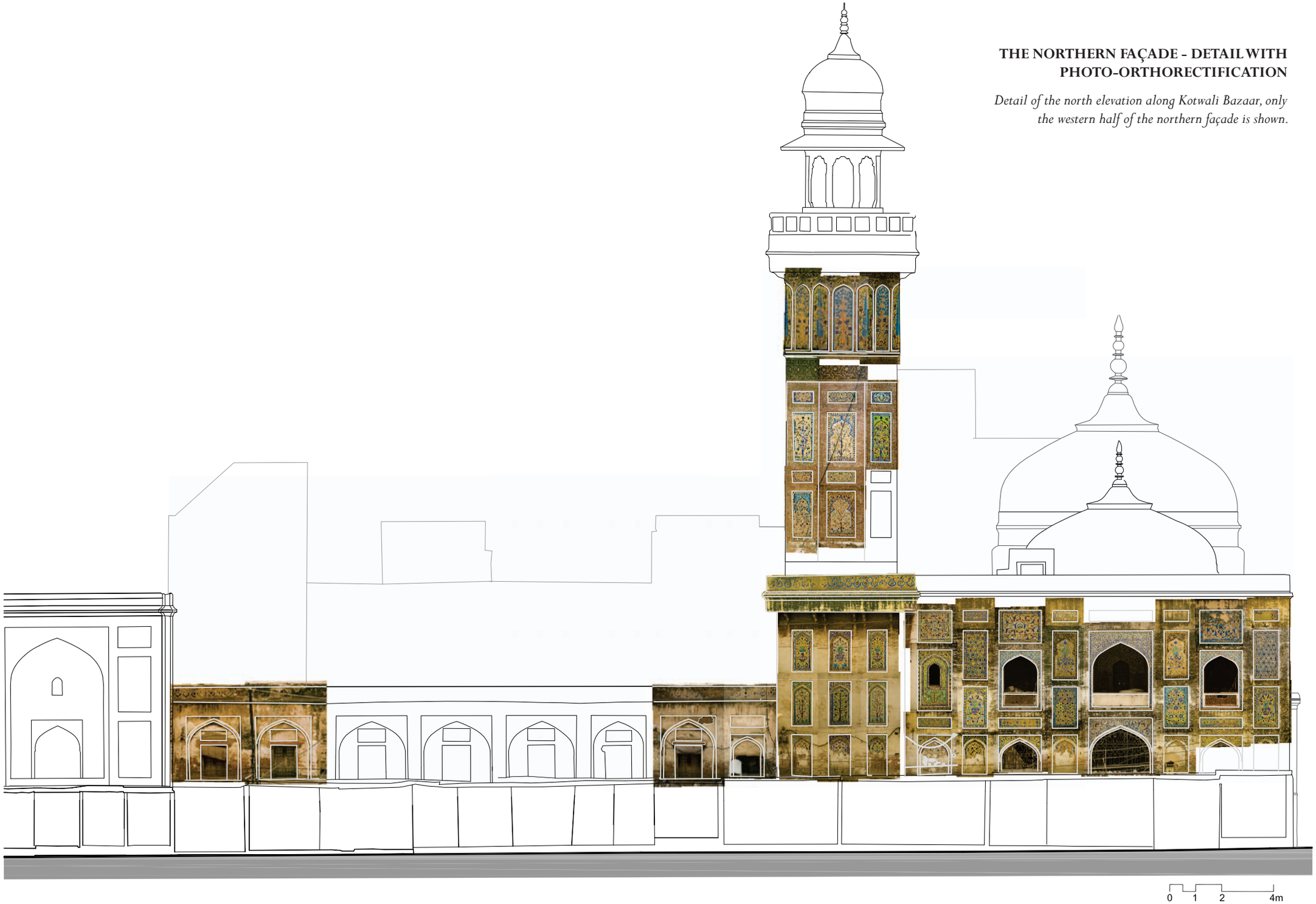


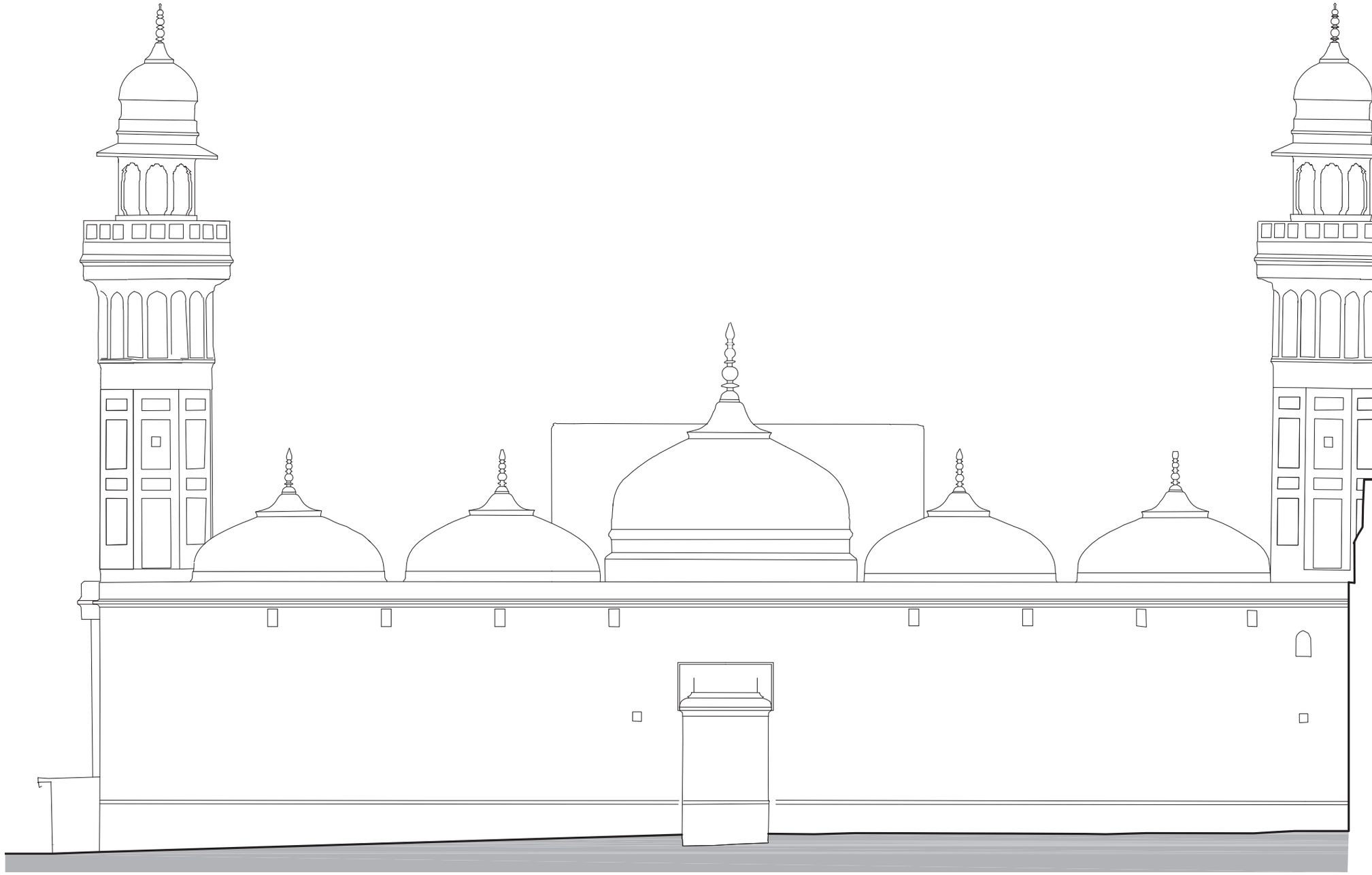
NORTH ELEVATION

North elevation of the mosque, showing in the foreground the modern additions to the original built-in shops along Kotwali Bazaar, and in the background the properties in the residential area beyond the southern limits of the complex. The balconies projecting into the Chowk from the iwan *on the eastern façade are visible. The relative height of the register at the courtyard level (Level 1) in relation to the register at the street-level is obscured by the recent shops and the elevated street-level.*

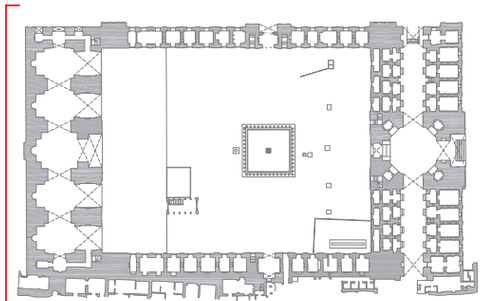
THE NORTHERN FAÇADE - DETAIL WITH PHOTO-ORTHORECTIFICATION

Detail of the north elevation along Kotwali Bazaar, only the western half of the northern façade is shown.



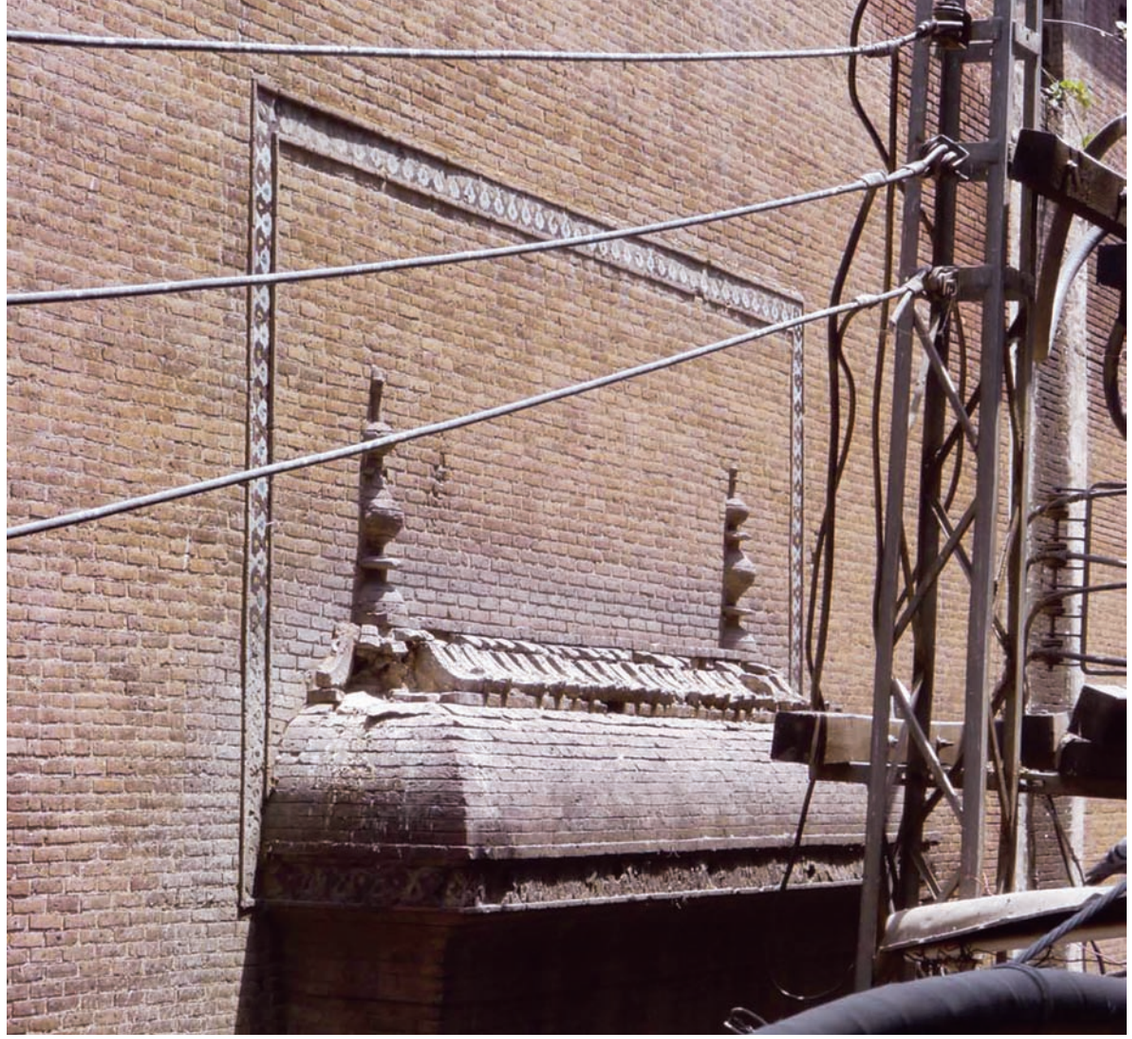


0 2 4 8m



WEST ELEVATION

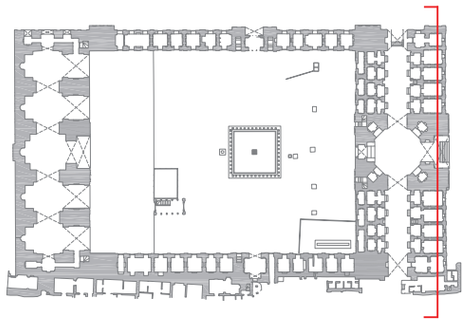
The west elevation consists primarily of the prayer chamber. The mihrab *at the centre of the chamber is projected outwards into the street and is the primary architectural feature on this side. Also clearly shown in this elevation is the incline in street-level from the northern side to the southern side, demonstrating the difference in the land levels along the western and southern sides of the complex. The south-western corner of the mosque is not accessible for documentation due to a residential building abutting the mosque. The relative height of the* iwan *of the prayer chamber is shown in the background.*



Above: There are no structures abutting the western façade of the mosque, with the exception of the south-western corner where a residential building is using the mosque's walls for support. The remaining western façade is fully accessible from the gali *immediately adjacent, which is occupied only by street hawkers, mobile food trolleys, and a conspicuous electricity transformer.*

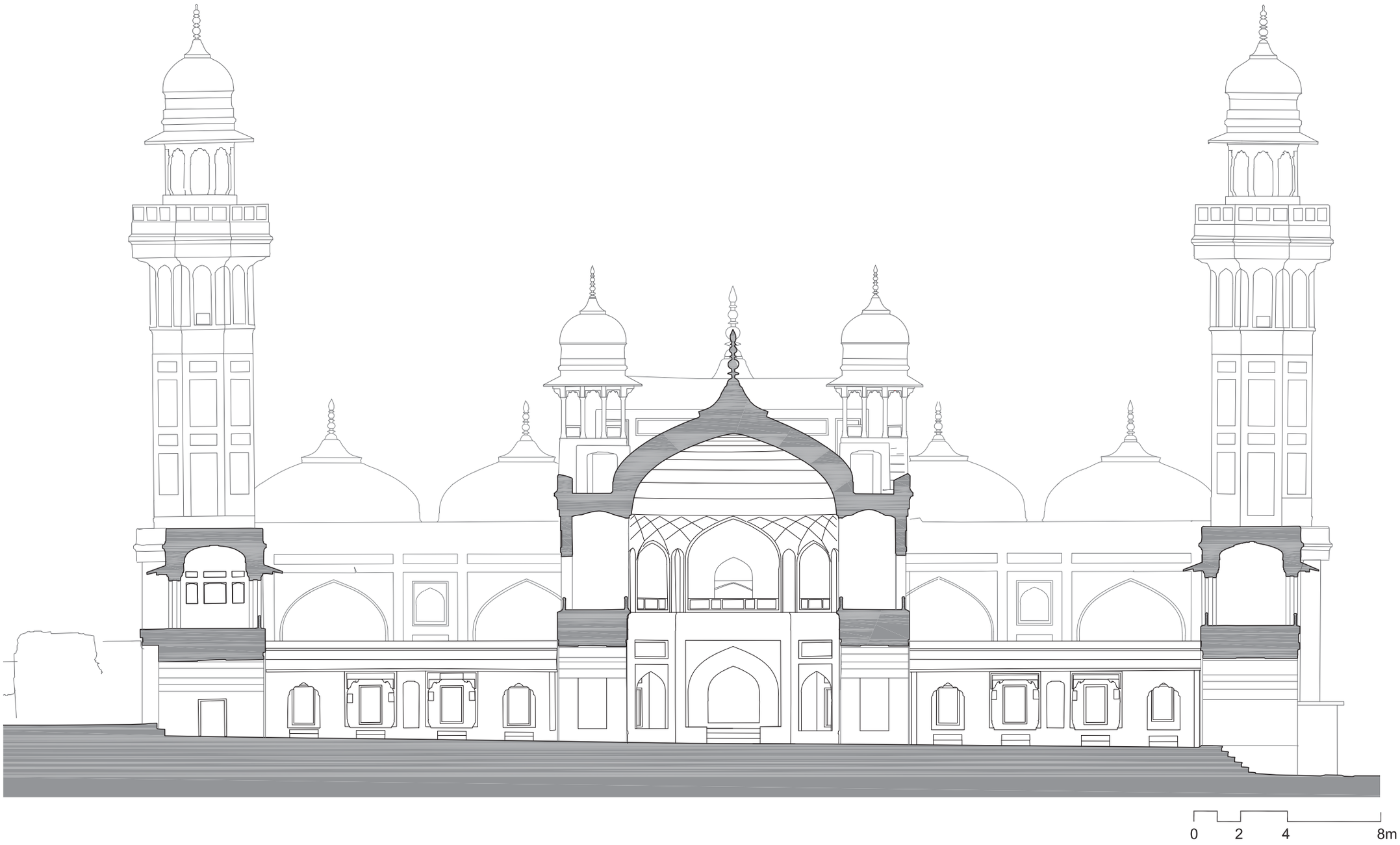
Top left and far left: Tile border around the mihrab *projection on the western façade and detail.*

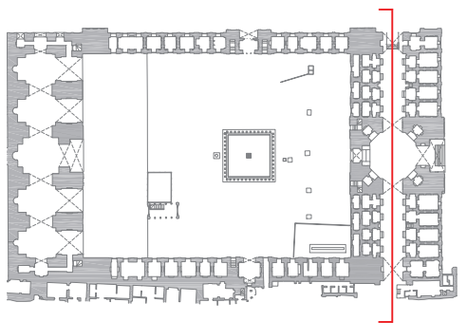
Left: Detail of glazed tile work bordering the top of the western façade.



SECTION FF LOOKING WEST

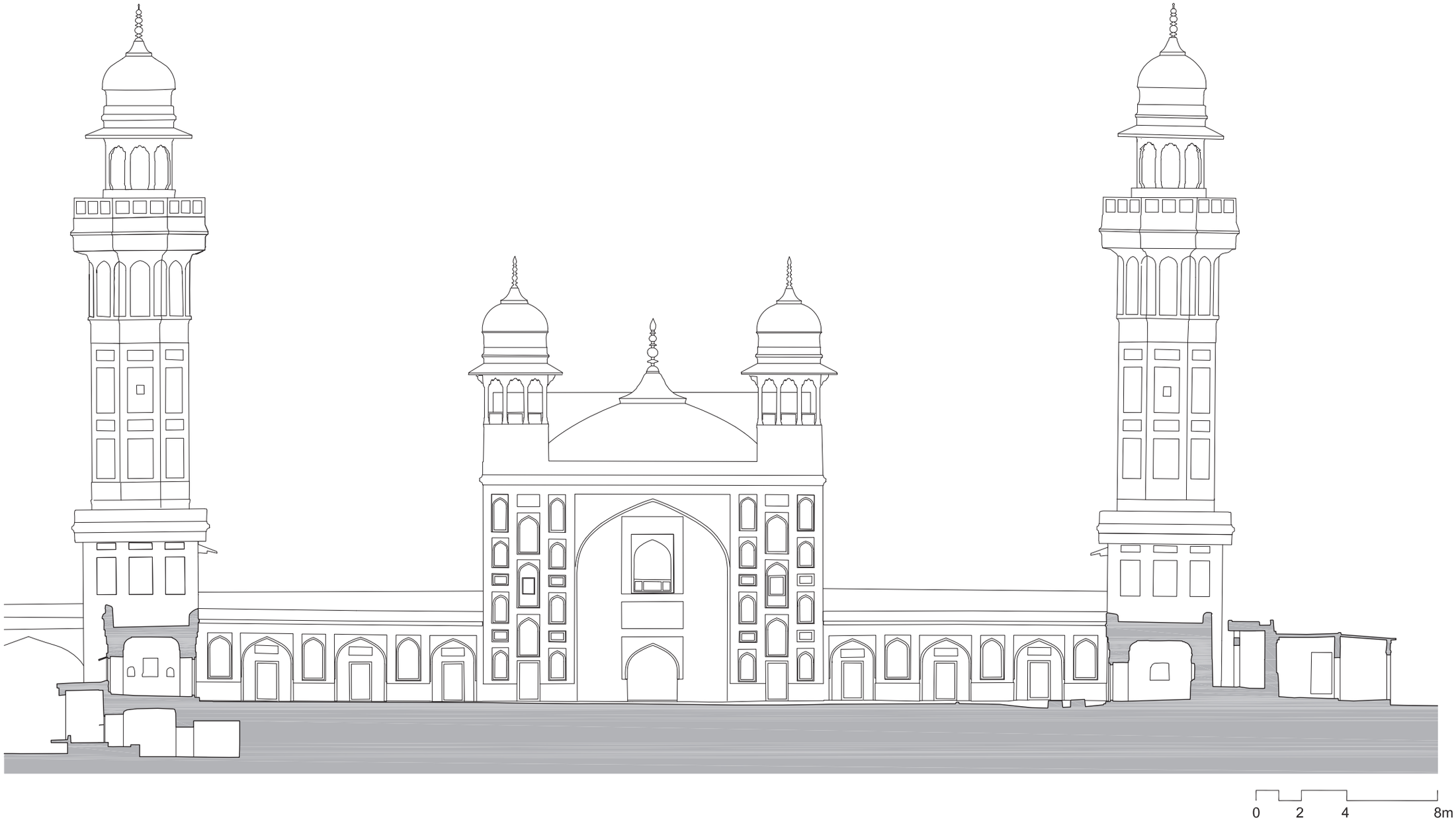
This sectional elevation cuts through the eastern façade of the mosque: both the shops on the Chowk and the shops on the eastern side of the Calligraphers' Bazaar are in section. Additionally, the steps leading from the level of the Calligraphers' Bazaar and dewrhi *level up to the level of the mosque courtyard are visible. On the northern side of the sectional elevation is Kotwali Gate, the north-western gate leading from the Chowk to Kotwali Bazaar with modern shops built into its sides. On the southern side on the left of the section is a residential property which abuts the south-eastern corner of the mosque and is partly built across the roof of the Calligraphers' Bazaar.*

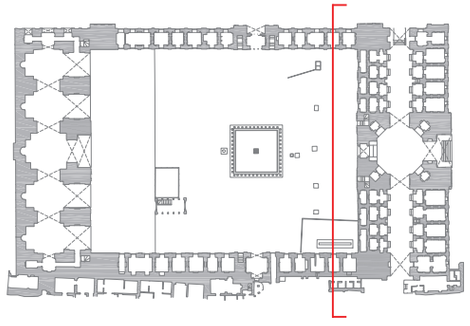




SECTION CC LOOKING WEST

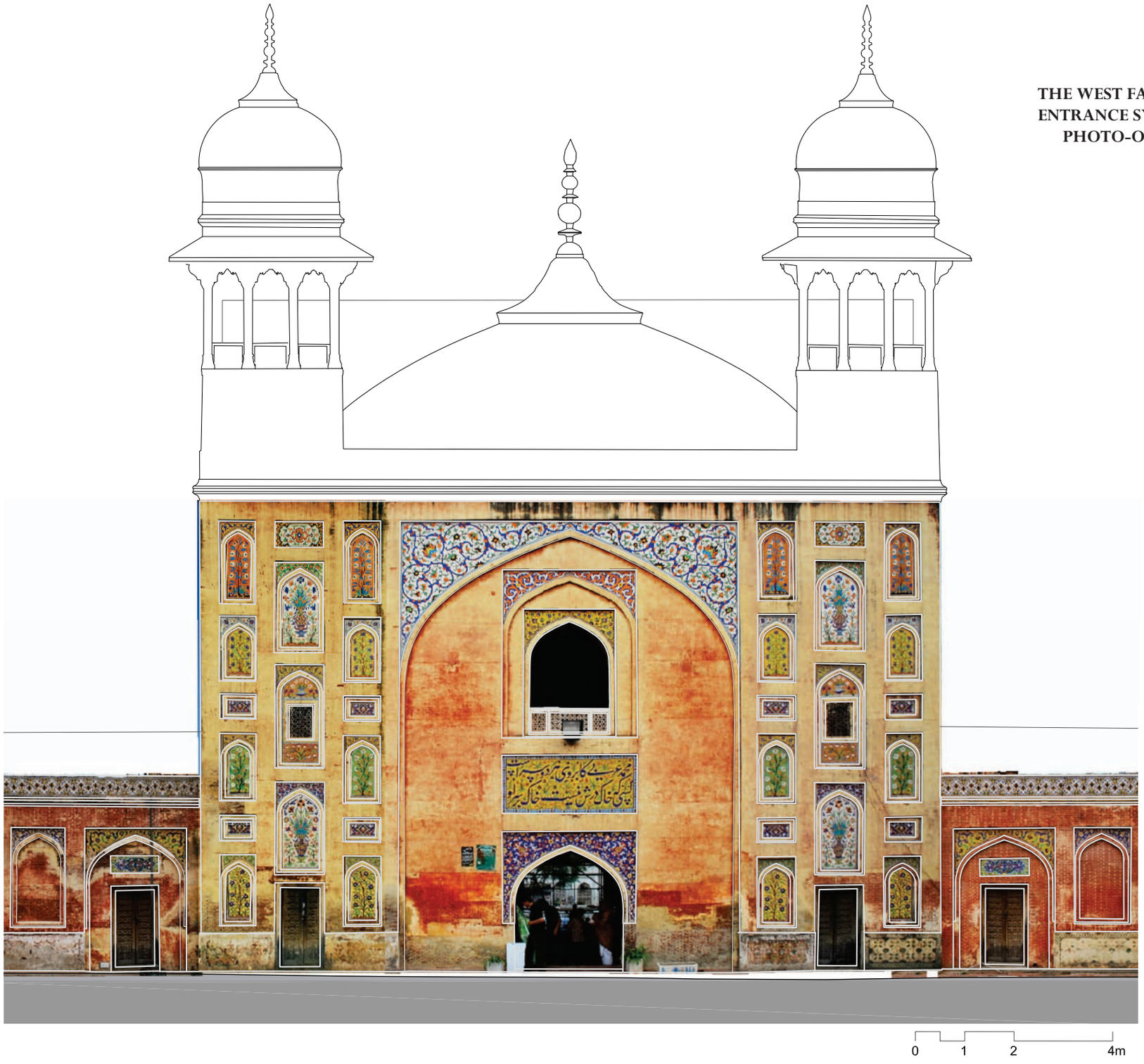
This sectional elevation cuts through the street of the Calligraphers' Bazaar, and the entrance dewrhi. *The individual archways, steps and raised platforms which form a transitional space outside each shop on the western side of the Calligraphers' Bazaar are visible. Additionally, on the northern and southern extremes of the Calligraphers' Bazaar roof are pavilions, which are located immediately east of the* minars. *Within the* dewrhi, *are the two western niches at the level of the Calligraphers' Bazaar mirroring two identical niches on the eastern side (not shown).*



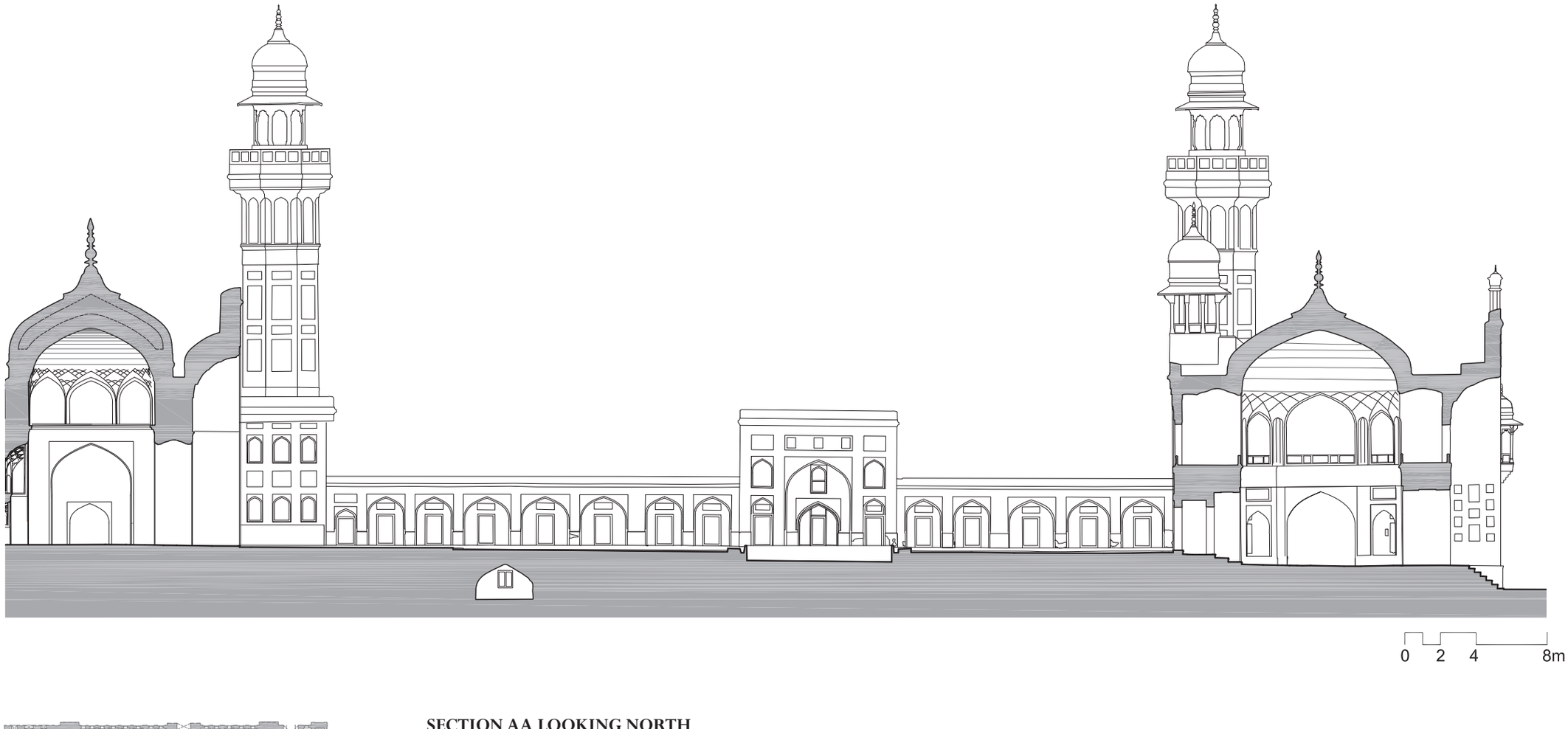


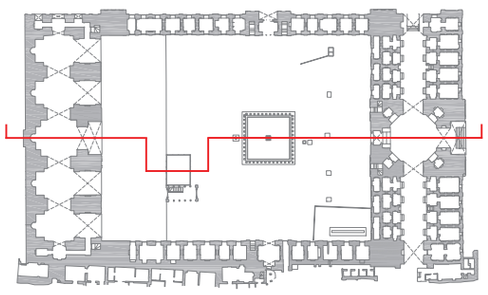
SECTION EE LOOKING EAST

This sectional elevation looks east back towards the entrance of the mosque. It shows the hujras *on the eastern side of the courtyard, section through the* hujras *on both the northern and southern side, the ablution facility built in the south-eastern corner of the courtyard and the toilets built outside the southern limits. At street-level on the northern side the original shops under the* hujras *extend southwards under the courtyard. The rise in street-level over time has necessitated the addition of new structures in front of the shops extending northwards into Kotwali Bazaar at a higher level. In the background is the arch of Kotwali Gate. On the southern side, the base of the* hujras *correspond roughly to the street-level outside; the floors of the latrine structures built outside the limits of the historic structures on the southern side are at a higher level than the* hujra *floors.*



THE WEST FACING FAÇADE OF THE ENTRANCE SYSTEM - DETAIL WITH PHOTO-ORTHORECTIFICATION

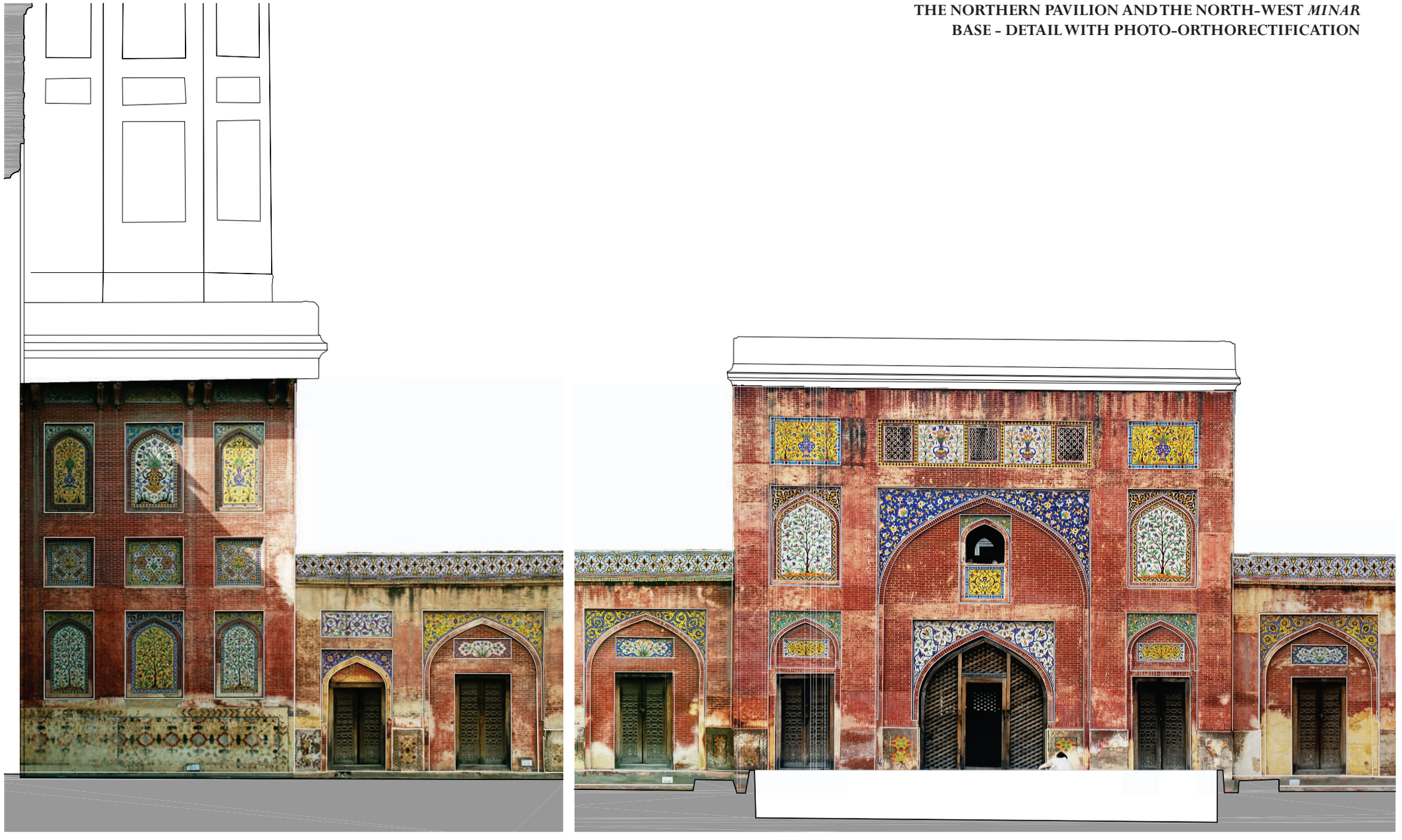


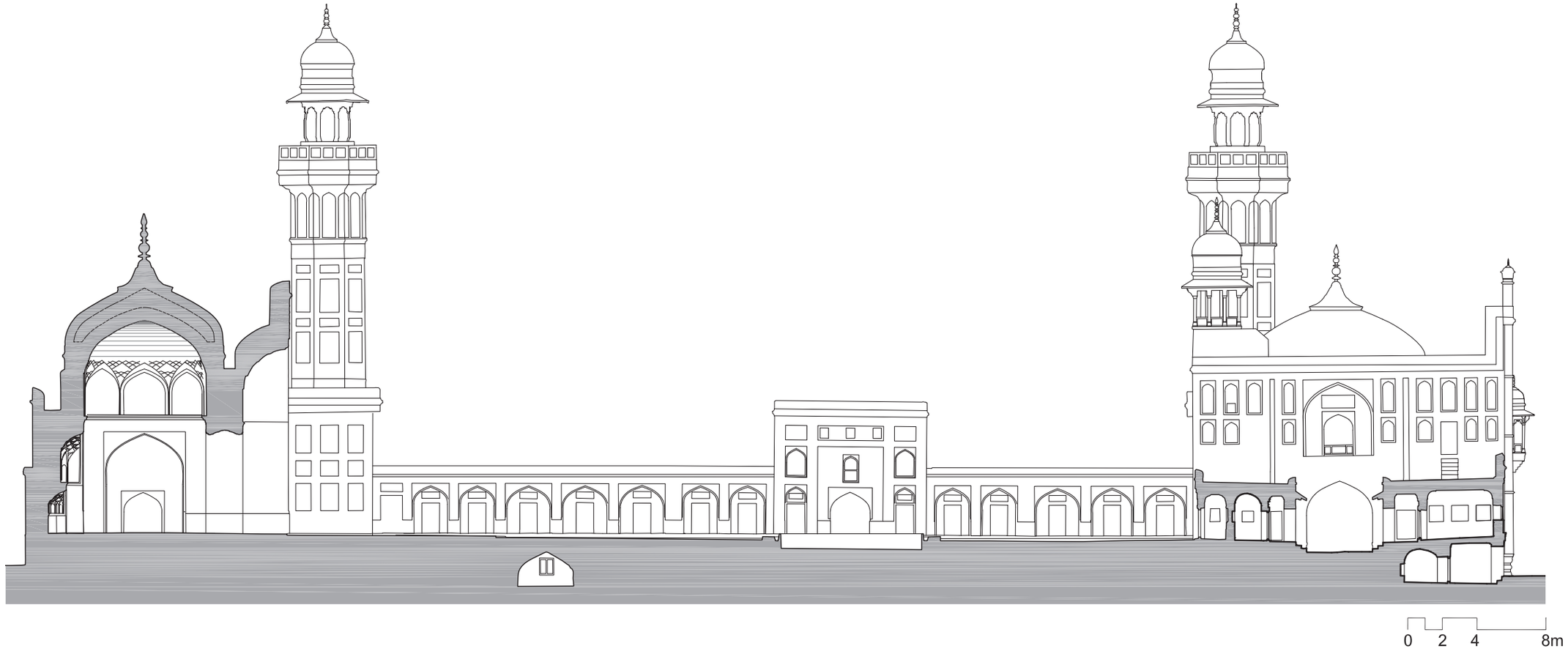


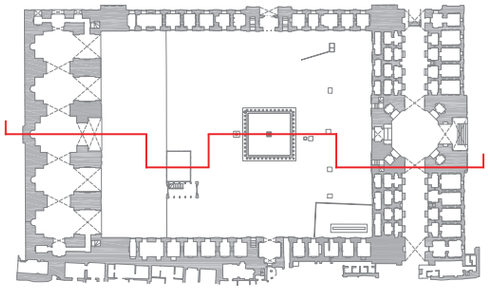
SECTION AA LOOKING NORTH

This section cuts through the courtyard, the prayer chamber's central dome, and the entrance dewrhi, *as well as the shrine of Ishaq Gazruni located beneath the level of the courtyard, and the ablution pool in the centre of the courtyard. Particularly evident is the successive rises in floor height from the Chowk in the east, to the Calligraphers' Bazaar and to the courtyard with the almost imperceptibly elevated western part of its floor.*
On the northern side is the elevation of the north row of hujras *with pavilion placed on an axis line in the centre of the lower, square part of the courtyard (see key plan, left).*
Whilst the base of the north-eastern minar *is incorporated in the volume of the Calligraphers Bazaar, that of the north-western* minar *is clearly visible from the courtyard.*

THE NORTHERN PAVILION AND THE NORTH-WEST *MINAR*
BASE - DETAIL WITH PHOTO-ORTHORECTIFICATION

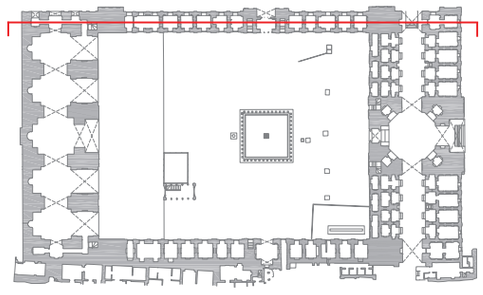






SECTION AA' LOOKING NORTH

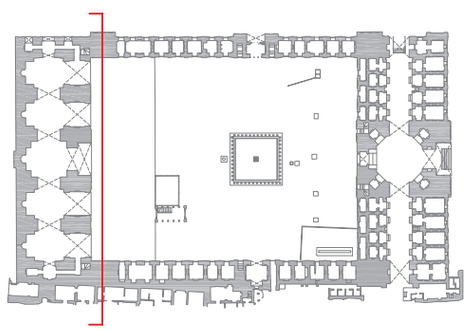
This is similar to the previous section. However, the plane of the section slices through the Calligraphers' Bazaar on the south side of the dewrhi, *showing the relation between the Calligraphers' Bazaar street, the individual shops and their external transitional spaces, and the shops underneath which open out into the Chowk.*



SECTION GG LOOKING SOUTH

This section cuts through the northern row of hujras*, the northern pavilion, the original shops at street-level below and the northern* minars *(western and eastern). On the east side, the section cuts through a shop at the level of the Chowk, above which is a shop accessed from the Calligraphers' Bazaar with transitional space and steps leading up. The passageway of the Calligraphers' Bazaar is at a lower level, above which is the pavilion to the east of the north-eastern* minar.

On the west side of the section is the prayer chamber with the section cutting through the different levels of small rooms on the northern side of the prayer chamber.



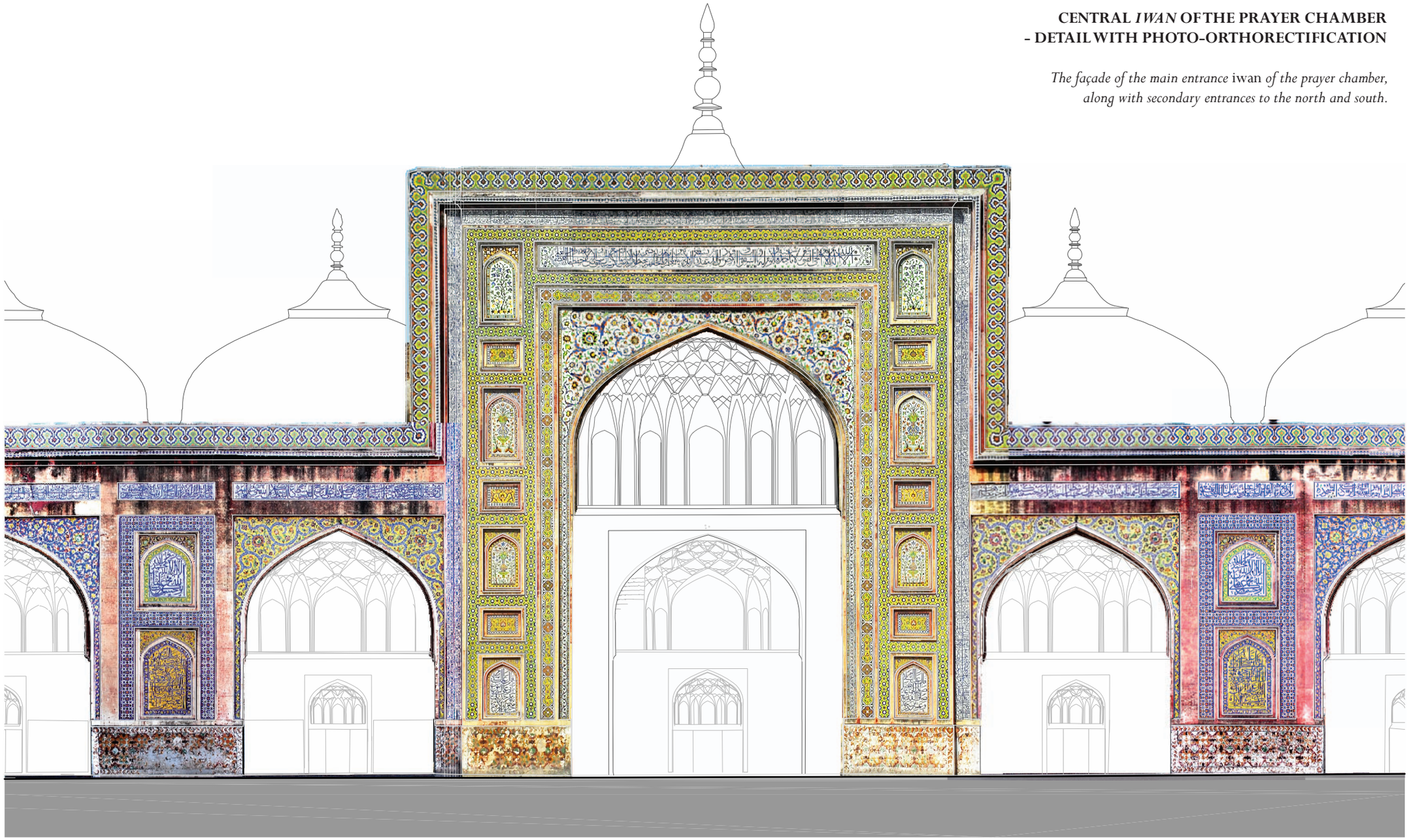
0 2 4 8m

SECTION BB LOOKING WEST

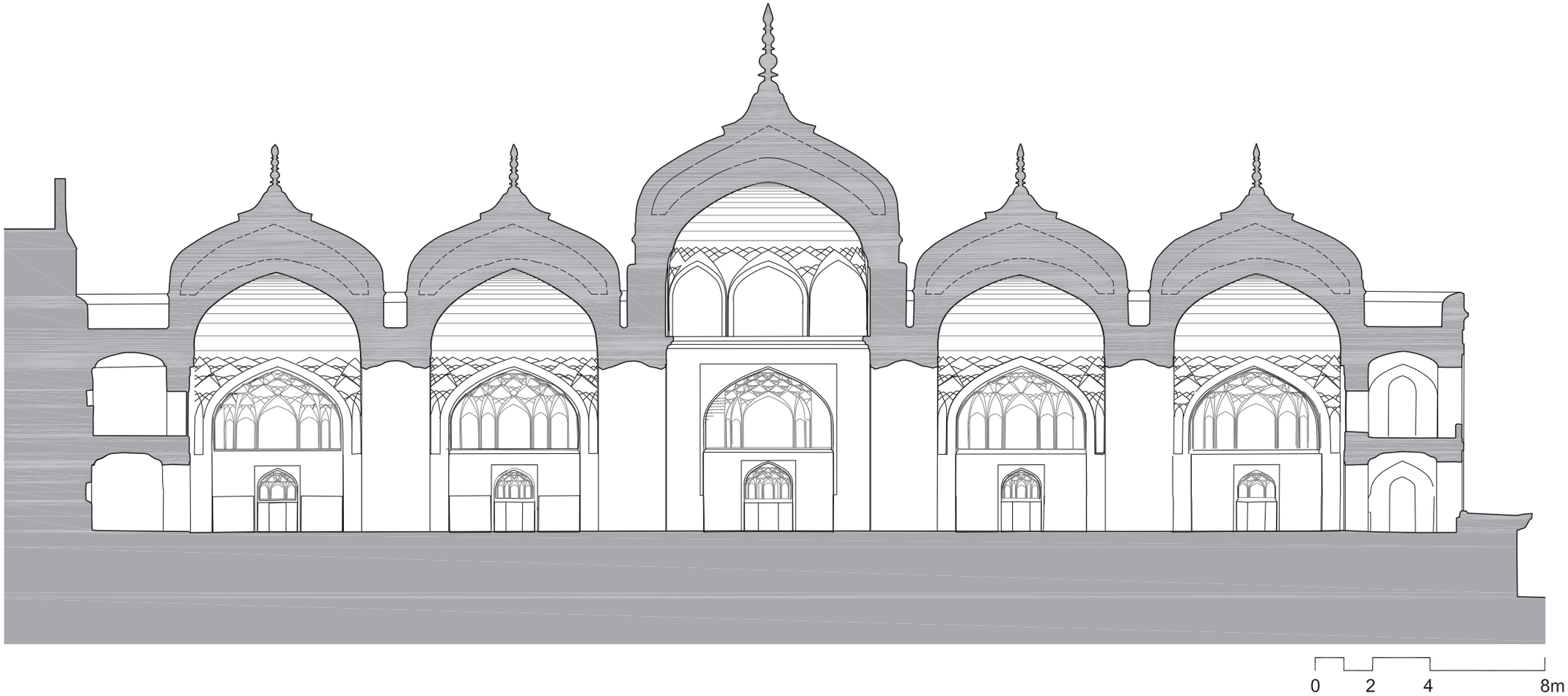
This is a sectional elevation looking west towards the prayer chamber and cutting through the western minars *(southern and northern). The elevation shows the façade of the prayer chamber with the central* iwan *and two smaller archways on either side with their corresponding domes.*

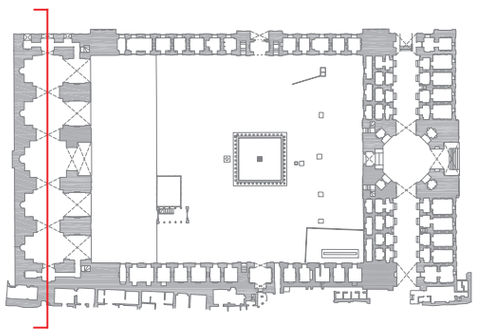
CENTRAL *IWAN* OF THE PRAYER CHAMBER
- DETAIL WITH PHOTO-ORTHORECTIFICATION

The façade of the main entrance iwan *of the prayer chamber, along with secondary entrances to the north and south.*



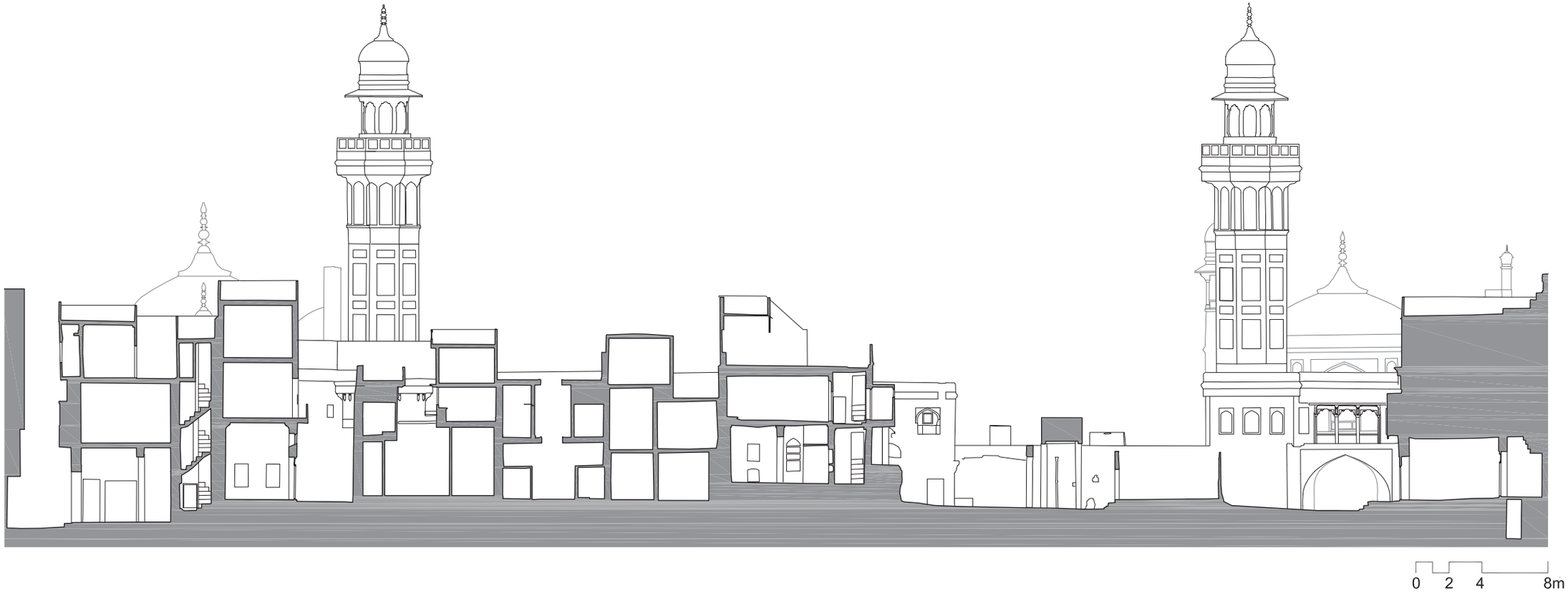
0 1 2 4m

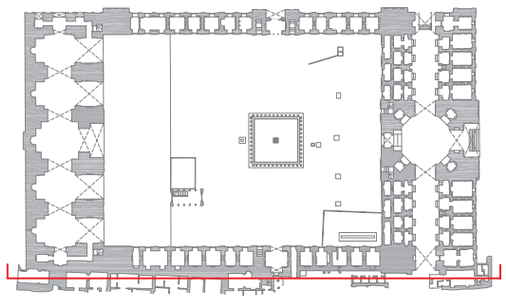




SECTION DD LOOKING WEST

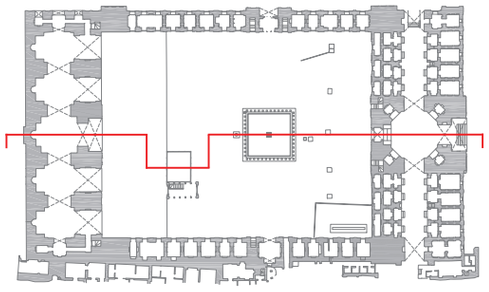
This is a section through the prayer chamber. Shown on the north and south of the chamber are smaller rooms at two levels. The relative height of the mosque courtyard with respect to the Kotwali Bazaar street-level is shown. Residential properties abut the mosque on its south-western corner.





SECTION HH LOOKING NORTH

This sectional elevation cuts through the properties abutting the structure of the monument in the southern residential neighbourhood of the mosque, with the elevations of the prayer chamber dome, the south-western minar, *and southern pavilion partially visible. Where no properties are abutting the mosque's southern wall, the base of the south-eastern* minar *and the south entrance to the Calligraphers' Bazaar are visible, together with the dome of the* dewrhi.



SECTION AA LOOKING SOUTH

This sectional elevation cuts through the entrance iwan, *courtyard and prayer chamber, also the central ablution pool and the sub-surface shrine of Ishaq Gazruni in the south-west of the courtyard with its pavilion above and the low wall enclosing the cenotaph on the floor of the courtyard.*
On the western side of the mosque is a street separating it from the residential neighbourhood, and on the southern side residential properties rise above the level of the hujra *roofs.*

THE SOUTHERN PAVILION AND THE SOUTH-WEST *MINAR* BASE - DETAIL WITH PHOTO-ORTHORECTIFICATION

Panel C

Panel A

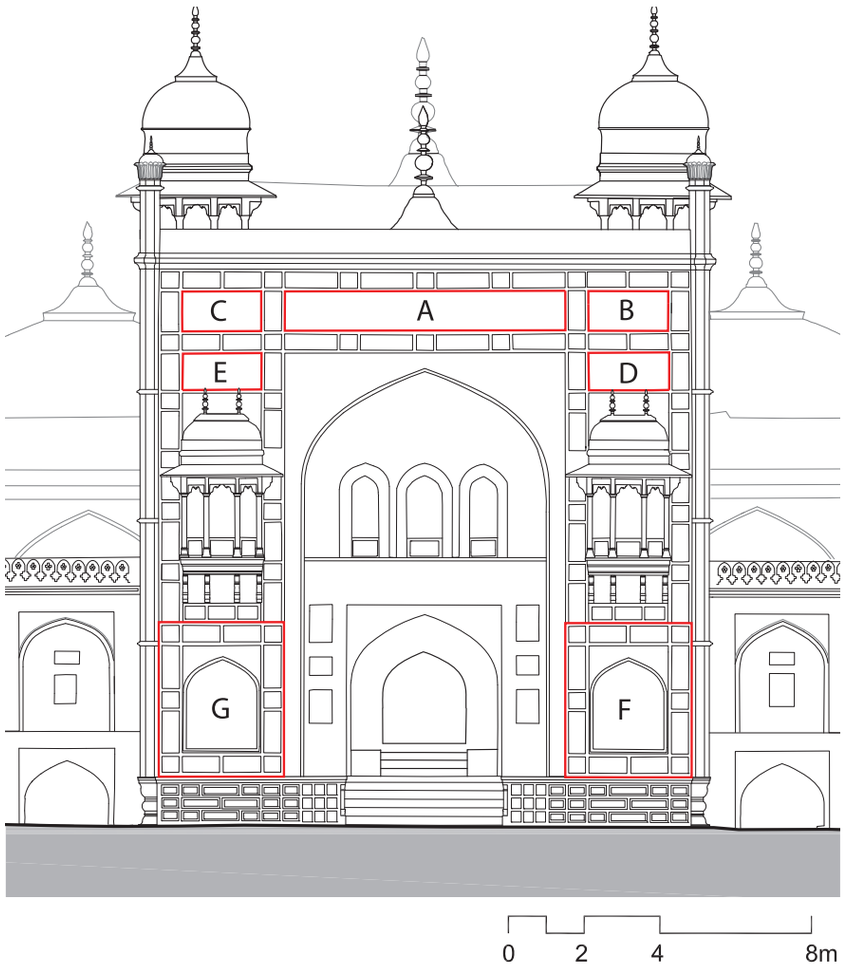
Panel B

Panel E

Panel D

Panel G

Panel F



CALLIGRAPHY ON THE EAST FACING FAÇADE OF THE ENTRANCE *IWAN*

The calligraphy on the iwan *facing the Chowk is heraldic in intent and nature. In the 17th century the 8 metre long central panel containing the Kalima-e-Tayyab accosted the person who entered the* jilau khana *with a powerful first announcement. This is supported by four smaller tablets, two on each side, placing the building in its historic context. The date is stated both in numerals and in a chronogram. The verse on the right side of the entrance is a panegyric verse in praise of this* jami' masjid. *The verse on the left exhorts the faithful to prayer and righteousness. This verse is signed by the calligrapher Muhammad Ali.*

5.2 CALLIGRAPHY

The following description sequence and all references to the calligraphy, its content, its translations, and references to calligraphers are drawn from Abdullah Chaghatai.[10] Where the text has been borrowed *verbatim*, it has been placed within quotation marks.

The display of verses on the walls of the Wazir Khan Mosque stretches from its main entrance to the rear-most wall of the prayer chamber. This decorative scheme of the Wazir Khan Mosque is displayed as an integrated whole over the entire fabric of the monument and is a fine specimen of Islamic calligraphy harmonizing with the general scheme of the decoration of the mosque.

The façade of the main eastern gateway's central part over the central arch bears the Kalima in *nastaliq* style along with the date A.H. 1045 (1635 AD) when the mosque was finally completed. On its right and left, the rectangular panels bear the name of Emperor Shah Jahan, during whose reign this mosque was built and the year of its foundation is embedded in chronogram in Persian text. There are other rectangles below on the right and left which bear Persian text explaining that the mosque was built by Wazir Khan. There are two Persian quatrains too on the right and left wings of the porch which have been very artistically calligraphed in bold *nastaliq* script by the calligraphist Muhammad Ali. These may be translated as follows:

On the right: *"The edifice, which like the sanctuary of heaven is a source of bounty. Has like the temple of Ka'ba for its object the benefit of mankind. To the congregation may its gate ever remain open with prosperity until the day of resurrection."*

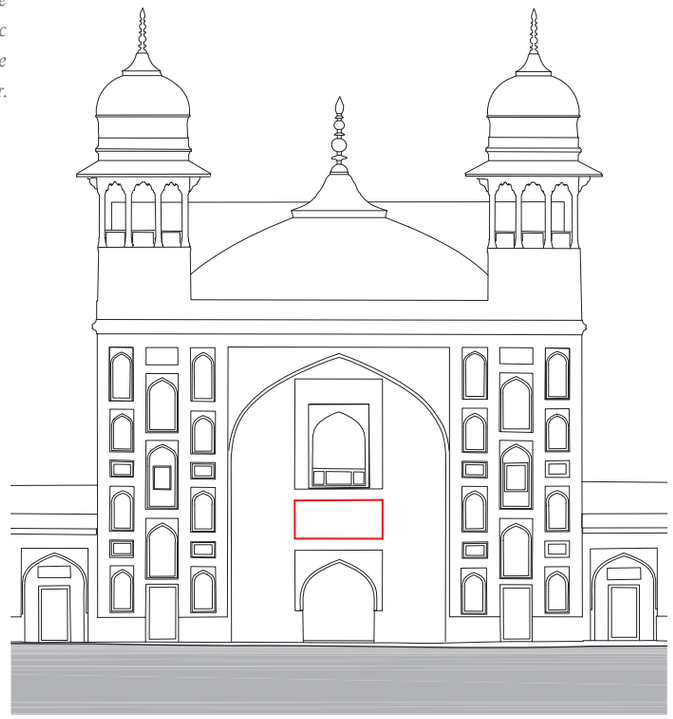
On the left: *"In the corn-field of this world, O well conducted man, whatever is sown by man is reaped by him in the world to come. In your dealings, then, have a good foundation in the world. For all have to prove their way to heaven through this gateway at last."*

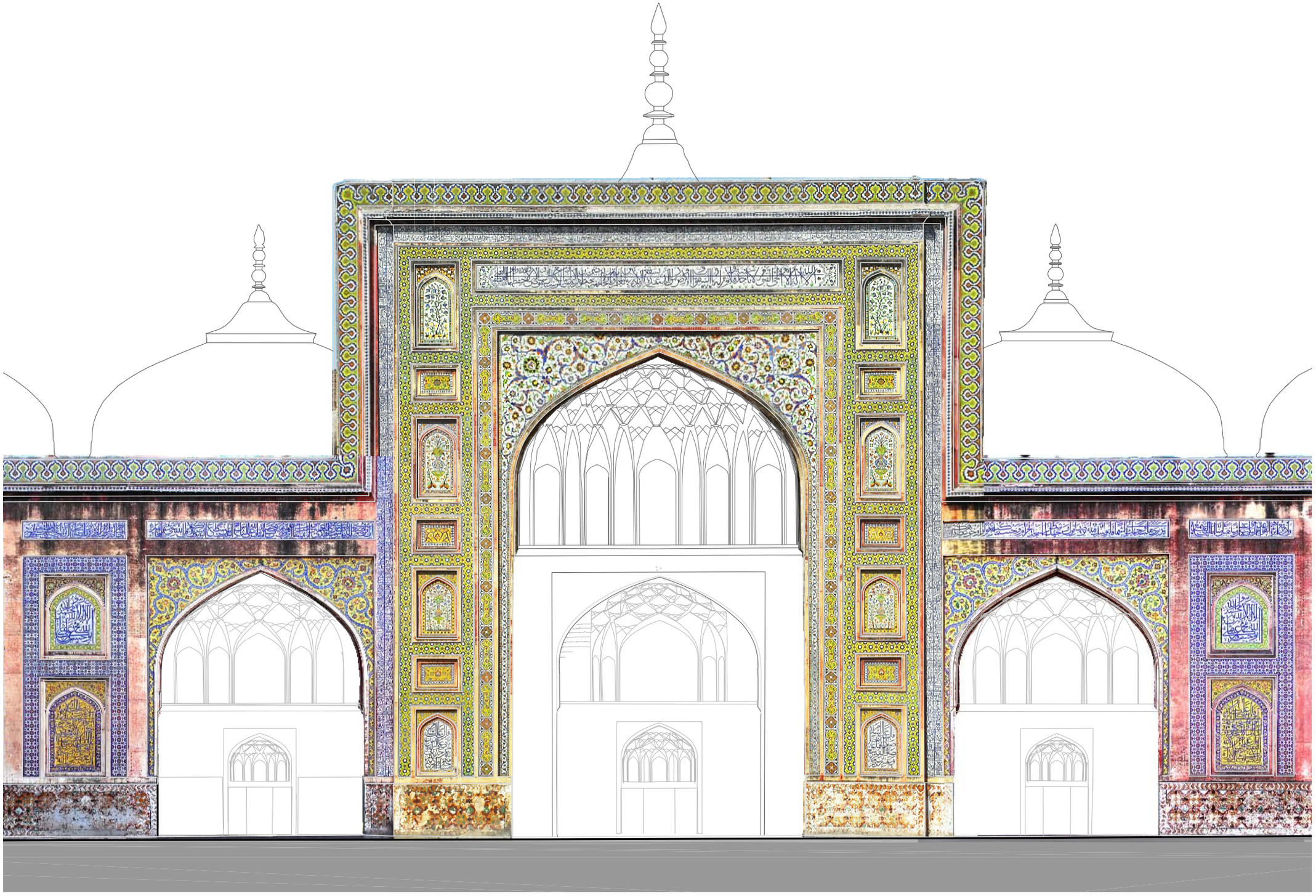
Through this main *iwan*'s vestibule, we enter the courtyard of the mosque. Just over the arch of the entrance towards the east, we find that the panel has been decorated in the best style of *kashikari* which bears a popular Persian couplet and it has been calligraphed in dark blue on a yellow ground. It says:

"Muhammad of Arabia is the honour of both the worlds,
He who is not the dust of his threshold,
let dust be thrown over his head."

CALLIGRAPHY ON THE WEST FACING FAÇADE OF THE ENTRANCE

The westward facing façade of the entrance to the courtyard has the following single calligraphic panel above the archway as you exit back into the Calligraphers' Bazaar.





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Except for narrow bands of faux brickwork in *tazakari*, the entire façade of the prayer chamber on the other (western) side of the courtyard is completely and profusely decorated with *kashikari*. This façade has five *iwans*, the central one of which is broader and higher than those on its right and left.

The decorative scheme of the central *iwan* comprises a series of concentric frames. The square containing the overall scheme of the central *iwan* confines an inner vertical rectangle which contains the main arch. The outer most border of this frame comprises a crenellated cornice in *kashikari* with an inner *dori* (ribbon), which turns along the roof line horizontally, extending to the end of the façade on the north and south. Inside this outer crenellated frame and separated yet again by a plaster panel, is a calligraphic scroll which runs on three sides of the *iwan*—a rendition in blue and white glazed calligraphy of the Surat al Fath[11] in exquisite *thuluth*.

Opposite: Part-elevation of the main façade of the prayer chamber, showing calligraphic panels on the central iwan.

Above and right: The outer most calligraphic band on the central iwan *carrying the Surat al Fath.*

Panel B

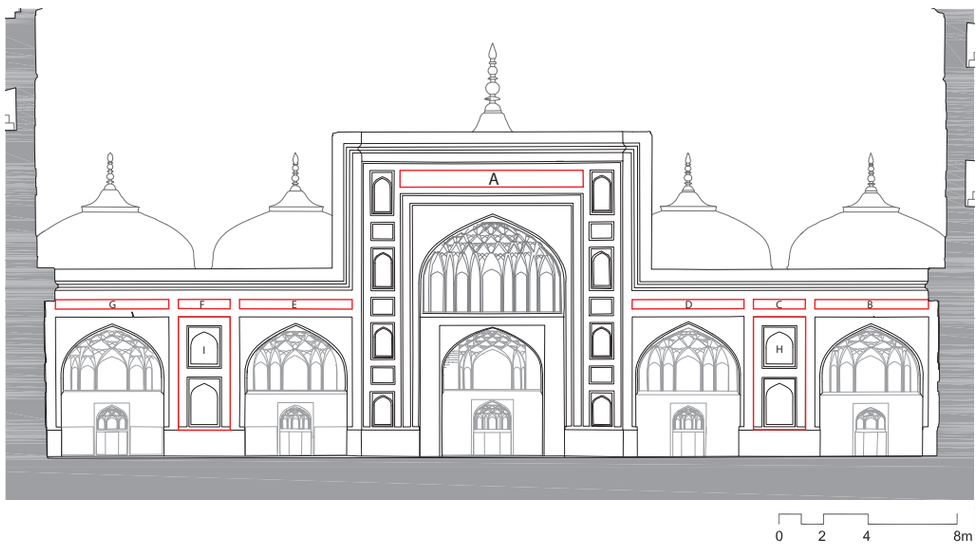
Panel C

Panel D

Panel E

Panel F

Panel G



CALLIGRAPHY PANELS ONTHE EAST FACING FAÇADE OF THE PRAYER CHAMBER

The calligraphic panels illustrated on this and the following two pages are refered to their location on the façade as lateral rectangles in the key drawing on the left. The principle horizontal panel (A) contains the Ayat al Kursi shown on the opposite page at the top. This calligraphy is signed by Muhammad Sharif (see opposite for an enlargement of this signature).

The calligraphy on the panels over the arches on either side of the central iwan *is signed at the end of the southern most panel by the calligrapher Haji Yousef Kashmiri and dated 1044 Hijri.*

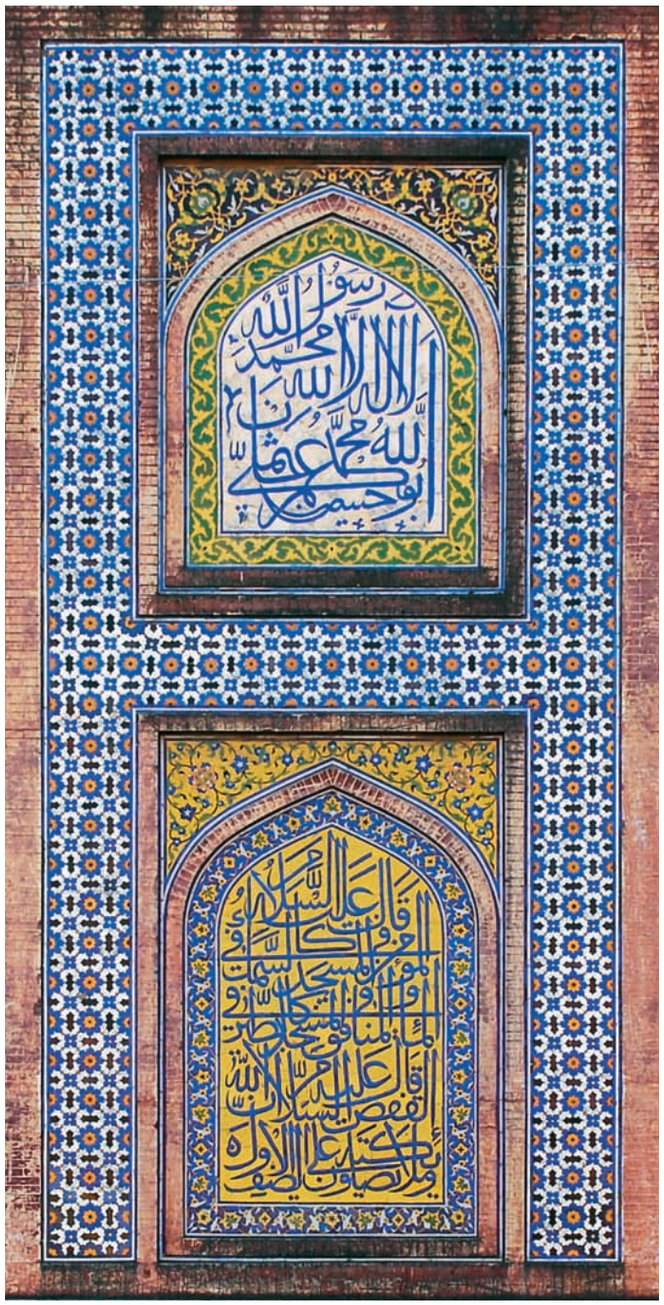
Panel A

Below the horizontal band of this frame and running the full width of the arch and its outer frame, is a rectangular tablet containing the Ayat al Kursi (Surat al Baqr, 255), also in *thuluth*, forming the principle epigram on the face of the mosque. The signature of the calligraphist Muhammad Sharif appears at the end of this band.

On both sides, the vertical space between the calligraphic scroll containing the Surat al Fath and the rectangle containing the arch is divided into a series of smaller rectangles, aligned vertically and horizontally, that form the frames for *kashikari* work containing calligraphy in the lower two oblong rectangles, one on either side, and pictorial *kashikari* tree-of-life interpretations and other motifs from the decorative vocabulary of the period. The calligraphy in the lower two panels just mentioned is in the form of stylized *thuluth* compositions. The spandrils of the main arch contain *kashikari* in flowing tendrils interspersed by floral motifs.

The smaller arches on the north and south of the central *iwan* also carry *thuluth* calligraphy in rectangular horizontal bands of blue and white *kashikari* above the crown of the arch. These bands contain the following verses of the Quran: Surat al Baqr (verses 125, 127, 144), Surat al 'Imran (verses 96, 97), the Surat Tauba (verse 18) and Surat Tauba (verses 108, 109). Some verses in the southern half of the façade repeat those that appear in the northern half. The name of the calligraphist appears at the end of the last rectangle above the southern-most wall, Haji Yousuf Kashmiri, with the year 1044 AH. The intervening wall space between the smaller arches in the northern half of the façade contain two *kashikari* panels. The upper one of these contains, in stylized *thuluth*, the Kalima-Tauhid and the names of Allah, Muhammad (PBUH), Abu Bakr, 'Umar, 'Usman, 'Ali and Hassanain. The larger lower panel contains also in stylized *thuluth tughra* style, the popular tradition: *"the believer in a mosque is like a fish in water; the hypocrite in a mosque is like a bird in the net."* The corresponding panel on the southern side contains another popular tradition.

Panel I



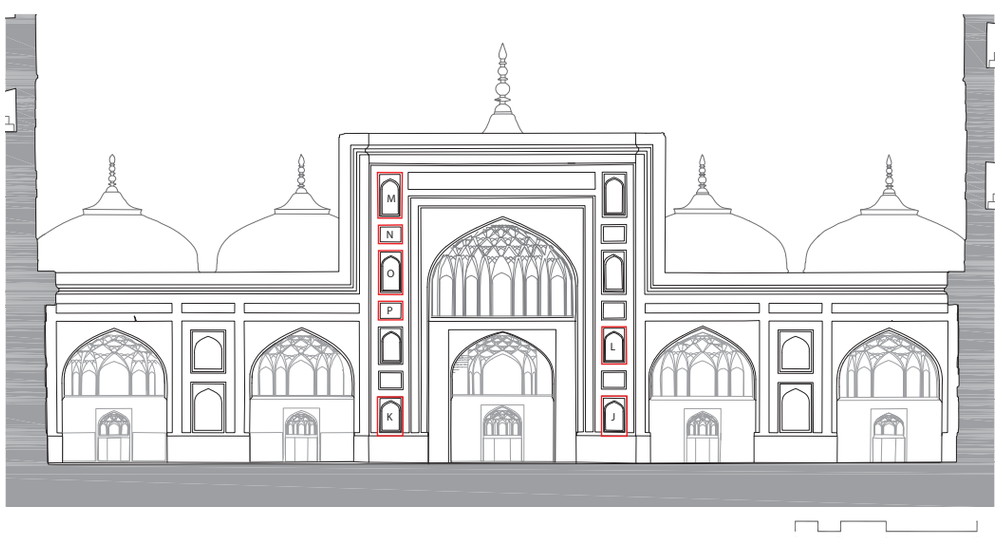
Panel H

Panel K

Panel J

Inside the prayer chamber of the mosque, the walls have been completely plastered with a thick layer of lime which has been artistically embellished with frescoes, and enriched with various types of decorative motifs along with verses from the Quran, traditions of the Prophet (PBUH) and other sayings. Careful observation indicates that the upper square (of the transition to the dome) bears the sacred Quranic text of the Sura (64) al Taghabun in stucco style written in relief. It is calligraphed in a perfect *thuluth* style of calligraphy. At its end it also bears the name of the calligraphist Hussein. In the same stucco style in relief there are other panels which also contain holy texts and they have been written in the best *thuluth* style of writing."

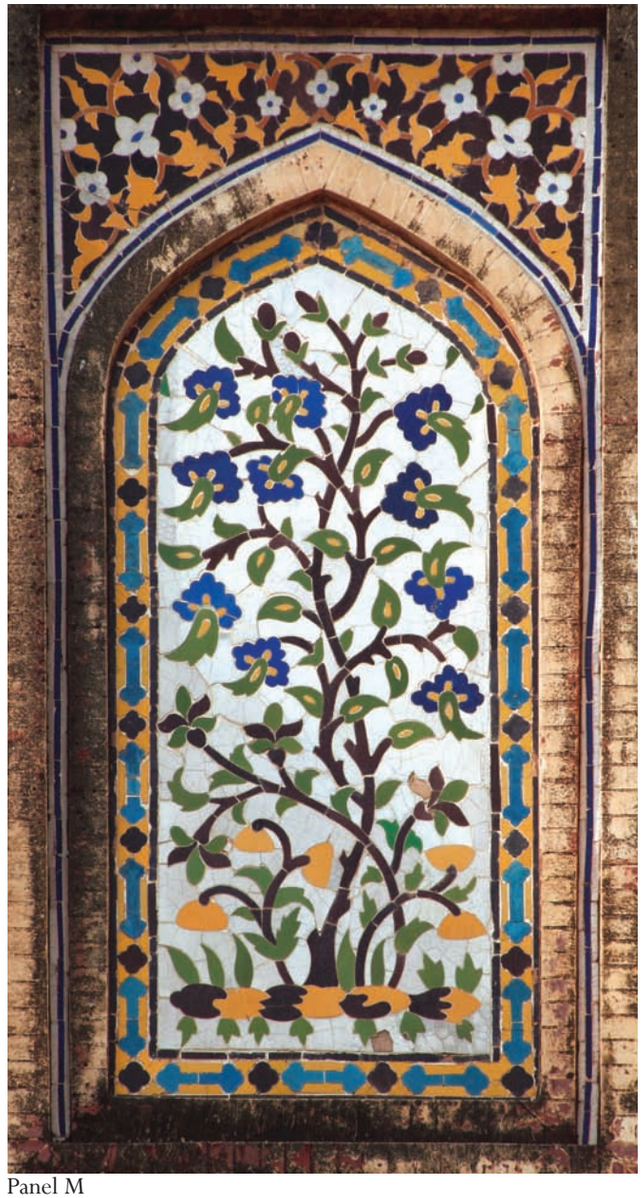
Those who have signed their names to the calligraphy work in the Wazir Khan Mosque are the calligraphers Muhammad Ali, Muhammad Sharif, Haji Muhammad Yousuf and Mulla Hussain.



CALLIGRAPHY ON THE EAST FACING FAÇADE OF THE PRAYER CHAMBER (CENTRAL *IWAN*)

Within the outer frame containing the Surat al Fath (described on page 65) are the pair of calligraphic panels on this page, shown at locations K and J in the key drawing on the left.

Panel L



Panel M

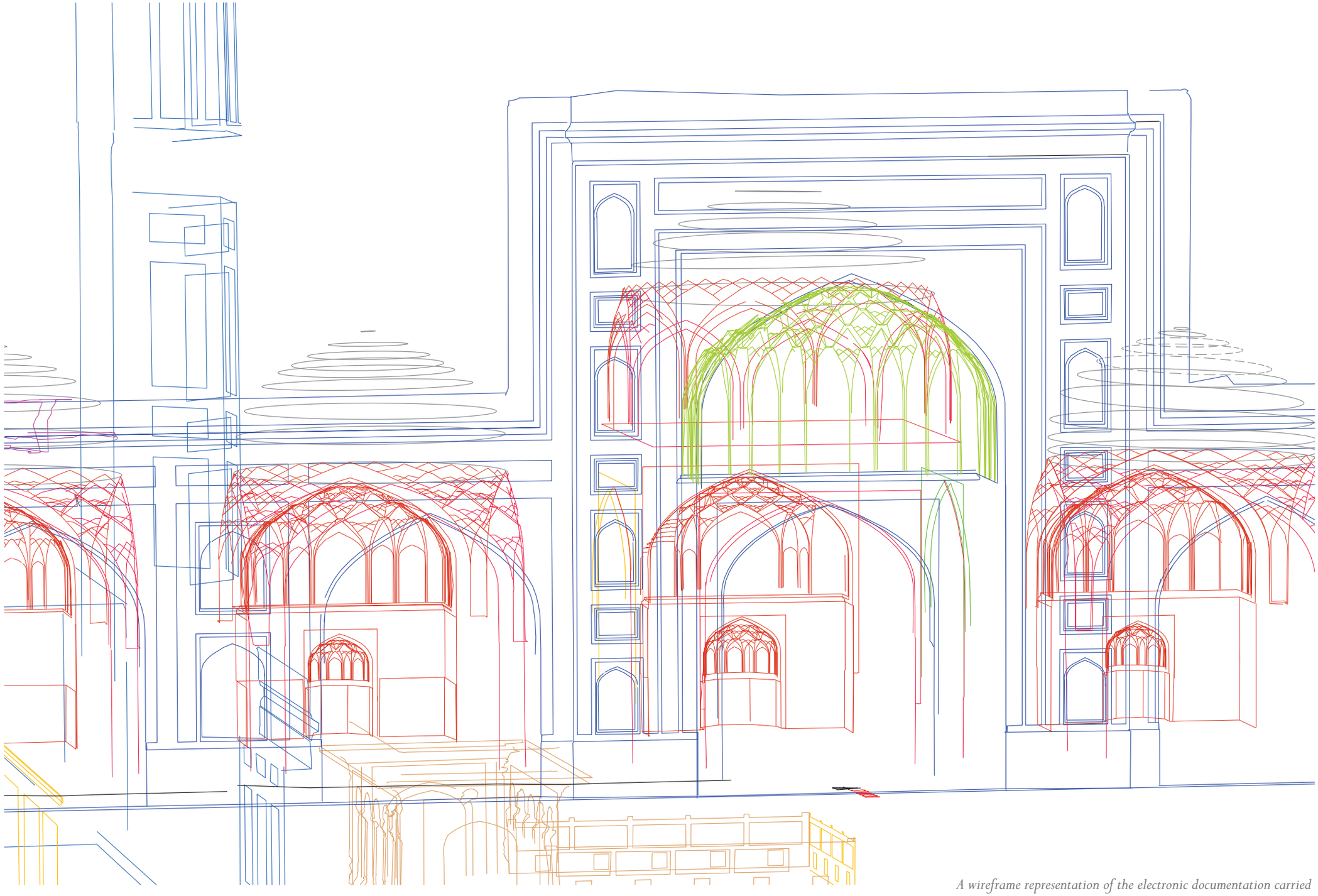
Panel O

OTHER DECORATIVE *KASHIKARI* PANELS ON THE EAST FACING FAÇADE OF THE PRAYER CHAMBER

In combination with the calligraphy on the east facing façade of the prayer chamber, the main panels of kashikari *work framing the* iwan *are of floral and arboreal designs. Horizontally, the two corresponding panels on either side of the* iwan *are identical in both colour and design, the variation occurring between each panel as you move up the façade vertically. The predominant colours are yellow, blue, orange and dark brown foliage on white backgrounds in the larger panels, or on yellow in the smaller panels.*

Panel N

Panel P



A wireframe representation of the electronic documentation carried out of the exterior and the interior of the prayer chamber.

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6 NEIGHBOURHOOD CONTEXT

The assessment of the issues faced by the neighbourhood in which the mosque is located has been greatly helped by the availability of detailed surveys carried out as part of the planning initiatives for the LWC as a whole undertaken by the AKTC / Government of Punjab partnership. This survey was augmented by detailed documentation of several elements of the neighbourhood context: private residential buildings, small monuments, encroached areas in public spaces etc.

6.1 CHOWK WAZIR KHAN

The angular movement path across the Chowk from the Chitta Gate to the gateway (leading to Kotwali Bazaar) in the north-western corner of the Chowk is an inherent morphological characteristic of the square and poses important issues of its treatment in terms of both an open space and in terms of traffic. As a result of this configuration, this path tends to be occupied by vendors who have historically consolidated their occupation of this public space in repeated confrontations with authority.[12] The current result of this is the Chowk having been transformed into a bazaar, distorting the space of a quadrangle and dividing it into two parts.

On the perimeter of the square, a detailed survey (and the establishment of the ROW by Revenue Department officials in February, 2010) has revealed that most of the shops and houses fronting the square on its eastern and northern sides have encroached into the space of the Chowk, leaving some remaining fragments of the historical perimeter with its arched structures embedded deep inside the new structures. As a result of these transformations, the historical openness of the square has been seriously sacrificed to low value structures. Increasing presence of the heavy commercial activities of the last four decades have resulted in ill-maintained shops and structures which have ultimately distorted the form of the open space and the monumental environment.

The current urban conditions and the current use of the Chowk are unacceptable, and the project of the conservation and presentation of the mosque itself will be severely compromised if these conditions are allowed to continue. Views of the mosque, in particular of the detail of its decoration, are obscured by the illegal occupation of public space. Fabrication of steel products in shops which are part of the monument and in shops owned by others in the square creates an unfriendly and noisy environment, besides being a major potential threat to the building fabric of the mosque.

6.1.1 Small Scale Monuments in the Square

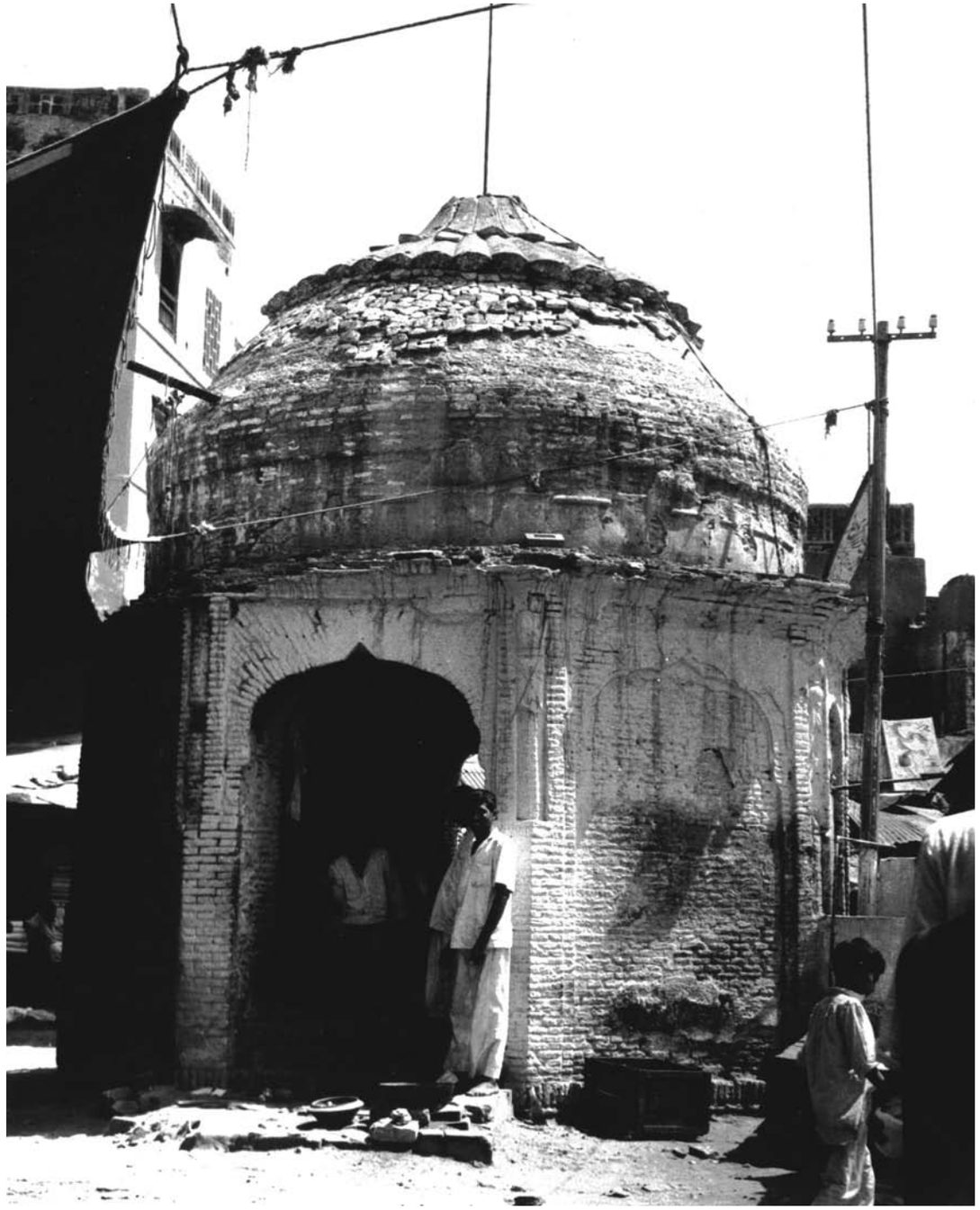
These monuments comprise the Chitta Gate, Dina Nath's Well and the Kotwali Gate, which are protected monuments under the federal legislation.[13] Once integral and prominent features of the urban ensemble of Chowk Wazir Khan, the present conditions prevailing in the Chowk have severely damaged the wholeness of these small monuments and have broken their physical relation with the Chowk and the mosque.

Chitta Gate, which provides the main entrance (including vehicular access) to the Chowk from Delhi Gate, is in a ruinous condition. Most of the old and original building fabric has been lost and damaged and the remaining structures are vulnerable to natural and man-made threats. The old façades have been heavily encroached upon by shopkeepers and private owners of neighbouring properties, and the gate has almost entirely lost its physical appearance due to these encroachments and its conditions of neglect and ruin. A total of 37 shops have been built into the fabric of this historic structure, which must be removed in order for the building to be properly restored. Similarly, the old well of Dina Nath on the north-eastern side of the Chowk is seriously damaged and encroached upon.

Right Top: Kotwali Gate has lost most of its visual impact due to the shops lining the angular movement path across the Wazir Khan Chowk and shops built within the gate structure on either side of the passageway.

Right: A metal worker outside a shop at the level of the Chowk on the eastern façade of the mosque.

Opposite: View from the entrance iwan *looking east across the Chowk. Chitta Gate is completely obscured by the Syed Suf Shrine, and only a small proportion of Dina Nath's Well is visible - the rest is hidden behind the shops on the angular movement path - recognisable by the orange Ufone advertising.*




چائے
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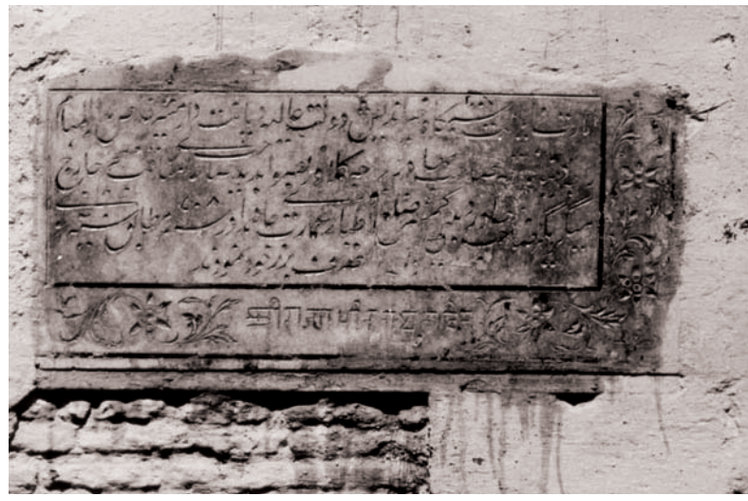
The spatial relationship of Chitta Gate with the main entrance *iwan* of the Wazir Khan Mosque was altered in 1852 when the original grave of Syed Suf was covered with a small domed structure which began to partly obstruct the mosque façade. This old shrine structure was demolished, rebuilt as a larger structure and expanded into a small mosque in 1990.[14] There is evidence to suggest that no significant structure existed on the grave of Syed Suf prior to the construction of the domed shrine in the mid 19th century.[15] According to Mohammed Latif, the domed structure that existed until 1990 was built by Sheikh Muhammad Sultan, contractor, upon the suggestion of a certain Major George MacGregor, the Deputy Commissioner of Lahore District, in 1852.[16]

MacGregor's name also appears on the marble plaque on the well[17] of Dina Nath as having encouraged Raja Dina Nath, Raja of Kalanour, to build the dome covering the well almost identical in style and size to the dome that was to be built the following year just yards away on the grave of Syed Suf. This well of Dina Nath still exists although it is completely shrouded by a ring of shops that have been allowed to be built against the fabric of its structure.

While the well of Dina Nath has by now acquired a certain historical and heritage value, the new shrine of Syed Suf, which also includes a sizable mosque built on the space formerly occupied by a Persian well,[18] is of indifferent architectural value. Its large dome and base structure, and the shops that have been built into it, almost completely obstruct the historic, axial vista of the mosque from the Chitta Gate, an important part of the 17th century urban design with which the mosque is associated. It is clear that as a result of the enlargement of the shrine, the cult of Syed Suf has grown strong and a large number of devotees pay regular visits. Consequently, substantial income appears to be generated by this establishment and shared by multiple beneficiaries. However, the presence of a new mosque yards away from the historic *jam'a masjid* of Wazir Khan raises questions of appropriateness. A number of small shops now girdle the 1990's structure on its eastern and northern sides and have become a spatial extension of the illegal bazaar on the diagonal movement path from Chitta Gate to Kotwali Gate. This suggests that this shrine and the economic activity associated with it appear to be part of the same system of rent seeking. The present structure of the shrine of Syed Suf not only hides the main eastern façade of the Wazir Khan Mosque from Chitta Gate but its enlarged footprint has usurped a substantial area of the Chowk. In a crowded commercial and production zone, tiny public toilets built into the body of the shrine structure provide the only public utility. A more sensitive treatment of this entire situation is clearly needed



Top: Dina Nath's Well in the morning before shop opening time.

Above: The historic inscription on Dina Nath's Well in Persian and Hindi. This inscription no longer exists or is hidden behind the abutting shops. This photo was found in one of the mosque's hujras *and dates from the 1970's.*

Opposite left: Photo of Dina Nath's Well from the 1970s's. This photo was found in storage in one of the mosque's hujras.

Opposite right: The well in 2011, almost entirely hidden behind shops. Only the entrance on the northern side remains relatively clear.

Above: Study of Chitta Darwaza, *by A.H.H. Murray, 1891, reproduced from Chaghatai, (1975)* 'The Wazir Khan Mosque, Lahore: History and Architecture', *Lahore.*

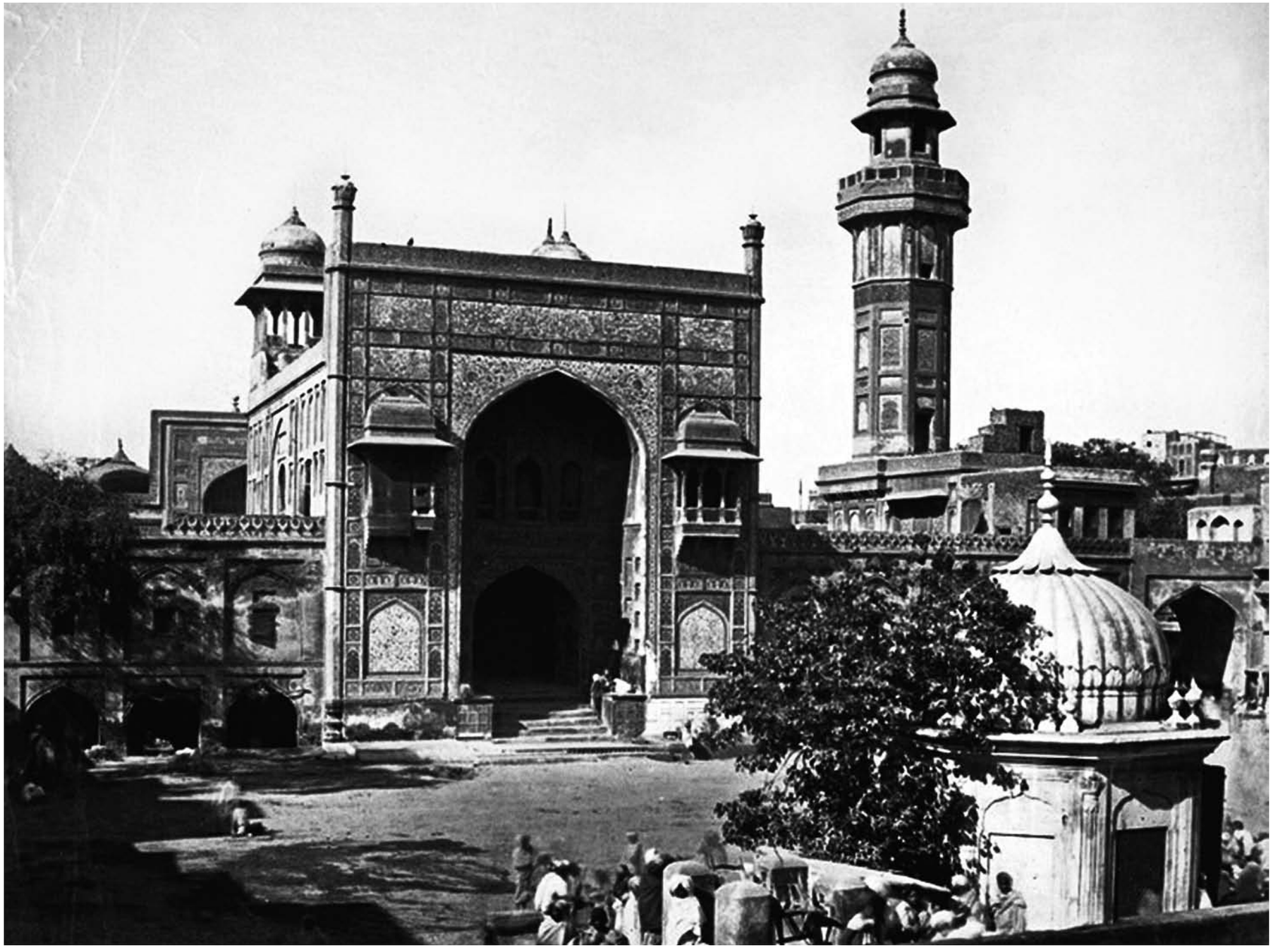
Left: View through Chitta Gate in 2011, with the multitude of shops that line the gate and the angular path leading to Kotwali Gate in the north-western corner of the Chowk.

Right: The ruinous state of Chitta Gate. This photo demonstrates that when passing through the gate from east to west, the view of the Wazir Khan's iwan, *which constitutes one of the main elements of the introductory space of the* jilau khana, *is blocked by the enlargement of the Syed Suf Shrine.*

Above: The condition of the underside of the gate's dome. Some fresco work is visible.

Overleaf left side: View of the Chowk clearly showing encroachments and the enlargement of the Syed Suf Shrine. Kotwali Gate is partially hidden by awnings.

Overleaf right side: 1880's photograph of the Chowk showing the original dome of the shrine dating from the 1850's. It is almost identical in style and proportion to the structure of Dina Nath's Well, and its size means that little of the mosque's iwan *would have been blocked from view as one entered the Chowk through Chitta Gate. Kotwali Gate on the extreme right in the photograph is a prominent feature of the Chowk. (Source: British Library Online Gallery).*



6.1.2 Poor Quality of Surrounding Buildings

Most of the buildings fronting the square are of poor quality. Some historic structures in the Chowk of considerable architectural merit are losing their charm and appearance under tremendous commercial pressure, and as a result of indifferent repairs carried out by their owners. The diagonal bazaar connecting Chitta Gate to Kotwali Bazaar has distorted the appearance of the square and divided the old square into two parts.

6.1.3 Parking in the Square

In addition to encroachments in the square, most of the time the rest of the remaining open space is occupied by cars, rickshaws and motor bikes which have transformed the Chowk into a parking lot.

6.2 BUILDINGS OF HISTORICAL AND ARCHITECTURAL MERIT WHICH ARE NOT LISTED

Most of the old buildings fronting the Chowk have now been transformed into contemporary buildings (constructed in cement concrete) with the old building fragments still embedded deep inside the ground floors of shops. Two buildings, which are not listed or protected under any act, are important to mention here and will play an essential role in the rehabilitation of the Chowk.

Located on the east of Gali Kharadian on the southern side of the Chowk, building H-1088, which appears to have been built in the mid- or late 19th century, displays traditional and old carved wooden elements. The old wooden balcony on its first floor[19] has been dismantled and replaced recently with cheap concrete work. The three storey building (H-687) on the south-west corner of the Chowk shows the influence of colonial architectural elements. Although the plane of the façades of these two buildings conflicts with the likely historical limits of the Chowk, they possess enough architectural merit to suggest that they are to be retained and appropriately dealt with.

6.3 BUILDINGS ABUTTING THE MOSQUE COMPLEX ON THE NORTHERN SIDE

The illegal construction of shops adhering to the historic fabric of the mosque on its northern side has contributed considerably to damage and deterioration. According to a document from the Auqaf Department, the original 12 shops on the northern side which were built to generate funds for the maintenance of the mosque, have now increased to 32 shops all of which are built illegally against the façade. This has:

i. Resulted in the obstruction of the northern *iwan*;
ii. Damaged the historic character of the northern façade of the mosque;
iii. Resulted in structural damage and a significant loss of the façades' surface decorations caused by incompatible structural elements such as reinforced cement concrete slabs and extraneous brickwork inserted into the fabric probably by means of making chases in the original masonry work;
iv. As a consequence, laid the historic fabric open to rain water penetration;
v. Prevented access to the façade for maintenance and upkeep;
vi. Generally resulted in the degradation and debasement of the monument.

The historic drain that ran along the base of the mosque on its northern side has been closed for about two decades. Owing to the presence of the new shops built against the façade, it has not been possible to determine whether the drain was merely filled up or whether its blockage was achieved through a design process. It is also not known whether any storm water or waste water connections to this drain were completely truncated.[20] The blockage of the drain in question was linked to the 1990 sewer laid along the centre of the street width, into which the rain water thenceforth was supposed to drain. It may be reasoned that a certain amount of water continues to find its way into that old drain system and seeps down into the ground alongside the structure. Serious repercussions of these drainage problems ensued later in the form of seepage and settlement of the courtyard floors as waste and storm water from the courtyard was not able to find its way out. This has also led to an increase in dampness in the shops and upper structure.

Above: Looking east down Kotwali Bazaar, on the mosque's northern side.

Opposite: Concrete slabs inserted into the mosque's fabric constitute the roofs of the extended shops on the north side.

6.4 BUILDINGS ABUTTING THE MOSQUE COMPLEX ON THE SOUTHERN SIDE

The area on the southern side of the mosque complex deserves special attention, as it is the site of the greatest and longest institutional indifference. This area is said to be the zone where the wells and open areas of land which were once part of the endowment existed. According to the *waqf* deed as reproduced in Latif,[21] several open and identifiable pieces of land were attached to the endowment. There is a strong likelihood that a significant part of this open land lay to the south of the mosque. Kanhaiyya Lal[22] implies in his description of the mosque written in the 1880's that in his time, the area to the south of the mosque complex comprised one large open precinct or *ahatta* associated with the well which was the source of water for the mosque. One of the wells is documented in the 19th century drawings contained in Abdullah Chaghatai's book[23] as well as in the 1907 cadastral map shown on page 10 of this report; its location has now been occupied by a house built in the early 20th century.

In being mostly residential in terms of land use, the conditions along the exterior of the mosque on the southern side are different from those on the northern side. But these conditions also pose serious hazards for the mosque. While the construction of residential buildings in the (originally *waqf*) open land on this side should not have happened, the houses built on this side appear to have been formerly separated from the mosque by a well established pathway running in an east-to-west direction, as is evidenced from careful documentation of the houses built under institutional management.[24] Today, the private houses and their allied facilities are very close to, if not actually abutting and structurally supported by, the historic fabric of the mosque, posing a serious structural threat to the monument. The conditions on the southern side are also characterised by poor water related interventions described in the next section. An example is the ill constructed and badly maintained concrete water tank just next to the eastern half of the row of *hujras* on the southern side which continuously leaks water into the foundations of the monument.

Currently, six private houses abut the mosque's southern wall. The wet areas (bathrooms and kitchens) of these private houses are located right next to the old wall of the mosque and have created serious threats to the historic wall and the adjoining *hujras*. These private interventions with ill maintained drainage systems have also badly affected the double storey pavilion in the centre of the southern row of *hujras*.

An examination of the urban morphology and oral history of the area to the south reveals that some of these buildings are even now in the ownership of the Auqaf Department, who are the institutional inheritors of the *waqf*. Almost all the houses abutting the southern perimeter of the mosque (west of the mausoleum of Imam Gammo) are known to be either still owned by the Auqaf Department or were once owned by the Auqaf Department. These houses bear property numbers H-629/3; H-629/1; H-629/2; H-628/2, H-628/1, and stretch all the way to the western edge of the mosque property projecting on to the street west of the complex. The number sequence of these houses suggests that they were once part of a larger plot of land.

An interesting feature of the plan form of these houses is the existence of small courtyards of a similar size and arranged in a linear series on the immediate south of the mosque perimeter. This morphology is evidence of the former existence of a street that has now been covered over and incorporated into the houses. This needs to be further investigated. The street could have existed at the time the houses were first built providing the needed separation from the southern wall of the mosque, but was later incorporated into the body of the houses, except for the small courtyards.

In addition to the houses described above there are other buildings which are said to be owned by the Auqaf Department, and which have occupied areas which were part of the open area associated with the *waqf* prior to 1907.

These buildings include:

a. The mausoleum of Imam Ghulam Muhammad bin Muhammad Siddique (d. 1244 AH; 1829 AD), popularly remembered as Imam Gammo (property SE-05-X1);[25]

Opposite: A house abutting the south-western corner of the Calligraphers' Bazaar. It is impossible to ascertain where the original boundary of the mosque was.

Above: The same house on the south-western corner as seen from its western side. A heavy steel girder has been inserted directly into the fabric of the pavilion at Level 2 of the Calligraphers' Bazaar.

Additionally, the occupants of the house are disposing of their household waste on the roof of the mosque. By the pattern of marks on the wall, it would seem that they throw their waste out of the open window, with little regard for sanitation, and without considering what happens to the rubbish in the long term.

b. The house immediately to the north of the mausoleum abutting the southern wall of the mosque which bears the same property number as that of the mausoleum; the overhead water reservoir in this house is partly supported by the historic exterior wall of the mosque.

c. House number H-655, which is the house occupying the former footprint of one of the wells;[26] this house did not exist in 1907.[27]

d. House number H-654, which presently contains a series of toilets on the ground floor used by the Auqaf staff also did not exist in 1907.

e. House number H-650; this property comprises two portions, one of which was next to the south entrance of the Calligraphers' Bazaar and has now been demolished. The other portion was, in 1907, at a small distance from the southern wall of the mosque; public latrines built into this structure now abut the wall.

f. House number SE-05-X2 which abuts the south-eastern corner of the mosque complex and is visible from the Chowk Wazir Khan. This house actually uses the walls of the mosque complex for foundation support.

From the above one can pose the likelihood that the pieces of land that were once part of the *waqf* endowment, have been allowed to be alienated and are currently occupied by the houses mentioned above. These houses and the other Auqaf owned properties that abut the mosque buildings with or without Auqaf authorization raise the following issues:

- As a result of the properties abutting the mosque perimeter, there is a lack of access to the outer perimeter of the mosque building from the southern side, preventing any maintenance or conservation activity;
- The absence of any proper disposal of rain water from the roof of the mosque structures on the southern side;
- Consequent water penetration into (i) the fabric of the mosque; (ii) the fabric of these houses themselves; and (iii) the foundation structures of the mosque;
- The structural conditions of the mosque, the conditions of the building fabric of the mosque and the conditions of its use and the urban setting of the mosque are all regrettably affected. The manner in which *waqf* properties have been allowed to be used as private or semi-private premises appears to be a major issue to be dealt with in the conservation of the mosque. The present condition of occupation and use of *waqf* properties affect the functioning of the city in the immediate environs of the mosque, thereby affecting its setting, presentability, maintenance and upkeep.

6.5 PUBLIC UTILITIES SERVING THE MOSQUE COMPLEX

Public utilities have been constructed on the southern side of the mosque, presumably to save the interior of the complex from the wear and tear of public use. The washrooms and latrines, used by the public as well as by officials of the Auqaf department, are poorly planned, of low quality and badly maintained. Large amounts of water leaking from these facilities is causing structural damage to the mosque and water ingress into the foundations of the monument has caused serious harm to it. These facilities exist in two locations - the first on the northern side of House H-650 where a small open passage services 4 latrine stalls. Of these only one is functional while the remaining three are abandoned and/or locked up, evidently due to prolonged blockages. Large PVC water reservoirs are perched unceremoniously on the roof of the concrete latrine structure. There is constant and profuse leaking of water from these tanks, all in all creating a wet environment. The second facility, mainly used by the officials of the Auqaf Department, has been built into the body of houses H-654 and H-655. There are a total of four latrines in here as well. There is leakage of water from a concrete overhead reservoir here, with considerable seepage of water into the fabric of both these houses. In this location the faucets and other plumbing fixtures also leak constantly. Both these facilities generally suffer from poor maintenance and repair.

Above: View of the southern residential neighbourhood from the roof of the Calligraphers' Bazaar. Housing quality is poor, and solid waste management is minimal. The 3-storeyed building to the right of the photograph is built on the footprint of the original Persian well which supplied water to the mosque through the southern pavilion.

Opposite: View of the entire south side of the mosque. Water tanks are visible on the eastern side of the pavilion, while the houses on the western side of the pavilion are abutting the southern wall and to some extent are encroaching upon the roof of the hujras.

7 INFRASTRUCTURE CONDITIONS AROUND AND WITHIN THE MOSQUE COMPLEX

At the neighbourhood level the condition of the infrastructure has been a perennial cause of damage to the fabric of the mosque complex. Construction of houses on the open spaces on the south side of the mosque complex (as discussed above) has put additional pressure on the ill maintained infrastructure of water and sanitation. The raising of the original street-levels due to the accumulation of historical detritus or due to deliberate interventions has made it impossible for smooth drainage of storm water from the streets and from the courtyard of the mosque through the original points of water egress. Periodic settlements of the floor of the courtyard at several locations are indicative of the huge problem of water ingress into the foundations and sub-strata of the mosque.

7.1 ELECTRICITY

In all likelihood electricity was introduced to the mosque complex along with the electrification of the Walled City as a whole. Until the late sixties domestic service in many residences in Lahore still used direct current (DC) supply. Photographic evidence from the repair work carried out in the 1970's suggests that modern alternating current was introduced earlier than that decade. The manner of introduction of electricity was not always sympathetic to the fabric of the mosque or to the surface decorations, and appears to be characterized by *ad hoc* workmanship and arbitrary detailing.

Presently electricity to the Wazir Khan Mosque is delivered from the 132 KV Mochi Gate grid station through the Delhi Gate 11 KV feeder. A 200 KVA transformer at Chowk Kotwali and one of 100 KVA rating in Chowk Wazir Khan step down the supply and power is delivered to two energy meters installed on the north façade of the north-western *minar* of the mosque, near Chowk Kotwali. The conditions of the connected loads vary seasonally. In the winter the loads are in the range of 6 kilowatts, but in the summer they rise to a total of about 13 kw. The connected load spikes up by a factor of 5 on ceremonial and festive occasions such as Eid-e-Milad un Nabi.

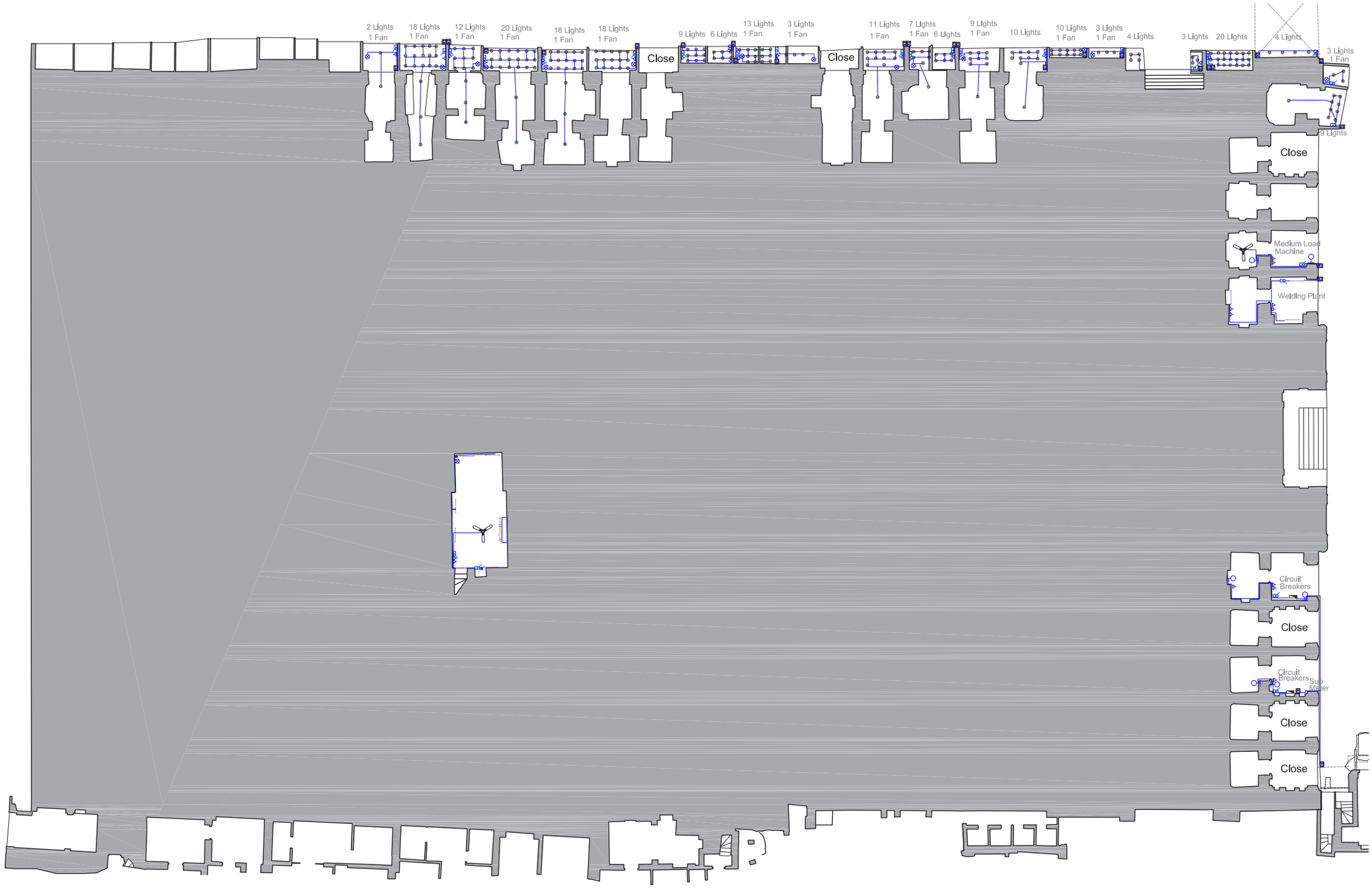
The electricity distribution system in the mosque is inadequate, to say the least. It has been installed by chasing grooves for the conduiting, and hacking away spaces in the historic walls in a quite arbitrary fashion for the installation of distribution boards, socket boxes etc. In all cases cement mortars have been used to fill in the grooves and gaps after such installation. One of the two distribution boards, each installed in the *hujra* adjacent to the north-west and south-west *minar*, is inactive. Both distribution boards are without covers, and have inadequate numbers and capacity of circuit breakers. The distribution circuitry is inadequate and has been introduced from time to time on an *ad hoc* basis. The scores of socket outlets are unprotected against water ingress and are a grave threat to the safety of the *namazis* and small children.

This is not a satisfactory state of affairs and the electrification system for the mosque has to be redesigned *ab-initio* in order to bring it into a state in which it can co-exist harmoniously with the historic monument as well as satisfy international engineering standards and safety codes.

Right, top: Electricity distribution board located in the western-most hujra *on the northern row.*

Right: A poor attempt at camouflaging sockets in the prayer chamber at the southern end. The plastic has been painted over with a continuation of the fresco design during recent restoration/repainting work, yet black cabling is left loose and unconcealed in front.

Opposite: Spot light fixed on the roof of the southern row of hujras*, with little concern for safety or concealment of wires.*



LEGEND					
S.no.	Symbols	Description	S.no.	Symbols	Description
1.		Energy Meter	9.		Electric Point
2.		Distribution Board	10.		Switch Board
3.		Chandelier (Damaged)	11.		4 Small Speakers
4.		Hanging Energy Saver	12.		Loud Speaker
5.		Spot Light (Not Functional)	13.		Bracket Fan
6.		Spot Light	14.		Exhaust Fan
7.		Small Spot Lights (temporary)	15.		Wall Mounted Light bulb
8.		Power Sockets (2 Pin Local)	16.		Loud Speaker

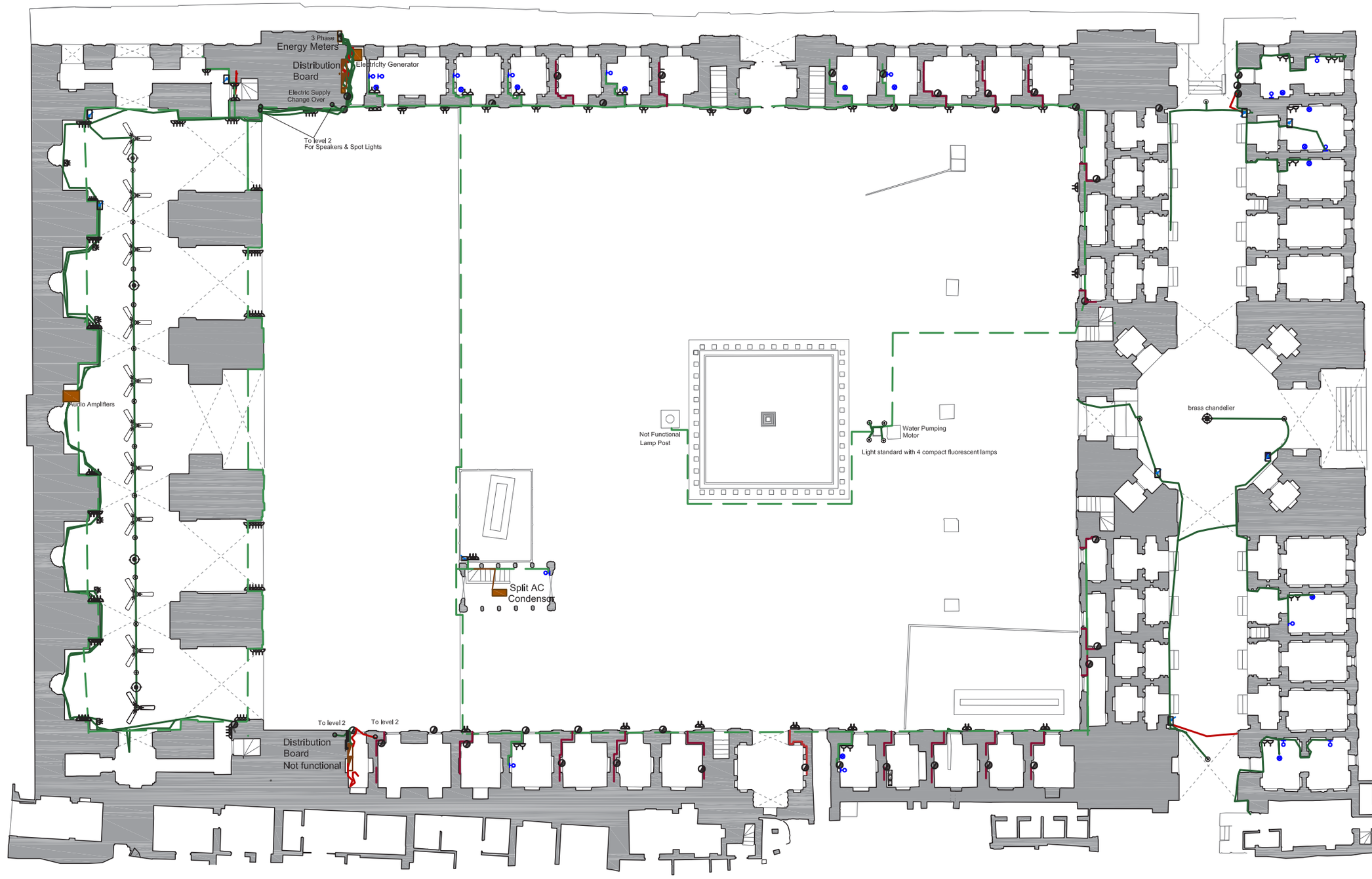
Power Cable Open (Functional)
Power Cable Open (Not functional)
Power Cable in Conduit (Functional)
Power Cable in Conduit (Not functional)

Note:

1. There are dangerous open connections of live wires
2. Insulation of electrical wires are damaged at a number of places
3. High risk for short circuiting & fire
4. No water proofing of electrical installations located in the open
5. Most of the sockets are damaged

EXISTING ELECTRIFICATION (LEVEL 0)

0 2 6 12m



LEGEND					
S.no.	Symbols	Description	S.no.	Symbols	Description
1.		Energy Meter	9.		Electric Point
2.		Distribution Board	10.		Switch Board
3.		Chandelier (Damaged)	11.		4 Small Speakers
4.		Hanging Energy Saver	12.		Loud Speaker
5.		Spot Light (Not Functional)	13.		Bracket Fan
6.		Spot Light	14.		Exhaust Fan
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Note:

1. There are dangerous open connections of live wires
2. Insulation of electrical wires are damaged at a number of places
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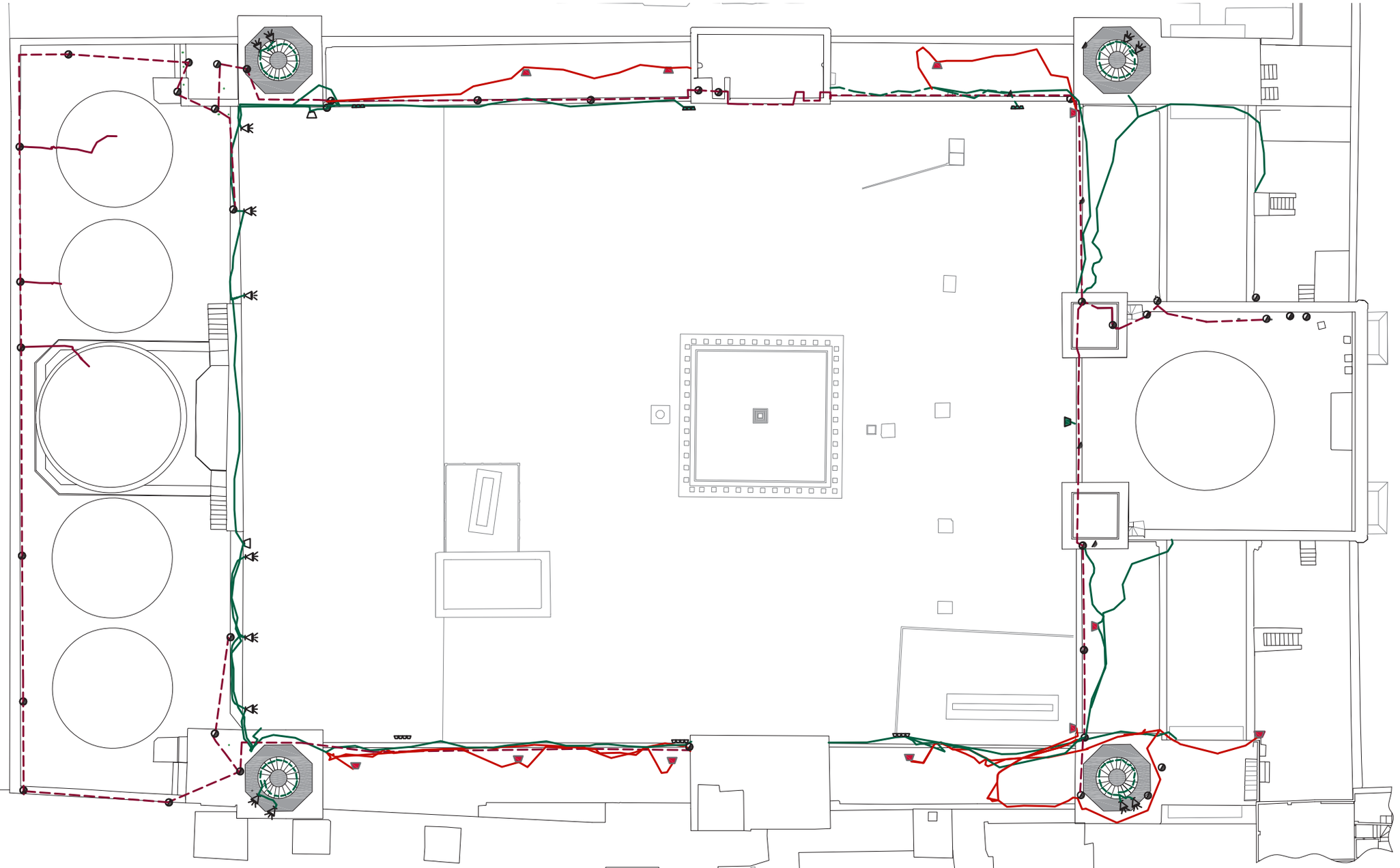
4. No water proofing of electrical installations located in the open
5. Most of the sockets are damaged

EXISTING ELECTRIFICATION (LEVEL 1)

0 2 6 12m



LEGEND					
S.no.	Symbols	Description	S.no.	Symbols	Description
1.		Energy Meter	9.		Electric Point
2.		Distribution Board	10.		Switch Board
3.		Chandelier (Damaged)	11.		4 Small Speakers
4.		Hanging Energy Saver	12.		Loud Speaker
5.		Spot Light (Not Functional)	13.		Bracket Fan
6.		Spot Light	14.		Exhaust Fan
7.		Small Spot Lights (temporary)	15.		Wall Mounted Light bulb
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Power Cable Open (Functional)
Power Cable Open (Not functional)
Power Cable in Conduit (Functional)
Power Cable in Conduit (Not functional)

Note:

1. There are dangerous open connections of live wires
2. Insulation of electrical wires are damaged at a number of places
3. High risk for short circuiting & fire
4. No water proofing of electrical installations located in the open
5. Most of the sockets are damaged

EXISTING ELECTRIFICATION (LEVEL 3)

0 2 6 12m

The hujra *in the south-eastern corner of the mosque containing the water pump, water cooler and geyser.*

LEGEND		
S.no.	Symbols	Description
1.		Point
2.		Gas Pipe 19mm Ø
3.		Water Heater
4.		Main Inlet
5.		Gas Meter

GAS SERVICES (LEVEL 1)

0 2 6 12m

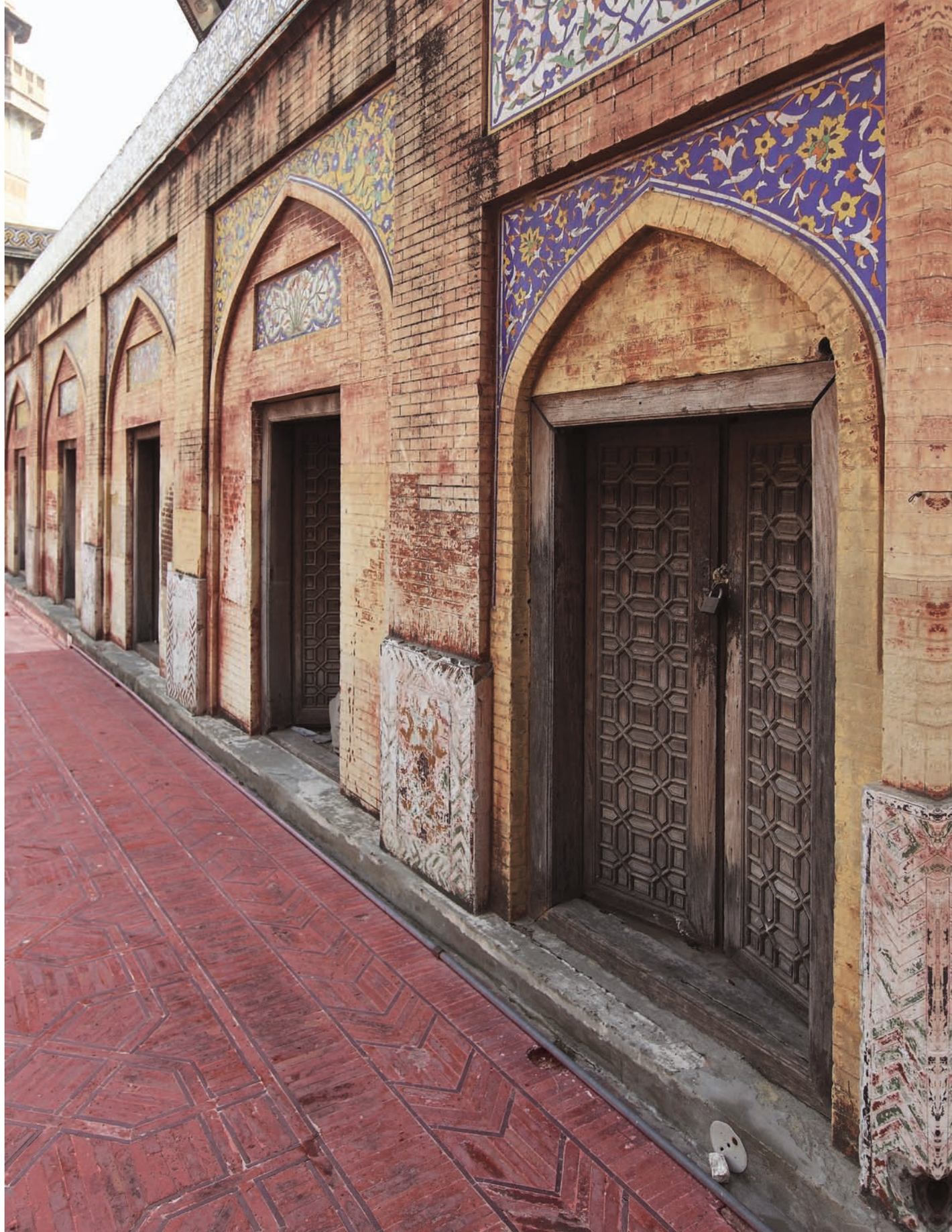
7.2 GAS

The mosque is supplied with natural gas, mainly for purposes of heating the prayer chamber during the winter months. The gas supply taps into the gas mains on the southern side of the mosque. The 19mm diameter gas supply pipe enters the courtyard at the southern wall of the third *hujra* from the east on the southern row of *hujras*, and then runs horizontally westwards, attached to the base of the buildings (the southern *hujras* and the axial pavilion) which constitute the southern side of the courtyard. The pipe enters the prayer chamber at its southern most limit.

A total of fourteen gas points have been recorded within the limits of the mosque. Of these, twelve gas points are used for gas heaters. These are functional in winters. For each of the five bays of the prayer chambers, there are two gas points serving direct fire radiant heaters. The remaining two are intended for heaters in the western most *hujra* on the northern row of *hujras* and the third *hujra* from the east on the southern row of *hujras*.

Of the remaining two gas points, one is intended for the water heater, which is located in the third *hujra* from the south-east side of courtyard, while the other gas point is used for a power generator capable of being operated by natural gas as well as on petrol which is located inside the first *hujra* from the north-west side of courtyard. The natural gas system as described above is connected to a gas meter mounted on the wall of the latrines located on the south side of the mosque complex.

The natural gas bills are paid by the Mosque Management Committee from its own funds and from donations from the local community.



Gas pipe running along the southern row of hujras*, supplying the prayer chamber.*

7.3 WATER

Water supply into the ablution pond in the courtyard was supplied originally from an ox driven Persian well on the south side of the mosque. Fragments of a raised platform abutting the exterior wall of the central pavilion in the southern *hujra* series are still visible. Water was led from the well to this raised platform which forms part of a delivery channel system ending in the cascade inside the central pavilion and into the ablution pond via a channel in the floor of the courtyard.

Electric motors (documented in the 1970's) appear to have replaced the animal driven Persian wheels during British times.[28] At some time this use of the well was discontinued, and a residential building using the structure of the well for foundations was built. Water supply is currently connected to the pressurized water supply grid of the Walled City. There are no tube wells installed specifically for the mosque.

Water supply to the public toilets and ablution areas located in the south of the mosque is ill-designed and appears not to be effectively managed and supervised. The need for overhead reservoirs (present in the case of both sets of latrines) is indicative of the poor pressure obtaining in the municipal water supply system, which could be alleviated as part of the new water supply programme for the city. Leaking water tanks and leaking faucets, valves and joints are endemic.

There is an urgent need for the design and realization of a modern and efficient toilet and ablution facility for the mosque. The design of this facility, its location, means of access and control, and its surveillance, supervision and maintenance should be thought of integrally with the overall strategic planning and design for the conservation of the mosque.

The ablution tank in the centre of the main courtyard was rebuilt to a modified design not conforming to the original. This should be restored to its original design for which there is ample photographic evidence. However, the water supply and drainage system of this ablution pond needs to be thought of integrally with the larger infrastructure design, and as part of the conservation and restoration of the courtyard as a whole.

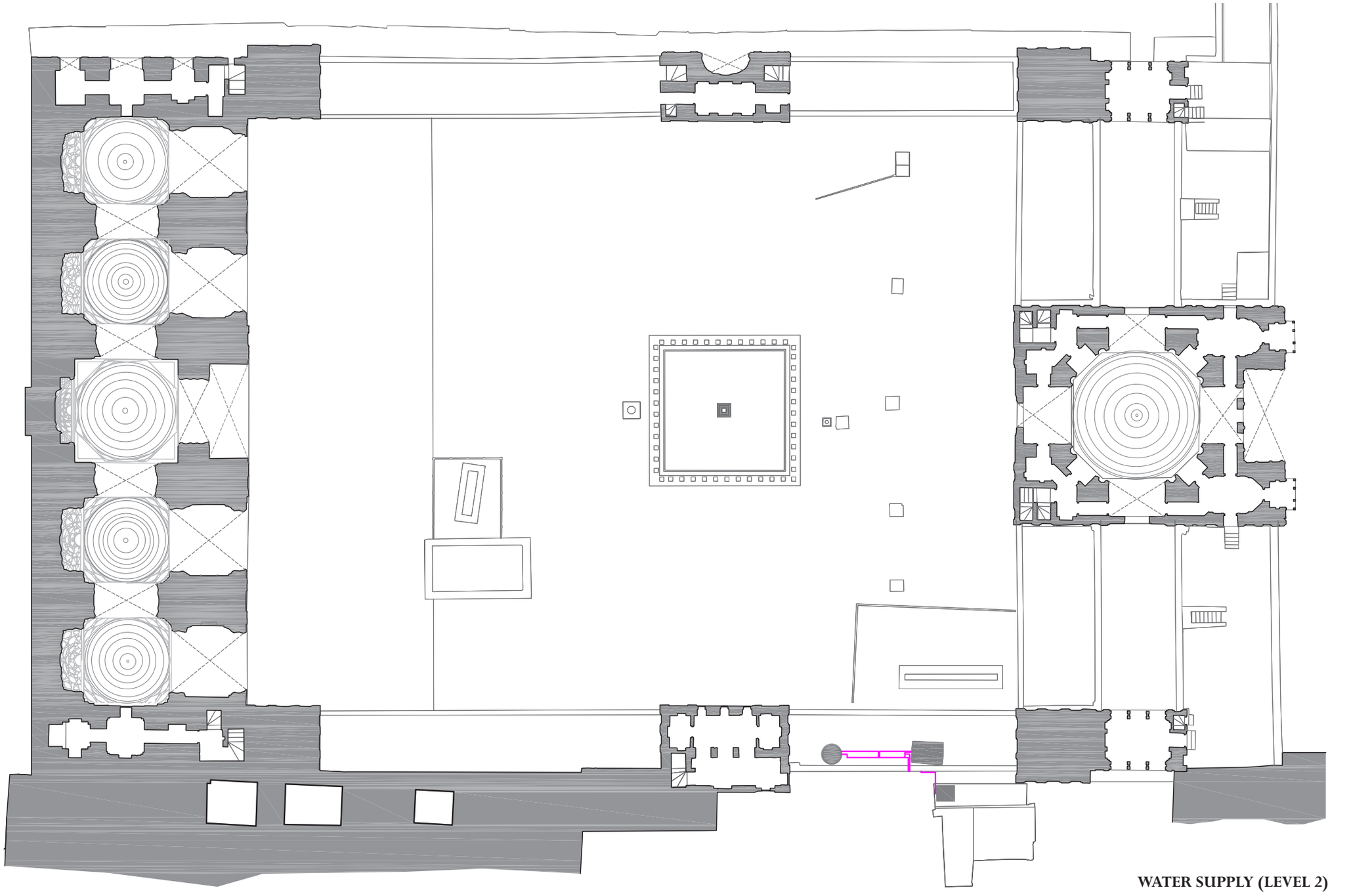
Above: Water supply pump positioned on the east side of the ablution pool - one of the first things visitors are confronted with on entering the courtyard from the entrance.

Opposite: Subsidence and inspection chamber lids in the south-east corner of the courtyard.

LEGEND		
S.no.	Symbol	Description
1.		Tap
2.		Valve
3.		Pipe Line
4.		Water Pump
5.		Water Heater

WATER SUPPLY (LEVEL 1)

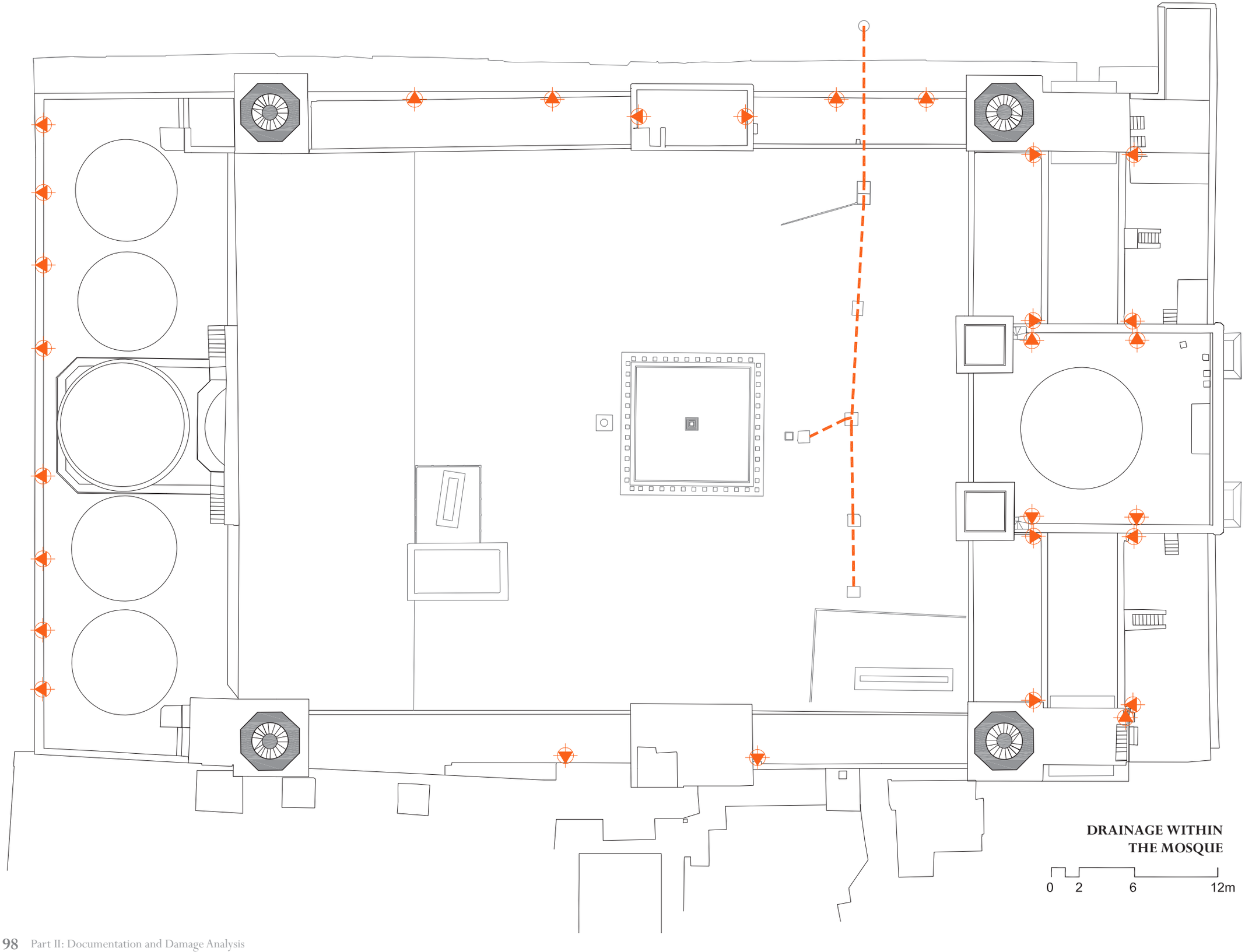
0 2 6 12m



WATER SUPPLY (LEVEL 2)

0 2 6 12m

LEGEND		
S.no	Symbols	Description
1.		Water Pipe Line
2.		Water Reservoir in P.V.C
3.		Reservoir in concrete


DRAINAGE WITHIN
THE MOSQUE
0 2 6 12m

7.4 DRAINAGE

a. The open drain running along the northern perimeter of the mosque was closed down in the late 1980's, and the rain water now collects in the street and finds its way into the new sewer that was laid in the main bazaar. The decommissioning and filling up of the open drain has been occasioned by, as well as led to the consolidation and construction of *pucca* extensions of the shops, whereas previously these had been temporary constructions, their *tharas* projecting out on to the street.

b. The open drain on the western side of the bazaar lane to the west of the mosque now flows into the main sewer running along Kotwali Bazaar and into Chowk Wazir Khan. Water in this open drain is slow moving with a tendency to dam up with floating solid waste. It is uncertain[29] whether there is any sub-surface percolation of the water under the street and whether such percolation could be affecting the foundation bearing strata of the soil on the western side of the monument. Most roofs drain out to rooftop rainwater receptacles which are led out into flat drains built in plaster render on the external face of walls. These in turn drain into the ground abutting the building façade. It is not known whether a system of collecting rainwater from these flat drains existed at the plane of the ground surrounding the mosque. Archaeological investigations of the original ground might reveal such a system if it ever existed.

c. There are crucial locations where rainwater collecting on the roofs is not properly expelled from the roofs. At one location it appears to simply disappear into the fabric of a house abutting the mosque structure on the southern flank, and seems to find its way into the substructure below the house. The possibility of this water seriously affecting the foundation structure of both the house and the mosque cannot be ruled out.

d. Storm water collecting on the galleries of the *minars* does not have any proper way of discharge, and flows along the tile surface of the octagonal façades of the *minars*.

e. Courtyard: the rainwater which falls into the courtyard is drained away by a series of gratings built along a sub-floor drain that exists at the beginning of the eastern fifth of the courtyard space. This drain flows northwards and finds its way into a discharge chute that exists in a shop/ *hujra* corresponding to the third *hujra* from the east on the northern (south facing) façade of the courtyard. There is evidence that a drain existed in the lower part of this *hujra*, at the level of the bazaar that linked the flow of the collected rainwater to the main drain that flowed along the northern flank of the mosque. This drain is now connected to the main sewer built in the 1970's that flows eastward down the centre of the Kotwali Bazaar.

f. It is reported[30] that originally, the north-south drain in the eastern part of the courtyard was divided into two drains each flowing either northwards or southwards, thus dividing the rainwater collected into two halves. However, the southern drain was disconnected when the level of street system on the south[31] was raised due to the construction of residential properties on that side.

g. According to the information board displayed at the entrance to the mosque,[32] the drainage of the courtyard of the Chowk was historically made possible by *gharqis* (soak-wells).

h. Drainage and waste water disposal from the ablution pond in the main courtyard is connected to the storm water disposal system of the courtyard described in the paragraphs above.

i. Drainage and waste water disposal of the public toilets located in the south of the mosque are linked to the disposal system of the residential neighbourhood in that location.

Top: Drainage grate at the level of the courtyard.

Above: Cover is lifted to expose drain and water supply pipes.

8 PROBLEMS AND ISSUES PERTAINING TO THE MOSQUE COMPLEX

8.1 HISTORY OF DAMAGES AND REPAIRS

Most of the Mughal monuments in Lahore were brutally vandalized under the Sikh and British rules.[33] The most precious elements from these monuments were deliberately removed and reused in private and public buildings. A majority of monuments were converted into very *ad hoc* functions like storage, ammunition depots, stables and residences. Badshahi Mosque and Maryam Zamani Mosque are examples of this, with the former used as an ammunition depot. Fortunately, and apparently due to a particular event during the rule of Ranjit Singh,[34] the Wazir Khan Mosque survived the vandalism of those years.[35]

Due to the lack of documentation and unavailability of many people associated with past restoration efforts, it has been difficult to establish a complete and thorough chronology of building damages and repairs. The available information on the damage history here is based primarily on oral accounts and the research carried out on published literature. According to M. Abdullah Chaghatai, the 1905 earthquake significantly damaged the mosque's structure. Although the extent of damage is not clear, he states that the cupola structures of the *minars* were rebuilt by replacing the collapsed brick masonry columns with red sandstone columns.[36] In the absence of any available documentation of the damage caused by that earthquake, one might associate the first cracks and tilting with this specific earthquake.

In 1971 a conservation cell was established under the provincial Auqaf Department[37] in order to carry out the restoration of five monuments[38] in the Punjab, financed by the Cess Fund[39] for the restoration of major monuments in the province. The Wazir Khan Mosque was one of the monuments included for repair and restoration activities by this conservation cell led by Muhammad Wali Ullah Khan. This cycle of conservation work ended in 1978 due to a shortage of funds. The work carried out included the conservation of the main façade overlooking the Chowk, selective conservation of surfaces and tile revetments in the courtyard, and the "restoration" of surface renders and decorations in the prayer chamber. The surface decorations on the *minars* and the north façade were not included. During this restoration phase the as-found condition of the building, especially the surface decorations, were documented photographically. Some of these photographs were found in a deteriorated state during the current documentation process in one of the *hujras* on the northern side of the mosque which used to be the site office during the 1978 restoration.

In 1979 additional funding from the Auqaf Department enabled the conservation cell to carry out some more restoration work on the remaining sections of the mosque, but no further work was done on the *minars*. However, in 1984-85 the restoration of the surface finishes of the north-east *minar* was carried out. Observation of this *minar* indicates that fragments of old *kashikari* were incorporated with the new materials during the restoration in an elegant manner. Not so visible when seen from the ground, on close inspection it appears that a consistent method was used to differentiate and interpret the values of the old fragments in relation to new work. Except for the intensive conservation of the surface area of the *minar* that was dedicated to *kashikari*, it is not known on what basis of evidence the *minar* was covered with *tazakari* work. In December 1987, the conservation cell of the Auqaf Department was converted into the provincial Archaeology Directorate under the Information and Culture Department. This was the period when the main drain of the mosque running northwards in the eastern section of the courtyard and descending into one of the shops at the street-level in the north bazaar, was blocked by a tenant in the shop and the consequent water seepage into the foundations and floors resulted in the subsidence of the north-east portion of the floor of the courtyard. The impact of this water percolation was extensive and appears also to have resulted in the subsidence of a portion of the north-west side of the courtyard. The restoration efforts in the late 1980's and early 1990's primarily focused on repairing the floor of the courtyard damaged due to heavy penetration of water as a result of this blockage.

Above: Subsidence and floor repair in the north-west corner of the courtyard has created different levels with badly finished edges.

Opposite: The north-eastern minar *and portion of the entrance* iwan*, as seen from the* hujra *roofs on the south side of the courtyard.*

The restoration and repair efforts in the 1990's and 2000's were more focused on the entrance portal and the calligraphers'/book binders' bazaar. Initially, the floor of the Calligraphers' Bazaar was repaired in 1994-95 and since then two efforts have been made to restore the northern and southern sections of the bazaar. In 2003 a grant from the American Embassy enabled the department to restore the north section of the Calligraphers' Bazaar. The south section of the bazaar was restored later in 2005-06. Lack of a comprehensive problem analysis, inadequate attention to roof drainage issues and the possible use of inappropriate materials (such as marble powder and white cement) has contributed to pronounced efflorescence caused in the main by rain water percolation in the walls in the primarily *tazakari* work carried out with this funding.

The failure of past restoration efforts to address all issues related to the building structure, its surface decorations, the problems of drainage and issues pertaining to the neighbourhood context is evident in the manner in which these problems have grown over time. While there may be several reasons for this including organisational inadequacies and lack of technical know how, one would be amiss if the absence of a comprehensive, all encompassing survey and analysis is not pointed out as the most significant cause of this failure.

Presently, inadequate care and maintenance threatens this world class monument in a variety of ways. A preliminary review of the condition of the mosque leads to the conclusion that its physical fabric has been inadequately protected from the elements and has been subject to unavoidable natural threats, such as earthquakes, causing certain structural impacts. However, it also appears glaringly evident that the present damage in the mosque is caused significantly by man-made factors. The mosque has never been as exposed to the pressures of rapid development in its immediate surroundings as it is at present. These pressures range from the immediate and long term impacts of inappropriate activities and the building of unauthorized structures to contain them, to environmental factors like the pollution generated by vehicles in the cramped physical environment of the Walled City. Additionally, lack of sophistication in the appreciation of the heritage, of architectural scholarship, of adequate technical and interpretive skills in the care and maintenance of the monument and the regulation of its use, and the deliberate vandalism of the structure are also main contributors to the damage.

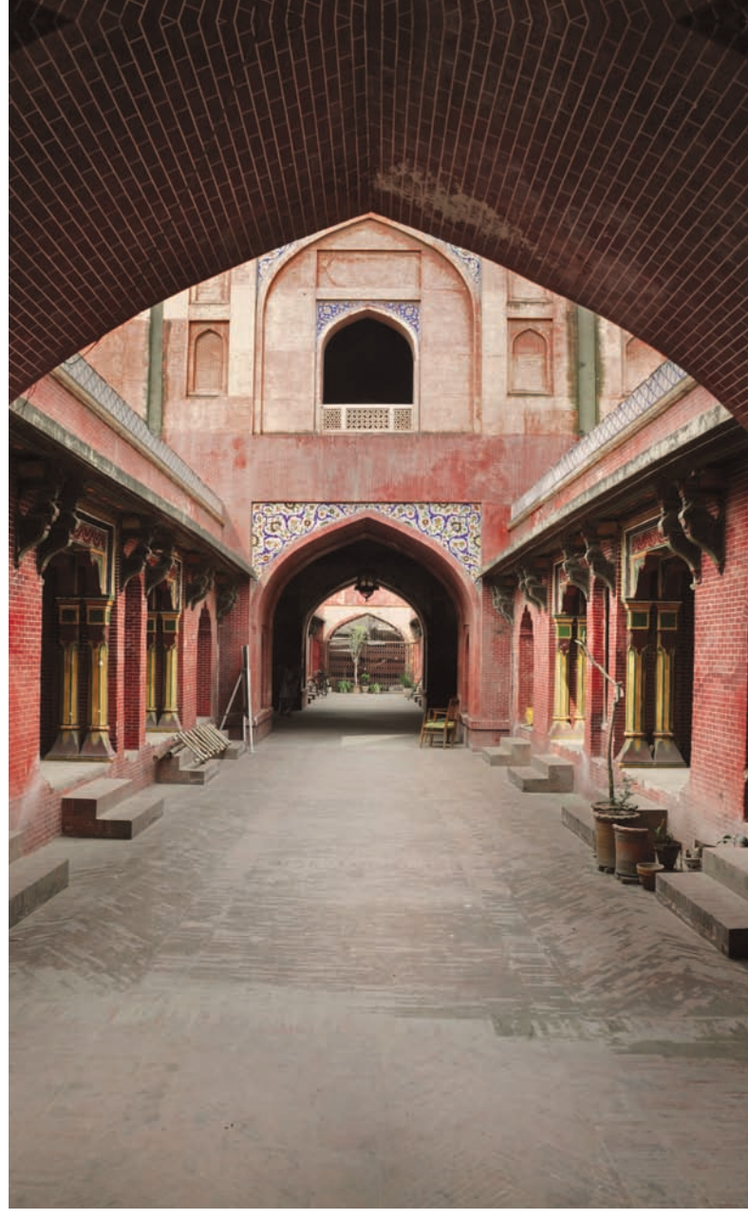
The absence of a professionally qualified team and lack of regular maintenance procedures greatly threaten the mosque complex with further deterioration. The non-permanent and periodic interventions in both the structure and the building fabric in the past have contributed little to safeguarding the architectural fabric of the mosque and to enhancing the appeal of its decorative craft techniques. The absence of a permanent mechanism for maintenance during these past efforts has significantly contributed to damages sustained by the mosque complex.

8.2 UNDESIRABLE USES

The inappropriate and undesirable uses to which certain parts of the mosque are currently being put fall into four distinct categories:

i. Undesirable uses of shops on the east façade at the street-level: these shops are currently rented out mainly to steel[40] fabricating businesses. This involves the conduct of fabrication operations on large pieces of steel - operations which involve cutting, hammering and welding. The handling and manipulation of long steel sections and bars on the mosque's eastern side is a major threat to the structure of the mosque. The fabrication of steel products in these shops not only destroys the overall ambience of the mosque's front and creates noise, pollution and occupation of the public square for production activity, as many of the steel products being made have unwieldy dimensions. The small shops which were not originally planned for such use have little capacity to accommodate the nature of the steel fabrication activity conducted in them and are thus vulnerable to structural and fabric damage by vibration and shock impact caused by the use and storage of heavy tools and steel products.

ii. Use (or lack of appropriate use) of the original shops in the northern façade: here the problem emanates chiefly from the fact that over the course of the centuries the street-level has risen (by less than 1 metre along the Kotwali Bazaar and up to 1.2 metres on the side of Chowk Wazir Khan) above the floor of the original (and historic) shop spaces. This



Above: The Calligraphers' Bazaar, which was the focus of much of the restoration works during the 1990's and 2000's.

Opposite: Metal work being undertaken outside the shops in the south-west corner of Wazir Khan Chowk - the southern-most 3 shops on the east facing façade of the Wazir Khan Mosque.

has resulted in new structures (that respond to the raised street-level) to be built on the face of the historic structure, relegating the original spaces intended to be used as shops instead to function as storage dumps or not to be used at all.

iii. Certain other shops at the street-level, as well as many historic *hujras* at the courtyard level are used as storage accommodation, and have been locked up for years. Some of this storage contains debris and junk building material from previous repair and maintenance operations. Still other *hujras* are locked up and/ or are in use by members of the mosque committee or their surrogates.

iv. Certain parts of the roof are used for processing hospital waste such as recycling plastics and other materials. This activity is conducted by janitorial staff associated with the Auqaf Department dispensary run in the Calligraphers' Bazaar.

In the mosque itself, a large number of rooms contain a lot of junk materials (discarded building material, junk items etc.) and therefore are never maintained for any productive use. (See Appendix A for documentation of the uses for which the different parts of the mosque are being put).

Far Right: The height of wall damage corresponds to the height of the pedestal fans being stored. In this instance, it is a small room on the southern side of the prayer chamber.

Right: Medical waste being stored on the roof of the Calligraphers' Bazaar.

Opposite: Use of hujras *on the southern side of the courtyard as storage space for the prayer mats which are laid out in the courtyard.*

Generally, the condition of the building fabric of the Wazir Khan Mosque is relatively more satisfactory as compared with most other monuments of the period under the care of the Auqaf. While this may be attributed to the greater intensity of public use, to the scrutiny and public surveillance that the mosque has always received, and the conservation operations carried out in the past, the credit for this also goes to the materials with which the mosque was constructed, which are consistent and coherent.[41] The thickness of the brick wall and the dimensions of the arcuated structural elements such as domes, vaults, arches and *muqarnas* elements, vary from small rooms to the domed spaces, depending on the span of the space. Most of the walls are covered with surface renders and decorations on the exterior and in the interior of the mosque prayer chamber. The only visible sections of the brick masonry are the west façade and the masonry on the *minars*.

The architectural and structural fabric of the superstructure of the mosque is threatened by several factors, most of them of human provenance. Of these the most important are:

- Poor roof drainage and the penetration of rain water into the historic architectural fabric. The drainage is affected primarily by lack of roof cleaning and ill considered interventions;
- Lack of maintenance;
- Poor and ill considered interventions for a variety of utilitarian needs, e.g., interventions for electrification; conduiting for electrification, intervention for running water, etc.

There is considerable and serious damage in almost all parts of the mosque owing to structural damage caused by seismic movement over a prolonged period of nearly four centuries, and by water ingress into the structural fabric. In the Calligraphers' Bazaar and the mosque courtyard, the damage is generally manifested as cracks, subsidence and leaning. In the prayer chamber on the western side of the mosque the cracks in the main arches adjacent to the two *minars* have a direct relationship with the leaning pattern of the *minars*. Although it is not confirmed when these cracks developed, their existence is noted on the record pertaining to major restoration activities carried out between 1971 and 1978. As a result of rising damp and water ingress, the most common type of damage to the roof and the walls is the erosion of surface lime plaster render.

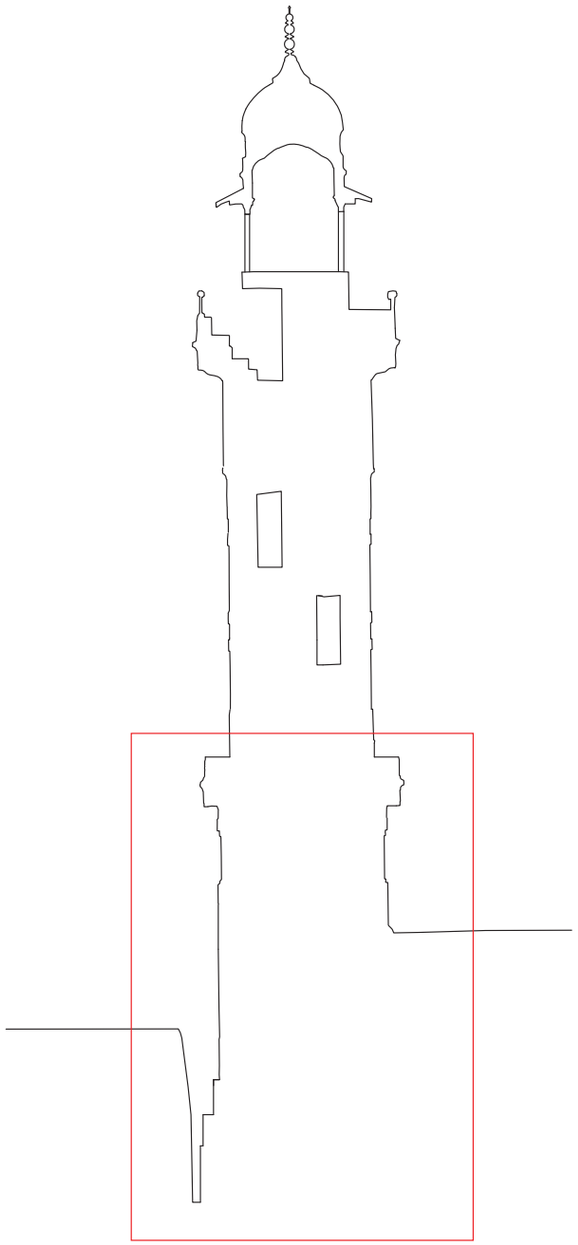
The repairs and "conservation" work carried out intermittently has withstood the test of time in some cases. The remainder of these interventions have unfortunately succumbed to the several causes of water related damage mentioned above, and to the use of inappropriate materials and methods, or a combination of both.

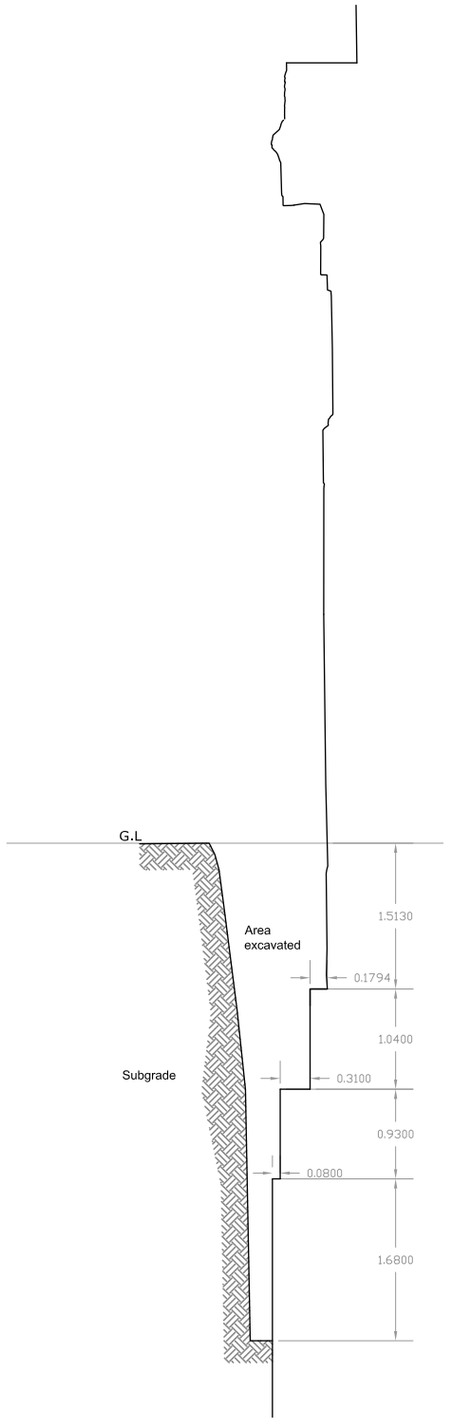
The major components of the building fabric such as the foundations, walls, roofs (flat and domed), floors, doors, windows etc. have various degrees of damage. Rising damp in the walls of shops at street-level (Level 0) and the *hujras* on Level 1 has damaged the surface lime plaster and has eroded the lime mortar constituting the masonry work in certain locations.

Considerable damage (mainly in the courtyard and the north and south wings containing the *hujras*) has occurred to the floors as a result of settlement caused by water ingress into the sub-grade structure and the superstructure, and as a result of interventions aimed at concealing service conduits in the floors.

The presence of toilets outside the south-eastern corner of the mosque has already contributed to damage to the courtyard floor and could further threaten the structure in the future. An old drain in this corner which used to remove the rain water from the courtyard is now blocked due to the rise in street-level outside, resulting in rain water accumulation in this corner. Excavations[42] carried out to investigate the foundations of the south-eastern *minar* revealed that at a depth of 3 metres (9.84 feet) there is a layer of earth 2.3 metres (7.54 feet) deep completely saturated with water, evidently from these sources. The main (mixed sewage and storm water) drainage line of the street runs on the south side at a distance of 8 metres (26.24 feet). The later addition of an *ad hoc* ablution space in the south-eastern corner of the courtyard itself appears to have further saturated the sub-grade under the floor of the courtyard, resulting in the periodic settlement of the courtyard floor. The latest settlement was observed in March, 2009.

Opposite: Looking west along Kotwali Bazaar, showing the shutters of the shops abutting the northern façade of the mosque.





SECTIONS SHOWING EXTENT OF EXCAVATION CARRIED OUT AT THE BASE OF THE SOUTH-EASTERN *MINAR* AS PART OF THE GEOPHYSICAL INVESTIGATIONS

9.1 ASSESSMENT OF STRUCTURAL BEHAVIOUR

9.1.1 GEOTECHNICAL INVESTIGATIONS

The investigations carried out by geophysical engineering contractors[43] appointed by AKTC-AKCSP addresses mainly the condition of the bearing strata in the cultural fill and natural soil formations. According to the geotechnical investigations, the causes of the structural cracks in the super structure could be attributed to the succession of earthquakes the mosque has experienced over its life. Additionally, it has provided important information in respect to the depth and width of the foundations in different locations of the mosque. The final report is attached to this document as Appendix C.

It appears from the geotechnical investigations that the sub-grade is actually "cultural fill" material that goes down to about 7 metres (22.96 feet) from the level of the courtyard of the mosque. Natural strata start beyond that and are stated to be good foundation soil. The foundations of the leaning *minars* are borne by the natural soil strata below the cultural fill, and therefore the *minars* have been thought to not be under any threat from subsidence owing to the poor bearing quality of the cultural fill. It may also be stated that at the level of the natural bearing strata, there is no presence of water percolation as a result of the poor drainage of the land area surrounding the monument. Water saturation was found at superficial levels in the cultural fill up to a depth of 2.3 metres (7.54 feet) around the south-eastern *minar*, but this does not affect the natural bearing strata, as the ground water table is now deep enough as not to affect the bearing qualities of the natural strata in significant ways.

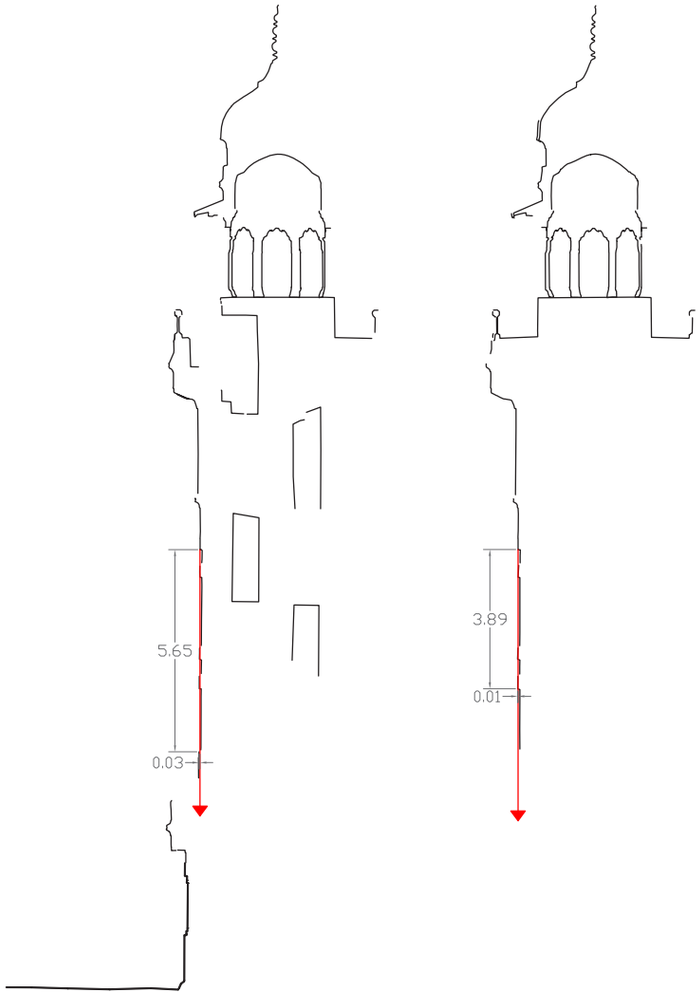
In order to ascertain the geometry of the foundation of the *minars*, a test pit and a drilling borehole were carried out. The test pit was excavated at the base of the southern wall of the south-eastern *minar* to a depth of 3.97 metres (13.02 feet) and an additional 1.68 metres (5.51 feet) with a manually operated auger. The total depth achieved with the combination of these two methods is 5.65 metres (18.53 feet), which is not the bottom of the foundation. Based on the stepped increments in the width of the foundation discovered during the excavation, the team suggested that the total width of the foundation in the bottom could be 9.05 metres (29.69 feet).

The bottom of the *minar* foundation was then explored by drilling a 10 metre (32.80 feet) deep angled borehole through the foundation masonry of the south-west *minar*. The depth of the foundation was determined to be 7.73 metres (25.36 feet) below the floor level of the courtyard, 0.73 metres (2.4 feet) below the depth of the cultural fill.

9.1.2 MEASUREMENT OF SUBSIDENCE AND DEFLECTION

The EDM survey provides us with an opportunity to accurately fix positions of the various parts of the monument relative to certain fixed "control" points established at the start of the survey. The accuracy of the method has helped establish the subsidence and deflections from the absolute horizontal and vertical parts of the monument. Using this method, thus, it has been possible to accurately document the tilt in the *minars*, the effects and relation of this tilting with major cracks in critical locations like the arches adjacent to the western *minars*, and the major deflection of the part of the building containing the *hujras* on the southern side of the courtyard. Using the documentation process as a monitoring mechanism has enabled the tracking of the rate of structural damage such as cracks and deflections more generally, and helped us in identifying the extent and nature of the periodic settlement of the brick floor in the south-eastern corner of the courtyard and its effect on the eastern *minars*.

In respect of the *minars*, it was decided to draw four sections of each side of each octagonal shaped *minar*. In order to find the relation between subsidence and deflection in the structure, the information gathered with this survey was analysed in reference to the results of the geotechnical investigation of the cultural fill and natural sub strata of the mosque.



Section 1 (looking West)

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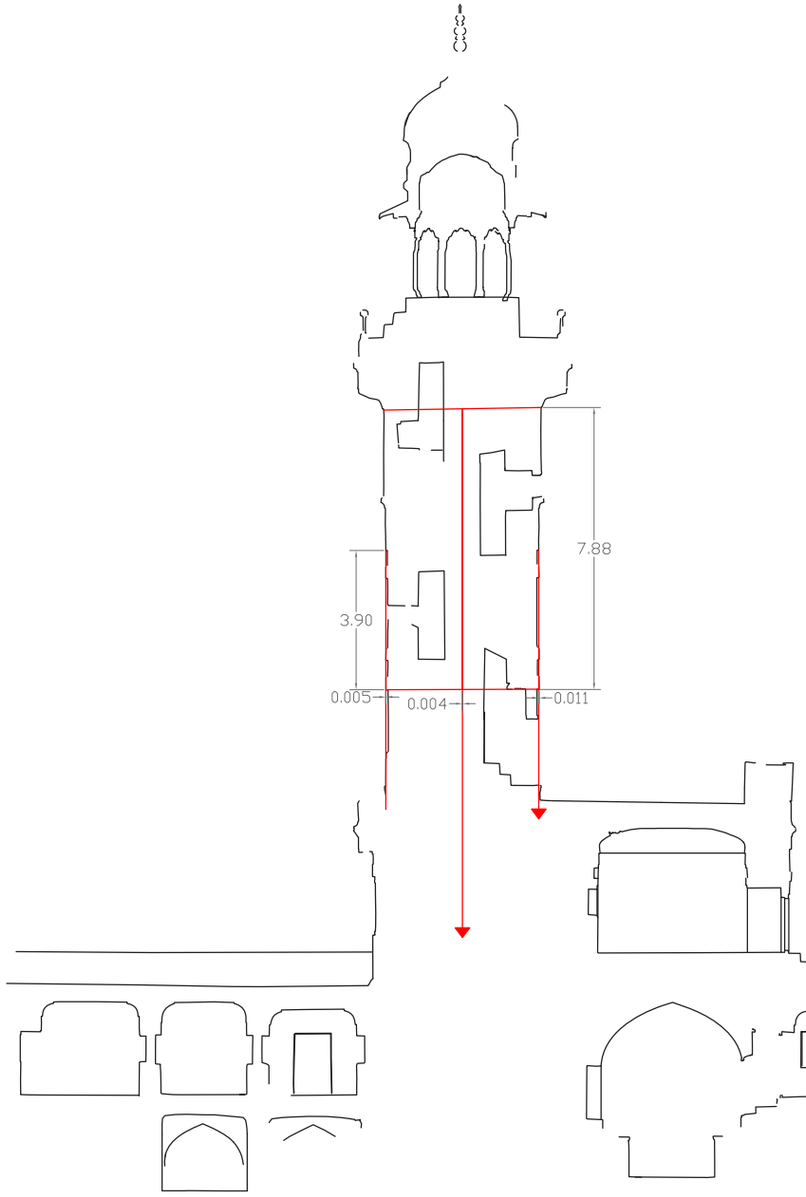
Section 2 (looking North-west)

0 1 2 4m



Section 3 (looking North)

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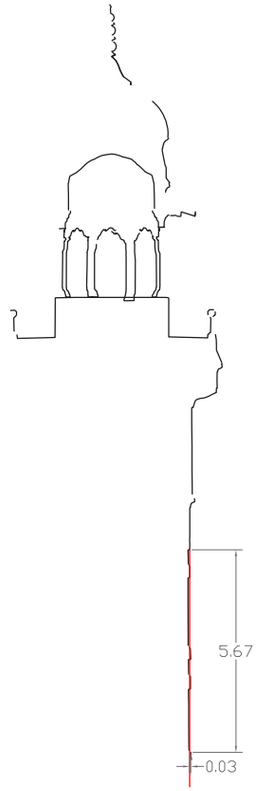

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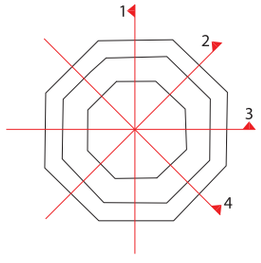
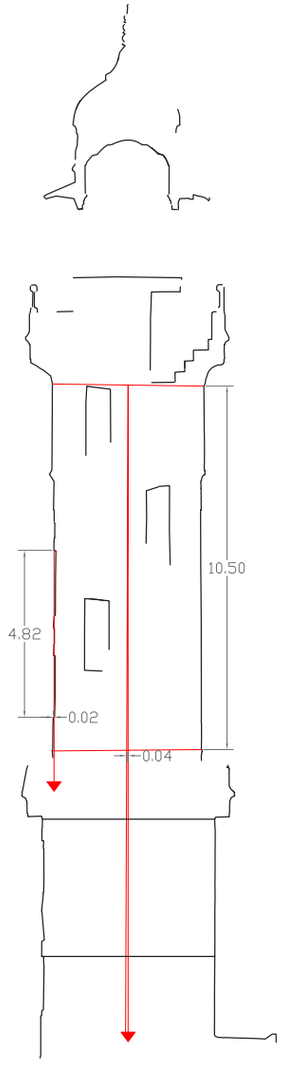


NORTH-EAST *MINAR*:
TILTING DOCUMENTATION



Section 1 (looking West)

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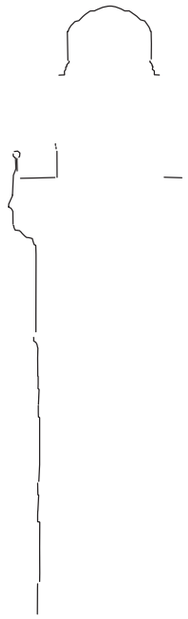

Section 2 (looking North - west)

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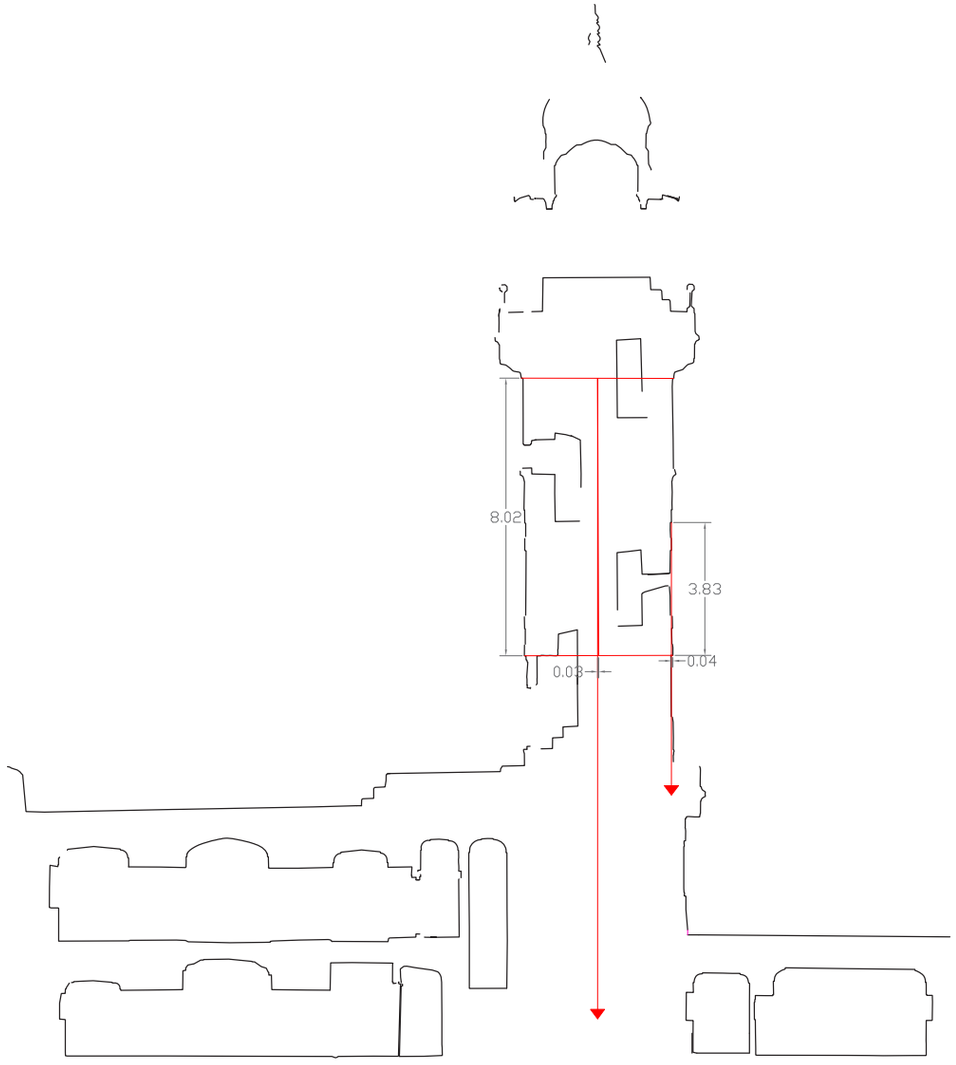

Section 3 (looking North)

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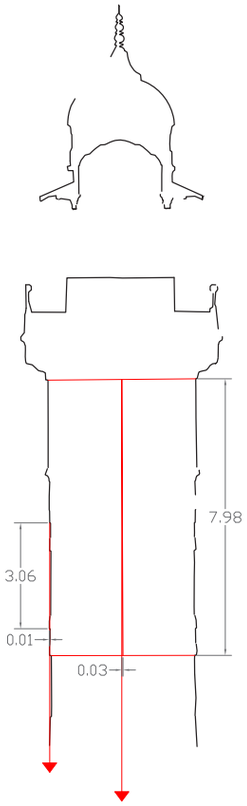

Section 4 (looking North - east)

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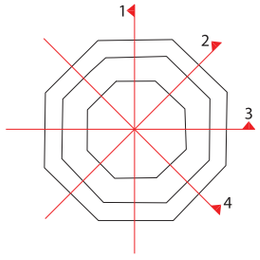
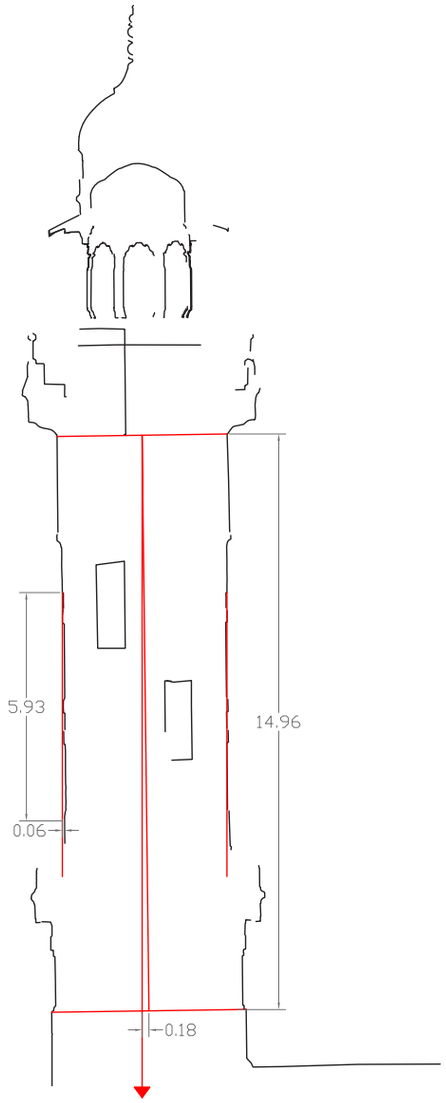


NORTH-WEST *MINAR*:
TILTING DOCUMENTATION



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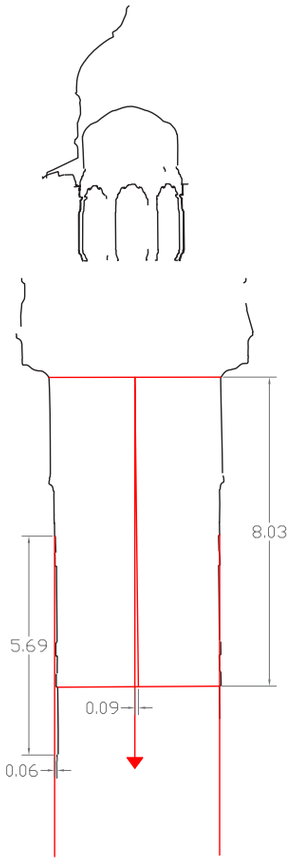

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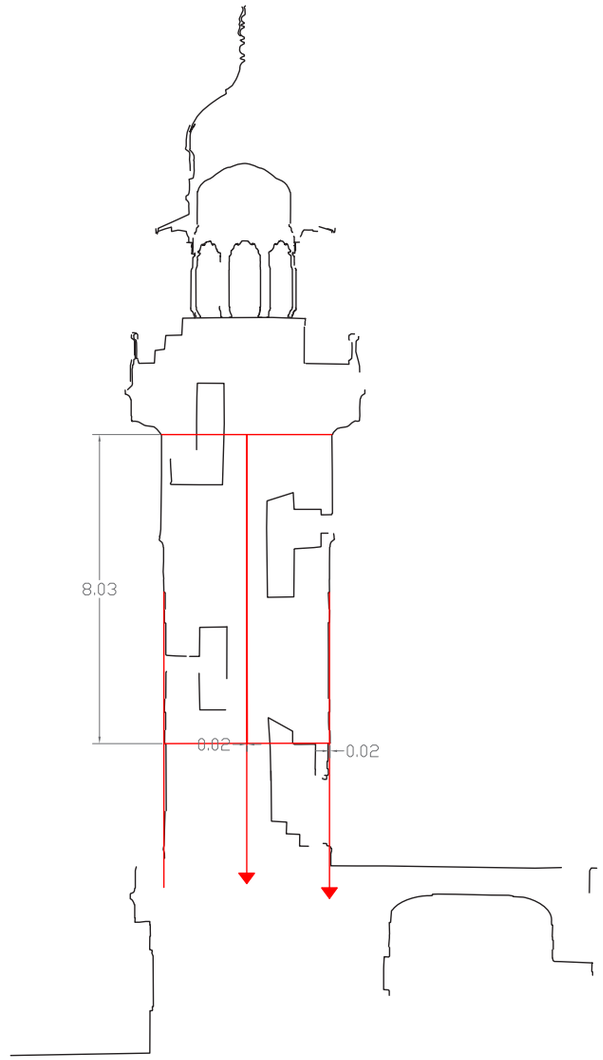

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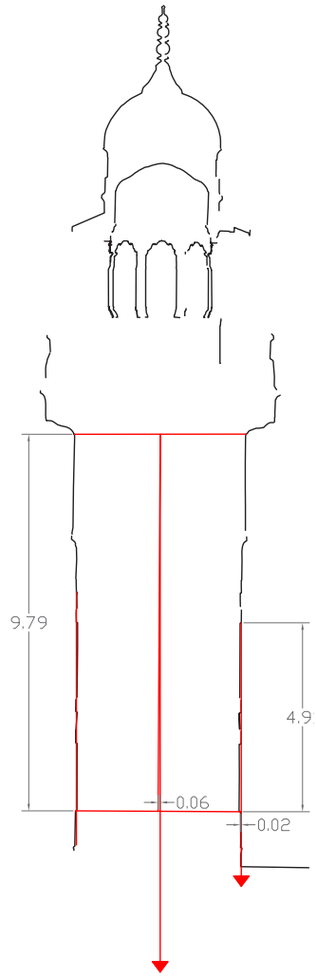

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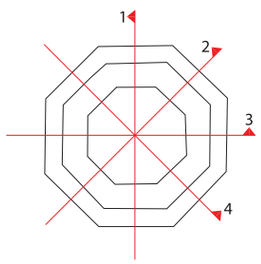
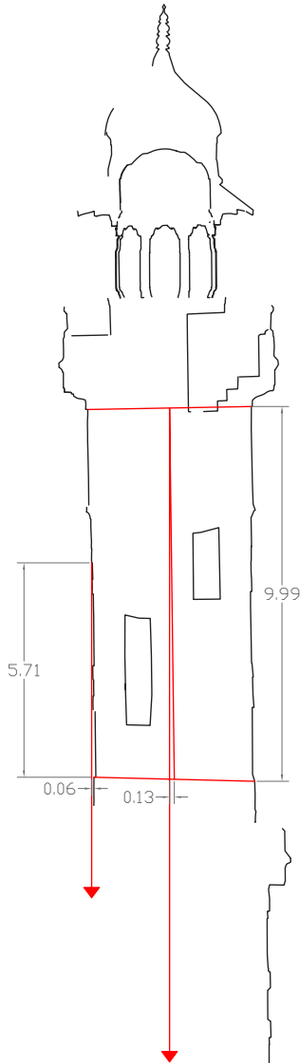


SOUTH-EAST *MINAR*:
TILTING DOCUMENTATION



Section 1 (looking West)

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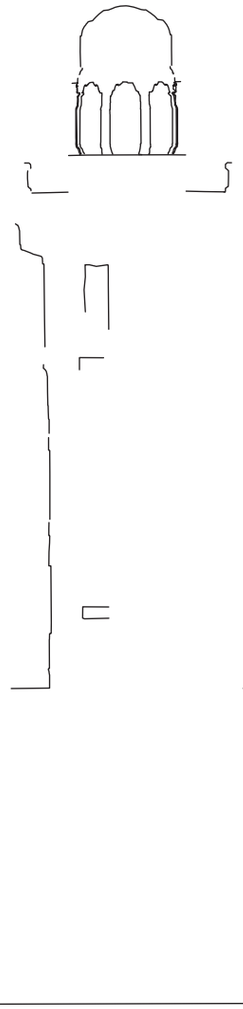

Section 2 (looking Northwest)

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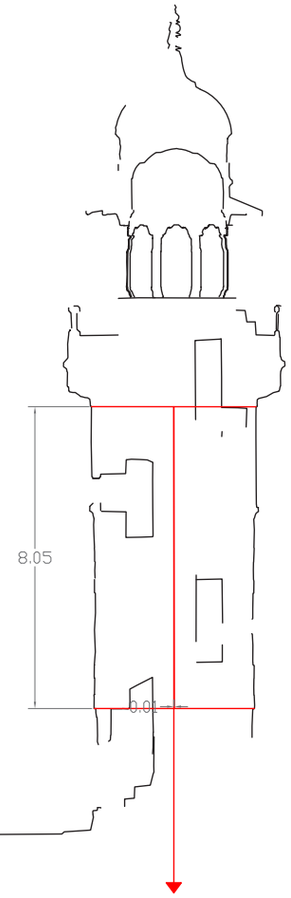

Section 3 (looking North)

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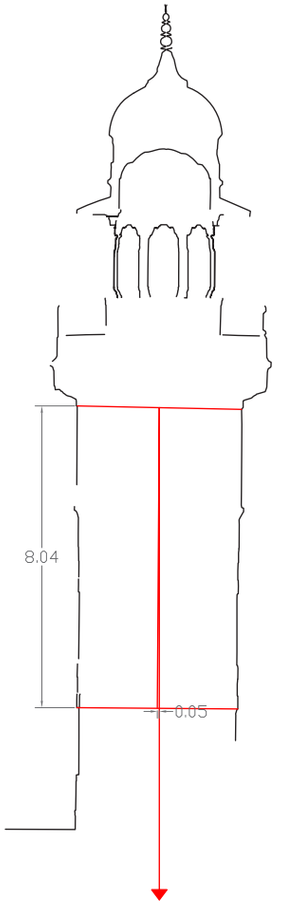

Section 4 (looking Northeast)

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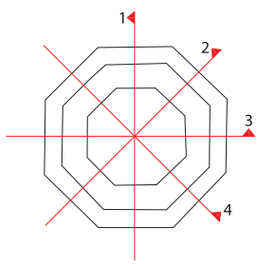
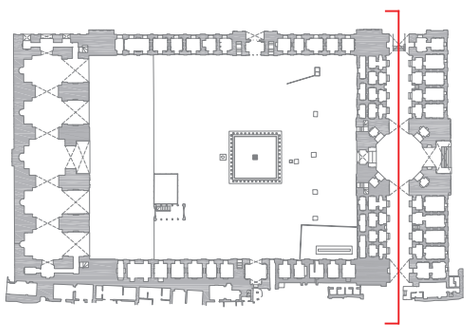


SOUTH-WEST *MINAR*:
TILTING DOCUMENTATION



CRACK DOCUMENTATION IN THE CALLIGRAPHERS' BAZAAR

9.1.3 MONITORING OF CRACKS

The existing cracks in the critical areas of the mosque have been identified and monitored periodically with the help of total station theodolite measurements and Vernier digital callipers. The outward leaning of the western *minars*, which were recorded precisely, has produced some major cracks in the apex of the northern and southern arches of the main chamber. Major cracks were identified in six locations in the prayer chamber of the mosque and each location was later equipped with a group of three stainless steel studs in a triangular formation. A detailed monitoring scheme has been set in place where the distance between each stud is recorded with the help of callipers and which can be periodically compared with recordings done at a later stage.

The roof of the pavilion at the centre of the southern array of *hujras* shows a large crack, probably due to the precarious condition of its southern wall.

9.2 STRUCTURAL THREATS

9.2.1 FOUNDATIONS

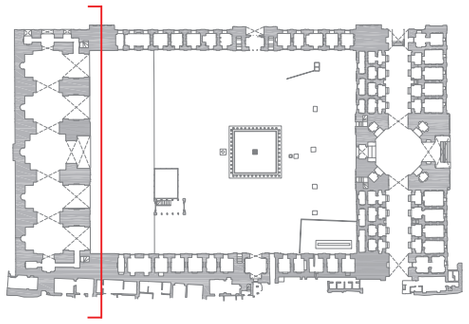
One of the key objectives of the geotechnical investigations described above, and in the Appendices in this report, was to ascertain the physical characteristics of the foundations, which has never been done before. Although the focus of these investigations has been on the foundations of the *minars*, the investigations have provided us with an overall sense of the nature of the foundations of the mosque complex. The geotechnical investigations revealed that the foundation of the mosque is resting well on stable and firm natural bearing strata and therefore the cracks in the super structure have causes other than foundation failure, causes which can be attributed to dynamic loads sustained by the monument. This investigation also revealed that the subsidence in different locations of the courtyard is closely related with the amount of water that has found its way into the cultural fill as a result of inadequate drainage in the mosque.

Before conservation work is seriously begun on the monument, it is necessary to undertake further investigations on the relatively less loaded parts of the mosque such as the structures enclosing the courtyard on the southern side to determine the depth of foundations and whether or not these are founded on the cultural fill. These investigations will bear on the steps to be taken to consolidate these structures, in conjunction with steps to be taken for the removal and control of the sources of water ingress, which is significant in these areas.

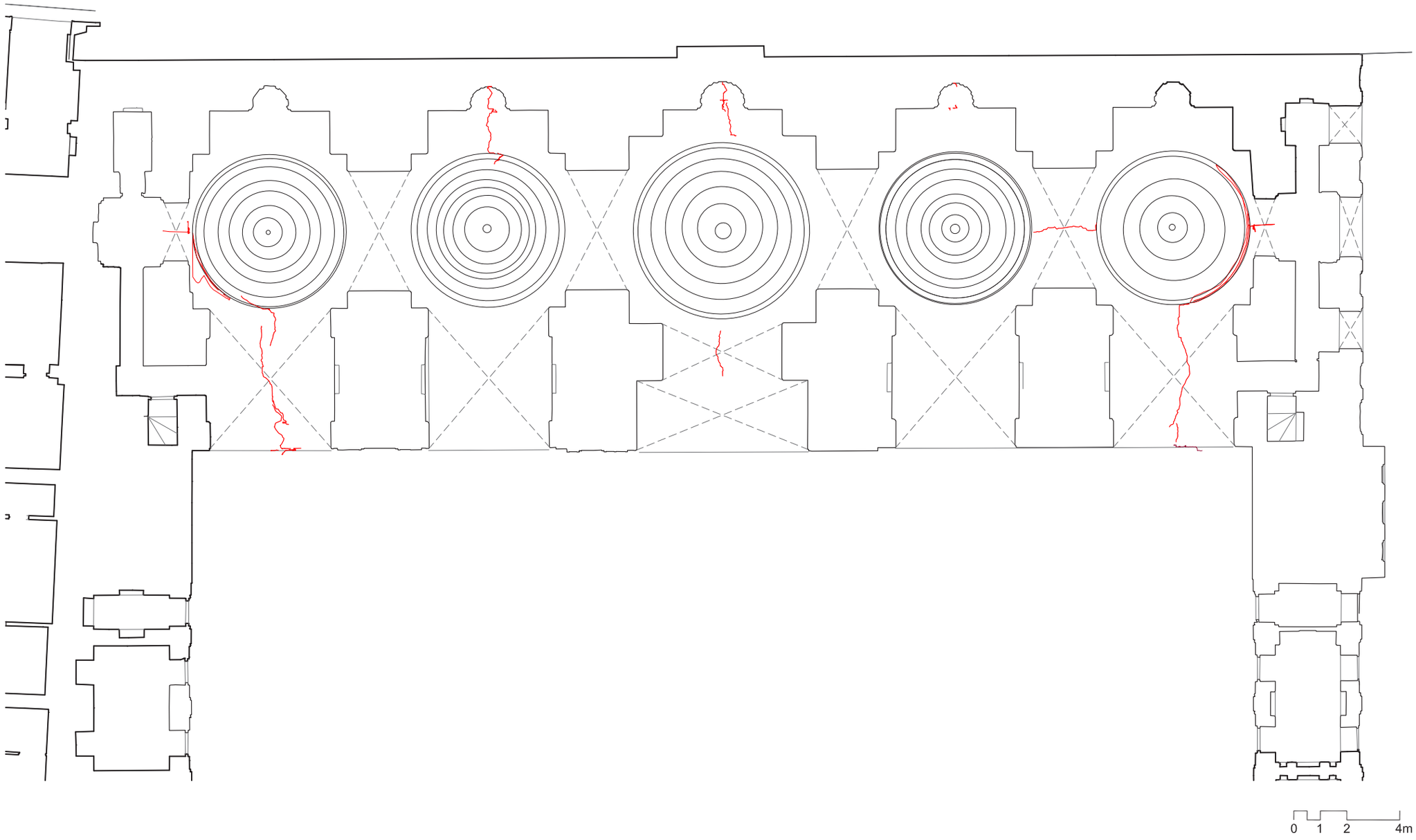
9.2.2 SUPERSTRUCTURE

While in structural terms the mosque appears to be generally robust, there are certain grave structural threats that need to be immediately addressed. Glaring structural cracks exist in the prayer chamber, and in the south-eastern corner of the Calligraphers' Bazaar fronting on the courtyard. There is no historical record available for the cracks in the prayer chamber, and expert opinion[44] has related this to an earthquake in the early 20th century.[45]

In order to facilitate the toilets and temporary ablution space in the south-eastern corner of the courtyard, many severely inappropriate interventions were made over the past several decades inside the rooms and on the roof. This has badly affected this portion of the mosque. Water tanks, water heaters and their related plumbing were introduced in this section with deleterious impacts on the historic building fabric. Leakages and the waste water from this facility have resulted in the settlement of the floor and increased the dampness in the rooms and roof. Over a period of time, the overflow of water from the storage tanks on the roof has weakened the roof and walls. During the documentation it has also been observed that some of the rooms in the mosque complex are rented out for a long time and never opened for maintenance.

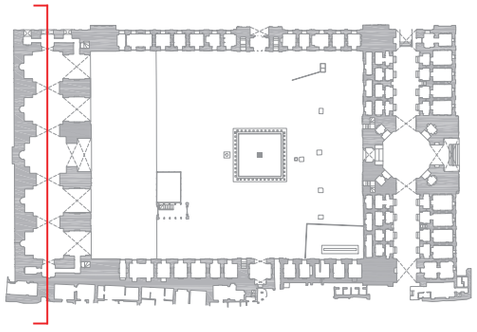


DOCUMENTATION OF CRACKS
IN THE PRAYER CHAMBER - EAST ELEVATION

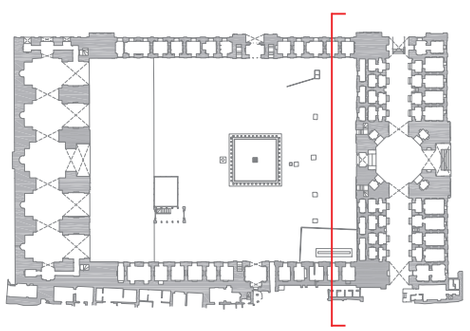


DOCUMENTATION OF CRACKS IN THE PRAYER CHAMBER - PLAN

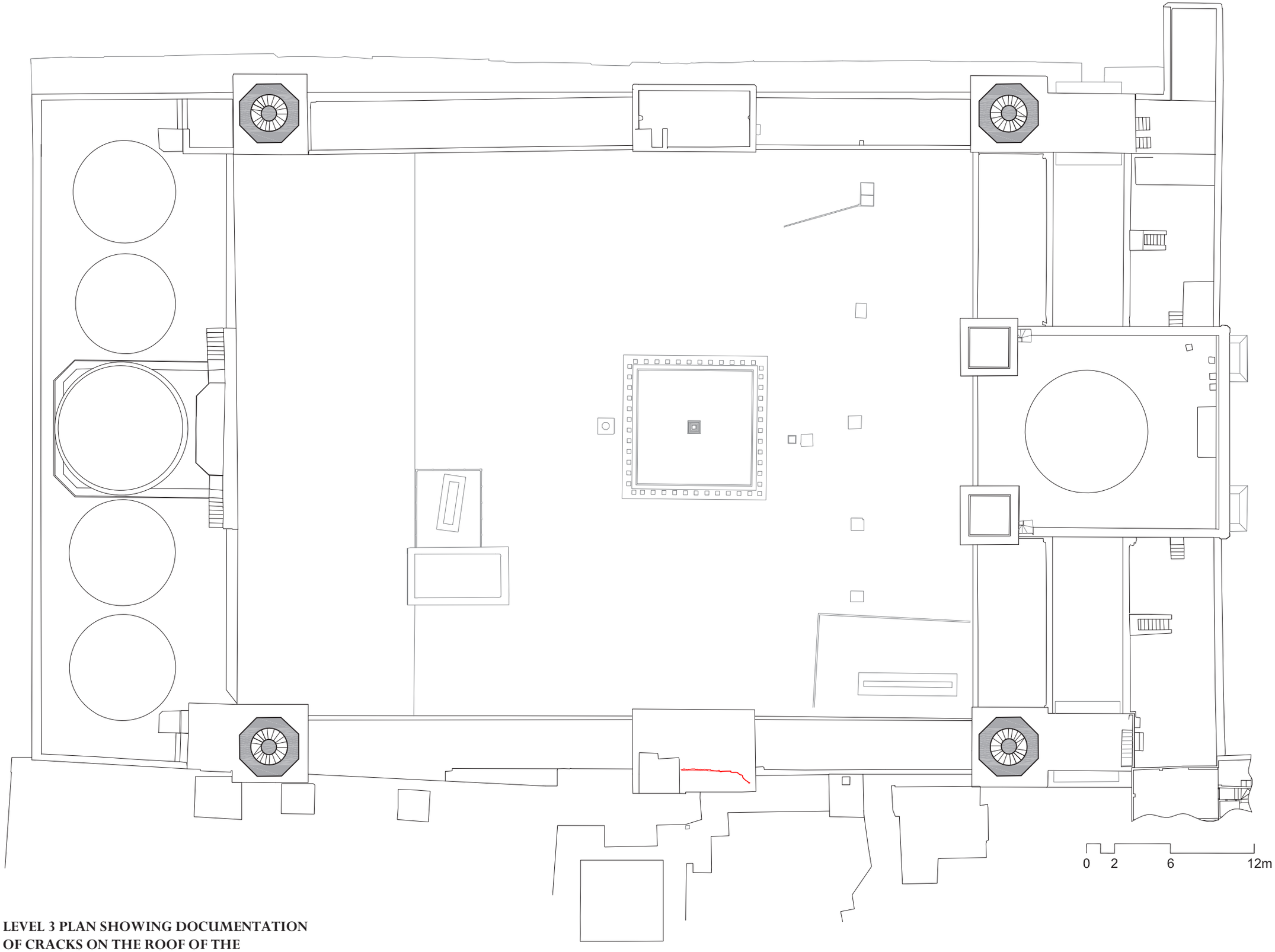
0 2 4 8m



DOCUMENTATION OF CRACKS IN THE PRAYER CHAMBER - SECTION



DOCUMENTATION OF CRACKS IN THE EASTERN FAÇADE OF THE COURTYARD



LEVEL 3 PLAN SHOWING DOCUMENTATION OF CRACKS ON THE ROOF OF THE SOUTHERN AXIAL PAVILION

Lack of maintenance by the shopkeepers in the old shops on the northern side of the mosque have been and will continue to be a potential threat to the structure of the mosque if appropriate action is not taken. Similarly, the houses on the southern side of the mosque, which were constructed on the open space between the mosque and the residential area further to the south, have their wet areas (bathrooms and kitchens) abutting the south wall of the mosque. Since these houses are privately owned, it is difficult to monitor the many ways (water ingress, impossibility of maintenance, vandalism, etc.) in which the mosque's building fabric could be threatened.

In the paragraphs below the structural condition of the monument is described in terms of (i) the *minars*; (ii) the courtyard; and (iii) the structures on each of the four sides of the courtyard.

i. THE *MINARS*

The varying degrees of deformation in all the four *minars* is not alarming at this stage, as has been demonstrated by Dr. Fritz Wenzel in his report (Appendix B), in which structural issues and analysis related to the *minars* and their foundations have been dealt with.

Aside from the north-eastern *minar* which was restored in the 1970's, the rest of the *minars* have similar forms of damages and their causes. The most common damage to the glazed tiles is various forms of disintegration of the glazed tiles explained below. Lack of maintenance, aging and water are the main causes of this damage. It has also been noticed that rain water collecting on the top gallery of each *minar* is not led off at a single point. Each octagonal gallery has eight holes at the corner of the floor and the parapet to drain off the surface water and water egressing out of these runs off as sheet flow on to the surface of the glazed tile.The domed surfaces of the *chhatri* has entirely lost its glazed tiles. Water again seems to be one of the main causes of this damage.

ii. THE COURTYARD

The courtyard of the Wazir Khan Mosque is one of the most exposed and threatened elements of the complex. The current condition of the courtyard can be read as a chronology of historical interventions done so far, in an effort to accommodate basic building services to the mosque complex. The effects of past interventions can be easily observed in the courtyard. One of the main agents of the damage is the poor drainage of water from the courtyard which has caused multiple settlements of the brick flooring at different locations in the courtyard. This damage was further augmented due to the construction of an *ad hoc* ablution space in the south-eastern corner of the courtyard.

The old surface water drain in the south-eastern part of the courtyard, which used to collect all the storm water from the courtyard, was blocked due to the construction of new building facilities which subsequently increased the level of the southern side of the neighbourhood outside the mosque.

Waste and storm water disposal cannot therefore happen according to the intended manner of the builders. The original water drainage system was altered several times in order to reroute the storm water and the waste water from the ablution tank. The introduction of electric conduits under the brick floor have destroyed the original brick patterns and introduced new materials.

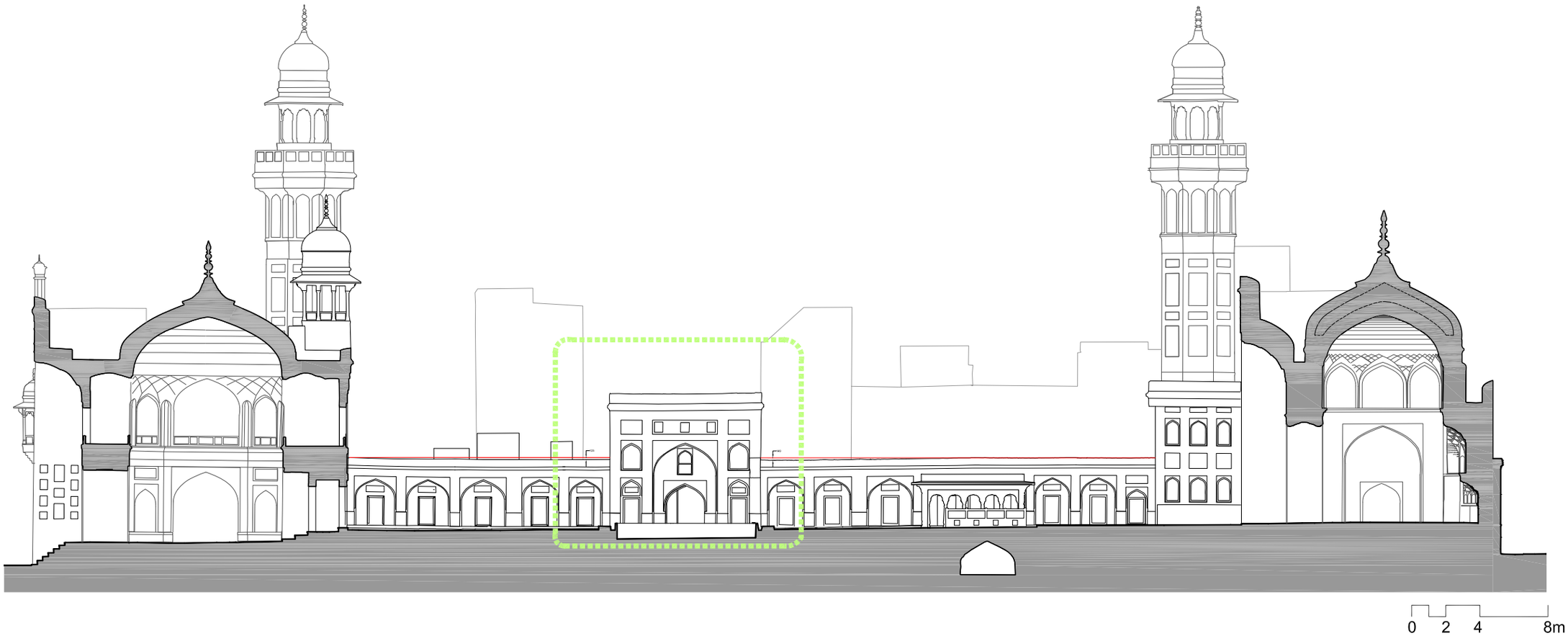
iii. THE EASTERN WING

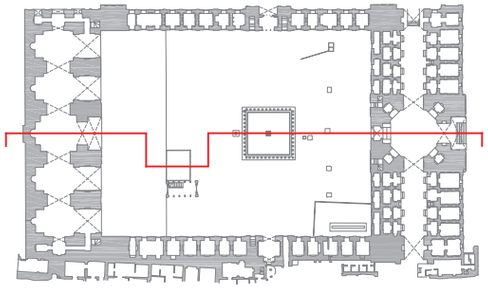
The eastern wing comprising the main entrance *iwan*, and the shops on its north and south overlooking the Chowk, and the Calligraphers' Bazaar is in a generally good condition, and being the most conspicuous part of the monument has been paid most attention in terms of repairs and maintenance. However, the roof drainage of this section is poor and water percolation from the roof into the building fabric at several locations is visible in the form of salt efflorescence even on new *tazakari* work carried out with US government funding into late 2007. Moreover the water ingress issues of the south-eastern part of the complex appears to have resulted in the numerous recorded structural cracks on the façade of the south-eastern part of the Calligraphers' Bazaar looking over into the courtyard.

Evidence of the roof being used for solid waste disposal was seen on one occasion. The source of this solid waste appears in one case (medical waste) to be the Auqaf dispensary being run in cells no. CB4 and CB5 of the Calligraphers' Bazaar (see Appendix A). In another case the solid waste is thrown out from the windows of the property abutting the southern edge of the Calligraphers' Bazaar.

Top: The crack in the apex of the arch forming the southern most entrance into the prayer chamber.

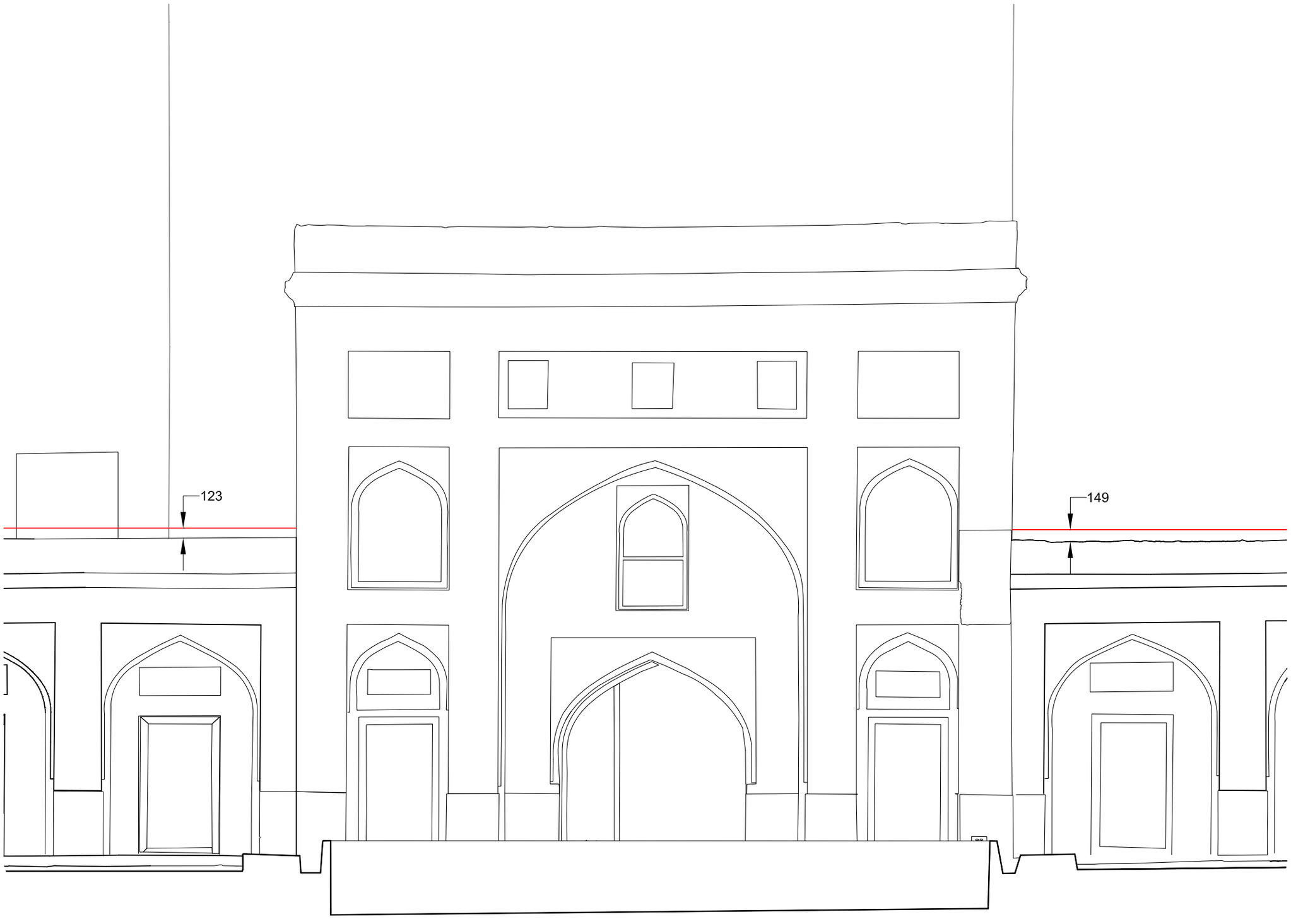
Above: A similar crack affecting the apex of the arch forming the northern most entrance. Both these are instances of the powerful lateral pull exerted by the respective minars.





SUBSIDENCE IN THE SOUTHERN ROW OF *HUJRAS*

Opposite page: detail of the southern hujras and the southern central pavilion. Note the subsidence experienced on this side. The two wings of the hujras on the south side of the courtyard have subsided as shown with respect to the central pavilion. Subsidence is shown in millimetres with reference to a horizontal line (in red) drawn from the point where the parapets end against the base of the south-east and south-west minars.


123
149

This residential property in the south-eastern corner has been built right up against the fabric of the southern extremity of the bazaar. The lack of regulative oversight and the crudeness with which the new construction invades the fabric of the monument is appalling.

As said before the inappropriate businesses operating in the shops at the street-level have caused damage to the outer renders, and are a source of vibration impacts to the structure. The precise extent of possible damage from this source is not yet visible.

iv. THE NORTHERN WING

The northern wing is affected by (i) poor drainage from the courtyard, (ii) the structural interventions from the construction of shops on the street-level against the monumental fabric, and (iii) installation of infrastructure on the monumental façade in a crude manner, approaching vandalism.

v. THE WESTERN WING (THE MOSQUE PRAYER CHAMBER)

This part of the mosque is affected by some major structural cracks which are visibly related to the inclination in the *minars*. This has caused the outer most section of the prayer chamber on its northern and southern side to tend to tear away from the mass of the base of the *minar*, appearing as identical crack systems on the two sides. Cracks appear on the apex of the arch of the northern most and southern most entrance arch in the main (eastern) façade of the prayer chamber, and travel upwards on both sides of the exterior (eastern) wall into the roof parapet. The cracks then travel westwards along the spanning system curving along the base of the two domes. Overall the cracks both horizontally and vertically follow the same distribution patterns on both the northern and southern side. However, cracks on the northern side are more extensively developed. In general the cracks have affected the decorative frescoes and plaster renders underneath them with water penetration and salt efflorescence visible on the underside.

vi. THE SOUTHERN WING

As compared to the northern wing of *hujras* the part of the monument that encloses the courtyard on its southern side has far more structural damage. This may be in part a result of its historic association with water. The large well with its Persian wheel that is now the site of a house, was located on the southern side, and water was introduced into the courtyard and the ablution pond in its centre through a water cascade in the southern axial pavilion. The Persian wheel that worked the well was replaced with electric motors in the 20th century, which led to a series of interventions, including interventions that tampered with the historical drainage system of the courtyard and its ablution pond described above.

The poor quality of drainage on the outside of the southern wing, as described above, has resulted in considerable damage to the structure of the southern pavilion and to the wings of *hujras* on its sides. The pavilion appears to have subsided in a major way, and apart from suffering serious structural damage itself, has caused the entire section of the *hujras* to its west to list downwards by 15 cm (6 inches) from the horizontal. A similar subsidence has also occurred on the row of *hujras* on the eastern side, measured at a maximum of 16.3 cm along the length of these *hujras*. Damage on the southern side of the pavilion has occurred in the form of major roof cracks, loss of historic masonry and surface deterioration.

9.3 THE CONDITION OF SURFACE TREATMENT AND ARCHITECTURAL DECORATIONS

It is important to understand the causes and the extent of weathering and damage to the various types of materials and different decorative craft techniques used in the mosque. For this purpose, a detailed weathering and damage analysis is underway in order to map and quantify the damage, and to forecast the nature of future threats and estimate the quantum of interventions necessary. The materials—brick, lime, red sandstone, glazed terracotta tiles, terracotta *jalli* and wood—used in the construction of the mosque have been put together in a variety of decorative craft techniques in the form of *kashikari*, *tazakari*, *naqqashi* and patterned floor brickwork. Each of these building crafts have different implications for treatment of the damage and of the nature and extent of intervention that will be required.

The condition of the material not only depends on its own chemical and physical characteristics but also depends a lot on the materials in its neighbourhood. Therefore, it is important to analyze the interdependency and interaction of different building materials during this damage mapping exercise. For example, incompatibility of cement used with the old building materials in previous restoration efforts increases the extent of damage in the mosque. Intentional use of cement in faux brickwork (*tazakari*) now shows efflorescence, scaling and exfoliation in a variety of locations in the mosque. Similarly, the interaction of concrete slabs of encroached shops with the old brick masonry of the northern façade shows a variety of damages to the masonry, mortar and surface decorations.

9.3.1 THREATS TO THE EXTERIOR RENDERS AND FINISHES

The intricate and delicate surface embellishments of the mosque are vulnerable to weathering, and prone to damages caused by environmental and man-made factors. Most of the past restoration efforts were focused on the protection and conservation of these surface decorations.

Almost all surface decorations, except the frescoes in the prayer chamber, are directly exposed to the weather. These surfaces include a variety of treatments of plaster render, glazed tile revetment, exposed brick revetment, and exposed brick surfaces in the courtyard. In general, the overwhelming cause of accelerated deterioration of plaster renders and other porous surfaces appears to be the absorption of water, the build up of algae and cyanobacteria and the consequent production of acidic chemicals and consequent salt crystallization which act on the porous material both on the surface and deep within the pores. A related cause is the presence of hundreds of pigeons in the mosque and the chemical effect of bird excrement and associated micro-organisms. The combination of these causes has damaged the north facing surfaces at a significantly higher rate than others: with shorter or no exposure to the sun, particularly during the winter months, these surfaces provide a hospitable environment for biological growth. The north facing sides of both the prayer chamber, the northern row of *hujras* and the southern row of *hujras* (despite the fact that on the courtyard side these have been the recipient of conservation and restoration work in the 1970's) along with the axial pavilions are therefore significantly more damaged than other exposures.

Along the Kotwali Bazaar, the north facing surfaces have been doubly vulnerable to damage as a result of the shops built against the monument and as a result of insensitive and aggressive insertion of metal brackets and other metal objects driven into the masonry which carry electrical and other utility cables. A large number of glazed tiles have already been lost completely on the spandrels and the rectangular panels above the windows of *hujras* on the northern façade.

Due to the illegally built shops adhering to the northern side of the mosque, the original rain spouts running in the wall of the mosque have ceased to function. As a result, water infiltrates into the renderings and the surface decorations of the façade. Again, their effect is extremely detrimental to the northern façade due to its comparatively reduced direct exposure to the sun.

Lesser natural causes are the exposure, or lack of it, to the sun, diurnal temperature changes and the temperature and moisture variations between seasons.

WAZIR KHAN MOSQUE

KASHIKARI PANELS CATALOGING AND RECORDING SCHEME

SE-1 (East Elevation)						
A	B	C	D	E	F	G
SE-1-CP201						
SE-1-CP202						
SE-1A-DP101	SE-1B-DP101	SE-1C-DP101				
SE-1A-DP102	SE-1B-DP102	SE-1C-DP102				
SE-1A-DP103	SE-1B-DP103	SE-1C-DP103				
SE-1A-DP104	SE-1B-DP104	SE-1C-DP104				
SE-1A-DP105	SE-1B-DP105	SE-1C-DP105				
SE-1A-DP106	SE-1B-DP106	SE-1C-DP106				
SE-1A-DP107	SE-1B-DP107	SE-1C-DP107				
SE-1A-DP108	SE-1B-DP108	SE-1C-DP108				
SE-1A-DP109	SE-1B-DP109	SE-1C-DP109				
SE-1A-DP110	SE-1B-DP110	SE-1C-DP110				
SE-1A-DP111	SE-1B-DP111	SE-1C-DP111				
SE-1A-DP112	SE-1B-DP112	SE-1C-DP112				
SE-1A-DP113	SE-1B-DP113	SE-1C-DP113				
SE-1A-DP114	SE-1B-DP114	SE-1C-DP114				
SE-1A-DP115	SE-1B-DP115	SE-1C-DP115				
SE-1A-DP116	SE-1B-DP116	SE-1C-DP116				
SE-1A-DP117		SE-1C-DP117				
SE-1A-DP118		SE-1C-DP118				
SE-1A-DP119		SE-1C-DP119				
SE-1A-DP120		SE-1C-DP120				
SE-1A-DP121		SE-1C-DP121				
SE-1A-DP122		SE-1C-DP122				
SE-1A-DP123		SE-1C-DP123				
SE-1A-DP124		SE-1C-DP124				
SE-1A-DP125		SE-1C-DP125				
SE-1A-DP126		SE-1C-DP126				
SE-1A-DP127		SE-1C-DP127				
SE-1A-DP128		SE-1C-DP128				
SE-1A-DP129		SE-1C-DP129				
SE-1A-DP130		SE-1C-DP130				
SE-1A-DP131		SE-1C-DP131				
SE-1A-DP132		SE-1C-DP132				
SE-1A-DP133						
SE-1A-DP134			SE-5D-DP116			
			SE-5D-DP117			
			SE-5D-DP118			

SE-6 (Section AA_looking north)						
A	B	C	D	E	F	G
SE-6A-DP101	SE-6B-DP101	SE-6C-DP101	SE-6D-DP101			
SE-6A-DP102	SE-6B-DP102	SE-6C-DP102	SE-6D-DP102			
SE-6A-DP103	SE-6B-DP103	SE-6C-DP103	SE-6D-DP103			
SE-6A-DP104	SE-6B-DP104	SE-6C-DP104	SE-6D-DP104			
SE-6A-DP105	SE-6B-DP105	SE-6C-DP105	SE-6D-DP105			
SE-6A-DP106	SE-6B-DP106	SE-6C-DP106	SE-6D-DP106			
SE-6A-DP107	SE-6B-DP107	SE-6C-DP107	SE-6D-DP107			
SE-6A-DP108	SE-6B-DP108	SE-6C-DP108	SE-6D-DP108			
SE-6A-DP109	SE-6B-DP109	SE-6C-DP109	SE-6D-DP109			
SE-6A-DP110	SE-6B-DP110	SE-6C-DP110	SE-6D-DP110			
SE-6A-DP111	SE-6B-DP111	SE-6C-DP111	SE-6D-DP111			
SE-6A-DP112	SE-6B-DP112	SE-6C-DP112	SE-6D-DP112			
	SE-6B-DP113	SE-6C-DP113	SE-6D-DP113			
	SE-6B-DP114	SE-6C-DP114	SE-6D-DP114			
		SE-6C-DP115				
		SE-6C-DP116				
		SE-6C-DP117				
		SE-6C-DP118				

SE-7 (Section AA_looking south)						
A	B	C	D	E	F	G
SE-7A-DP101	SE-7-CP201			SE-7E-DP101	SE-7F-DP101	
SE-7A-DP102	SE-7-CP202			SE-7E-DP102	SE-7F-DP102	
SE-7A-DP103	SE-7B-DP101		SE-7D-DP101	SE-7E-DP103	SE-7F-DP103	
SE-7A-DP104	SE-7B-DP102		SE-7D-DP102	SE-7E-DP104	SE-7F-DP104	
SE-7A-DP105	SE-7B-DP103		SE-7D-DP103	SE-7E-DP105	SE-7F-DP105	
SE-7A-DP106	SE-7B-DP104		SE-7D-DP104	SE-7E-DP106	SE-7F-DP106	
SE-7A-DP107	SE-7B-DP105		SE-7D-DP105	SE-7E-DP107	SE-7F-DP107	
SE-7A-DP108	SE-7B-DP106		SE-7D-DP106	SE-7E-DP108	SE-7F-DP108	
SE-7A-DP109				SE-7E-DP109	SE-7F-DP109	
SE-7A-DP110				SE-7E-DP110	SE-7F-DP110	
SE-7A-DP111				SE-7E-DP111	SE-7F-DP111	
SE-7A-DP112				SE-7E-DP112	SE-7F-DP112	
SE-7A-DP113				SE-7E-DP113		
SE-7A-DP114				SE-7E-DP114		

SE-8 (Section EE_looking east)						
A	B	C	D	E	F	G
SE-8A-DP101	SE-8B-DP101	SE-8-CP201			SE-8F-DP101	SE-8G-DP101
SE-8A-DP102	SE-8B-DP102	SE-8-CP202			SE-8F-DP102	SE-8G-DP102
SE-8A-DP103	SE-8B-DP103	SE-8C-DP101	SE-8D-DP101	SE-8E-DP101	SE-8F-DP103	SE-8G-DP103
SE-8A-DP104	SE-8B-DP104	SE-8C-DP102	SE-8D-DP102	SE-8E-DP102	SE-8F-DP104	SE-8G-DP104
SE-8A-DP105	SE-8B-DP105	SE-8C-DP103	SE-8D-DP103	SE-8E-DP103	SE-8F-DP105	SE-8G-DP105
SE-8A-DP106	SE-8B-DP106	SE-8C-DP104	SE-8D-DP104	SE-8E-DP104	SE-8F-DP106	SE-8G-DP106
SE-8A-DP107	SE-8B-DP107	SE-8C-DP105	SE-8D-DP105	SE-8E-DP105	SE-8F-DP107	SE-8G-DP107
SE-8A-DP108	SE-8B-DP108	SE-8C-DP106		SE-8E-DP106	SE-8F-DP108	SE-8G-DP108
	SE-8B-DP109	SE-8C-DP107		SE-8E-DP107	SE-8F-DP109	
	SE-8B-DP110	SE-8C-DP108		SE-8E-DP108	SE-8F-DP110	
	SE-8B-DP111	SE-8C-DP109		SE-8E-DP109	SE-8F-DP111	
		SE-8C-DP110		SE-8E-DP110		
		SE-8C-DP111		SE-8E-DP111		
		SE-8C-DP112		SE-8E-DP112		
		SE-8C-DP113		SE-8E-DP113		
		SE-8C-DP114		SE-8E-DP114		
		SE-8C-DP115		SE-8E-DP115		
		SE-8C-DP116		SE-8E-DP116		

i. Glazed Tile

There are 637 individual panels of glazed ceramic *kashikari* tile work in the Wazir Khan Mosque. The documentation and analysis work being described in this report has identified and catalogued each one of these panels, such that it carries a unique identification code. As each of these panels is recorded it is subjected to meticulous analysis and separation of the various kinds and degrees of damage. This is a considerable task, and is likely to be progressive work which will continue into the foreseeable future. However, the present analytic results will help set up a pilot conservation and restoration project, the success of which will guide us into more extensive stages of glazed tile conservation.

Further resources are needed to be applied until the work on documentation and analysis already started and completed for some eleven of these panels is completed. The ongoing work includes the following:

1. Photographing and orthorectifying the photographs: many panels particularly on the sides of the *minars* that look in directions away from the monument, and parts of the north elevation have yet to be photographed;
2. Drawing up precise closed vector polygons of each piece of tile that makes up a panel: this is carried out by tracing over each tile using a CAD /orthorectified photograph interface;
3. Analysing each tile panel and establishing the extent of the various types of damage;
4. Quantifying the damage and drawing up the total area of each type of damage;
5. Assessing each panel for the degree of intervention to be taken up, based on risk management criteria, on decisions relating to the intensity of damage already sustained and the degree of manageable aging and patina, and arriving at more precisely defined interventions in the tile mosaics.

The most common damage to the glazed tiles revetment is various forms of disintegration: layering, exfoliation, loss of bonding, etc. Aging, lack of maintenance, rain water, biological growth and bird excrement are the main cause of this damage. The degree of damages to the glazed tiles varies from location to location.

The threats and damage processes are of two basic types:

1. Disintegration of materials. This class of damage ranges across an array of conditions:

   - Exfoliation and partial loss of glaze,
   - Complete loss of glaze,
   - Spalling/pitting of terracotta base,
   - Breakout and complete loss of tile,
   - Detachment of tile and base mortar from the wall,
   - Complete loss of tile and base mortar.

2. Surface changes:

   - Discoloration of glaze,
   - Deposits of dust and biofilm,
   - Heavy deposits and encrustation of biofilm (lichen, algae, microspores, cyanobacteria etc),
   - Dampness on façade surface.

These conditions are illustrated in section 10.10 (p.143), using some of the panels that have been documented and analysed in detail. The painstaking and slow process of this documentation and analysis is an ongoing one, and will continue for at least one year, before all the areas with glazed tile revetment have been covered.

Concurrently with particular respect to the *kashikari* work, it is important to set up a monitoring programme which measures the rate of deterioration of the historic tiles. This monitoring regime should be made a part of the new institutional and maintenance regime to be set up for the post-conservation care and upkeep of the monument.

Opposite: Minar *elevation indicating unique codes ascribed to each tile panel.*

ii. Plaster renders and *Tazakari*

Plaster renders are especially vulnerable to the natural causes described above. Plaster renders that carry the decorative craft known as *tazakari* (incised faux brickwork) are susceptible to a combination of discoloration by rainwater, particularly washing away of pigment in poor quality red ochre used in the outer skin, and discoloration by biological causes. Beyond discoloration, the outer pigmented layer is the first to disengage, pointing to the need for effective keying and mechanical bonding and the degree of chemical bonding achieved of the coloured layer to the base layer. From this first exfoliative effect, the process of the loss of the two or three layers of the plaster render to the exposure of the base brickwork is seen in various stages in all parts of the mosque, and is shared by zones where the render is used without the *tazakari* work.

The recent use of materials such as white cement to accelerate the work process also activates the cement's salt content to effloresce in combination with water leaching from the roof and outer walls, resulting in ugly white patches on the under-surfaces of the domes and ceilings, where rainwater penetration is significant.

iii. Glazed tiles interlaced with unglazed terracotta lattices

This form of glazed tile work has suffered consistent damage in the form of the loss of the glazed tile elements, while the terracotta lattice or filigree work in which the glazed tiles are embedded has survived with lesser damage.

The main reason for this could be ascribed to the loss of bond between the tile and the mortar bed in which it is embedded. This in turn is caused by the lack of an effective seal between the glazed tile and the surrounding terracotta elements which allow rain water to penetrate into the mortar, causing chemical changes in the mortar over the long term, eventually leading to loss of cohesion and detachment of the tile. An added factor is the fact that the terracotta lattice work is relatively more porous than the glazed tile, and water interacting with salt ions can be retained for longer periods.

Left, top: Jalli *work in the Level 2 southern pavilion of the Calligraphers' Bazaar.*

Left: Broken pieces of jalli *work discarded on the roof of the Calligraphers' Bazaar.*

iv. Terracotta *jalli* work

Except for some instances of bio-film, the perforated terracotta *jalli* work is in relatively good condition on the parapet surrounding the ambulatory at the top of the *minars*. This may be on account of the airiness of the locations where it is used and its exposure to sun and good drying conditions. Elsewhere (in the axial pavilions and in the Calligraphers' Bazaar) its condition has been subject to weathering and wear and tear caused by use, repairs such as covering over with red ochre paint, and in the latest version of repairs covering over with white lime "*pucca qal'i*".

In the Calligraphers' Bazaar the *jalli* work is part of the balustrade looking into the *dewrhi* and in the openings from the central *dewrhi* building looking into the bazaars. This balustrade has been rebuilt in *pucca qal'i* and / or treated with *pucca qal'i*, turning its appearance into white. The pavilions at Level 2 at either end of the bazaar still contain original terracotta *jalli* work, but these have been generally poorly treated over the decades and in need of some cleaning up and reconditioning. Broken pieces of old or reordered terracotta screen work were found strewn over the roof of the Calligraphers' Bazaar (Level 2).

9.3.2 THREATS TO INTERIORS

Most of the damage to the interior spaces and surface decorations are due to neglect and lack of maintenance. Many of the *hujras* in the courtyard are not functional and have rarely been opened since their use as storage for junk materials associated with past restoration projects. Adapting these small rooms for the storage of unused building materials and discarded items of daily use has already damaged the building fabric and interior, and is likely to cause further damage. The majority of the threats to the interior finishes of the prayer chamber are directly related to the damages on the roof and domed surface of the structure.

The use of conduits on the roof of the mosque, laid when electricity was introduced, is the other threat to the interior. At many locations it can be observed that there is incomplete, inadequately designed, and badly detailed and executed conduiting. This has had many damaging effects on the fabric of the mosque.

i. Frescoes

Most of the interior, in particular of the prayer chamber in its entirety, is rendered in elaborate fresco, in calligraphic wall scrolls and in decorative floral and arboreal motifs, some of which have profound symbological and connotative significance.[46] These have been repainted/restored several times and are now left with no visible original work. Use of cement-based grouts during past repair of structural cracks have provided a path for water to travel inside and have resulted in the presence of crystallized salts (efflorescence) on the surface of the frescoes. This process of the fragmentation of the lime renders and with it the deterioration of the fresco work could be surmised to be the historical reason for the abnormal high rate of fresco repairs and restoration and the consequent loss of authenticity seen in the interiors.

Mechanical threats like the puncturing of walls, chipping of corners, insertion of nails on decorative features and storing disproportionately large items in small spaces are the most common threats to the interiors and the building fabric of the mosque.

ii. Plaster Renders

In secondary areas of the mosque, such as the *hujras* and the shops below, there is considerable neglect of upkeep and the plaster renders, many of which bear traces of lost fresco work, are in various stages of disrepair and loss. The loss due to rising damp, including damp penetration caused by rain water or wash water splashing from the courtyard floor or damp penetrating the walls from the exterior, results in varying degrees of salt crystallization, exfoliation, disengagement and falling off to be seen in various places in the complex.

9.4 DAMAGE, WEATHERING AND DETERIORATION

An attempt has been made to arrive at a classification of the various types of threats and damage. This is illustrated in the following table. In each of the ensuing pages a particular class of threat or damage is illustrated by means of several photographs.

Above:Washing the floor with piped water under pressure, an activity unknown to the 17th century builders of the monument. Note the damp rising up the wall and the plaster render with the precious wall painting breaking out under the force of the stream of water.

DOCUMENTATION OF INSTANCES OF DAMAGE, WEATHERING AND DETERIORATION

		STREET-LEVEL SHOPS ON NORTHERN SIDE								STREET-LEVEL SHOPS FACING CHOWK								CALLIGRAPHERS' BAZAAR									*DEWRHI*									COURT-YARD		PRAYER CHAMBER								
		Primary Elements				Surface & Decorative Treatment				(Primary Elements)				Surface & Decorative Treatment				(Primary Elements)					Surface & Decorative Treatment				(Primary Elements)					Surface & Decorative Treatment				(Primary Elements)		(Primary Elements)					Surface & Decorative Treatment			
						Exterior								Exterior									Exterior									Exterior											Exterior			
		Foundations	Walls	Spans	Floors	*Kashikari*	Plaster render	*Tazakari*	Interior (frescoes)	Foundations	Walls	Spans	Floors	*Kashikari*	Plaster render	*Tazakari*	Interior (frescoes)	Foundations	Walls	Spans	Floors	Roofs	*Kashikari*	Plaster render	*Tazakari*	Interior (frescoes)	Foundations	Walls	Spans	Floors	Roofs	*Kashikari*	Plaster render	*Tazakari*	Interior (frescoes)	Foundations	Floors	Foundations	Walls	Spans	Floors	Roofs	*Kashikari*	Plaster render	*Tazakari*	Interior (frescoes)
DAMAGE RESULTING FROM UNDESIRABLE USES & INTERVENTIONS	Mechanical damage		■				■				■				■																						■		■					■		■
	Vandalism		■		■		■						■								■																■							■		■
DAMAGE TO STRUCTURAL ELEMENTS	Loss of Structural elements e.g. brickwork										■																														■					
	Structural cracks										■								■			■		■	■			■	■		■		■		■		■		■	■		■		■		■
	Deformation																																													■
DAMAGE TO SURFACE & DECORATIVE TREATMENTS	Loss of cohesion						■				■				■									■	■								■		■									■		■
	Detachment of plaster render		■	■			■				■	■			■				■					■	■			■	■				■		■				■	■				■		■
	Loss of adhesion														■														■						■											■
	Spalling		■				■				■				■				■					■	■								■		■				■	■				■		■
	Pitting and Minor Cracks		■	■			■				■	■	■		■				■					■	■			■	■				■		■		■		■	■	■			■		■
	Exfoliation										■										■			■	■														■	■				■		■
	Salt Crystalisation & Efflorescence		■								■								■		■			■	■			■			■		■	■	■				■	■		■				■
	Rising damp from floors & subfloors or ingress of rain water		■				■				■	■	■		■				■		■	■		■	■			■			■				■		■		■	■		■		■		■
	Biological Colonisation or Growth of Higher Plants		■				■	■				■													■									■			■			■						
	Chromatic changes		■			■	■	■			■				■										■						■			■								■				■

NORTHERN ROW OF *HUJRAS*									NORTH AXIAL PAVILION									SOUTHERN ROW OF *HUJRAS*									SOUTH AXIAL PAVILION									*MINARS*										
(Primary Elements)					Surface & Decorative Treatment				(Primary Elements)					Surface & Decorative Treatment				(Primary Elements)					Surface & Decorative Treatment				(Primary Elements)					Surface & Decorative Treatment					Surface & Decorative Treatment						
					Exterior									Exterior									Exterior									Exterior					Exterior						
Foundations	**Walls**	**Spans**	**Floors**	**Roofs**	***Kashikari***	**Plaster render**	***Tazakari***	Interior (frescoes)	**Foundations**	**Walls**	**Spans**	**Floors**	**Roofs**	***Kashikari***	**Plaster render**	***Tazakari***	Interior (frescoes)	**Foundations**	**Walls**	**Spans**	**Floors**	**Roofs**	***Kashikari***	**Plaster render**	***Tazakari***	Interior (frescoes)	**Foundations**	**Walls**	**Spans**	**Floors**	**Roofs**	***Kashikari***	**Plaster render**	***Tazakari***	Interior (frescoes)	**Superstructure**	***Kashikari***	**Plaster render**	***Tazakari*** (NE *minar* only)	Interior (frescoes)		
	■																		■		■							■															
																			■																								
	■	■																	■									■															
		■																	■	■	■							■	■	■	■		■										
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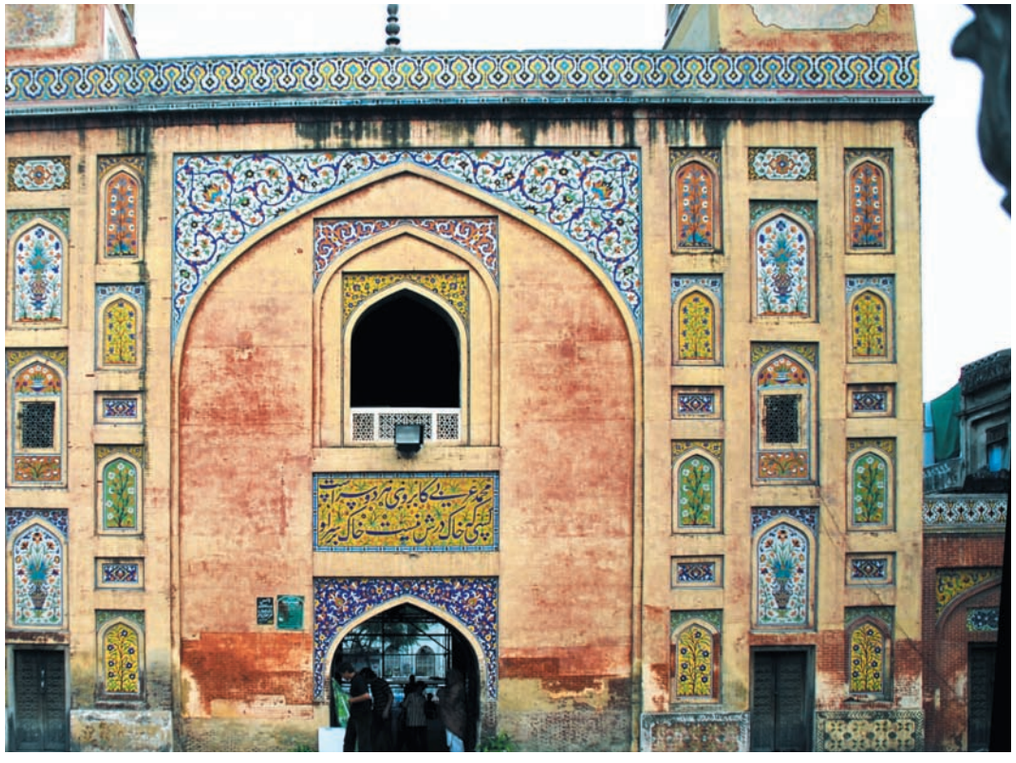
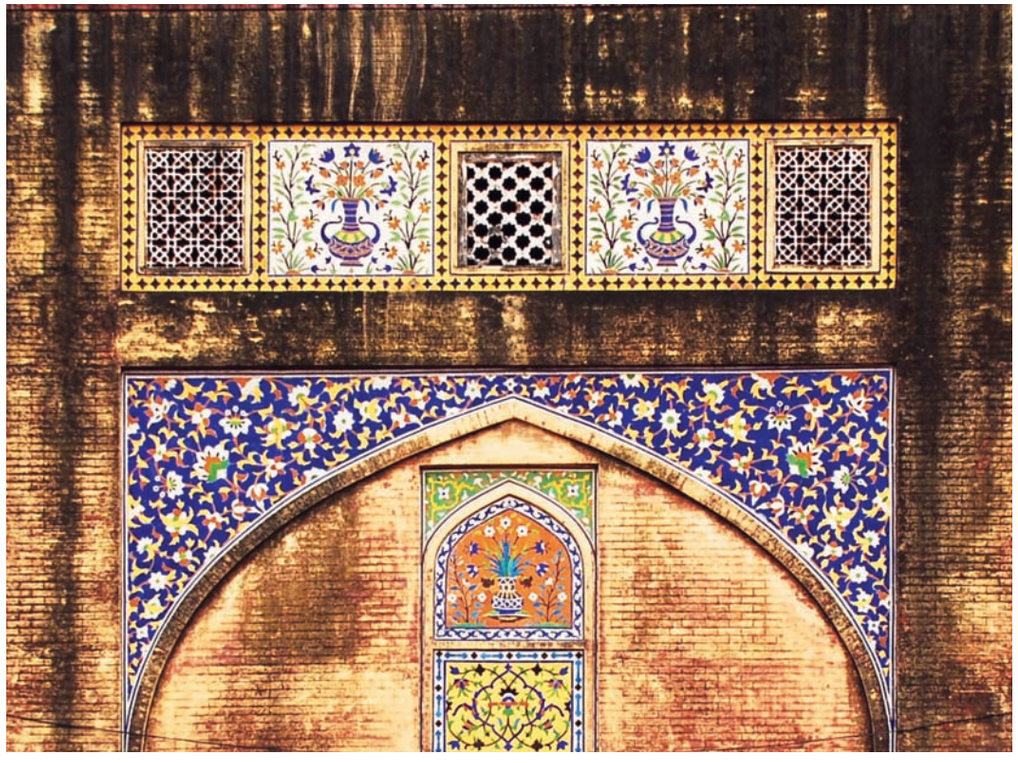
Mechanical damage	**DAMAGE RESULTING FROM UNDESIRABLE USES & INTERVENTIONS**
Vandalism	
Loss of Structural elements e.g. brickwork	**DAMAGE TO STRUCTURAL ELEMENTS**
Structural cracks	
Deformation	
Loss of cohesion	**DAMAGE TO SURFACE & DECORATIVE TREATMENTS**
Detachment of plaster render	
Loss of adhesion	
Spalling	
Pitting and Minor Cracks	
Exfoliation	
Salt Crystalisation & Efflorescence	
Rising damp from floors & subfloors or ingress of rain water	
Biological Colonisation or Higher Plants	
Chromatic changes	





DISCOLOURATION

Three examples of discolouration, biological deposits and dust on various surfaces of the exterior.

Top Left: Discolouration and fading of exterior plaster render and tazakari *work on the courtyard façade of the entrance* dewrhi.

Above: Deposits of soil, dust and micro-algae on the northern façade of the southern axial pavilion.

Left: A similar process is occurring on the façade of the prayer chamber facing north.

MECHANICAL DAMAGE (opposite)

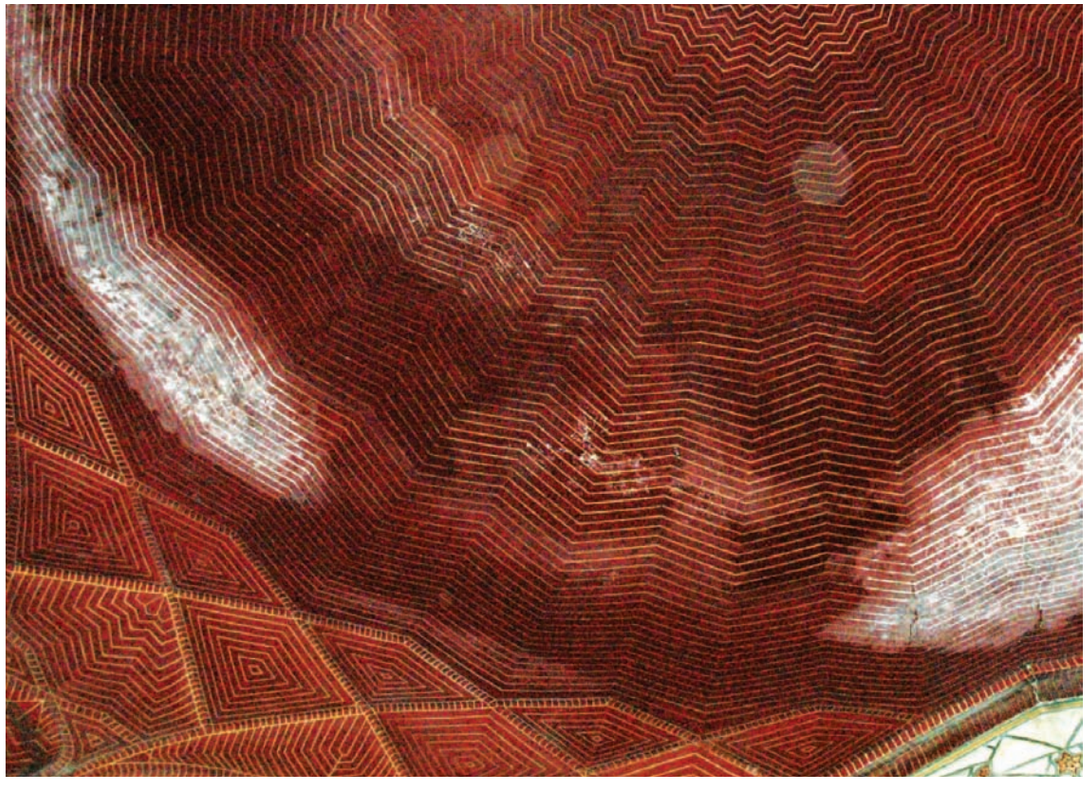
Instances of mechanical damage occasioned by insensitive uses and installations.

Top left: Damage caused to the historic fresco work by careless and insensitive moving about of electric fans.

Top right: Installation of leaking water tanks on the roofs of the southern hujras.

Bottom left: Insensitive installation of electric distribution cables on the historic monument.

Bottom right: Insertion of water/gas pipes into the historic walls.



EFFLORESCENCE

Salt crystallisation / efflorescence occurs mainly at instances of water ingress from the exterior. But it is also caused by salts leaching from inappropriate materials used in repairs such as cement and white cement.
Salt crystallization results in the beginning of a process of disintegration of material at the finer grain.

Top: Efflorescence in the dome of the entrance dewrhi *caused by rain water penetration through the structure.*

Bottom: Efflorescence caused by the drying of render and the leeching of salts contained in inappropriate mortar.

BIOLOGICAL GROWTH

Top: At a microbial scale lichen and cyanobacteria begins a process of deterioration of lime based renders as well as porous left over of tile work after the glaze has exfoliated.

Left: Lack of vigilant maintenance can encourage higher order plants which cause mechanical degredation.

Puncturing of floor to accommodate fixtures such as metal hooks for tying shamiana *ropes indicates the need for better and more appropriately located details.*

Poor detailing of waste and storm water disposal grating.

Cutting up the patterned floor to accommodate a collector drain. A better and well distributed system of under floor drains is required.

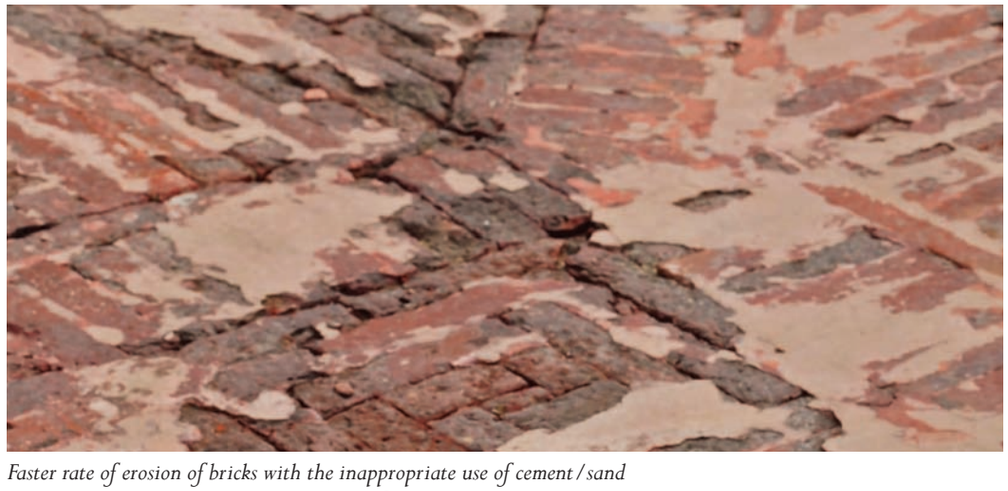
Inappropriate use of materials to repair floor - in this case coloured cement/sand or coloured lime render.

Brick and fake brick markings on cement/sand or lime/sand renders create an unsatisfactory appearance. Note the subsidence crack on the right of the photograph.

EXAMPLES OF DIFFERENT TYPES OF DAMAGE TO THE COURTYARD FLOOR

Inappropriate use of cement / sand renders and over-grouting between bricks.

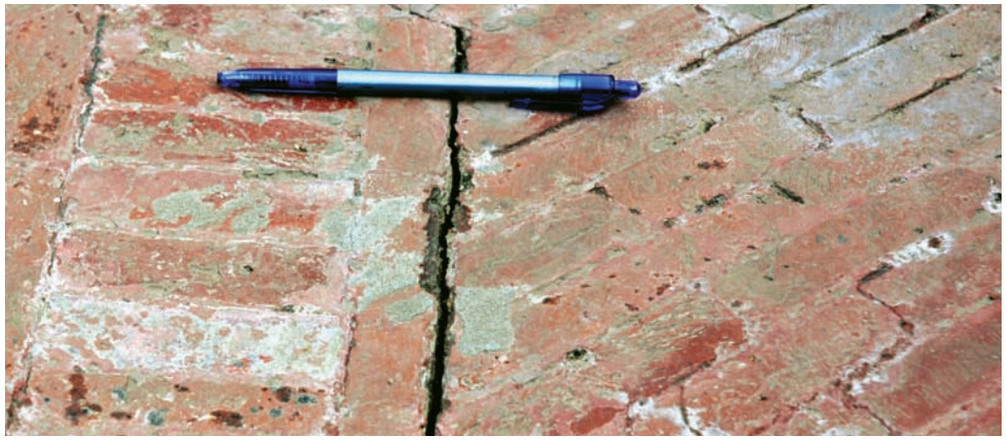
Erosion and disintegration of brick with surface wear.



Faster rate of erosion of bricks with the inappropriate use of cement / sand renders used to achieve a water repellent surface.

Subsidence and inadequate repair at different levels.

Puncturing of floors for installment of drains, drain outlets and gratings indicate the need for better and more sophisticated detailing.



Major crack in the floor of the south-eastern part of the courtyard.

Major crack in the roof of the southern axial pavilion.

Major crack in the wall above the northern most archway of the prayer chamber.

EXAMPLES OF MAJOR STRUCTURAL CRACKS

Major crack in one of the domes of the chhatri *above the entrance* iwan.

Major crack in the vault of the northern most archway of the prayer chamber.

Erosion of mortar between the joints on the exposed surfaces of masonry.

Powdering of brick.

Sanding of mortar.

EXAMPLES OF LOSS OF COHESION

Peeling of upper coat of paint surface in the northern axial pavilion.

Partial loss of bond between tile and mortar.

Breakout of tile embedded in unglazed terracotta lattice.

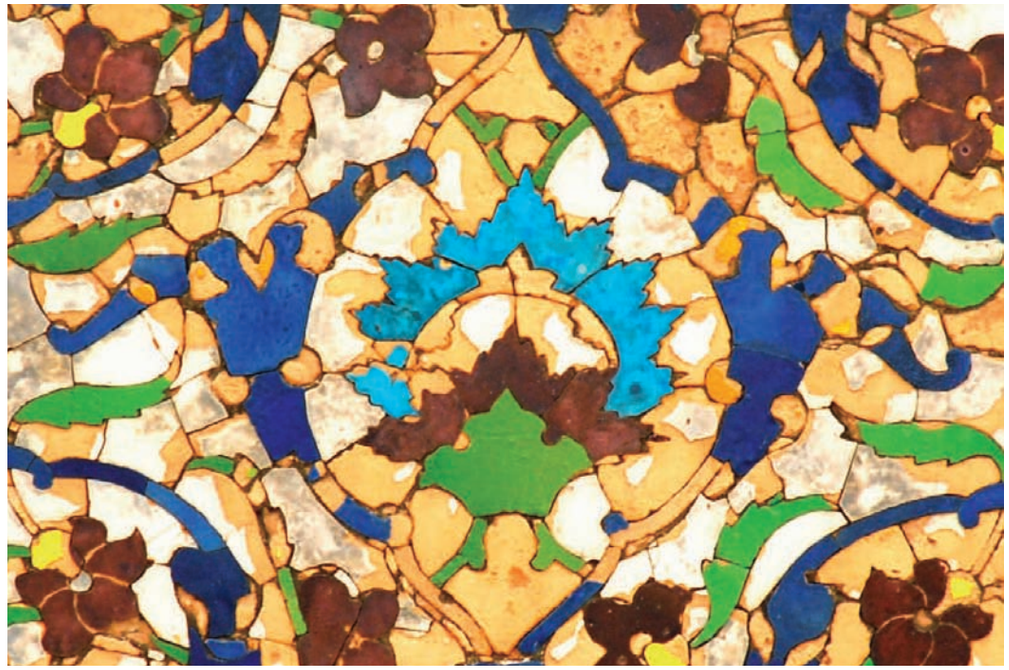
Complete loss of bond between tile and mortar.

Peeling of the upper coat of surface render in the prayer chamber.

Advanced state of the deterioration of both mortar based external finishes such as faux brick and plain plaster render, as well as deterioration of crenellated tile work on the roof line of the north façade.

EXAMPLES OF LOSS OF ADHESION

Hairline cracks on the glazed surface of tiles. These cracks are sometimes indistinguishable from the fine joints of the cut-to-shape tiles, but could be the beginning of more advanced weathering processes.

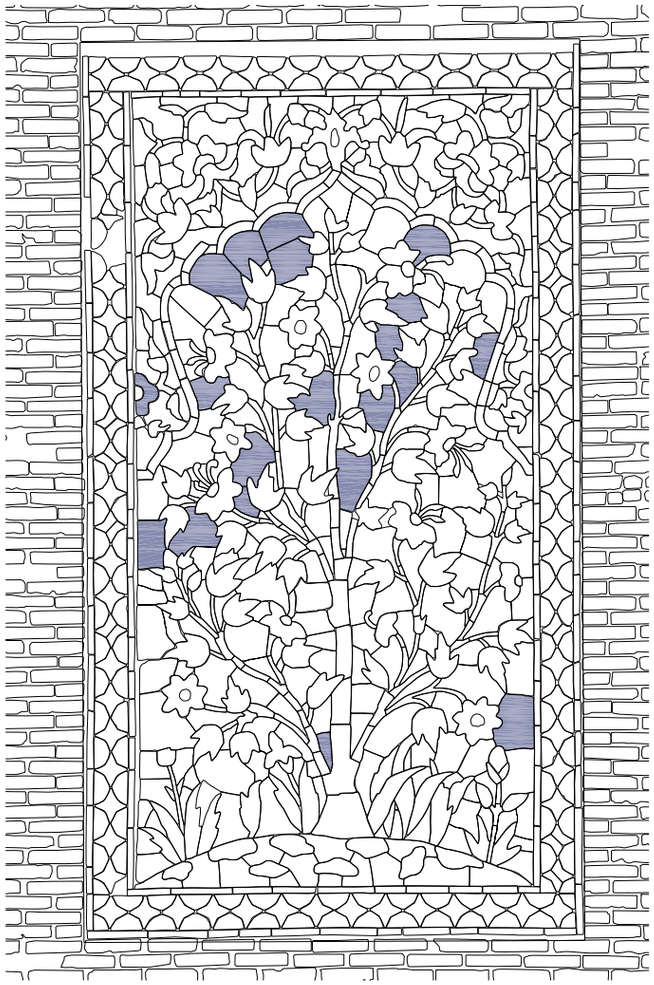


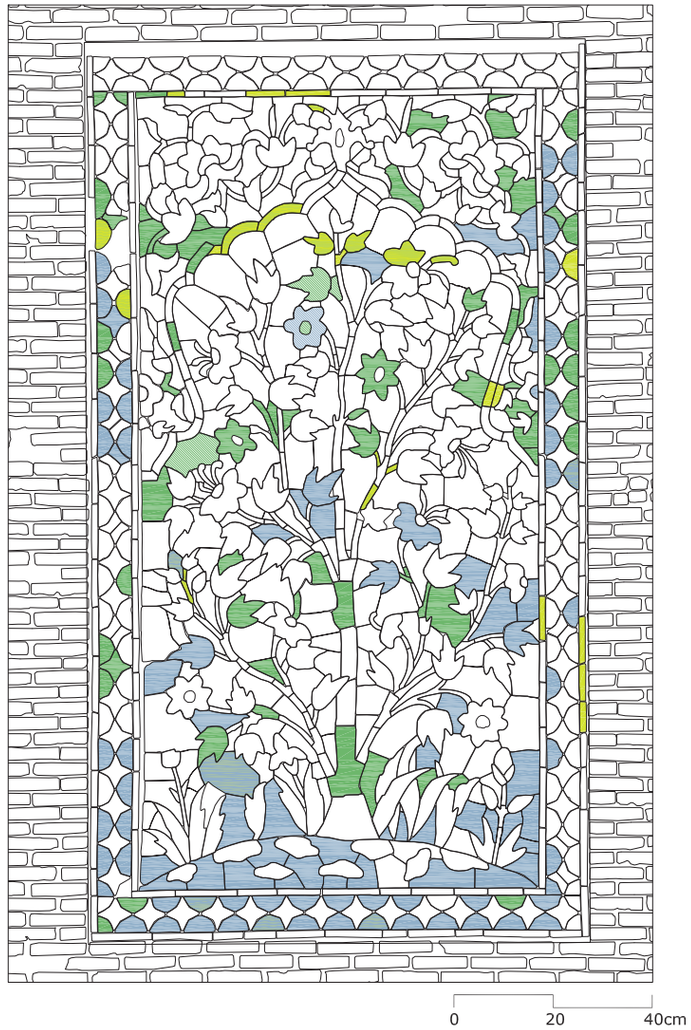
Exfoliation of glaze from the terracotta body of the tile is the most common damage type on glazed tiles. In many instances concurrent existence of exfoliated glaze and tiles with glaze still intact presents a characteristic age-value of some interest and this situation could be one of the lower priority interventions to be addressed.

Pitting and spalling of thin layers of terracotta body of the tile. At this stage of deterioration, piece-meal replacement of sections of tile may be considered.

Advanced spalling of the core terracotta body of the tile.

EXAMPLES OF OTHER PROGRESSIVE FORMS OF WEATHERING AND DETERIORATION





SURFACE CHANGES

- **Discoloration of glaze**
- **Deposits of dust and biofilm**
- **Heavy deposit and encrustation of biofilm (lichen, algae, microspores, cyanobacteria etc.)**

DISINTEGRATION OF MATERIAL

- **Exfoliation and partial loss of glaze**
- **Complete loss of glaze**
- **Spalling/pitting of terracotta base**
- **Breakout and complete loss of tile**
- **Detachment of tile and base mortar from the wall**
- **Complete loss of tile and base mortar**

DOCUMENTATION OF SURFACE CHANGES AND TILE DISINTEGRATION ON A SOUTH FACING *KASHIKARI* PANEL ON THE SOUTH-EASTERN *MINAR*

This arboreal and geometric south facing glazed tile panel on the south-eastern minar *displays instances of discoloration of glaze, exfoliation of glaze from the terracotta body, complete loss of glaze from terracotta and spalling of tile body.*

9.5 DAMAGE ANALYSIS OF INSTANCES OF EXTERIOR GLAZED TILE WORK

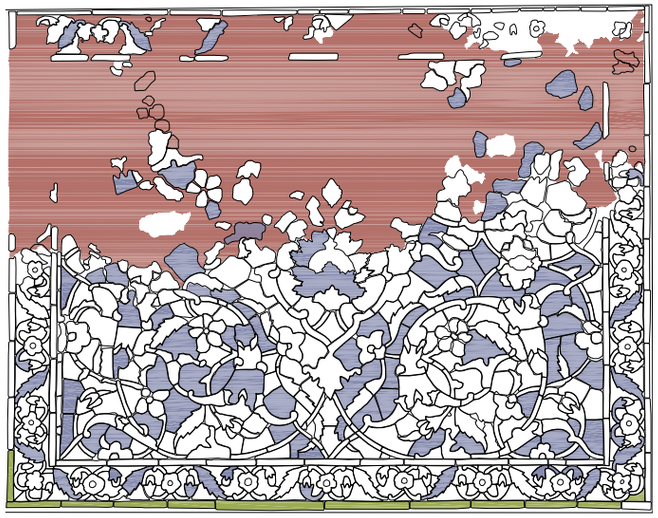
The illustrations on the page opposite and on the following two pages represent part of the process of analysis (described briefly in Section 9.3.1.i) of changes and damages sustained by the monument complex based on a categorization of various forms of weathering and other natural factors, as well as the effects of human use and handling of the monument. These changes, recorded at more general levels for various parts of the monument in the table on pages 130-31, are here recorded and analysed in detail for three specific panels of *kashikari*, two on the northern façade of the complex, and the third on the south-eastern *minar*.

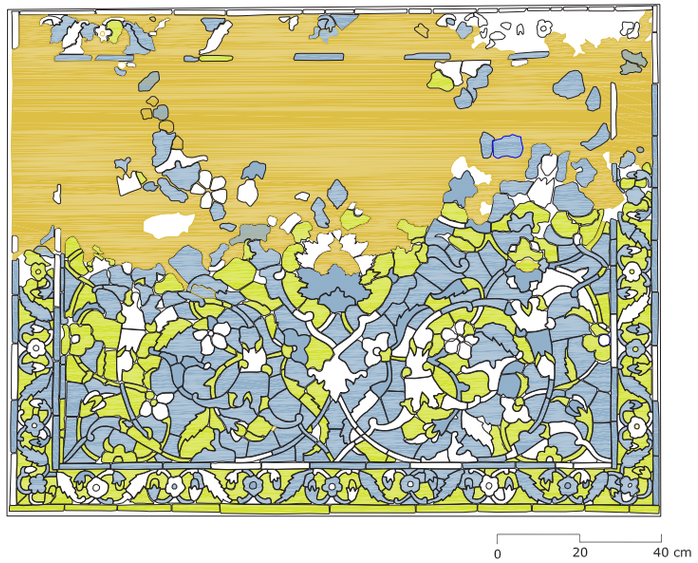
The classification attempts to cover two main stages of changes that clearly appear: the first involving surface changes and the second pertaining to more substantive changes of progressive depth.

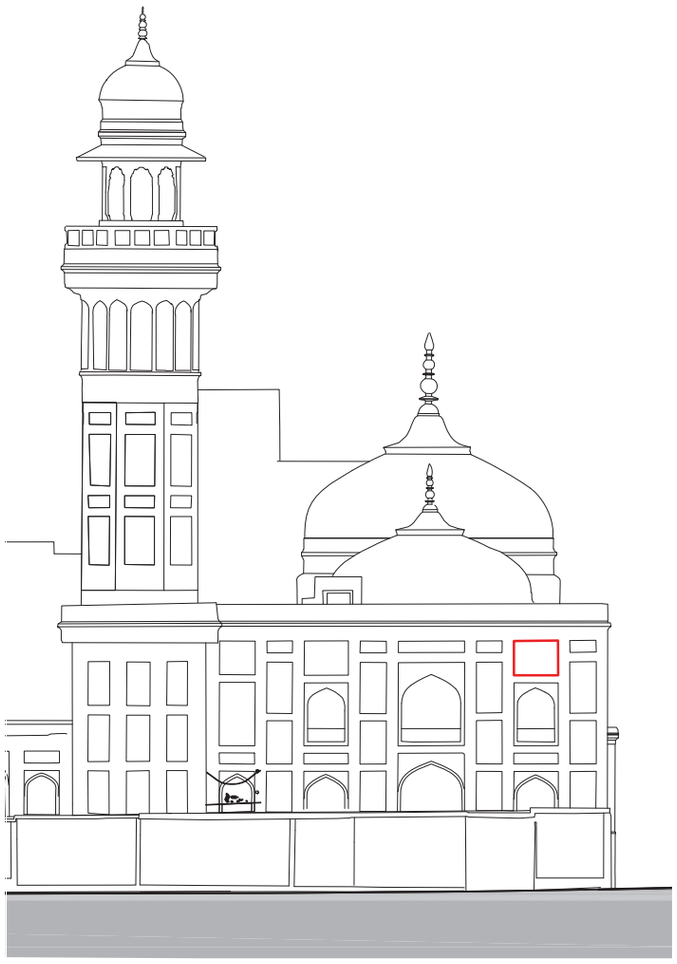
The surface changes observed ranged from slight discoloration and loss of chromatic quality, through deposits of dust and carbon particles (ranging from light to heavy), and long term infestation by algal colonies, which characteristically appear as dark brown to black stains covering large areas of the monument, chiefly on parts less exposed to the sun. These surface changes represent a combination of chemical factors deriving from biological and non-biological sources, the latter relating chiefly to the impact of air borne pollutants emanating from vehicle exhausts. The cracking of the glaze film manifested by hairline cracks appears to result naturally from the diurnal and seasonal temperature changes. In addition the non-biological or abiotic impacts of atmospheric pollutants can result in etching and pitting of the glazed tile surface, resulting in the penetration of water, the intrusion of algal colonization at the glaze and clay interface of the tile, accompanied by cyanobacterial colonization. The mechanics of biological decay of glazed tile has been demonstrated in certain scientific studies.[47] The biological sources in the Wazir Khan complex, on the other hand, are related to processes common on historic monuments in the subcontinent, and could comprise a host of algal taxa in combination with cyanobacterial species and strains, which behave differently in the hot dry and hot wet parts of the year in Pakistan and India.[48]

The incipient changes described as surface changes give rise to more significant damage to the tile revetments, described under five categories that in fact represent gradual transformation of the glazed tile surface until the occurrence of the complete loss of the tile and its mortar under-bed. The earliest aspects of these changes, the exfoliation of the glaze, creates an age-value that could be the factor constraining us from aggressive "conservation" interventions. Pitting and spalling of the terracotta body under the glaze represents the first serious area of intervention, opening up the loci of significant scales of intervention. These could involve completion of the lost parts of a panel. Such reconstruction may or may not be carried out using tiles that attempt to recreate the complete panel, This could well involve tile glazed a specific tone of colour or even blank glazed tiles to distinguish the 17th century work from contemporary work, even if the evidence for a reconstruction exists. Tile panels that are detached from the base masonry could be re-anchored to the latter using appropriate grouts.

As stated previously the analysis of tile damage represented in these pages is a slow and laborious process the progression of which will produce the raw material for informing decisions such as those described in the previous paragraph.







SURFACE CHANGES

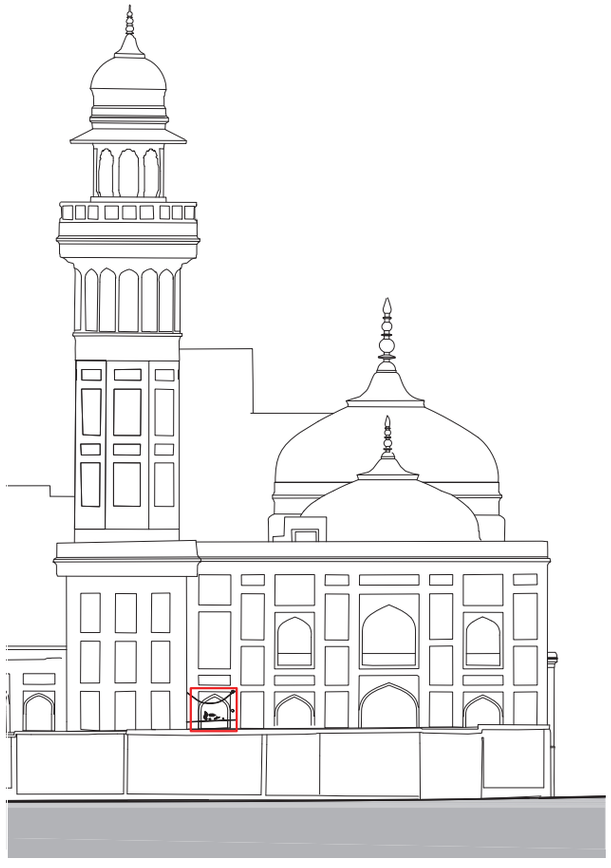
- Discoloration of glaze
- Deposits of dust and biofilm
- Heavy deposit and encrustation of biofilm (lichen, algae, microspores, cyanobacteria etc.)

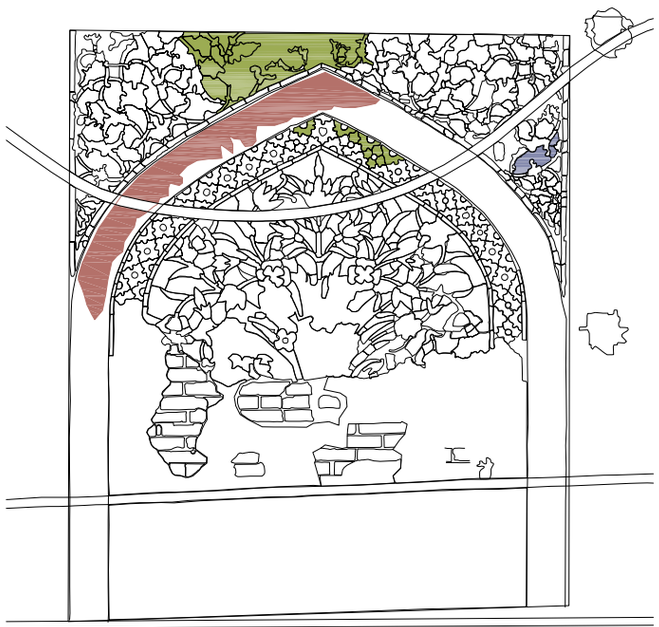
DISINTEGRATION OF MATERIAL

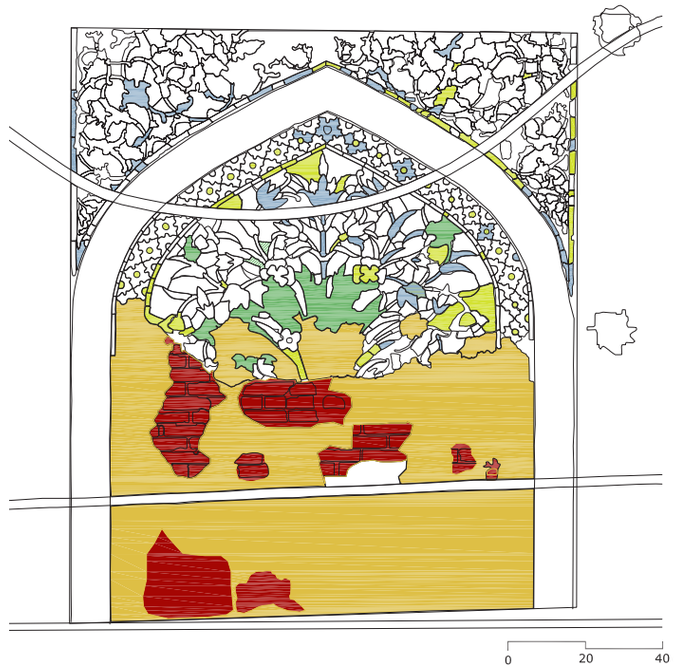
- Exfoliation and partial loss of glaze
- Complete loss of glaze
- Spalling/pitting of terracotta base
- Breakout and complete loss of tile
- Detachment of tile and base mortar from the wall
- Complete loss of tile and base mortar

DOCUMENTATION OF SURFACE CHANGES AND TILE DISINTEGRATION OF A PANEL ON THE NORTHERN FAÇADE OF THE PRAYER CHAMBER

This floral/geometric glazed tile panel on the north façade of the prayer chamber, is located above Kotwali Bazaar. It displays instances of discoloration of glaze, deposits, complete loss of tiles and base mortar, exfoliation of glaze from the terracotta body, complete loss of glaze from terracotta and spalling of tile body.







SURFACE CHANGES

- Discoloration of glaze
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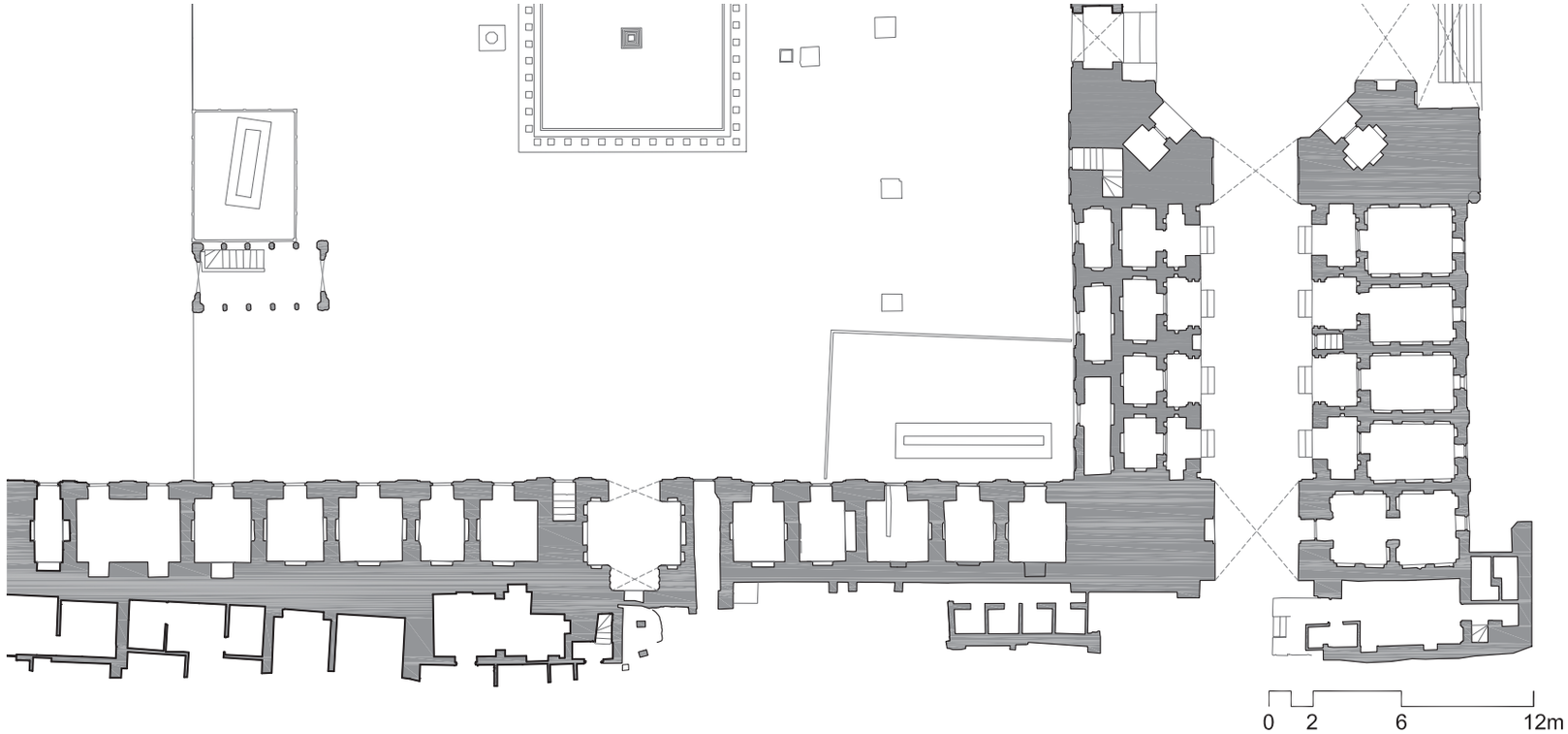
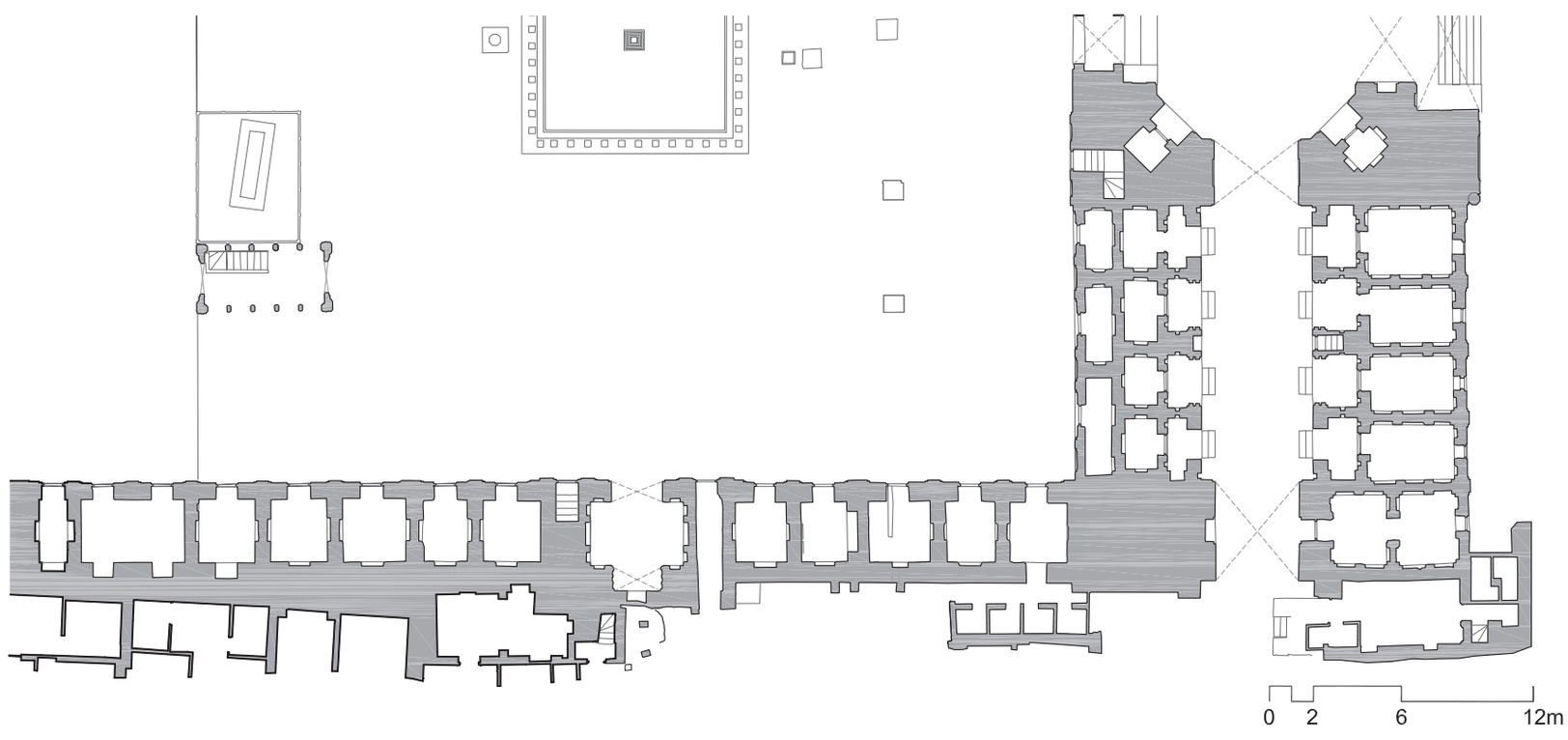
DISINTEGRATION OF MATERIAL

- Exfoliation and partial loss of glaze
- Complete loss of glaze
- Spalling/pitting of terracotta base
- Breakout and complete loss of tile
- Detachment of tile and base mortar from the wall
- Complete loss of tile and base mortar

DOCUMENTATION OF SURFACE CHANGES AND TILE DISINTEGRATION ON THE NORTHERN FAÇADE OF THE PRAYER CHAMBER

This arboreal glazed tile panel on the north façade of the prayer chamber, is located directly above the roofs of the shops on Level 0 and thus has suffered from the damages associated with Kotwali Bazaar. It displays instances of deposits, complete loss of tiles and base mortar, exfoliation of glaze from the terracotta body, complete loss of glaze from terracotta and spalling of tile body.





PLANS SHOWING CHANGES IN THE SOUTH-EASTERN CORNER OF THE MOSQUE COURTYARD

Top: Showing the ablution facility in the south-eastern corner, and the adjacent hujra *(the first on the southern row) which at that time was still intact.*

Below: The ablution facility after removal, and the passageway created through the hujra *to the latrines located outside.*

Opposite, top: The ablution facility before removal (seen from the north-west).

Opposite, below: The south-eastern corner of the courtyard, after the removal of the ablution facility, but before commencement of excavations.

10 CHANGES TO THE MOSQUE SINCE DOCUMENTATION

1. An important intervention made in the mosque some years ago was the reconstruction of the central ablution pond in the centre of the courtyard. At the same time a secondary ablution facility (now removed) was built in the south-eastern corner of the courtyard. On the other side of the row of the southern *hujras* exists the Auqaf established row of toilets. The sharp subsidence of the eastern half of the row of *hujras* on the south side is evidence of the abundant water seepage that has been the consequence of these two facilities on the southern and northern side of the *hujras*. In addition, in recent months, the courtyard floor on the south-eastern side has also shown a considerable subsidence. The outcry caused by this has resulted in a repair operation which is described below.

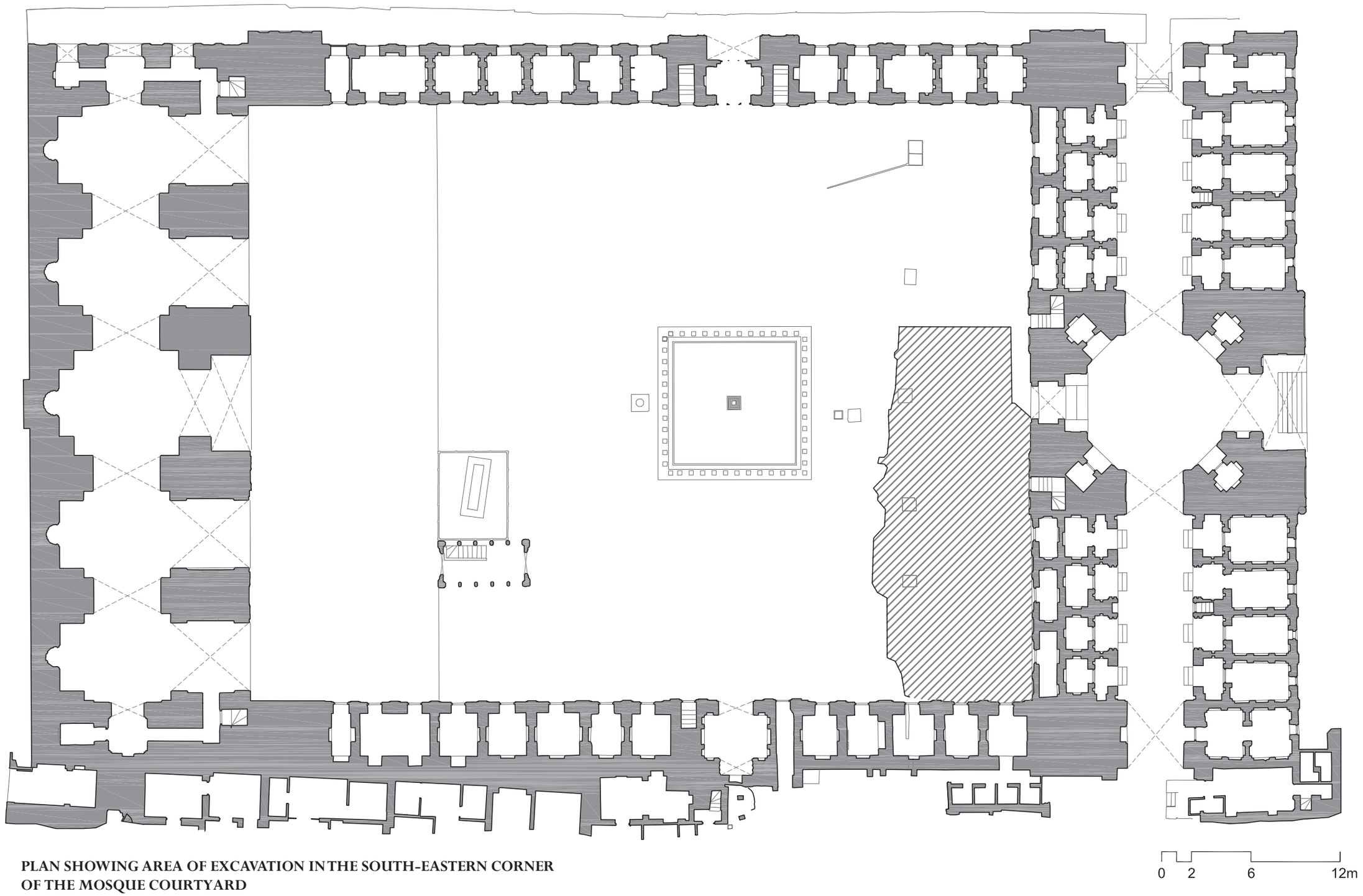
2. Another change brought about recently is the creation of a new access into the mosque courtyard from the southern side, i.e. from the proximity of the present toilet block. This was achieved by opening up an entrance portal in the external wall of the first *hujra* from the east in the southern flank of the courtyard.

3. In April 2011, the Punjab Archaeology Department commenced dismantling a portion of the courtyard of the mosque. This activity was aimed at addressing the subsidence of the courtyard floor, mentioned above.

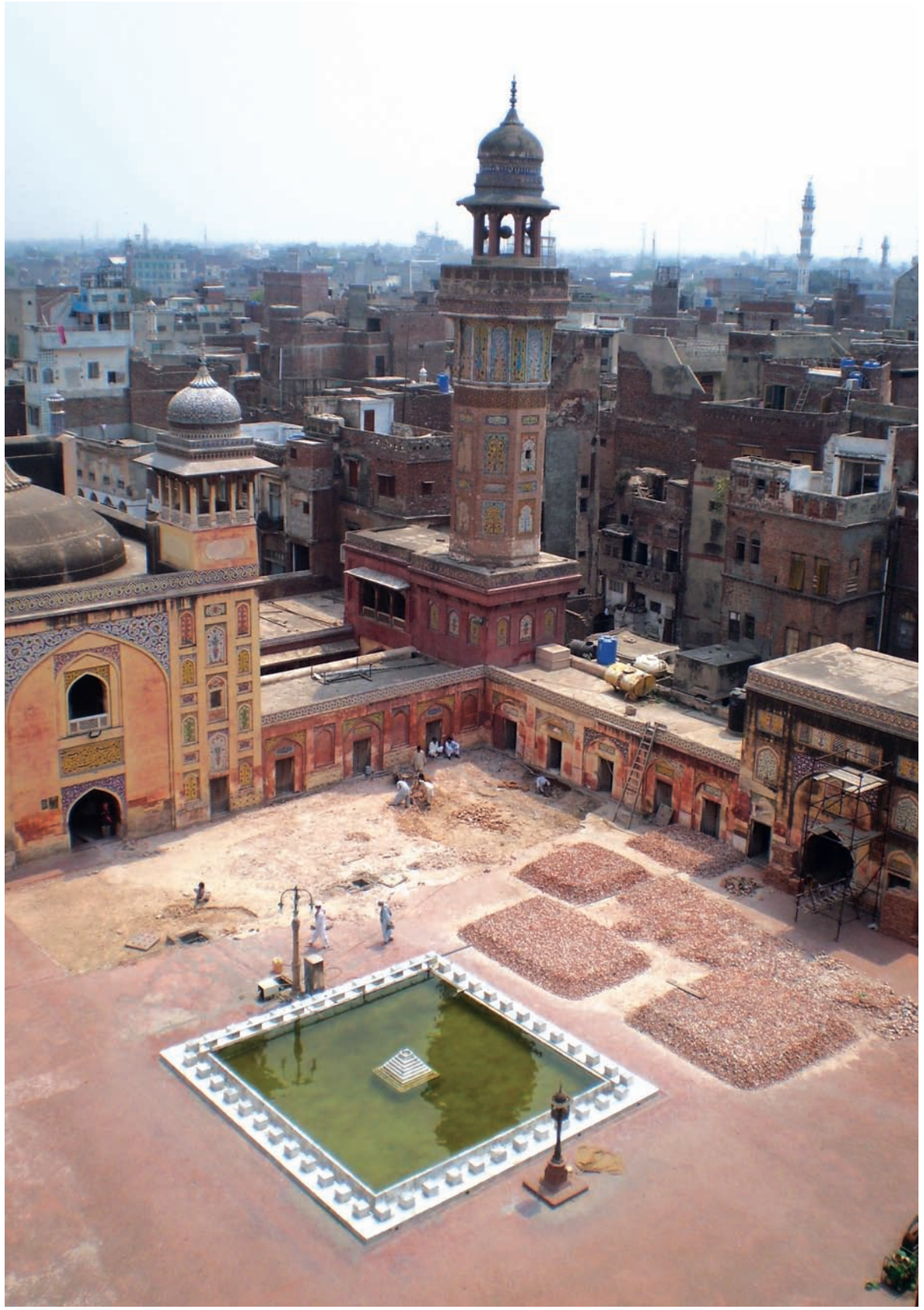
   In a meeting at the site held on 19th April, 2011 between the Director General, Punjab Archaeology Department, the Director General, PMU Sustainable Development of the Walled City of Lahore and representatives of AKTC-AKCSP, the removal of the historic lime sub-floor by the Archaeology Department was discussed. The Archaeology Department representative mentioned that the Department intended to repair the courtyard floor by replacing the sub-floor by cement concrete. In the discussion which followed, it was agreed that the Department will substitute the cement concrete base with lime and kankar lime mix to be as authentically close to the original base concrete as possible.

   It was also decided to use the opportunity to explore the depth of the foundations of the *hujra* wing on the southern side of the courtyard.

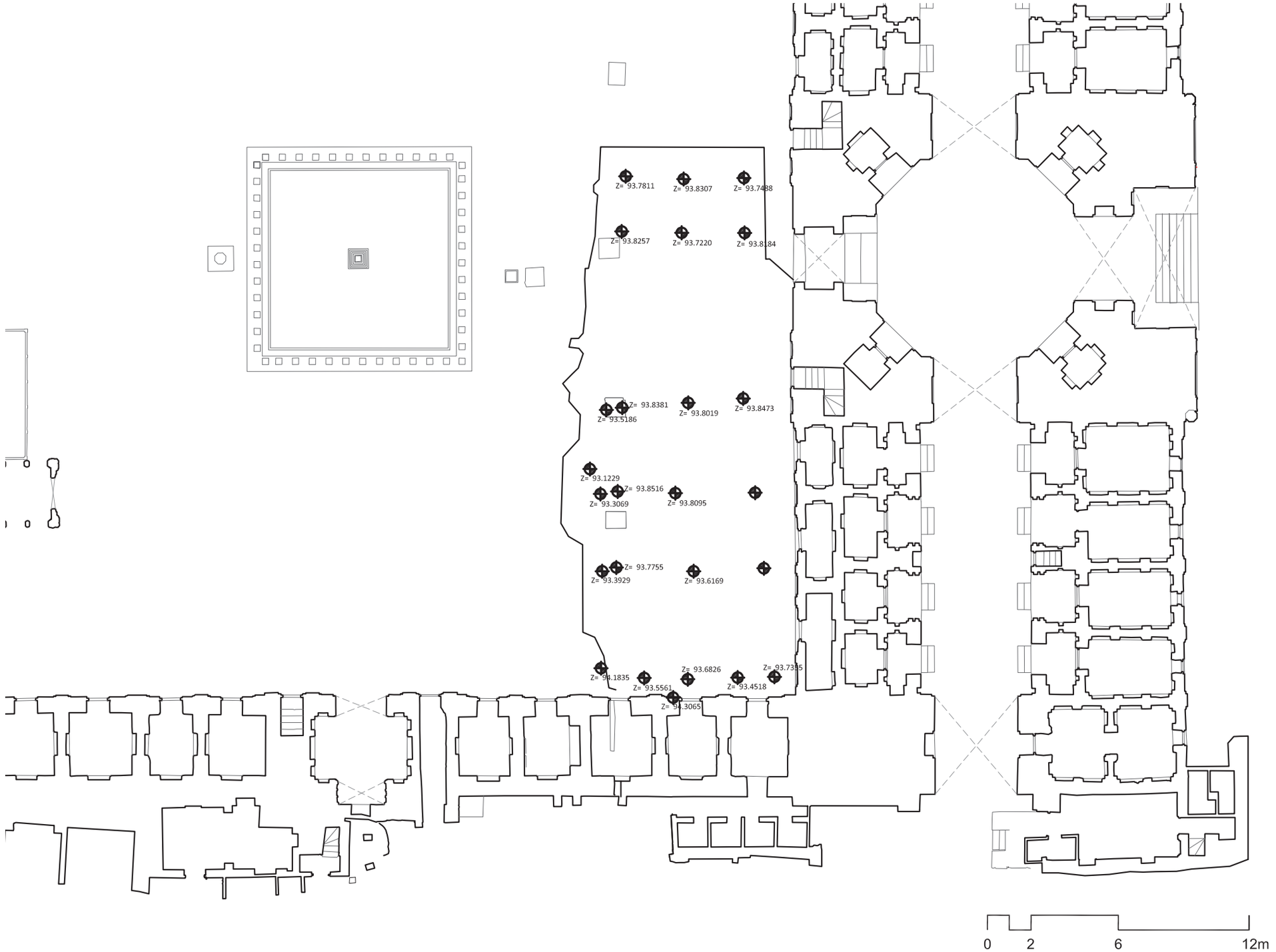
   The expanse of the courtyard floor removed by the Punjab Archaeology Department was documented as were the depth of the excavations. This is shown overleaf.



PLAN SHOWING AREA OF EXCAVATION IN THE SOUTH-EASTERN CORNER OF THE MOSQUE COURTYARD



View from the north-west minar *of the excavation work in the south-east corner of the courtyard.*



PLAN SHOWING EXCAVATIONS AND THEIR DEPTHS AT VARIOUS LOCATIONS

Close-up view of the excavation work.

ENDNOTES

1. This would hold true for the country as a whole. The pioneering documentation effort carried out by the Conservation and Rehabilitation Centre for the city and the monuments of Uch, District Bahawalpur, and the conservation process that followed it is perhaps the only glaring exception.

2. Chaghatai, Abdullah, (1975) *The Wazir Khan Mosque, Lahore.* Lahore: Kitab Khana-i-Nauras.

3. See in particular, Chaghatai, op. cit.

4. International Council of Monuments and Sites (ICOMOS) is an international non-governmental organization of professionals, dedicated to the conservation of the world's historic monuments and sites. The relevant documents are: (i) the International Charter for the Conservation and Rehabilitation of Monuments and Sites, 1964 (the Venice Charter), (ii) the Charter for the Conservation of Historic Towns and Urban Areas, 1987 and (iii) ICOMOS Charter - Principles for the Analysis, Conservation and Structural Restoration of Architectural Herirage, 2003.

5. The United Nations Educational, Scientific and Cultural Organization (UNESCO).

6. ± 3mm.

7. Reflectorless Electromagnetic Distance Measurement.

8. The software used was TheoLT by Latimer CAD of UK.

9. The software used was Manual TREXtify by Bjorn Van Genechten, Catholic University Leuven, Belgium.

10. Chaghatai, Abdullah, (1975) *The Wazir Khan Mosque, Lahore.* Lahore: Kitab Khana-i-Nauras.

11. Kamil Khan Mumtaz has published on his website an article titled "*Reading Masjid Wazir Khan*". In this erudite interpretation of the calligraphy of the Wazir Khan Mosque, he links the use of the Surat-al Fath on the main façade of the prayer chamber to the graphic illustration of an event in the life of Prophet Muhammad (PBUH) in the fresco on the entrados of the first secondary arch on the northern half of this façade, as one instance of the use of calligraphy in Islamic architecture to illustrate esoteric meaning and imbue to architecture the role of a vehicle of transcendence from the material to the spiritual. (www.kamilkhanmumtaz.com)

12. Qureshi, Muhammad Abdullah, (1962) "*Masaajid: Ahd-e-Ghazvanvi se zamana - e - haal tak*". The author states that in 1850 the British administration cleared out encroached houses and buildings built during the Sikh rule from Chowk Wazir Khan. Illegal occupation by shops were removed at least twice over the course of the last 150 years: the first during the early British period, and the second in 1953 soon after religious disturbances and the declaration of Martial Law in that year.

13. The Antiquities Act (1975).

14. Kanhaiyya Lal Hindi, (1884) *Tarikh-e-Lahore*. Lahore: Victoria Press. Latif also mentions the epigraphic tablets on the two monuments, the dates and the circumstances surrounding the constructions; however, Qureshi, has claimed that the dome was built earlier and had already undergone several transformations before the most recent one in 1990.

15. Aijazuddin, F.S. Lahore, (reprint:1991) *Lahore: Illustrated Views of the 19th Century*.

16. Latif, Syed Muhammad, (1892) in *Lahore, its History, Architectural Remains and Antiquities* offers the complete transcript of the plaque that existed on the structure demolished in 1990.

17. Photographed in the 1970's.

18. This well is evidenced by etchings and water colours produced in the 19th century, and by a photograph taken in the 1880's.

19. As recorded in 1988. See *Pakistan Environmental Planning and Architectural Consultants/Lahore Development Authority, Walled City of Lahore*, Lahore, 1992, reprinted and republished by Sustainable Development of the Walled City of Lahore, 2010.

20. The functioning open drain was part of a system of similar drains that ran along the sides of the streets all the way through Delhi Gate Bazaar to Delhi Gate, and which have likewise been closed, their function taken over by the main sewer in the bazaar.

21. Published in Latif, Syed Muhammad, (1892) *Lahore, its History, Architectural Remains and Antiquities*. Lahore: New Imperial Press.

22. Kanhaiyya Lal Hindi, (1884) *Tarikh-e-Lahore*. Lahore: Victoria Press.

23. Chaghatai, Abdullah, (1975) *The Wazir Khan Mosque, Lahore.* Lahore: Kitab Khana-i-Nauras.

24. Chaghatai, (1975) op. cit.

25. Numbers such as SE-05-X1 and SE-05-X2 are accorded by AKTC-AKCSP in their city wide inventory to properties that lack the normal number codes established during British times.

26. Chaghatai mentions that in the early seventies the well still existed and that water was being drawn from it using an electric motor. (1975, p.38)

27. From a comparison of the present situation with the 1907 cadastral map obtained from the Punjab Revenue Department.

28. Chaghatai, Abdullah, (1975) *The Wazir Khan Mosque, Lahore.* Lahore: Kitab Khana-i-Nauras.

29. The geotechnical investigations carried out by AKCSP were in the main restricted to the four *minars* and those parts of the foundations that could be accessed from within the courtyard.

30. Oral communication by Mr. Talib Hussain.

31. The 1907 cadastral map obtained from the Punjab Revenue Department clearly shows the drain in the south side of the mosque.

32. Authored in all probability by the late Wali Ullah Khan; the authority on which this statement is based is not known.

33. Evidence for this is found in numerous instances: Asif Khan's tomb, the upper structure of the Hazuri Bagh pavilion, the precious stones in the Naulakha pavilion and Shish Mahal of the Lahore Fort, etc.

34. Chaghatai, (1975) op. cit. Chaghatai recounts that once Maharaja Ranjit Singh became seriously ill after spending a morning of amusement on one of the *minars* of the mosque, but thereafter left the mosque alone after having been told that his illness was the consequence of his disgracing the mosque and the tomb of Syed Ishaq Gazruni.

35. Kanhaiyya, Lal Hindi. (1884) op. cit.

36. Chaghatai, (1975) op. cit

37. Qureshi, (1962) op cit., mentions that the Auqaf Department was established in 1961.

38. These monuments were Badshahi Masjid, Lahore, Wazir Khan Masjid, Lahore, the tomb of Shah Rukn-e-Alam, Multan, the tomb of Bahau Uddin Zikarya, Multan and Shahi Masjid, Chiniot.

39. Established under Sir Sikandar Hayat Khan, Punjab Chief Minister in the early 1940s.

40. The progression of steel fabrication from simple knife making on the eastern side of the Chowk to large scale fabrication of steel architectural elements is a measure of the growing failure of municipal regulatory functions.

41. Lime mortar has the tendency to become stronger with the passage of time due to progressive carbonation of the lime. Lime mortar in historic buildings also has relatively low compressive strength and higher flexibility than other forms of mortar, absorbs seismic and thermal movement and protects the bricks from the effects of such movement. The fact that the basic construction module is the small *waziri* brick embedded in relatively thick mortar beds in the body of the walls also appears to have lent resilience to the building fabric. The size of the brick used in the masonry is 1.25 x 4 x 8 inches.

42. In the 1907 revenue map, the location of a manually excavated pit was occupied by a house.

43. Geotechnical investigations were carried out in August - September 2009 by Berkeley Associates of Lahore.

44. Please refer to Appendix B.

45. Chaghatai mentions the earthquake of 1902 in discussing the damage sustained by the mosque. This is supported by Dr. Wenzel (ibid.)

46. Mumtaz, op. cit.

47. Watanabe, K., Ohfuji, H., Ando, J., and Kitagawa, R., (2006) "*Elemental behaviour during the process of corrosion of sekishu glazed roof-tiles affected by …… crustose lichen*", Clay Minerals 41, p.p.819–826.

48. Samad, L.K., and Adhikary, S.B., (2008) "*Diversity of Micro-algae and Cyanobacteria on Building Facades and Monuments in India*", *Algae* Volume 23(2): p.p.91-114.

PART III: CONSERVATION AND RESTORATION: STRATEGIC CHOICES AND DEVELOPMENT OF PROPOSALS

11 A FRAMEWORK FOR FURTHER ACTION

Heritage documentation is an integral part of the conservation process and documentation of the appropriate intensity and detail is the means to arrive at an effective understanding of a given heritage element and the challenges it poses in terms of various dimensions of conservation. It is essential because it provides the data for recording condition, understanding, interpretation and action.[1]

The conservation process can be seen as a four-step cycle, each step informing the next. These steps begin with (i) an evaluation of authenticity, significance and value (which includes careful documentation of the building), followed by (ii) a process of diagnosis (which involves an analysis of recorded conditions), (iii) a process of intervention—the measures which will arrest deterioration and restore value, and (iv) a process of monitoring the effects of intervention and maintaining the state in which the building was conserved. The basic premise of the conservation cycle is to understand the historic environment in order to successfully manage and conserve it.

The documentation of the Wazir Khan complex, some of which this report includes, and the resulting evaluation of its conditions have enabled the consideration of a range of problems and issues that the monumental complex faces. In order to proceed further towards a medium to long term conservation strategy for the mosque complex, several decisions are required to be made that pertain to the following broad areas of consideration.

1. Problems and issues pertaining to the neighbourhood of the mosque complex;

2. The problem of encroachments, lack of municipal control and regulation of a heritage site. This comprises at least two important aspects which need to be considered:

   a) The manner in which *waqf* properties have been allowed to be used as private or semi-private premises;

   b) The manner in which the present condition of occupation and use of *waqf* properties affect the functioning of the city in the immediate environs of the mosque, thereby affecting its setting, presentability, maintenance and upkeep.

3. Infrastructure issues:

   a) The infrastructure conditions, in particular water supply, rain water drainage and waste water disposal;

   b) Improvement of existing municipal utility services: the ways in which services improvement being carried out as part of the Pilot Urban Rehabilitation and Infrastructure Improvement Project[2], will impinge on the services improvement for and within the mosque complex.

4. Issues of conservation of the mosque complex per se:

   a) The uses to which certain parts of the mosque are currently being put, including unregulated structures which have been allowed to be built against the structure of the monument;

   b) Problems and issues pertaining to the conservation work to be carried out within the limits of the mosque.

5. Issues pertaining to the institutional context of the monument and its urban environment - present and future.

These strategic issues are inter-related and must be thought of in an integrated way. Actions emanating from any strategies adopted must ensue from them in a coordinated manner. The following discussion will attempt to elaborate on these issues, to be followed later in the document with proposals for a structured strategic framework.

11.1 THE NEIGHBOURHOOD OF THE MOSQUE COMPLEX

The problems and issues pertaining to the neighbourhood context have been dealt with in the detailed discussion in Section 6. Unregulated construction near the mosque or abutting the monument is conspicuous. A general impression of the encroachments at the neighbourhood level is that they are associated with the commercial activities primarily on the northern and eastern sides of the mosque complex. The residential encroachments on the southern side are rather less visible but nevertheless have serious repercussions of damage to the structure of the mosque. Most of the buildings that abut the mosque on the south side, whether built and / or owned by the Auqaf Department or by private owners, have their wet areas (bathrooms, toilets and kitchens) adjacent to the south wall of the mosque. The poor drainage system of these wet areas has contributed greatly to the damage to the structure of the mosque. Additionally, the structural loads of several houses bear directly onto the old walls of the mosque which has resulted in structural damage, obstructed access for maintenance, and obscured the architectural features of the mosque.

The **strategic issues** to be dealt with here relate to:

a) The land and properties surrounding the mosque proper that formed part of the historic endowment;

b) The later period structures present on these locations and how they must be dealt with. This implies the possibility of the removal of many of these later period constructions, some of which are actually supported by the 17th century walls of the monument;

c) The fate of the *jilau khana* of the mosque, i.e., Chowk Wazir Khan: the current bad state and conditions of use of this important element will continue to affect the future state of upkeep and presentation of the mosque itself. As part of the Pilot Urban Rehabilitation and Infrastructure Improvement Project, Chowk Wazir Khan and the bazaar along the north façade up to the Chowk Kotwali have already been integrated in the project proposals with a primary focus on removing the encroached properties and improving the façades and public space in Chowk Wazir Khan;

d) Demolition of encroaching shops and houses and renting/ reusing shops abutting the mosque and those present in Chowk Wazir Khan;

e) Access to the building fabric of the mosque proper from all sides, for its proper care and maintenance;

f) The neighboring properties on the southern side of the mosque. The conservation of Wazir Khan Mosque needs to address the emerging threats caused by the neighbourhood properties on its southern side. Six houses (Auqaf and privately owned) which were constructed later in the open space, have now obstructed and damaged the south façade and its structure. The most visible structural deformations like the leaning of the *minars*, settlement in the courtyard floor and *hujra* block have occurred on the southern side of the mosque. The project is an opportunity to stop and reverse such damaging trends and to deal appropriately with the illegal constructions which have caused permanent damage to the very fabric of the monument.

The proposal at the neighborhood level will have to address these urgent needs and the future needs which are critical to the use and maintenance of the structure of the mosque. A major focus should be to not encourage large and inappropriate commercial activities within and around the mosque. The area of the mosque should be a haven of peace within the crowded hum-drum of the commercial areas of the Walled City.

The **strategic actions** at the level of the neighbourhood that are indicated by the analysis contained in this report are:

i. That all later period constructions that abut the 17th century edifice must be removed to an extent that the structure of the mosque is accessible from all sides for repair and maintenance and for the proper drainage from its roofs.

ii. The properties owned by the Auqaf or by private owners which abut or are adjacent to the mosque's southern perimeter should be removed, and their occupants accommodated

elsewhere, thus creating more room between the mosque and residential area to implement the old right of way (ROW). Demolition of these houses should be followed by redesigning the old street between the mosque and the neighbourhood.

iii. The full weight of the current and future legislation relating to listed historic monuments must be brought to bear on the regulatory regime to be imposed on the neighbourhood of the mosque;

iv. Existing institutional arrangements must be reviewed in depth and new institutional structures established that prevent any future institutional neglect of the kind that has been visible on this prized monument over the past two centuries. **The mosque and its environment should be the prime focus of the initial activities of the Authority to be established under the forthcoming Lahore Walled City Act.**[3]

v. The urban design of Chowk Wazir Khan and Kotwali Bazaar should be integrated with the conservation design of the mosque; a specific aspect to be dealt with within this context is the need to expose those parts of the façades of the mosque that are presently hidden by the raised levels of the street and the floor of the Chowk.

vi. Appropriate measures for the reduction of the intensity of traffic and its proper regulation should be taken. While this could be the result of the lowering of the floor of the Chowk, all changes in the existing pattern of movement of people and goods in the Chowk and the Kotwali Bazaar should be integrated with a comprehensive re-design of traffic in the larger neighbourhood of Delhi Gate, Yakki Gate and Sheranwala Gate.

vii. The 1990 structure of the *mazaar* and shrine of Syed Suf should be reduced to a reasonable size and an appropriate style that does not obstruct the axial view of the mosque entrance *iwan* from Chitta Gate and that does not impose upon the 17th century ensemble visually and stylistically.

viii. An appropriate design of the reconditioning of the Chowk should be prepared as part of the urban design component of the current urban rehabilitation and infrastructure design project. This could involve acquisition of certain properties which intrude into the public space of the Chowk, their demolition and the construction of new façades which are duly respectful of the grand entrance façade of the mosque.

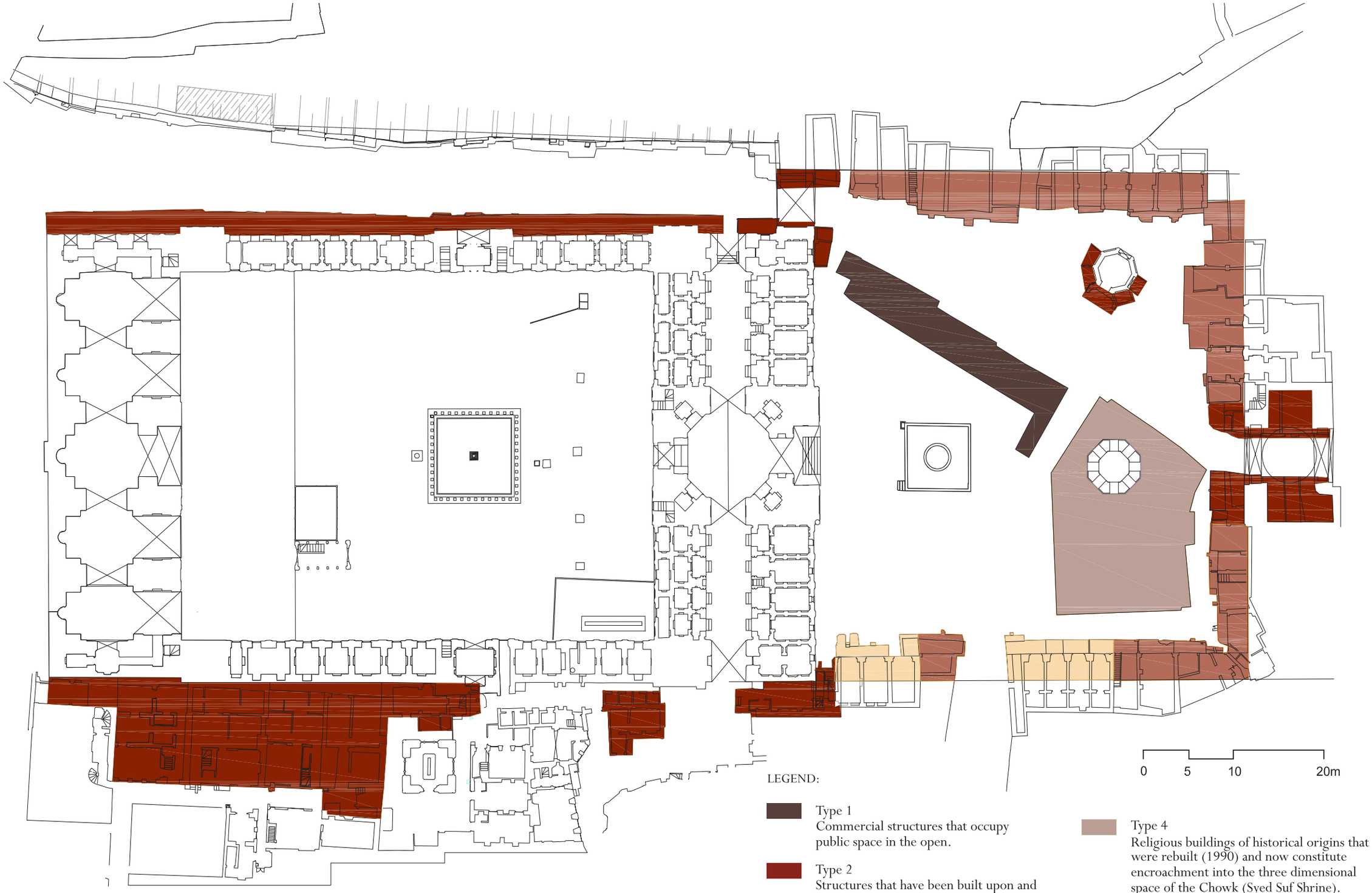
ix. The heritage component of the Chowk itself, including Chitta Gate and Dina Nath's Well, should be appropriately conserved, rehabilitated and presented so as to recapitulate the essence of the Chowk's former scale and ambience. This would involve the right of way of the Chowk to be cleared, and properties that are of architectural and historic merit to be listed and appropriately conserved;

x. Recently discovered fragments of what could be the original façade of the Chowk or its later modifications are embedded deep inside modern constructions. These should be laid bare, conserved and appropriately displayed.

11.2 ENCROACHMENTS, LACK OF MUNICIPAL CONTROL AND REGULATION

The encroachments within and surrounding the mosque are by now recognized and the parties involved identified. These structures are of five kinds, and for each a specific strategy is recommended for adoption:

	Types of Encroachments	Proposed Strategy
1	Structures that occupy public space in the open;	These include the shops on the Chowk that have come to arise on the diagonal path leading from Chitta Gate to Kotwali Gate. The removal of these shops is essential and is already being actively considered as part of the Punjab Government/World Bank financed Pilot Urban Rehabilitation and Infrastructure Improvement Project currently being undertaken.
2	Structures that have been built against the building structure of the mosque and other protected properties in the Chowk such as Dina Nath's Well and the two gates - Chitta and Kotwali;	A similar strategy of removal of such unlawful constructions has been incorporated within the Pilot Urban Rehabilitation and Infrsatructure Project.
3	Structures that are illegal outgrowths from the original perimeter/ Right of Way (ROW) of the Chowk, i.e. property which replaced the original structures that constituted the 17th century layout of the Chowk;	The extent to which these structures will be either allowed to continue as at present, or be pushed back to the line designating the legal ROW (as determined by officials of the Revenue Department in February, 2010), or removed altogether up till the original ROW is contingent upon the precise urban design of the Chowk that will be approved. Options for the design have been prepared and are currently under consideration. (See illustrations on the following pages).
4	Elements that constitute a considerable degree of visual obstruction to the mosque's entrance *iwan;*	The only structure that subscribes to this description is the Syed Suf Shrine that was built in 1990. It is proposed that ways must be found to replace it with a suitable and appropriate structure of lesser size which enables the old axial link between Chitta Gate and the main *iwan* of the mosque to be reinstated.
5	Encroachments constructed in the 19th and early 20th centuries but which today constitute elements of historic importance and some degree of architectural merit and which therefore justify conservation in their own right.	There are two properties that fit this description: H-1088, and H-687. Both these properties will lend value to the Chowk and the mosque if properly conserved, integrated into the design of the Chowk, and displayed. However, this may meet with resistance from the owners of other properties which are not being conserved or whose properties will be altered to one extent or another in order to bring them into the parameters of the law. This issue will need to be addressed and mitigated.



LEGEND:

Type 1
Commercial structures that occupy public space in the open.

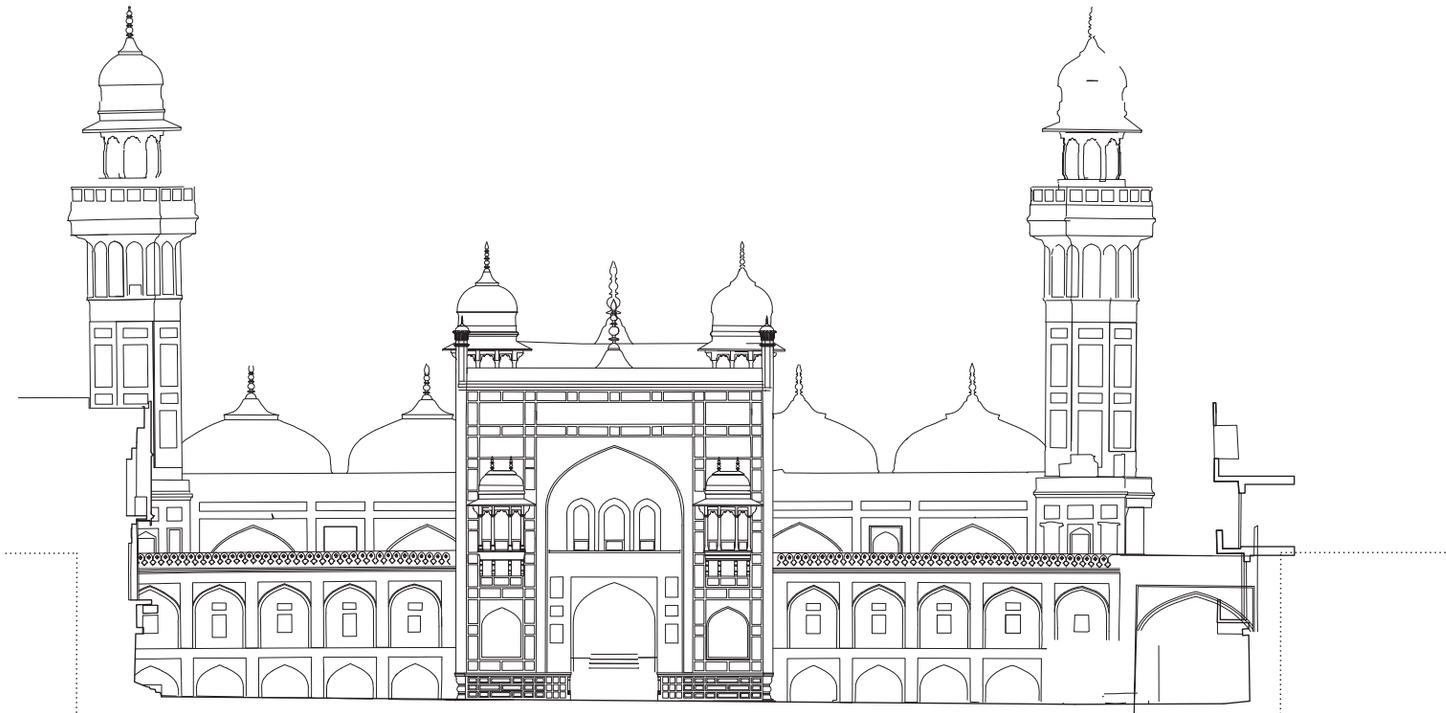
Type 2
Structures that have been built upon and against the building structure of the mosque or other protected monuments.

Type 3
Structures that are illegal outgrowths from the original perimeter/ROW of the Chowk.

Type 4
Religious buildings of historical origins that were rebuilt (1990) and now constitute encroachment into the three dimensional space of the Chowk (Syed Suf Shrine).

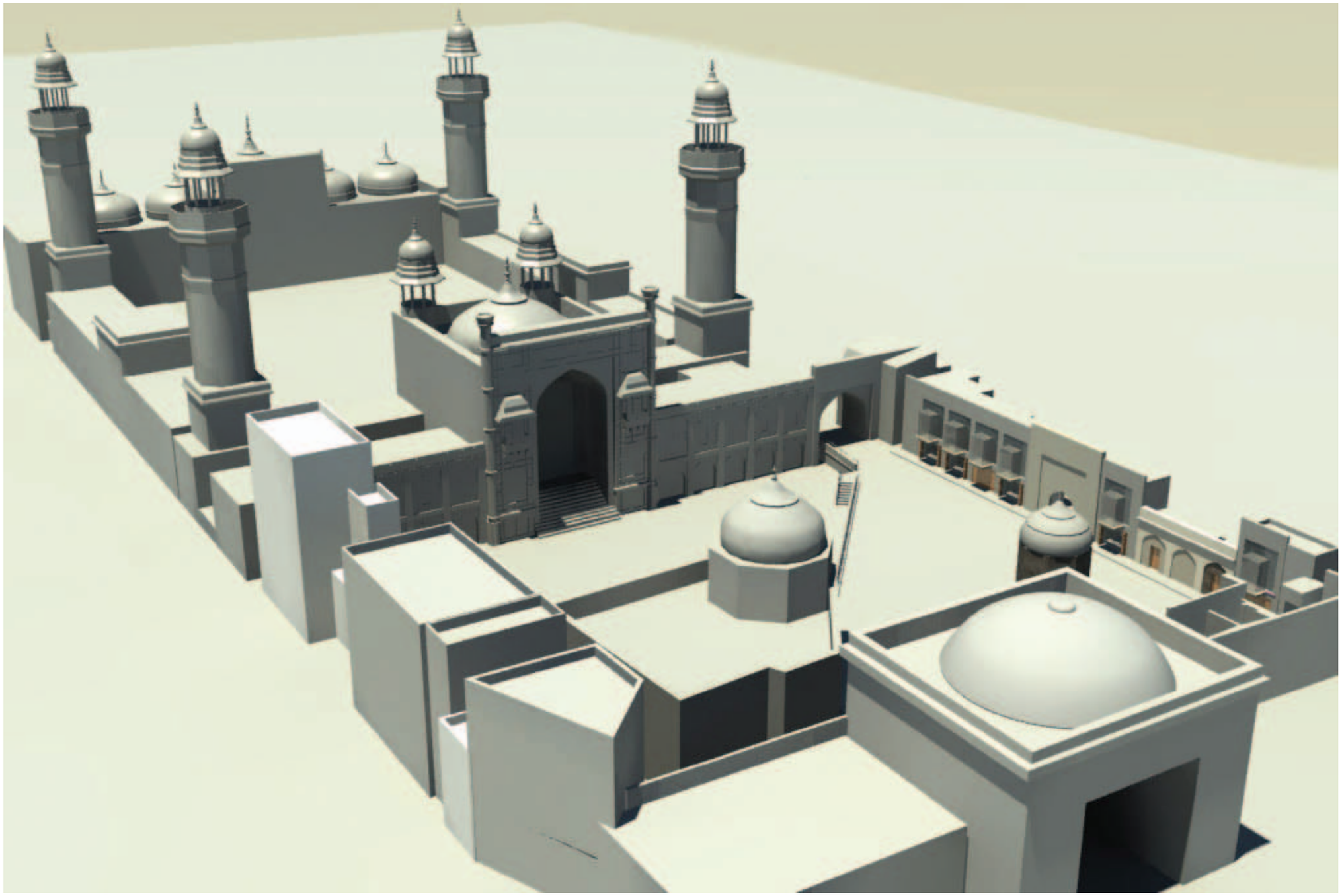
Type 5
Encroachments which happened in the 19th and 20th century but which today costitute elements of cultural and artistic worth.

TYPES OF ENCROACHMENT IN THE WAZIR KHAN CHOWK AND TO THE NORTH AND SOUTH OF THE MOSQUE

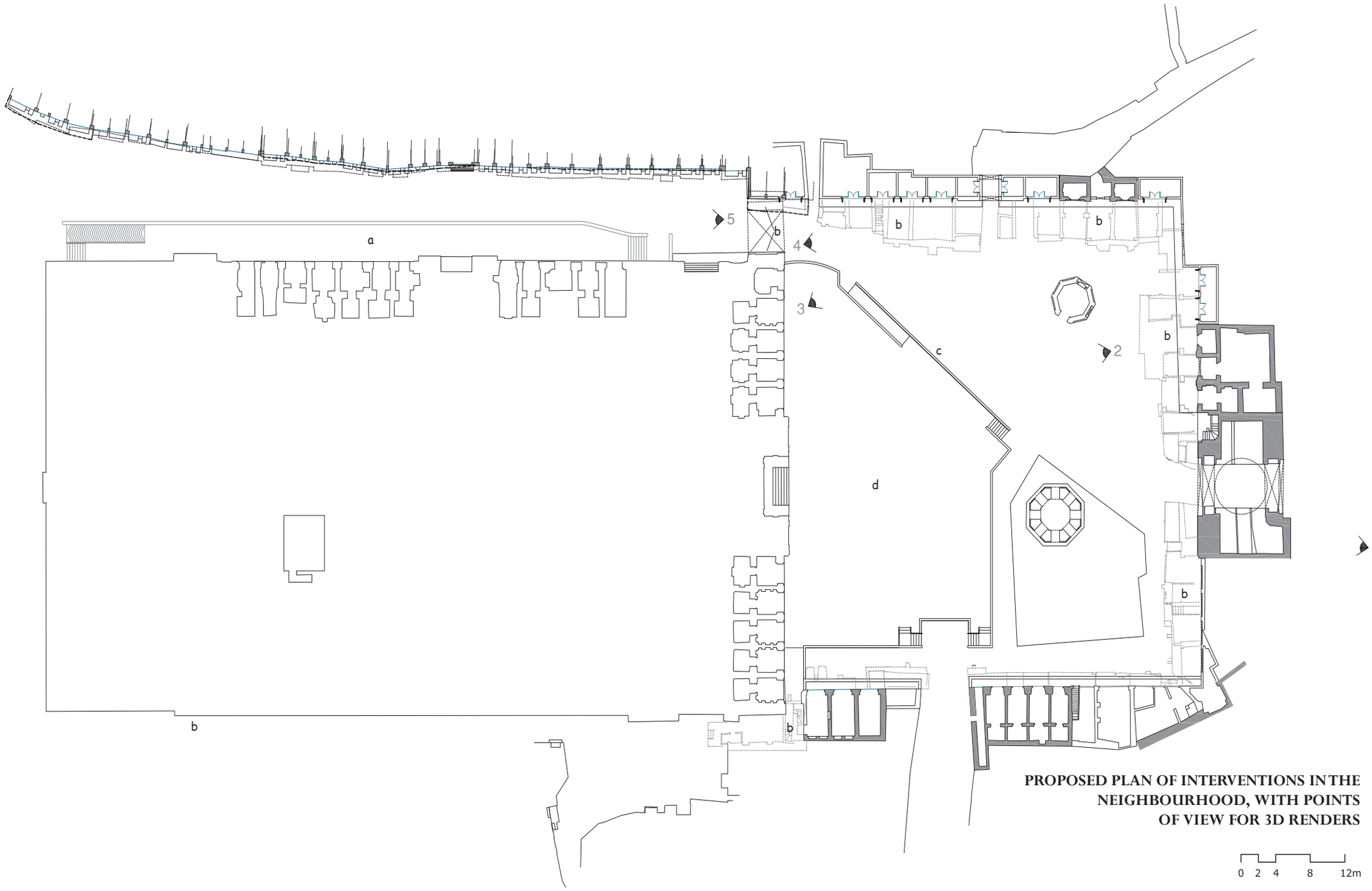


EXTENT OF BASE OF MAIN FAÇADE BENEATH THE CURRENT LEVEL OF THE CHOWK.

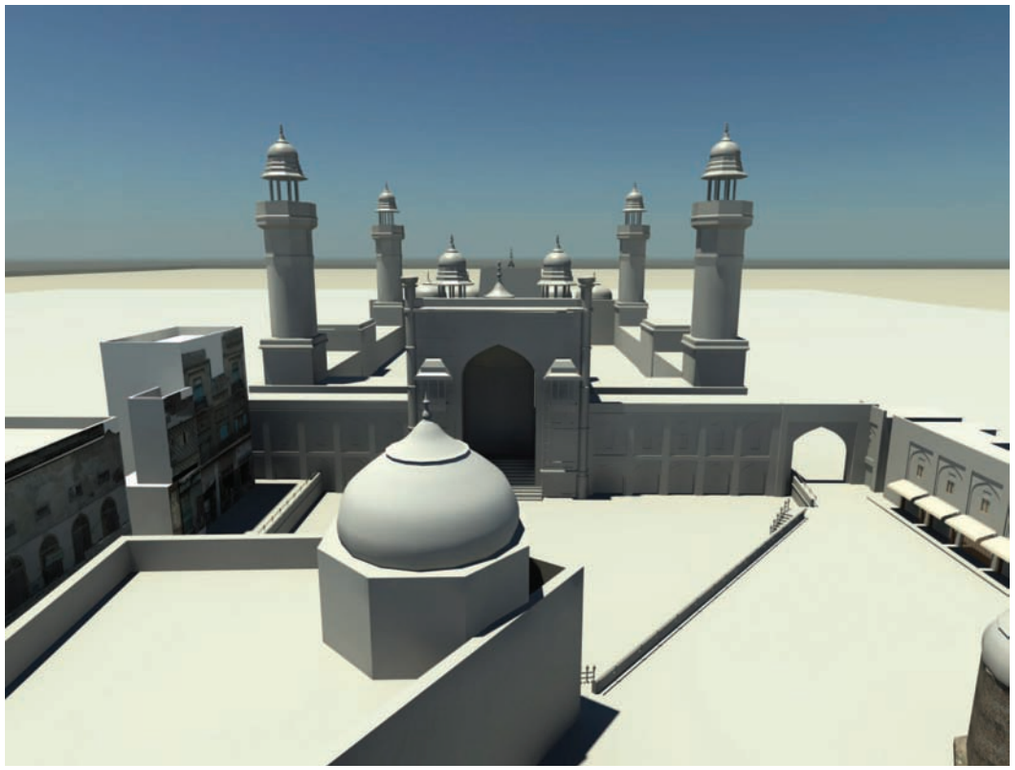
Two versions of the main façade of the mosque fronting on to Chowk Wazir Khan, showing the extent of the base of the façade currently hidden from view as a result of the rise of the floor of the Chowk in the nearly four centuries of its existence. The lower drawing also indicates the original proportions of the façade as it will be revealed if the floor of the Chowk is lowered to its original level, some 1.2 m (4 feet) below the current level.



A general view from south-east of the Wazir Khan Mosque with the restored space of its Chowk.



Plan showing the full range of interventions proposed to be made in the neighbourhood context of the Wazir Khan Mosque.
Clockwise from top: a) the street surface of Kotwali Bazaar lowered to expose the north façade of the mosque, made possible by the increase in street width obtained after the removal of shops that are currently built against the north façade; b) removal of other existing buildings encroaching into the space of the Chowk or abutting the historic walls of the monument in the Chowk, or on the southern perimeter of the monument; c) removal of shops along the diagonal movement path between Chitta Gate and Kotwali Gate; d) lowering of the floor of the Chowk in front of the main entrance.



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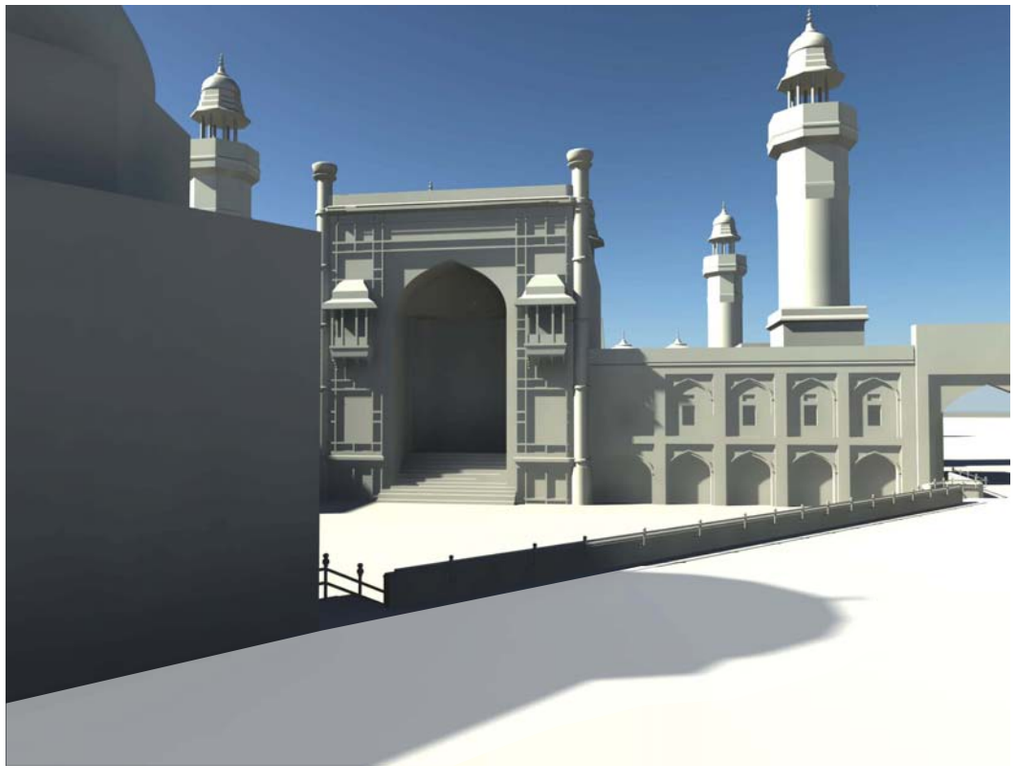

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3

Chowk Wazir Khan: three views of the proposed interventions. These interventions will result in the removal of all shops squatting on the angular pathway between Chitta Gate and Kotwali Gate and the lowering of the floor of the square to its 17th century level, thus revealing the full height of the façade.

Top, left: View along the central axis with the 1990 dome of the Syed Suf Shrine in the foreground, shown in its current state.

Top, right: The view at ground level; the line of sight has been moved laterally to enable the iwan *to be seen around the Syed Suf Shrine.*

Left: View of the proposed new buildings on the northern flank, showing the lowered floor of the Chowk seen in relation to the traffic channel, the existing level of which has been retained.

4a

4b

View looking east along the northern façade of the Chowk, where new buildings are proposed to be constructed after acquiring and removing the existing buildings. Two alternatives to the proposed façade forming the northern side of the Chowk are presented, each re-interpreting the historic original with two variants of modern materials. The structure of the Dina Nath's Well is shown at the centre-right.

5 *View of Kotwali Bazaar looking west, showing the lowered, pedestrian part of the street with the additional space obtained by removing the illegal structures adhering to the north façade, now fully exposed at the original elevation of the street.*

11.3 IMPROVEMENTS IN THE MODERN SERVICES INFRASTRUCTURE

Parallel to the conservation of the building fabric of the mosque complex, it is important that the existing services, inadequately incorporated in the past in piecemeal fashion and that have posed considerable threat to the monument's structure and to surface decorations are improved at the highest appropriate standards. The present layout and quality of utility services serving the complex is evidence of the very *ad hoc* approach adopted. This has been the cause of rapid and serious deterioration of the structure, the building fabric and the surface renders and revetments.

A detailed infrastructure planning process needs to be started. It is proposed that a framework of infrastructure planning to be prepared for the mosque should be integrated with the detailed design of infrastructure currently being designed by the project design and management consultants, appointed by the Punjab Government, for the Pilot Urban Rehabilitation and Infrastructure Improvement Project.

Mechanical and electrical engineering consultants may be appointed for the design of the services for the mosque building proper. These consultants and the engineers mentioned in reference to the Pilot Project above will work in a fully coordinated manner with AKTC-AKCSP and move the conservation programme forward in full integration with the structural consolidation and architectural conservation of the monumental complex.

11.4 PROPOSALS FOR INTERVENTION IN THE MOSQUE PROPER

Addressing the threats to the mosque complex is the primary objective of the proposed conservation strategy. The overall plan of action for the area of the Wazir Khan Mosque embraces the conservation of the mosque, the improvement of the adjacent open spaces and building façades, the removal of the commercial and residential encroachments and the establishment of a new, rational and well detailed system of service infrastructure.

The **strategic actions** recommended to be taken towards launching the conservation process of the mosque proper comprise:

a. Legal and institutional measures: implementing appropriate legal and institutional measures to clear the mosque of all illegal construction and encroachment within the ambit of the applicable existing and future legal instruments;

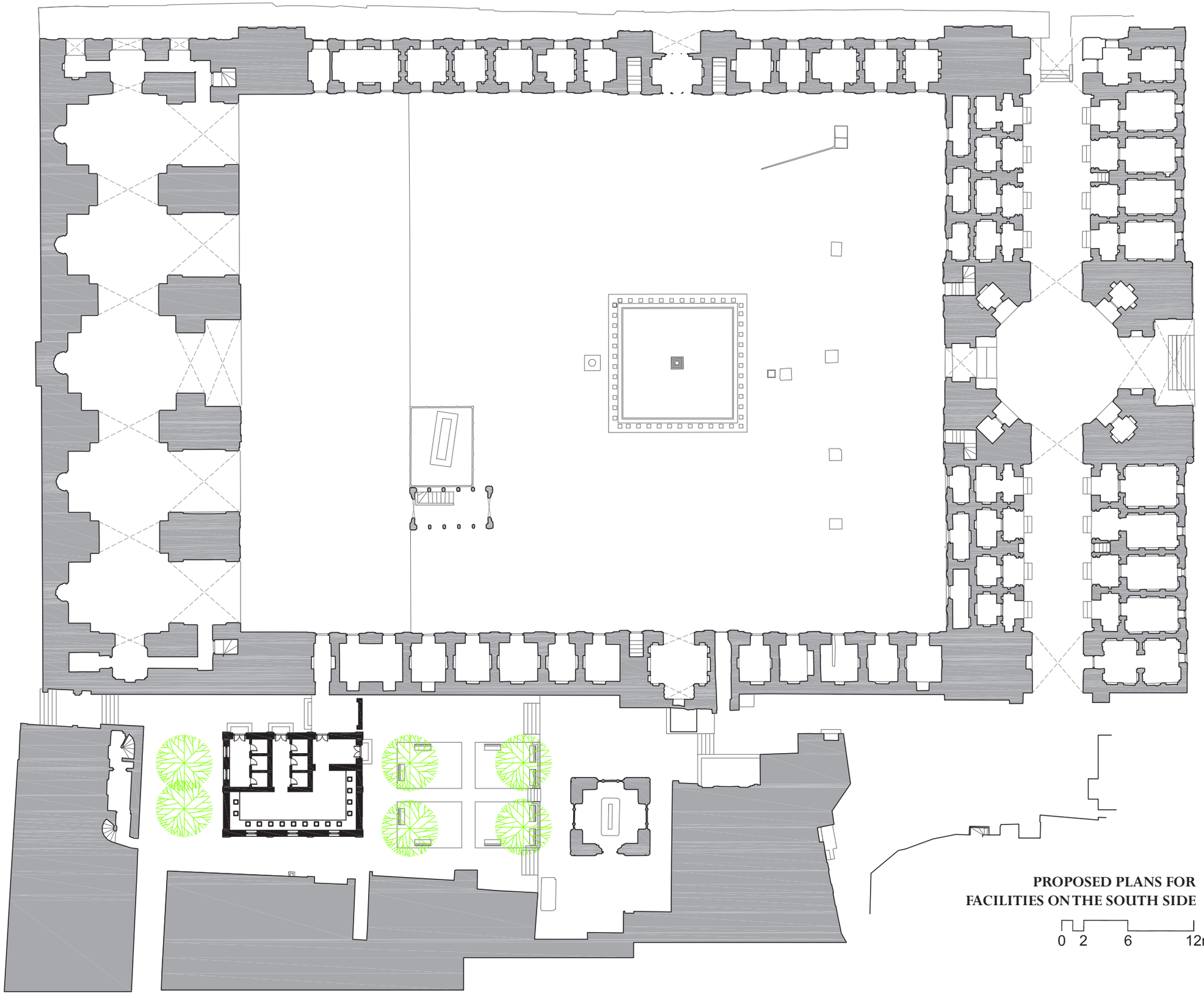
b. Appropriate uses: establishing a range of appropriate uses for the non-religious parts of the building originally intended for generating revenue, including those intended for supporting the livelihood of a certain class of craftsmen (calligraphers and bookbinders). These uses would be integrated with the planning for the future of the neighbourhood in which the mosque is located, and with planning for the safety and longevity of the architectural fabric of the mosque;

c. Structural consolidation: consolidating the structure of the mosque within the framework of expert structural analysis contained in this report;

d. Conservation of the building fabric: carrying out the repair of the architectural fabric not included in the works carried out under item (c);

e. Conservation of the ornamentation and surface decoration: the conservation and restoration of the surface renders and revetments, including decorations such as the *kashikari* work, the *naqqashi* work and the *tazakari* work on the exterior as well as in the interior of the building;

f. Services infrastructure: establishing a well-designed, modern system of service infrastructure that is properly integrated into the schema of the architectural fabric and which does not pose hazards to the building or its users;



PROPOSED PLANS FOR FACILITIES ON THE SOUTH SIDE

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g. Display and illumination: establishing an appropriate and effective system of display including setting the building in its historic context, and exploiting the full potential of the magnificent architecture and its decorative features by effectively illuminating it at night;

h. Information and communication system: establishing the appropriate types and size of information systems, including electronic information system, to provide the public and visitors the full breadth of information that is needed to gain an adequate understanding of the historic structure;

i. On-the-job training of professionals and craftsmen: exploiting the valuable opportunity afforded by the conservation of the mosque for the training and development of conservation skills for both professionals and craftsmen, to take place as on-the-job training. The on and off restoration efforts in the past produced quite a few craftsmen in building craft techniques and it is vital to identify and use all the remaining resources generated by past restoration efforts in the current plan for its conservation. Similarly, the local residents and craftsmen already active in their fields should, by employing them in future conservation programmes at the mosque, be given an opportunity for developing their skills and increasing their awareness of heritage preservation. Designing all restoration programmes in this manner would provide a strong basis for preventive conservation in the future.

   As mentioned above, a number of skills and crafts are involved, each involving programmatic, technical, quantitative and qualitative specificities.

11.4.1 BASIC PRINCIPLES CONCERNING MATERIALS AND TECHNIQUES

Certain basic principles that must be adopted before proceeding further in the conservation process must now be enunciated:

a. All materials to be used in the conservation process should be compatible with the historic materials and technologies;

b. There should be compatibility in terms of the physical and chemical properties of the material and this compatibility should be thoroughly tested out using the best available laboratory technologies;

c. No intervention should be carried out without recording the existing state of the exact location of the intervention;

d. No new materials should be used that is stronger than the historic material, except under very exceptional circumstances and only when directed by the conservation expert in charge;

e. As far as possible, interventions affecting authenticity should be reversible.

11.4.2 THE CONSOLIDATION OF THE STRUCTURE OF THE MOSQUE

This section deals mainly with the structure of the mosque complex. It includes the foundations and superstructure of the mosque's building and *minars*. One of the most critical things is to find a relation between the leaning *minars* and crack patterns in the adjacent archways, and to find a way to stitch the large cracks in the structure without losing the surface decorations significantly.

The expert opinion related to the structure of the mosque complex is summarized as follows:

a. The brick masonry of the mosque shows cracks and deformations. This includes the tilting of the *minars* and its effects on the structure of the prayer chamber;

b. The digital measurement[4] of the *minars* shows that the leaning is minor and less alarming than expected. The cracks in the immediate structure and the leaning of the *minars* have a direct relationship as a consequence of seismic processes;

c. The investigation programme carried out to discover the condition of cultural fill, soil, the dimensions of the *minar* foundations, and the extent of tilting support the previous paragraph;

d. The exploratory boreholes and open pits show that the stepped foundation of the *minar* is well rested on firm natural soil which comprises sand and sufficiently consolidated stiff clay. Therefore, no major intervention is recommended for the foundation.

e. The engineering calculations based on the geotechnical investigations proved that the static and dynamic loads of the *minars* are safe;

f. The engineering reinforcement should be restricted only to weak areas in the structural fabric and should be carried out by skilled craftsmen and with close cooperation between them and the consulting engineer/architectural conservator;

g. The subsidence of the southern courtyard pavilion as a whole by as much as nearly 30 cm (11.81 inches) is, however, a point of anxiety. It is likely that the foundation bearing strata at this point are seriously affected by water ingress and have resulted in bearing strata failure. The remedy for this, for now, is an immediate and urgent attention to the problem of water ingress from all sources in the southern side of the building. This urgent attention could address the issue of the removal of certain or all offending buildings. The nature of the bearing soil in this area, however, must also be ascertained as soon as possible.

For a detailed discussion please refer to the interim report on structural consolidation and conservation of the Wazir Khan Mosque in Appendices B1 and B2 at the end of this report. Two salient aspects are sumarised below:

i. Foundations (Geotechnical Interventions)

This component will deal mainly with the foundation subsidence of *minars* and other structures and its impact on the superstructure of the building. As established by the geotechnical investigations (see Appendix C) the foundation of each *minar* is well rested on firm soil and therefore no major intervention is recommended for the foundations of the *minars*.

Except for the southern axial pavilion which exhibits serious structural deterioration, foundations of other structures have in general no major structural failure. Although there has been subsidence of structure in the southern *hujra* wing on both sides of the southern pavilion, this subsidence appears to have been gradual and, thanks to the resilience of the lime mortars used in the Mughal period masonry, exhibits no major structural failure. Since some areas in the courtyard of the mosque have been observed and documented to have varying degrees of subsidence, it is important to investigate the strip foundations under such structures during the conservation of the mosque. It is likely that the foundations of the remaining structures also bear on natural strata. However, as the geophysical investigations focused on the *minars*, this aspect was not fully explored in all parts of the monument. Serious attention therefore needs to be focussed on the structural consolidation of the southern pavilion and the southern wing of *hujras*.

ii. *Minars*

A lesser variety of issues needs to be tackled for the structural consolidation of the *minars*. Despite a visible tilt of the south-east and south-west *minars*, the overall condition of the foundation and superstructure of the *minars* are stable. Nevertheless, it has been established that the tilt of the *minars* on the south side is greater than the *minars* on the north side, evidence that the south side of the mosque has been subjected to an increased pressure as a result of residential encroachment on land which had previously and originally been open land.

Major clearance of residential constructions on the south of the complex and the management of water ingress from the public ablution and toilet facilities on that side are actions which are therefore critically justified.

There is also a need to channelise the rain water collecting in the projecting galleries under the *chhatris* in a more controlled manner, thus avoiding the water running directly on the surface of glazed tiles on all eight sides of the octagon.

11.4.3 STRUCTURAL CONSOLIDATION AND CONSERVATION OF THE BUILDING FABRIC IN GENERAL (Primary Elements)

Structural restoration at the level of building fabric (walls, flat and domed roofs, ceilings, floors etc.) involves the repairing of cracks, an extensive exercise involving traditional and modern techniques of stitching the brickwork. Large openings like archways in the prayer chamber and the main *iwan* are the main structural and architectural features of the structure. Cracks in the apex of these archways are a common damage pattern.

The introduction of alien materials along with traditional ones in past restoration efforts have significantly damaged the areas around the cracks. Therefore removing all incompatible materials from the old repairs is the primary task in structural consolidation.

i. External Walls

Most of the anomalies in the external walls are in the form of cracks, bulging, deteriorated masonry and the insertion of alien structural elements and concrete slabs. Structural consolidation of the damaged portions in the external walls is the most important activity for their conservation.

A larger section of external wall on the south-western side of the mosque is not even visible to inspect and monitor due to residential encroachments. The conservation programme must include the option to expose this section of walls for monitoring and for restoration. This entails that the houses which have their structural elements resting directly on the external walls should be cleared off and a buffer zone between the residential urban fabric of the city and the structure of the mosque should be created.

The whole length of external wall on the north side has been encroached upon by the shops at Level 0. This illegal process has substantially damaged the external wall by necessitating *ad hoc* insertion of concrete slabs that form the roofs of the shops, damaging the fabric of the historic wall. The removal of all these encroaching shops is not only crucial for the unobstructed view of the north façade but also important to restore the original fabric of the wall and to protect it in the future.

ii. Internal/Partition Walls

Structurally, the walls perpendicular to the external walls at Level 1 in the *hujras* and Calligraphers' Bazaar are also taking loads of the roof and therefore, we cannot categorise them as partition walls in the usual, non-load bearing sense. Most of these walls are in good condition and need only a localised consolidation programme.

The internal walls in the shops on the eastern and northern sides at Level 0 have some major damage types. Rising damp, erosion of old mortar and the later application of cement based renders are the major problems which affect the walls. Rising damp in the walls is associated with the poor drainage system of the mosque complex. Therefore, it is very important to rectify the drainage system before working directly on the restoration of walls at Level 0. This work will include the removal of all the later applied cement based pointings and plasters, repointing with lime mortar and then rendering with lime plaster.

iii. Floors

The entire floor of the Calligraphers' Bazaar, courtyard and the prayer chamber are made of brick. All the floors in the covered areas, except the prayer chamber, are finished with lime. The *hujras*, which have been used as a dumping place for junk materials, have lost a significant amount of the floor finish. As mentioned earlier these rooms should be cleaned before conservation/restoration work can commence.

At Level 0, over time, the original floors have been filled up with many layers of soil to relate the internal floor level to the gradual rise of the street-level outside. The current investigation pits in these old shops at two locations on the eastern and northern sides revealed that the original level of floor is made of lime about 1 metre below the existing level of the floor. This raised many questions related to the restoration of the original floor level. Whether the existing level of street will remain the same or should it be lowered to the old level is one of the more important considerations. The decision of lowering the level of the entire Chowk and the streets will certainly affect the design and redeployment of the infrastructure services in the area, particularly waste and storm water drainage.

Irrespective of any solution related to the old and original levels of the Chowk and the shops, the principle should be to reintroduce the original materials like lime and brick to replace the existing cemented floors in the shops at Level 0.

The courtyard floor is the single largest floor area that has been under threat for the longest time and has continued to remain in that state until this time, when it has been opened up again for extensive repairs. These repairs have been necessitated from time to time for various reasons. It is now necessary that a redesigned drainage system for the mosque should also include a comprehensive new drainage system for the courtyard. In the process of creating this new drainage system, the entire floor should be restored in a manner that removes all the visible errors and evidence of *ad hoc* repairs that is unfortunately visible for all to see.

The repair works recently (April, 2011) started by the Auqaf Department are yet another set of *ad hoc* repairs which are not likely to bear much fruit in the immediate or long term, and have meant only to placate and pacify public opinion as orchestrated by the media. It is important that the full extent of this work should be integrated with the proposals contained in this document.

PLAN SHOWING LOCATION OF EXPLORATORY PITS AT LEVEL 0

The pits were dug to ascertain level of the original floor, where possible. One of these pits in the Chowk led to the discovery of what appeared to be the original floor 1.2 metres below the present surface paving.

iv. Stairs

The four staircases of the *minars* are in reasonably good condition. The remaining stairs on Level 1, which lead to the roof and Level 2 of the mosque, are in relatively bad condition and have lost their top coat of renders and corners. The two uncovered staircases on Level 1 in the Calligraphers' Bazaar and the two staircases on Level 2 to approach the eastern *minars* are in a bad shape and need a repair programme which, in parallel to their restoration, should precisely address their protection against weather conditions. The three staircases in the central pavilions of the courtyard also need a repair programme and, again, protection against weathering conditions. The two staircases under the *chhatris* of the entrance *iwan* on the western side are in good condition and therefore, need only minor repairs. Handrails of an appropriate design should be provided at all locations.

v. Roof (Flat Roof and Domes)

The roof system of the mosque complex includes flat and domed roofing surfaces. The structural anomalies in the roofing system of the prayer chamber are directly associated with the structural deformations caused by the lateral movement of the mass of the base of the *minars* and the consequent movements in the mass of the prayer chamber walls. Therefore, any restoration or structural consolidation programme of the roof should not be addressed in isolation. For example the cracks in the archways of the prayer chamber run through the walls, vaulted archway, parapet, base of the dome and then extend themselves on the dome surface.

In the past, the cracks in the parapet, roof and dome have been filled with cement-based mortar and over a period of time the failure of cement-based grout has provided an access to the rain water resulting in efflorescence on the surface of frescoes inside. The most critical task during the restoration of these cracks is therefore to find a balance between the new infill material and its compatibility with the old fabric of the structure.

The rest of the flat roofs of the *hujras* and Calligraphers' Bazaar are structurally sound but have lost a number of surface layers. The only critically damaged roof is the roof of the pavilion on the southern side of the courtyard which has a major crack in the centre running in an east to west direction. The entire section of the southern wall has also leaned towards the south due to this crack which also runs through the south-eastern corner of the room. These structural cracks, which in the case of the corner have resulted in the loss of a quantity of brick masonry, should be filled with lime mortar or brick laid in lime mortar. Filling of the cracks should be necessarily supported by the stitching method in which new bricks are inserted across a masonry crack. Removing some old bricks and inserting new ones is recommended in the stitching process.

Appendices B1 and B2 at the end of this report include the expert opinion related to repair of cracks.

11.4.4 CONSERVATION OF SECONDARY ELEMENTS

External Openings

Doors and windows in the mosque complex need only minor repairs. Major repair is required to the windows on the northern side of the mosque where the masonry supports for the sandstone lintels are damaged. Similarly, the small windows on the eastern façade of the mosque need repairs as the wooden frames are damaged. Missing doors on Level 2 should be replaced. The two steel doors of the eastern *minars* should be replaced with wooden doors.

The large openings in the prayer chamber towards the Kotwali Bazaar raises an interesting issue of how to control the dust and smoke traveling through these openings and reduce its damaging effects on the frescoes inside the prayer chamber and increase the comfort level of its users. The same issue also applies to the bare openings in the rooms on Level 2 of the mosque complex. The solution to this issue would be a quiet intervention with glass which should not be alarmingly conspicuous on the façade.

A whole scheme of design is needed for the shop openings once the encroached structures are removed from the eastern and northern façades.

11.4.5 FINISHES

This monument is covered with an extensive and intricate blanket of architectural and decorative ornamentation, profuse and endowed with artistic excellence and deep religious significations. It therefore requires careful and methodical treatment at the following levels:

- Detailed documentation and damage analysis,
- Careful analysis and the determination of values with which it originated and values which reside in the ornament at the present time,
- Organization of a programmatic approach based on *in situ* fact finding, laboratory analysis, and the development of sequential arrays of intervention and treatment.

In general the finishes are affected to a greater and lesser degree by the same kind of weathering and damages on account of being constituted with the same base brick, terracotta and lime mortar material. Certain finishes such as *kashikari* work are inherently more resilient and wear-worthy than the more fragile and porous materials (terracotta body) which support the glazes in *kashikari* and comprise the body (base layers of the lime plaster renders) of the other finishes such as simple plaster render or *tazakari* work. Exposed brickwork is another material that is relatively durable and wear-resistant due to its being embedded in fine lime mortar beds. Most floors in the exterior, and that of the prayer chamber are constituted by brick and have generally withstood the wear of four hundred years of use.

A range of damages has been identified for plaster renders, exposed mortar beds, and the stages of damage through which *kashikari* tile work can be observed to undergo. The last stage of such damage is of course the complete loss of plaster render or glazed tile revetment.

In many cases, however, the relevant elements exist at the stage prior to complete loss, i.e., in a state of detachment from the brick bearing surfaces. A sensitive evaluation of the causative factors (rainwater penetration, water rise due to floor washing, rain splashing, and capillarity, sub-surface efflorescence and salt crystallization) and whether and to what extent such elements can still be saved *in situ* is necessary during the conservation process.

The ultimate aim of the conservation process is to keep a balance between the restoration of old surfaces and centuries-old "as found" state of the building. The purpose should not be a "new look" for the monument but rather the conservation process should aim at enhancing the charm and character of surface finishes even while working with the fact that they have been slowly deteriorating.

i. *Kashikari*

The most predominant feature of the exterior of the mosque is its *kashikari* work, known for its richness and the range of its artistic and technical breadth. Any repair and conservation work that is to commence as a result of the present work will address the urgent need to arrest the deterioration of this work and to establish a permanent and long term mechanism for continuous conservation and maintenance.

The existing and remaining stock of *kashikari* displays different types of damage forms and their causes. Age, orientation and exposure to the sun and climate, chemical composition, and the combined effects of rainwater penetration, salt crystallization, and atmospheric pollution all contribute to the damage patterns of the tile work. The old *kashikari* work on the northern, external façade of the prayer chamber shows different and more extensive damage than surfaces with a more southerly exposure. While this damage exemplifies, on the one hand, the conditions created by the greater amounts of rainwater that saturates the buildings' exterior on the northern side for longer stretches of time, and the consequent vulnerability to bio-film and bacterial action, on the other hand it also exhibits the nature of the damage caused by the intense atmospheric chemical pollution from the traffic in Kotwali Bazaar.

Keeping in view the above factors, it is important to propose a variety of restoration schemes for the conservation of *kashikari*. The hard glazed surface of the tiles resists well the extreme weather conditions as compared with the lime mortars and other porous materials. The real challenge seems to be the application of different approaches in restoring the different degrees of damage that the glazed tile work has suffered.

The most vibrant examples of the oldest extant and the most fragile examples of deteriorated tiles are to be found on the *minars*

and comprise varying degrees of tile deterioration. It is here that the entire range of subtle distinctions in weathering forms can be observed and recorded. Based on the observations made, some decisions could be made for the approaches to be adopted. As a principle strategy it would seem important that older pieces of tile which are in an acceptable state of preserve are conserved, and the temptation to replace such tile with new work, or to otherwise match them to new work should be avoided. Tiles should be replaced as part of an ongoing process of monitoring and decision making. A possible progression of priorities in replacing/conserving and protecting tile work could be as follows:

1. Complete loss of tiles with base mortar: (high priority)
2. Falling away of tiles from the base mortar: (high priority)
3. Break out of terracotta due to spalling and pitting of the terracotta body after the earlier loss of glaze: (high priority)
4. Exfoliation of glaze and biscuit: (medium priority)
5. Exfoliation of glaze only: (low priority)
6. No exfoliation of glaze—intact tile.

It would seem that a programme of tile replacement should be pertinent to only the first three of the six categories of damage. However, this could also depend on how valid the justification of the replacement is on grounds of evidence and authenticity. This may depend upon whether the authenticity of the replacement is supported by extant evidence or by comparison with extant work. Where the authenticity is weak or is non-existent, then tile replacement will not be justified and it is best to not to take recourse to reconstruction and complete replacement of tile. Such cases might be dealt with by closing up the edge of the undeteriorated part of the tile panel with plaster renders, or where absolutely required, using blank tiles (glazed or unglazed, as suited) to complete the panel.

The following other measures are also strongly recommended to be followed in the conservation of glazed tile:

- Establish compatibility of new base lime mortars with the old and firm sections of *kashikari*;
- New work should be carefully designed in juxtaposition with existing tile work so as not to contrast strongly with the extant tile, and blend in with the historic ambience of the extant work.
- Loose and disintegrated sections should be strengthened and reattached by appropriate grouting techniques in order to save the extant sections in juxtaposition.

ii. Pilot Glazed Ceramic Tile Production Facility and a Pilot Restoration Project

This project would use local and international expertise in traditional ceramic tile technology to set up a pilot facility for producing glazed ceramic tileware on scientific lines. The aim is to expand operations for restoration work on the monument in areas identified for this purpose. Local experts and craftsmen engaged previously on the restoration of glazed tiles would be identified and involved in the process.

iii. Fresco Work

Technical expertise of the highest caliber will be required for this purpose. An international consultant with experience in historic fresco work in this part of the world is proposed to be engaged.

The main tasks for this consultant would be as follows:

a. Undertake a preliminary investigation into the condition of the frescoes in the mosque and produce a report indicating (i) condition; (ii) issues of restoration; (iii) potential for restoration; and (iv) strategy for restoration.

b. Identify an area of interior frescoes to be taken up as a pilot restoration project; indicate the technical objectives to be achieved and the end goal of the restoration work.

c. Undertake the work so identified, if approved and authorized, and to oversee the pilot restoration project until completion. This partial restoration project, if successful, could result in further expansion.

iv. Establishing a Field Laboratory for Material Science

This laboratory will enable the conservators to analyse both old and new materials and bring scientific rigour to the conservation process. The targeted investigations relate to analysis of the material fabric of the monument including (i) material forming the architectural fabric; (ii) chemical composition and physical properties of the glazed tile revetments; (iii) composition and physical properties of other wall renders, including decorative renders; and (iv) chemical analysis of the various layers of frescoes on the walls.

11.5 ISSUES PERTAINING TO THE INSTITUTIONAL CONTEXT OF THE MONUMENT AND ITS URBAN ENVIRONMENT - PRESENT AND FUTURE

This aspect of the project for the conservation of this monument must be dealt with realism and forthrightness. An examination of the institutional context which is required to provide the technical services for protecting and preserving monuments in the province of Punjab reveals the following urgent needs:

a. The prioritization of our cultural identity and our heritage above certain other priorities.

b. Organizational efficiency and greater operational and technical rigour.

c. Advanced training of staff in the public sector agencies involved at all levels and for their exposure to best practice field contexts in other countries, at the least other countries of the greater Asian region.

d. Greater autonomy for professionals in decision-making in the field of heritage care.

e. Higher standards of professional rigour and work ethics.

11.5.1 NEW PROJECT ADMINISTRATIVE FRAMEWORK

The care and conservation of a monument such as the Wazir Khan Mosque at the required levels of quality would necessitate that the above needs are fulfilled. Since this is not possible immediately, an effective and autonomous organizational framework for the conservation of the mosque may be developed. This would draw on the best available professional services from international and national not-for-profit and civil society organizations engaged in urban and monument conservation, as well as from government agencies

The new organizational set-up would:

a. Have the limited purpose of overseeing and administering the conservation project; and of ensuring that the project provides training opportunities to the relevant personnel in the concerned public sector agencies;

b. Contain representatives of donor agencies, of the Government of the Punjab and of the Aga Khan Trust for Culture;

c. Be mandated by a notification to be issued by the Government, which will transfer the operational control of the project to the new organization;

d. Be funded to the necessary degree from the following sources:

   i. The Government of Pakistan;

   ii. The Government of the Punjab.

   iii. Multi-national and /or bilateral donors;

   iv. The Pakistani corporate sector;

   v. The Pakistani civil society sector;

   vi. International organizations such as the Getty Foundation, the World Monument Fund, etc.

11.5.2 COORDINATION WITH ONGOING URBAN REHABILITATION AND INFRASTRUCTURE WORKS

The Pilot Urban Rehabilitation and Infrastructure Improvement Project is soon to be implemented, with extremely important ramifications for the conservation of the Wazir Khan Mosque. Some of these are:

a. Shops which were built onto the main façade of the monument on its north will be removed as a result of the Pilot Project.

b. The roads around the mosque and the floor of Wazir Khan Chowk have risen to as much as 1.2 metres from their original level over the centuries. In order to expose the façades of the mosque fully, the surface of the street to the north of the mosque and the floor of the courtyard will be lowered to their original levels.

c. The area of the Chowk will be cleared of encroachments in open public space (not encroachments which are outgrowths of buildings forming the perimeter of the Chowk).

d. New underground electrical, telecom, water supply and storm water drainage infrastructure will be built.

e. The gas distribution network may be re-ordered.

f. The sewerage system may be modified to one extent or the other.

It is extremely important that these impacts of the Pilot Project on the Wazir Khan Mosque and its vicinity are taken on board and coordinated with the conservation process of the mosque, as proposed in the previous pages.

During conservation, it is extremely important that the members of the present mosque committee are fully integrated with the decision making process, and that they be treated as a community based organization which is the vehicle for community support and participation during the conservation process.

When the conservation process is complete the mosque committee is expected to continue with its present functions. However, the precise manner in which they are to work and link administratively with the new administrative framework of the Walled City will need to be defined.

11.5.3 THE FUTURE ADMINISTRATION OF THE MOSQUE AND ITS ENVIRONS

The jurisdiction of the Lahore Walled City Authority to be set up under the Lahore Walled City Bill, 2011, to be enacted by the Punjab Assembly shortly, is essentially that of a local government, exercising full municipal control of the Walled City and its heritage assets. Although the trusteeship of the Wazir Khan Mosque will continue to vest in the Auqaf Department, its enlistment under the heritage register to be maintained by the Authority, and the exercise of technical control of heritage vested in it will necessitate new administrative regimes to be established.

The future of the mosque will depend eventually on the effectiveness of such control and administrative regimes, which will have to be meticulously thought through before they are applied.

ENDNOTES

1. Blake, Bill, (2003) *Metric Survey for Heritage Documentation*.

2. This project comprises the Cultural Heritage Component (CHC) of the Punjab Municipal Services Improvement Project, funded by the World Bank. The CHC was included specifically for the Lahore Walled City to establish best practices in the area of urban rehabilitation and for possible replication in other historic cores of Pakistan.

3. At the time of the publication of this report, this Act had been presented to the Punjab Assembly and awaits approval.

4. REDM survey with total station provided an accurate (± 3 mm) sectional detail of the *minar* which enables us to calculate the tilt of the *minars* in CAD format.

APPENDICES

USE OF SPACE WITHIN THE MONUMENTAL COMPLEX

Although the original *Waqf* deed of the Wazir Khan Mosque stated the desired uses of the various rooms within the mosque complex, little regard is now paid to it. The rows of *hujras* on the northern and southern side of the courtyard were intended for meditation and teaching, but are now largely used to house services relating to electricity, gas and water, as storage for prayer rugs and electrical items, and as living rooms for various members of the mosque staff. A number of these rooms, particularly those used for the storage of items not often required and where debris and detritus from previous repair operations are also kept, are locked and are rarely accessed.

On the east side of the courtyard, all the rooms are used for storage and all are either rarely or never opened.

In the prayer chamber, although all areas are accessed on a daily or weekly basis, the chambers at the north and south side are used for the storage of pedestal fans which are taken out when required during prayer times. Being unwieldy, the shifting of these fans has caused considerable damage to the walls decorated with fresco work.

The original deed stated that the shops located within the Calligraphers' Bazaar were dedicated exclusively to book binders and calligraphers. However, the majority of these spaces are now used by the Auqaf or Archaeology Departments either as storage or as offices. And additionally, a medical dispensary run by the Auqaf exists on the northern side of the bazaar. The shop located at the north-east end and the shop located at the south-east end of the bazaar are currently occupied by a key maker and rubber handle maker respectively.

On the mosque's external façades, shops were integrated on the eastern and northern sides in the original design. However, rising street-levels within Wazir Khan Chowk and Kotwali Bazaar have rendered these original rooms as impractical for anything other than semi-underground storage, and accordingly, particularly on the Kotwali Bazaar side, shop owners have extended outwards to provide more useable space. On the northern side, shops are mainly in the fabric, garment, bag or crockery business, whilst on the east side, metal workers predominate, using the Chowk as a work area in the open.

In the rest of the Chowk, the original right of way marked by the concerned Patwari from the Revenue Department in February, 2010, is shown on page 193 as a red line. The original space of the Chowk is no longer discernable, as most of the buildings contemporary to the mosque have been demolished and the new ones extended into the Chowk. Most of these shops (including along the angular pathway) are in the fabric or garment business, but in the Dina Nath Well area in particular there is a large number of food stalls with outside seating benches.

The following plans show use of space within the mosque, at street-level on its northern and eastern sides and within the Chowk, as well as how frequently the mosque's spaces are accessed.

LEGEND FOR USE OF SPACE AT LEVEL 0

EAST SIDE

E1 Wood and iron items
E1a Bike Parking
E2 Storage of floor tiles.
E2a Iron stands, clothes and nylon bags during the day
E3 Storage of welding equipment
E3a Iron grills, jalis, welding equipment and discarded rusted items
E4 Bricks, metal items, burner, cooking pot.
E5 Welding equipment and metal work
E6 Sewing Machine repair workshop
E6a Table of sewing machines requiring repair
E7 Welding and metal work
E7a Welding equipment
E8 Tea shop
E9 Empty
E10 Storage of bangles
E10a Bangle Shop
E10b Jewelery shop

NORTH SIDE

N1 Kitchen crockery shop
N2 Cloth shop
N2a Key maker
N3 Ladies' fashion shop (undergarments, hairclips etc)
N3a Cloth shop
N4 Cloth shop
N5 Cloth shop
N6 Ladies' Hair Accessories
N6a Storage
N7 Clothes Shop
N7a Storage
N8 Closed and never used
N8a Haberdasherie
N8b Cloth shop
N9 Cloth Shop
N9a Cloth storage
N10 Ready-made garments
N10a Storage
N11 Bangles shop
N11a Burka Shop
N12 Ladies' shoe shop
N13 haberdasherie
N13a Garment shop
N14 Kitchen item shop
N15 Garment shop
N15a Clothes stock
N16 Ladies' shoes
N16a Shoe stock
N17 Children's garments
N17a Storage of stock
N18 Ladies' shoes
N18a Shoe storage
N19 Ladies' and children's shoe shop
N20 Handmade pots for kitchens
N21 Ladies' garments
N22 Crockery shop
N23 Crockery shop
N24 Ladies' garments
N25 Ladies' garments
N26 Crockery shop
N27 Ladies' garments
N28 Bakery / general store
N29 Ladies' garments

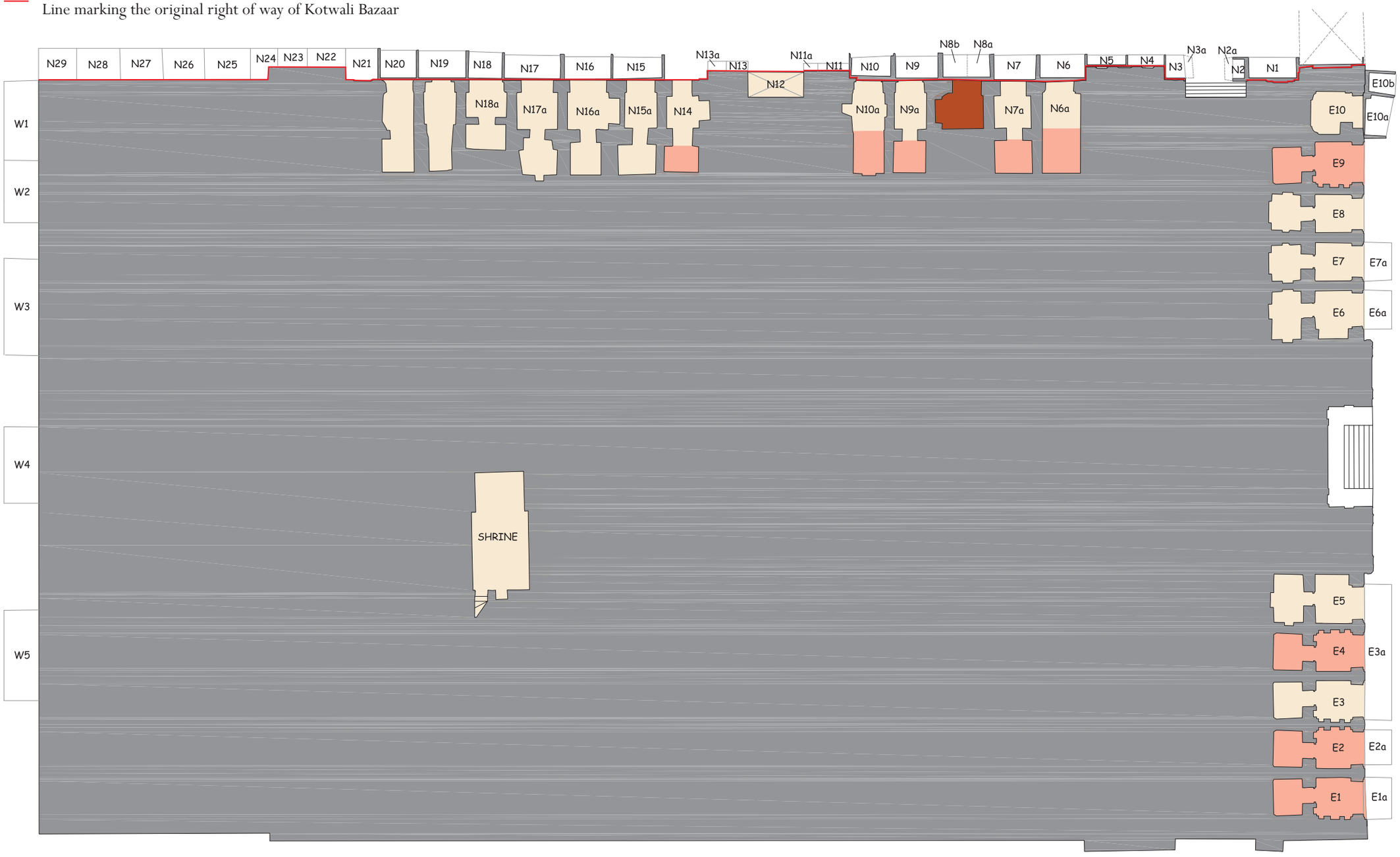
WEST SIDE

W1 Bike parking
W2 Road-side cobbler
W3 Shopkeepers' bike parking
W4 Vegetable stall
W5 Tea stall

USE OF SPACE AT LEVEL 0

(See Legend Opposite)

Line marking the original right of way of Kotwali Bazaar



HOW OFTEN EACH SPACE IS ACCESSED: Frequently accessed | Sometimes accessed | Never accessed

LEGEND FOR USE OF SPACE AT LEVEL 1

MAIN PRAYER CHAMBER

M1 Pedestal fan storage

M2 Quran stands and seating benches

M3 Book shelves

M4 Gas heater

M5 Speaker stand

M6 Mimbar

M7 Sound cabinet

M8 Quran stands

NORTHERN ROW OF HUJRAS

N1 Generator and electricity distribution room

N2 Imam and Hateeb's sitting room

N3 Auqaf clerk

N4 Private room

N5 Electrician's living room

N6 Mozan's living room

N7 Auqaf library

N8 Rug storage and other bulky items

N9 Electrician's room

N10 Room for shoe stand person

N11 Used by Auqaf

N12 Used by Archaeology Department

N13 Used by Archaeology Department

SOUTHERN ROW OF HUJRAS

S1 Electrical and miscellaneous items

S2 Rug storage

S3 Pedestal fans and new electrical items

S4 Shrine storage

S5 Storage Committee

S6 Storage Committee (unused)

S7 Auqaf storage and clerk's room

S8 Water cooler

S9 Water cooler

S10 Rugs, charpoi and dysfunctional water coolers

S11 Storage of ceramic items

S12 Water pump and geyser

S13 Archaeology Department storage

S14 Access to external latrines

EASTERN SIDE OF COURTYARD

E1 Storage Committee

E2 Electrical Items

E3 Storage of unused items

E4 Archaeology Department storage

COURTYARD

C1 Storage of prayer caps

C2 Plants for shrine

CALLIGRAPHERS' BAZAAR

CB1 Keymaker and keymaker's storage

CB2 Auqaf Office (junior staff)

CB3 Auqaf Office (Senior Manager)

CB4 Auqaf's 'Data Darbar' medical dispensary

CB5 Auqaf's 'Data Darbar' patient consulting roor

CB6 Auqaf Department storage

CB7 Auqaf Department storage (documents and other records)

CB8 Auqaf Department storage (ceramic items)

CB9 Management Committee office

CB10 Plants

CB11 Shoe stand

CB12 Archaeology Department storage

CB13 Archaeology Department office

CB14 Archaeology Department storage

CB15 Storage Committee

CB16 Rubber handle workshop

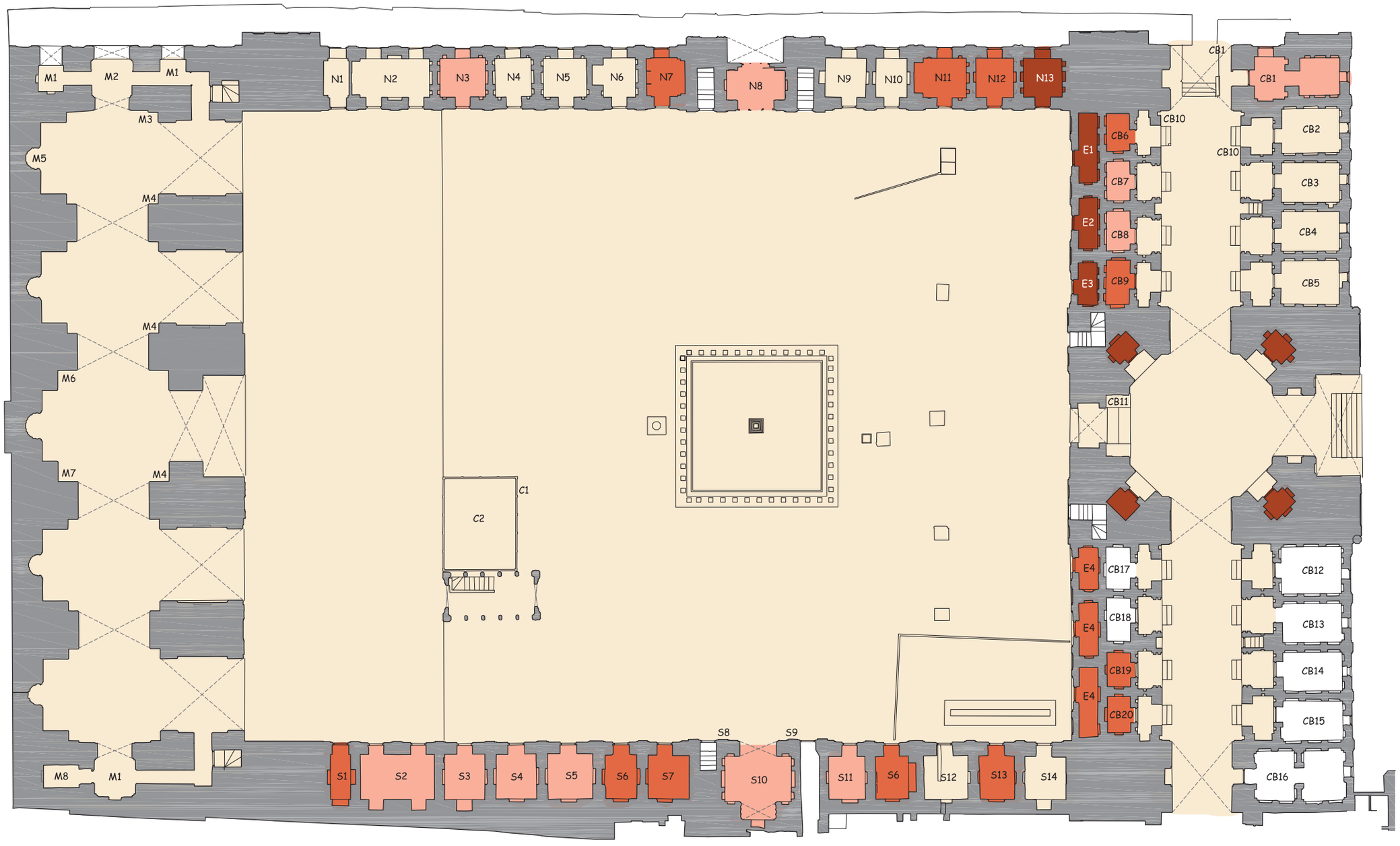
CB17 Storage Committee

CB18 Archaeology Deparment storage

CB19 Archaeology Department storage

CB20 Empty

USE OF SPACE AT LEVEL 1
(See Legend Opposite)



HOW OFTEN EACH SPACE IS ACCESSED:
(where information is missing, area has been left blank)

Frequently accessed
(daily)

Sometimes accessed
(weekly or monthly)

Rarely accessed
(a few times per year)

Never accessed

LEGEND FOR USE OF SPACE IN WAZIR KHAN CHOWK

NORTH SIDE

N1 Khalifa naan shop
N2 Children's garment shop
N3 Boutique shop
N4 Suitcase and bag shop
N5 Quilts, rugs, bedsheets etc
N6 Children's garments
N7 Mobile shop
N8 Cloth shop (with pathan style dresses)
N9 Cosmetics and quilt shop
N10 Tea shop
N11 Small hotel specialising in lunches
N12 Tea shop
N13 Naan shop

EAST SIDE

E1 Closed shop
E2 Shop
E3 Tobacco shop
E4 Unknown
E5 Koozi Haleem shop
E6 Pakora shop (built in 1880)
E7 Artificial jewelery shop
E8 Children's garments
E9 Jewelery shop
E10 Bag shop
E11 Knife Sharpener
E12 Knife sharpener
E13 Knife sharpener

SOUTH SIDE

S1 Knife sharpener
S2 Management of Syed Suf Shrine
S3 Office
S4 Clothes Shop
S5 Kabaria shop
S6 Cold drink supplier
S7 Electrician's workshop
S8 Chicken tandoori shop
S9 Food shop
S10 Metal workshop
S11 Metal worshop

DINA NATH'S WELL

DN1 Dupata and shawl shop
DN2 Children's garments
DN3 Children's garments
DN4 Crockery shop
DN5 Water and juice shop

ANGULAR PATHWAY

AP1 11 shops specialising in clothes and shawls
AP2 Handbag shop
AP3 Tandoor oven
AP4 Garbage collection point
AP5 Begging area

SYED SUF SHRINE

SS1 Parking for handcarts, rikshaws, bikes and cars

USE OF SPACE IN
WAZIR KHAN CHOWK
(See Legend Opposite)

Patwari line established in February, 2010 marking the original right of way.

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Interim Report
Structural Consolidation and Conservation of the Wazir Khan Mosque in Lahore.

This report sums up the results of the first three missions as structural consultant to the building complex and the conclusions from them up to now. It replies to section 1.1 – 1.4 of the contract of Dec. 2008/Jan. 2009: Preliminary evaluation, expert advice and specifications for tests, advice on monitoring, conceptual report on structural stability including recommendations for structural interventions.

Contents

The photographs were taken by myself
during my visits to the site.

References

[1] Gilmore Hankey Kirke: The Walled City of Lahore.
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[2] Correspondence Directorate General of Archaeology
Government of the Punjab
Subsidence and Repair, NE corner of the mosque.
25 / 27 July 1989, 30 Sept. 1992

[3] Berkeley Associates: Factual Report on Geotechnical Investigations.
October 10, 2009-11-17

[4] Information, measurements, drawings
by Aga Khan Cultural Services Pakistan, Lahore Team

Visits to the site

1 26 – 28 September 2008

2 14 – 19 April 2009

3 23 – 26 Sept. and 29 Sept. – 1 Oct. 2009

Initial situation

The brick masonry of the mosque shows cracks and deformations. The damage concentrates on the western part of the complex.

There are cracks in the walls, the parapet, and in the roof construction above the area for the prayers which consists of 5 cupolas and a flat slab around and between them. The cracks in the roof construction have been sealed from the top in former times. On the whole they remained tight up to now, indicating that a horizontal moving of the structure happened – a single one? – which came to rest since the last repair.

There are also cracks in the walls adjoining the minarets. The minarets subsided, the walls took over part of their weight. A process that came to rest as well.

The minarets themselves underwent a certain measure of tilting. At the present the structural stability of them proves to be sufficient.

For the future the main question remained whether new moving of the structure with new cracks in the walls and cupolas and tilting of the minarets are to be feared from the conditions of the soil. It was known that there is a thick layer of cultural deposit, but it was unknown in what depth the natural soil begins, how able it is to take loads, and how deep the foundations of the minarets reach down.

Investigation programme

An investigation programme was worked out to discover

– the conditions of the soil
– the measures of the minaret foundations
– the level of the bottom of the minaret foundations
– the extent of tilting of the minarets.

The programme was developed, the specifications were drawn up, and the realization was supervised with the help of Geotechnical Engineer Dr.-Ing. Michael Goldscheider, Karlsruhe. The programme was executed by the Soil Investigation Agency “Berkeley Associates”, Lahore. The leaning of the minarets was measured by engineers of AKCSP, Lahore.

Soil

Six exploratory boreholes were drilled down vertically to a depth of 25 m: four of them in the courtyard close to the four minarets, the fifth also in the courtyard near the western building unit, the sixth outside the courtyard in the SE corner of the Wazir Khan Square. Approximately, the results of the exploration resemble one another, they are meaningful not only for the mosque complex but also for the surrounding area of the Walled City.

The borings showed three layers: 4 – 8 m cultural fill, in four of the six cases an intermediate layer of 2 – 3 m brown, stiff to very stiff lean clay / silty clay, and up to the maximum explored depth of 25 m grey, medium dense to dense silty sand / poorly graded sand.

As described further below, the bottom of the minaret foundations reaches down to firm soil: to sand and to stiff clay respectively. The consolidation of the clay is at it’s end, the related subsidence of the minarets came to rest, the bearing capacity of both sand and consolidated clay is high, there is no fear of new settlement movement.

The cultural fill of all investigated samples proved to be dampened. That may be the result of rainwater and, even more, of seepage from water mains or sewers. The dampness will not affect the natural soil below the minaret foundations, but penetration and retaining of water in the cultural fill may cause subsidence of parts of the courtyard and of walls which are not founded as deep as the minarets. In addition rising damp may occur in the walls. An example what can happen gives the drainage failure described in [2].

Minaret foundations

The geometry of the minaret foundations was determined from an excavated testpit right at the southern wall of the SE minaret. The depth of exploration by pit (3,97 m) and continuing auger holes (1,68 m) didn’t reach the bottom of the foundation. Steps of the wall profile lead to a probable width of the bottom of 9,05 m.

The bottom of the minaret foundations was explored by drilling a 10 m deep angle borehole through the foundation masonry of the SW minaret. The depth of the foundation came out to be 7,73 m below the floor level of the courtyard. The bottom level of the foundation block is situated, as mentioned above, in the firm soil, that is sand and sufficiently consolidated stiff clay. By this the stability of the minaret structure related to the soil conditions can be seen as guaranteed.

Strip foundations

There are a whole lot of buildings and foundations between the four minarets. Their walls don’t show severe cracks and subsidence. Their form and structure is diverse. A lot of testpits and boreholes would have been necessary to achieve a complete overview of the buildings foundations. The disturbance of the mosque area would have become too extensive. If during the restoration phase local problems occur, then restricted investigations are still possible.

Deformations

Plumbing of the four minarets was executed by the team of AKCSP. The results were, besides the data of soil and foundations, needed for the calculation of the edge pressure underneath the minaret foundation, and for the decision whether preventive measures against further tilting of the minarets should be planned and carried out. In contrast to the visual impression, the leaning of the minarets proved to be minor. The centroidal distance of the different parts of the minaret from the plumb line of the crucial SW minaret is 0 cm (foundation) to 30 cm (cap). The distance of the total mass is 8,5 cm to the south, it influences the force distribution and stability rather slightly.

The cracks in the western building unit of the mosque complex show approximately a mirror image. That applies to the front wall, it’s parapet, the flat slab and the cupolas. It regards the position (appearing more in the North and South, less in the middle), the crack pattern in the flat slab and the adjoining parts of the cupolas, and the width of the cracks. The latter indicate that the NW and SW minaret moved aside and the structure between them was torn; front wall, parapet, slab and cupolas teared, their lengthening corresponds to the sum of its cracks, and the sum of those cracks corresponds roughly to the remained leaning of the minarets. As already mentioned further above, the today’s situation looks like the result of a single occurrence. It seems a likely supposition that this was an earthquake. This assumption goes well with the gap between the SW part of the mosque and a neighbouring wall of another building, a gap which obviously occurred later as well.

Assessment of structural stability

Static loads: Based on the mentioned investigation data (soil, foundation, leaning of the minarets) and taking into consideration the static loads (dead weight, effect of inclination, wind) the minarets prove to be stable. The edge pressure of the consolidated soil (3,74 kp/cm²) is low, the situation is safe.

Dynamic loads: The effect of dynamic loads, i.e. earthquake loads, has not been calculated. The today’s damage refers to the occurrence of an earthquake in the past. It caused cracks in the masonry, but no collapse. Lahore is not a place of high risk (Seismic zone 2 A). In case of a new earthquake the minarets may be shaken, but the explored situation of soil and foundation turned into certainty that they again will not collapse. New cracks in the masonry of the adjoining mosque buildings are not avoidable, they must be repaired anew. An earthquake calculation (which necessarily turns out to be relatively extensive) and it’s conclusions would not come to another result. And the “proof of time”, i.e. of more than 370 years, confirms it. Besides, Gilmore Hankey Kirk [1] come to a similar assessment.

Recommendations

The building complex and especially the minarets must not be underpinned. Extensive engineering reinforcement of the buildings is not advisable as well. Local structural measures should be planned and carried out step by step in advance of the repair work of the craftsmen and restorers. Structural advice for local strengthening can be given case by case. To repair the monument and to fill up the cracks cautiously needs skilled craftsmanship and agreement with the consultant. The existing cementation (?) of the cracks in the flat slab and at the outer surface of the cupolas is to be examined, if necessary to be exchanged. The filling up of the cracks at the inner surface of the cupolas and in the parapet should be carried out in agreement with the restorer. It cannot be excluded that the repair of the cracks in the cupolas needs engineering measures. That depends on the until now inaccessible specific condition of the underside of the vaulted construction. If it consists of cement, the capping of the front wall in the west of the courtyard should be replaced by a construction of less expanding material.

Another recommendation is to extend the monitoring programme now and to measure and register the width of the accessible cracks periodically. That will help us later to select the most appropriate way and material for the repair.

Conclusions

The brick masonry of the Wazir Khan Mosque in Lahore shows cracks and deformations. The minarets underwent a certain measure of tilting. The question was whether new moving of the structure with new cracks and tilting are to be feared.

An investigation programme was worked out to discover the conditions of the soil, the dimensions of the minaret foundations, the level of their bottom, and the extent of the tilting.

Exploratory boreholes showed that the bottom of the minaret foundation reaches through a thick layer of cultural fill down to the natural soil. A testpit made steps visible which widen the minaret foundation. The cultural fill proved to be dampened, the natural soil to be consolidated.

Plumbing of the minarets turned out that the leaning of the minarets is minor than expected. The cracks in the building complex and the leaning of the minarets fit together. They point to effects of an earthquake.

By calculation the minaret proved to be safe against static loads. They can also be considered as resistant against the dynamic earthquake loads.

Engineering reinforcement can be restricted to local strengthening of weak areas. Most of the repair work can be done by skilled craftsmen. A close cooperation between them and the consulting engineer is advisable.

An extension of the monitoring programme to a periodical crack observation is recommendable.

Thanks

Thanks to the colleagues of AKCSP who supported my investigations to the best.

Fritz Wenzel 2009 November 25

List of Appendices 1a – 7b

1a, 1b Damage photos
2 Borehole BH-03 (SW minaret)
3 Testpit photos (SE minaret)
4 Profile of minaret foundation (SE minaret)
5 Bottom level of minaret foundation (SW minaret)
6a, 6b Plumbing (NW and SW minaret)
7a, 7b Rough stability calculation

Appendix 1a · Damage photos

Parapet, southern end

Parapet, northern end

Cupola underside

Cupola spandrel, south

Roof, southern end

Roof, northern end

Appendix 1b · Damage photos

Roof, southern end

Roof, northern end

Gap and displacement between mosque and neighbouring building in Southwest

Berkeley Associates

2

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.357 N: 1005.236
GROUND ELEV: 94.512 m

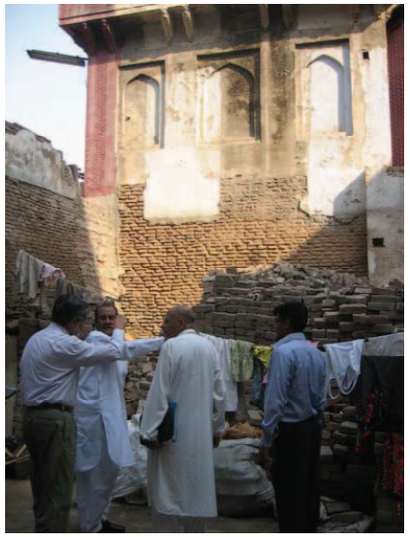
BOREHOLE NO: BH-03
DEPTH OF W.T: NIL
BORING STARTED ON: 17-08-2009
LOGGED BY: CHUGHTAI

SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 30-08-2009
CHECKED BY: ALI

Appendix 2:
Borehole BH-03, SW-minaret

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE 30 60
0		Hand Auger Light Percussion Method			FILL MATERIAL 0.0 to 0.12 m Bricks 0.12 to 0.20 m moist, mixture of cement, sand, stone 0.20 to 0.45 m moist, brown clayey silt, mixed with pieces of bricks, 0.45 to 1.30 m moist, brown, clayey silt, trace brick pieces and concretion, 1.30 to 4.60 m moist, silt, concretion, mixed with pieces of bricks and bones. 4.6 to 5.0 m moist, brown, clayey silt, trace concretion.			
5	89.5		SPT-1		5.0 to 6.0 m moist, brown grey, medium dense, sandy silt, trace mica.		13	
6	88.5		SPT-2		6.0 to 6.50 m moist, brown grey, medium dense, sandy silt, mixed with bone and potery pieces.		11	
7	87.5		SPT-3		Brown grey, medium dense, sandy silt, trace mica.		21	
	87.0		UDS-1		Brown, very stiff LEAN CLAY, (CL) trace sand.			
8	86.5		SPT-4				26	
9	85.5		SPT-5				26	
10	84.5	Hydraulic Feed Straight Rotary drilling	SPT-6		Grey, medium dense, SILTY SAND, trace mica.		26	
11	83.5		SPT-7				25	
12	82.5		SPT-8				27	
13	81.5		SPT-9				28	
14	80.5		SPT-10				28	
15	79.5		SPT-11				24	
16	78.5		SPT-12				27	
17	77.5		SPT-13				22	
18	76.5		SPT-14				21	
19	75.5		SPT-15				24	
20	74.5		SPT-16				27	
21	73.5		SPT-17		Grey, medium dense, SILTY SAND, trace mica. moxed with spots of clay at 21.0 and 24.0 m depth.		28	
22	72.5		SPT-18				25	
23	71.5		SPT-19				26	
24	70.5		SPT-20				28	
25	69.5		SPT-21				29	
26					(BOTTOM OF BOREHOLE)			

Appendix 3 · Testpit (SE minaret)



Before

Cleared

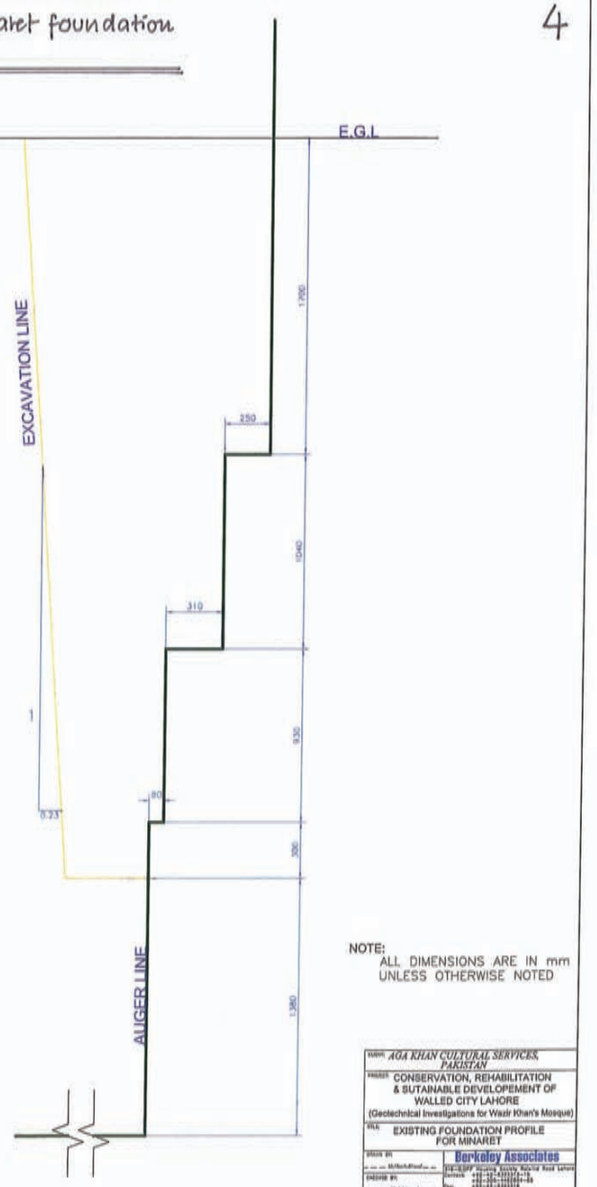
Steps of the foundation wall

Auger hole

FIG. 5-1

Appendix 4:
Profile of minaret foundation
SE- minaret

4



NOTE:
ALL DIMENSIONS ARE IN mm
UNLESS OTHERWISE NOTED

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EXISTING FOUNDATION PROFILE FOR MINARET
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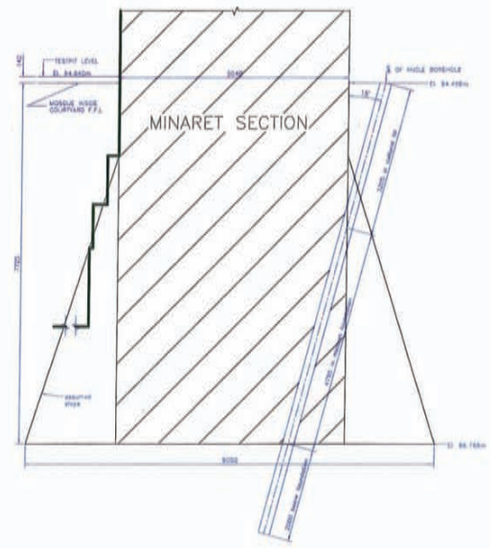
1:25
J-488
Fig. 5-1

FIG. 5-2

Appendix 5:
Bottom level of minaret foundation
SW- minaret.

5



NOTE: (a) ALL DIMENSTIONS ARE IN mm UNLESS OTEHRWISE NOTED
(b) WIDTH OF BOREHOLE IS NOT TO SCALE

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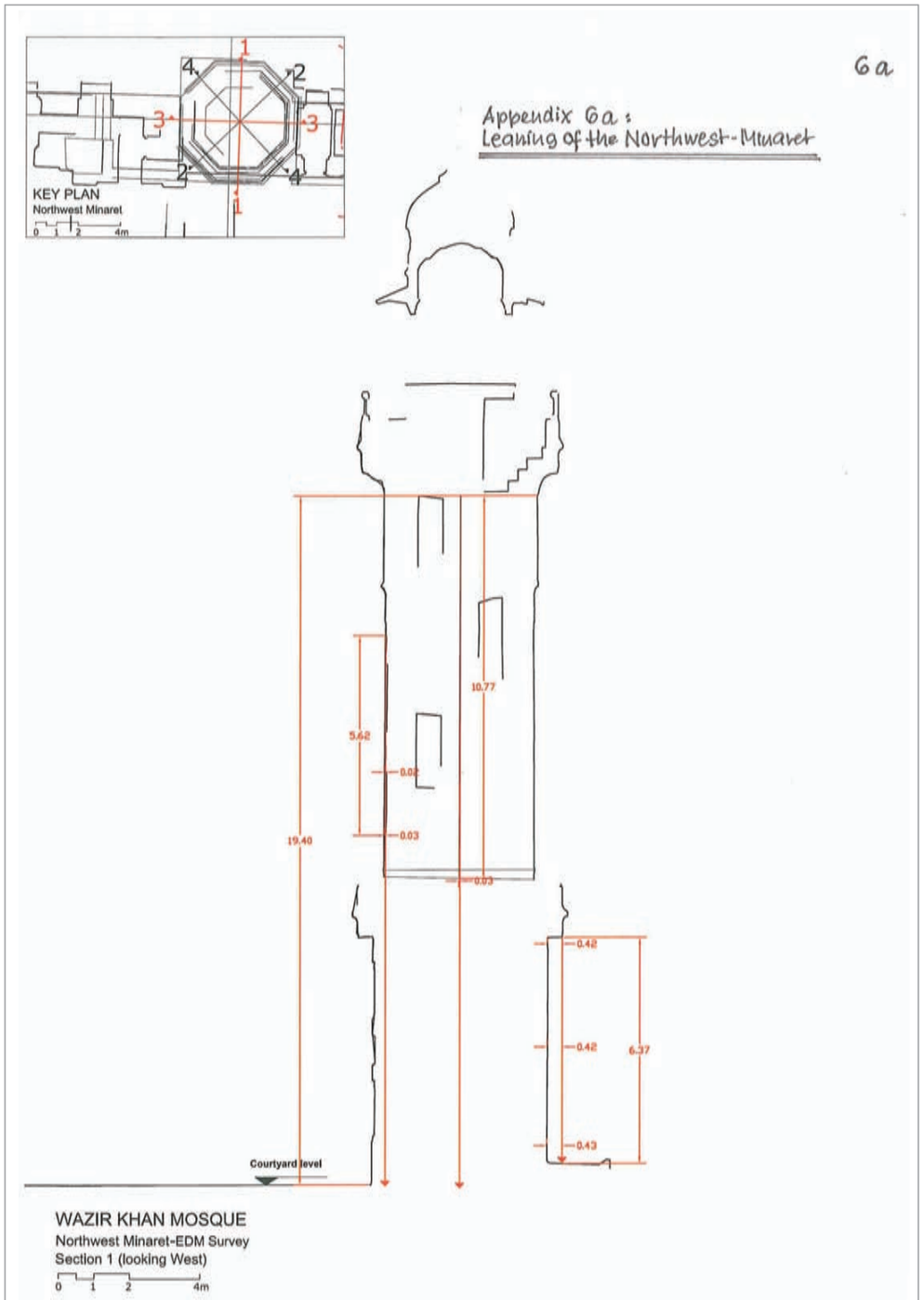
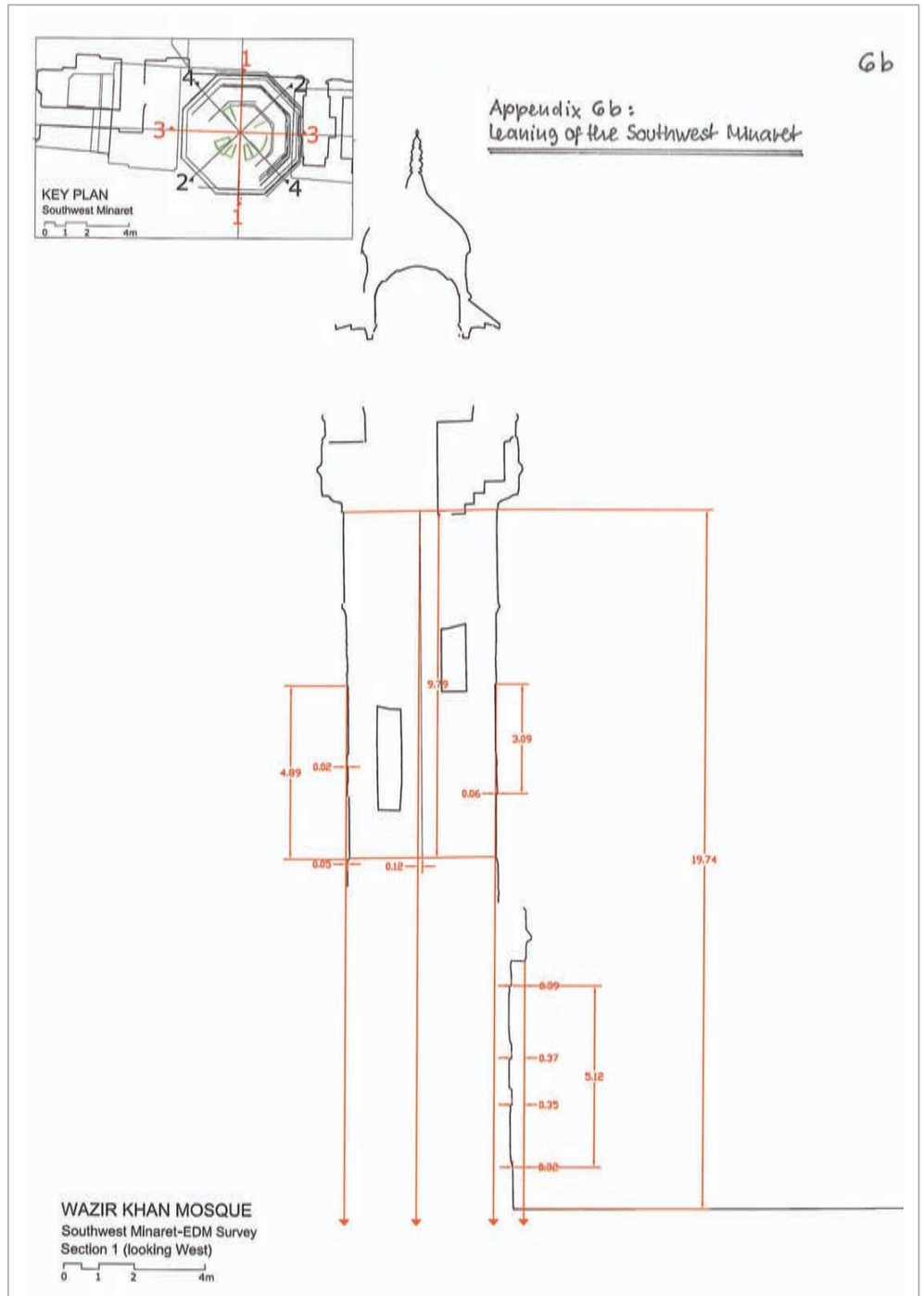
INTERPRETED MINARET FOUNDATION DETAIL
Berkeley Associates
1:100
J-488
Fig. 5-2

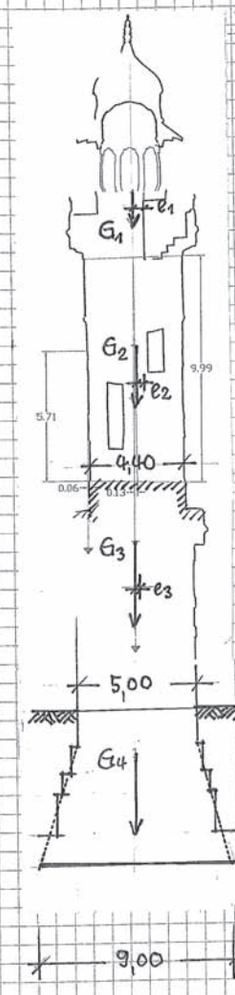

6a
Appendix 6a :
Leaning of the Northwest-Minaret
KEY PLAN
Northwest Minaret
0 1 2 4m
10.77
5.62
0.02
0.03
19.40
0.03
0.42
0.42
6.37
0.43
Courtyard level
WAZIR KHAN MOSQUE
Northwest Minaret-EDM Survey
Section 1 (looking West)
0 1 2 4m


6b
Appendix 6b :
Leaning of the Southwest Minaret
KEY PLAN
Southwest Minaret
0 1 2 4m
9.79
3.09
4.09
0.02
0.06
0.05
0.12
19.74
0.09
0.37
5.12
0.35
0.02
WAZIR KHAN MOSQUE
Southwest Minaret-EDM Survey
Section 1 (looking West)
0 1 2 4m

Appendix 7 : Rough Stability Calculation

7a

Dead Load



Cap:

Assumption: $G_1 \approx 50\%$ of G_2

$G_1 = 235\,620 \cdot 0{,}5 = 117\,810$ Kp

Centroidal distance from centre line of the minaret $e_1 \approx 30$ cm [1]

Eight-sided, spiral staircase:

$A_2 = 4{,}40 \cdot 4{,}40 - 4 \cdot 1{,}23^2/2 = 16{,}03\ m^2$

Masonry 70%, hollow space 30%

$V_2 = 16{,}03 \cdot 10{,}00 \cdot 0{,}7 = 112{,}2\ m^3$

$G_2 = 112{,}2 \cdot 2100 = 235\,620$ Kp [2]

Centroidal distance $e_2 \approx 20$ cm [1]

Solid, square:

$V_3 = 5{,}00 \cdot 5{,}00 \cdot 10{,}00 = 250{,}0\ m^3$

$G_3 = 250{,}0 \cdot 2100 = 525\,000$ Kp [2]

Centroidal distance $e_3 \approx 7$ cm [1]

Solid, two-sided stepped:

$V_4 = 5{,}00 \cdot 5{,}00 \cdot 1{,}70 + \frac{5{,}00+9{,}00}{2} \cdot 5{,}00 \cdot 6{,}00$

$= 252{,}5\ m^3$

$G_4 = 252{,}5 \cdot 2100 = 530\,250$ Kg [2]

Centroidal distance $e_4 \approx 0$ cm

$\Sigma G = 1.408.680{,}00$ Kg

Decisive:

Southwest Minaret

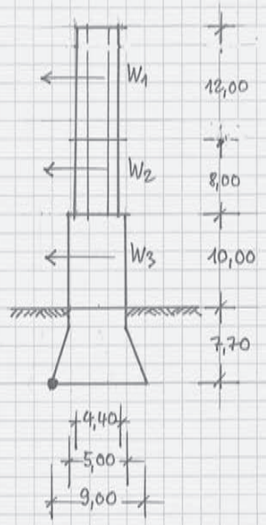
Section looking West

Notes:

1) In accordance with appendix G6
2) Specific gravity: local information
3) Probably four-sided stepped, but for safety reasons not considered

7b

Wind



Rough assumptions, on the safe side.

$4{,}40 \cdot 1{,}4 \cdot 75 = 462$ Kp/m

$4{,}40 \cdot 1{,}4 \cdot 65 = 400$ Kp/m

$5{,}00 \cdot 1{,}4 \cdot 50 = 350$ Kp/m

According to DIN 1055-4.

$M_1 = 462 \cdot 12{,}00 \cdot 31{,}70 = 175.745$ Kpm

$M_2 = 400 \cdot 8{,}00 \cdot 21{,}70 = 69.440$ "

$M_3 = 350 \cdot 10{,}00 \cdot 12{,}70 = 44.450$ "

$\Sigma M_w = 289.635$ Kpm

$W = 500 \cdot 900^2/6 = 67.500.000\ cm^3$

$\sigma_w = \pm 289\,635\,00\ \text{cm} / 67\,500\,000 = \pm 0{,}43$ Kp/cm²

Leaning

$\Sigma M_L = 117\,810 \cdot 0{,}30 + 235\,620 \cdot 0{,}20 + 525\,000 \cdot 0{,}07 = 119\,217$ Kpm

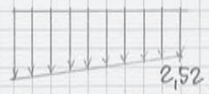
$W = 67.500.000\ cm^3$

$\sigma_L = 119\,217\,00\ \text{cm} / 67.500.000 = \pm 0{,}18$ Kp/cm²

Altogether

$\sigma = \frac{1.408.680}{500 \cdot 900} \pm 0{,}43 \pm 0{,}18$

$= 3{,}13 \pm 0{,}61 = 3{,}74 / 2{,}52$ kp/cm² $\ll \sigma_{allowable}$.



25.11.2009 Fritz Wenzel

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REPORT ON THE FOURTH FIELD MISSION TO WAZIR KHAN MOSQUE LAHORE 5-7 JUNE 2010

REPORT ON THE FOURTH FIELD MISSION TO WAZIR KHAN MOSQUE LAHORE 5-7 JUNE 2010

Initial position

Starting point for this paper is my Interim Report “Structural Consolidation and Conservation of the Wazir Khan Mosque in Lahore" from 25 November 2009. After investigation of masonry damage, conditions of soil, minaret foundation, and extent of minaret tilting, the Interim Report reached those conclusions:
Structure, foundation, and subsoil of the mosque are safe enough against further loads and deformations. Engineering reinforcement can be restricted to local strengthening of weak areas. Most of the repair work can be done by skilled craftsmen. Occasional structural advice will be sufficient.
This time the following themes were on the agenda of the visit, and appropriate kinds of action were discussed and considered:

Crack pattern in general

In the main the masonry of the mosque shows elder cracks. This fact doesn't exclude that part of them got widened in recent time. The reasons for cracking are different:

Firstly the higher own weight of the minarets and because of that their higher settlement in comparison with the adjacent walls, whose adjoining parts act now as unintended buttresses of the minarets and cracked accordingly.
Secondly, probably as a result of earthquake: A certain tilting of the minarets influenced the fabric of the Prayer Chamber in the West and led to cracks in the parapet and the vaults behind.
Thirdly, gaps and cracks in the South of the mosque complex and in the neighbouring houses are dealt with further below.
Fourthly: Apart from the structurally relevant cracks the building shows a number of narrow fissures and chinks, what is usual for such expanded masonry complexes.

Levelling of the roof edge around the courtyard

In accordance with an idea of Masood Khan, my proposal is to carry out a levelling of the roof edge around the courtyard. The measured divergences from the horizontal will lead to a more differentiated understanding of the particular crack pattern and the reasons for it. Please send the results of the levelling to Karlsruhe in due course.

Crack treatment in general

For the repair of the structurally not relevant fissures and chinks, traditional methods, techniques, and materials should be applied. Please use lime-mortar, no cement- or resin-based mortar!

For the filling of the structural relevant cracks with mortar, proven grouting methods and techniques do exist. Pure cement-mortar is to be avoided, the admixture of cement to the lime-mortar is to be restricted to the (for hardening) necessary minimum.

Stitching, i.e. inserting of steel bars across a masonry crack, proves to be ineffective, because in case of new tension- or shear forces the masonry will fail next to the old crack.

To repair a cracked area not by injection but by removing old bricks and inserting new ones is (only then and there) recommendable, where the crack is very wide, or the masonry beside the crack shows damage itself.

Cracking and tilting of vault and wall of the Middle Pavilion South

The thrust of the barrel vault pushed the upper part of the southern wall outwards and caused a wide gap in the crown of the vault. The gap runs through from the eastern to the western end of the vault (Fig. 1 and 2). The shift of the southern wall is visible at the eastern wall up in the corner (Fig. 3). The condition of the outer corner including bond and joints of both walls is insufficient as well (Fig. 4).

My idea for an unobtrusive repair is to insert 3 or 4 tie rods, crossing the room right under the vault, and to close the long and wide gap by bricks and mortar. On the basis of a survey and record drawings of the structure, I could work out a corresponding structural proposal. The outside corner needs repair by craftsmen.

Gap between Mosque and adjacent house in the South

The gap between the mosque and the adjacent house in the South (Fig. 5) is similar to the gap further away in the South-West (Fig. 6), described in my Interim Report of 25 November 2009. Recommendation: Don't fill up the gaps with grout, leave them open, avoid seeping of rain water into them by closing their edges with compressible material.

Cracks in the neighbouring property in the South

The neighbouring property in the South shows cracks in the wall adjoining the mosque (Fig. 7). An investigation of the inner structure and damage condition of the building is recommended, negative influence of a weak structure on the construction of the mosque should be assessable in good time.

Discussion with the archaeologist

In a discussion and a round of the building complex (Fig. 8) questions arose about the origin of the rising damp in the area. There was an agreement that the main reason is to be seen in the leaky trade water mains and sewers.

I was asked for a settlement prognosis for the soil of the mosque area. My answer was that no further subsidence is to be feared from the natural soil, which follows 4-8 m below the cultural fill und proved to be the base for the minaret foundations.

Different from this is the situation of the cultural fill. Its further behaviour depends on the change of dampness and is not predicable. I can only repeat what I wrote on this problem in my Interim Report in November 2009:

„The cultural fill of all investigated samples proved to be dampened. That may be the result of rainwater and, even more, of seepage from water mains and sewers. The dampness will not affect the natural soil below the minaret foundations, but penetration and retaining of water in the cultural fill may cause subsidence of parts of the courtyard and of walls which are not founded as deep as the minarets. In addition, rising damp may occur in the walls."

Thanks

Thanks again to the colleagues of AKCSP who supported my site mission to the best.

Fritz Wenzel

Fritz Wenzel 12 July 2010

Below 8 photos, taken by myself

Fig. 1, 2 Gap in the crown of the southern barrel vault of Middle Pavilion South

Fig. 3 Shift of the southern wall by thrust of the barrel vault (see upper corner)

Fig. 4 Condition of the outer corner between southern and eastern wall

Fig. 5 Gap between mosque and adjacent house in the South

Fig. 6 Similar gap further away in the South-We area of the mosque

Fig.7 Crack in the wall of the neighbouring property in the South

Fig. 8 Round with the archaeologi

Aga Khan Cultural Services, Pakistan

Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)

Factual Report on
Geotechnical Investigations

October 10, 2009

Doc. No. J-488
Rev 00

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Conservation, Rehabilitation and Sustainable Development of Walled City Lahore
(Geotechnical Investigations for Wazir Khan's Mosque)

00	10-10-09	Issued to Client	FNS		KA			
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			Prepared by		**Checked by**		**Clients Approval**	

Client	**Aga Khan Cultural Services, Pakistan**	
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FACTUAL REPORT ON GEOTECHNICAL INVESTIGATIONS

Document No.	**J-488**

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1 INTRODUCTION

1.1 General

Aga Khan Cultural Services, Pakistan in collaboration with Government of Punjab has initiated the project of "Conservation, Rehabilitation and Sustainable Development of Walled City Lahore". As a part of this project, geotechnical investigations had been planned in order to start the studies leading to the conservation of Wazir Khan Mosque. M/s Berkeley Associates have been entrusted with execution of Geotechnical Investigations for the Wazir Khan Mosque. The scope of work for the geotechnical investigations was prepared by Project Consultant M/s Buro fur Baukonstruktionen GmbH, Karlsruhe Germany.

The geotechnical investigations comprised drilling of boreholes, performance of in-situ tests in the boreholes and collection of soil from the boreholes and performance of laboratory testing on selected soil samples as per laboratory testing advice prepared by Project Consultant.

The field work for these geotechnical investigations was carried out during the period from August 10, 2009 to October 05, 2009.

1.2 Scope of Work

The scope of geotechnical investigations is as follows;

- Drilling of seven (07) exploratory boreholes (six (06) vertical and one (01) inclined)
- Excavation of testpit
- Performance of standard penetration tests (SPTs) in the boreholes.
- Collection of disturbed and undisturbed samples.
- Obtaining pertinent ground water information in the boreholes.
- Performance of laboratory tests on selected soil samples.
- Preparation of a factual geotechnical investigation report upon completion of field and laboratory testing.

1.3 Methodology

Keeping in view the scope of work and specifications generally followed for the geotechnical studies, a programme of field work was prepared. The exploratory borings were drilled using both hand auger cum light percussion drilling method in cultural fill and straight rotary drilling method in natural soil.

Angle bore hole was drilled at an angle of 15 degrees with vertical using straight rotary drilling rig and steel casing. The samples were recovered through single tube core barrel.

The excavation of testpit was made manually in 1 V: 0.23 H configuration.

Standard penetration tests (SPTs) were performed in designated boreholes in natural soil in accordance with ASTM D 1586.

The cultural fill samples were collected, rapped in polythene bags and preserved in wooden boxes. These samples were preserved without wasting even a single sample in order to get a continuous formation.

Soil samples were also collected from natural soil using appropriate samplers for identification and subsequent laboratory testing. Selected soil samples were subjected to various laboratory tests for evaluation of classification, strength and chemical characteristics of sub-soils.

This report has been prepared on the basis of geotechnical investigations carried out at the project site and subsequent laboratory testing performed on the selected soil samples.

2 FIELD INVESTIGATIONS

2.1 General

Keeping in view the scope of the geotechnical studies, the field investigation programme was prepared. These field investigations included the following activities;

- Drilling of exploratory boreholes
- In-situ testing in the boreholes
- Soil sampling from boreholes

Photographs taken at site during the field investigations are attached in Appendix-D.

The details of the field work are discussed in this chapter.

2.2 Exploratory Boreholes

A total of seven (07) boreholes were drilled at site. The locations of these boreholes are shown in Fig. 2-1.

BH-1 to BH-6 were drilled vertically each down to a depth of 25 m below the finished floor level (FFL) whereas; BH-7 was drilled through the minaret foundation at an angle of 15 degrees with vertical. This angle borehole was drilled up to 2.0 m below the bottom of foundation of minaret which hit at a depth of 8.0 m below the finished floor level (FFL). For continuous sampling of cultural fill, all the boreholes except BH-7 were drilled using hand auger cum light percussion drilling method and thereafter drilled by straight rotary drilling method in natural soil. The detail of drilling is given in the following table:

Sr. No.	Borehole Designation	Depth drilled in Cultural Fill (m)	Depth drilled in Natural Soil (m)
1	BH-1	5.0	20.0
2	BH-2	4.0	21.0
3	BH-3	5.0	20.0
4	BH-4	6.0	19.0
5	BH-5	8.0	17.0
6	BH-6	5.0	20.0

The diameter of all the boreholes was 100 mm. SPTs were performed in these boreholes at 1.0 depth interval in natural soil. Disturbed and Undisturbed soil samples were collected from the boreholes using appropriate samplers. Brick samples of foundation were also collected from angle borehole since cores were not possible due to zero RQD.

A careful record of all the materials encountered in each borehole was maintained in the form of borehole logs. Data of SPTs conducted in each hole was also recorded on the respective borehole logs. The borehole logs are included in Appendix-B.

2.3 Testpit Excavation

To obtain the details of minaret foundation and visual classification of foundation soils at shallow depth, one (01) testpit was manually excavated down to a depth of 3.97 m below the finished floor level (FFL). Subsurface log of the testpit was prepared after carefully observing the soils on the walls of the excavated pit. Location of testpit is shown on Fig. 2-1.The testpit log is also included in Appendix-B.

Three (03) additional auger holes were drilled at the bottom of testpit in order to access the further foundation details. These auger holes were drilled down to 1.38 m from bottom of testpit.

2.4 In-situ Testing in Boreholes

During the field investigations, standard penetration tests (SPTs) were carried out in all the boreholes except BH-7. A brief description of the test is provided in the following section.

2.4.1 Standard Penetration Tests

For evaluating the consistency and compactness of the foundation soils, the standard penetration tests (SPTs) were performed in all the designated exploratory boreholes except BH-7 in natural soil. SPTs were conducted in accordance with the procedures described in latest version of ASTM designation D 1586. A donut type hammer, weighing 63.5 kg, has been used for the tests. The hammer was lifted and dropped mechanically through a manila rope using pulley hanged to a tripod. Prior to performing each SPT, the loose material existing in the hole was properly removed. A split spoon sampler without a liner was used for all the tests. Disturbed soil samples

were obtained through the split spoon sampler. Profiles of observed SPT N-values are shown in Fig. 2-2 (Appendix-A).

2.5 Sampling in Boreholes

The cultural fill samples were collected, rapped in polythene bags and preserved in wooden boxes. These samples were preserved without wasting even a single sample in order to get a continuous formation.

Disturbed and undisturbed soil samples were also obtained from natural soil during these soil investigations. Disturbed soil samples were obtained from the boreholes through split spoon sampler while performing SPTs. The disturbed samples were placed in polythene bags and preserved in wide-mouthed plastic jars. The jars were clearly labelled to indicate the project name, project code, borehole designation and depth of sample. Undisturbed soil samples from cohesive soils were obtained from the boreholes by appropriate sampler. The Shelby tubes containing undisturbed soil samples were properly waxed and labelled to indicate the project name, project code, borehole designation and depth of sample. Brick samples of foundation were also recovered from angle borehole. These samples were preserved in wooden box. All the soil samples were carefully transported to our testing laboratory.

2.6 Groundwater Observations

At the time of these investigations, ground water table was not encountered in any of the borehole drilled down to a maximum depth of 25 m. However, some trapped water in the cultural fill was encountered.

3 LABORATORY TESTING

For evaluation of physical and mechanical characteristics of the sub-soils, selected disturbed and undisturbed soil samples were tested in the laboratory. The laboratory testing was carried out at testing facilities of Berkeley Associates Lahore. The laboratory testing program was prepared by the project Consultant. The following laboratory tests were performed on selected soil samples.

- Particle size distribution
- Atterberg's limits
- Bulk density
- In-situ moisture content

A brief description of these tests is given in the following sections. A summary of laboratory test results is provided in Table 3-1.

3.1 Particle Size Distribution

For classifying the subsurface soils, eleven (11) selected soil samples were subjected to sieve analyses during these studies. Most of the samples containing more than 30 percent material passing sieve no. 200 were further subjected to hydrometer analyses. The sieve analyses were performed in accordance with the procedures specified in ASTM designation D 422 , with sample preparation by ASTM designation D 2217 (wet preparation method), Procedure B. The hydrometer analyses were carried out in accordance with procedure as specified in ASTM designation D 422. Results of sieve and hydrometer analyses were plotted in the form of gradation curves. These curves for all the tested samples are presented in Appendix-C. The percentages of fines (passing sieve no. 200), sand and concretion fractions of the tested soil samples are also indicated in Table 3-1.

3.2 Atterberg Limits

For evaluating plasticity characteristics of cohesive soils, liquid and plastic limit tests were performed on two (02) selected soil samples. The tests were performed as specified in ASTM designation D 4318. Both the liquid limit tests were performed with at least three trials. The test results are summarized in Table 3-1. According to Casagrande's Plasticity Chart (shown as Fig. 3-1), the fine-grained soil samples are classified as CL.

3.3 Bulk and Dry Density

Three (03) undisturbed soil samples were tested for determination of their bulk densities. The test results are provided in Table 3-1. The bulk density of the tested samples ranges from 15.8 kN/m^3 to 18.1 kN/m^3.

3.4 In-situ Moisture Content

Six (06) undisturbed soil samples were tested for determination of their in-situ moisture contents. The test results are provided in Table 3-1. The in-situ moisture content of the tested samples ranges from 17.0 % to 26.9 %.

4 GEOTECHNICAL CHARACTERIZATION OF SUBSOIL

4.1 General

The geotechnical investigations carried out for the project comprised field and laboratory work. The field and laboratory investigations were aimed at evaluating the physical characteristics of the foundation soils. The subsurface conditions and physical characteristics of the soils existing at the project site are discussed in the following sections.

4.2 Geology

The natural soil deposits at the project site belong to Chung Fun formation. These alluvial deposits comprise earthy brown to brown silt, clay and sand. The beds are largely hard, laminated and sandy with interbeds of clay and layers or lenses of sand. The cultural fill is underlain by natural soil deposit.

4.3 Seismicity

According to Building Code of Pakistan (Seismic Provisions – 2007), issued by Government of Islamic Republic of Pakistan, Seismic Zone 2A has been assigned to Lahore. Peak ground acceleration associated with Zone 2A has been recommended to vary from 0.08g to 0.16g.

4.4 Stratigraphy

During these investigations, the subsurface was explored to a maximum depth of twenty five (25) m below the existing ground surface and the following geotechnical units have been identified;

Soil Unit	Description	Layer Thickness
Layer 1	Cultural fill	4.0 m - 8.0 m
Layer 2	Brown stiff to very stiff lean clay/ silty clay	2.0 m - 3.0 m

Layer 3	Grey, medium dense to dense silty sand/ poorly graded sand	Up to maximum explored depth of 25.0 m

Patches of sandy silt with the thickness ranging from 1.0 m to 2.5 m were encountered under the Layer 2.

Linear subsurface profiles developed on the basis of boreholes drilled at the site is shown in Figs. 4-1 & 4-2.

4.5 Groundwater Table

At the time of these investigations the ground water table was not encountered in any of the borehole except some trapped water or soil in saturated state in top cultural fill.

4.6 Seismic Soil Profile Characterization

In accordance with the procedures described in Building Code of Pakistan, (Seismic Provision 2007), the criteria for classification of un-cemented soil profiles are to be based on;

- V_s = average shear wave velocity of the top 100 ft. (30 m) soil profile

or

- N = average field SPT resistance for the top 100 ft. (30 m) soil profile

or

- S_u = average undrained shear strength for the top 100 ft. (30 m) soil profile

On the basis of observed SPT data an average N value of 23 is obtained, so the soil profile type as per Building Code of Pakistan should be taken as **S_D** (i.e. Stiff Soil).

5 EXISTING FOUNDATIONS

Different methodologies were adopted to determine the geometry and depth of existing foundation of minaret; and are as follows:

- Excavation of testpit
- Drilling of angle borehole

The details of these methodologies are discussed in the following sections.

5.1 Excavation of Testpit

To determine the geometry of foundation, one (01) testpit was excavated near Minaret. The test pit was excavated manually having the plan dimensions of 4'-6" X 5'-0". Depth of the testpit was limited to 3.97 m below natural ground level due to the stability problems. Beyond this depth three (03) auger holes were also drilled at the bottom of testpit to determine the remaining features of the footing. However, the actual depth of foundation could not be reached and determined. Foundation profile obtained from excavation of the testpit and drilling of auger holes is shown on Fig. 5-1.

5.2 Drilling of Angle Borehole

In order to determine the actual depth of existing foundation, a supplementary 10 m deep angle borehole was drilled near Minaret. The borehole was drilled inside courtyard at an angle of 15 degrees with the vertical by using straight rotary drilling method.

After drilling the angle borehole, the depth of foundation came out to be 7.73 m below the finished floor level (FFL) of courtyard and is shown in Fig. 5-2.

6 CONCLUSIONS

1. During these investigations, the subsurface was explored to a maximum depth of twenty five (25) m below the existing ground surface. The location of boreholes and testpit is shown on Fig. 2-1. Various soil layers encountered at the site below the existing ground surface are described in section 4.4 and graphically represented in linear subsurface profile shown on Figs. 4-1 & 4-2.

2. After the excavation of testpit, drilling of auger holes at the bottom of testpit and drilling of angle borehole near the minaret, the interpreted width of foundation came out to be 9.05 m whereas depth of foundation came out to be 7.73 m below finished floor level (FFL) of mosque courtyard. The details of existing minaret foundation are shown on Fig. 5-2.

3. At the time of these investigations the ground water table was not encountered in any of the borehole except some trapped water or soil in saturated state in top cultural fill.

4. On the basis of our evaluations, the soil profile type as per Pakistan Building Code should be taken as $\mathbf{S_D}$ (i.e. Stiff Soil).

APPENDIX - A

TABLE AND FIGURES

Berkeley Associates

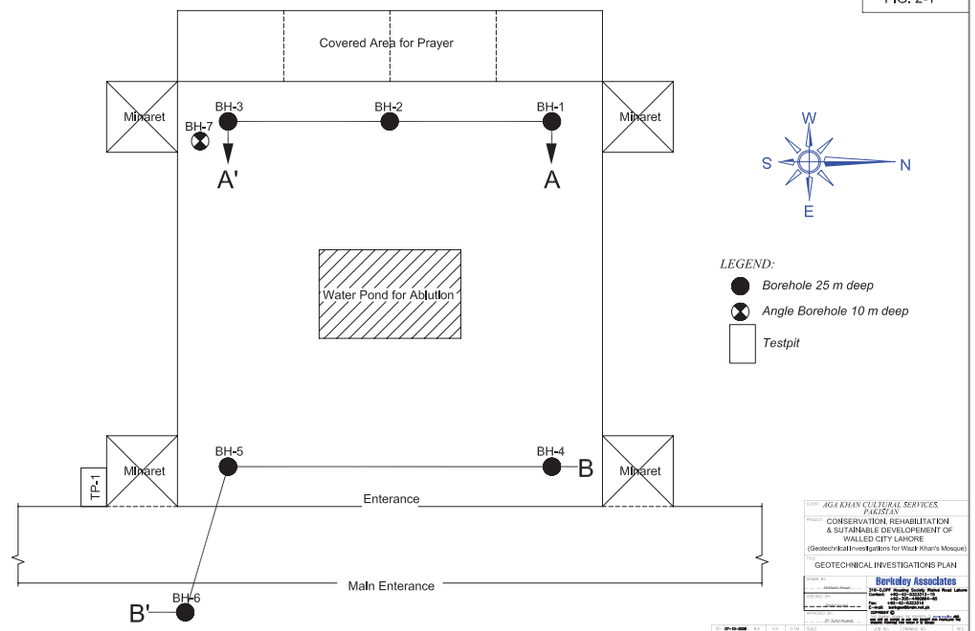
Table 3-1 Summary of Laboratory Test Results Sheet 1 of 1

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)			
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref**. J 488/L-018/09		**Date:** 28/09/2009

Borehole No.	Sample No.	Depth (m)	Partical Size Analysis			Atterberg Limits		Bulk Density	N.M.C %
			Conc. %	Sand %	Fines %	LL %	PI %	γ_b kN/m^3	
BH 02									
	UDS-2	7.5	5.1	3.9	91.0	30	11	17.90	17.0
	SPT-6	10.0	0.0	42.8	57.2				17.8
	SPT-8	12.0	0.0	86.2	13.8				
BH 03									
	UDS-1	7.5	0.0	2.7	97.3	33	12	18.1	24.6
	SPT-7	11.0	0.0	71.9	28.1				
BH 04									
	SPT-3	7.0	0.0	1.0	99.0				26.9
	SPT-6	10.0	0.0	82.5	17.5				
BH 05									
	UDS-1	8.0	0.0	49.7	50.3			15.8	21.3
	SPT-2	10.0	0.0	68.1	31.9				
BH 06									
	SPT-4	7.0	0.0	22.0	78.0				20.6
	SPT-7	10.0	0.0	69.9	30.1				

Tested by: Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

FIG. 2-1



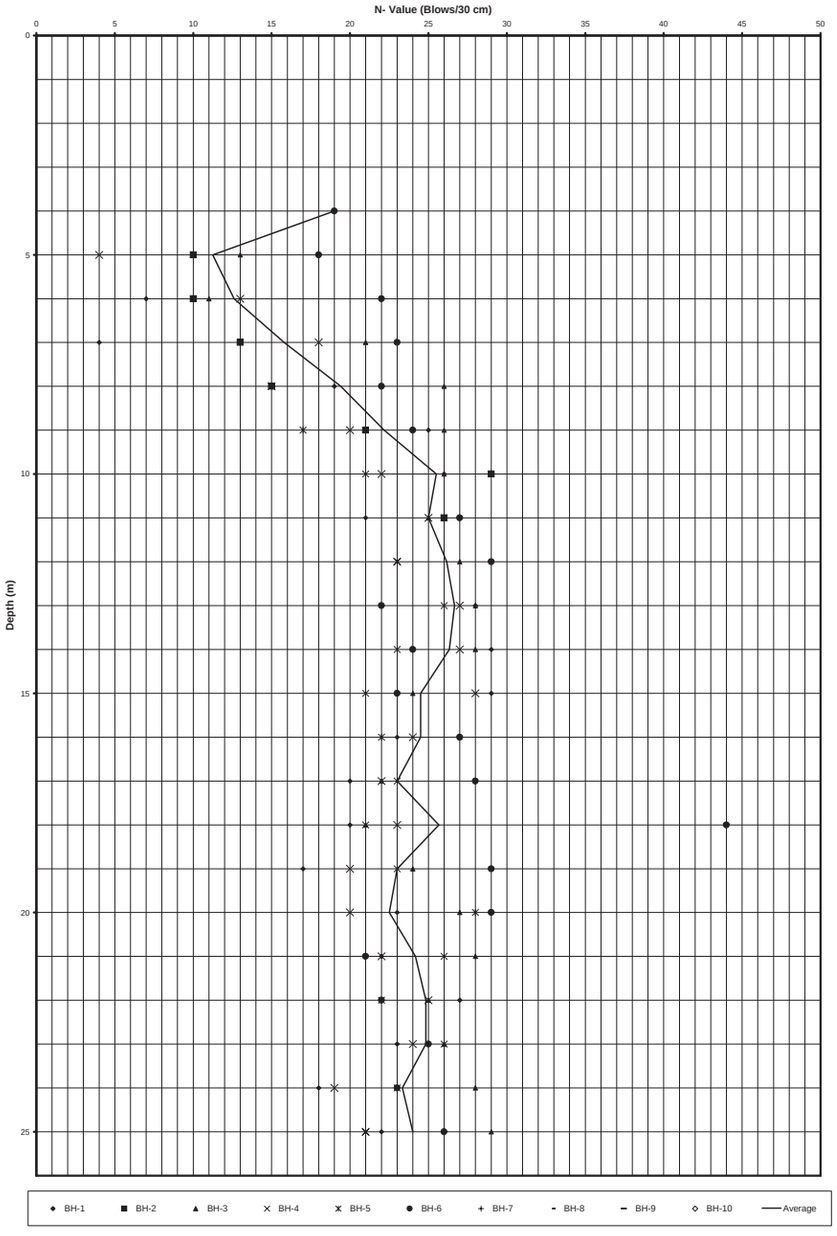


Fig. 2-2 Profile of Observed SPT N Values Versus Depth

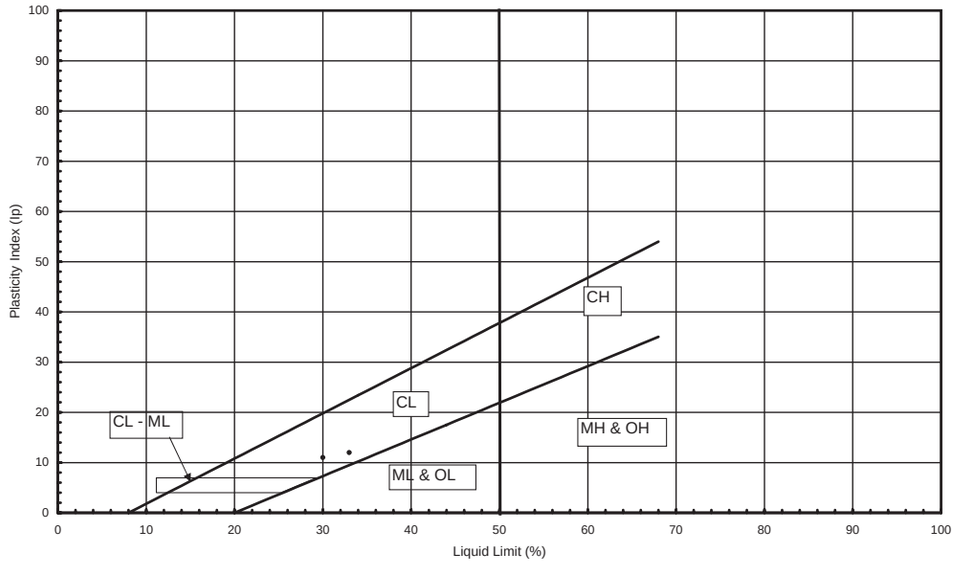
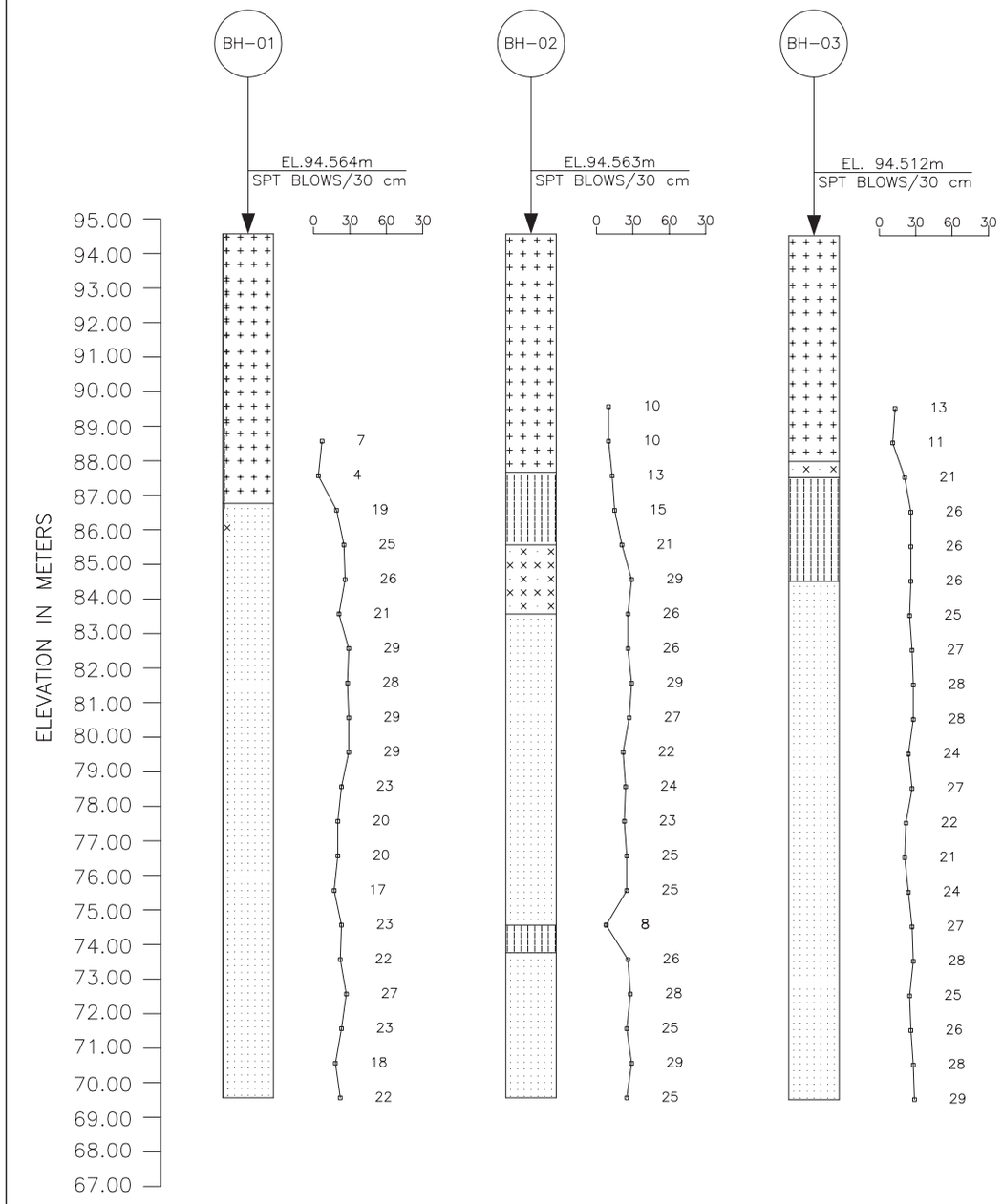


Fig. 3-1 Casagrande Plasticity Chart

FIG. 4-1



LEGEND:

- CULTURAL FILL
- SANDY SILT/SILT WITH SAND/ SILT
- POORLY GRADED SAND/ SILTY SAND
- LEAN CLAY/ SILTY CLAY
- WATER TABLE
- SPT

NOTES:

- ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED
- THE WIDTH OF BOREHOLE IS NOT TO SCALE

CLIENT: *AGA KHAN CULTURAL SERVICES, PAKISTAN*

PROJECT: CONSERVATION, REHABILITATION & SUTAINABLE DEVELOPEMENT OF WALLED CITY LAHORE
(Geotechnical Investigations for Wazir Khan's Mosque)

TITLE: LINEAR SUBSURFACE PROFILE A-A'

DRAWN BY: Mehboob Ahmad

CHECKED BY: Khalid Ayyub

APPROVED BY: Dr. Tahir Masood

Berkeley Associates
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Fax: +92-42-5323316
E-mail: berkgee@brain.net.pk

REV.	DATE	DRAWN	CHECKED	APPROVED
00	07-10-2009	M.A	K.A	D.T.M

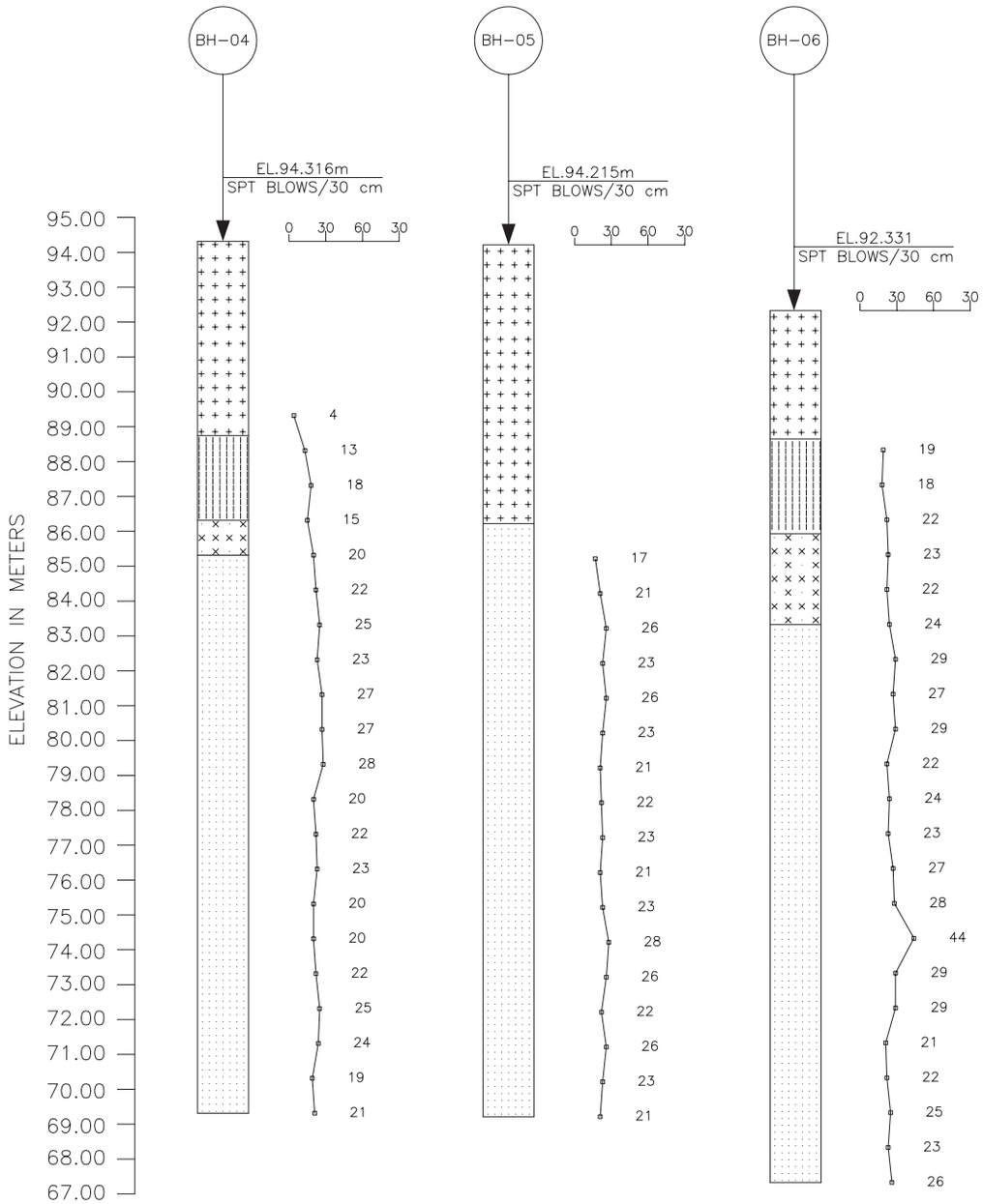
SCALE VER. 1:200
HOR. N.T.S

JOB NO. J-488

DRAWING NO. Fig. 4-1

REV. 00

FIG. 4-2



LEGEND:

- CULTURAL FILL
- SANDY SILT/SILT WITH SAND/ SILT
- POORLY GRADED SAND/ SILTY SAND
- LEAN CLAY/ SILTY CLAY
- WATER TABLE
- SPT

NOTES:

- ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED
- THE WIDTH OF BOREHOLE IS NOT TO SCALE

CLIENT: *AGA KHAN CULTURAL SERVICES, PAKISTAN*

PROJECT: CONSERVATION, REHABILITATION & SUTAINABLE DEVELOPEMENT OF WALLED CITY LAHORE
(Geotechnical Investigations for Wazir Khan's Mosque)

TITLE: LINEAR SUBSURFACE PROFILE B-B'

DRAWN BY: Mehboob Ahmad

CHECKED BY: Khalid Ayyub

APPROVED BY: Dr. Tahir Masood

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REV.	DATE	DRAWN	CHECKED	APPROVED
00	07–10–2009	M.A	K.A	D.T.M

SCALE VER. 1:200 HOR. N.T.S | JOB NO. J–488 | DRAWING NO. Fig. 4–2 | REV. 00

FIG. 5-1

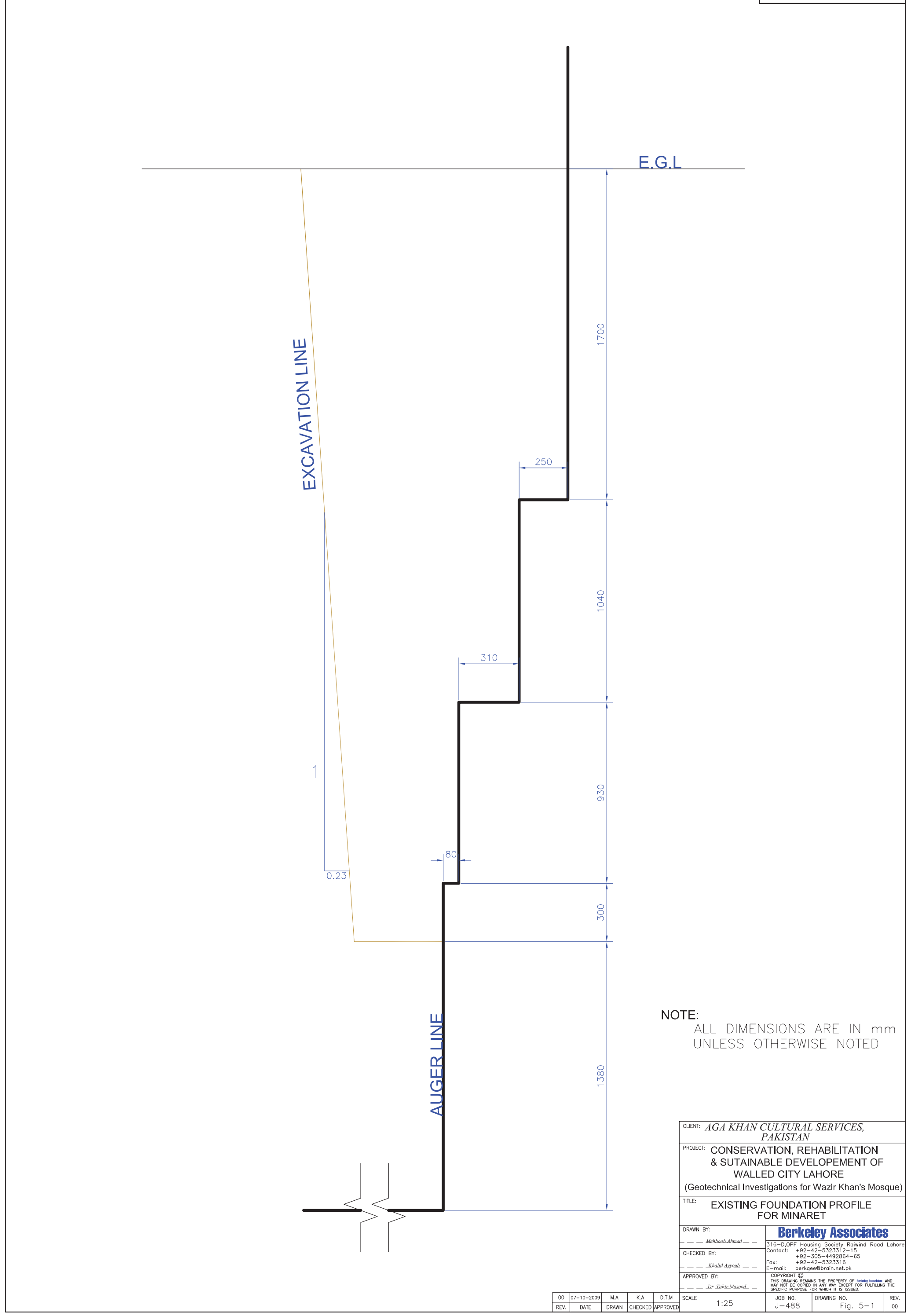
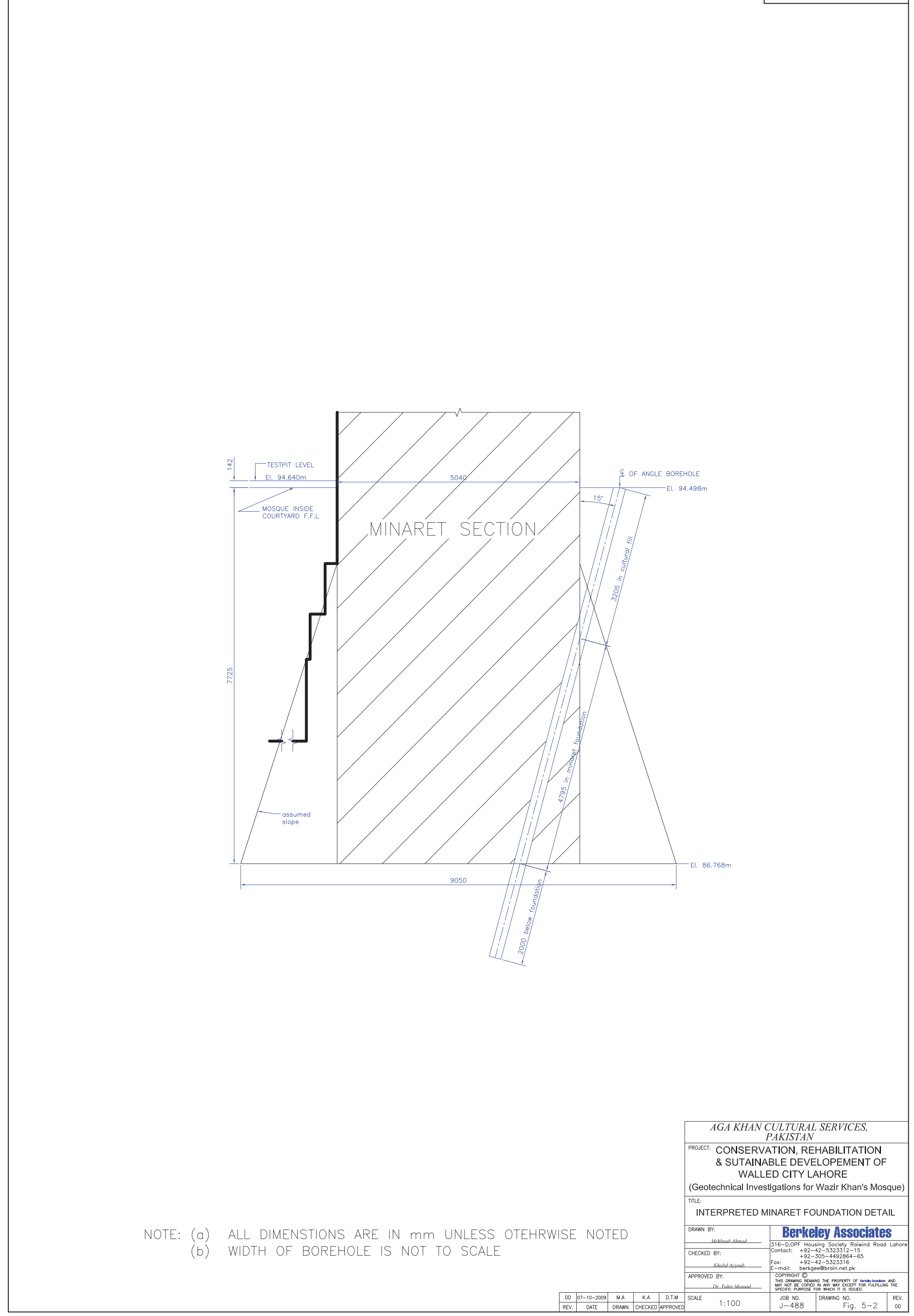

E.G.L
EXCAVATION LINE
AUGER LINE
1700
1040
930
300
1380
250
310
80
1
0.23
NOTE:
ALL DIMENSIONS ARE IN mm
UNLESS OTHERWISE NOTED
AGA KHAN CULTURAL SERVICES, PAKISTAN
CONSERVATION, REHABILITATION & SUTAINABLE DEVELOPEMENT OF WALLED CITY LAHORE
(Geotechnical Investigations for Wazir Khan's Mosque)
EXISTING FOUNDATION PROFILE FOR MINARET
Berkeley Associates
1:25
J-488
Fig. 5-1

FIG. 5-2


MINARET SECTION
TESTPIT LEVEL
El. 94.640m
MOSQUE INSIDE COURTYARD F.F.L
142
5040
7725
9050
15°
El. 94.498m
El. 86.768m
assumed slope
3205 in cultural fill
4795 in minaret foundation
2000 below foundation
NOTE: (a) ALL DIMENSTIONS ARE IN mm UNLESS OTEHRWISE NOTED
(b) WIDTH OF BOREHOLE IS NOT TO SCALE
AGA KHAN CULTURAL SERVICES, PAKISTAN
CONSERVATION, REHABILITATION & SUTAINABLE DEVELOPEMENT OF WALLED CITY LAHORE
(Geotechnical Investigations for Wazir Khan's Mosque)
INTERPRETED MINARET FOUNDATION DETAIL
Berkeley Associates
1:100
J-488
Fig. 5-2

APPENDIX - B

BORE HOLE & TESTPIT LOGS

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.442 N: 1038.073
GROUND ELEV: 94.564 m

BOREHOLE NO: BH-01
DEPTH OF W.T: NIL
BORING STARTED ON: 15-08-2009
LOGGED BY: CHUGHTAI

SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 16-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 / 60)
0								
1					FILL MATERIAL 0.0 to 0.12 m Bricks			
2					0.12 to 0.15 m molst, cement sand. 0.15 to 0.50 m moist, sandy silt mixed with pieces of bricks.			
3					0.50 to 1.0 m moist, sandy silt, concretion size 4 mm. 1.0 to 2.0 m molst, brown grey, clay sandy silt, mixed with concretions			
4					2.0 to 3.0 m moist, brown grey,clay sany silt, mixed with concretions. 3.0 to 4.8 m moist, brown grey, clay sandy silt, mixed with hard black bricks pieces.			
5					4.8 to 5.0 m moist, layers white loose bone mixed with clay silt.			
	89.0	Hand Auger Light Percussion Method	UDS-1		5.0 to 7.0 m moist, brown, clayey silt, trace pieces of bricks and portry.			
6	88.5		SPT-1				7	
7	87.5		SPT-2		7.0 to 7.8 m moist, brown, clayey silt, trace bricks and bone pieces.		4	
8	86.5		SPT-3		Grey, medlum dense SILTY SAND trace mica.		19	
9	85.5		SPT-4				25	
10	84.5		SPT-5				26	
11	83.5	Hydraullc Feed Stralght Rotary drllling	SPT-6				21	
12	82.5		SPT-7				29	
13	81.5		SPT-8				28	
14	80.5		SPT-9				29	
15	79.5		SPT-10				29	
16	78.5		SPT-11				23	
17	77.5		SPT-12				20	
18	76.5		SPT-13				20	
19	75.5		SPT-14				17	
20	74.5		SPT-15		(CONTINUED)		23	

CLIENT:
Aga Khan Culture Servlces, Paklstan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.442 N: 1038.073
GROUND ELEV: 94.564 m
BOREHOLE NO: BH-01
DEPTH OF W.T: NIL
BORING STARTED ON: 15-08-2009
LOGGED BY: CHUGHTAI
SHEET 2 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 16-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE
20	74.5		SPT-15				23	30 60
21	73.5		SPT-16		Grey, medium dense SILTY SAND trace mica.		22	
22	72.5	Hydraullc Feed Stralght Rotary drllling	SPT-17				27	
23	71.5		SPT-18				23	
24	70.5		SPT-19				18	
25	69.5		SPT-20				22	
26					(BOTTOM OF BOREHOLE)			
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.553 N: 1022.803
GROUND ELEV: 94.563 m
BOREHOLE NO: BH-02
DEPTH OF W.T: NIL
BORING STARTED ON: 16-08-2009
LOGGED BY: CHUGHTAI
SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 04-09-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE
0								30 60
1					FILL MATERIAL 0.0 to 0.12 m Bricks 0.12 to 0.22 m moist, mixture of cement, sand, stone 0.22 to 0.40 m moist, brown grey sandy silt, mixed with pieces of bricks. 0.40 to 1.5 m brown, moist clayey silt, trace concretion. 1.5 to 1.70 m moist, silt, concretion, mixed with pieces of bricks. 1.70 to 2.0 m moist, brown, silt, mixed with concretions. 2.0 to 2.5 m moist, brown clay, sandy silt, mixed with concretion and bricks. 2.5 to 3.75 m moist, brown clay, mixed with concretions. 3.75 to 4.0 m brown, moist, clayey silt, trace sand. 4.0 to 6.0 m moist, brown, silty clay mixed with pieces of bricks and bones. 0.6 to 6.9 m moist, brown grey sandy silt mixed with pieces of bricks and bones.			
2								
3								
4	90.0		UDS-1					
5	89.5	Hand Auger Light Percussion Method	SPT-1				10	
6	88.5		SPT-2				10	
7	87.5		SPT-3				13	
	87.0		UDS-2		Brown, stiff LEAN CLAY, (CL) trace mica.			
8	86.5		SPT-4				15	
9	85.5	Hydraullc Feed Stralght Rotary drllling	SPT-5				21	
10	84.5		SPT-6		Grey,medium dense, SANDY SILT, (ML)		29	
11	83.5		SPT-7				26	
12	82.5		SPT-8		Grey, medium dense, SILTY SAND, trace mica.		26	
13	81.5		SPT-9				29	
14	80.5		SPT-10				27	
15	79.5		SPT-11				22	
16	78.5		SPT-12				24	
17	77.5		SPT-13				23	
18	76.5		SPT-14				25	
19	75.5		SPT-15				25	
20	74.5		SPT-16		(CONTINUED)		8	

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.553 N: 1022.803
GROUND ELEV: 94.563 m
BOREHOLE NO: BH-02
DEPTH OF W.T: NIL
BORING STARTED ON: 16-08-2009
LOGGED BY: CHUGHTAI
SHEET 2 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 04-09-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
20	74.5		SPT-16				8	
	74.0		UDS-3		Brown grey, firm			
21	73.5		SPT-17		SILTY CLAY, trace sand.		26	
22	72.5		SPT-18		Grey, medlum dense, SILTY SAND, trace mica.		28	
23	71.5		SPT-19		sllty clay at 22.0 to 22.17 m depth.		25	
24	70.5		SPT-20				29	
25	69.5	Hydraulic Feed Straight Rotary drilling	SPT-21				25	
26					(BOTTOM OF BOREHOLE)			
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.357 N: 1005.236
GROUND ELEV: 94.512 m
BOREHOLE NO: BH-03
DEPTH OF W.T: NIL
BORING STARTED ON: 17-08-2009
LOGGED BY: CHUGHTAI
SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 30-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
0								
1					FILL MATERIAL 0.0 to 0.12 m Bricks			
2					0.12 to 0.20 m moist, mixture of cement, sand, stone 0.20 to 0.45 m moist, brown clayey silt, mixed with pieces of bricks.			
3					0.45 to 1.30 m moist, brown, clayey silt, trace brick pieces and concretion. 1.30 to 4.60 m moist, silt, concretion, mixed with pieces of bricks and bones.			
4					4.6 to 5.0 m moist, brown, clayey silt, trace concretion.			
5	89.5	Hand Auger Light Percussion Method	SPT-1		5.0 to 6.0 m moist, brown grey, medium dense, sandy silt, trace mica.		13	
6	88.5		SPT-2		6.0 to 6.50 m moist, brown grey, medium dense, sandy silt, mixed with bone and potery pieces.		11	
7	87.5		SPT-3		Brown grey, medium dense, sandy silt, trace mica.		21	
	87.0		UDS-1		Brown, very stiff			
8	86.5		SPT-4		LEAN CLAY, (CL) trace sand.		26	
9	85.5		SPT-5				26	
10	84.5	Hydraulic Feed Straight Rotary drilling	SPT-6		Grey, medium dense, SILTY SAND, trace mica.		26	
11	83.5		SPT-7				25	
12	82.5		SPT-8				27	
13	81.5		SPT-9				28	
14	80.5		SPT-10				28	
15	79.5		SPT-11				24	
16	78.5		SPT-12				27	
17	77.5		SPT-13				22	
18	76.5		SPT-14				21	
19	75.5		SPT-15				24	
20	74.5		SPT-16		(CONTINUED)		27	

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1050.357 N: 1005.236
GROUND ELEV: 94.512 m
BOREHOLE NO: BH-03
DEPTH OF W.T: NIL
BORING STARTED ON: 17-08-2009
LOGGED BY: CHUGHTAI
SHEET 2 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 30-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
20	74.5		SPT-16				27	
21	73.5		SPT-17		Grey, medium dense, SILTY SAND, trace mlca.		28	
22	72.5	Hydraulic Feed Straight Rotary drilling	SPT-18		moxed with spots of clay at 21.0 and 24.0 m depth.		25	
23	71.5		SPT-19				26	
24	70.5		SPT-20				28	
25	69.5		SPT-21				29	
26					(BOTTOM OF BOREHOLE)			
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1096.697 N: 1036.246
GROUND ELEV: 94.316 m
BOREHOLE NO: BH-04
DEPTH OF W.T: NIL
BORING STARTED ON: 15-08-2009
LOGGED BY: CHUGHTAI
SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 10-09-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
0								
1					FILL MATERIAL 0.0 to 0.12 m Bricks 0.12 to 0.22 m mixture of cement, sand, stone 0.22 to 1.0 m moist, sand, pieces of bricks mixed with clayey silt. 1.0 to 1.5 m moist, white stone mixture of powder bricks. 1.5 to 3.7 m moist, brown, clayey silt, mixed with pieces of bricks. 3.7 to 4.0 m moist, brown, clayey silt, trace sand 4.0 to 5.5 m moist, brown, soft, clayey silt, mixed withh pieces of bricks.			
2								
3								
4								
	89.8	Hand Auger Light Percussion Method	UDS-1					
5	89.3		SPT-1				4	
	88.8		UDS-2					
6	88.3		SPT-2		Brown, stiff to very stiff, SILTY CLAY, trace brlck pleces upto 6.0 m depth.		13	
7	87.3		SPT-3				18	
8	86.3		SPT-4				15	
9	85.3		SPT-5		Grey brown, medium dense, SANDY SILT,		20	
10	84.3	Hydraulic Feed Straight Rotary drilling	SPT-6		Grey, medlum dense, SILTY SAND, trace mlca.		22	
11	83.3		SPT-7				25	
12	82.3		SPT-8				23	
13	81.3		SPT-9				27	
14	80.3		SPT-10				27	
15	79.3		SPT-11				28	
16	78.3		SPT-12				20	
17	77.3		SPT-13				22	
18	76.3		SPT-14				23	
19	75.3		SPT-15				20	
20	74.3		SPT-16		(CONTINUED)		20	

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1096.697 N: 1036.246
GROUND ELEV: 94.316 m
BOREHOLE NO: BH-04
DEPTH OF W.T: NIL
BORING STARTED ON: 15-08-2009
LOGGED BY: CHUGHTAI
SHEET 2 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 10-09-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
20	74.3	Hydraulic Feed Straight Rotary drilling	SPT-16		Grey, medium dense, SILTY SAND, trace mica.	20	20	
21	73.3		SPT-17			21	22	
22	72.3		SPT-18			22	25	
23	71.3		SPT-19			23	24	
24	70.3		SPT-20			24	19	
25	69.3		SPT-21			25	21	
26					(BOTTOM OF BOREHOLE)	26		
27						27		
28						28		
29						29		
30						30		
31						31		
32						32		
33						33		
34						34		
35						35		
36						36		
37						37		
38						38		
39						39		
40						40		

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1094.160 N: 1005.063
GROUND ELEV: 94.215 m
BOREHOLE NO: BH-05
DEPTH OF W.T: NIL
BORING STARTED ON: 21-08-2009
LOGGED BY: CHUGHTAI
SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 27-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
0		Hand Auger Light Percussion Method			FILL MATERIAL 0.0 to 0.10 m Bricks 0.10 to 0.39 m moist, mixture of powder bricks, cement, lime stone 0.39 to 1.40 m moist, brown, mixture of clayey silt, pieces of bricks 1.40 to 1.80 m layers pieces of bricks. 1.80 to 3.0 m moist, brown, pieces of bricks mixed with clayey sandy silt. 3.0 to 4.0 m saturated, blackish grey, silty clay/clayey silt mixed with bricks. 4.0 to 5.0 m saturated, blackish grey, sandy clay silt mixed with pieces of bricks. 5.0 to 5.5 m saturated, blacklsh grey, clayey sllt, mlxed wlth pieces of bricks. 5.5 to 6.0 m layers pieces of bricks. 6.0 to 6.85 m saturated, brown grey, silty clay, mixed with pieces of bricks. 6.85 to 7.0 m saturated, brown, clayey silt, trace sand 7.0 to 8.0 m moist to saturated, brown, silty clay, mixed with pieces of carban spots.bricks.			
8	86.2		UDS-1					
9	85.2		SPT-1		Grey, medium dense, SILTY SAND, trace mlca.		17	
10	84.2		SPT-2				21	
11	83.2	Hydraullc Feed Stralght Rotary drllling	SPT-3				26	
12	82.2		SPT-4				23	
13	81.2		SPT-5				26	
14	80.2		SPT-6				23	
15	79.2		SPT-7				21	
16	78.2		SPT-8				22	
17	77.2		SPT-9				23	
18	76.2		SPT-10				21	
19	75.2		SPT-11				23	
20	74.2		SPT-12		(CONTINUED)		28	

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1094.160 N: 1005.063
GROUND ELEV: 94.215 m
BOREHOLE NO: BH-05
DEPTH OF W.T: NIL
BORING STARTED ON: 21-08-2009
LOGGED BY: CHUGHTAI
SHEET 2 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 27-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
20	74.2	Hydraullc Feed Stralght Rotary drilllng	SPT-12		Grey, medium dense, SILTY SAND, trace mica.		28	
21	73.2		SPT-13				26	
22	72.2		SPT-14				22	
23	71.2		SPT-15				26	
24	70.2		SPT-16				23	
25	69.2		SPT-17				21	
26					(BOTTOM OF BOREHOLE)			
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1119.102 N: 1001.585
GROUND ELEV: 94.331 m
BOREHOLE NO: BH-06
DEPTH OF W.T: NIL
BORING STARTED ON: 17-08-2009
LOGGED BY: CHUGHTAI
SHEET 1 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 19-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
0		Hand Auger Light Percussion Method			FILL MATERIAL 0.0 to 0.10 m Bricks 0.10 to 2.0 m moist, Brown, clayey silt mixed with pieces of bricks. 2.0 to 2.10 m layers Brick pieces. 2.10 to 3.0 m moist, Brown, clayey silt, trace concretion and brick pieces. 3.0 to 3.4 m moist, Grey, silty clay, trace brick pieces			
1								
2								
3								
4	90.3		SPT-1		Brown, moist, SILT/CLAYEY SILT, trace concretions.		19	
5	89.3		SPT-2				18	
	88.8		UDS-1					
6	88.3		SPT-3				22	
7	87.3		SPT-4		Grey, medium dense, SANDY SILT, trace mica.		23	
8	86.3		SPT-5				22	
9	85.3	Hydraullc Feed Stralght Rotary drilllng	SPT-6		Grey, medium dense to dense, SILTY SAND, silty clay at 16.0 to 16.2 m depth. trace mica.		24	
10	84.3		SPT-7				29	
11	83.3		SPT-8				27	
12	82.3		SPT-9				29	
13	81.3		SPT-10				22	
14	80.3		SPT-11				24	
15	79.3		SPT-12				23	
16	78.3		SPT-13				27	
17	77.3		SPT-14				28	
18	76.3		SPT-15				44	
19	75.3		SPT-16				29	
20	74.3		SPT-17		(CONTINUED)		29	

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1119.102 N: 1001.585
GROUND ELEV: 94.331 m
BOREHOLE NO: BH-06
DEPTH OF W.T: NIL
BORING STARTED ON: 17-08-2009
LOGGED BY: CHUGHTAI
SHEET 2 OF 2
FINAL DEPTH: 25.0 m
ENDED ON: 19-08-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS FOR LAST 30 cm PENETRATION	STANDARD PENETRATION TEST PROFILE (30 60)
20	74.3	Hydraulic Feed Straight Rotary drilling	SPT-17		Grey, medium dense, SILTY SAND, trace mica. spots of silty clay at 21.0 m depth.		29	
21	73.3		SPT-18				21	
22	72.3		SPT-19				22	
23	71.3		SPT-20				25	
24	70.3		SPT-21				23	
25	69.3		SPT-22				26	
26					(BOTTOM OF BOREHOLE)			
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

CLIENT:
Aga Khan Culture Servlces, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1049.528 N: 1002.203
GROUND ELEV: 94.498 m
BOREHOLE NO: BH-07
DEPTH OF W.T: NIL
BORING STARTED ON: 04-10-2009
LOGGED BY: CHUGHTAI
SHEET 1 OF 1
FINAL DEPTH: 10.0 m
ENDED ON: 05-10-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	SPT BLOWS	CORE RECOVERY %	R.Q.D	STANDARD PENETRATION TEST PROFILE (10 20)
0		Hydraulic Feed Straight Rotary drilling	R-1		Red Brown Bricks, Jointed Fractured mixed with mixture of limestone.			21.7	NIL	
1										
2										
3			R-2					12.0		
4										
5			R-3					10.0		
6					Red Brown Bricks, trace bricks powder			12.0		
7			R-4							
8			R-5 DS-1		Yellow Grey SILTY CLAY,			NIL		
9			DS-2 DS-3							
10					(BOTTOM OF BOREHOLE)					
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

CLIENT:
Aga Khan Culture Servlces, Pakistan

Berkeley Associates

PROJECT: GEOTECHNICAL INVESTIGATION OF WAZIR KHAN'S MOSQUE
STRUCTURE: LAHORE
COORDS. E: 1101.540 N: 992.673
GROUND ELEV: 94.640 m

BOREHOLE NO: TP-1
DEPTH OF W.T: NIL
BORING STARTED ON: 25-09-2009
LOGGED BY: CHUGHTAI

SHEET 1 OF 1
FINAL DEPTH: 5.35 m
ENDED ON: 27-09-2009
CHECKED BY: ALI

DEPTH, m	REDUCED LEVEL, m	DRILLING DETAILS	SAMPLES	LEGEND	DESCRIPTION OF MATERIAL	DEPTH, m	BULK DENSITY PROFILE g/cm3	MOISTURE CONTENT PROFILE (%)	DRY DENSITY PROFILE g/cm3
0							4 8 12 16	4 8 12 16	4 8 12 16
1		Manually Excavated Testpit			Red Brown, layer by layer Bricks mixed with mixture of limestone concretion, soil, all mixed with pieces of bricks.				
2									
3									
4					Brown, moist to saturated mixed with pieces of bricks				
5					Brown, saturated soil M.C near 50 % mixed with pieces of bricks				
6									
7					(BOTTOM OF TEST PIT)				
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

CLIENT:
Aga Khan Culture Services, Pakistan

Berkeley Associates

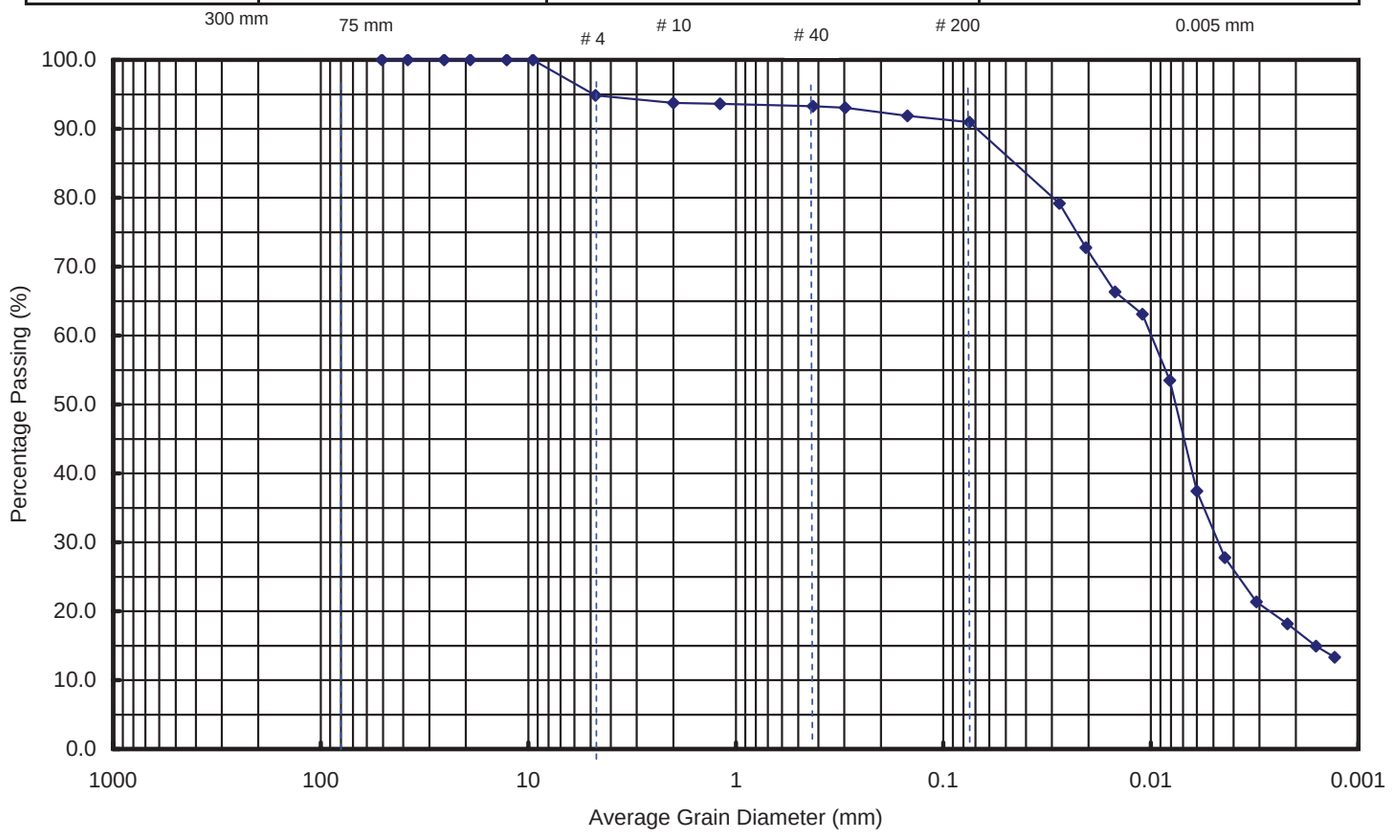
APPENDIX - C

LABORATORY TEST RESULTS

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-2	**Depth**: 7.5 meter	**Sample No**.UDS-2	**Sample Type**: Undisturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	94.9
2.00	93.8
1.19	93.6
0.425	93.3
0.297	93.1
0.149	91.9
0.075	91.0

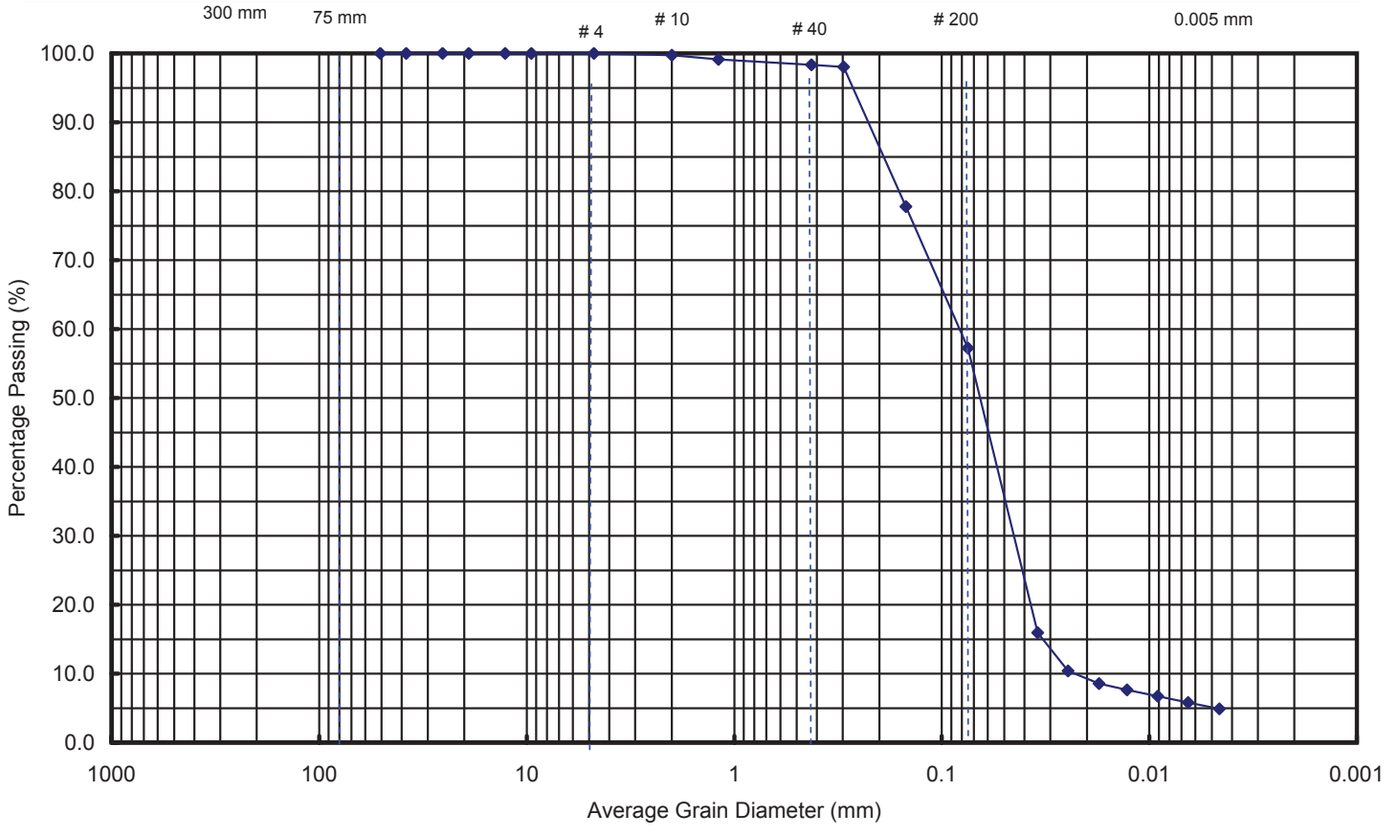
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-2	**Depth**: 10.0 meter	**Sample No**.SPT-6	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	99.7
1.19	99.1
0.425	98.3
0.297	98.0
0.149	77.8
0.075	57.3

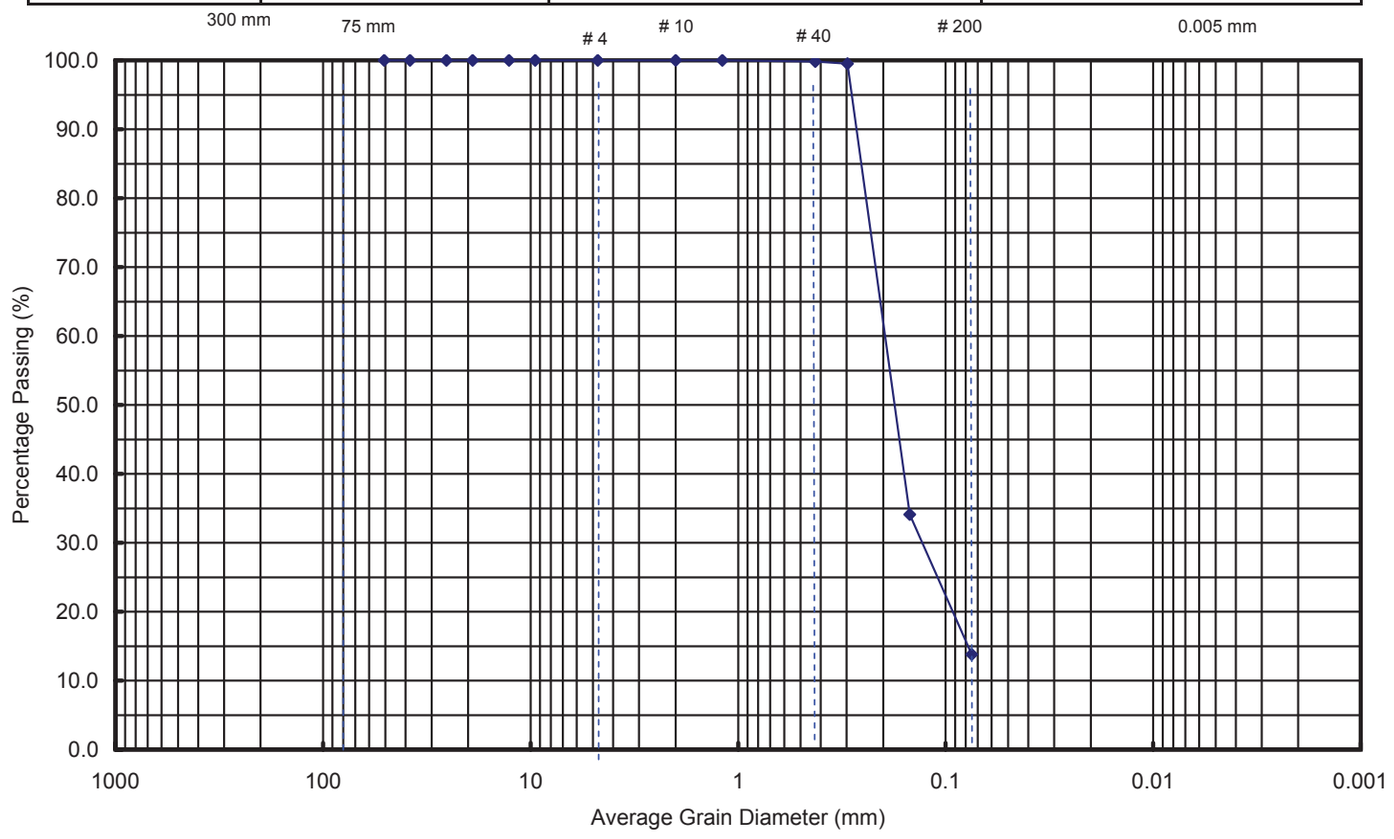
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-2	**Depth**: 12.0 meter	**Sample No**.SPT-8	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	100.0
1.19	100.0
0.425	99.8
0.297	99.5
0.149	34.1
0.075	13.8

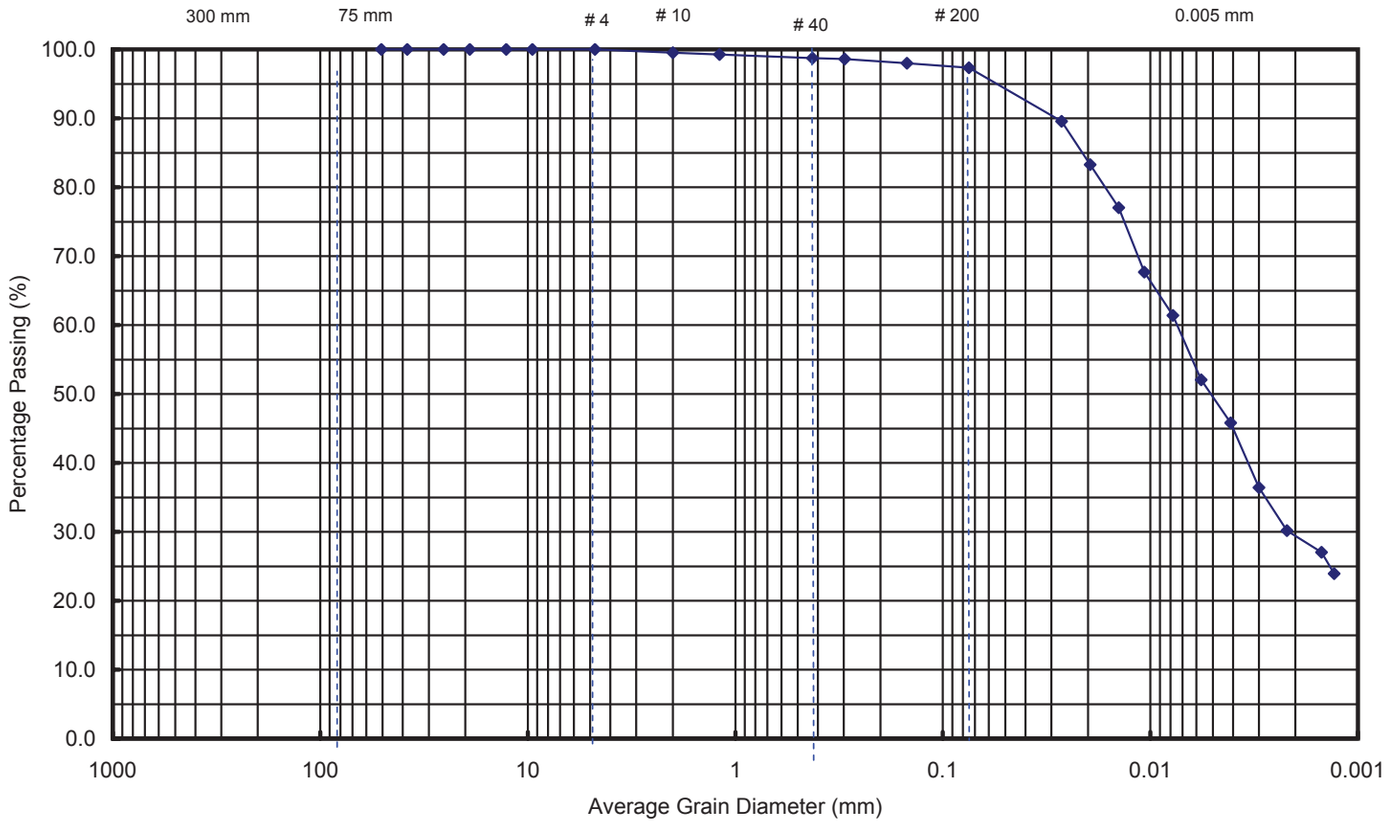
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-3	**Depth**: 7.5 meter	**Sample No**.UDS-1	**Sample Type**: Undisturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	99.5
1.19	99.3
0.425	98.7
0.297	98.6
0.149	98.0
0.075	97.3

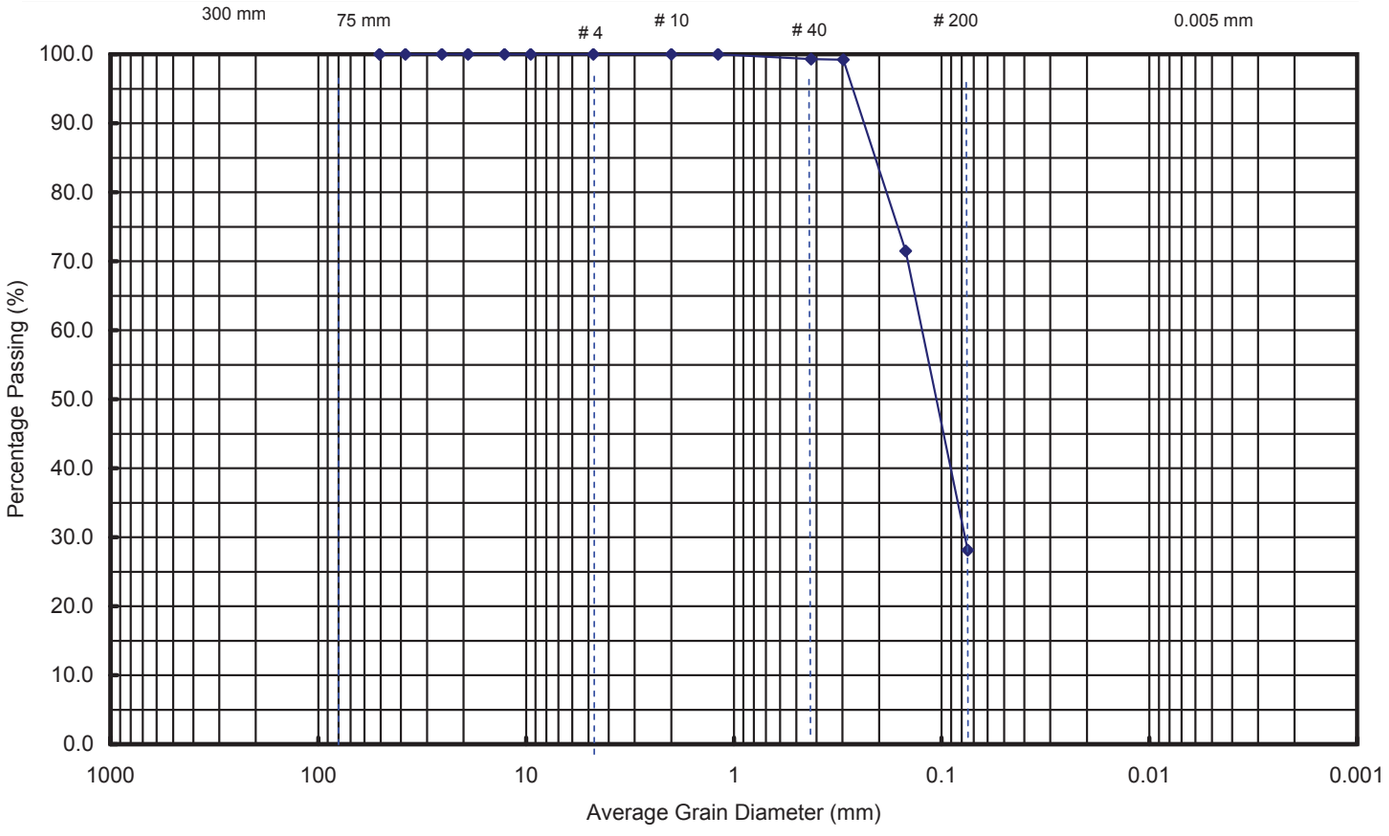
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-3	**Depth**: 11.0 meter	**Sample No**.SPT-7	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	100.0
1.19	100.0
0.425	99.3
0.297	99.2
0.149	71.5
0.075	28.1

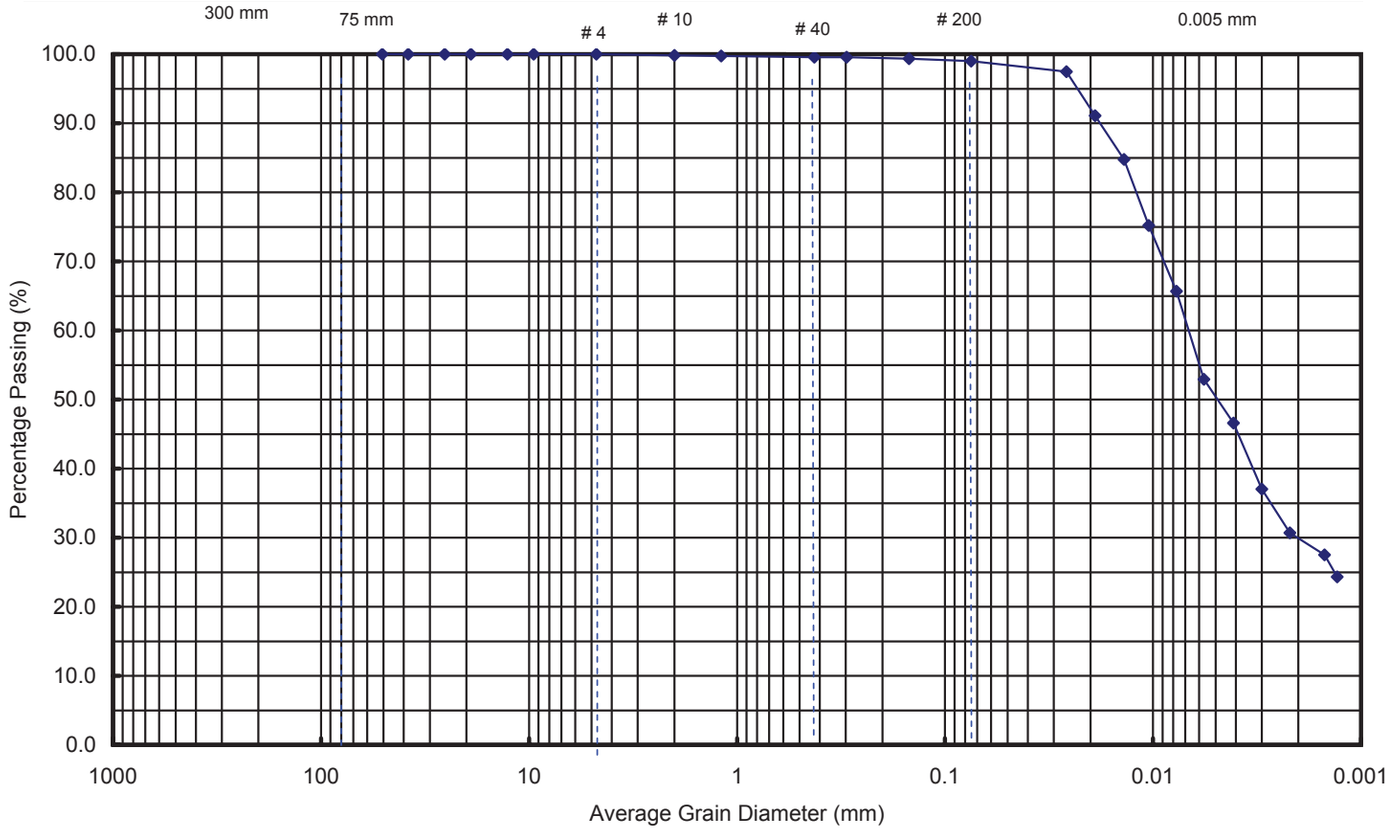
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-4	**Depth**: 7.0 meter	**Sample No**. SPT-3	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	99.8
1.19	99.7
0.425	99.6
0.297	99.6
0.149	99.4
0.075	99.0

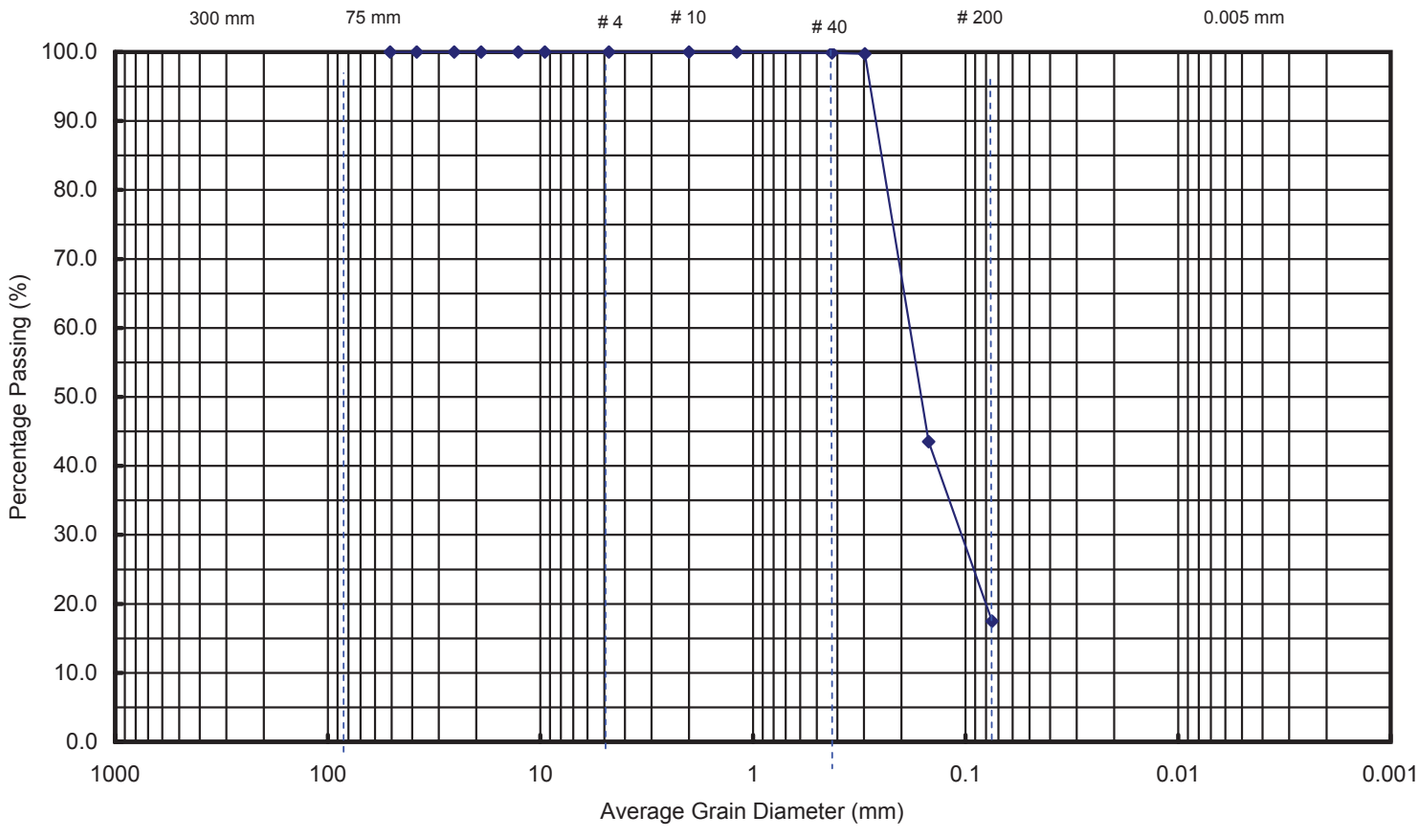
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-4	**Depth**: 10.0 meter	**Sample No**.SPT-6	**Sample Type**: Disturbed



Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

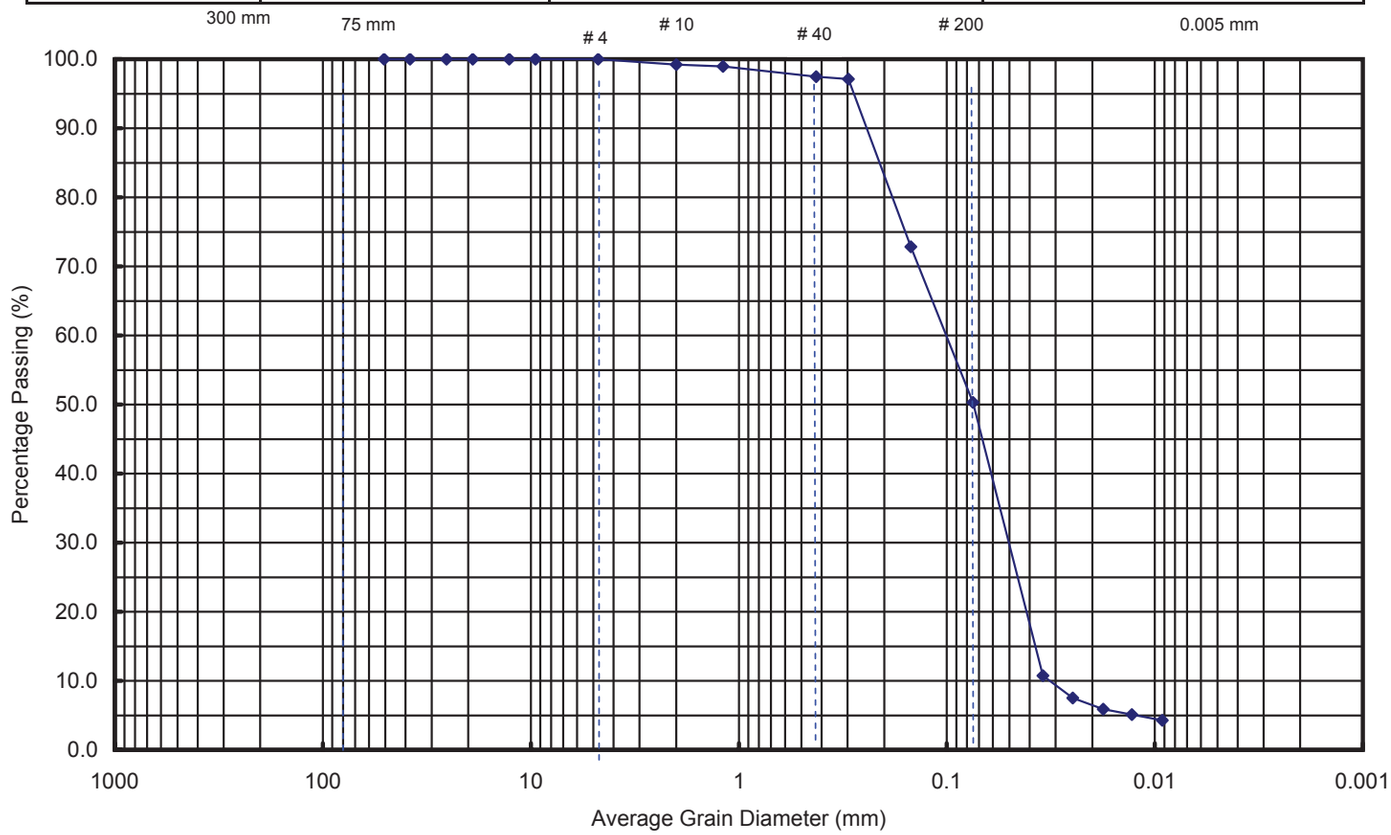
Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	100.0
1.19	100.0
0.425	99.9
0.297	99.7
0.149	43.5
0.075	17.5

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-5	**Depth**: 8.0 meter	**Sample No**.UDS-1	**Sample Type**: Undisturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	99.2
1.19	99.0
0.425	97.5
0.297	97.1
0.149	72.8
0.075	50.3

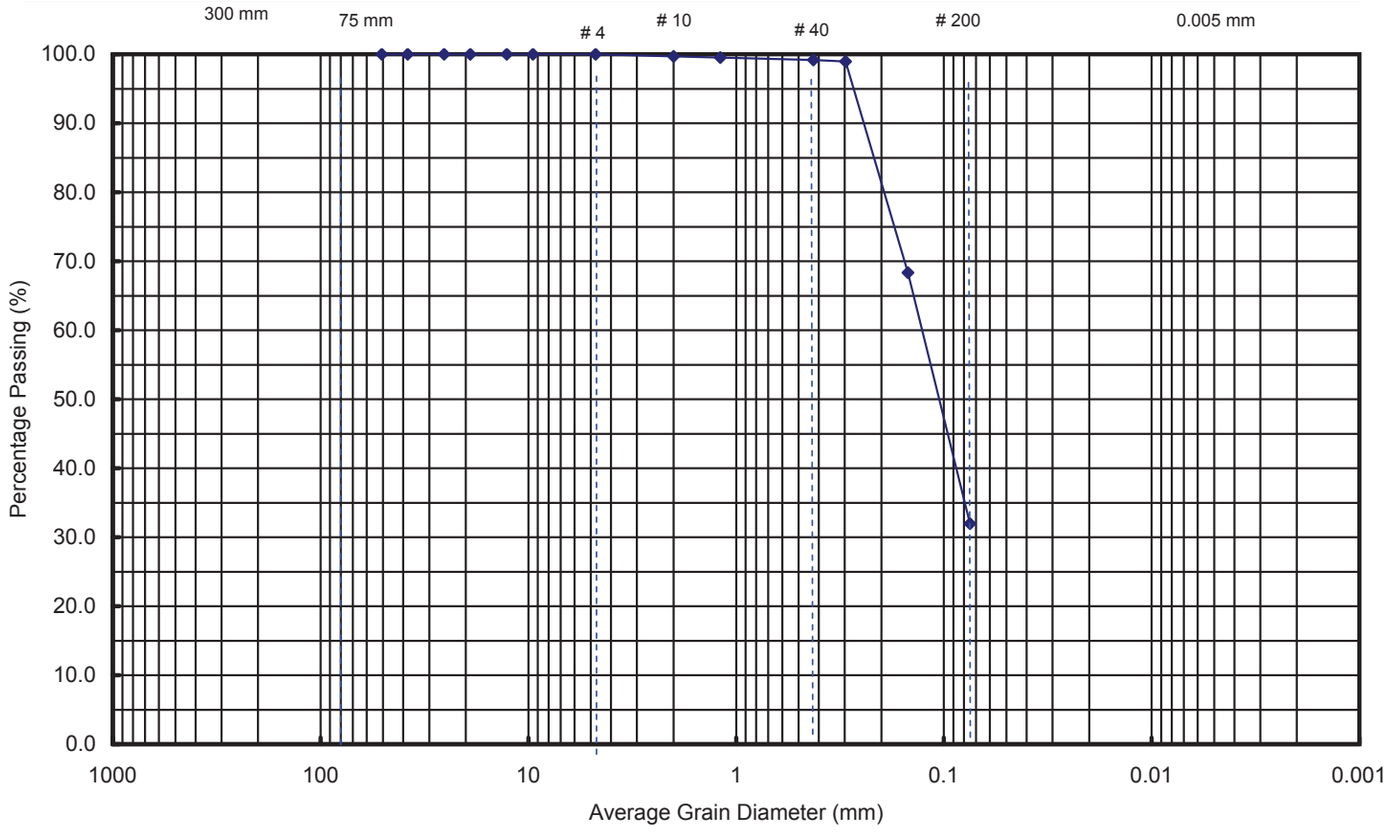
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-5	**Depth**: 10.0 meter	**Sample No**.SPT-2	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	99.7
1.19	99.5
0.425	99.2
0.297	99.0
0.149	68.3
0.075	32.0

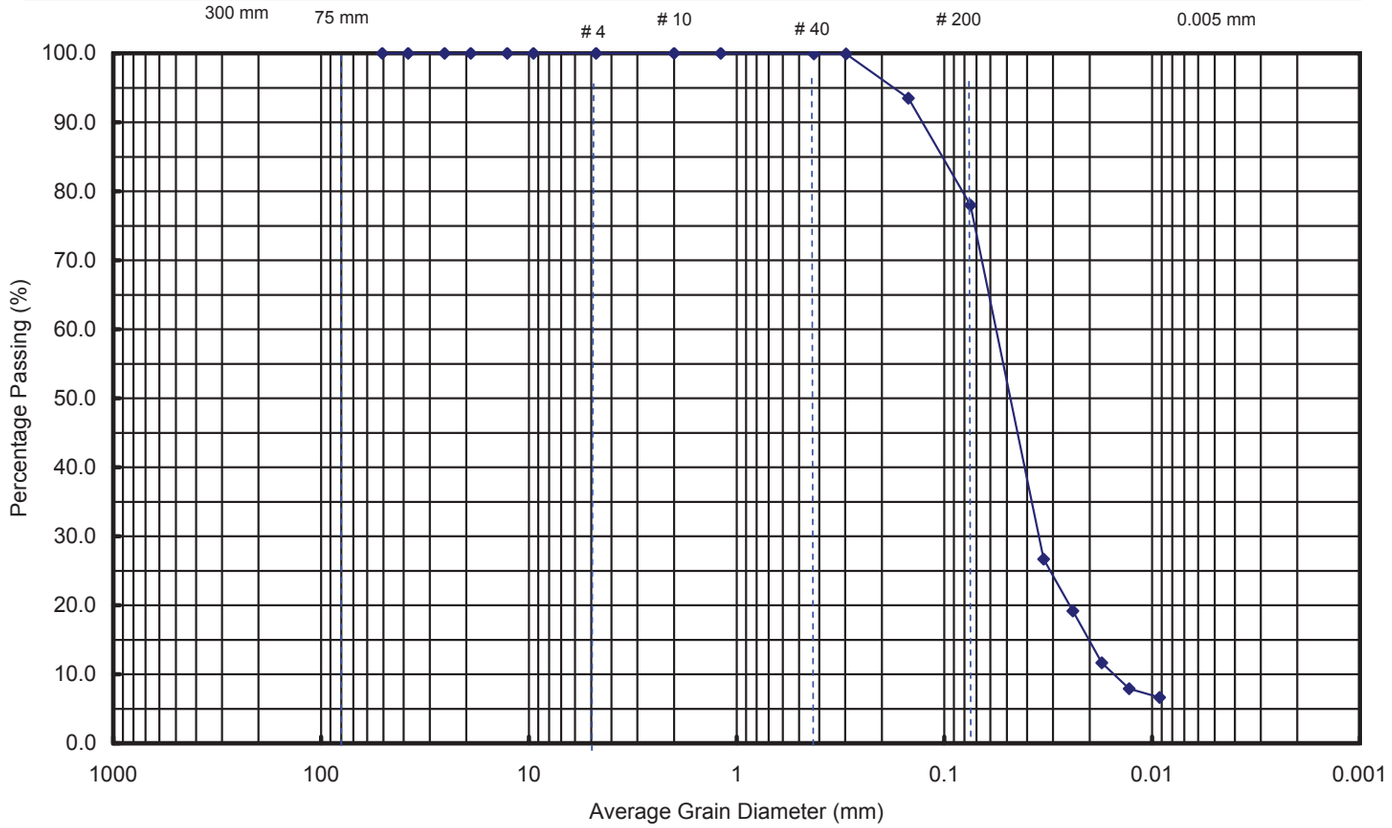
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-6	**Depth**: 7.0 meter	**Sample No**.SPT-4	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	100.0
1.19	100.0
0.425	99.9
0.297	99.9
0.149	93.5
0.075	78.0

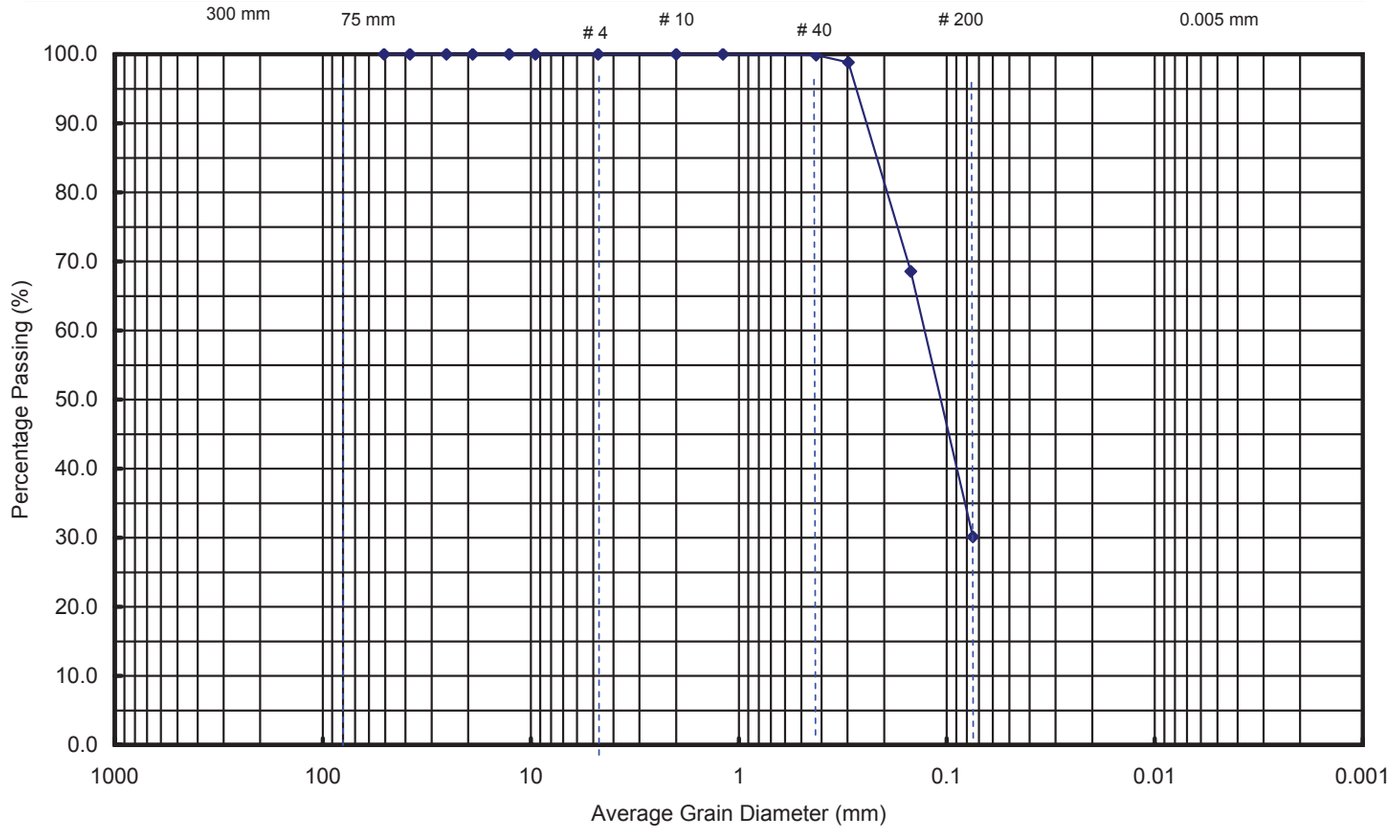
Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Grain Size Analysis

Project:	Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)		
Client:	Aga Khan Cultural Services, Pakistan	**Lab Ref.**: J 488/L-018/09	**Date**:28/09/2009
BH-6	**Depth**: 10.0 meter	**Sample No**.SPT-7	**Sample Type**: Disturbed



Seive Size. mm	Passing % age
50.8	100.0
38.1	100.0
25.4	100.0
19.00	100.0
12.7	100.0
9.51	100.0
4.75	100.0
2.00	100.0
1.19	100.0
0.425	99.9
0.297	98.8
0.149	68.5
0.075	30.1

Boulder	Cobbles	Gravel	Sand			Silt	Clay
			Coarse	Medium	Fine		

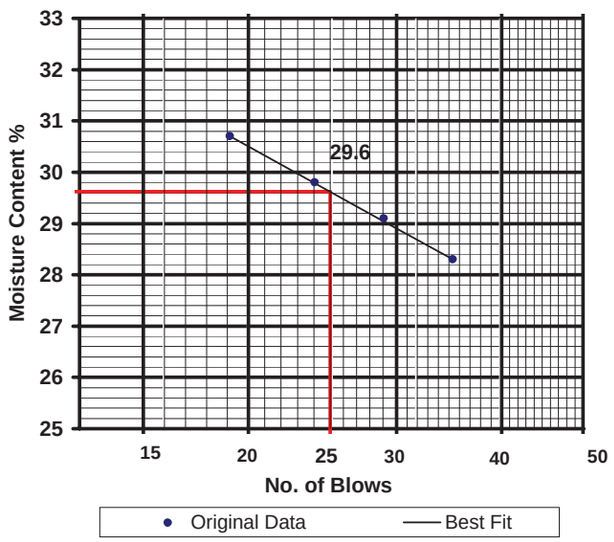
Tested by:Asif Imran	Checked by: Muhammad Ajmal	Approved by: Engr. Farooq Naveed

Berkeley Associates

Standard Test Methods for Liquid Limit,Plastic Limit, and Plasticity Index of Soils

Project: Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)			
Client: Aga Khan Cultural Services, Pakistan			**Date:** 26/09/2009
Borehole No.BH-2	Depth: 7.5 Meter	**Sample No.** UDS-2	Lab Ref. J 488/L-018/09

		Liquid Limit				Plastic Limit	
Description	**Unit**	**AASHTO T-89/ASTM D4318-00, Method"A"**				**AASHTO T-90**	
Trial #		**1**	**2**	**3**	**4**	**1**	**2**
No. of blows		35	29	24	19		
Dish No.		40	37	16	29	12	2
Wt. Of dish+wet soil	g	33.15	30.05	49.99	42.11	35.83	42.26
Wt. Of dish+dry soil	g	30.11	27.15	42.96	37.01	32.88	39.39
Wt. Of dish	g	19.35	17.17	19.34	20.42	16.99	24.14
Wt. Of water	g	3.04	2.9	7.03	5.1	2.95	2.87
Wt. Of dry soil	g	10.76	9.98	23.62	16.59	15.89	15.25
Water content %		28.3	29.1	29.8	30.7	18.6	18.8



Liquid Limit	**30 %**
Plastic Limit	**19 %**
Plasticity Index	**11 %**
Group of soil	

Note:

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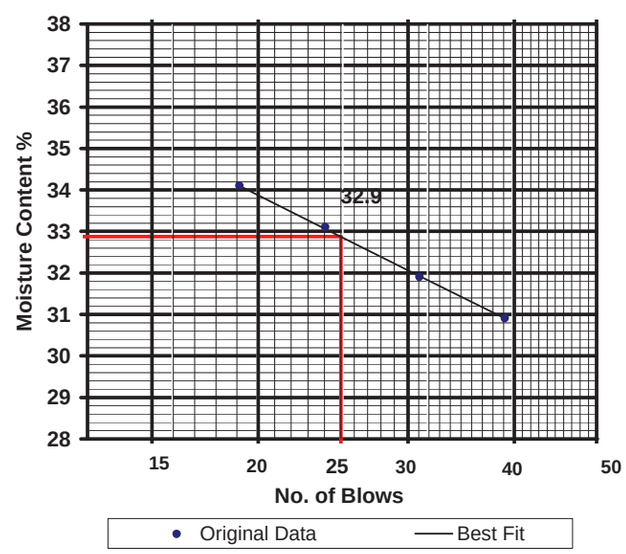
Tested by: Asif Imran	Checked by: Ajmal Malik	Approved by: Engr.Farooq Naveed

Berkeley Associates

Standard Test Methods for Liquid Limit,Plastic Limit, and Plasticity Index of Soils

Project: Conservation, Rehabilitation and Sustainable Development of Walled City Lahore (Geotechnical Investigations for Wazir Khan's Mosque)			
Client: Aga Khan Cultural Services, Pakistan			**Date:** 26/09/2009
Borehole No.BH-3	**Depth:** 7.5 Meter	**Sample No.** UDS-1	Lab Ref. J 488/L-018/09

		Liquid Limit				Plastic Limit	
Description	**Unit**	**AASHTO T-89/ASTM D4318-00, Method"A"**				**AASHTO T-90**	
Trial #		**1**	**2**	**3**	**4**	**1**	**2**
No. of blows		39	31	24	19		
Dish No.		13	31	15	23	2	24
Wt. Of dish+wet soil	g	35.83	34.91	34.33	34.62	34.79	29.49
Wt. Of dish+dry soil	g	32.69	30.85	29.96	31.52	33.02	27.51
Wt. Of dish	g	22.53	18.11	16.76	22.42	24.47	18.07
Wt. Of water	g	3.14	4.06	4.37	3.1	1.77	1.98
Wt. Of dry soil	g	10.16	12.74	13.2	9.1	8.55	9.44
Water content %		30.9	31.9	33.1	34.1	20.7	21.0



Liquid Limit	**33 %**
Plastic Limit	**21 %**
Plasticity Index	**12 %**
Group of soil	

Note:

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Tested by: Asif Imran	Checked by: Ajmal Malik	Approved by: Engr.Farooq Naveed

APPENDIX - D

FIELD PHOTOGRAPHS

Floor tiles being preserved for preparation of circulation pit for drilling

Borehole being drilled in cultural fill by light percussion drilling method

Borehole being drilled in natural soil deposit by straight rotary drilling method

Cultural fill samples being preserved

SPT sample being recovered from natural soil

Natural soil SPT sample being preserved

Borehole being backfilled with cement bentonite slurry

A view of excavated testpit showing steps of minaret foundation

The spectacular monumental ensemble of the Wazir Khan Mosque in the Walled City of Lahore was built in 1634 during the reign of the Mughal emperor Shah Jahan. Its endowment then comprised the congregational mosque, an elaborate forecourt, a *serai*, a hammam, a bazaar, and a special bazaar for calligraphers and bookbinders. The mosque, the calligraphers' bazaar, and the hammam still stand, while the other elements have disappeared—victims to Lahore's turbulent history over nearly four centuries since the original dedication. What remains is increasingly in need of care and attention.

Over a two year period starting in 2009, the Historic Cities Programme of the Aga Khan Trust for Culture, through the Aga Khan Cultural Service - Pakistan, conducted a baseline documentation of the monument and its surrounding areas. This volume contains the result of this work and presents an assessment of the organisational, technical and financial requirements for the conservation of the mosque as well as the revitalisation and enhancement of its surrounding context.

The Trust has been actively engaged with the Punjab Government in the conservation of the urban fabric of the Walled City of Lahore and has, since 2007, collaborated in urban rehabilitation and infrastructure improvement efforts in the neighbourhood of the monument.

AGA KHAN CULTURAL SERVICE - PAKISTAN

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