



TB CARE I

TECHNICAL ASSISTANCE FOR RENOVATION OF MDR-TB WARD AT  
MULAGO HOSPITAL

Kampala, Uganda

November 9 – 12 2011

ENVIRONMENTAL/ENGINEERING REPORT

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## **1. Acknowledgements**

The consultants would like to extend their heartfelt thanks to Dr Kasozi Samuel- MDR-TB Coordinator National Tuberculosis and Leprosy program (NTLP), Dr Moses Joloba- Head of department of Medical Microbiology, Makerere University College of Health Sciences, Dr Alphonse Okwera- Head of TB Unit of Mulago Hospital, Mrs. Priscilla Nakiboneka (Engineer) - Ministry of Health, Mr. Julius Mukibi (Engineer) - Mulago Hospital, Mr. Emmanuel Lubwama (Architect) - Nyika Consultants LTD.

Dr. Amos Kutwa- Regional Representative KNCV Tuberculosis Foundation- also deserves appreciation and gratitude for his input in this report.

## **2. Introduction and Background**

Mulago is the national referral hospital and specifically, the main TB treatment center for the capital city of Uganda, Kampala- a city of 3million inhabitants. The existing TB ward consists of 80 beds for 40 male and 40 female patients.

Statistics show that 3500 to 4000 TB cases of all types are reported annually in Uganda. 25% of the reported cases are extra pulmonary TB; while 75% are pulmonary TB out of which 55% are new smear positive pulmonary TB. Moreover, 50% of all the patients are HIV positive.

Studies show that at least 25% of referral cases are retreatment ones-, and over 55% of the retreatment ones are defaulters. There are 226 MDR TB cases on waiting list. It was found out that 12% of patients among retreatment cases and 1% of new cases were diagnosed MDR-TB cases.

A great achievement worth mentioning is that currently there are no second line drugs, however the Ministry of Health is in the process of procuring both first line and second line drugs. The Ministry is yet to conceptualize mode of care; however the TB unit urged to start with ambulatory management as the ward is being renovated.

So far two health care workers have contracted the disease. This is a data from those working in the TB complex only, and no surveillance is done for the whole hospital. Although this is the case, many positive steps are taken. Discussions are going on for adapting surveillance in place. Capacity building is also going on through training doctors and nurses who are working at the ward. Drug sensitivity test capacity has as well increased which is a basis for conducting treatment. Moreover, International and national guidelines are being implemented and the 2006 master plan of Mulago hospital is updated every year.

Point of care TB laboratory is ready for use. This laboratory has a microscopy and LPA including GeneXpert. It, however, needs a hematology or chemistry sections – if the laboratory is to provide all rounded services.

In line with the National TB/Leprosy Program (NTLP) of Uganda, renovation is planned for the establishment of an MDR TB treatment facility at Mulago Hospital TB Unit. The aforementioned facts and figures show the seriousness of the situation which vividly show that there is an acute need of improved infection control measures.

Through TB CARE 1 a funding of 80,000 USD is available for renovation.

### Climate of Kampala

Kampala has got tropical wet and dry climates. Because of the city's higher altitude (1202 meters above sea level) it is cooler than other cities of similar latitudes. The city seldom gets too hot. This provides an excellent opportunity for utilizing natural means of ventilation without compromising the comfort of patients inside the health facility.

## **3. Scope of Work**

### **Terms of Reference**

The following were Objectives laid out in the T.O.R, to be carried out by the consultants

- To assess the risk of TB transmission in the existing Mulago TB unit so as to recommend ways of further reducing the risk of transmission to health workers, patients and community.
- To advise NTLP/MoH on the appropriate remodeling and/or renovations required by considering patient flow and on the maintenance required for isolation facilities for MDR-TB patient groups.
- To provide technical in-put leading to the process of obtaining bills of quantities for required renovations.

### Suggested Key activities

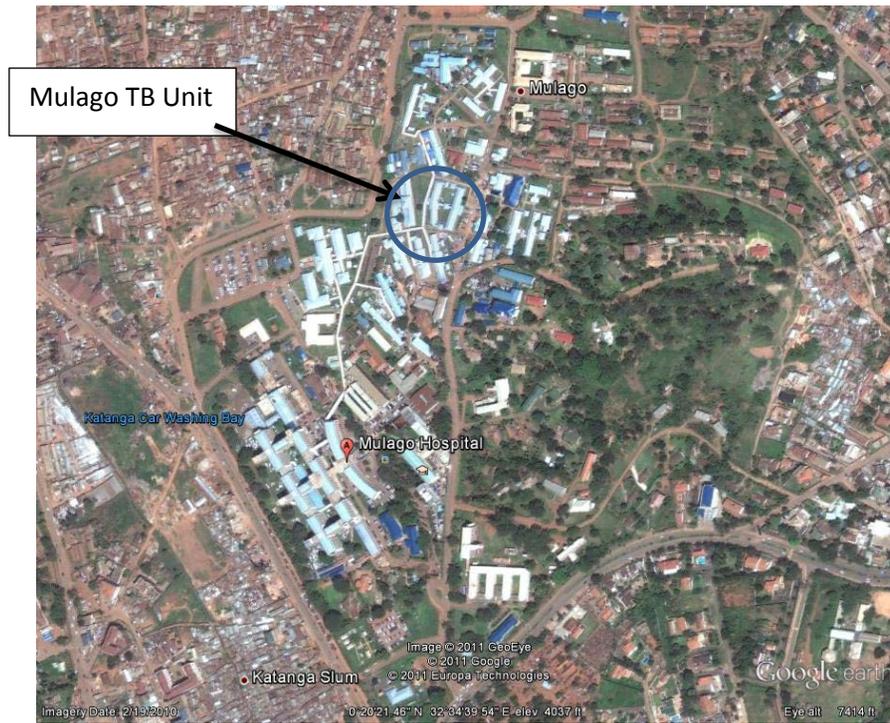
- Assess the risk of TB transmission in the existing Mulago TB unit so as to recommend ways of reducing the risk of transmission to health workers, patients and community.

- Review the existing Mulago TB unit buildings and existing plans and advice on the appropriate remodeling/renovation required considering patient flow, health workers' safety and required isolation facilities for MDR-TB patient groups.
- Work and collaborate with the Infrastructure Division of Ministry, Mulago hospital to come up with the proposed renovations
- Assist in developing and reviewing building plans to ensure that remodeling meets the required standards
- Assist in developing the bills of quantities for the proposed renovation.
- Provide assistance during the renovations to ensure that the works meets the stipulated requirements.
- Advise on the maintenance needs for the suggested environmental control measures
- Provide all recommendations regarding this task in writing to NTLP-MoH, infrastructure division and Mulago engineering department.

Proposed time frame

NTLP/MoH would like to have this TA in the second week of November 2011 (9<sup>th</sup> to 12<sup>th</sup>).

#### 4. As-Built Assessment



Location of Mulago TB Unit within the wider context of Mulago Hospital



Aerial view of the facility

**Overall configuration:** - The TB unit is composed of single storey blocks organized around a central courtyard. The courtyard is rectangular in disposition and is cut across by a central circulation route from the entrance canopy to the other end of the block. The site has got a pronounced slope towards the western side.

**Building volumes:** - The interior spaces inside wards are spacious with minimum height of 2.8 meters at the perimeter of the wall and reaching 5 meters at the middle ridge line. The wards are designed as single rectangular halls for multiple numbers of patients where the beds are placed on either side of these spaces. Offices inside the wards have level ceilings at equal heights to the walls leaving above them, inaccessible spaces that can accumulate dust over time, which can compromise hygiene. Whereas bath rooms and walkways leading to them suffer from lack of adequate room height and they are below known building standards.

The general waiting area near the main entry way to the TB Unit is found at a depressed level relative to the main access road to the facility. Although in principle it is an ideal covered space for waiting TB patients, its performance is marred by the fact that the land form by itself became a barrier for free movement of air.

**Openings:** - Both operable and permanently open windows are provided sufficiently on the walls of the wards. Calculation of the ratio of window area to floor area showed that 14 % of the floor area is taken up by windows; which is found to be more than the minimum 10% recommendation. Types of openings include louvered windows at standard height and wire mesh covered top windows. Furthermore the gap between the exterior walls and the ceiling constitute a wire mesh covered clerestory opening. All of these openings have wooden frames which in some exposed places show signs of damages due to rain falling at an angle which could not be protected wherever the roof overhangs are not sufficient. It looks like the operation of window louvers was inhibited by the presence of wire mesh on the exterior part of the windows without providing adequate clearance; hence most of the wire mesh is gone also partly due to long years of service without maintenance. Within the wards, at heights of about 20cm from the ground small irregularly placed and sized cluster of punctures are observed with

the intention to enhance ventilation, but it is evident that most of these are clogged and no longer functional.

**Pompeii walls (air bricks):-** These are striking features that are applied in places like the walkway to the proposed male ward toilets. These features provide the desired privacy without compromising air movement and ventilation, they are also aesthetically pleasing.

**Common toilets:** - pronounced undercut already existing on the doors of the common bath rooms and toilets greatly enhances cross ventilation. Furthermore the windows are also louver types which are ideal for ventilation.

**Finish materials:** Floors are made out of cement screed and most of the floor finish is still intact, except for observed patched cracks at certain places. Corridors to bath rooms have cast in place aggregate chips flooring. About a centimeter level difference is observed at perimeter of the rooms between the grade beams and the floors, these places should be carefully watched for potential places to harbor bacteria, as these are difficult to clean. Walls are painted with grey glossy oil paint up to about 1.5meters from the ground level and beyond with white non glossy paint. Ceilings are either bare timber planks constructed as integral part of the roof structure or painted chip wood ceilings following mostly the slope of the roof. The timber plank finishes show signs of deterioration at certain places in the proposed male ward because of leakage on the roof.

**Roofing:** - The highest ridge line of the roof lies along the center of the building in the longitudinal direction; these ridges are terminated at either end as louvered roof vents which help dissipate the accumulated heat inside the roof space.

**Structure:** - The existing structural system is a load bearing wall structure with most likely top tie beams running all along the perimeter of the wall. Nyika consultants LTD should verify this either through getting old drawings from the hospital's archive if any, or exposing certain portions to identify what exists underneath the finish coat.

## 5. Principles

- **Reduced exposure:**

- ***Separation of staff from patients:*** It is proposed to build a separate block for the staff which is a commendable proposal for protecting the staff from nosocomial infection of TB. This separate block is intended to be constructed on the left side of a vacant area at the front part of the TB unit. The staff block is to be composed of records, dispensary, nurses work station, doctor's office, store, covered waiting area and toilet facilities.
- ***Separation of patient categories:*** Creating new partition walls to separate patients into TB suspects, confirmed cases of smear positive, smear negative and separate isolation for MDR and XDR cases is proposed; as per the recommendation of WHO. To enable this external corridor need to be added to provide circulation for both male and female wards. The MDR and XDR cases will be provided with separate bath room facilities. The category proposals are as follows.
  - Two 6-beds wards for sputum and culture negative patients (PTB & ETB)
  - Five 3-beds wards for suspected and diagnosed cases (SS+/++)
  - One 6-bed room for suspects
  - Four single patient isolation rooms for MDR and XDR-TB cases with own ablution rooms; these room can be used for two patients in a room if patients have the same strain to TB.
  - Adequately ventilated, outside sputum collection area with roof above perforated walls made of air bricks or Pompeii walls.
  - Please refer to Annex II for the floor plans and sections of wards
- ***Limited patient and visitors' movement:***
  - Gates are proposed at the places where the central circulation leads to the newly added external corridors to restrict movement of patients and visitors alike.
- Surgical masks on patients

- N95/FFP2 Respirators on staff and students
- Short hospitalization
- ***Building design standards for the prevention of airborne infections:***
  - Adequate meter/square per patient (40 beds)
  - Adequate air changes per hour (not <12 ACH) in patient areas. Sample ACH calculation was conducted for the present meeting room and was found out to be far more than the recommended 12.
  - Primarily natural ventilation system- If additional mechanical ventilation or upper-room UVGI systems will be necessary, these systems can be easily installed, because they have been incorporated in the building (electrical) design: a parallel system that automatically switches to a solar back-up system in case of power supply interruptions
- **Patient Recreation and landscaping**
  - The newly added half open corridors on the side of the internal courtyard provide added opportunity for patients' interaction with the central green area. Paved walk ways and hard landscaped areas are proposed which will invite patients to make use of these spaces and hence spend most of their time outside.

## 6. Findings and Recommendations

### ***Recommendation for the Consultant (Nyika Consultants LTD)***

Bill of quantity document must evolve and be a direct reflection of renovation design working drawings. The working drawings must be composed of Architectural, Structural (for ridge ventilation detailing, exterior corridor, etc...), electrical, and sanitary and if required mechanical designs.

The level of intervention should also be clear by comparing the renovation designs with the as-built drawings. As-built drawings should be done not only in plans but also in sections and elevations documenting every existing feature as is. As-built drawings should not also be limited to architectural or physical elements, to get the full benefit these drawings, electrical and sanitary as-built drawings must be there. Reflected ceiling plans are also important for interventions that are suggested to be implemented on the ceiling surfaces. Moreover, reflected ceiling plans should also show the exposed timber structural elements as the new partition walls to be introduced are best aligned with these. The drawings should also reflect in every way details of the existing features.

Proper graphics for doing renovation design works should be followed. For example existing features should be shown with broken lines while new additions are to be shown with continuous lines with proper graphical representation of the construction material used. Demolishing should also be shown with a different representation. This same principle applies to both elevations as well as sectional drawings.

Door and window schedules should be prepared for all existing doors and windows; this will enable one to have a complete inventory of these elements for possible reuse for new openings to be proposed. If the designer decides to retain doors; unless there is strong justification, it is better to keep hinges (as indicated by swings directions) of existing doors on the floor plan drawings as they are. Apart from the extra work in redoing the hinges, changing hinge location may result in hiding switches, since it is obvious that door swings dictate location of switches,.

The building standards are evaluated based on '2006 Guidelines for Design and Construction of Health Care Facilities' of AIA Facilities Guidelines Institute. For reference excerpt is annexed in Appendix III.

### **Suggested modifications**

The suggested modifications don't interfere with the existing structural set up. Since the structural system of the building is load bearing care should be exercised in creating new openings. The suggested new openings are such that they should not be excessively wide; avoid removing buttresses which are very essential for the building to remain structurally intact after the intervention. Apart from creating few openings at selected places the perimeter load bearing wall is to be maintained. These suggestions should be referred in conjunction with the drawings under Annex-II.

Not much is changed in the female and male wings compared to the level of modification that is planned on the center portion of the MDR/XDR wing. The floor level of this center wing will be filled to be same level as the female wing. The resulting level difference that will occur with the male ward will be reconciled with a ramp which will connect the newly added half open corridor. Major partition wall demolishing and construction of new ones will occur at the central wing.

There is no need of ceiling in the male ward; the exposed wooden structural truss and wooden ceiling surface after surface preparation can be varnish coated to bring out its natural beauty. For the female ward replace ceiling materials.

Provide also metal louvers of size 20 x 20cm on every bay between the truss elements on the horizontal surface of the ceilings. These are the openings which will help the accumulated hot air to escape to the ridge ventilation above through stack effect.

Ridge ventilation running along the entire length of the wards as shown in Annex-II is proposed to create stack effect ventilation. Referring to the existing as built set up the width of the skylight should be 1.45m.

On either side, the vertical opening will be covered with permanently opened fixed louvers. At MDR/XDR ward locations consider using extractor fans to complement ridge ventilation.

The existing walk way around the Female ward measuring 130cm wide (clear distance) is proposed to serve as a circulation area, but it is smaller than the minimum standard width of 180cm for a one way corridor. Therefore a full 2m wide corridor is planned in addition to the existing corridor for circulation. The existing corridor space will be used for patients' day area- an open shades space which is an extension of their indoor ward rooms. It is preferable that this corridor be covered with the same iron sheet roof material as that used for the existing buildings but with a shallower slope to allow head room in the added open corridors. As a result, 170m<sup>2</sup> of ground floor slab will be constructed for the additional external corridor. Part and parcel of this additional circulation area are ramps that are used to reconcile the level difference.

Clearstory openings to be of wire meshes to be maintained as they are except for replacing the old wire meshes and upgrading the frames.

Ward Capacity is proposed to accommodate- 22 male and 19 female beds including isolation rooms. Increasing beyond this could possibly compromise infection control. It is proposed to use built-in ward robes between beds to dictate/suggest bed layout. Most of the built in cabinets will be 2m(H) x 60cm(W) x 40cm(D), but in areas where it is close to an existing window the height will be reduced to below window sill level. A total of 33 of them are proposed. Maintain a clear distance of at least 120cm between foot of beds and other structures and 90cm between beds and between beds and walls in furnishing the wards. Ensure that, this is also maintained throughout the operation of the facility.

Raise the frames of the wire meshes by about 2cm to enable free operation of the glass blades of the louver windows

Extend the roof overhangs beyond what now exists to avoid exposure of the wooden window frames to rain and other weather elements.

Provide translucent fiberglass roofing both in the proposed exterior corridors as well as the roofing of MDR/XDR rooms to introduce an atmosphere of lightness and utilize therapeutic nature of the sun's rays.

Repair leakages as these have very detrimental effect on the wooden structures

Major electrical design modification is expected as a result of the physical modifications suggested. In terms of electrical load there is not going to be major changes except possible slight increase in power requirement due to inclusion of four new single phase extractor fans inside the MDR/XDR rooms.

The fact that hand wash basins are a requirement in each patient room and new bath rooms are proposed for MDR/XDR patients requires design modification of water supply and waste disposal system of the building.

After having completed all modifications it is necessary to do overall corrective plastering, painting and pointing to have even final surface which is receptive for appropriate painting or any other desired type of finishing.

Although it may seem trivial, as part of the renovation project demolishing the flue extending above the roof will save a lot of trouble in dealing with leakage.

### **Summary of modifications**

These suggested modifications will best be understood in conjunction with the floor plans in Annex-II.

### **Exterior /landscaping**

- Providing new structures of relatives' sheds and sputum booth. Sample sputum booth is presented. The sputum booth should be placed at minimum of 6m distance from existing structures and such location is suggested.

### **SS-ve room, Suspects- A, Suspect-B, and S+++**

- Provide partition walls reaching up to the roof surface not to allow any cross flow of air among the wards
- Adjustable ventilation metal louvers one in each of three bed wards and two in each of the six bed wards.
- Carefully remove two 150cm wide door for possible re-use, construct wall to fill the resulting voids.
- Carefully remove windows with designation of W2 for reuse in their modified form in the bath rooms of the isolation rooms.
- Built in cabinets with as explained above.
- Supply and installation of hand wash basin with ceramic backing on the wall as shown on the floor plan.

### **MDR/XDR Rooms**

- Even out the variable floor levels so that these rooms will be the same level as female ward.
- Anteroom enclosed by air brick wall, care has to be exercised to maintain wall parts that are essential for structural support
- New partition walls defining the wards and the bath rooms
- Dormer louvered opening on the roof to enable cross ventilation above the roof of the bath room.
- Four built in cabinets in this case shared between two patients.

### **Toilet blocks**

- Replace all sanitary fixtures with new including faucets and accessories
- Remove small leakage marks from the wooden roof structure and mend leakages.
- Demolish deteriorated wooden frames of the iron bar grill and replace with new frames in female toilet.

**Non-patient rooms**

- Two stores and guardian room which can accommodate three people fit in the existing rooms. It is required to dismantle sanitary fixtures and plumbing system to convert the existing toilet into a store. Wall demolishing and relocation of door is necessary for the guardian room. These three rooms need to have a new false ceiling at height of about 3m.

**7. Cost estimation**

Cost estimation based on square meter price

Total area of the facility 900 sq.m including sheds to be placed in the garden; taking 300USD per square meter for renovation the total estimated cost amounts to 270,000

Costing Ward 5 and 6 of Mulago TB Unit	Price in USD
Renovation cost	270,000
Sewer connection and site sanitary (about 7.5%)	20,000
Landscape work (about 10%)	27,000
Design and supervision cost of local firms (10%)	27,000
Contingency (10%)	27,000
Excluding; loose furniture, equipment, mechanical ventilation and additional UVGI equipment, insurances during contract period, submission fees and tender Costs.	<b>371,000</b>

## 8. Annex I- Patient Room Space Requirement

*(The following material is excerpt from '2006 Guidelines for Design and Construction of Health Care Facilities' of Facilities Guidelines Institute and AIA)*

### 2.2 Typical Patient Rooms

#### 2.2.1 Capacity

**2.2.1.1** New construction. In new construction, the maximum number of beds per room shall be one unless the functional program demonstrates the necessity of a two-bed arrangement. Approval of a two-bed arrangement shall be obtained from the licensing authority.

#### **2.2.1.2** Renovation.

Where renovation work is undertaken and the present capacity is more than one patient, maximum room capacity shall be no more than the present capacity, with a maximum of four patients.

#### 2.2.2 Space Requirements

Minor encroachments, including columns and hand washing stations, that do not interfere with functions may be ignored when determining space requirements for patient rooms.

**\*2.2.2.1** Area. In new construction, patient rooms shall be constructed to meet the needs of the functional program and have a minimum of 100 square feet (9.29 square meters) of clear floor area per bed in multiple bed rooms and 120 square feet (11.15 square meters) of clear floor area in single-bed rooms, exclusive of toilet rooms, closets, lockers, wardrobes, alcoves, or vestibules.

**2.2.2.2** Dimensions and clearances. The dimensions and arrangement of rooms shall be such that there is a minimum of 3 feet (91.44 centimeters) between the sides and foot of the bed and any wall or any other fixed obstruction. In multiple-bed rooms, a clearance of 4 feet (1.22 meters) shall be available at the foot of each bed to permit the passage of equipment and beds.

#### **2.2.2.3** Renovation.

Where renovation work is undertaken, every effort shall be made to meet the above minimum standards. If it is not possible to meet the above minimum standards, the authorities having jurisdiction may grant approval to deviate from this requirement. In such cases, patient rooms shall have no less than 80 square feet (7.43 square meters) of clear floor area per bed in multiple-bed areas and 100 square feet (9.29 square meters) of clear floor area in single-bed rooms, exclusive of the spaces previously noted in this section.

## 9. Annex II- Photographs



Interior of female ward



View of the female ward from the interior courtyard



**View of female ward from outside**



**View of male ward from the interior courtyard**



**View of male ward from outside the courtyard**



**Interior view of male ward**



**Newly constructed laboratory – to provide the necessary diagnostic service for MDR TB treatment**

## 10. Annex III- Concept Renderings



Aerial view of the whole complex



Ceiling louvers proposed inside female ward. These louvers enable ventilation of the wards via raised ridge ventilation



**Ridge ventilation proposed inside male ward existing clerestory windows are maintained by replacing the old wire meshes**



**Pompeii wall (air brick wall) to screen the passerby people from the female MDR ward because they are very close at this location**

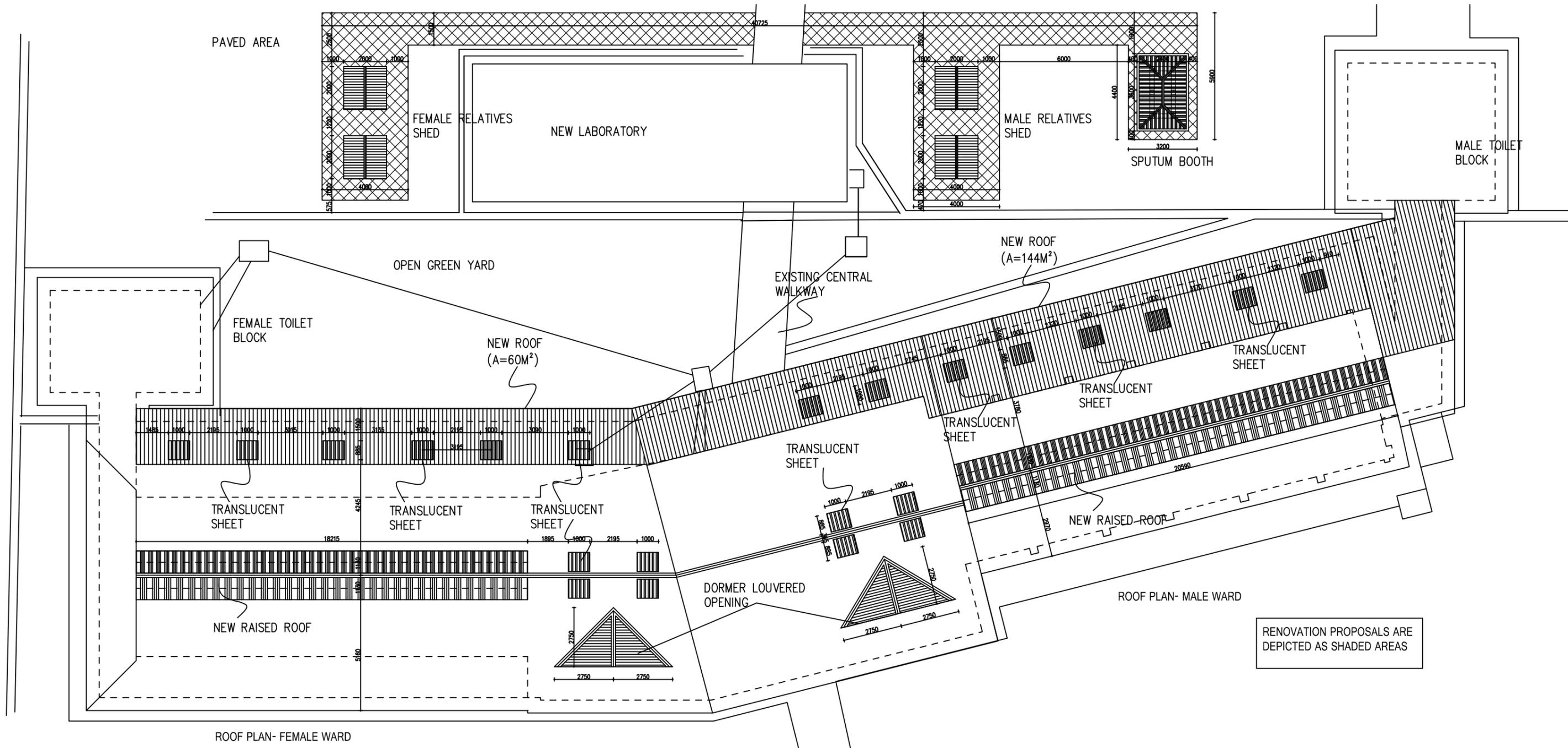


**View of visitor shed**



**View of sputum booth**

## **11. ANNEX IV – Drawings**



PAVED AREA

FEMALE RELATIVES SHED

NEW LABORATORY

MALE RELATIVES SHED

SPUTUM BOOTH

MALE TOILET BLOCK

OPEN GREEN YARD

EXISTING CENTRAL WALKWAY

NEW ROOF (A=144M<sup>2</sup>)

FEMALE TOILET BLOCK

NEW ROOF (A=60M<sup>2</sup>)

TRANSLUCENT SHEET

NEW RAISED ROOF

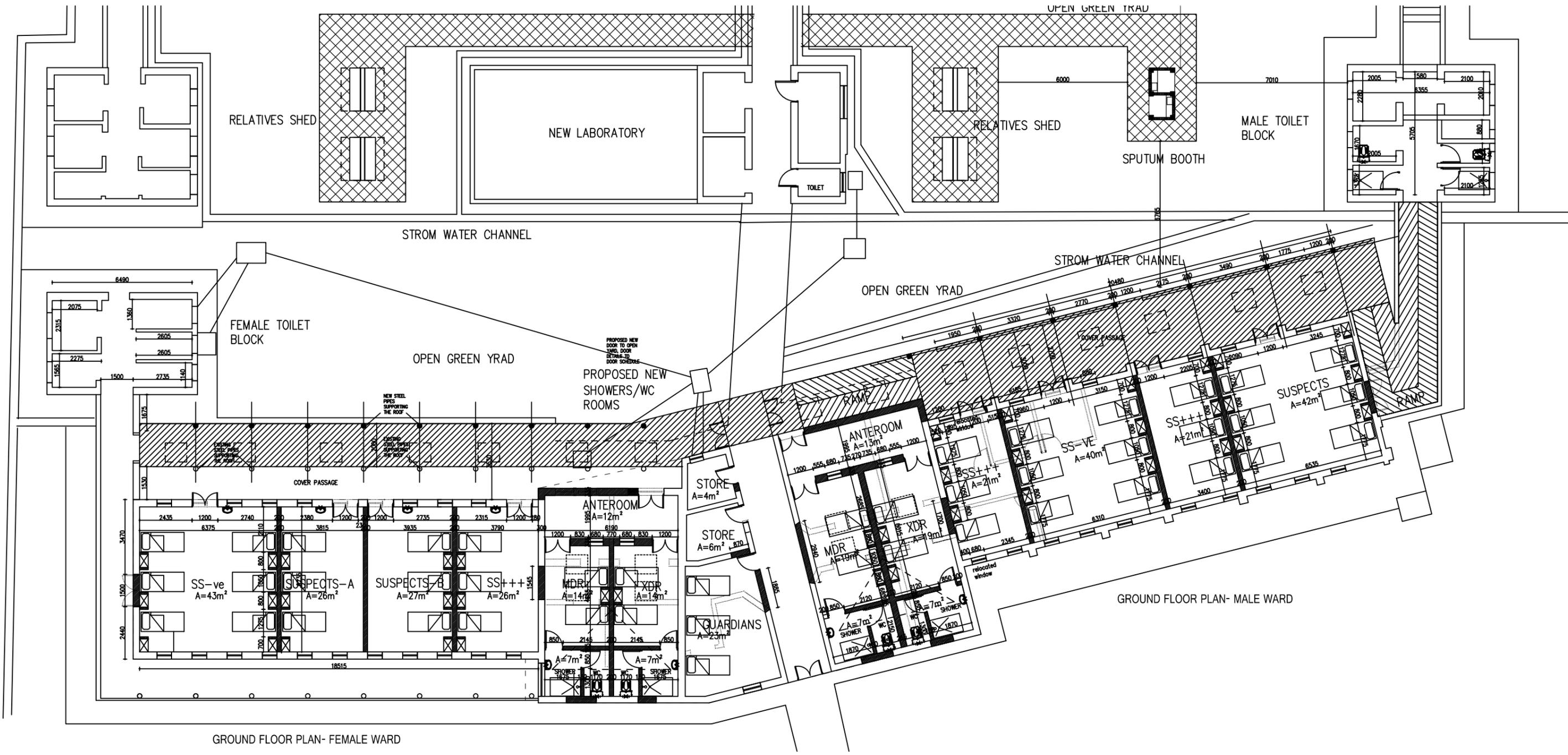
NEW RAISED ROOF

DORMER LOUVERED OPENING

ROOF PLAN- MALE WARD

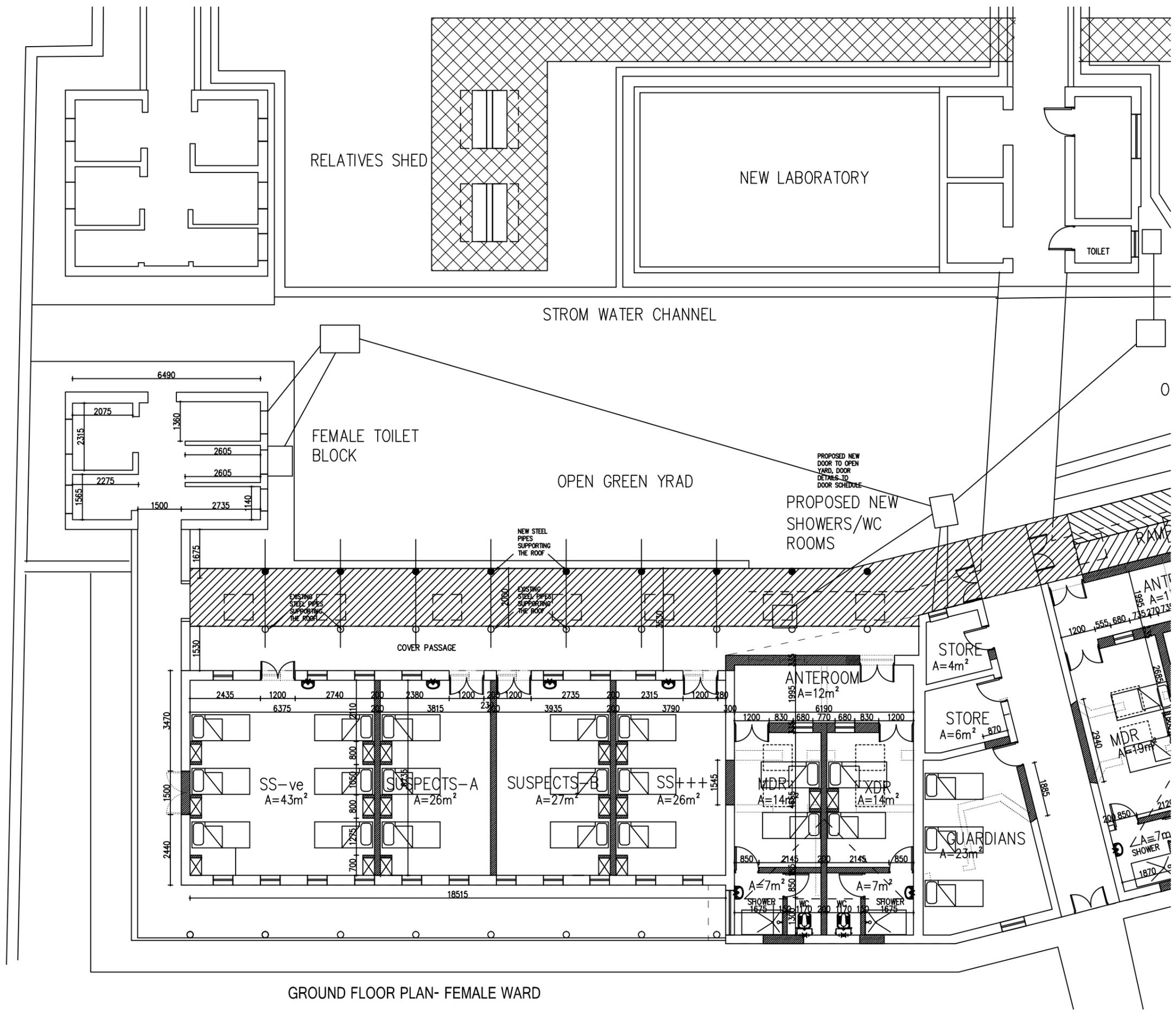
ROOF PLAN- FEMALE WARD

RENOVATION PROPOSALS ARE DEPICTED AS SHADED AREAS

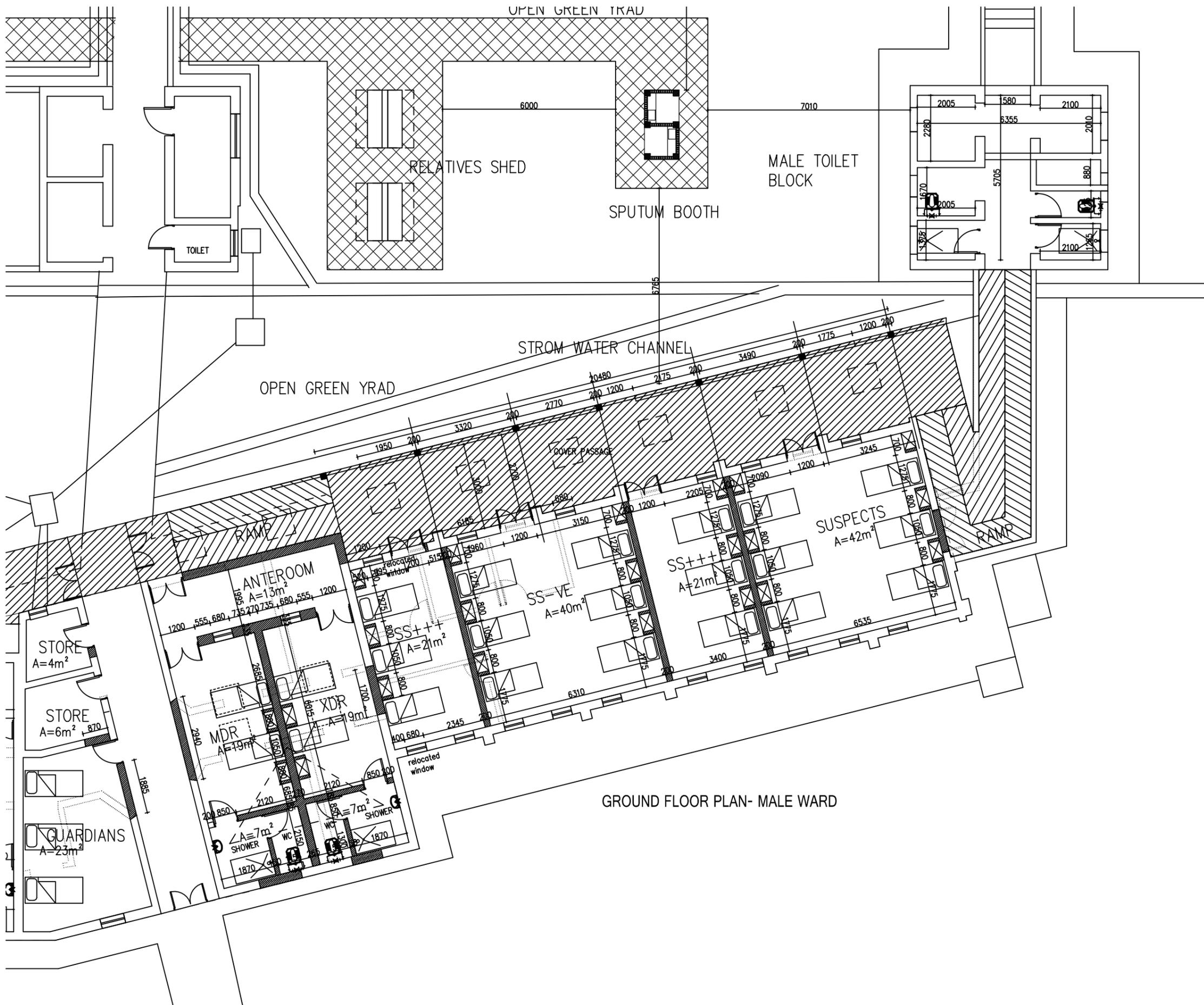


GROUND FLOOR PLAN- FEMALE WARD

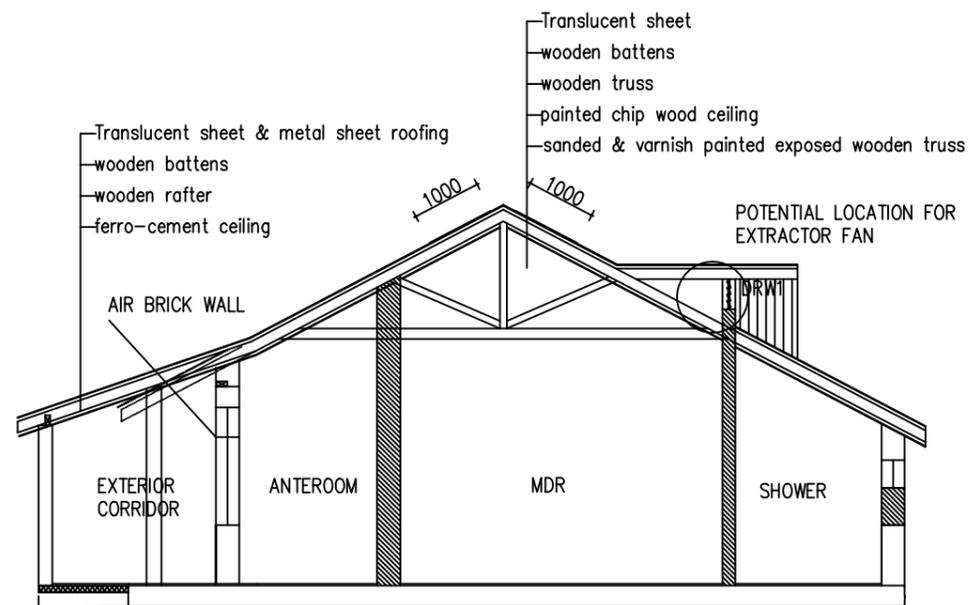
GROUND FLOOR PLAN- MALE WARD



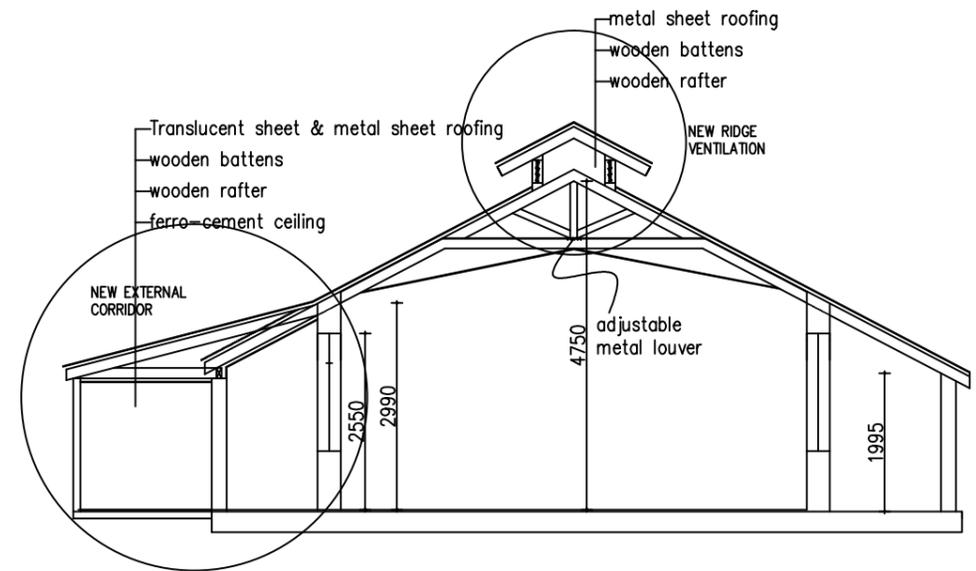
GROUND FLOOR PLAN- FEMALE WARD



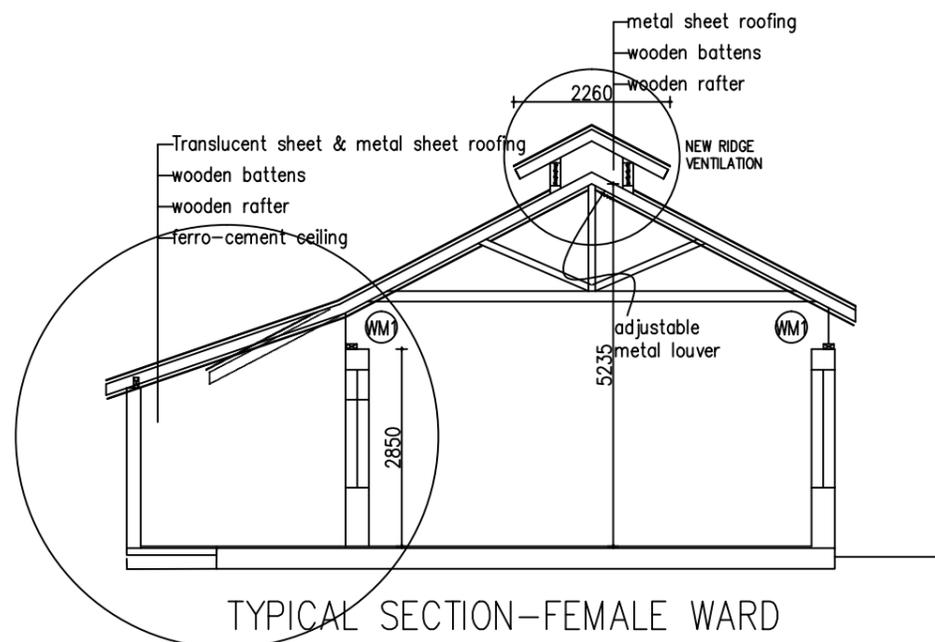
GROUND FLOOR PLAN- MALE WARD



TYPICAL SECTION- ISOLATION



TYPICAL SECTION-FEMALE WARD

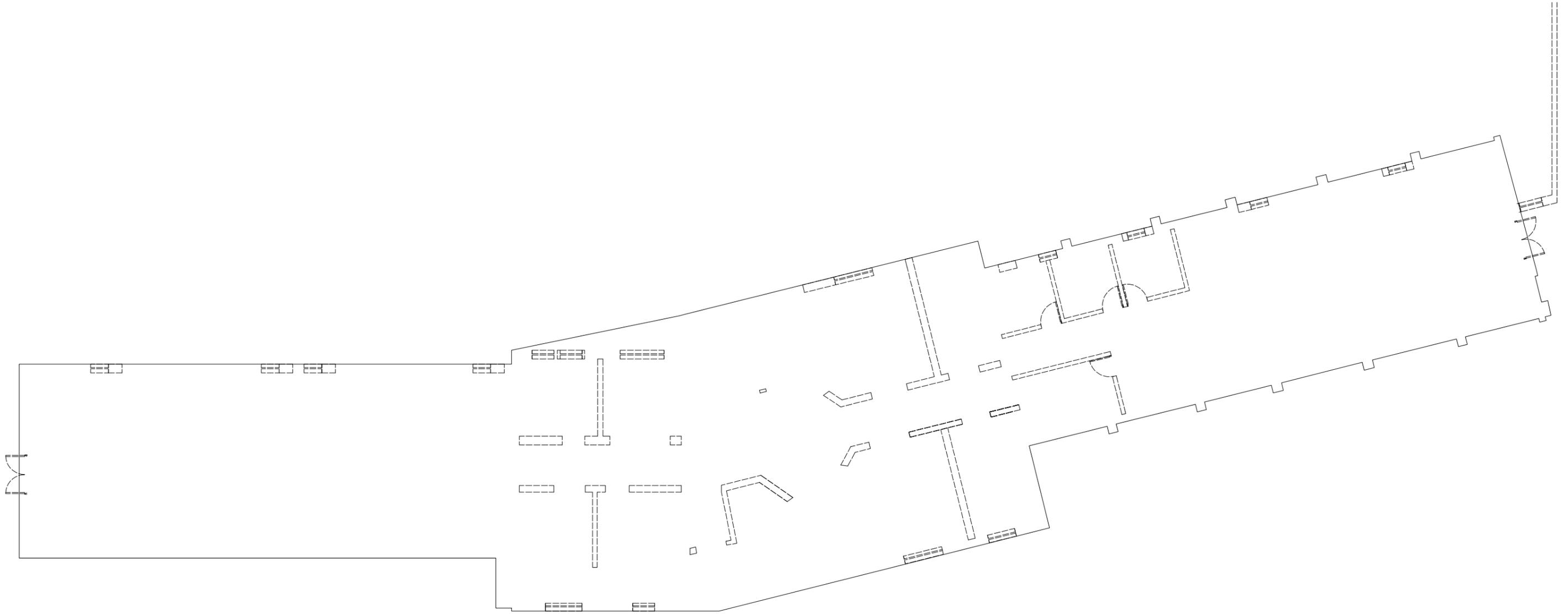


TYPICAL SECTION-FEMALE WARD

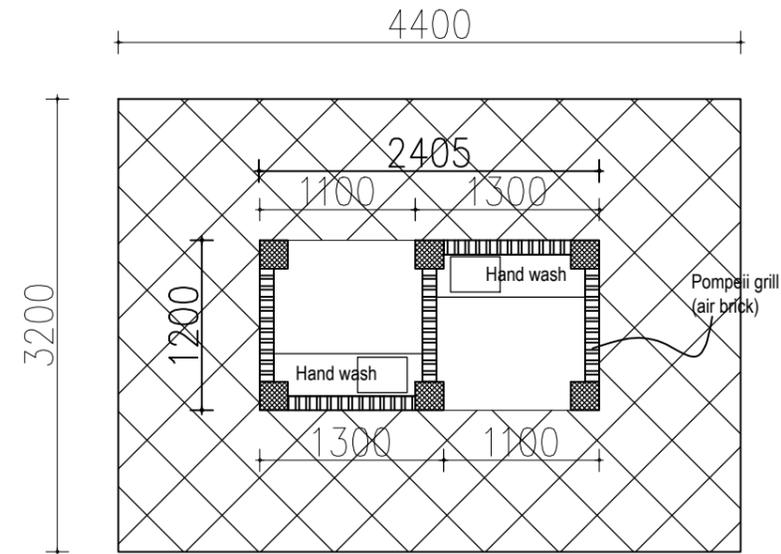


REFLECTED CEILING PLAN- FEMALE WARD

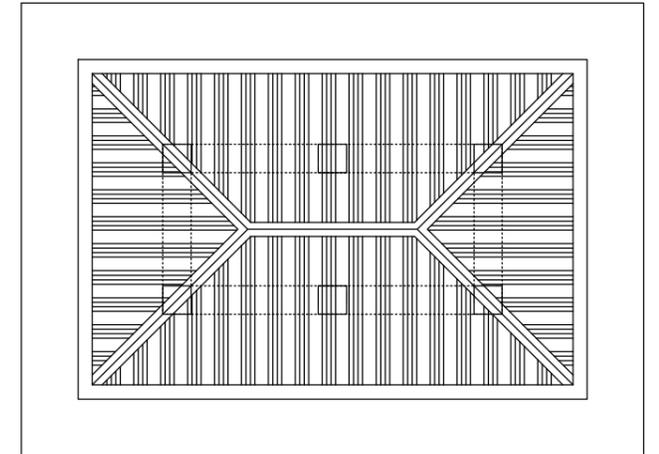
REFLECTED CEILING PLAN- MALE WARD



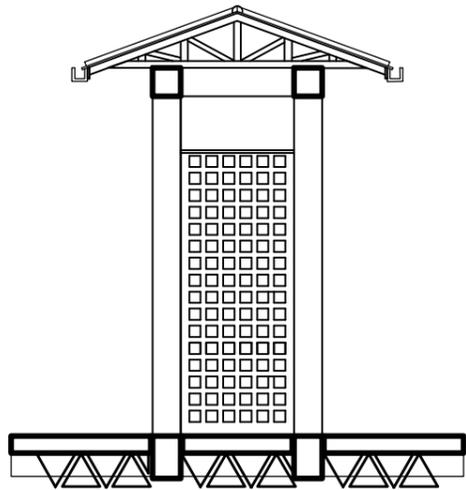
DEMOLISHING PLAN (Exterior wall outline included for reference)



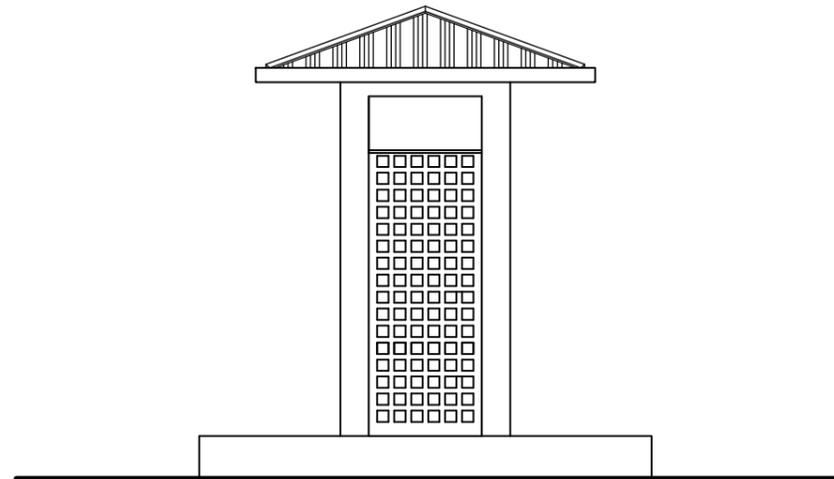
PLAN



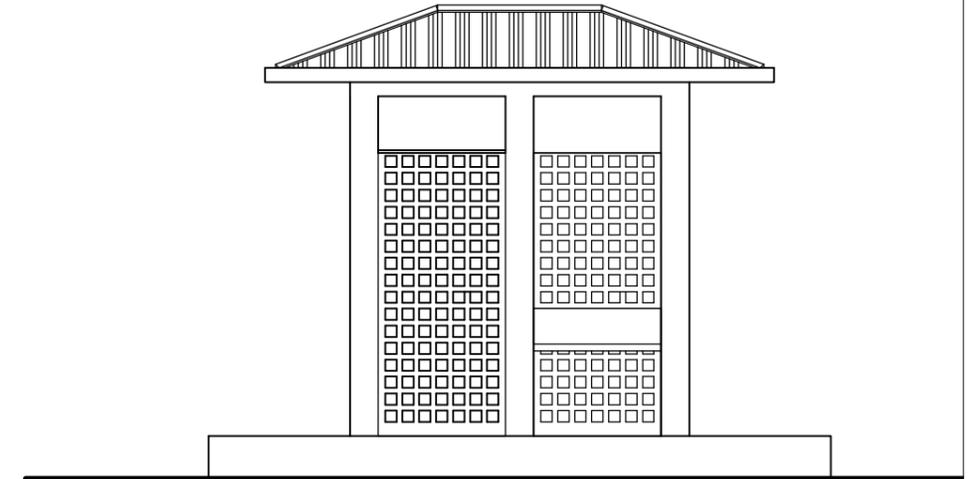
ROOF PLAN



SECTION A-A



SIDE VIEW



FRONT ELEVATION

SPUTUM BOOTH

DRAWINGS							
DESIGNATION	W1	W2	WM1	LW1(NEW)	LW2(NEW)	DRW1(NEW PAIR)	W3(NEW)
LOCATION	MALE WARD	FEMALE WARD	MALE WARD(clerestory)	FEMALE/MALE WARD(ridge vent)	FEMALE/MALE WARD(horizontal ceiling)	MDR/XDR WARD (dormer roof opening)	MDR/XDR WARD TOILETS
OPENING SIZE	1725 X 670	1880 X 670	1700 X 400	1700 X 400	1000 X 200	850 X 385	485 X 670
AREA	0.25m <sup>2</sup> (WIRE MESH)	0.25m <sup>2</sup> (WIRE MESH)	0.67 m <sup>2</sup> (WIRE MESH)	0.63 m <sup>2</sup> (LOUVER)	0.2 m <sup>2</sup>	0.16 x 2 m <sup>2</sup>	0.45m <sup>2</sup> (glass louver)
TOTAL AREA	1m <sup>2</sup>	1.11m <sup>2</sup>	0.67 m <sup>2</sup>	0.63 m <sup>2</sup>	0.2 m <sup>2</sup>	0.16 x 2 m <sup>2</sup>	0.45m <sup>2</sup>
MATERIAL	glass louvers and wire mesh with wooden frame	glass louvers and wire mesh with wooden frame	wire mesh with wooden frame	sheet metal louver with wooden frame	adjustable sheet metal louver with wooden frame	adjustable sheet metal/wooden louver with wooden frame	glass louvers with wooden frame
QUANTITY	18(existing qty)	20	22	22	11	2	4(2 in each ward)

NEW WINDOWS AND OPENINGS SCHEDULE