CHERANGRE BAPTIST CHURCH

CONCEPTUAL DESIGN
Cherangre Baptist Church, Tura, Meghalaya India

SUMMARY

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REPORT

PROJECT LEADER'S SIGNATURE

Matthew K. Hood

PROJECT LEADER'S SIGNATURE

eMi

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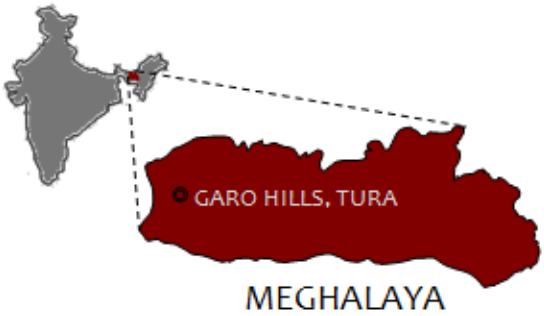
basement, A-329, Shivalik, New Delhi 17
email: info@emi2.org
phone: 0135-263-1059 | email: info@emi2southasia.org

SUMMARY

THE NEED

To provide a space that can be used to serve the poor and needy, as well as equip and help members with spiritual and societal needs.

Cherangre Baptist Church (CBC) started in the 1950s and was born out of the need to have a proper institution to worship the Lord Almighty as a single congregation and to enable members to raise a unified vision of fulfilling the Lord's mission through action. Now, convinced by the strength of the faith and commitment of its own members, CBC is taking steps to become a full-fledged One Congregation Church by 2013.

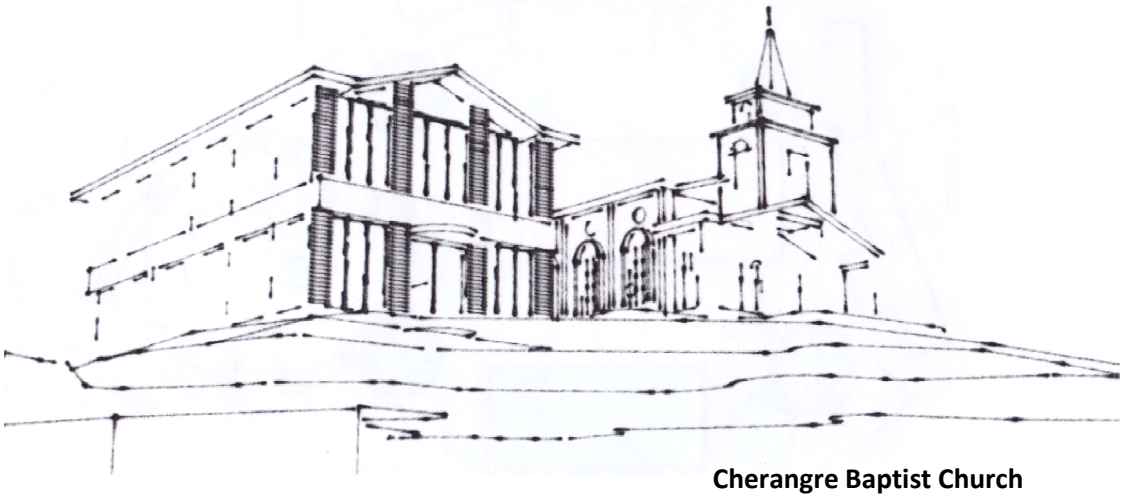


Presently, the church can seat only 500 people,
With the church growing at such a fast rate, this space isn't sufficient.

THE SOLUTION

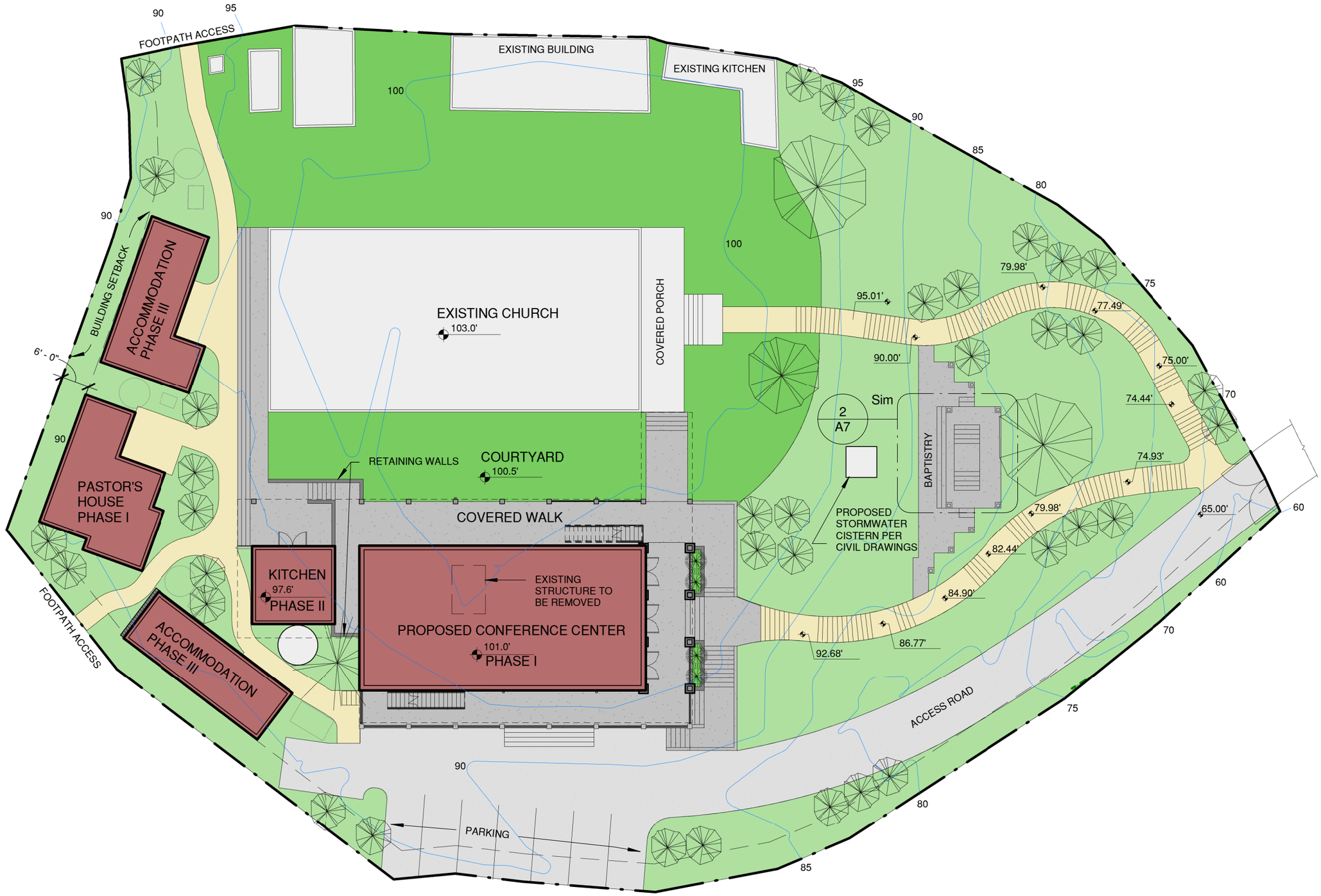
Construction of a church addition to provide seating for 1000 people along with conference hall and dining facilities.

A new church building with a seating capacity of 1000 people along with a conference hall, dining hall, baptistery, and library.



Cherangre Baptist Church
Development Summary

Size of Campus Area	25,833 sq. ft. (0.6 acres)
Facilities Seating Capacity	1400 occupants
Cost to Complete	Rp. 95,47,680 or US$173,864



1 CONCEPTUAL MASTER PLAN

3/64" = 1'-0"

LEGEND:

- SOAK PIT SYSTEM PER CIVIL DWGS.
- SEPTIC SYSTEM PER CIVIL DWGS.
- EXISTING STRUCTURE TO REMAIN
- PROPOSED STRUCTURE
- TOTAL USEABLE SITE AREA = 25,833.4 SQ. FT.

NOTES:

1. WATER AND WASTEWATER FACILITIES ARE TO BE PROVIDED DURING PHASE I CONSTRUCTION UNLESS NOTED OTHERWISE, BUT THE WATER SYSTEM SHOWN CAN BE CONSTRUCTED PARTIALLY AS NEEDED TO SERVE BUILDINGS AS THEY ARE CONSTRUCTED.

PROJECT NORTH

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CHERANGRE BAPTIST CHURCH

WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

0' 2' 10' 20' 40'
3/64" = 1'-0"

CONCEPTUAL MASTER PLAN

PROJECT NUMBER : 5560

DRAWN BY : MKH

DRAWING ISSUE : AUGUST 2012

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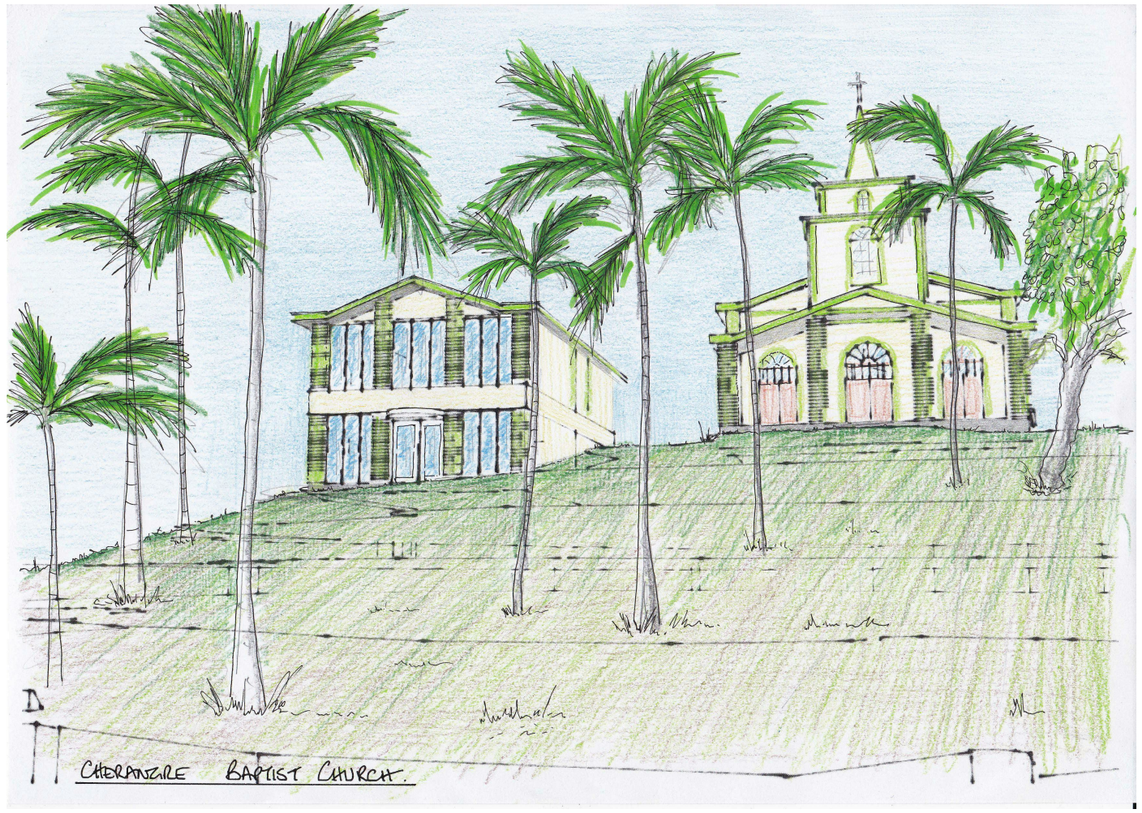
MJC	15.6.12

M1



1 CONCEPTUAL CAMPUS PERSPECTIVES

N.T.S.

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CAMPUS PERSPECTIVES

NOT TO SCALE

PROJECT NUMBER :
5560

DRAWN BY :
DB

DRAWING ISSUE :
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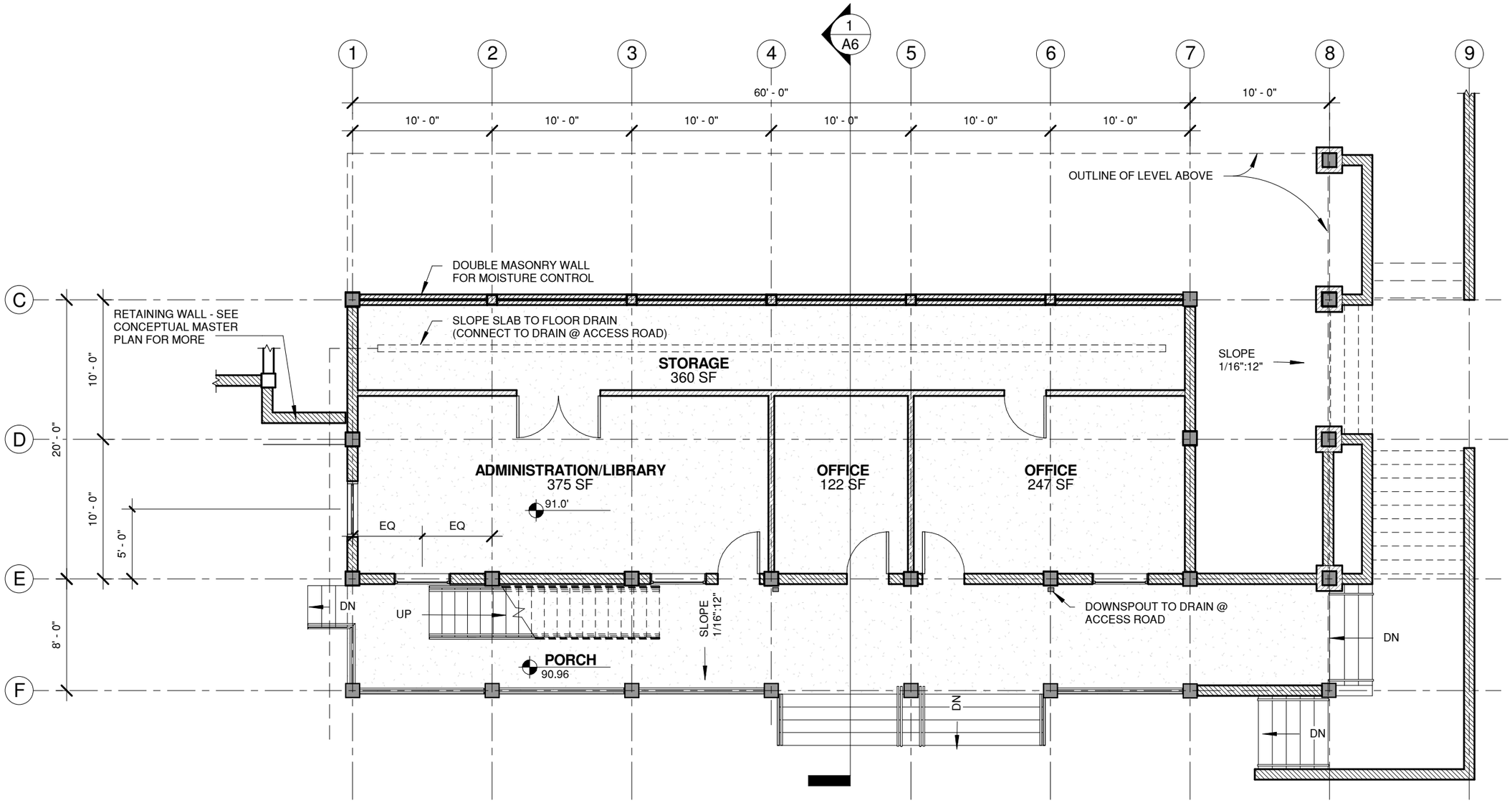
R1



1 CONCEPTUAL CONFERENCE CENTER PLAN - LEVEL ONE

1/8" = 1'-0"

1,260 SQ. FT.

PROJECT NORTH

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CONFERENCE CENTER PLAN - LEVEL ONE

20' 10' 5' 0 1'
1/8" = 1'-0"

PROJECT NUMBER :
5560

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MKH

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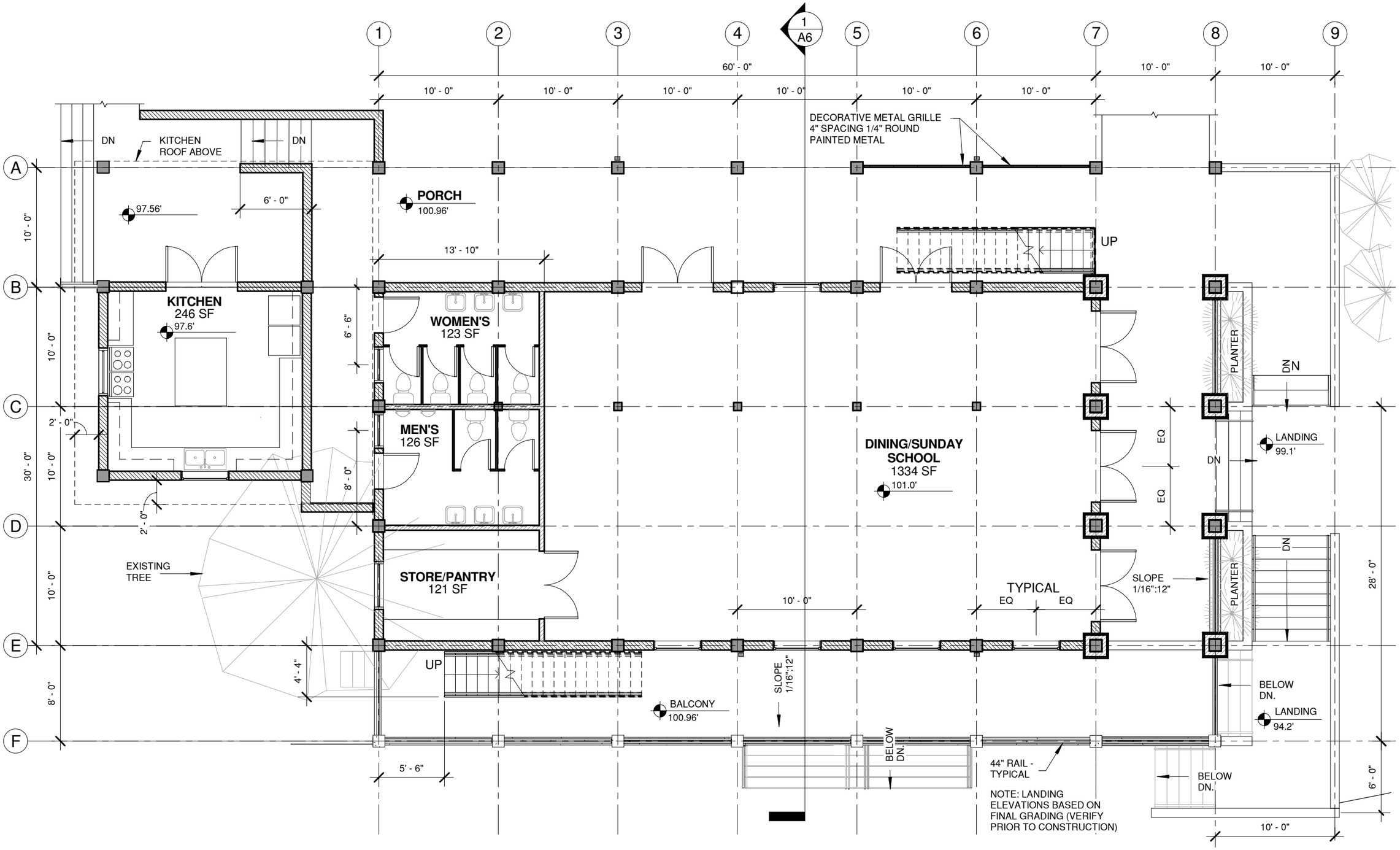
A1



1 CONCEPTUAL CONFERENCE CENTER PLAN - LEVEL TWO

1/8" = 1'-0"

1,860 SQ. FT.

PROJECT NORTH

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CONFERENCE CENTER PLAN - LEVEL TWO

0 1' 5' 10' 20'
1/8" = 1'-0"

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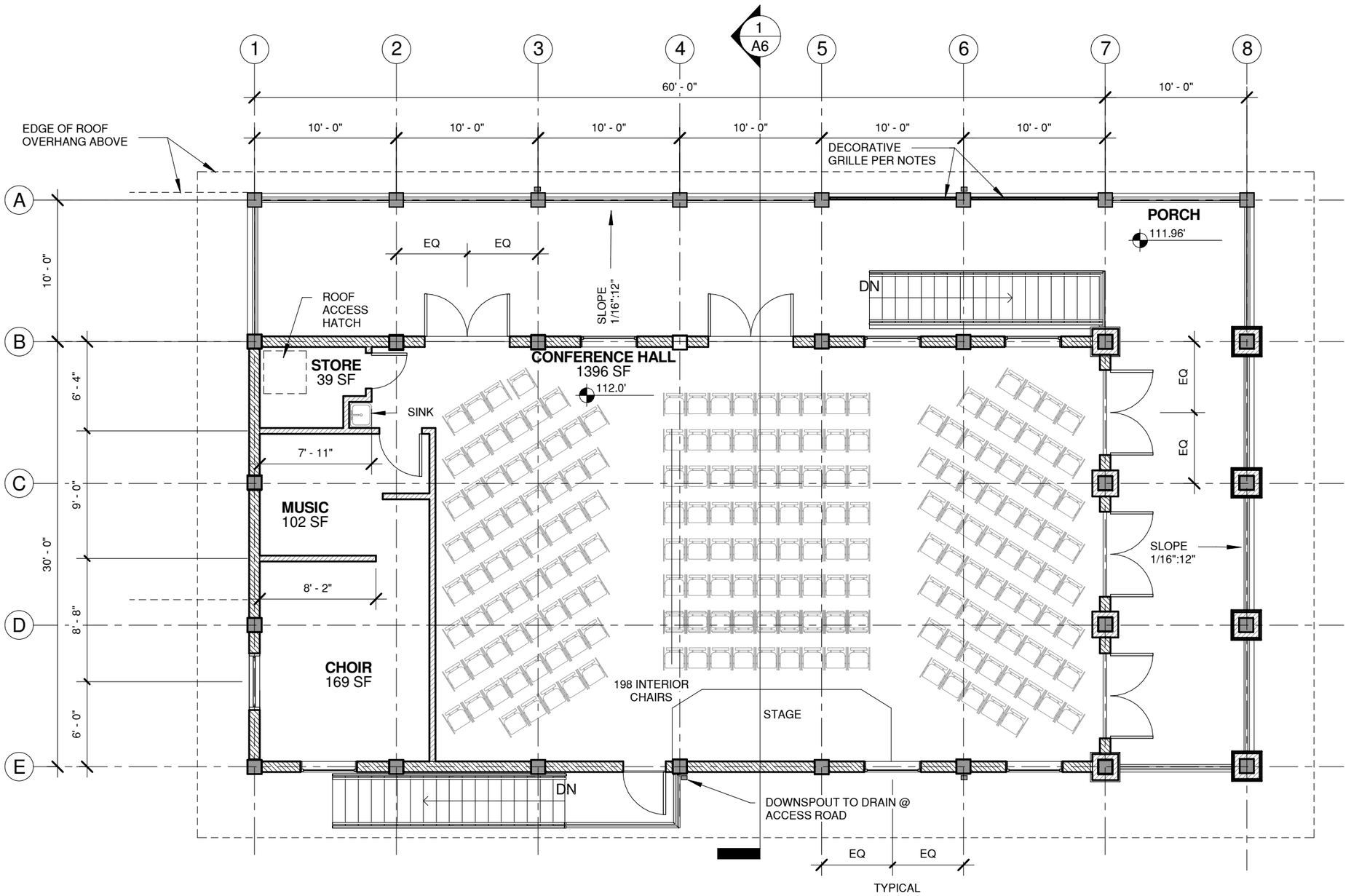
A2



1 CONCEPTUAL CONFERENCE CENTER PLAN - LEVEL THREE

1/8" = 1'-0"

1,860 SQ. FT.

PROJECT NORTH

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WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CONFERENCE CENTER PLAN - LEVEL THREE

0 1' 5' 10' 20'
1/8" = 1'-0"

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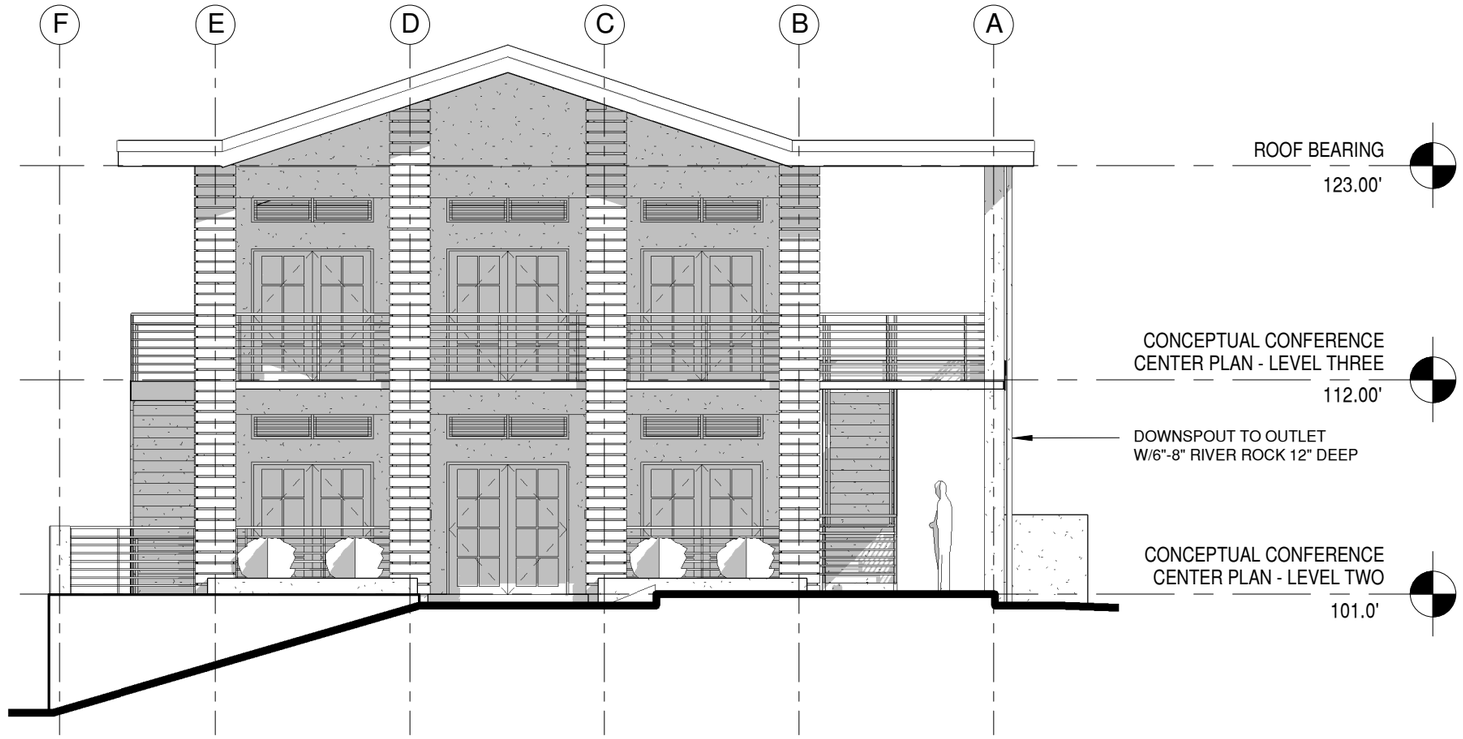
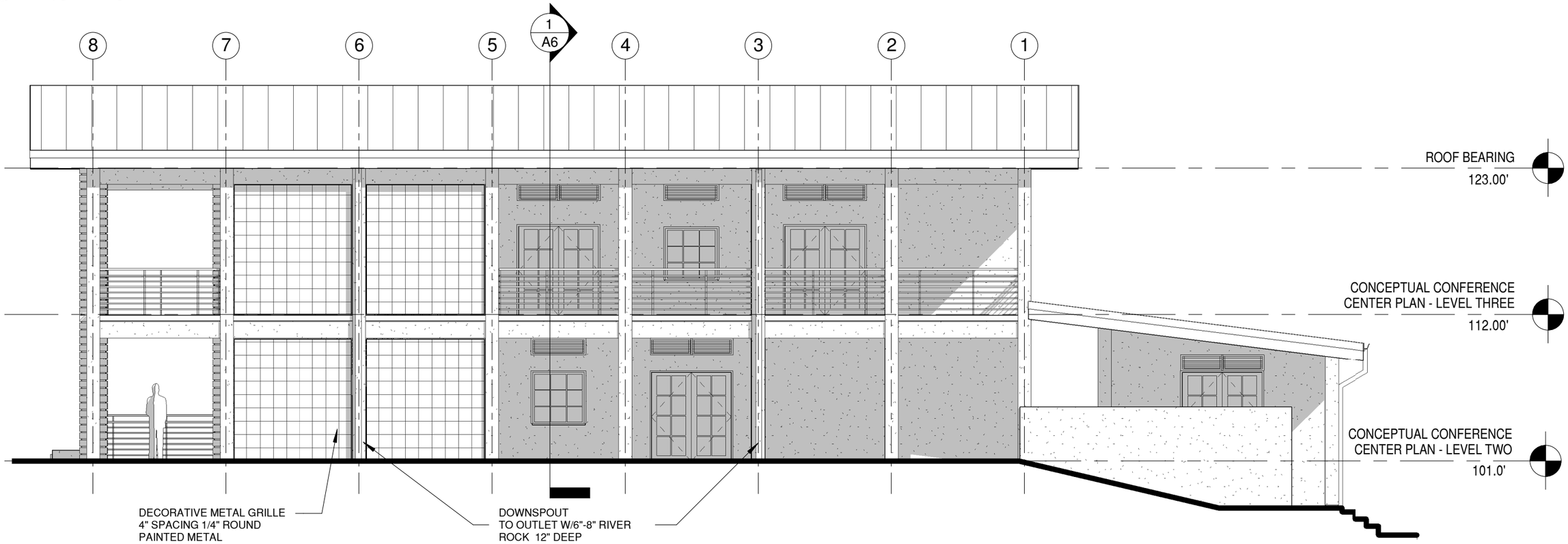
A3



1 CONCEPTUAL CONFERENCE CENTER EAST ELEVATION

1/8" = 1'-0"



2 CONCEPTUAL CONFERENCE CENTER NORTH ELEVATION

1/8" = 1'-0"

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WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CONFERENCE CENTER EAST & NORTH ELEVATIONS

20' 10' 5' 0 1'
1/8" = 1'-0"

PROJECT NUMBER :
5560

DRAWN BY :
MKH

DRAWING ISSUE :
AUGUST 2012

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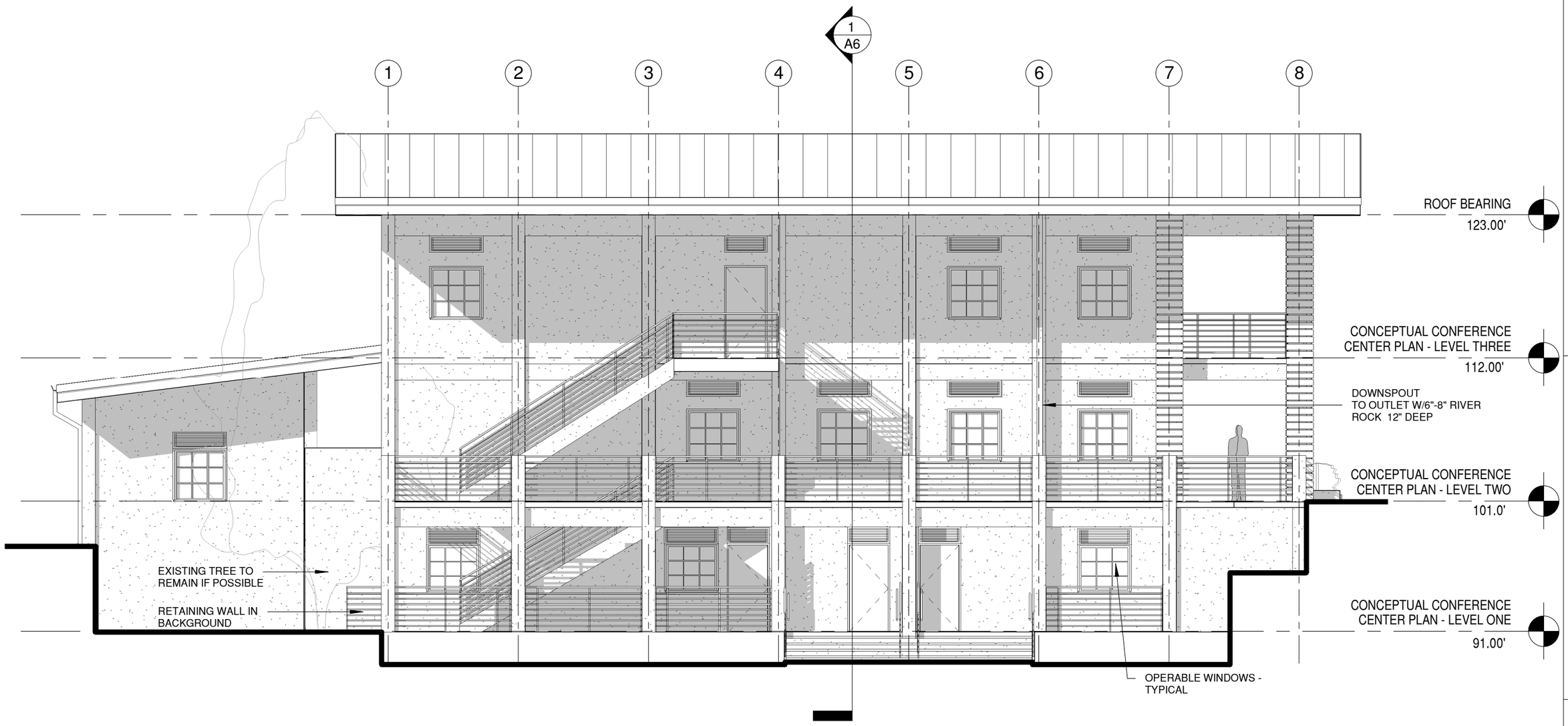
A4



1 CONCEPTUAL CONFERENCE CENTER SOUTH ELEVATION

1/8" = 1'-0"

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CONFERENCE CENTER SOUTH ELEVATION

20' 10' 5' 0 1'
1/8" = 1'-0"

PROJECT NUMBER :
5560

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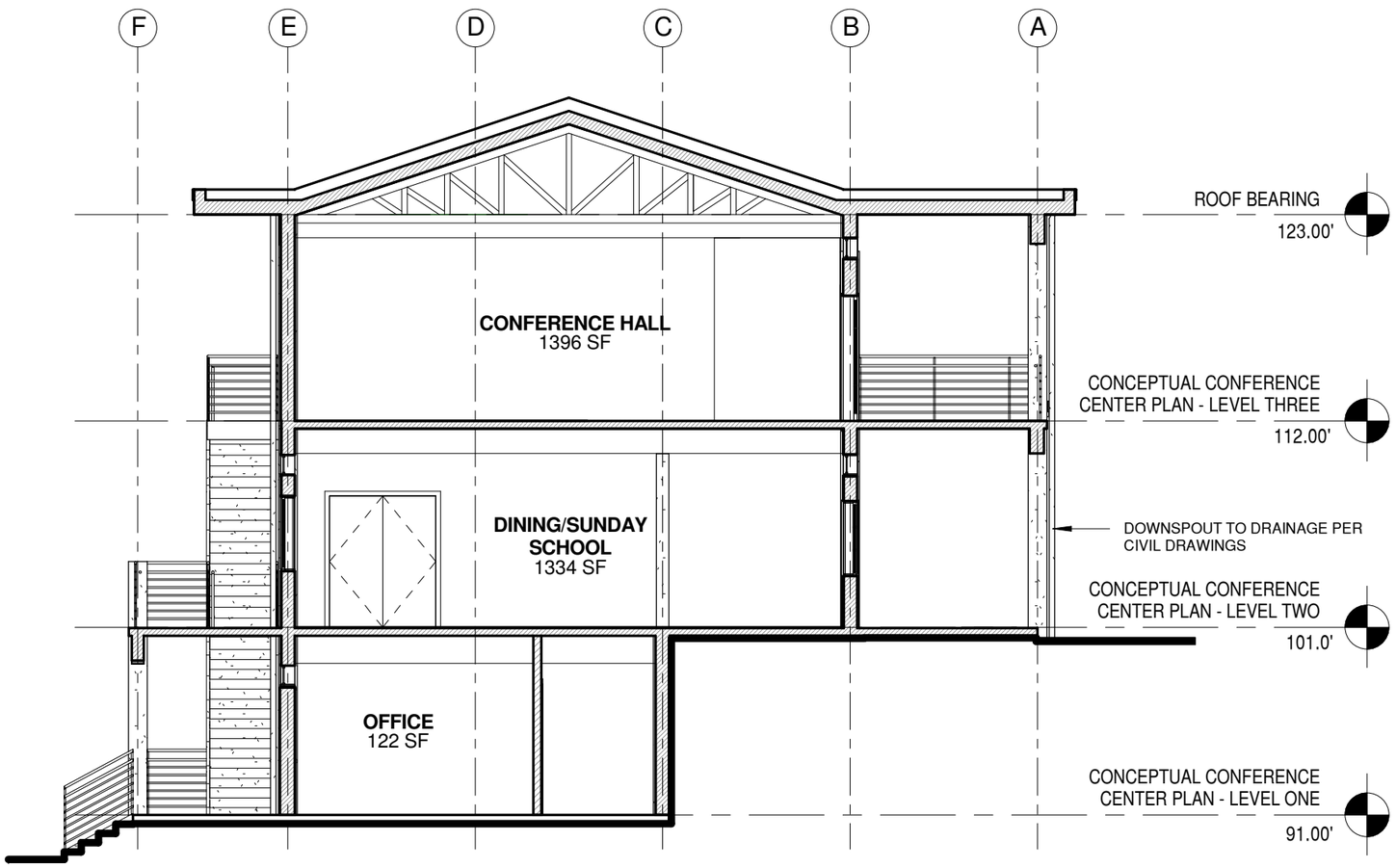
A5



1 CONCEPTUAL CONFERENCE CENTER BUILDING SECTION

1/8" = 1'-0"

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CONFERENCE CENTER BUILDING SECTION

20' 10' 5' 0 1'
1/8" = 1'-0"

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MKH

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AUGUST 2012

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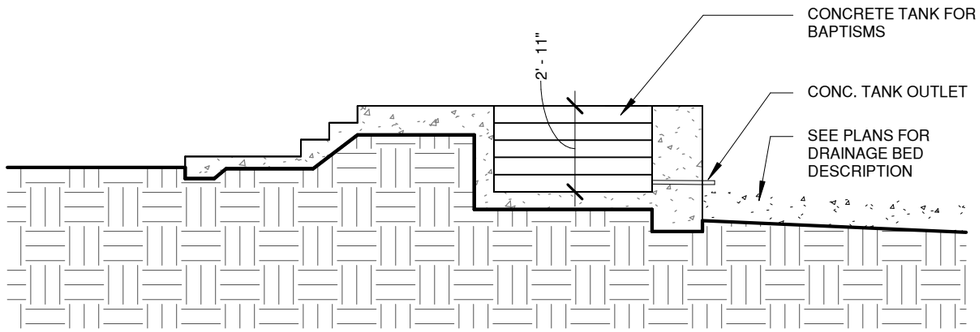
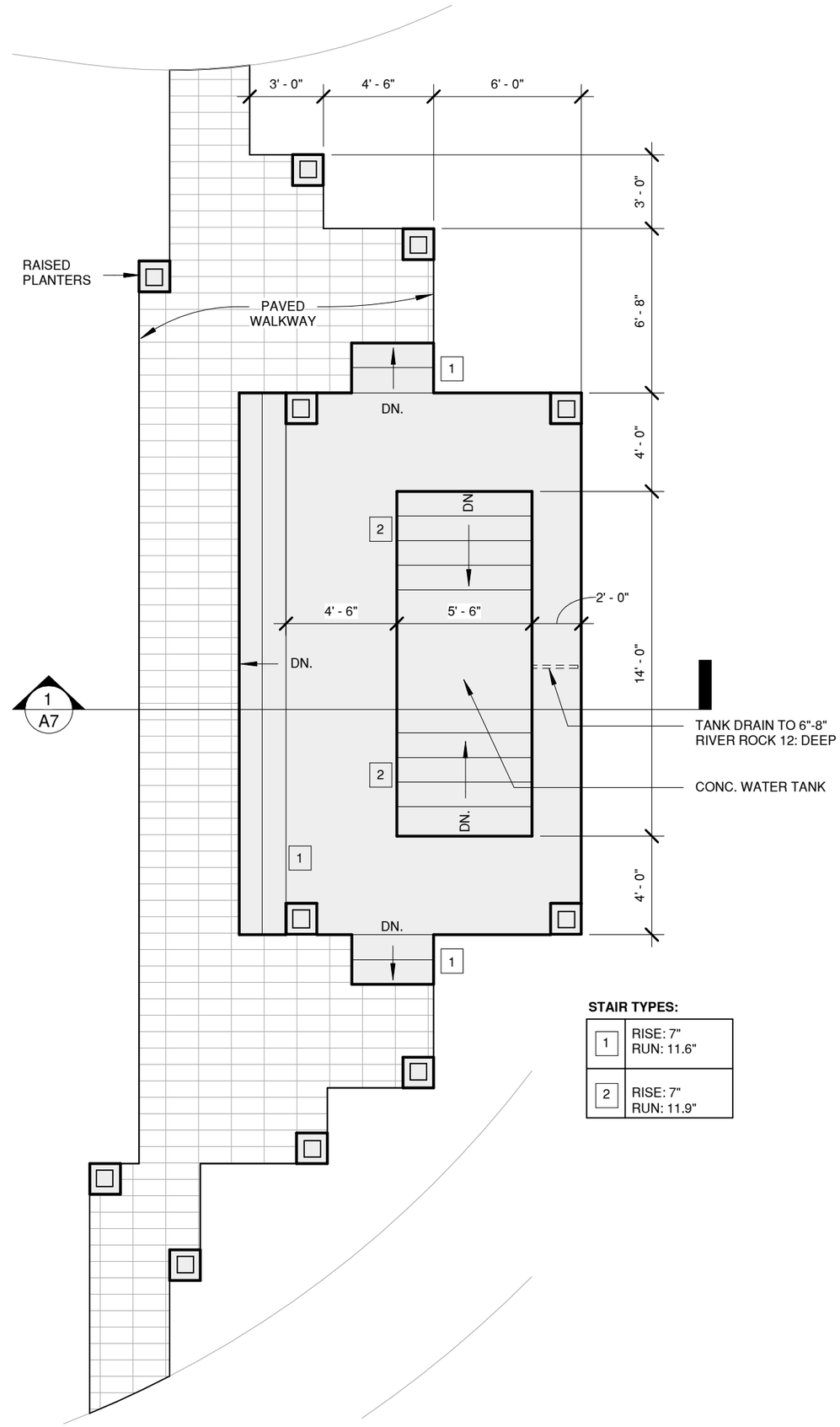
A6



1 CONCEPTUAL BAPTISTRY SECTION
3/16" = 1'-0"



STAIR TYPES:

1	RISE: 7" RUN: 11.6"
2	RISE: 7" RUN: 11.9"

2 CONCEPTUAL BAPTISTRY PLAN
3/16" = 1'-0"

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL BAPTISTRY PLAN & SECTION

0 1' 5' 10'
3/16" = 1'-0"

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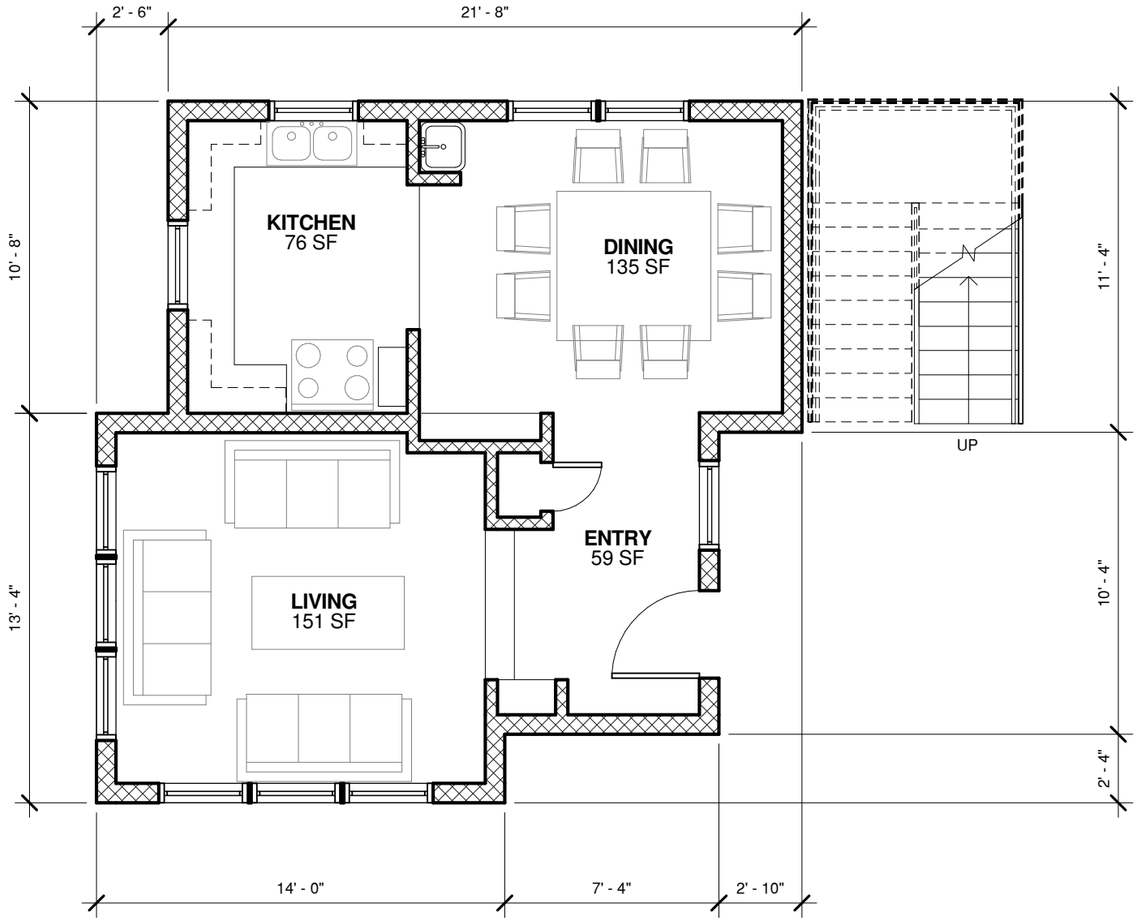
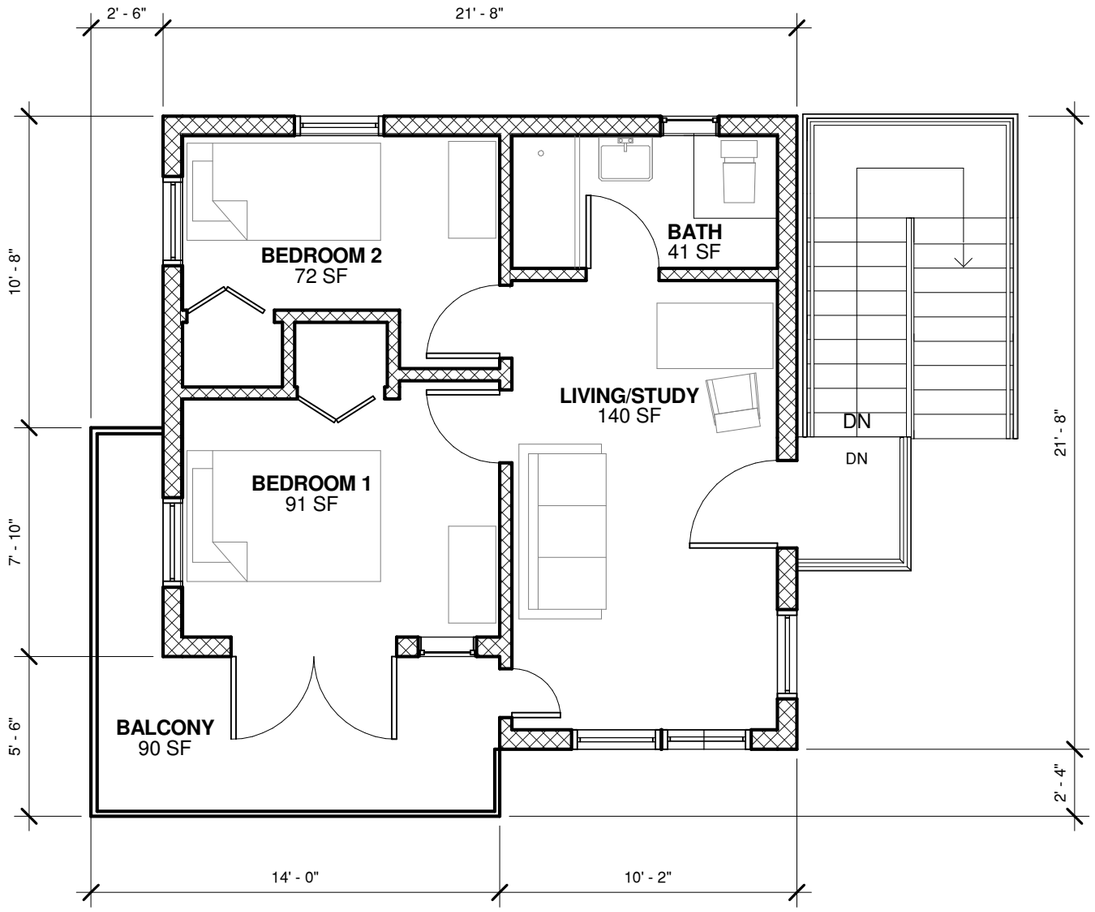
A7



1 CONCEPTUAL PASTOR'S HOUSE PLAN - LEVEL ONE — 421 SQ. FT.

3/16" = 1'-0"



2 CONCEPTUAL PASTOR'S HOUSE PLAN - LEVEL TWO — 344 SQ. FT.

3/16" = 1'-0"

BUILDING NORTH

10'
5'
3/16" = 1'-0"
0 1'

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL PASTOR'S HOUSE PLANS - LEVEL ONE AND TWO

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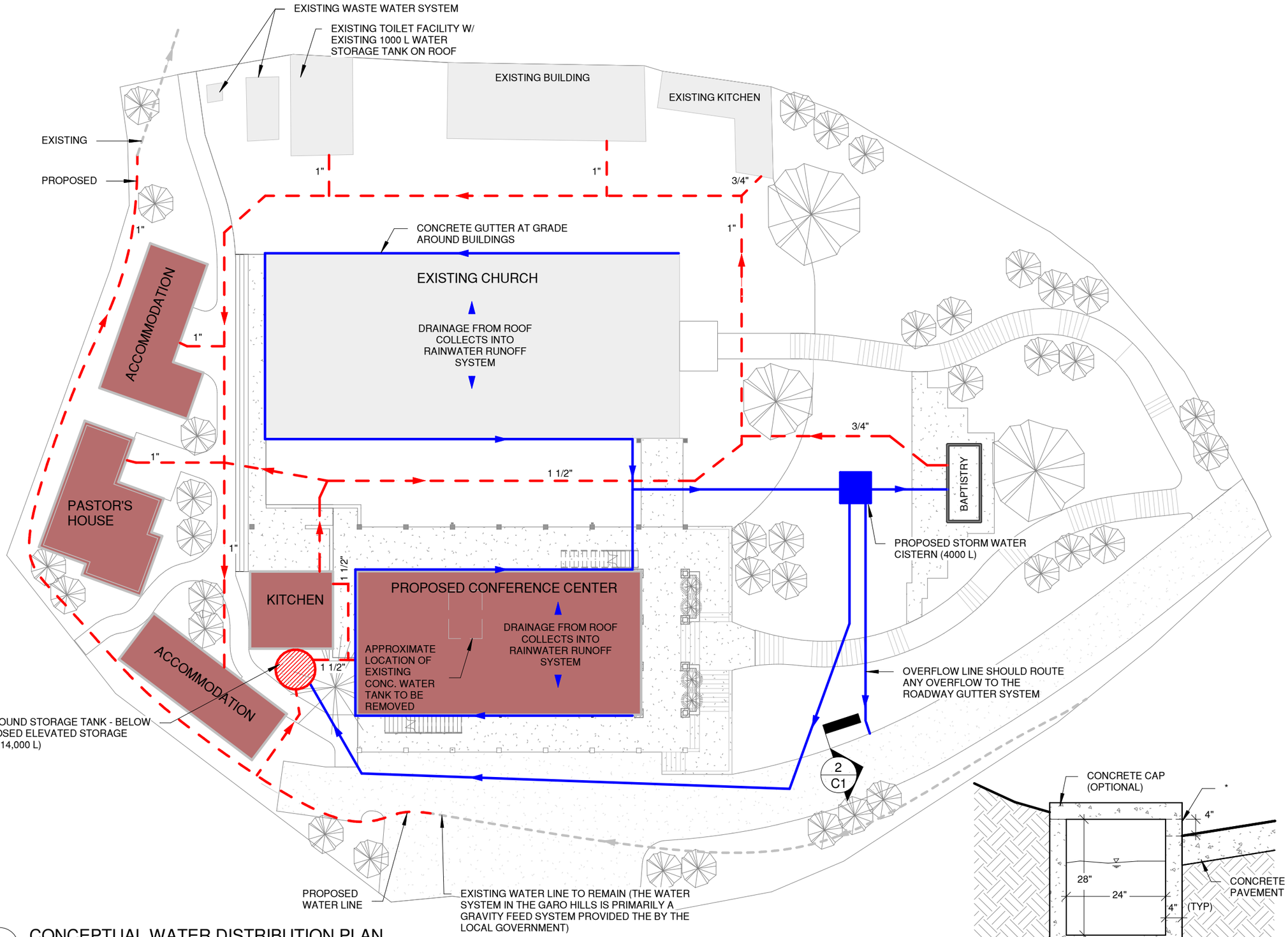

1 CONCEPTUAL WATER DISTRIBUTION PLAN

3/64" = 1'-0"

LEGEND:

- EXISTING WATER LINE
- PROPOSED WATER LINE & DIRECTIONAL FLOW
- STORAGE TANK
- RAINWATER RUNOFF
- CISTERN

NOTES:

1. WATER AND WASTEWATER FACILITIES ARE TO BE PROVIDED DURING PHASE I CONSTRUCTION UNLESS NOTED OTHERWISE, BUT THE WATER SYSTEM SHOWN CAN BE CONSTRUCTED PARTIALLY AS NEEDED TO SERVE BUILDINGS AS THEY ARE CONSTRUCTED.

SYSTEM DATA:

1. ELEVATED STORAGE TANK 14,000 L
(W/CENTRIFIGUL PUMP CAPABLE OF 30 LPM @ TDH OF 10M)
2. GROUND STORAGE TANK 4,000 L
3. STORMWATER CISTERN 4,000 L

2 CONCRETE CURB AND GUTTER

6" = 1'-0"

* MAKE 6" CUT IN CONCRETE CURB EVERY 6' TO CAPTURE RUNOFF DRAINAGE FROM ROAD.

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL WATER DISTRIBUTION PLAN

0' 2' 10' 20' 40'
3/64" = 1'-0"

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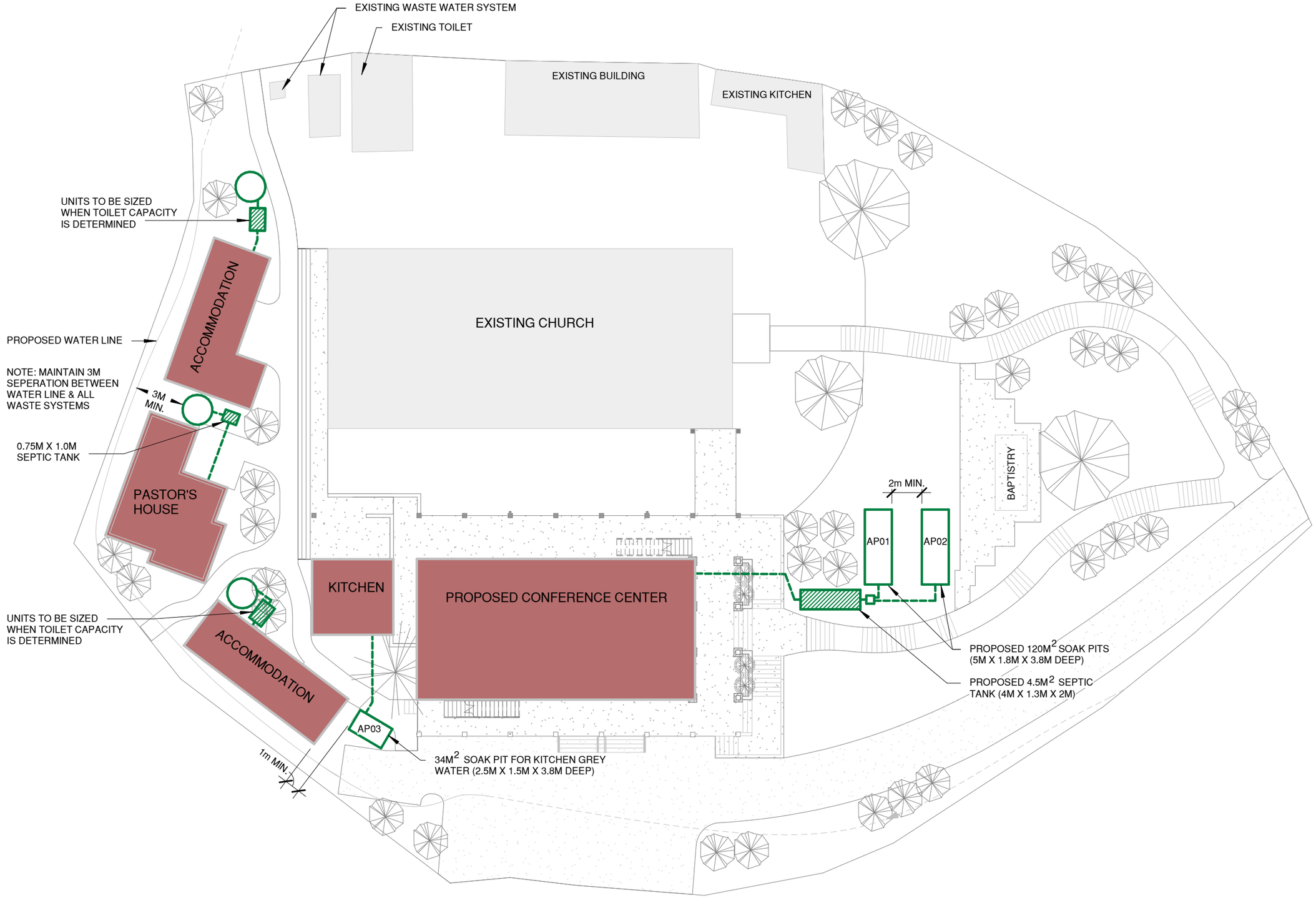

1 CONCEPTUAL WASTEWATER DISTRIBUTION PLAN

3/64" = 1'-0"

LEGEND:

- PROPOSED WASTEWATER LINE
- SOAK PIT SYSTEM PER CIVIL DWGS.
- SEPTIC SYSTEM PER CIVIL DWGS.

NOTES:

1. WATER AND WASTEWATER FACILITIES ARE TO BE PROVIDED DURING PHASE I CONSTRUCTION UNLESS NOTED OTHERWISE, BUT THE WATER SYSTEM SHOWN CAN BE CONSTRUCTED PARTIALLY AS NEEDED TO SERVE BUILDINGS AS THEY ARE CONSTRUCTED.

SYSTEM DATA:

1. ELEVATED STORAGE TANK 14,000 L
(W/CENTRIFIGUL PUMP CAPABLE OF 30 LPM @ TDH OF 10M)
2. GROUND STORAGE TANK 4,000 L
3. STORMWATER CISTERN 4,000 L

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL WASTEWATER DISTRIBUTION PLAN

0' 2' 10' 20' 40'
3/64" = 1'-0"

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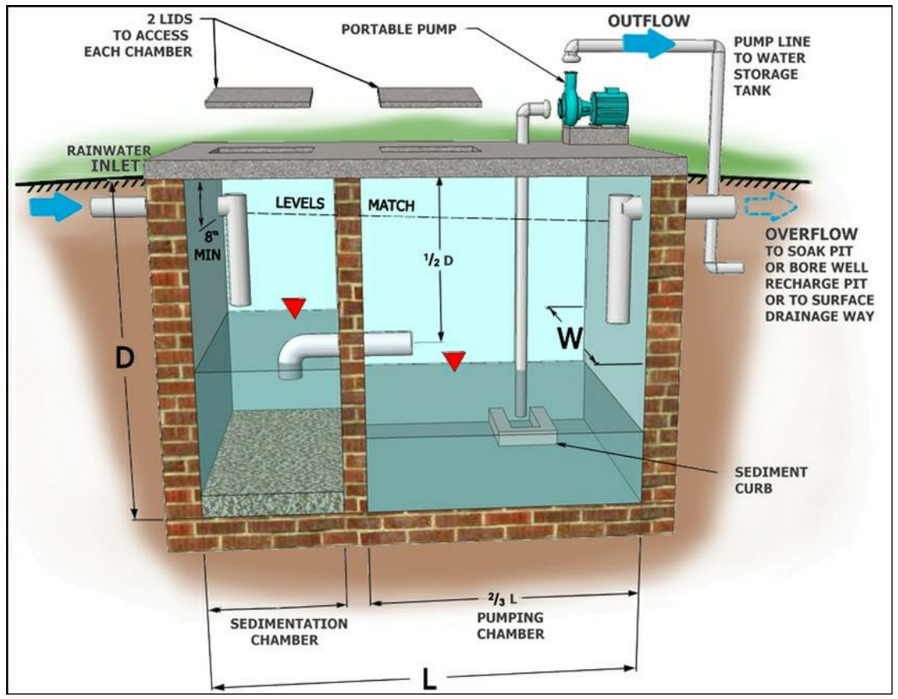
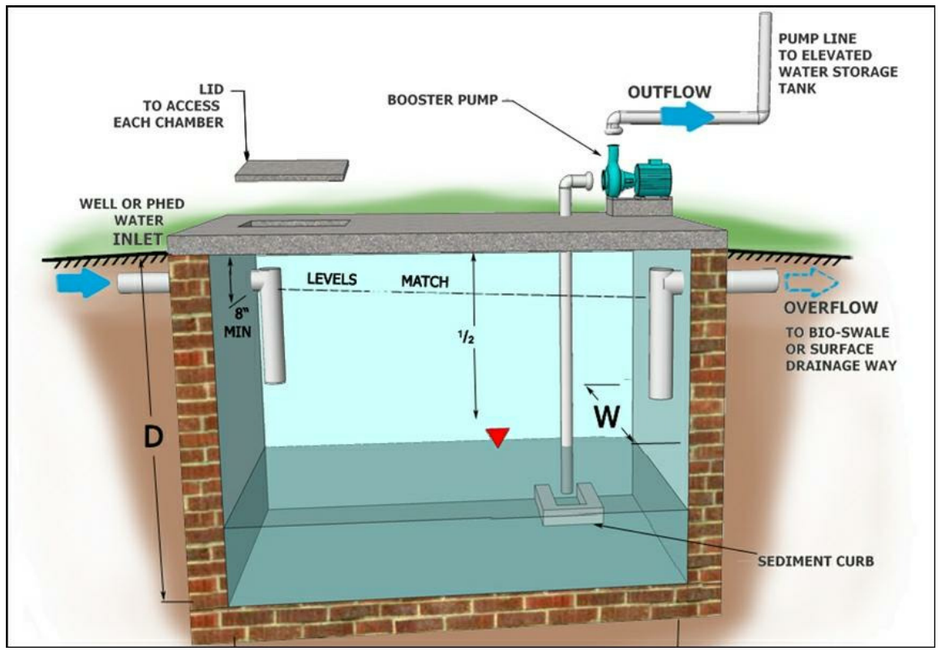
C2



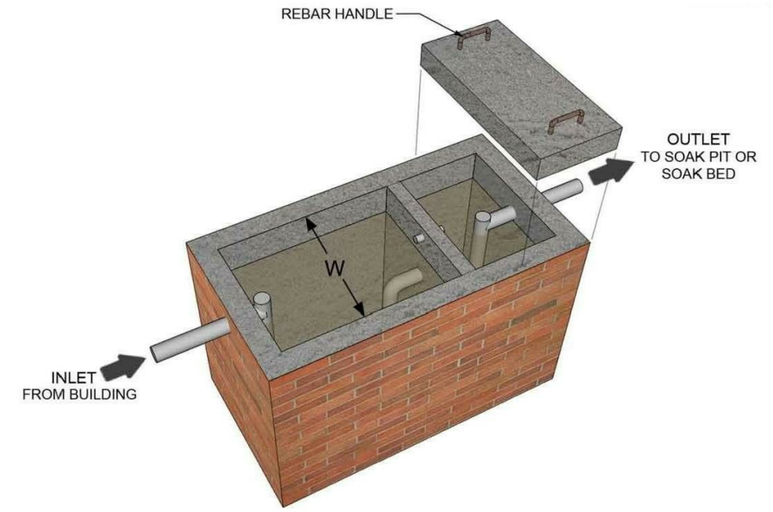
1 CONCEPTUAL STORMWATER HARVESTING CISTERN DESIGN

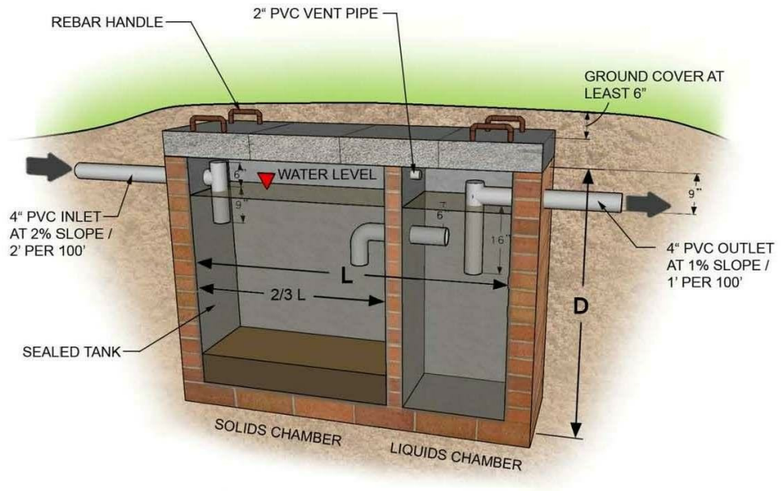
N.T.S.



2 CONCEPTUAL GROUND STORAGE CISTERN AND SUMP PUMP DESIGN

N.T.S.





3 CONCEPTUAL SEPTIC TANK DESIGN

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CIVIL DESIGN DETAILS

NOT TO SCALE

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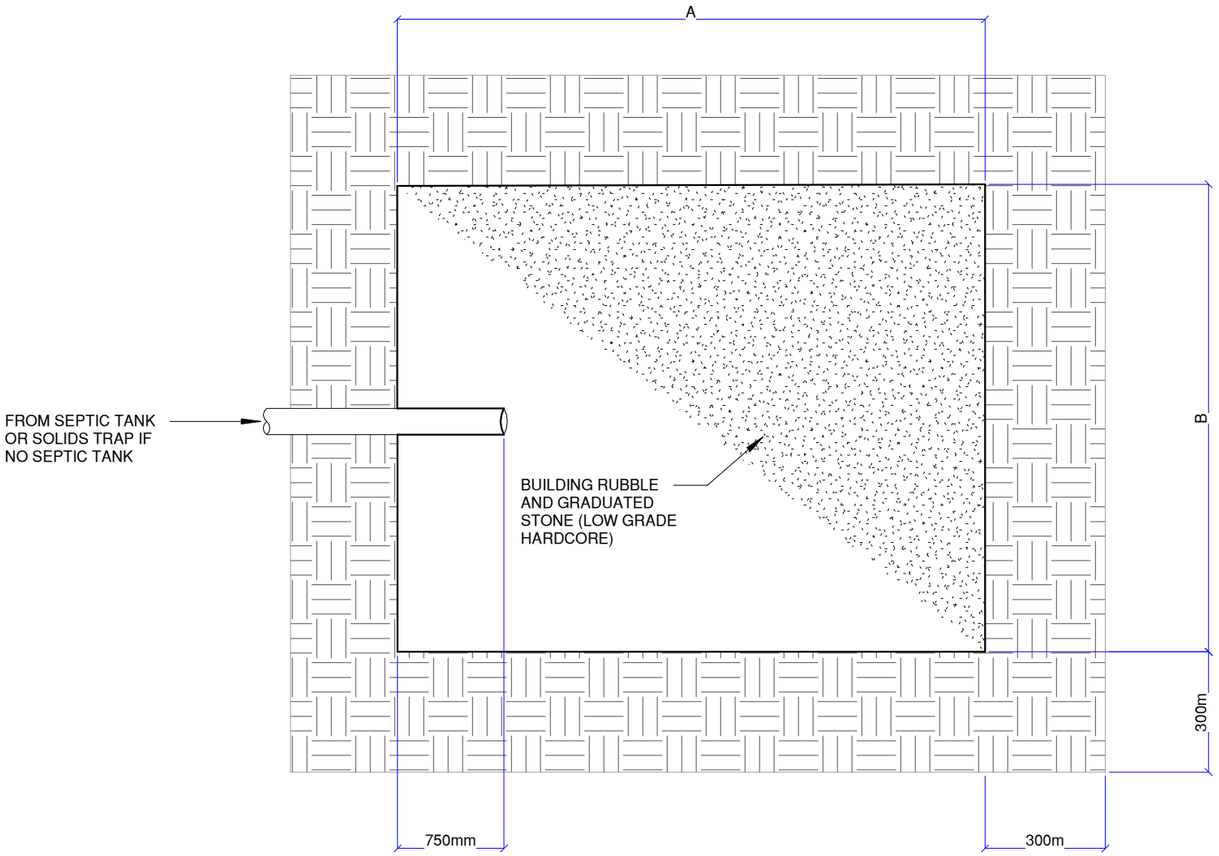
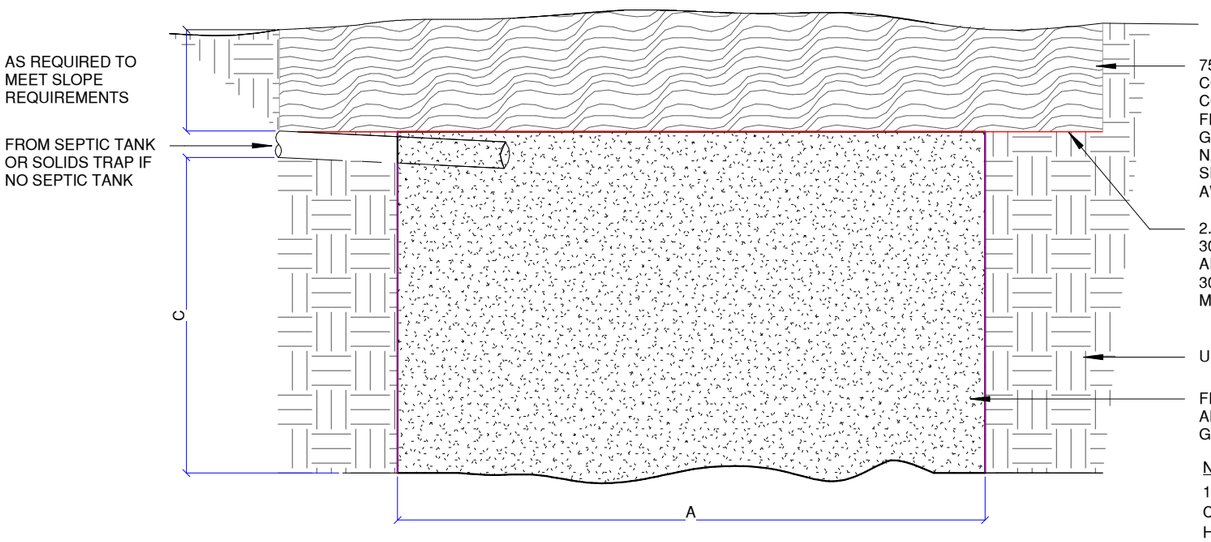
C3

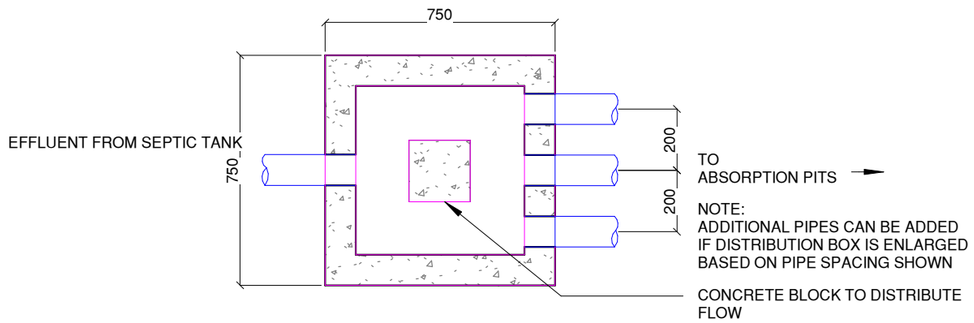


1 **SQUARE SOAK PIT PLAN**
NOT TO SCALE

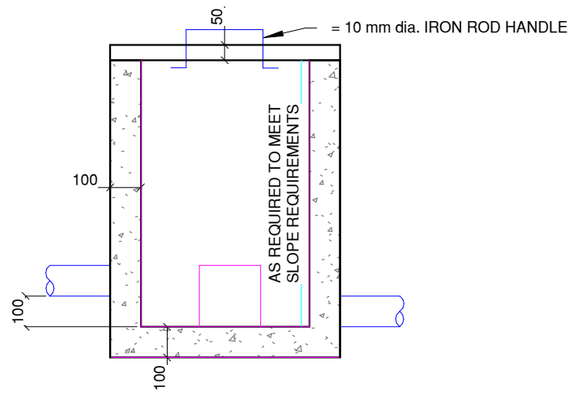


NOTE:
1. BUILDING RUBBLE MAY CONSIST OF CONCRETE, ASPHALT, HARDROCK, AND BAKED CLAY BUT NOT EARTH BRICKS OR WOOD AND OTHER ORGANIC MATTER.

2 **SOAK PIT SECTION**
NOT TO SCALE



3 **DISTRIBUTION BOX PLAN**
NOT TO SCALE



4 **DISTRIBUTION BOX SECTION**
NOT TO SCALE

SOAK PIT TABLE				
	DMENSIONS			
SOAK PIT	A (m)	B (m)	C (m)	ABSORPTION AREA (sq. m)
AP01	5	1.8	3.8	120
AP02	5	1.8	3.8	120
AP03	2.5	1.5	3.8	34

5 **SOAK PIT TABLE**
NOT TO SCALE

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CHERANGRE BAPTIST CHURCH
WEST GARO HILLS, TURA, MEGHALAYA 794002, INDIA

CONCEPTUAL CIVIL DESIGN DETAILS

NOT TO SCALE

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C4

REPORT

CHERANGRE BAPTIST CHURCH – TURA, INDIA

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 MINISTRY OVERVIEW

Cherangre Baptist Church (CBC) started in the 1950s under Tura Baptist Church and has been a branch of Wadanang Baptist Church since 1981. CBC was born out of the need to have a proper institution to worship the Lord Almighty as a single congregation and to enable members to raise a unified vision of fulfilling the Lord's mission through action. Now, convinced by the strength of faith and commitment of its own members, CBC is taking steps to become a full-fledged One Congregation Church by 2013.

Cherangre Baptist Church desires to effectively and productively utilize God's given resources of land. The facilities under this project will cater to everyone, including the poor and needy, as well as equip and help members with spiritual and societal needs. Through these facilities, members will be trained to go out and proclaim the gospel in the mission field.

Figure 1.1: Existing Church

1.2 TEAM PERSONNEL

Engineering Ministries International (EMI) is a non-profit Christian development organization whose vision is to mobilize design professionals to provide design assistance to selected non-profit organizations in developing nations. The design professionals work free-of-charge and their work is coordinated through one of seven EMI offices located in Colorado, India (eMi^2), Costa Rica, Canada, the United Kingdom, Uganda, and Egypt. The goal of EMI is to serve those in need and proclaim the gospel of Christ through partnership with local ministries in developing countries. EMI is the most experienced cross cultural and professional non-profit design service available in the world.

Figure 1.2: EMI Team

This EMI team included:

Matt Hood	Project Leader
Huberth Marak	Project Leader
Edward Leung	Architect
May Leung	Nurse
David Booth	Architect
Charles Cothern	Civil Engineer
Matt Schneider	Civil Engineer
Kathleen Chu	Architect, EMI Intern

1.3 SCOPE OF WORK

The team was in Tura from March 26-29, 2012, for the purpose of completing the following:

- Conceptual master plan for the Cherangre Baptist Church site
- Conceptual planning for water supply and wastewater systems
- Conceptual planning for the storm water systems
- Preliminary square footage costing

2.0 SITE EVALUATION

2.1 SITE DESCRIPTION

Figure 2.1: Aerial Image of CBC Site

The Cherangre Baptist Church campus is located on a steep slope, and has a total usable area of 2400m^2. The site is located along a main road on the south end and a small access road on the western side that connects with adjacent residential areas. A pocket of trees sits on the south side of the existing church while other small groups are dispersed throughout the site. A road was constructed through the site on the southwestern property line around 1990. The road cut creates a steep drop in the land that can be seen in the site survey.

2.2 SITE SURVEY

The goal of the site survey was to locate boundaries, local features, and to document the basic topography. To accomplish this goal, the site was measured using a Sokkia Set 4 Total Station. The boundary is not defined by any government markers according to the ministry staff. The boundary is defined along the northern boundary by a row of trees and "boundary marker trees". The southern boundary is marked by a combination of bamboo fencing, "boundary marker trees" and markers (bamboo stakes) placed by the ministry staff. The ministry staff walked the boundary with EMI representatives. The western and eastern boundaries are defined by access to public roads. Refer to the drawing set for a graphic representation of this site.

2.3 FIELD INVESTIGATIONS – SOILS

Observation of the soil on the site revealed a tan relatively hard soil capable of standing in open cuts nearly vertical even after 20 years of rainy seasons. This was observed primarily in the cut made for the driveway on the western and southern side of the property. This driveway cut was made in the early 1990s and the cuts are still nearly vertical. As observed during construction of the percolation pit, the soil has some binding characteristics and sticks together in a clump when squeezed in the hand. As it dries out it tends to separate again. Small amounts of clay are in the soil. Also present was a reddish limestone. This rock had voids that were "geode" like.

A percolation pit was constructed south of the existing church near the existing water tank, and was 863.6 mm (34 inches) in diameter to a depth 787.4 mm (31 inches). The soil characteristics were consistent throughout the excavation including a few small limestone rocks. The percolation rate based on the field test was estimated to be in excess of 200 lpd (liters per day)/m^2. These percolation rates, which determine how quickly water soaks into the ground, are acceptable for a soil seepage-type onsite wastewater disposal system. For design purposes, 40 lpd/m^2 has been used to size facilities based on concern over how the rainy season may affect the soil saturation level.

Figure 2.2: Existing Road Cut Through Site

3.0 ARCHITECTURAL DESIGN

3.1 DESIGN CONSIDERATIONS

The drawings and report for CBC have been produced after numerous meetings, and dialogue between EMI and members of Cherangre Baptist Church. CBC requested that EMI submit a design for a church addition to provide seating for about 1000 people and conference hall and dining hall facilities to cater for around 400 people as well as a library. The following dialogue is generally based on the drawings produced.

1. Site Design:

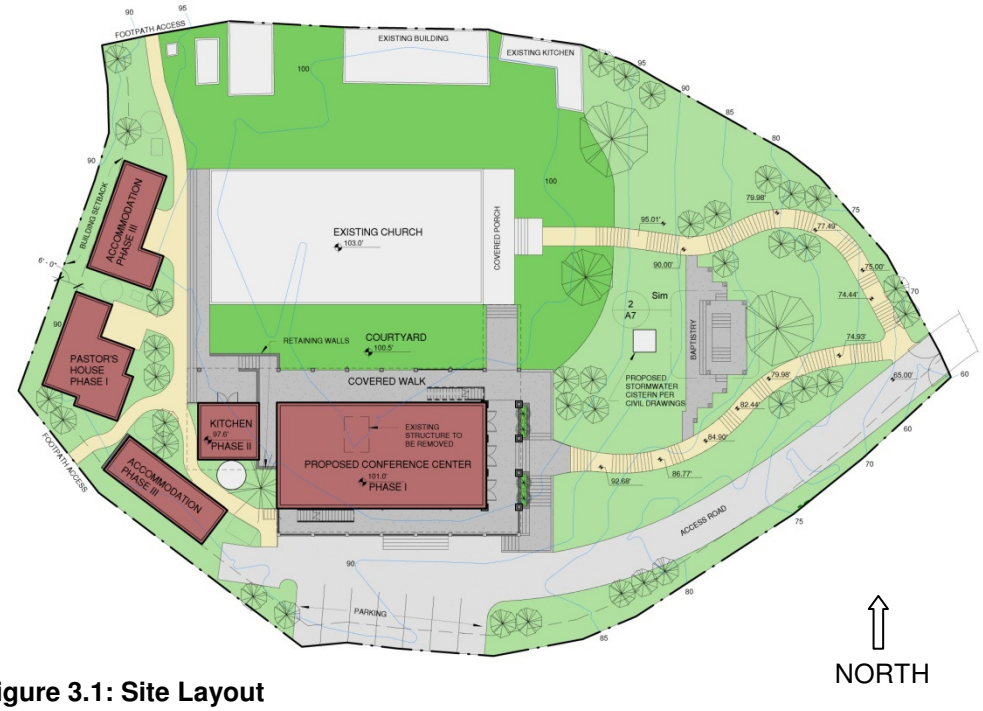


Figure 3.1: Site Layout

The EMI team decided on a multiple story building to house the additional desired program. This decision allowed CBC to maintain the precious open areas on the site, which are used for daily meetings, dining, and leisure activities.

The new two story multi-purpose building (Conference Center), designed to the south of the existing church building, creates a courtyard between the two facilities. The slope of the land allows the southern half of the building to have a walk-out basement to be used for offices and a library. One complete floor level would contain the dining hall and toilets and the other would provide conference facilities.

It was agreed that the main pastor's house and other accommodations would be constructed along the rear section of the site west of the existing road. The existing toilet block, storage facility, and cooking areas, to the north of the existing church, will remain untouched for the time being, but could be developed in the future as needed. A kitchen area is planned to the west of the new conference center building.

The existing pedestrian path that begins at the site entry driveway and climbs up the hill directly to the area right in front of the church has been redesigned for easier use. CBC has emphasized the importance

of having a new baptismal and decorative fountain near the existing church. A Baptism Pool is proposed along the plateau area near the pedestrian path so that the church would be a back drop for baptismal services.

2. Floor Plan – Existing Church and Proposed Conference Center

A seating plan was produced to understand the seating capacity for the expanded church building. The current church can hold less than 500 people, but at completion, CBC would like to have enough room for 1000 people attending church services (in the sanctuary or remotely).

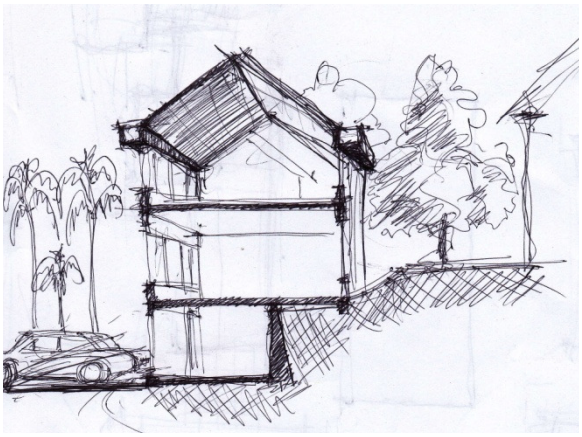


Figure 3.2: Conceptual Conference Center Section Sketch

Recently the stage area has been expanded to make room for more sound equipment, musical instruments, etc, but it could be made smaller, by one building bay to maximize the number of seats. Rooms on either side of the stage can be used for storage and rehearsal, and their walls for projection screens. Reducing the stage area enables 504 seats to be accommodated at the lower level. In addition to this, tiered balcony seating has been suggested to accommodate for 200 more people. The balcony would be built within the two building bays at the entry end of the building with two access staircases. If the church required 1000 seats total then different pew seating could be used, and further extensions could be provided as wing additions on the sides of the building. This was discussed with the church and it was agreed that any overspill could be accommodated in the conference hall in the proposed Conference Center building through the use of media streaming, rather than with building additions.

The new building houses the new conference hall and new dining hall, toilet accommodations, offices, storage, library and music rooms. The conference hall, on the upper level, can cater to 198 people, and can also be used for children's programs. A dining hall, on the ground floor level, can accommodate 200 people, and has direct access to the courtyard for overflow and eating outside. The dining hall can also be partitioned and used for Sunday school classrooms and/or children's activities. The kitchen is hidden behind (west of) the dining hall for easy access.

3. Programming of Spaces

Table 3.1: Proposed Program of Spaces:

Room	# of units	Total Square feet
Offices	2	369
Dining Room/Sunday School	1	1,334
Administration/Library	1	375
Conference Hall	1	1,396
Store/Pantry	3	521
Music	1	102
Toilets	2	249
Choir Practice Room	1	169
Circulation/Other	1	465
Total		**4,980**

4. Phasing

The Phasing for CBC will be dictated by funding, ministry priorities, and infrastructure development, and should minimize disruption of normal church functions. Detailed programming for individual spaces will be provided with future EMI project trips. See Conceptual Master Plan for phasing recommendation.

5. Perspective Illustration

Figure 3.3: Conceptual Conference Center Perspective Sketch

The perspective drawing for CBC shows how the building could look upon completion when looking from the street pedestrian access to the front of the church. The new proposed building with a glass façade is to remain unassuming and delicate so as not to make it overpower the prominent existing church building. The buildings share common details such as the green striped columns and roof lines.

3.2 ESTIMATED COST

The current (2012) construction unit cost in Tura is approximately 1600 Rupees (US$29) per square foot. It is estimated that the Conference Center will cost approximately Rs. **95,47,680** or US $**173,864**.

Table 3.2: Estimated Cost for Phase I Development

Building Usage	**Approx. Area**	**Estimated Cost**	
		(Rupees)	**(US$)***
Phase I Development	**463 SM (4,980 SF)**	**79,68,000**	**144,420**
Site Works and Utility		**15,00,000**	**28,000**
eMi^2 Investment (1% of building cost)		**79,680**	**1,444**
Total Estimated Cost for Phase I Development =		**95,47,680**	**173,864**

*Exchange rate: US$ 1 = 55 Rupees

3.2.1 INVESTING IN eMi^2

eMi² offers non-profit design services to Christian ministries in South Asia. This design service provides the expertise and materials needed to plan, order, and express the vision of the ministry's development project. As funds are raised for the development project, we ask our clients to consider reinvesting just 1% of the cost of the first phase of new construction

back into the ministry of eMi².

This reinvestment enables other ministries like CBC to continue to avail of non-profit design services from eMi² and allows us to tell them the good news about your gift sponsoring their design project.

3.2.2 MATERIAL QUANTITY – PHASE 1

The material quantities listed below is a rough estimate performed using the Concept Design plans for the Phase I Development.

Table 3.3: Material Quantity Estimate for Phase 1 Construction

PHASE 1 – Conference Center		
Material	**Quantity**	
Total Quantity of RCC	19,297 ft3	546 m3
Total Quantity of Brick Infill Wall	7,624 ft3	216 m3
Area of Windows/Doors	2,403 ft2	223 m2
Area to be Painted	13,944 ft2	1,295 m2
Area to be Plastered	13,944 ft2	1,295 m2

**RCC- reinforced concrete*

3.3 USE OF LOCAL MATERIALS

In order to reduce the construction cost, it is recommended to use locally available materials:

Alternative Use of Brick:

Block making is an effective way to incorporate local materials, reduce building costs, and promote self-sufficiency. Block making can be taught as a vocational skill to utilize the available labor of men and women in Tura.

One company specializing in block making is **Hydraform India** (www.hydraformindia.com). Information regarding a wide range of block making machines, on-site training, and their experience with community-based projects in developing areas can be found on their website. Hydraform India is located in New Delhi.

Figure 3.4: Block Making

4.0 STRUCTURAL DESIGN

4.1 STRUCTURAL CONSIDERATIONS

The facilities for the Cherangre Baptist Church are one, two, and three-level construction. The buildings are planned to be built in multiple phases to accommodate project financial constraints and development of the programs. These structures are planned to be constructed using a reinforced concrete frame system with infill walls of brick. The structures are also planned for concrete roofs. Probable column locations were identified in a grid system on the plans. Construction documents and detailed structural drawings are to be completed before construction begins.

Tura is located in a very high damage risk zone for earthquakes and a moderate damage risk zone for wind hazards. The facilities should be of engineered construction and designed structurally for building self weight, occupancy loads, and any lateral loads caused by wind or earthquakes. The appropriate state and national codes (i.e. BIS) for construction should be used to guide the engineering process.

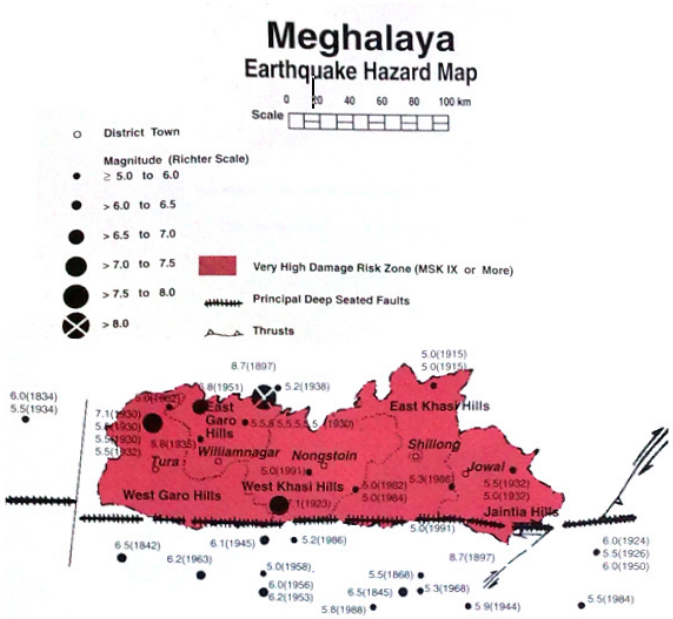


Figure 4.1: Meghalaya Earthquake Hazard Map (Source Wikipedia)

In accordance with the same, eMi^2 recommends the following:

a. Use of the following Indian Standard (IS) codes, or equivalent, to govern the engineering of the structure: IS 456:2000, IS 875:1987.
b. Concrete for the slab-on-grade, columns, and roof slab should be mixed using a 4:2:1 volumetric ratio (gravel : sand : cement).
c. All concrete should be mixed using a mechanical drum mixer to ensure proper mixing and cured strength.
d. Reinforcing steel should be mild steel and have yield strength of 250 N/mm^2 (40,000 pounds per square inch).
e. With the type of soils encountered at the site in mind, a soil bearing strength of 144 kN/m^2 (3,000 pounds per square foot) could be considered in design.
f. According to the *Vulnerability Atlas of India 1997*, earthquake hazard risk to be considered for the Tura area is defined as: Very High Damage Risk Zone (MSK IX) or "Zone V". Wind hazard risk is defined as: Moderate Damage Risk Zone – A (39-44 m/s).

5.0 WATER SUPPLY SYSTEM

5.1 EXISTING WATER CONDITIONS

The water system in the West Garo Hills in Tura is primarily a gravity feed system provided by the local government. The system operates on a somewhat random schedule typically for a few hours in the morning and a few hours in the evening. Consequently, users, including the church, have installed their own individual storage systems which usually consist of black plastic 500 to 1,000 liter tanks located on the roof or a high point which provides some gravity flow. Ground storage has also been used as an option, where a tank is located at the terminus of the water tap for use by bucket when the government system is not functioning. The system is generally reliable; however, during the end of the dry season (March through May) there are occasional shortages according to the ministry staff.

Figure 5.1: Existing Water Pipe System in Tura

The church has constructed a 4,000 +/- liter concrete/brick tank on the south side of the church near the church service tap. This 4,000 liter storage tank provides water for use on the property. The church has a small portable electric centrifugal pump that they use to pump water to other locations, primarily a tank located on the roof of the toilet for use there. This tank is 1,000 liters, provides gravity flow to faucets in the toilet rooms and needs to be filled per week. All other water must be carried to the different locations as needed: kitchen, etc.

5.2 EXISTING/PROPOSED WATER SOURCES

1. Storage Tanks and Government Source

The government source will be utilized to provide water service to the proposed new facilities. There will be toilets on Level Two of the Conference Center building, and a sink on Level Three. eMi^2 recommends that a storage tank be installed on a tower west of the proposed Conference Center Building, which provides the highest elevation on site and therefore will provide the best pressure throughout the site. The tank will be a minimum of 14,000 liters and will provide service to the interior toilets on Level Two and the exterior toilets and proposed kitchen (as well as future buildings) through a service line. The tank will be located a minimum elevation of 2 meters above the sink on Level Three.

In addition to the elevated storage tank, a new ground storage tank will be constructed to replace the existing (removed) ground storage facility and will receive water from the existing government tap. The ground storage facility is to be 2 m x 2 m x 1 m (h) providing storage of approximately 4,000 liters; it will be located below the elevated storage tank.

The elevated storage tank will be filled by use of a small electric centrifugal pump capable of delivering 30 lpm (liters per minute) at a total dynamic head of 10 m. This will allow sufficient time each day for the pump to rest after filling the tank, and will allow the tank to be filled multiple times per day at need. This pump can operate automatically by a float switch in the elevated tank, or manually. The proposed pump will be connected to the ground storage tank and will receive suction pressure from that tank. When the tank is full the pump will automatically shut off.

If a pump control failure occurs in which the pump continues to operate no damage will occur because the tank will overflow to the ground storage tank through a 50 mm (2 inch) line (looped flow provided by the overflow system).

The overflow will be located at a level representing the full design storage for the tank. The distribution discharge will be located 0.1 m above the floor of the tank, and will be equipped with a drain located at the bottom of the tank for periodic maintenance including draining away any sediment. Access will be provided at the top of the tank (including a man way), and will have a 50 mm (2 inch) fitting in the top of the tank for installation of water level controls. The water level float control should be located so that the "on" switch will occur when the water level drops to the mid-point of the tank and the "off" switch is located 0.1 meters below the full design level. The float controls will be adjustable so that if the water usage is significantly less than projected the control levels can be lowered to reduce the possibility of stagnate water.

2. Storm Water Harvesting/Storm Water Discharge

A secondary and separate water system will consist of rain water collection and storage. The church roof is currently guttered. Storm water is routed through downspouts to a concrete channel on the south, north and west sides of the building. This concrete channel currently discharges into a ditch beside the access driveway at the southeast corner of the church, and discharges to the public r.o.w. on the east side of the property.

This water source could be collected for use by installing an 8 inch pvc pipe in the concrete channel and manifolding each of the 90 mm (3 ½ inch) downspouts to the pipe, which would help reduce the amount of debris collected in the storm water cistern. The pipe would discharge into a 4,000 L storm water cistern east of the proposed conference center building. The new conference center building will also have downspouts collected in a pipe system and then routed to the storm water cistern.

5.3 WATER USAGE ESTIMATE

The water usage for the site was calculated based on the seating capacity and the proposed number of plumbing fixtures. Overall storage requirements are not calculated since the primary source is through a government system; however storage projections for the facilities to be served by the proposed elevated storage tank are calculated.

Figure 5.2: Elevated Storage Tank

The projected church seating capacity is 968 (including occupancy in the Conference Center). Water use projection is difficult without the existence of meters or other measuring devices. After observing the water usage in different settings and based on previous research, an estimate of 70 liters per capita per day seems appropriate. Since the church population does not live on site, consideration to a proportional usage needs to be made. A reasonable reduction from residential usage to church parishioner usage is 80%, or a church parishioner will use 1/5 the amount of water they would use at home if they did not come to church. Therefore a usage per parishioner of 14 lpd has been used for sizing storage and distribution facilities. Activities at the church are limited to primarily Sundays with occasional use throughout the week usually in the evenings. There are usually at most 4 staff members at the church daily. Weddings and other special events occur throughout the year. Based on the wide variety of activities, a typical Sunday use was used for the basis of design.

Using the calculated usage of 14 lpd and the seating capacity of 968 the total projected usage for a Sunday activity would be 13,552 lpd (14 x 968). To determine the storage needs it was assumed that each toilet will have an equal use and the kitchen will use 21%. Therefore the usage breakdown is as shown in Table 5.1: Usage Distribution

Table 5.1: Usage Distribution

User	Percent Usage	Calculated Usage
Main Kitchen	21%	2,710 lpd
Toilets	79%	10,164 lpd
Total	100%	12,874 lpd

Water will also need to be supplied for special occasions (weddings, conferences, etc.) ranging in size from 1,000-2,000 people which will occur several times a year. Due to the infrequency of these events, the fact that the water usage will likely fluctuate between 15-45 liters per day per person depending on the attendee's lifestyle, and that all attendees may not stay on the property permanently, sizing tank storage for the largest gathering scenario is not recommended. Water supply for large events is provided by the connection to the central government system. During large gatherings special attention will need to be provided by the ministry staff to insure that the tank continues to be supplied by the central system by operating the pumps as necessary.

5.4 DISTRIBUTION SYSTEM

Drawing C1 shows a schematic of the proposed water system. The water system shown can be constructed partially as needed to serve buildings as they are constructed. Once all development is complete, the water distribution system will be composed of a fill waterline from the pump at the ground storage tank to the elevated storage tank and to the Level Three plumbing fixtures then to the Level Two facilities and to the outdoor toilets and the Main Kitchen.

The stormwater cistern will be pumped to the ground storage tank and used as needed.

Filtration of the water for drinking and kitchen use will take place in the Main Kitchen and the Level Three sink. The distribution line from the tank to the outdoor facilities will be a 40 mm (1 ½ inch) line. The branch to the housing and the toilets will be 25 mm (1 inch).

Each outdoor building should have a shut-off valve to facilitate future construction or repairs without shutting off water to the entire site. The pipelines should be made of galvanized steel pipe. Valves should be metallic for durability.

Figure 5.3: Point-Of-Use Water Filtration System

In general, all of the buildings on site will be at the same elevation or lower in elevation than the elevated storage tank. Estimated pressures are calculated below:

Table 5.2: Estimated Pressures

Facility	Static Pressure	Working Pressure
Level Two Conference Center Toilets	8 psi	8 psi
Outdoor Toilets	12 psi	11 psi
Main Kitchen	15 psi	13 psi
Level Three Conference Center Sink	5 psi	5 psi

5.5 WATER TREATMENT

Bacteriological and chemical tests were conducted for the tap water. The results are shown in Table 5.3:

Table 5.3: Tap Water Testing Results

Constituent	Units	Measured
Nitrite	ppm	0.1
Nitrate	ppm	0.5
Iron	mg/l	0.15
Total Bacteriological Colony	units/sq. in	1
Ecoli	units/sq. in	0
Salmonella	units/sq. in	0

Note: Petri dishes were read after 48 hour growth period.The government provided water is relatively safe as compared to other available sources. However, eMi^2 recommends that all water used for drinking and cooking purposes be treated with an Aquaguard or similar appliance water treatment system before consumption. These appliances could be located in the Main Kitchen and the Level Three Conference Center sink.

6.0 WASTEWATER AND SOLID WASTE SYSTEMS

6.1 EXISTING WASTE SYSTEMS

The existing waste system serving the site is a septic tank in combination with a soak pit that serves an existing outdoor toilet block. The septic tank has a surface area of approximately 3 m^2 (34 ft^2) and serves the outdoor toilets.

6.2 PROPOSED WASTEWATER TREATMENT SYSTEM

The wastewater generated from both the full time residence and the regular parishioners and special occurrence attendees will initially be treated outside each building in sealed concrete septic tanks (see Appendix A). Black and grey water from the residential and community buildings will be collected together and treated together. Each septic system will discharge liquid waste (grey water) by overflow to an adjacent enclosed soak pit. The grey water will disperse into the ground through the soak pits. The Conference Center plumbing will be constructed with a new septic tank and soak pit.

Figure 6.1: Soil Percolation Testing

The black water flow to the new septic tank was calculated based on the number of occupants for the church building. An occupancy of 1,000 people was used, and the sizing of the septic tank and soak pit was determined from this number. According to EMI standards, for institutional purposes, toilet flushing will require 3.0-19.8 L/head/day. The minimum number of 3.0 L/head/day was taken, as it is not likely that 1,000 people will be using the toilet each day. Incorporating a safety factor of 1.2, which also accounts for hand washing in the bathroom sinks, will result in a waste flow of 3,600 Lpd. The dimensions of the septic tank will be 4 m x 1.3 m x 2 m (deep). Based on a 30 Lpd/m^2 percolation rate, the soak pit will have an area of 120 m^2. This yields 2 soak pits at 5m x 1.8m x 3.8m each. .

The waste flow from the building will be piped to the septic tank/soak pit as shown on Drawing C2. This treatment system keeps blackwater away from human contact and also prevents unwanted odors on the site.

The final number, location, and size of each septic tank and soak pit will be dependent upon several factors including construction sequencing, toilet capacity and final location of each building.

6.3 GREYWATER DISPOSAL

Grey water for the Main Kitchen, which serves 200 people, will be collected and directed to a soak pit. Calculations for the load yield a total of 1,000 Lpd with an area of 34 m^2. This soak pit will be 2.5m x 1.5m x 3.8m deep. The kitchen soak pit is sized according to Table 6.1: Kitchen Use Calculations.

Table 6.1: Kitchen Use Calculations

	L/head/day	L/day
Janitorial	2	400
Utensil Washing	4	800
Cooking	4	800

See C2 for a potential location for the kitchen soak pit.

General

The septic tanks should be sealed and of watertight construction. Maintenance of the wastewater units is of utmost importance to their longevity, therefore sludge levels in the septic tanks should be checked once per year. The tanks should be cleaned out when the sludge reaches one-third of the tank depth – this should occur every three to five years. DO NOT DUMP cleaning chemicals, acids, paints, disinfectants, pesticides, poisons or oils down the drain as they will interfere with the breakdown of the sludge material inside the septic tank.

6.4 SOLID WASTE DISPOSAL

(a) Paper products should be collected and burned in a designated area away from human contact on a more remote part of the site.

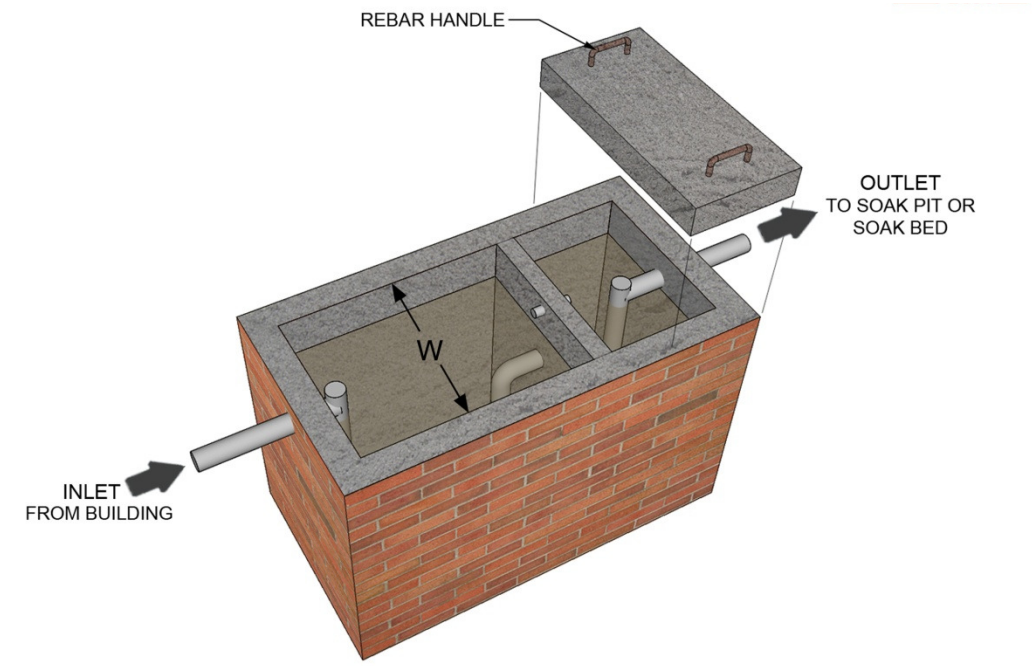
(b) It is recommended that plastics and metals be collected and hauled to a recycling area. If a recycling program does not exist, then these items can be hauled to a dump.

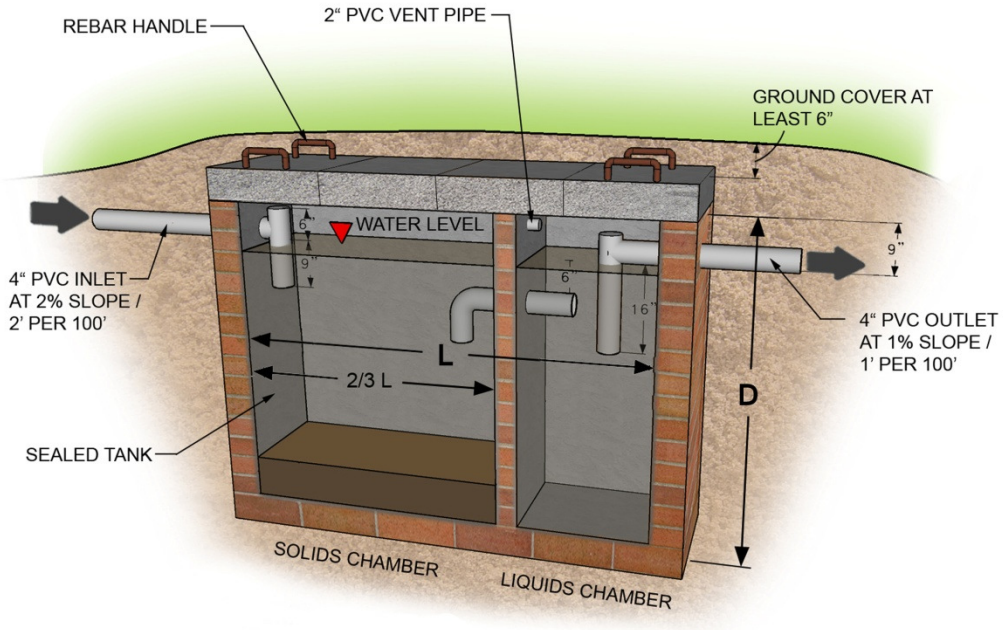
(c) Organic materials such as organic waste from the kitchen and tree/brush clearing should be separated into a designated compost area where the organics will decompose. This area should be free of all waste that does not decompose and should be located to minimize human and animal contact.

7.0 FINAL SUMMARY

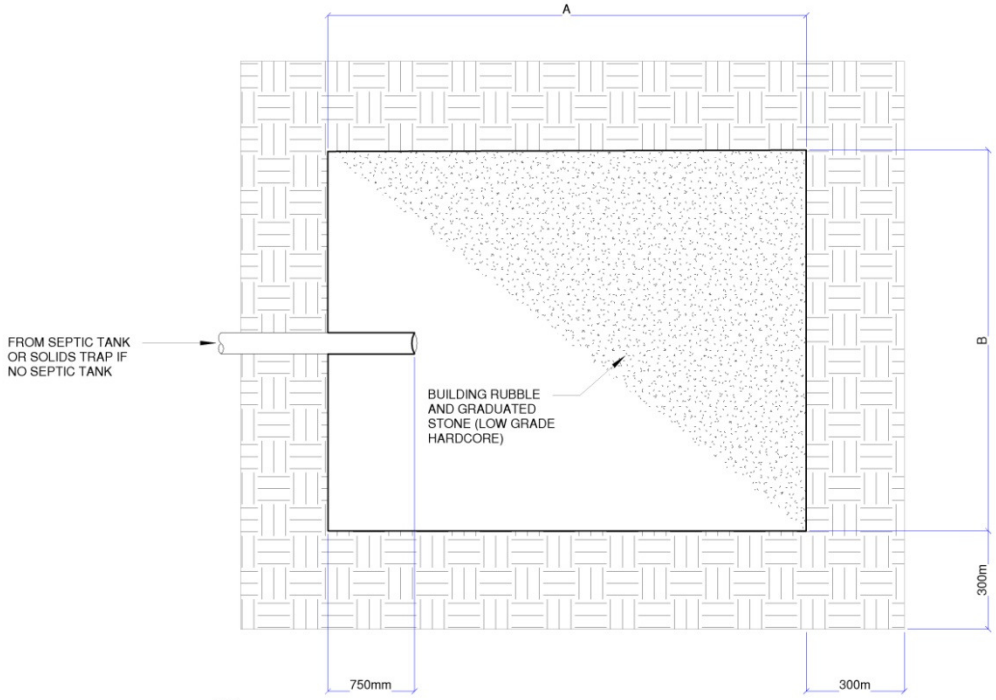
Each member of the team would like to thank Cherangre Baptist Church for the opportunity and the privilege we had to serve the organization with our engineering and architecture talents. Each of us greatly enjoyed the time we had to get to know pastors and staff, and it is our sincere hope that the plans included with this report will bring this project one step closer to fulfillment. It is the special privilege of eMi^2 to be a part of this project in a small way at the beginning planning stages and we pray that God will richly bless and establish the Cherangre Baptist Church programs and developments in the coming days, as He has so faithfully done in the past.

8.0 APPENDIX A: CONCEPTUAL SEPTIC TANK DESIGN

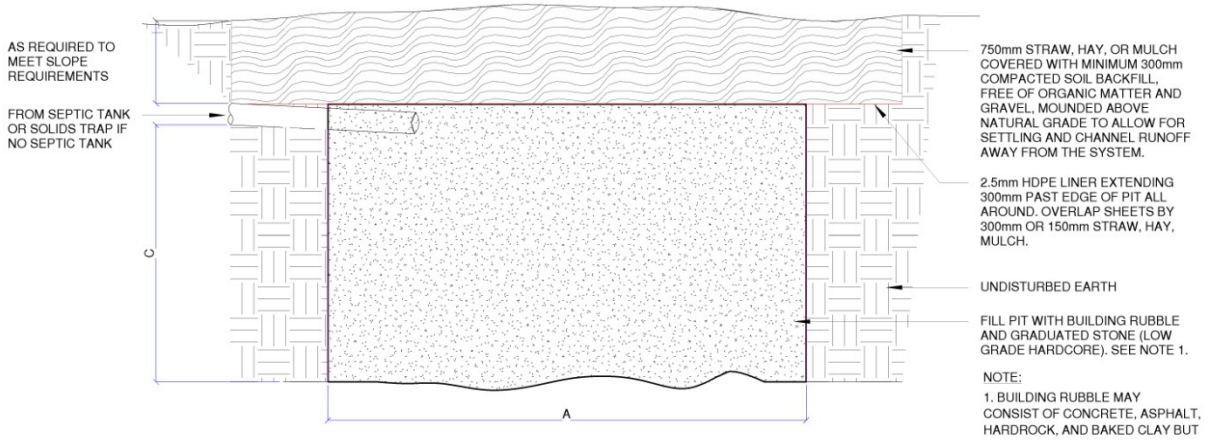




9.0 APPENDIX B: CONCEPTUAL SOAK PIT DESIGN

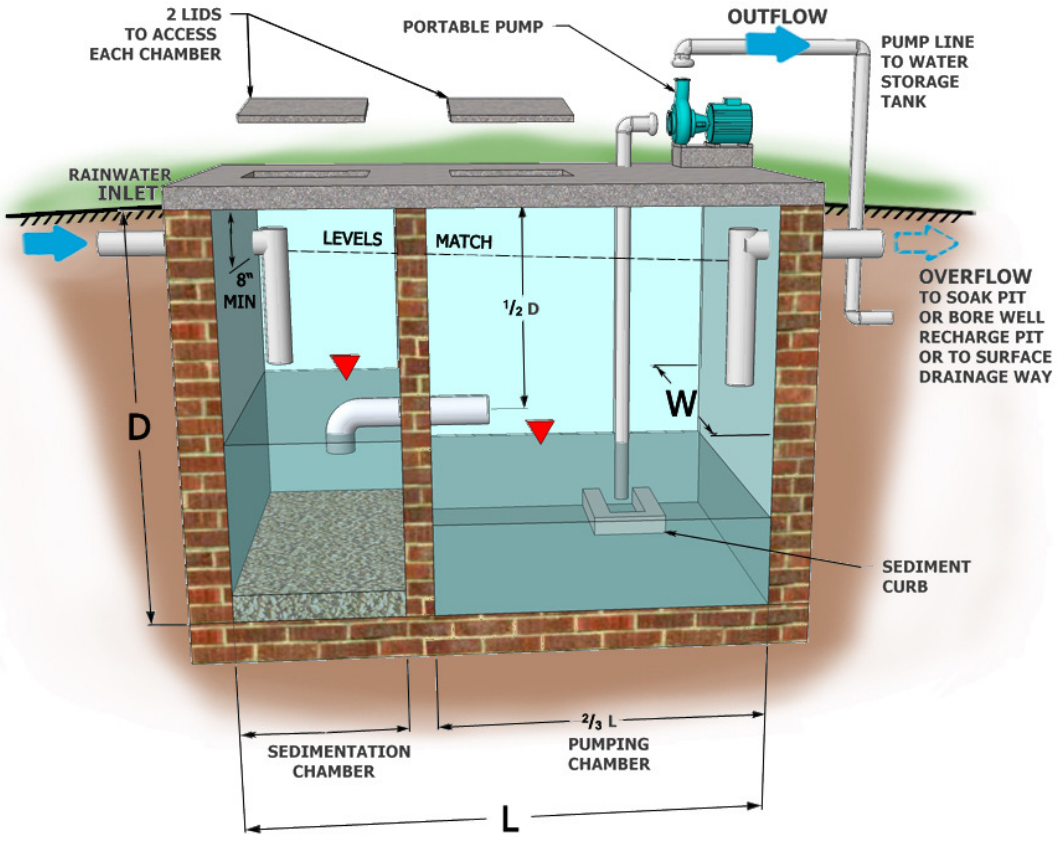


1 **SQUARE SOAK PIT PLAN**
NOT TO SCALE



2 **SOAK PIT SECTION**
NOT TO SCALE

10.0 APPENDIX C: CONCEPTUAL STORMWATER HARVESTING CISTERN DESIGN



11.0 APPENDIX D: CONCEPTUAL GROUND STORAGE TANK AND SUMP PUMP DESIGN