EASTERN UNIVERSITY, SRI LANKA

MASTER PLAN

FOR THE PHYSICAL DEVELOPMENTS OF THE MAIN CAMPUS PREMISES IN VANTHARUMOOLAI

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Section 1

MASTER PLAN PROPOSAL FOR PHYSICAL DEVELOPMENTS

IN

VANTHARUMOOLAI MAIN CAMPUS

EASTERN UNIVERSITY, SRI LANKA

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1. Introduction

This report presents the concept planning framework to guide future physical developments in the Main Campus Premises in Vantharumoolai, Chenkalady of the Eastern University, Sri Lanka. The report includes background information, a discussion on the main issues pertaining to prevailing development patterns, concept proposal for future developments, and strategies to guide different aspects of those developments. However, the scope of work of this assignment does not include detail project proposals, which needs to be prepared at the stages of development of such projects.

1.1 Background

The Eastern University of Sri Lanka was established in 1981 under the provisions of the Universities Act 1978, at its main campus premises in Vantharumoolai, in a land occupied by Chankaladi Central School. Most of the activities within this campus are still accommodated in buildings which were originally built for the school. Over time, the activities got extended and the University acquired several other properties and institutions, both in its vicinity and at a distance. Swami Vipulananda Institute of Aesthetic Studies and the Trincomalee Campus are such institutions which got affiliated to the University at a later stage. The medical faculty established at Batticaloa is another institute affiliated to the University. While the academic activities are strengthened and extended, the physical environments too need to be improved to facilitate those activities in all premises of the University. For an effective use of available land and other physical resources for developments, University Authorities felt the need for a Master Plan. In this background, the Council of the University had decided to obtain consultancy services to prepare a Master Plan from a competent organization, selected through competitive bidding. Uni-Consultancy Services (UNIC), the project consultancy arm of the University of Moratuwa, has been selected through the bidding process and invited to prepare a Master Plan. The team of Consultants, appointed by UNIC for the project, commenced work in April 2012 .

1.2 The Objective and Scope of Work

The objective of the project is to develop an overall guide plan for future developments within three premises, namely: Main Campus Premises in Vantharumoolai, Chenkalady; Trincomalee Campus at Koneshpuri, Trincomalee and Swami Vipulananda Institute of Aesthetics Studies at Kallady, Batticaloa: this report contains only work pertaining to the premises in Chenkaldy and Kallady. The Scope of the consultancy services, specified in the agreement are:

1. A detail survey of the existing situation, facilities of the University, and physical conditions of the project sites including land, building, infrastructure and other physical elements and detail survey of the future requirement of the University, facilities already in line and potential development within the project sites.
2. Review the existing facilities in the University and develop a Master Plan for a period of thirty years from 2012, integrating the requirement of individual Departments and Faculties of the University, available and future potentials of the region, opportunities available for the expansion of respective academic disciplines, upcoming national needs in higher education and emerging global trends in University education.
3. An analysis of the potential of the project sites in terms of location advantages, geographic conditions, scenic sites etc., and constraints for development such as flood, soil erosion etc. and proposals to address them.

1.3 The Team

The Master Plan team consisted of the following members:

Name	Role	Input/Discipline
Prof. U G A Puswewala	Team Leader	Coordination
Dr. J N Munasinghe	Member	Planning and Urban Design
Architect U P Liyanage	Member	Architecture
Architect S Rathnamalala	Member	Architecture
Landscape Architect/Eng. S Udalamaththa	Member	Landscape Architecture
Dr. J Manatunge	Member	Environmental Engineering
Dr. L Rajapakshe	Member	Hydrological Design
Mr. T D C Pushpakumara	Member	Special Survey Tasks

1.4 The Process of Work

In line with the assigned scope of work, the facilities required to strengthen the academic and supportive activities of the University within the said premises have been identified. The physical environment appropriate to accommodate such facilities is then envisaged, along with the projects that are already in progress. Accordingly, planning scenarios are prepared for:

1. Developments that are already in progress and need to be realized within next 03 years period (short term 2015),
2. Developments which need to be accomplished in order to accommodate the envisaged facilities within next 10-12 years (medium term: 2025), and
3. Developments, predictable within the forthcoming period of 20-25 years (Long term: 2035)

The proposals are prepared on available and obtainable information, observable development patterns in respective areas and the ongoing trends in university education both in Sri Lanka and in the international context. Therefore, details of the project proposals given in this report may need amendments with time, although the conceptual framework may remain intact. However, the overall concept plan provides maximum flexibility to integrate future changes in the University's requirements.

In line with the methodology proposed in the preliminary proposal the preparation of the Master Plan adopted a '*Socially Responsible, Economically Viable and Environmentally Sustainable Integrated Approach towards Planning and Design*'. Therefore, the team mainly considered the following:

Physical aspects:

1. Potentials of the location, land, infrastructure and other resources.
2. Least disturbances to the existing activities and valuable assets of the University campuses and their surroundings in future developments.
3. Responsiveness to existing climatic conditions and the topography.

Functional Aspects:

1. Present activity pattern of the University Campuses and the trends of their developments as envisaged by the Academic Development Plan.
2. Emerging global and local trends in higher education.
3. State of the art technology available and upcoming for provision of education related infrastructure.

Social aspects:

1. Existing and future needs of the students, academic staff and non academic staff.
2. Special needs of cultural groups, disabled persons, study programmes, etc.
3. Provisions for interactions with the local community.

Economic Aspects:

1. Optimization of the economical use of available and envisaged resources.
2. Minimization of the costs likely to involve in construction of buildings, roads and other physical developments.
3. Possibilities for all integrated developments.

Environmental Aspects:

1. Minimum disturbances to the eco systems of the locality.
2. Possibilities of integrating natural environmental systems into future developments.
3. Carrying capacities of the environmental systems.

Aesthetic Aspects:

1. Integration of available landmarks, vistas, scenic settings, etc into future developments.
2. Establishment of a strong image to the University through character of the buildings and the landscape.

The process involved can be stated as given in Figure 1 below:

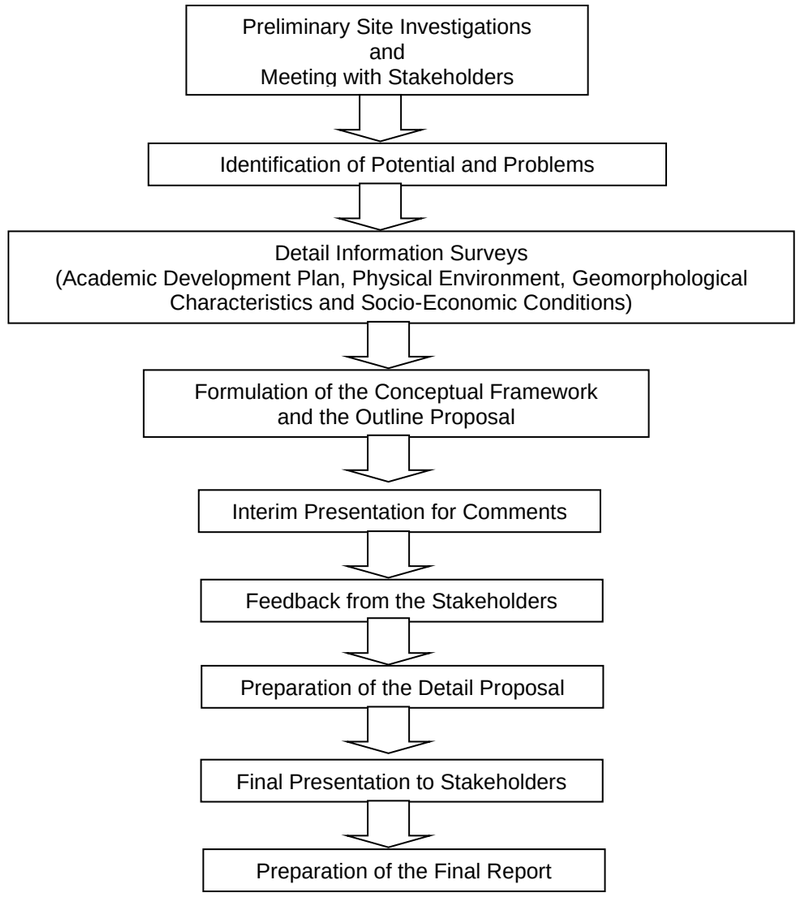


Figure 1.1: The Process Involved

Throughout the process the team had close communication with the representatives of the University. The information surveys were carried out under the supervision of the experts in the area and with modern technological inputs. In the preparation of the proposal, computer applications such as Remote Sensing and GIS Software for Geo-morphological Analysis, AutoCAD for Drawing and Drafting purposes, Sketch-up, Photoshop and 3D Max for Presentation purposes and MS Project for Project Administration purposes, were used.

2. Findings of the Preliminary Survey

The following are the main findings of the preliminary survey, and considered in the preparation of the Master Plan.

2.1 Inconsistent on-going Physical Developments

Vantharumoolai premises has relatively larger extent of lands (72 ha), which is presently allocated for various purposes without a long term plan. Many isolated building construction projects are in progress and they are not integrated into a whole. Although the immediate requirements could be fulfilled by this strategy, there will be many problems in future if the available lands are not used with a comprehensive understanding of the future needs of the University. In addition to the likely shortage of land in future, it is likely that other problems such as inability to provide services, higher operation and maintenance costs, and lack of aesthetic value, also occur if the present scenario continues.

Figure 1.2: Aerial View of Vantharumoolai Main Premises and Surroundings

2.2 Need to facilitate further expansions

The main premises at Vantharumoolai accommodates four Faculties of Studies, namely: Agriculture, Science, Commerce & Management and Art & Culture. There are sixteen academic departments in them. There are four undergraduate degree courses and three postgraduate degree courses conducted by these faculties. The total student population at present is less than 3000 (2012). But all Faculties envisage increased intakes of students both for presently available academic programmes and for new programmes. Hence, the available land needs to be optimally used, paying adequate attention to the carrying capacities of the land, natural systems and available infrastructure.

The preliminary analysis of the basic information on the threshold levels shows that the Main Campus premises in Vantharumoolai in terms of student populations in their currently available land extents shall not exceed 10,000, in order to assure the sustainability and smooth functioning of existing natural and infrastructure systems.

2.3 Environmental conditions less conducive for Learning

The hot dry weather conditions that prevail over a larger segment of the year in the Eastern province results in an environment that is less conducive for academic activities and living in the premises. The atmospheric temperature varies between 35^0 C and 40^0C and the relative humidity is low. Under these conditions most of the indoor facilities necessitate air-conditioning and the outdoor environments need shading and means of reducing glare and heat radiation. Yet, the outdoor environments are not provided with adequate measures to mitigate the effects of adverse climatic conditions, while the indoor air cooling incur high costs.

2.4 Need for a Strong Identity to the University

All campuses presently consist of a variety of building types that do not contribute to strong statements of identity. The need for identity to the University is expressed both by the students and by the staff. Currently, an effort to establish an identity to the University is apparent through the construction of main entrance gates in Vantharumoolai main campus premises. But, it is clear that a proper composition of buildings with a consistent architectural language in them is a necessity to establish the identity through its built environment. This is not possible with the ongoing scenario of physical developments.

2.5 Effects of the Flash Floods

A high percentage of lands in Vantharumoolai premises is inundated during heavy rains. Most of the buildings are elevated from ground level, but they are not reachable after heavy rains. It could be observed that the flash floods are due to poor drainage facilities within the sites. This needs to be addressed at the earliest to use the lands in an effective manner. A total hydrological study has been carried out for these premises, which is given in Section 3 of this report.

2.6 The Developments in Eastern Region of Sri Lanka

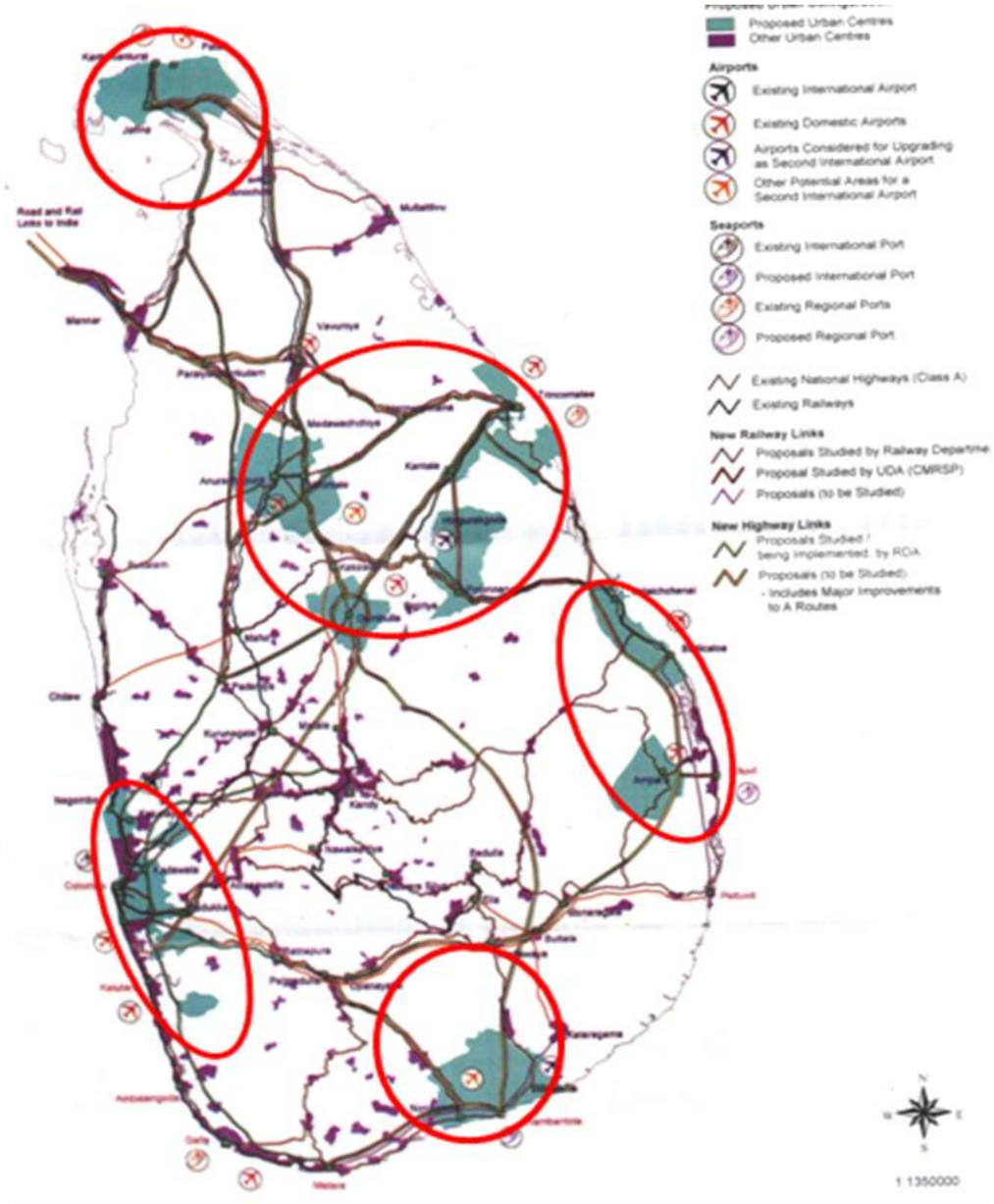
The National Physical Planning Policy of Sri Lanka (2011) indicates that all premises of the University are within the areas earmarked for future urban metropolises in Sri Lanka (Figure 3). Vantharumoolai Campus is located within the Eastern Metropolis. According to National Physical Planning Policy, this metropolis will have residential populations of 2 million by 2030.
The implications of this indication include:

1. An increased demand for higher education opportunities from the respective regions because of the increased urban population.

2. An increasing demand for land in the area for urban development activities, and since a large percentage of land in the area is used for agricultural purposes and is low lying, there will be a dearth in supply of readily developable land for residential, commercial and other purposes.

3. An improved physical and social infrastructure in the area including, road network, pipe born water supply, electricity, telecommunication facilities, hospitals, schools, etc.

Therefore, the University shall not be viewed as an entity that is isolated from its context in future, and the forthcoming urbanization trends will be supportive for its expected expansions. The developments of the University could be well integrated with the parallel developments in the other higher education institutions and tertiary education facilities in those areas.



National Physical Planning Policy of Sri Lanka
National Physical Planning Department, 2010

Figure 1.3: Future Urban Metropolises of Sri Lanka

3. Conceptual Framework for Development Plan

3.1 The Approach

Although the project is to develop a 'Master Plan', Master Planning by definition is a dated method of framing development possibilities. Especially, in a situation where the context and the requirements change rapidly, Master Plans are too rigid to adapt to changing situations. Therefore, instead of fixed *Blue Print* Master Plan, a more flexible Concept plan is expected as an outcome. In the concept plan no great amount of details on buildings and other facilities are discussed. Instead only the broad strategies for the different aspects of developments along with the most appropriate locations for buildings and other facilities are proposed. The Corporate Plan of the University is considered as the broader guiding framework for the development of the Plan. Most of the information that is not available in the Corporate Plan was obtained from the University authorities staff at different discussion sessions.

3.2 The Goal and Objectives

The Goal of the Master Plan is to '**guide the Physical Developments within Main Campus at Vantharumoolai, Chenkaladi, Trincomalee Campus at Koneshpuri and Swami Vipulananda Institute of Aesthetics Studies at Kallady, Batticaloa of the Eastern University, facilitating the image of a dry zone Garden Campus, adequately providing expansion possibilities and optimizing land utility, integrating the emerging developments in an economically viable, functionally efficient, environmentally sustainable and aesthetically pleasing manner'.**

Thus, the objectives of the project can be stated as follows:

1. To establish a physical development strategy that will integrate presently scattered developments and future developments into a united whole.
2. To provide a spatial strategy to facilitate 10,000 students in Vantharumoolai Main Campus, and 5,000 students in Trincomalee Campus, and 1,000 students in Swami Vipulananda Institute within the presently available premises by 2035.
3. To preserve ecologically sensitive and aesthetically pleasing elements within the premises.
4. To provide an environment conducive for studies in hot dry climate.
5. To enable a strong Image of the Place.

4. Detail Analysis

In order to obtain a better understanding of the University, its prevalent capacities, and development possibilities, a detail analysis was undertaken on relevant aspects, as described below.

In the following analysis the student populations were projected based on the current trends of the student enrollment by the universities in Sri Lanka and the foreseeable trends of demand for different disciplines of studies. The main sources of information in this regard are the University Grants Commission reports and the Corporate Plan of the Eastern University. The day time populations are calculated using the present enrollment and recruitment policies of the Sri Lankan Universities, with a small percentage added for postgraduate student population and visitors, which are occasional rather than regular.

The space requirements for each facility type was computed based on three different sources of information: The observations of the team on present space allocations within Universities of Sri Lanka, Space allocation guides such as Time Saver Standards, and Space and Time provision standards of International Universities.

4.1 Student Population and Projections

4.1.1 Vantharumoolai Main Campus

Student populations of the Main Campus premises are projected based on the information provided by the University at the meetings the team had with Deans of the Faculties and Heads of Departments. The current trends of developments and the expectations of academic departments, stated in the Corporate Plan were also taken into consideration. Table 1a below shows the expected student populations, at three different time horizons:

Table 1a : Expected Student Populations of Different Faculties of Studies **(Vantharumoolai)**

Faculty of Studies	*2012*	*2015**	*2025**	*2035 ***
Commerce & Management	< 650	800*	1,200*	1,500**
Agriculture	< 150	400*	1,000*	1,500**
Science	< 1,100	1,500*	3,000*	3,500**
Arts & Culture	< 1,200	1,400*	1,500*	2,000**
New	-	-	300*	1,000**
Total	**< 3,100**	**4,100***	**7,000***	**9,500****

* Computed based on Information Provided by the University
** Computed based on Projections and Analysis of Global and National Trends

Based on the above student populations, the expected day time population within the University could be computed in the manner given in Table 1b.

Table 1b: Projected Daytime Population of Different Faculties of Studies **(Vantharumoolai)**

Faculty of Studies	*2012*	*2015**	*2025**	*2035***
Commerce & Management	< 800	960 *	1,440 *	1,800**
Agriculture	< 200	480 *	1,200 *	1,800**
Science	1300-1400	1,800 *	3,600 *	4,200**
Arts & Culture	1.400-1,500	1,700 *	1,800 *	2,400**
New	-	-	360*	1,200**
Total	**3,500– 4,000**	**4,940**	**8,400**	**11,400**

Assumption:
Regular Staff (@ ratio of 1 for every 5 students) + Postgraduate Students & Research Staff
* Based on Information provided by the University
**Based on Projections and Analysis of Global and National Trends

The Space requirements projected based on student population are as given in Table 1c.

Table 1c: Projected Space Requirements for different facilities **(Vantharumoolai).**

Faculty / Facility	*2012 (sq m)*	*2015 (sq m)*	*2025 (sq m)*	*2035 (sq m)*
Commerce & Management		8,000*	12,000*	15,000*
Agriculture		4,000*	10,000*	15,000*
Science		15,000*	30,000*	35,000*
Arts & Culture		14,000*	15,000*	20,000*
Library & Common Facilities (Computer, Auditoriums, etc)		4,000**	7,000**	9,500**
Common Areas (Canteens, Rest Rooms, etc)		2,000 #	3,500 #	5,000 #
Admin & Staff Facilities		2,000 #	3,500 #	5,000 #
Total		**49,000**	**81,000**	**104,500**

Based on Information provided by the University (Except buildings presently under construction)
* @ 10 sq m per Student ** @ 01 sq m per Student # @ 0.5 sq m per Student

The above figures can be compared with the available floor areas at different stages of development in order to understand the immediate, medium and long term floor space needs. The comparison of the requirements with the available floor spaces at the three time horizons are given in Table 1d.

The floor spaces expected to be available in future (ie: 2015 and 2025) are projected considering buildings that are already under construction and the projects that are proposed to be completed in the near future.

Table 1d: Comparison of Space Requirements and Fulfillment for different Facilities **(Vantharumoolai)**

Faculty / Facility	*2015 (sq m)*	*2025 (sq m)*	*2035 (sq m)*
Commerce & Management	*4,500* Fulfilled*	*10,000* (5,000)*	*10,000**
Agriculture	*3,500* Fulfilled*	*10,000* (5,000)*	*10,000**
Science	*16,000* Fulfilled*	*32,000* (10,000)*	*35,000**
Arts & Culture	*44,000* (20,000)*	*50,000* (30,000)*	*50,000**
Library & Common Facilities (Computer, Auditoriums, etc)	*7,000* Fulfilled*	*10,100* (4,000)*	*10,500 **
Common Areas (Canteens, Rest Rooms, etc)	*3,500* Fulfilled*	*5,000* (1,500)*	*5,000 **
Admin & Staff Facilities	*3,500* (1,000)*	*5,000* (2,500)*	*5,000**
Student & Staff Accommodation	*Min 41,000 +10,000 (25,000 + 8,000)*	*Min 70,000+17,000 (40,000+17,000)*	

* Available,
(Shortage)

The above table shows that the immediate requirements (within next three years) for all academic activities could be fulfilled with the projects that are already in progress. The critical requirement is in accommodation facilities for both students and staff. More than seventy percent of the buildings now used as student hostels are in worn-out conditions, inundated during rains and of low standards. Therefore, they need to be replaced with suitable new buildings. Academic staff does not have in-house residences, while a few run-down quarters are available for non-academic staff.

In order to accomplish the state of a residential campus, relatively larger investment is required to build new student hostels and staff quarters. These facilities will have to be supported by concurrently developed infrastructure.

4.2 Carrying Capacities

In order to consider the possibilities of accommodating the said populations and the space requirements, the potential carrying capacities of the premises can be analyzed as given in the Tables 3a and 3b.

In this analysis, the upper limit of the population density is computed by equating with the urban densities of the Eastern Province, which is 200 persons per hectare. This could be justified in terms of the possibilities and constraints foreseeable in infrastructure developments in these areas with the upcoming urban development trends. The Built: Land Area Ratio is the lower value of the urban areas of the region. This was selected in order to assure the lower, yet optimum density that needed to be achieved in a university environment. The Floor Area Ratio is the recommended limit for many of the medium density urban areas of the province.

Table 2: Analysis of Carrying Capacities of Vantharumoolai Main Campus Premises

Indications	*Present Situation*	*Optimum Level*	*Remarks*
Population Density (Persons/ha)	< 120	< 200 (day time)	Threshold will be reached by 2035
Built : Land Area Ratio	< 0.08 (< 08 %)	0.1 (10 %)	Optimum Foot Print Area : 50,000 sq.m
Floor Space Density sq m/ sq m	< 0.16 (105,000 sq M)	0.25 (25%)	Maximum Achievable Floor Area : 125,000 sq m
Road Length km	2.4 km (approx)	Existing (or Less)	
Road Density km/ha	0.0.48	Existing (or Less)	

This analysis shows that the maximum population density recommendable is 200 persons per hectare. Accordingly, the student population in Vantharumoolai Main premises shall not exceed 10,000. This is the student population projected for 2035.

4.3 Physical Infrastructure

Vantharumoolai premises will be served by regional Municipal water supply network, as it is located within the earmarked new metropolitan area. When student population increases up to 10,000 in 2035 the tentative average demand is estimated to be around 900,000 liters per day. The improved service networks that can be expected in this area with the upcoming urban metropolitan development will be able to cater to this demand in the future. Still, prevalent scarcity of water resources in all parts of the island necessitates the efficient use of water, rain water harvesting and reuse of grey water.

For waste water a new disposal system, with treatment facilities, etc, will have to be designed due to critical conditions of the land and also due to increasing populations. Further details with this regard are given in Section 2 of the Report.

The surface drainage patterns in Vantharumoolai could be improved to avoid flash floods and retain rain water for different uses. The existing land form with elevations, ground depressions and creeks could be used to organize the natural surface flow. The details on this aspect are given in Section 3 of the Report.

The present method of toilet waste disposal in all premises is septic tanks. This method is observed to be more feasible and sustainable even with the projected populations and likely seasonal changes in flows.

Ceylon Electricity Board (CEB) national grid is the sole source of energy. It is estimated that the demand will be increased up to 30 kW by 2025 in Vantharumoolai. Although the demand will be met with the upcoming developments in the area, it is highly advisable to maximize the use of alternative, clean energy sources such as solar photovoltaic panels for all activities.

Solid waste is another area of challenge with the increase of population. With the current patterns of use, the daily generation may be increased to a level as high as 14,000 kgs per day by 2020 in Vantharumoolai. Presently adopted practices for collection and disposal are not sustainable and therefore, better methods need to be established.

The current traffic volumes are expected to increase five-fold inside all premises with the projected population increase and facility developments. This is likely to be enhanced by the presently available policies on individual mobility and car ownership. However, the existing road network is more than sufficient to take the traffic loads in future. But the surface conditions need to be improved and parking facilities need to be organized.

The critical aspect is the pedestrian traffic that has not been given adequate thought yet. For the University to develop the premises as residential garden campuses, it will be necessary to provide a robust network of walkways throughout the premises. The landscape needs to

play a major role to provide a pleasant walk for pedestrians under the harsh climatic conditions experienced in the area.

4.4 Land Suitability

The land of Vantharumoolai was subject to suitability analysis in order to identify the locations appropriate for different facilities. The following are considered as the indicators of suitability.

Indicator	*Attributes*
Congruence	Compliance with Existing Activities/Environment
	Availability of Space to Accommodate
Adjacency	Compatibility with Neighbor (Necessity)
	Complimenting the Neighbor (Additional)
Proximity	Distance for Convenience (Economy)
	Distance for Necessity (Function)

Congruence indicates the ability of a particular activity to fit in to a location in terms of the supportiveness of that location and its surroundings. It also refers to the availability of adequate space to locate a particular activity. Adjacency indicates the extent to which an activity is compatible with its adjoining activities, when located in a particular piece of land. Proximity is an indication of the convenience and linkage that a location provides to an activity by accommodating that activity in it.

The land area of the Vantharumoolai premises was subject to this suitability analysis by subdividing them into 20m x 20 m cells. The conditions prevalent within each of these cells and their suitability for proposed activities were the units of observation. Results of this analysis are shown in Figure 4.

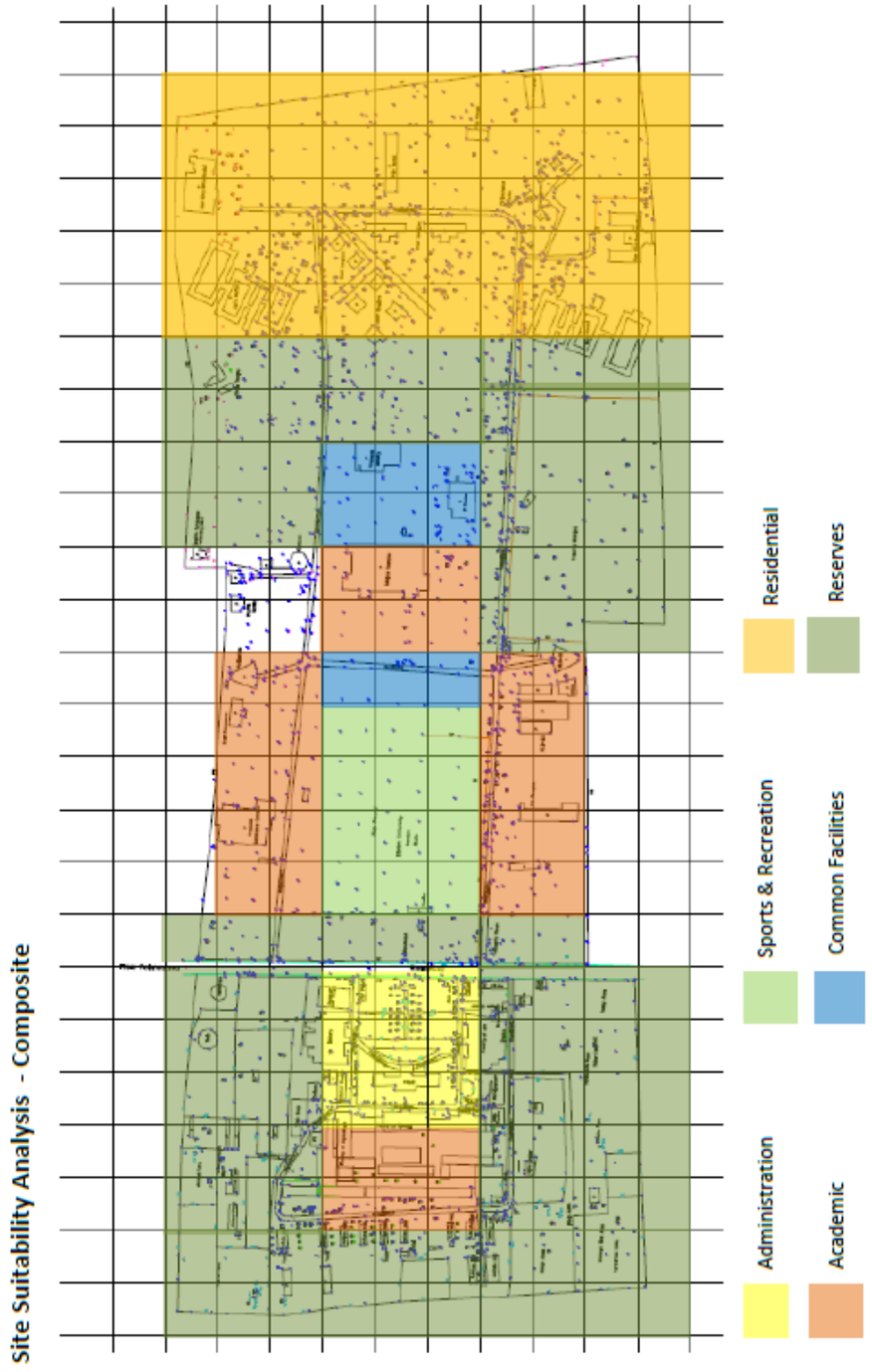


Figure 1.4: Land Suitability Analysis in Vantharumoolai

4.5 Zoning Possibilities

The above land suitability analysis enabled to earmark zones for different activities within these premises. The Figures 5 a, and 5 b are the activity zones proposed for the two premises. In the preparation of these zoning maps the existing activities, the available road and other infrastructure, and the effects of flash floods have been considered. These zoning maps are used as the guiding framework to identify the most suitable locations for individual facilities. The zones are broader categories of activities. Five such activity types have been identified as follows:

1. Academic : Faculty spaces including lecture rooms, auditoriums, laboratories and staff areas.
2. Administration: Central administration activities including Vice Chancellor's / Rector's office, Registrar's office, finance, examination, welfare and other similar units.
3. Common Facilities: Students' requirements such as Libraries, Discussion areas, Computer clusters, Meeting halls, Canteens, etc.
4. Sports and Recreation: Sports grounds, Gymnasiums, Swimming pools, Gathering places, Performing areas, etc.
5. Residential: Student hostels and Staff quarters.

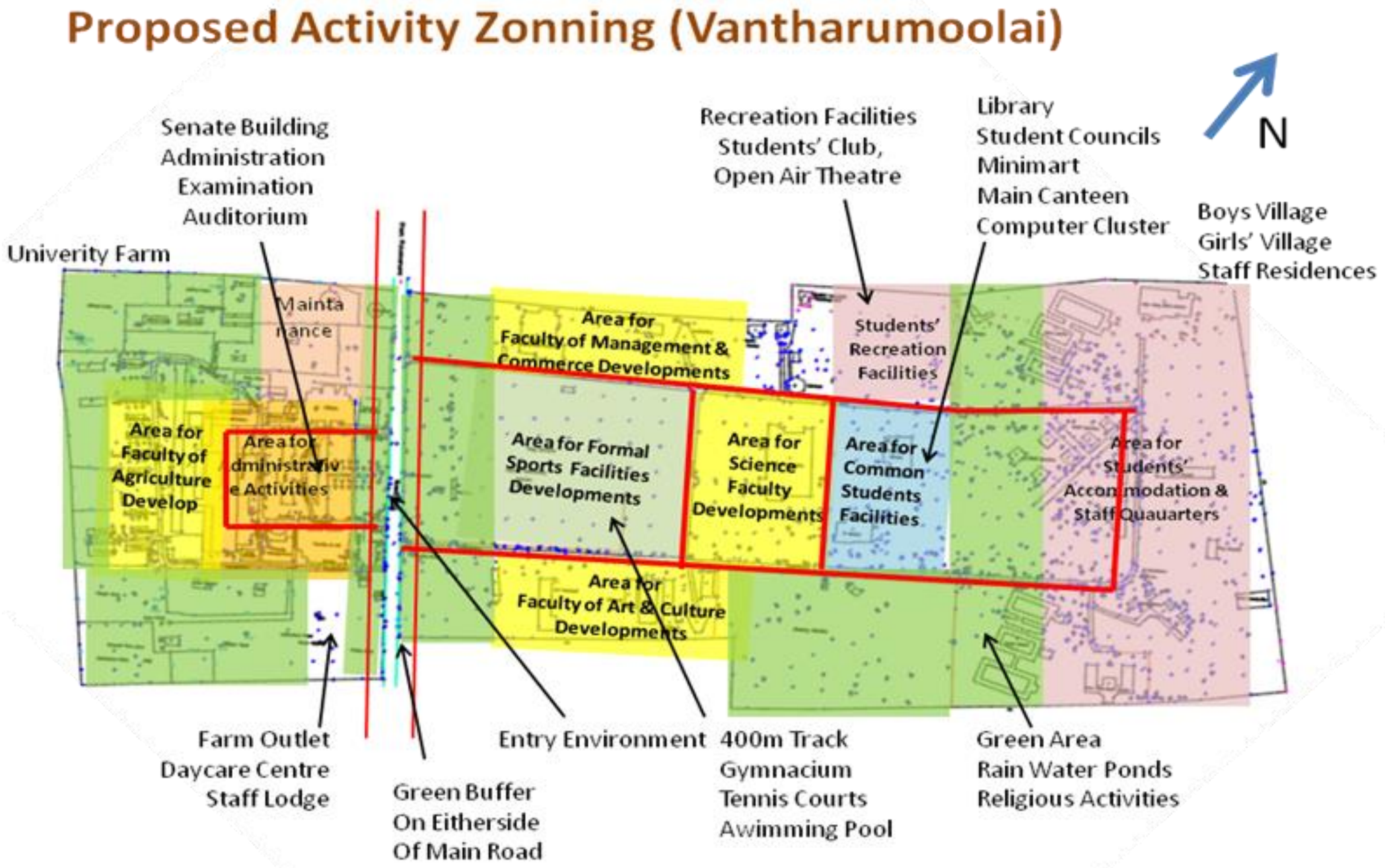


Figure 1.5: Activity Zoning for Vantharumoolai Premises

4.6 Facility Requirements

The university intends to introduce a number of new facilities, over and above the expectations of the individual faculties and the academic departments, in the two premises as given below:

Table 3: New Facilities Expected in Vantharumoolai

Facility	**Vantharumoolai**
1. New Senate and Administration Building 2.	Extension to existing building
3. A 1000 seat Auditorium	New Building
4. Sports Facilities, including a Swimming Pool, Gymnasium 5.	New Buildings
6. Cultural Resource Centre & Language Centre	New Building
7. Examination Halls	New Building
8. Canteens and Common Facilities	New Building
9. Centre for Graduate Studies	New Building
10. Common Areas for Student Gatherings	New Facility
11. Areas for Religious Observations	New Facility
12. Agricultural Farm	New Facility
13. Vice Chancellor's/Rectors Bungalow	New Building
14. Residential Units for staff	New Buildings
15. Accommodation for Non Academic Staff	New Buildings
16. Hostel Facilities for minimum of .80% of the total students	New Buildings
17. Space for Maintenance Stores and Garages	New Buildings

5 Strategies

5.1 Strategy 1: Physical Development

Figure 6 a and 6 b show the locations earmarked for different facilities. These locations are proposed within the zoning plan given above, in order to accomplish the objectives of the project stated earlier. Clustered development pattern is proposed in the two locations for four reasons:

1. Establish a strong character to the place.
2. Optimize the use of land and leave provision for future expansion possibilities.
3. Facilitate easy and cost effective provision of infrastructure networks.
4. Reduce walking distances between buildings and facilitate walking with shaded areas.

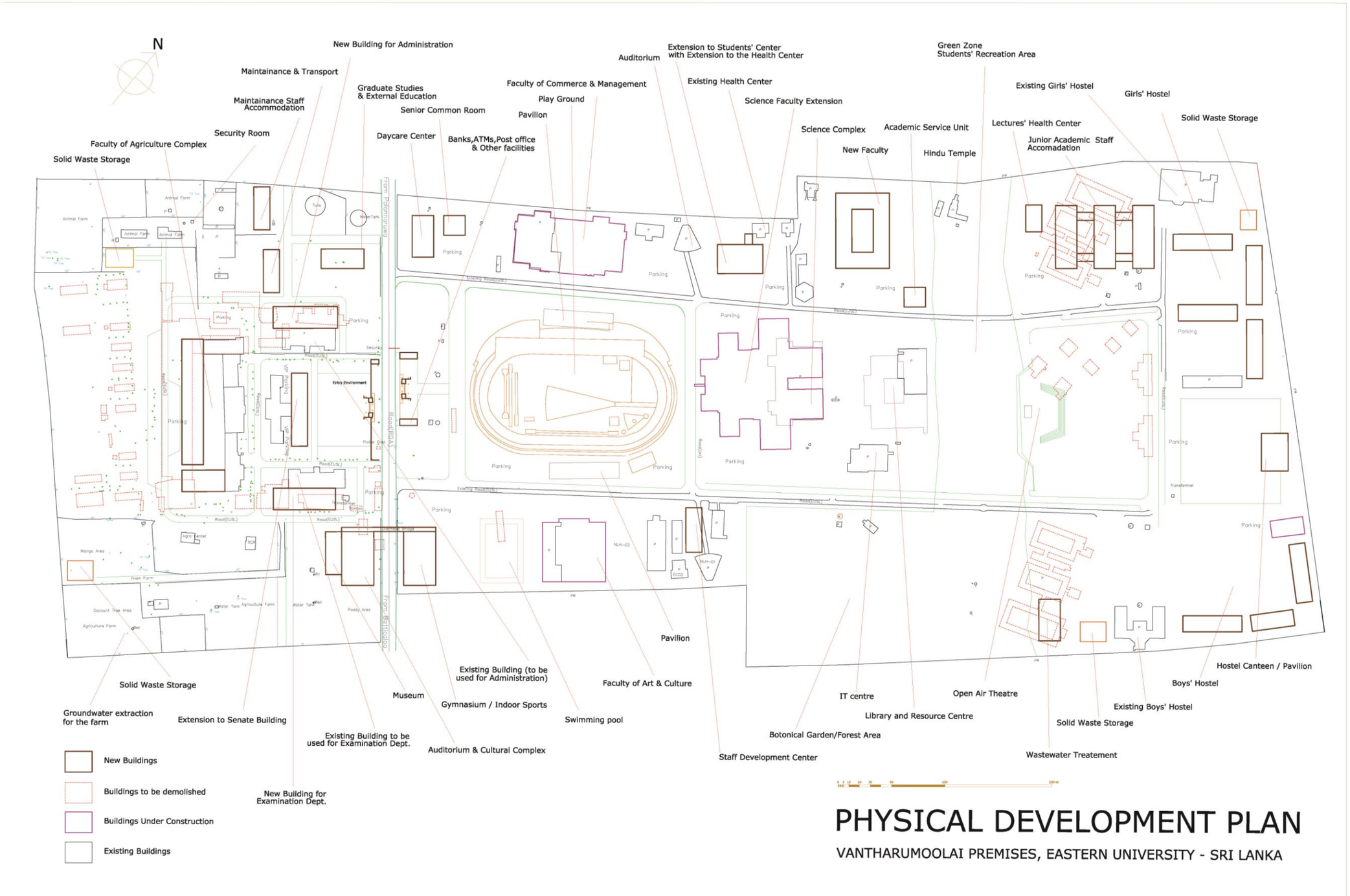


Figure 1.6 : Proposed Physical Development Strategy for Vantharumoolai Main Campus Premises

5.2 Strategy 2: Space Provision

The following tables show the proposed space allocations for different facilities:

Table 4 : Locations of Individual Facilities: Vantharumoolai

Faculty/Unit	Proposed Location	Type of Development	Tentative Floor Area
Senate & General Administration	New 04 storey extension to the existing building at the front	New Building	2000 sq m
Auditorium	New Building closer to entrance	New Building	1000 sq m
Sports Facilities	Closer to existing Play Ground	Extensions	1000 sq m
Cultural Resource Centre.	New 04 storey Building adjacent to New Library	New Building	5000 sq m
Language Centre	Within Cultural Centre Building	New Building	500 sqm
Examination Halls	New Building closer to Administration unit.	New Building	700 sq m
Canteen and Common Facilities	New Building	New Building	1,000 sq m
Centre for Graduate Studies	A Location out of the main premises	New Building	600 sq m
Common Areas for Student Gatherings	Common Courtyards inside Buildings and Open Air Theatre	Combined with new developments	1000 sq m
Areas for Religious Observations	Closer to Hostels and Behind the New Library	New facility	400 sq m
Agricultural Farm.	In the existing location with possibilities for a new location	Improvements to existing	
Vice Chancellor's Bungalow	In a land away from the main premises	New Building	300 sq m
Residential Units for Married staff	In a new land away from the main premises	New Buildings	2,400 sq m
Residential Facilities for Bachelors	Within main premises closer to student hostels	New Building	3,000 sq m
Hostel Facilities for 8,000 students	Replacement of existing single storey hostel buildings with 03 storey buildings.	New Building built in phases with the increase of students	80,000 sq m
Accommodation for Non-Academic Staff	Replacement of existing single storey hostel buildings with 03 storey buildings.	New Building	1,000 sq m
Space for Maintenance Department		New Building	300 sq m-
Faculty of Science	Present Location and New Developments	Extensions and New Building	35,000 sq m
Faculty of Management & Commerce	Present Location and New Developments		15,000 sq m
Faculty of Art & Culture	Present Location and New Developments		20,000 sq m
Faculty of Agriculture	New Building behind existing Administration complex	New Building	20,000 sq m
New Faculties	Within main premises	New Building	10,000 sq m

5.3 Strategy 3: Traffic Management:

The Traffic Management Strategies include the following aspects:

1. Road Network and Flow Patterns
2. Car Parking Facilities
3. Pedestrian Walkways

Only a minimum length of new roads is proposed in both Vantharumoolai premises and the Swami Vipilananda Institute premises to maintain the optimum road density. But the existing roads need widening and surface improvement to facilitate smooth flow of vehicles. The main loop of the access road is proposed to be 10 meters wide, with two lanes each of 3.5 meters width for both way vehicular traffic and cycle lanes on either side of them each 1.5 meters wide. The minor roads shall be 7 meters wide allowing two lanes of traffic. Bitumen surface layering is proposed on all roads with suitable paving materials at nodes and at the entrances of the main buildings. Parking is not encouraged on road sides. Shading all along with trees with large canopies is proposed. Details on planting are given in the landscape proposal (Section 4 of this Report)

Parking facilities are clustered closer to facility locations. Most of the parking will be in the ground floor of newly constructed buildings with suitable paving material and trees for adequate shade on the paving. Others are in outer door. Outer door Parking places with number of vehicle are shown in the Table 6 and Table 7 for Batticaloa and Swami Vipulananda institute respectively.

A network of pedestrian paths is proposed in both places, on either side of the roads as well as between different facility locations across the garden. Details of these are given in Section 4 of this Report.

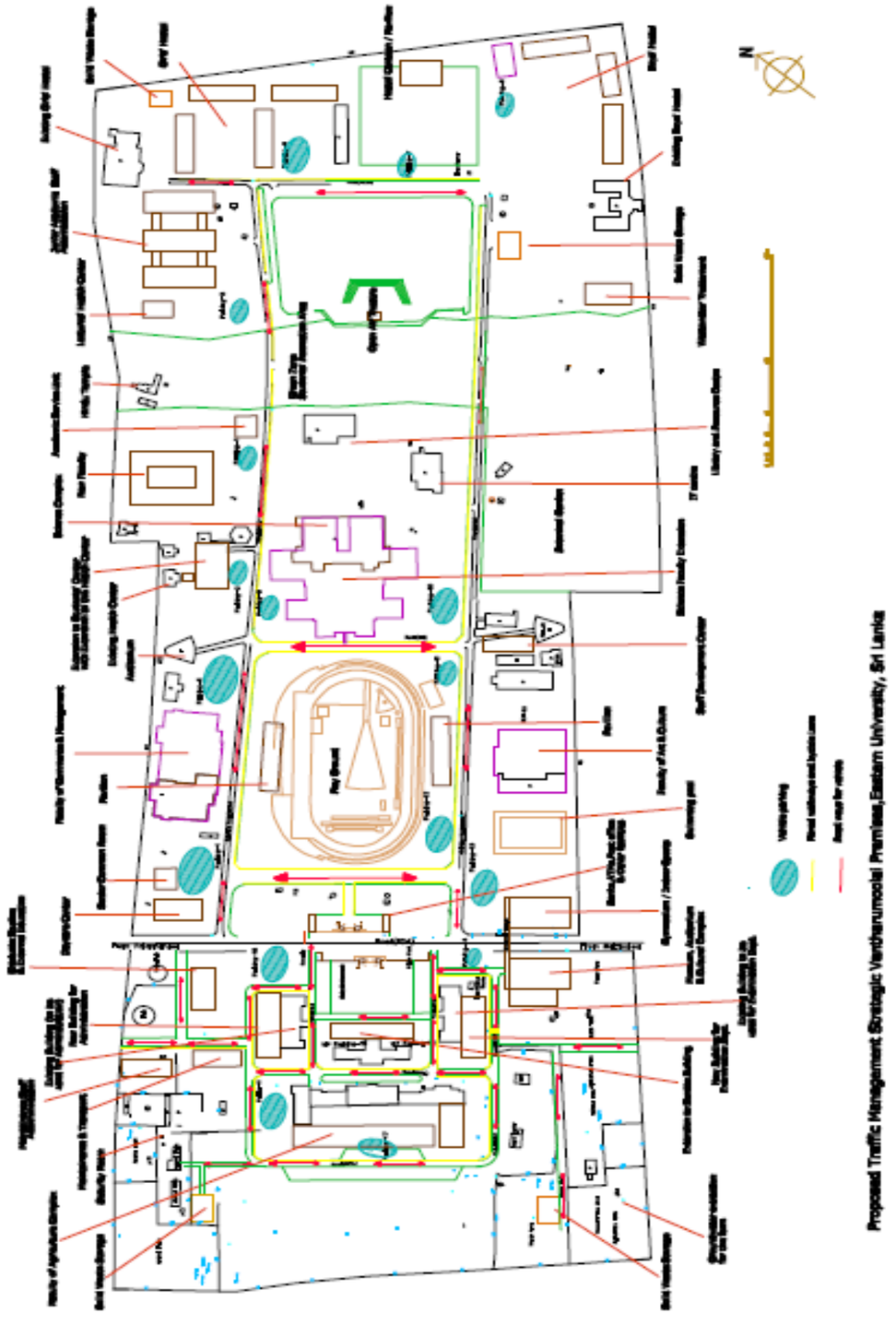


Figure 1.7: Location of Parking Facilities in Vantharumoolai Main Campus Premises

Table -5 Outdoor parking area in Batticaloa Campus

Parking lot No	**Nominal No of vehicle accommodated**	Maximum number of vehicle accommodated
1	30	60
2	25	50
3	10	22
4	10	22
5	30	58
6	10	20
7	08	20
8	10	30
9	10	30
10	15	40
11	10	25
12	15	45
13	16	48
14	20	50
15	5	7
16	5	7
17	6	8
18	15	20
19	15	20
Total	265	582

5.4 Strategy 4: Environment Management and Infrastructure

The environment management and infrastructure strategy involves three items as given below and separately explained in detail.

1. Water Supply, Waste Disposal and Environmental Management
   (Please see Section 2)
2. The improvement of Surface Water Drainage
   (Please see Section 3)
3. Landscape Improvement
   (Please see Section 4)

All these proposals are prepared considering the findings of the site analysis and the development proposals for the area at local and national level planning.

5.5 Strategy 5: The Identity of the University

The Identity was highlighted as an important requirement of the University at all discussions the Consultant team had with academic staff, students and the other stakeholders. The identity of the University at all premises is proposed to be achieved through several measures as given below:

1. Cohesive composition of built elements, integrated with natural features in respective sites will establish legible environments within them. The composition may integrate sizeable fore- courts, both at the entrance and at main nodes and at critical facility locations (Refer Figures 8a and 8b).

2. The architectural character of the buildings is another measure that contributes to the character of the places and thereby builds the image of the University. For all premises a broader design framework is suggested to assure the consistency of buildings (Refer Section 5 for details).

3. Landscape also plays a major role in establishing a strong character to the place. The tree planting, ground paving and rainwater ponds could be noted as the main elements in the landscape (Refer Section 4 for details).

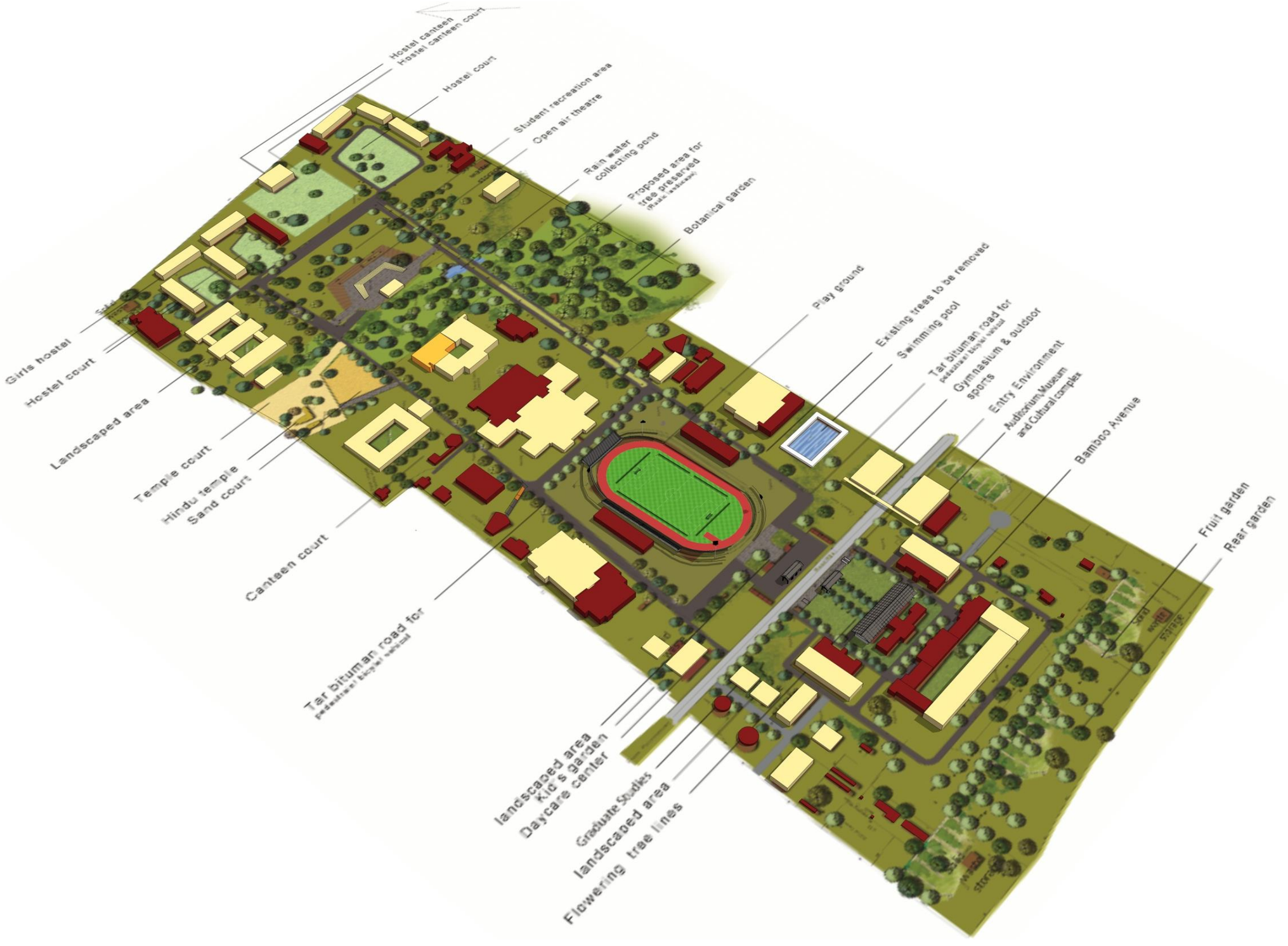


Figure 1.8 : Overall Composition of Buildings and Open Courts, Vantharumoolai Main Campus

5.6 Strategy 6: Implementation

The implementation of the Master Plan proposal may need three types of actions:

1. The Master Plan has to be incorporated in to the Corporate Plan of the University. Such incorporation will add recognition to the Plan and assure that all developments in future will comply with the guidance provided in it.

2. In order to monitor the progress of implemmentation the University shall appoint a committee with representatives from all stakeholders. The committee will have regular meetings to set out priority developments, review the ongoing developments and the appropriateness of the proposals for new developments.

3. The development activities shall be reviewed and timely amendments to the Master Plan shall be made when required by the committee with the consultation of appropriate persons.

6.0 Tentative Costs of Implementation

The following are the tentative costs of the projects as estimated in 2013.

Table 6: Locations of Individual Facilities: Vantharumoolai

Faculty/Unit	Proposed Location	Type of Development	Tentative Floor Area	Approx Cost
Senate & General Administration	New 04 storey extension to the existing building at the front	New Building	2000 sq m	120m
Auditorium	New Building closer to entrance	New Building	1000 sq m	70m
Sports Facilities	Closer to existing Play Ground	Extensions	1000 sq m	60m
Cultural Resource Centre.	New 04 storey Building adjacent to New Library	New Building	5000 sq m	250m
Language Centre	Within Cultural Centre Building	New Building	500 sqm	30m
Examination Halls	New Building closer to Administration unit.	New Building	700 sq m	42m
Canteen and Common Facilities	New Building	New Building	1,000 sq m	50m
Centre for Graduate Studies	A Location out of the main premises	New Building	600 sq m	36m
Common Areas for Student Gatherings	Common Courtyards inside Buildings and Open Air Theatre	Combined with new developments	1000 sq m	30m
Areas for Religious Observations	Closer to Hostels and Behind the New Library	New facility	400 sq m	20m
Agricultural Farm.	In the existing location with possibilities for a new location	Improvements to existing		10m
Vice Chancellor's Bungalow	In a land away from the main premises	New Building	300 sq m	18m
Residential Units for Married staff	In a new land away from the main premises	New Buildings	2,400 sq m	144m
Residential Facilities for Bachelors	Within main premises closer to student hostels	New Building	3,000 sq m	180m
Hostel Facilities for 8,000 students	Replacement of existing single storey hostel buildings with 03 storey buildings.	New Building built in phases with the increase of students	80,000 sq m	4800m In 04 phases of 1200m each
Accommodation for Non-Academic Staff	Replacement of existing single storey hostel buildings with 03 storey buildings.	New Building	1,000 sq m	60m
Space for Maintenance Department		New Building	300 sq m-	15m
Faculty of Science	Present Location and New Developments	Extensions and New Building	35,000 sq m	2100m
Faculty of Management & Commerce	Present Location and New Developments		15,000 sq m	900m
Faculty of Art & Culture	Present Location and New Developments		20,000 sq m	1200m
Faculty of Agriculture	New Building behind existing Administration complex	New Building	20,000 sq m	1200m
New Faculties	Within main premises	New Building	10,000 sq m	600m
Road and other Infrastructure	Within main premises			100m

7.0 References

National Physical Planning Policy 2009, National Physical Planning Department

Draft Corporate Plan- Eastern University, Sri Lanka

Time Saver Standards for Architectural Design (Eighth Edition), 2005, McGraw-Hill Publishers. (http://www.ehow.com/about_6673588_time_saver-standards-architectural-design.html#ixzz2Qh4plBbq)

Section 2

PROPOSALS FOR WATER SUPPLY, WASTE WATER DISPOSAL AND ENVIRONMENTAL IMPROVEMNETS IN VANTHARUMOOLAI MAIN CAMPUS EASTERN UNIVERSITY, SRI LANKA

Contents

1.0 Water Supply

1.1 Water Supply for Vantharumoolai Campus

Water demand forecast depends on the anticipated occupancy in each unit and have been based on the type of facilities that are expected to be provided at each unit. Per capita water consumption has been determined to reflect the nature of the occupants and warm climatic conditions prevalent in the locality. In addition to the water demand of individual units, service water demand such as fire, gardening, common services has been calculated in line with the standards recommended by local authorities and other concerned government agencies.

1.1.1 Water Demand Calculation

- Demand obtained for the individual units: Administrative units, academic entities, hostels, canteens, kitchens, staff quarters etc. Day time population and residential population projections for year 2030 has been taken for the calculation of the water demand.
- Service Requirements such as laboratory needs of water, fire requirements, gardening, housekeeping, janitorial services etc.

Data Sources:

- Consultations with and Service Planners
- Referring to respective Standards and Codes of Practice
- Referring to relevant Rules & Regulations

Calculated parameters:

(i) Average water demand (daily): to be used in determining the suitability of the yield of the source, fixing capacities of the treatment plant, and storage tanks etc.

(ii) Maximum and minimum demands (hourly and daily): to be used in the design of distribution pipe networks, fixing the capacities of pumps etc. (Daily peak factor has been assumed as 1.2 and the hourly peak factor as 2.0).

Water Demand:

Average water demand will be approximately 900,000 liters per day
Maximum daily demand: 1,080,000 liters per day
Maximum hourly demand: 90,000 liters per hour

1.1.2 Source of water supply

The main source of water supply is National water Supply & Drainage Board. Each building should have appropriately designed overhead storage tanks depending on the demand calculated based on the number of occupants. Two elevated storage tanks will have to be located at both sides of the campus, especially to cater to the needs of the residential areas (student hostels and staff quarters).

In addition to water supply from NWS&DB, possibility of rainwater harvesting should also be exploited. In addition to this, possibility of re-using wastewater should be explored, with special emphasis paid on the grey water produced at academic and administrative buildings and the residential areas. Separate sewerage networks for black and grey water would provide an array of options for wastewater re-use, which can be expected to satisfy the water demand for gardening, toilet flushing etc. at least partially.

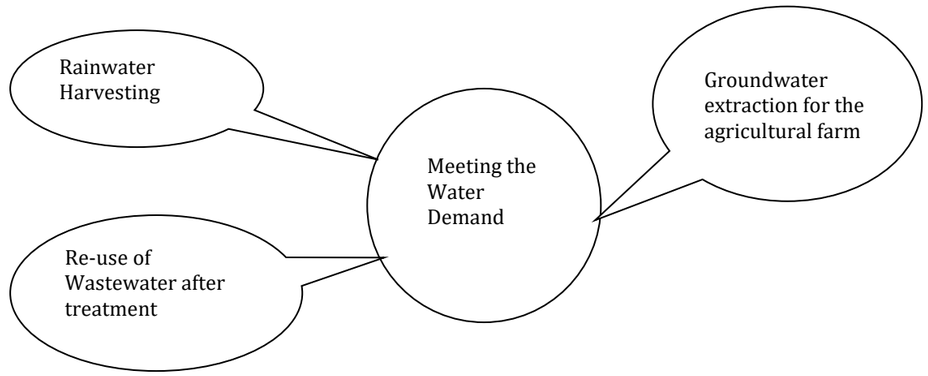


Figure 2.1. Options for satisfying the water demand

1.1.3 Water Distribution Network

Basically the pipe network should be divided into several zones to cater to individual water demand of building clusters of a particular activity zone and to suit periodic fluctuations of the water requirement. Hence, pipe network has to be designed to cater the minimum and maximum water demand for each zone using appropriate sets of pumps with Variable Speed Drives. This method is basically adopted to avoid having one large structure (e.g. having one large overhead storage tank) above ground level. These structural components, mainly water towers, cost huge amounts of money and visually impairment of natural scenery. The proposed trace of water mains is shown in “Annex 3-8”

Pipe material should be decided by considering soil characteristics, ground water levels and tidal variation etc. Hence, basic assumption is that Polyethylene (PE) pipes are more suitable for conditions prevalent in this particular site.

2.0 Wastewater Disposal - Vantharumoolai Campus

2.1 Objectives

To provide conceptual, but sufficiently detailed, designs for wastewater discharge for proposed future development of Eastern University of Sri Lanka.

- To select most suitable options available for wastewater treatment in terms of technical feasibility, cost effectiveness and long-term sustainability
- To determine most appropriate options available for wastewater disposal based on technical feasibility and environmental and ecological acceptability and cost effectiveness

The above options will be provided separately for different functional areas (hostels, academic entities, staff quarters etc.) separately or in combination. The conceptual designs proposed here may be used for subsequent detailed designs and implementation. The specific objective should aim at the following:

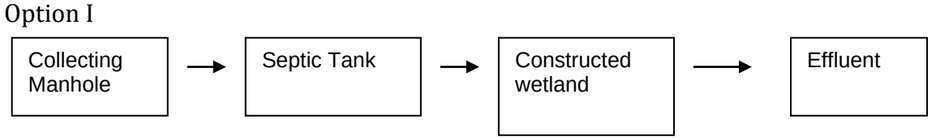
- To design processes that are more energy efficient and more sustainable with compared to conventional practices
- Through concerted efforts, plan to optimize the re-use and recycle water
- Reduced environmental impacts by, for example, recycling for maintaining green areas thus thwarting local heat island effects
- To design unit processes so that they use less chemicals and subsequently produce fewer chemical effluents/sludge
- Engineering solutions aiming at trouble-free and uninterrupted operations.

2.2 Wastewater Disposal for Vantharumoolai Campus

2.2.1 Wastewater Treatment for Academic entities; Administration units etc.

Considering the ample land availability, providing individual septic tanks is the best option for academic departments. Generation of wastewater for these entities is only during the daytime, hence the wastewater is predominantly wash water, wastewater generated at urinals and flushing of toilets. The solid accumulation is limited with compared to a place where people reside (e.g., the hostel). The effluent treatment will follow by use of constructed wetlands or provision allowed for soakage gullies/pits (Figure 1). The treated effluent can be utilized for watering gardens and green areas.

Option I



Option II

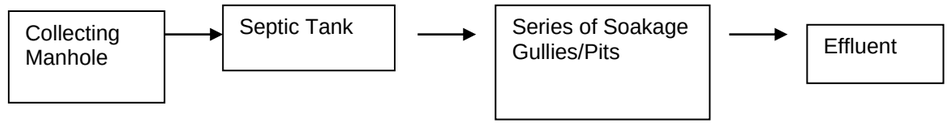


Figure 2.2. Options available for wastewater disposal for Administration buildings and academic departments

The expected volumes of wastewater should be calculated depending on the number of occupants of the particular location. The design and detailing of septic tanks, constructed wetlands, soakage gullies and pits should be based on SLS 745: Code of Practice: Sri Lanka Standards Part I and Part II (2004) on the design and construction of septic tanks and associated effluent disposal systems.

Estimated volumes of wastewater:

Vantharumoolai Campus: 11,400 persons @ 25 litres per day = 285 m^3/day

2.2.2 Student hostels, Staff Quarters and other facilities

Design of the sewer networks connecting these entities should involve, apart from conventional sewer connections:

- selection of suitable material for pipelines which can be used to minimize the gradient
- Having provisions for regular cleaning and maintenance

All other waste water generating points should be connected using appropriately-designed sewer networks. High capacity low-lift pumps will be used where pumping is necessary. Waste water from kitchens, canteens, restaurants etc. and other facilities can be treated either separately or in a central facility: this should be determined based on a cost-benefit analysis weighing the necessity of having a complex sewer network with compared to separate treatment plants. Options for final disposal of the treated waste water will be explored in line with the design philosophy that has been outlined above.

Estimated volumes of wastewater:

Vantharumoolai Campus: 5,000 persons @ 140 litres per day = 700 m^3/day

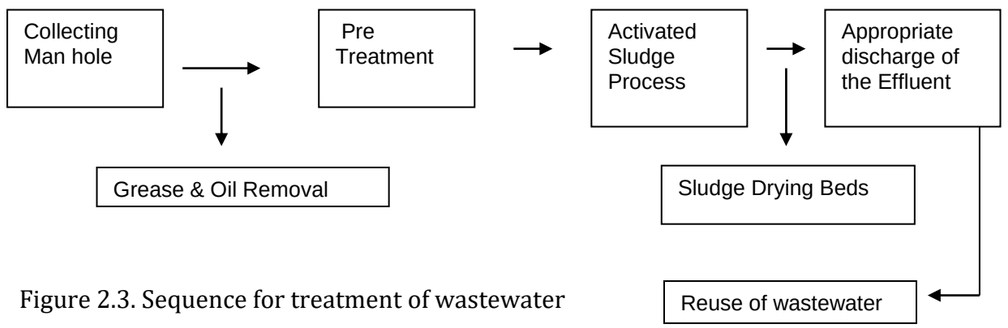


Figure 2.3. Sequence for treatment of wastewater

The following should be given proper consideration:

1. Effluent disposal options should conform to CEA Effluent Standards: National Environmental (Protection and Quality) Regulations, No. 1 of 2008.
2. Water re-use should always be given priority and for both grey and black water after appropriate treatment. Reclaimed water can be effectively used for irrigation, toilet flushing etc., which will reduce the cost for water supply.
3. Identification of most suitable site/s for treatment plant/s; Identification of alternative process sequences, identification of alternatives for disposal of treated effluent should be done after a proper cost-benefit analysis for comparison of alternatives and best alternative should be selected. The proposed trace of sewer trunk lines are shown in "Annex 3-8".

3.0 Electricity Infrastructure

The electricity demand cannot be estimated accurately without knowing the type of equipment that will be used, the utility of the functional spaces and types of activities of each building. The consumption of electricity, unlike estimates of water and wastewater which is a direct function of the number of persons, is a determinant of usage of equipment.

However, the main campus at Vantharumoolai the supply will be over 1,000 kVA, and the supply will be provided at high voltage (33kV or 11kV). The University is required to install its own substation and to undertake its operation and maintenance. The location or locations of the substation will be decided by the CEB so as to minimize low voltage lines and thereby minimizing energy losses. A meter cubicle constructed of masonry has to be built by the University according to the CEB's specifications and drawing at a location determined after site investigation, which will be done by the representative of DGM (Customer Services) or the Commercial Engineer of the CEB. The substation will have to be provided with a proper approach road at least 15 feet wide.

4.0 Environmental Management Plan: Potential Activities, Anticipated Environmental Impacts and Mitigation

This Environmental Assessment for projects proposed under the Master Plan should be prepared to establish the mechanism to determine and assess potential environmental impacts of civil works or any subprojects that are to be identified and cleared once specific projects are identified. Thereafter, mitigation measures, monitoring strategies and institutional measures can be detailed out depending on the environmental safeguard requirement.

Generally an EIA/IEE or an EMP is not mandatory (or needed) for the type of development proposed under the Master Plan, considering the nature of the proposed development at Eastern University of Sri Lanka. However, an EMP is proposed here as a precautionary measure and as a guideline for future environmental assessments, if needed. Some typical environmental impacts and mitigation measures for likely project activities are listed in Table 1, which may be treated as a guide during planning, project execution and operations.

Table 1. Some typical environmental impacts and mitigation measures for likely project activities

Activity	Potential environmental impact	Possible mitigation measures
IMPACTS DUE TO CONSTRUCTION ACTIVITITES, INCLUDING SITE PREPARATION, DEMOLITION AND REFURBISHMENT		
Clearing of vegetation	Loss of trees and vegetation Loss of habitats	Consider alternative options to minimize the loss of trees and vegetation If tree-removal is required, obtain tree-cutting permit from the Forest Department (if needed) Plant same species of trees (or native species) as compensatory measures
	Soil erosion	Careful arrangement to control soil erosion by adopting proper protection measures before starting earthworks or clearing of vegetation
Operation of heavy machinery for demolitions, excavations, construction etc.	Noise and vibration Air pollution due to fugitive dust particles, particulate matter and smoke/emissions	No high noise generating machinery is encouraged Extreme precautions should be taken to avoid any noise generating activities which will disturb on-going activities of the University. To avoid any disturbances to neighbourhood, such machinery should be operated only during day-light hours and subjected to provisions of National Environmental (Noise Control) Regulations No.1 of 1996 Damp down exposed soil and any stockpiled on site by spraying with water when necessary during dry weather The contactor would be required to keep all equipment in good order to minimize air pollution complying to National Environmental (Ambient Air Quality) Regulations, 1994
Cut and Fill activities	Issues related to slope stability and increased erosion of slopes	Avoid disturbing steep slopes to the extend as possible Locations that are vulnerable to slope failure should be strengthened/ protected Erosion control and slope protection measures should be implemented
Material handling/storage during Cut and Fill activities	Water contamination due to washing away of material Excessive dust and particulate emissions	Allocate designated areas for stockpiling of soils, gravel, and other construction materials and keep them covered using tarpaulins Damp down exposed soil and any stockpiled on site by spraying with water when necessary during dry weather Avoid rainy season as much as possible. If any case rainy period is unavoidable, make sure to have temporary drainage so as to drain off the rain water Filling and storage of construction material within the site could potentially contaminate the surface runoff, notably increasing the turbidity during construction. Erosion control practices should be implemented during construction to limit turbidity and silt transport off site
Land reclamation and filling Filling of low-lying areas	Loss of habitats Disturbance to hydrology and disruption of drainage pathways leading to local flooding Water contamination due to washing away of material	Filling of wetlands and low-lying areas should be kept to a minimum; Proper ecological impact assessment should be conducted before filling Provision of proper drainage canals around the site is necessary to facilitate proper drainage, and culverts have to be constructed appropriately It has to be ensured that the fill material is free from any invasive flora species and/or hazardous materials Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies Watering will be necessary for any activity that causes generation of dust particles within the proposed site Avoid rainy season as much as possible. If any case rainy period is unavoidable, make sure to have temporary drainage so as to drain off the rain water

Transportation of excavated/fill material , demolition waste, and construction material	Elevated fugitive dust, particulate matter and vehicular emissions along transportation routes Noise and vibration along transportation routes	Use tarpaulins to cover sand and other loose material when transported by trucks Fit all heavy equipment and machinery with air pollution control devices which are operating correctly and limit transport activities to day-time hours Since gravel and unpaved roads create air-borne dust, frequent watering in the residential areas is of importance
Disposal of excavated material, demolished material and construction waste	Landfilling Negative impacts due to improper disposal of hazardous waste	The generation of construction waste is inevitable; however, best practices applicable to construction should be followed to minimize generation of waste. Prepare and implement waste management plan as part of the construction contractor's site-specific plan; Possibilities of recycling of waste material should be explored wherever possible and remaining amounts should be used as fill material or disposed in a landfill. Construction of proposed buildings and related facilities would not generate hazardous or toxic waste and therefore do not create any potential hazard to human health due to contamination. If accidental spills do occur during construction (materials such as paints, solvents, bituminous material or any other hazardous or toxic constituents) appropriate measures should be taken to clean up such spills immediately and waste material should be disposed appropriately (e.g., in a secure landfill) Precautionary measures should be taken to minimize and control spoilage of material during storage and handling and during construction processes. There should be provisions for proper storage of construction materials to reduce the amount of waste caused by damage or exposure to elements.
Extraction of groundwater for construction activities	Increased strain on groundwater resources	Water for construction has to be obtained either from water bowsers and/or from dug wells within the site.
Operation of labour camps	Improper sewage and solid waste disposal Disturbance caused to day-to-day activities of the University	On-site sewage disposal using protected pit latrines without causing negative environmental impacts. Proper sanitary conditions should be maintained within the labour camps together with proposer disposal of kitchen waste. All solid waste generated at the labour camp should be collected in closed bins until they are handed over to the local authority The labour camps located within the site should not disturb the activities of the University and also the serenity of the residential neighborhood, which is important to maintain harmony so as not to create negative social impacts.
Increased traffic due to construction activities	Congestion of roads Disturbance to pedestrians and other road users	Site vehicles should not be parked along the roadside or outside the site area. Construction vehicles and equipment would be parked within the site during construction and appropriate signage would be posted on affected roadways The access gate to the site has to be provided with an appropriately sized bay, so that turning of vehicles would not cause obstruction to other vehicular traffic along the access road Construction materials and machinery should not be placed in a manner that blocks any roads, paths or local accesses; Unloading of construction materials should be carried in a manner and time so as to avoid blockage of roads/paths/access; Waste should not be placed on the roads

IMPACTS DURING OPERATIONAL STAGES		
Water supply	Extraction of groundwater for consumption (Trincomalee Campus)	If groundwater is being used or proposed, it is however necessary to carry out pumping and recovery test by the Water Resources Board or NWS&DB in order to estimate the maximum yield or the safe abstraction rate without disturbing the other users in the locality. Quality of drinking water, should conform to SLS 614 (1983): Sri Lanka Standards for Potable Water Explore the possibilities for implementing suitable systems for rainwater harvesting in the proposed buildings of the University in order to accommodate the National Rainwater Policy (2006). For new projects, the Urban Development Authority (Amendment) Act No. 36 of 2007 requires the formulation of a scheme for rainwater harvesting to be included in the Development Plan prepared in terms of Section 8A of the UDA Law No. 41 of 1978. These by-laws on drainage are aimed at rainwater harvesting as a strategy for localized flood mitigation, in both existing and future construction. Apart from satisfying the above requirement, rainwater harvesting will be beneficial by alleviating the severity of flooding and supplementing water requirements.
Disposal of solid waste (a) solid waste from lecture rooms, administrative buildings, hostels, residential areas, kitchens and canteens (b) Hazardous/toxic wastes from workshops, laboratories etc., (c) any other waste	Negative impacts due to improper disposal of solid waste	<u>Solid Waste from Lecture rooms, administrative buildings, hostels and Canteens</u> Lecture room and office waste which is predominantly paper can be recycled, if properly separated. Appropriate bins should be fixed for this purpose. Food and kitchen waste generated at residential areas, kitchens, canteens or elsewhere should be collected using proper bins, emptied at a central collecting bin and allow the local authority to remove the waste from the site. All attempts should be made at minimizing the waste generation, by way of attempting to compost the biodegradable part, and handing over the non-biodegradable portion to the collectors. Recyclable material: handed over to recyclers Biodegradable material: collected separately; composting is recommended Reusable material: be used for productive purposes or handed over to third parties. Residual material: Non-biodegradable material which cannot be recycled or re-used should be handed over to the Local Authority. Follow "*Technical Guidelines on Solid Waste Management In Sri Lanka*", published by the Central Environmental Authority (CEA, undated). <u>Hazardous/ Toxic Wastes from Workshops and Laboratories</u> Proper hazardous waste management system shall be introduced with appropriate segregation of waste, storage and its proper disposal. Chemical waste should be collected appropriately (e.g., separate collection of organic and inorganic chemicals, volatile matter, combustibles etc.) Recover used chemicals, oil and lubricants and reuse or remove from the laboratories, workshops and sites. Dispose appropriately Place storage areas for chemicals, fuels and lubricants (including spent stocks) away from any drainage leading to water bodies Raising awareness among staff and students on proper management of hazardous waste, with attention paid to waste minimization, recovery and recycling and safe disposal of hazardous waste. Hazardous/toxic material will be specially disposed with the consultation of PHI of the Local Authority, Central Environmental Authority, specialized institutions and/or commercial waste processing organizations Follow the "*Guidelines for the Management of Scheduled Waste in Sri Lanka: In accordance to the National Environmental (Protection & Quality) Regulation No. 01 of 2008*", prepared by the Central Environmental Authority (CEA, 2009).

Disposal of e-waste	Piling up of e-waste, if not properly disposed Pollution caused by e-waste	E-waste should not be mixed with other types of waste E-waste should be handed over to designated collection centres or directly hand over to commercial e-waste processing organizations E-wastes should be recycled to the extent as possible
Disposal of wastewater (black and gray water)	Pollution of surface and groundwater Public nuisance due to smell, spread of deceases etc.	Wastewater should be disposed safely, ensuring that effluent quality is in conformity with National Environmental (Protection & Quality) Regulations No. 1 of 1990. For on-site wastewater disposal, The Code of Practice, Sri Lanka Standards 745: Part I & II (2004) on the design and construction of septic tanks and associated effluent disposal systems (soakage pits) has to be followed in deciding the capacities and dimensions of the tanks.
Operation of machinery and equipment in offices, workshops and laboratories	Noise and vibration Occupational Health and Safety issues	Plan activities in consultation with academic and non-academic departments so that activities with the greatest potential to generate noise are conducted during periods of the day which will result in least disturbance to other activities within the University Implementation of Occupational Health and Safety plans should be given priority
	High energy consumption Emission of excessive amounts of pollutants (air, particulates, radiation, noise and vibration, solid waste, liquid waste including oil and grease, visual) Need for regular maintenance, wear and tear	Ensure that the equipment, machinery and other appliances purchased have high energy performance/low environmental impact (e.g., star rating for low energy consumption) Enter into purchase and service agreements with 'green' suppliers who are environmentally responsible Use environmentally friendly material for any partition work, cleaning, maintenance work etc.
Protection from lightning risks for buildings and especially for improved communication networks and electric lines		Hazards due to lightning should be mitigated. Lightning can create dangerous voltage gradients in the earth and can charge extended metal objects such as telephone cables and fences. Very high voltage can cause the electrical breakdown of insulators, causing them to act as conductors. These transferred potentials are dangerous to people and electronic apparatus. Measures to control lightning can mitigate the hazard; these include lightning rods, shielding wires, and bonding of electrical and structural parts of buildings to form a continuous enclosure.
Increased Traffic		Traffic in the immediate area would be slightly affected with increased student intakes to each campus of the University, and therefore proper traffic management plans should be established. New traffic generation is expected due to staff, students and visitors using their private vehicles, other vehicles which deliver goods and services Any gravel roads have to be raised above flood levels and also may need tarring and its related construction impacts should be appropriately mitigated. Vehicles should not be parked along the roadside or outside the campus. Sufficient parking spaces should be provided in all the academic entities of each campus.

5.0 Environmental Screening

The infrastructure upgrading and construction is envisaged to be moderate to major in scale, and the precise time frame when civil works will be undertaken is not known except that it will be in different zones and locations as identified in the proposed Master Plan. In general, no formal environmental investigations, such as IEE and EIA are likely to be required for the upgrading and new construction of individual facilities. However, as a precautionary measure, the University should adopt the following steps in order to ensure that during implementation each physical infrastructure upgrading/construction activity individually will not result in adverse environmental consequences, and fully comply with environmental requirements and good practices:

(i) Environmental screening and categorization of sub-projects
(ii) Use of environmental guidelines and criteria for planning and design;
(iii) Incorporation of environmental measures into plan, design and contract documents; and
(iv) Monitoring of environmental compliance.

The screening will:

(i) check if the proposed works require further environmental investigations prior to permitting upgrading or construction works

(ii) review the plan and design at early stage to ensure that it adopts environmental guidelines, criteria and good practices ; and

(iii) provide environmental guidance for preparing an appropriate EMP, and/or attach applicable environmental terms and conditions specific to the proposed upgrading and construction works. Then prepare a site specific EMP as suggested in Table 2 or the format provided in Table 3, which outlines a possible checklist and format for environmental screening and EMP.

Table 2. Format for Simple Site Specific Environmental Management Plan

Description of upgrading/ construction activities and location (*what activities and where*)	Potential environmental concerns (*what issue*) and significance (*why*)	Potential mitigation measures (*what may be done at what stage/time*?)	Who is responsible for the mitigation measures?	Estimated cost of mitigation

Each sub-project should identify a set of environmental monitoring and reporting procedures including, required environmental baseline data, environmental parameters, location of monitoring and frequency as suggested in Table 4.

Table 3. Format for Reporting Environmental Monitoring Plan (EMoP)

Environmental Element to be monitored	Parameters to be monitored	Places to be monitored	Frequency of monitoring	Responsible authority of monitoring	Remarks

Typical format for Environmental Screening for proposed projects/project components under the Master Plan

(This form is an indicative document only. This has to be tailored to suit specific projects/project components)

REPORT ON ENVIRONMENTAL SCREENING & ENVIRONMENTAL MANAGEMENT PLAN

1. Project Identification

Project Title	

2. Project Location

Location	
Definition of Project Area	*(Extent of the project & areas affected during construction and/or operations)*
Adjacent land and features	

3. Project Description

Proposed start date	
Proposed completion date	
Estimated total cost	
Description of the project	(*supporting material such as maps, drawings etc. attached as required*)
Project Management Team	

4. Description of the existing environment

4.1 Physical features	
Topography and terrain	
Soil	(*type and quality*)
Surface water	(*sources, distance from the site, and quality*)
Ground water	(*sources, distance from the site, and quality*)
Flooding	
Air quality	(*any pollution issues*)
Noise level and vibration	*(any anticipated issues)*
4.2 Ecological features – Eco-system components	
Flora	(*trees, ground cover, aquatic vegetation etc.*)
Presence of lowland; habitats; special designations and sensitive zones	
Fauna	(*Mammals, birds, insects, amphibians etc.)*
Other features	
Residential/Sensitive Areas/Land use	
Traditional economic and cultural activities	
Archeological resources	

5. Public Consultation

Public consulted	Consultation method	Date	Details/Issues raised

6. Environmental Effects and Mitigation Measures

6a. Screening for Potential Environmental Impacts

	Screening question	**Yes**	**No**	**Significance of the effect (pre-construction/pre-project, during construction, and during operations) (Low, moderate, high)**	**Remarks**
1	Will refurbishment, Demolition/construction and operation proposed under any of the project components involve actions which will cause physical changes in the locality				
2	Will the Project involve use, storage, transport, handling or production of substances/materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health?				
3	Will the Project produce solid wastes (municipal, hazardous/toxic waste, e-waste etc.) due to any project component during refurbishment, demolition, construction or operations?				
4	Will the Project (during construction and operations) release pollutants or any hazardous, toxic/noxious substances to air?				
5	Will the Project cause noise and vibration or release of light, heat energy or electromagnetic radiation?				
6	Will the Project lead to risks of contamination of land or water from releases of pollutants onto ground or into surface or groundwater or coastal wasters?				
7	Will the project cause localized flooding and poor drainage during construction? Is the project area located in a flooding location?				
8	Will there be any risks and vulnerabilities to public safety due to physical hazards during construction or operation of the Project?				
9	Are there any transport routes on or around the location which are susceptible to congestion or which cause social problems, which could be affected by the project?				
10	Are there any routes or facilities on or around the location which are used by the public for access to recreation or other facilities, which is affected by the project?				
11	Are there any areas or features of high landscape or scenic value on or around the location which could be affected?				
12	Are there any other areas on or around the location which are important or sensitive for reasons of their ecology e.g. wetlands, watercourses or other water bodies, the coastal zone, mountains, forests which could be affected by the project?				

13	Are there any areas on or around the location which are used by protected, important or sensitive species of fauna or flora e.g. for breeding, nesting, foraging, resting, migration, which could be affected by the project?				
14	Is the project located in a previously undeveloped area where there will be loss of green-field land?				
15	Will the project cause the removal of trees?				
16	Are there any areas or features of historic or cultural importance on or around the location which could be affected by the project?				
17	Are there existing land uses on or around the location e.g. homes, gardens, other private property, industry, commerce, recreation, public open space, community facilities, agriculture, forestry, tourism, mining or quarrying which could be affected by the project?				
18	Are there any areas on or around the location which are densely populated or built-up, which could be affected by the project?				
19	Are there any areas on or around the location which are occupied by sensitive land uses e.g. hospitals, schools, places of worship, community facilities, which could be affected by the project				
20	Are there any areas on or around the location which contain important, high quality or scarce resources e.g., groundwater, surface waters, forestry, agriculture, fisheries, minerals, which could be affected by the project?				
21	Are there any areas on or around the location which are already subject to pollution or environmental damage e.g. where existing legal environmental standards are exceeded, which could be affected by the project?				

6b. Environmental Management Plan (EMP)

Key project activities/components	**Potential Environmental Impacts**	**Mitigation Measures**

Note: This EMP has to be filled for any concerns highlighted in the above screening as significant (high and moderate). All the key project activities/components have to be identified and corresponding potential environmental impacts have to be identified and suitable mitigation measures have to be detailed. Information contained in Table 1 can be used to identify impacts and propose suitable mitigation measures.

7. Summary of environmental effects:

Assuming that all mitigation measures are implemented as proposed, the following effects can be predicted.

Key project activities	**Potential Environmental Effects**	**Significance of the environmental effect with mitigation in place** **NS**- Effect not significant, or can be rendered insignificant with mitigation **SP** - Significant positive effect **SN** - Significant negative effect **U** - Outcome unknown or cannot be predicted, even with mitigation **NA** – Not applicable

8. Screening Decision Recommendation:

Final recommendation	Environmental Category of Project : Comments:

9. EMP implementation responsibilities and costs

Item	Cost	Implementation Responsibility

	Name/Designation/Contact information	**Signature**
Screening report and EMP completed by		
Screening report and EMP reviewed by		
Screening report and EMP approved by		

6.0 Waste Management Plan

Guidelines for Preparation of Waste Management Plan (WMP) for

Eastern University, Sri Lanka (EUSL)

6.1 Objective of the Waste Management Plan

Under the accepted norms of approval procedure of building plans, local councils and the Urban Development Authority have mandated the Project Proponent to submit and subsequently establish and implement a Waste Management Plan (WMP) for both the construction and operational phases of proposed building project. In pursuant thereto, the Project Proponent, who is the Eastern University, Sri Lanka (EUSL) will have to:

(i) Address waste management relevant to construction of the proposed buildings, infrastructure and other related facilities;

Oblige each contractor who will involve in construction, supply of material and goods, and operation of facilities of EUSL and who will carry out works on-site (collectively, the Contractors, and individually, the Contractor – main or sub) to establish and implement their own contract-specific "Contractor's Waste Management Plan" (C-WMP) consistent with the requirements set forth herein, which they shall be required to submit for Project Management of EUSL for review and subsequent acceptance

(ii) Commission a separate operational Waste Management Plan (WMP) prior to commencement of operations of the facilities that are proposed as part of the Master Plan and any facility which are proposed as part of development of the EUSL. This WMP will guide the waste management during the operational stage of the EUSL facilities and academic and non-academic entities, including residences and extra- and co-curricular facilities.

The measures described in this outline WMP, as part of the mitigation strategies of environmental impacts, will identify approaches for economically feasible, technically most practical ways to manage solid waste generated at EUSL, during construction and subsequently during operations. However, the information contained in this report is subjective and the final WMP has to be formulated updating the contents of this report. This report has been prepared with information predicted with the information available at the time of preparation of the Master Plan, and therefore, final WMP has to be prepared together with and as part of the EMP for which suggestions and guidance have been provided in this report.

6.2 Policies, Strategies, Legislation and Principles related to solid waste management

Any waste management plan has to be prepared adhering to provisions of following National Legislation, Policies and Strategies:

National Plans, Policies, strategies related to Pollution and Waste

1. National Implementation Plan for the Stockholm Convention of Persistent Organic Pollutants (2006)
2. National Industrial Pollution Management Policy
3. National Industrial Pollution Management Strategy
4. National Policy on Solid Waste Management (2002) – Cabinet Approved
5. National Strategy for Solid Waste Management (2002) – Cabinet Approved

National Legislation related to Solid Waste Management

1. Part IVB of National Environmental Act No. 47 of 1980 amended by Acts No. 56 of 1988; No. 53 of 2000
2. Part II of the National Environmental (Protection and Quality) Regulations No. 1 of 2008 as applicable to Scheduled Waste & Regulations for hazardous waste Management published by CEA in the Gazatte Extra Ordinary No. 924/13 dated 23rd May 1996.
3. Part IVB of the above Act for regulation of Environmental Quality
4. Technical Guidelines on Solid Waste Management Published by Central Environmental Authority (CEA)
5. Municipal Council Ordinance No. 16 of 1947 with special attention on Section 129, Section 130 and Section 131 and By-laws No-1, 29, 30, 31, 32, 33, 34, 44, 45, 46, 47, 54, 58 and 61., Section 100 of the Pradeshiya Sabha Act. No. 15 of 1987 (as amended)
6. Public Nuisance under the Criminal Law: Section 261 of the Penal Code (Penal Code No. 2 of 1883 as amended)
7. Code of Criminal Procedure Act Chapter IX and Section 8(1) (Code of Criminal Procedure Act No. 15 of 1979 as amended)
8. Nuisance Ordinance No. 15 of 1982 and Police Ordinance No. 16 of 1864 (as amended)

In addition to above the following principles related to sustainability should be observed while preparing the WMP:

Sustainability Principles related to Solid Waste Management

1. Precautionary Principle (Principle 15)
2. Polluter-Pays Principle (Principle 15)
3. Public rights: participation, access to justice (Principle 10)
4. Principle of Preventive Action
5. Principle of Accountability

6.3 Generally accepted Norms

Piles of garbage lining the streets, overflowing dumps and mountains of solid waste are indicators of one of the most visible and serious environmental issues facing society today. Apart from the eyesore it creates, more serious implications are the health hazards created by improper disposal of waste. All forms of human activity result in the generation of waste which can harm the environment, while careful management and minimization of waste can limit the damage to the environment, while conserving scarce resources.

Municipal solid waste consists of material discarded from community activities, which are commonly referred to as garbage, refuse or rubbish. In addition, different wastes are identified according to their source such as industrial waste, and sewage sludge. It is common practice nowadays to encourage hierarchy of waste management, which generally favors waste minimization, reuse and recycling over landfills and incineration. This strategy is known as the 3R principle: reduce, reuse and recycle. It is inevitable that even with a strict adherence to the 3R principle, landfills will be required for certain types of wastes. Source separation, segregation and processing can reduce large quantities of waste that reduce the burden on final disposal of wastes.

Recovery of waste materials can be done in two ways: reuse and recycling. Reuse entails packaging being used more than once in the same system (e.g., returnable glass bottles). Recycling is the reuse of material to make similar or new products (e.g., plastic bottles). Resource recovery and composting (for biodegradable waste) also can contribute greatly to reduce the quantities of waste that need final disposal.

At present, the main problem pertaining to solid waste in Sri Lanka is non-segregation and non-separation of waste at source, which makes it impossible to reuse, recycle and resource recovery and can make solid waste management ineffective. In addition, the amount of waste being generated is increasing, along with the quantity of non-degradable waste because of poor packing. There is lack of adequately constructed storage space for temporary transfer of solid waste before its final disposal, and poor collection and sorting of waste are most notable issues to be addressed. Impacts of poor solid waste management include the breeding of disease vectors and vermin, landfill leachate, public nuisance and pollution – water, soil and air.

Hazardous waste is the waste material that is reactive, toxic or corrosive, or otherwise poses a hazard to human health and the environment. Hazardous wastes need special collection and disposal. Toxic and hazardous wastes include bio-hazardous/medical waste, chemical waste, contaminated waste, radioactive waste etc. Operation of laboratories will generate substantial amounts of chemical, biological and contaminated waste including radioactive waste, which needs special attention and professional support to dispose properly.

Electronic waste has increased with the increased use of electronic equipment. It is commonly referred to as E-waste or electrical and Electronic Equipment (WEEE). It usually includes surplus, obsolete, broken or discarded electrical and electronic equipment and appliances. The processing of electronic waste is somewhat difficult due to scarcity of waste processing facilities and/or lack of containment facilities.

This waste management plan (WMP) for EUSL has to be prepared with the above concepts in focus and following general accepted guidelines should be adopted elsewhere.

6.4 Computation of Probable Waste Generation and Source Segregation

6.4.1 Waste Management Plans to be prepared

The WMP that has to be prepared according to the functional usage of the floor space of each building, facility and infrastructure installation. Also, the location of the building, size of each component, nature and method of construction, duration of construction etc. will provide information of the above-mentioned information during the construction stage.

The functional usage will provide information related to solid waste during operational stage:

- Generation patterns of solid waste
- Quantity and nature of solid waste
- Options for waste segregation/re-use and recycling
- Collection of solid waste and transfer to temporary storage before final disposal

Therefore, WMP have to be drafted during the above two stages:

(i) For Construction stage of each facility/facilities

(ii) For Operation stage of each facility/ facilities

6.4.2 WMP for Waste Generated during Construction

The following data is needed for calculation of waste quantities:

- initial preparation phase: duration and number persons involved
- construction phase: duration and number persons involved

The approximate number of persons involved in construction and related activities (at peak construction periods), and the proportion who will be accommodated at site should be known.

Assumptions for calculation of waste generation:

(i) Waste generation per capita per day: 0.60 kg (for resident laborers) & 0.30 kg for day laborers.

(ii) Proportion of biodegradable waste: non-biodegradable waste: 0.85:0.15 (by weight)

(iii) Density of waste: 300 kg/m^3

Two distinct waste generation streams can be broadly identified during construction stage:

(a) Municipal Solid Waste:

a. From labour dormitories, dining areas and kitchens

b. Project Management activities – Project Proponent's representatives at the site premises

(b) Waste arising from Demolition and Construction activities

The amount of waste arising from (a) can be estimated from the assumptions mentioned above. The amount of waste arising from (b) has to be calculated as a part of Contractor's Waste Management Plan (C-WMP).

Waste arising from construction activities

Possible waste arisings during construction of the facilities at EUSL will include construction and demolition material , hazardous waste, and general municipal solid waste (described above), There are three categories of waste, other than municipal solid waste, that needs particular attention during construction:

- Excavated earth material
- Demolition waste
- Construction waste

Waste Management during Construction and Source Segregation

Each contractor (and/or sub-contractor/s) will be responsible for the handling, treatment and disposal of all construction waste (whether directly or indirectly generated). Neither the EUSL, nor the Project Manager should be responsible for any actual construction wastes arising (including demolition waste), but should endeavor to ensure that all waste management issues are appropriately addressed and observed by all Contractors.

Contractors and sub-contractors shall engage competent personnel:

- To prepare and be responsible for Contractor's Construction Waste Management Plan (C-WMP) pursuant to compliance with the requirements set forth
- To actively and comprehensively manage all of Contractor's waste handling and collection activities to ensure compliance with statues and regulations (as described above)
- To directly and exclusively perform and be responsible for the following of the Contractor's waste handling and collection activities:
    - Providing waste collection bins and other containers of all sorts
    - Handling, emptying and removal of those bins and containers
    - Removal of waste of all sorts form the Project Site
    - Pest and Vermin control

Each Contractor and sub-contractors shall use the generic C-WMP as the basis and *Pro forma* for preparation of individual WMP. The Contractor shall elaborate and/or expand on that generic WMP as noted therein or additionally as may required to address all aspects of the overall waste management scheme.

The WMP should specifically address the proposed arrangements for:

- avoidance, reuse, recovery/recycling
- Collection
- storage, treatment and disposal of each category of waste anticipated to arise from their works

In addition, the proposed designation of areas for segregation and temporary storage of re-usable and recyclable material should be explicitly mentioned.

In view of all listed above, the Project Proponent will conduct regular (with the first audit conducted at the commencement of the construction work and quarterly thereafter) of each contractor's waste stream to:

- determine if wastes are being managed in accordance with the approved procedure
- assess all aspects of contractor's waste management, including waste generation, storage, recycling, transport and disposal
- ensure that the wastes arising from contractor's works are handled, stored, collected, transferred and disposed in a manner that is environmentally acceptable and complaint with the relevant statutory requirements
- ensure that Contractors properly implement the appropriate environmental protection and waste pollution control mitigation measures
- to encourage the reuse and recycle of materials

6.4.3 Quantities of Waste Generated during Operations

The quantities of waste should be calculated based on the following assumptions:

Day-Students + Non-resident staff:

Biodegradable waste: 1 kg/20 persons

Non-Biodegradable waste: 2 kg/20 persons

Resident Students + Resident staff:

Biodegradable waste: 1 kg/5 persons

Non-Biodegradable waste: 2 kg/5 persons

Administrative units:

Mostly biodegradable waste, amount should be determined based on an waste audit.

Kitchens, canteens and dining areas (not included above):

Waste arising: 0.1 kg/meal (biodegradable)

Non-biodegradable waste equivalent to 25% of biodegradable waste

Visitors:

Waste arising: 1 kg/10 guests (biodegradable)

Non-biodegradable waste equivalent to 25% of biodegradable waste

Typical composition of solid waste and percentages by weight according to recent information collected by National Solid Waste Management Support Centre (Unpublished Report of research carried out by Department of Civil Engineering, University of Moratuwa) is as follows:

Paper	-	6-8%	Plastics & polythene	-	5-8%
Metal	-	2-3%	Glass	-	<1%
Organic matters		80-85%	Others	-	2%

Based on the above, the assumption of the ratio of biodegradable and non-biodegradable waste can be reasonably determined.

Segregation of Waste during Operations

Office waste which is predominantly paper can be recycled, if properly separated. Appropriate bins should be fixed for this purpose. Food and kitchen waste generated at the kitchen, canteens, common rooms, offices, residences and dormitories or elsewhere. MSW should be collected using proper bins, emptied at a central collecting bin in each building/facility. All attempts will be made at minimizing the waste generation, by way of separating the biodegradable part, and handing over the non-biodegradable portion to the recyclers.

- Recyclable material: handed over to recyclers
- Biodegradable material: collected separately be handed over to the local authority.
- Reusable material: be used for productive purposes or handed over to third parties.
- Residual material: Non-biodegradable material which cannot be recycled or re-used be handed over to be handed over to the Local Authority.

6.5 National Colour Code for Segregated Waste

Waste should be collected using separate bins of different colours. This is the colour code for separated solid waste as given in Technical Guidelines on Solid Waste Management Published by Central Environmental Authority (CEA):

Green	-	Organic waste (Biodegradable)
Blue	-	Paper (Non-biodegradable)
Orange	-	Plastics & polythene (Non-biodegradable)
Brown	-	Metals/Coconut shells (Non-biodegradable)
Red	-	Glass (Non-biodegradable)

6.6 In-House Collection Methodology

In Each Building/Facility

Providing proper collection bins for solid waste is needed for each building and facility, especially where kitchens, canteens, lecture halls, administrative offices and student hostels and staff residences are located. Typically at each location, 5 bins should be kept for the collection of organic waste, paper, plastics & polythene, metal and glass separately. Size of the bins used will be 20-50 liters, depending on the waste type.

In the kitchen, dining areas and canteens area

Separate bins (50 liters) should be provided for the kitchen which will be kept within these premises.

In Office areas and students' and visitors' areas

Separate bins (20 liters) will be provided for storing paper, plastics & polythene, metal, glass and organic waste separately. All the bins will be.

Common areas

Four sets of bins (20 litres) should be provided such areas to collect waste separately. ***In laboratories:*** (See below for Scheduled Waste)

6.7 Waste Minimizing Techniques

The basic tenet of the Project Waste Management Plan (P-WMP), which is intended to be adopted for waste management during the operations of EUSL, is to include standard protocols and procedures for waste reduction and recycling as well as the intents of the Project Proponent to properly dispose of the solid waste without incurring any nuisance to the public and minimizing pollution and promoting environmental conservation.

Regardless of how simple it may be, the basic tenet of the WMP (whether produced by the Project Proponent, or contractors) must always be to elevate waste management practices to the highest priority option available, as the Project Proponent holds that is makes more sense to avoid producing a waste rather than to develop extensive waste management practices once a waste is produced.

Environmentally Responsible Purchasing

In the context of waste reduction, environmentally responsible purchasing involves the introduction of practices that discourage unnecessary purchase and encourage the purchase of products with improved recyclability, reduced packaging, greater durability, and where economically rational, with high recycled content. For example, at a minimum, recycled paper for general use and recycled toners for photocopiers and printers shall be considered.

Waste minimization is best accomplished at the source through careful planning, design and supervision of the works. Good management practices, such as responsible purchasing policies, purchasing targets, recycling of paper, etc., will reduce and prevent large amounts of waste being generated. Careful consideration of material requirements can minimize the amount of raw materials wasted and thus be more economical over the life cycle of the project.

Table 4. Generally accepted waste management hierarchy

Waste Management Option	Description	Priority
Avoidance/Elimination of waste generation	Avoidance or Complete elimination of waste	↑ Highest Priority
Reduction at source	The reduction of waste generally within the confines of the source at which waste is generated	
Reuse and Recycling	The use, reuse and recycling of wastes for original or some other purpose such as input material or materials of recovery	
Treatment and/or processing of waste	The destruction, detoxification, neutralizing, etc., of wastes into less harmful substances	↓ Lowest Priority
Safe Disposal and/or energy recovery	The release of wastes into land, water or air in properly controlled or safe ways so as to render them harmless; land disposal may involve volume reduction, encapsulation, leachate containment and monitoring techniques; Energy recovery involves thermal destruction of waste to recover energy while effective emission control in place	
Waste dumping	Uncontrolled disposal of waste into open landfills without any pollution control efforts	

6.8 Waste Transfer System to the Final Collection Chamber

Final collection chamber for biodegradable waste

The collection chambers as located in the drawings should be used to store organic (bio-degradable) waste and the temperature within this chamber should be maintained at an appropriate level. This chamber will be fully sealed and all the necessary drains will be provided in order to drain out the any leachate, which will be connected to the wastewater lines.

The floor and all the walls will be tiled in order to make cleaning of the chamber easier. Waste will be stored in roll out tipping bucket carts (wheel mounted bins) for easy transfer of waste to collecting trucks. Size of this room will be 4 m x 5 m as shown.

This area has been designed to store more than 3 days collection of organic waste if there is any failure in garbage collection by Local Authority.

Final collection chamber for non-biodegradable waste

In the location identified for waste storage, there should be a separate collection chamber to be used to store all non-biodegradable waste. Separate space will be given for each sorted waste: to store paper, polythene & plastics, metal, glass etc., separately. The size of this chamber is 4 m x 5 m and the capacity is adequate to store more than the 7 days collection. It is expected that waste recyclers will collect this sorted non-biodegradable waste at least once a week. Any residues will be handed over the Local Authority.

6.9 Scheduled Waste Streams and Containerization

It has to be noted that following have been excluded from above estimates:

- Hazardous waste: Chemical and biological waste from laboratories and research facilities, Paints and solvents, detergents and cleaning agents, oils and lubricants and their containers, contaminated packaging (this waste includes samples – spent or unspent; empty containers which are contaminated; organic and inorganic waste etc.)
- Sludges: Sewage sludge, industrial sludge etc.
- E-waste, electronic and electrical waste, bulbs, batteries etc.
- Large items such as discarded office furniture, fittings and fixtures etc.
- Miscellaneous items: Metals, PVC and large plastic items, non-hazardous industrial waste such as machinery and equipment

Certain other materials associated with products in MSW are often not accounted for because the appropriate sources and quantities cannot be estimated accurately.

Accurate calculation of the volumes and quantities of above waste is not possible until all the technical details and processes are finalized. However, the quantities of waste are small in volumes, and generation frequency can be regarded as infrequent. These types of waste needs containerization using appropriate bins, containers wither plastic, glass, cardboard or metal depending on the nature of the waste.

Hazardous/ Toxic Wastes from Laboratories, Research Stations, and Workshops

Proper hazardous waste management system will be introduced with appropriate segregation of hazardous waste, storage and its proper disposal. Chemical waste should be collected appropriately (e.g., separate collection of organic and inorganic chemicals, volatile matter, combustibles etc.) aiming at recovering used chemicals, oil and lubricants and reuse or remove from the machinery areas, workshops and equipment rooms. Such hazardous material will be placed in safe storage areas for chemicals, fuels and lubricants (including spent stocks) away from any drainage leading to water bodies and appropriately disposed.

Raising awareness among students, staff, guests and visitors on proper management of hazardous waste, with attention paid to waste minimization, recovery and recycling and safe disposal of hazardous waste is important. Hazardous/toxic material should be specially disposed of with the consultation of Central Environmental Authority, specialized institutions and/or commercial waste processing organizations by PHI of EUSL.

There is no storage time limit for laboratory hazardous waste accumulation until container is being filled. Hazardous waste container should be located in a reserved place in the laboratory/workshop and it is vital to manage as per to the CEA regulations. Once the hazardous waste accumulation area is filled, it is picked-up and transferred to the main (< 90-day) hazardous waste storage area within 3 days.

Disposal of hazardous waste should conform to “Guidelines for the Management of Scheduled Waste in Sri Lanka: In accordance to the National Environmental (Protection & Quality) Regulation No. 01 of 2008”, prepared by the Central Environmental Authority (CEA, 2009). Accurate identification and classification is the first step in proper handling and disposal of laboratory waste. Proper waste identification is allows to proper segregation and storage. This step makes handling of waste safer and handing over to the PHI of EUSL. Proper identification is therefore the first step in efficient waste management.

E-waste should not be mixed with other types of waste and should be handed over to designated collection centres or directly hand over to commercial e-waste processing organizations. E-wastes should be recycled to the extent as possible.

6.10 Implementation Programme

Awareness programmes should be conducted for the students and employees and leaflets will have to be distributed to visitors and all other people who are working within this building.

All the instructions have to be displayed at important places about the waste separation and other good practices on solid waste management.

Training programmes should be conducted for the janitorial staff and the service administration.

Section 3

PROPOSAL FOR DRAINAGE IMPROVEMENT AND STORM WATER MANAGEMENT IN VANTHARUMOOLAI MAIN CAMPUS EASTERN UNIVERSITY, SRI LANKA

Contents

1. Introduction

General

Recent storm events in 2008 and 2011 have resulted in major damage to the existing infrastructure in the premises of main campus of the Eastern University, Sri Lanka (EUSL) located in Vantharumoolai, Swami Vipulananda Institute of Aesthetic Studies (SVIAS) in Batticaloa and Trincomalee Campus located in Koneshpuram, Trincomalee, disrupting the academic programmes for prolonged periods.

It is therefore deemed highly desirable to establish an improved drainage system that would address the present drainage issues, detain stormwater on site for reuse while reducing flood risk, and to improve the quality of stormwater where possible on each Campus, also encompassing concerns of future expansions with emphasis on sustainable land-use development approaches. Thus, as a part of the Master Plan for the Physical Developments of the Eastern University of Sri Lanka, relevant hydrological studies and detailed drainage assessments were undertaken covering the core campus premises and underdeveloped areas with future development potential to delineate recommendations for drainage improvement and to propose a stormwater management plan as the first step in setting the long range plan for improvements to the University's stormwater management infrastructure.

Due to the notable differences in hydrologic and topographic features as well as sources and sequences of flood patterns and inundation, the drainage issues in the three premises were addressed separately. The identified drainage issues at the premises of Swami Vipulananda Institute of Aesthetic Studies (SVIAS), Batticaloa along with the proposed drainage improvements and stormwater management plan are presented below.

Objectives

The proposed drainage improvements in the Master Plan are focused on eliminating or reducing recently observed ponding/surcharging conditions within the EUSL Main Campus and other premises while taking into account sustainable drainage development principles based on known or proposed future development scenarios. The future developments will lead to higher density of urbanization in terms of increased student population and building density resulting in an increase in impervious surface, which generally gives rise to higher runoff flows and volumes. The existing greeneries and the landscaped areas, for instance at the EUSL Main Campus premises and Trincomalee Campus, provide outstanding opportunities for sustainable stormwater management design while further improvements are proposed to develop additional greeneries and retention/detention facilities on the Main campus and SVIAS premises.

The main objectives of the incorporated Drainage Improvement and Stormwater Management Plan are to;

- Provide general short-/long-term guidelines to alleviate flood risk and flood damage to existing EUSL infrastructure facilities and services to minimize subsequent interruption to academic programmes and other functionalities
- Provide guidelines to consider alternatives for the Master Plan for the Physical Developments of the Eastern University, Sri Lanka to reduce future flood risk to the existing infrastructure facilities and proposed future developments to eliminate or minimize flood damage and disturbance to the functionalities
- Provide guidelines to locate/relocate/remove important infrastructure facilities and services from the identified floodplain locations
- Help identifying deficiencies in the existing drainage and flood management facilities and propose improvements including regional/local detention and/or channel improvements with emphasis on sustainable land-use development approaches ensuring adequate provisions required to meet the future needs of the University
- Provide guidelines to integrate each individual future development over the planning horizon of next 15-25 years (up to 2035) as part of the campus-wide drainage management facilities to properly address the issues pertaining to stormwater generation, retention/detention, and conveyance with adequate provisions for further capacity enhancement.

Scope of the Work

This study will follow standard hydrologic and hydraulic analysis methods to assess present and anticipated drainage scenarios and identify drainage issues based on available/gathered data. The required drainage improvements for stormwater management to existing/future infrastructure developments in the Master Plan and remedial measures to avoid identified or anticipated issues either to maintain the present desirable drainage patterns unchanged or to further enhance the circumstances, minimizing the adverse effects to the environment due to probable changes in the hydrology and flow conditions at the site are recommended.

The analyses and recommendations are based on the information and data gathered at the site, through the client and relevant authorities.

2. Description of the Site

General

Vantharumoolai Main Campus

The EUSL main campus is located in Vantharumoolai, Batticaloa on either side of the Valachchenai-Batticoloa (A15) main road (Figs. 1a & 2a) and the topography of the site is characterized by flat terrain with virtually no undulations. The overall area extent is 119 acres (48.16 ha) and the close proximity to several water bodies (Uppu Aru and Kadiraveli Aru and other low-lying areas) in the downstream floodplains have made the EUSL main campus premises highly vulnerable to recurrent flooding.

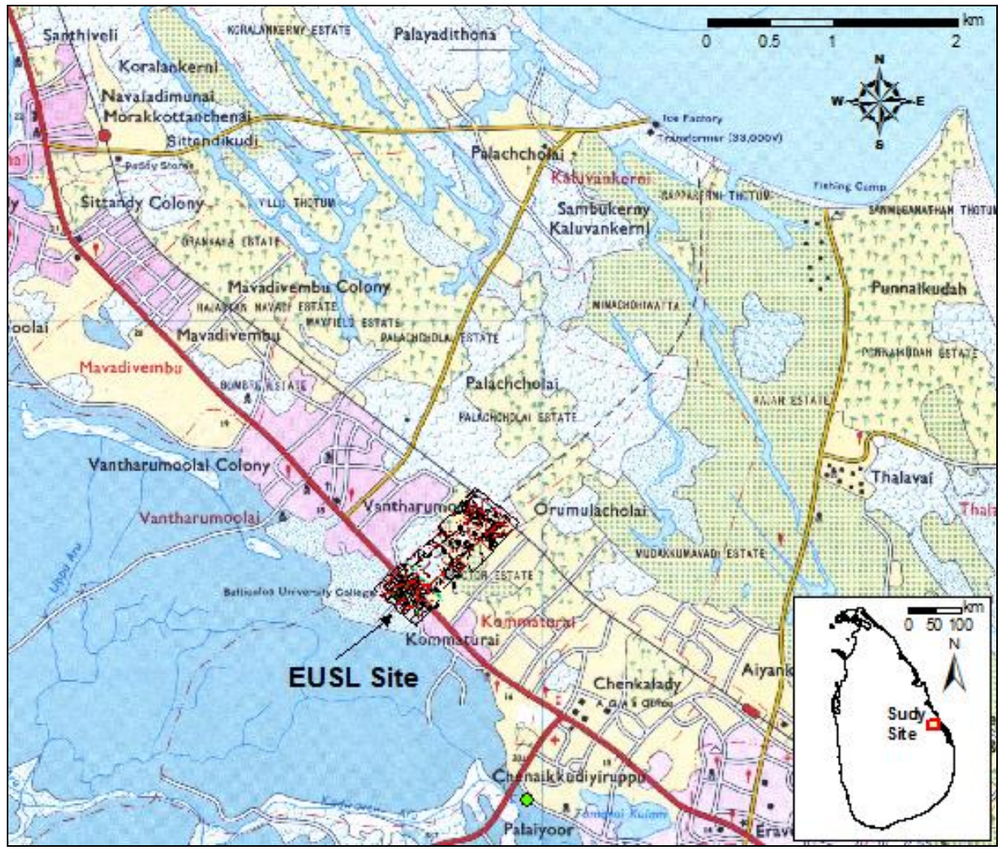


Fig. 3.1a. Location Map (Source: 1: 50,000 topo maps; Survey Dept.)

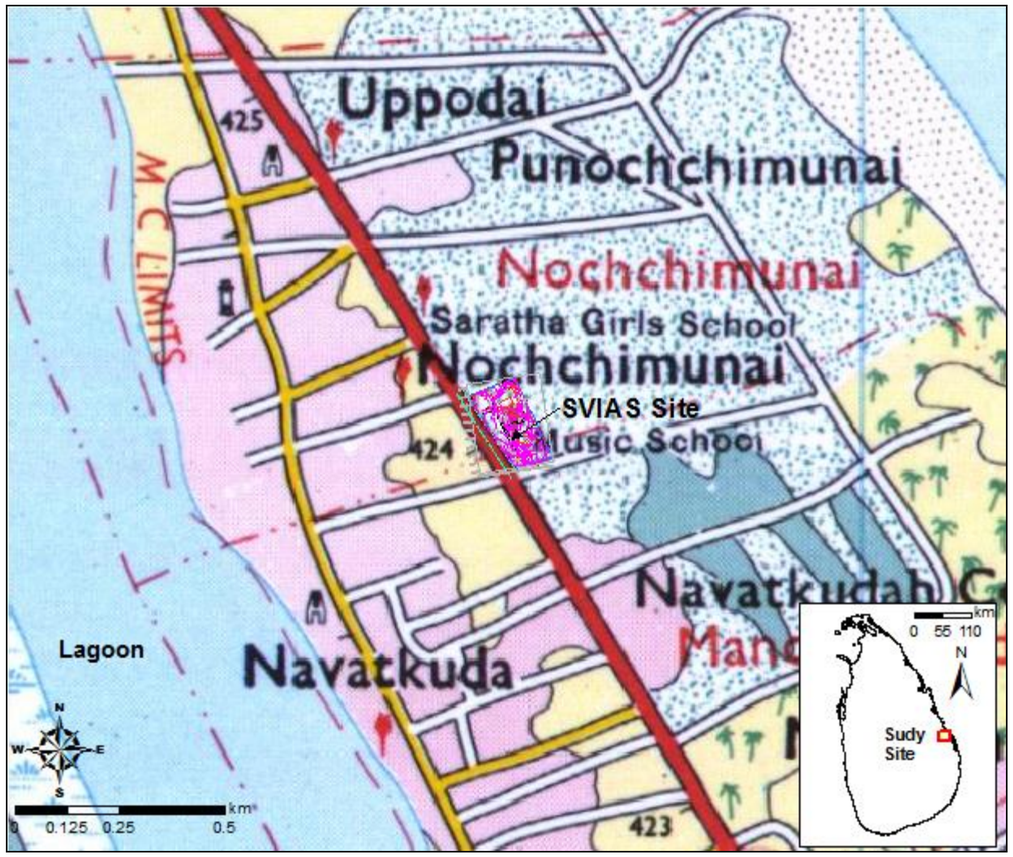


Fig. 3.1b. Location Map (Source: 1: 50,000 topo maps; Survey Dept.)

Climate, Topography and Hydrology

Batticaloa region is located in the dry zone of the country in the eastern coastline with a dry-monsoonal climate pattern featuring a monthly temperature variation of 23.2 °C ~ 34.1 °C and a mean annual rainfall of 1,650 mm. The area falls within the Hydrological Zone I (Ponrajah, 1984) and during the monsoon season from November to February, heavy rains are recorded (up to 75~80 % of annual rainfall), causing recurrent floods, especially in low-lying floodplains and associated flood fringes.

The site topography of Vantharumoolai Main Campus premises with ground elevations varying from 2.25 m ~ 4.50 m is basically characterized by flat terrain mildly sloping (< 2.0 %) in a south-westerly direction towards the downstream paddy lands in low-lying Uppu Aru, Varakatta Aru and Kadiraveli Aru floodplains (Annex 3-1 a).

The site topography SVIAS with ground elevations varying from mere 3.85 m ~ 4.50 m is characterized by extremely flat terrain with no significant undulations or slopes (Annex 3-1b).

Fig. 3.2: Location Map (Source: Google Maps Inc.)

3. Drainage and Storm Water Management

3.1 Present Condition

Vantharumoolai Main Campus

The presently existing storm drainage system in EUSL premises is a combination of open channels and shallow ditches, small roadway culverts and drains (toe drains) in some parts, and roof gutters and associated (gutter) drains (in most of the buildings). No closed conduits and catch basins (collecting runoff from curb and gutter roads, parking lots, and rooftop drainage) are incorporated. No any perennial streams or detention ponds are found, however accumulated stormwater flows and localized ponding is observed during monsoonal rain season. Drainage outlets from the site located north to the Valachchenai-Batticoloa main road are diverted outside the premises through the existing green belt area and connected to the main channel network while areas closer to the road are drained to existing roadside drains. The area located south to the main road is drained to the downstream open area connected to the paddies and floodplain via the main shallow open channel across the premises (Annex 3-2a & 3-3a).

3.2 Drainage Issues Identified

Vantharumoolai Main Campus

The major flood and drainage related issues identified during initial reconnaissance survey and subsequent site visits, via stakeholder interviews, field detailed/contour and GPS surveys, subsequent hydrological studies and flood/inundation modelling and mapping exercises are highlighted as follows (Figs. 3 a-e).

i). Recurrent flooding recorded in low-lying areas within EUSL Main Campus premises, especially in the southern parts of the university, Faculty of Agricultural including animal farm area and area upstream of the playground

ii). Inadequacy of existing drainage network (including capacity inadequacy of drains/ channels/culverts, disconnected road side drains, new road embankment constructions without culvert crossings/side drains, discontinued/blocked roof gutter drains, roof gutters/downpipes open to roadways and other open areas, improper or no regular maintenances/repairs)

iii). Areas without any drainage facilities presently in place

iv). Cross drainage runoff flows from offsite areas passing through EUSL premises

v). Improper landscaping practices without maintaining proper slopes and flow diversions; erosion in non-lined, unprotected channels

vi). Inadequate or no on-site runoff retention/detention and rainwater harvesting systems, and unplanned filling/solid waste storage in existing detention areas

vii). For major storm events (extreme events) with return period over 25 years, large extents within the university premises undergo severe flooding caused due to the backwater propagation effect when the low-lying floodplains in the downstream are inundated.

Fig. 3.3a: Blocked gutter drain (Left) and silted drain with blocked/closed culvert (Right)

Fig. 3.3b: Gutter drains not connected to main drainage lines with open ditches with inadequate capacity (Left) and Broken roof gutters (Right)

Fig. 3.3c: Blocked, discontinued and leaking gutter drain (Left) and Blocked/silted main drains (Right)

Fig. 3.3d: Silted/partially blocked cross drainage culvert (Left) and Blocked roadside (toe) drainage line (Right)

Fig.3.3e: Cross drainage culvert with inadequate capacity/not well maintained and unlined open channel used to convey accumulated stormwater to downstream floodplain

3.3 Hydrologic and Hydraulic Assessment

Topographic maps with 1:10,000 and 1:50,000 scales were primarily used together with the collected Global Positioning System (GPS) coordinates to locate the structures. Supplementary topo and land use information from Google Earth maps, Google terrain data, SRMT/BTOPO30 arc 1.5 satellite DEM data and other relevant images have also been obtained as required and used for developing a Digital Terrain Model for runoff inundation modelling (Annex I).

Rainfall and Intensity Duration Frequency [IDF] curves for runoff generation were obtained from Ranatunge (2001) for 2-10 year design return periods and Ponrajah (1984) for others.

A computerized hydraulic/hydrodynamic model of the site location and floodplain was formulated based on the Digital Terrain Model (DTM) developed using SRMT/GTOPO30 satellite DEM data in combination with field survey data/floodplain cross section data, using SMS (Surface-water Modelling System- US Army Corps of Engineers/Aquaveo). The model was run using peak flow generated by Rational method for the identified contributing catchment area as upper boundary for culverts and downstream accumulation (fixed flow), no slip boundaries at upper and lower banks at a spatial and temporal resolutions of 25 m x 25 m and 15 min, respectively. The flow depth and velocity profiles were generated at selected nodal points after reaching peak flow state.

The inundation patterns and identified flood depth data are presented in Annex 2 a –b. However, these depths should used with caution (as indicative values only) due to course grid used and interpolation of scarcely available terrain maps.

The existing drainage network was assessed for the flows from identified catchment/sub-catchment areas and adequacy of existing facilities and improvements required were considered (Annexes 1 - 2).

3.4 Recommendations for Further Improvement

Vantharumoolai Main Campus

The following recommendations are proposed to address the recurrent flooding and drainage issues at the premises of EUSL Main Campus in Vantharumoolai, Batticaloa, with long-term recommendations to improve drainage management ensuring sustainable future development of infrastructure facilities and incorporated services.

i). Capacity enhancement and required expansions to the existing drainage system to accommodate at least 25-year return period flood event (preferably resistant to a 50-year design storm event).

ii). Intercepting cross drainage from offsite runoff using boundary drains and diverting those flows either to the roadside drains or nearest natural streams/drainage channels where feasible or provision or channels with adequate capacity (bio-swales merging with existing/proposed landscape).

iii). Adopt a proper landscape plan and proper drainage management practices; maintain proper slopes and raise extremely low-lying areas above identified flood line with adequate drainage provisions to alleviate flood risk to adjoining areas. Raise local roads above flood line where necessary and provide adequate cross drainage structures.

iv). Design and introduce an engineered channelway to handle on-site runoff generation and cross drainage flows due to off-site runoff via EUSL premises (one connected to the main culvert and ponding area off playground and via existing forested area) with adequate capacity, proper slopes, adequate cross drainage culverts at internal road crossings, rubble stone lining and vegetation cover to minimize erosion while optimizing infiltration recharge, and subsequently discharging associated redundant flows to nearby roadside drains/natural streams/outside drainage network or any other receiving drainage way.

v). An additional similar engineered channelway is proposed to replace the existing open channel in the EUSL main premises (one replacing existing canal beside administrative building area). Partly blocked areas with inadequate capacity need to be cleared and blocked culverts should be replaced with structures of appropriate sizes (to accommodate 25-year return period design storm flow; preferably resistant to a 50-year design storm event).

vi). On-site retention and detention of flood volume is recommended; the green belt and low-lying green belt area located north to the playground and on the opposite side of the local/internal road can be effectively used for this purpose. Introduction of bio-swales that can function as detention basins is promoted. Such detention facilities and bio-swales can be developed and merged into existing/proposed landscape plan with a naturalistic form rather than a geometric form. The banks of the bio-swales should be planted with water-tolerant ground cover and low-growing shrubs to stabilize the banks and mitigate the occurrence of intermittent flooding. Engineered spillway should be designed to release above 10-year return period flood and sized to accommodate 25 or 50-year design return period peak flood.

vii). Promotion of Rain Water Harvesting as a Flood Management Measure: As per the National Rainwater Policy (2006) and the Urban Development Authority (Amendment) Act No. 36 of 2007, it is required to implement provisions for rainwater harvesting in new Development Plans (Section 8A of the UDA Law No. 41 of 1978). These by-laws on drainage are aimed at rainwater harvesting as a strategy for localized flood mitigation, in both existing and future construction. Apart from satisfying the legal requirement, rainwater harvesting will be of immense benefit to the proposed flood management plan at EUSL for alleviating the risk of localized flooding and also as a secondary source to supplement water usage for gardening and landscaping purposes, etc. Thus, it is highly recommended to adopt a suitable system for rainwater harvesting under the proposed flood protection and drainage improvement project.

viii). All existing drains/ditches, rain gutters and downspouts (via rainwater harvesting system), off-flow from rainwater harvesting systems, remnant flows from service utilities/farm/irrigated areas, and any other water sources should be connected to the drainage network and no flows should be diverted to open spaces/roadways.

ix). All future expansions and infrastructure development facilities should be made a part of the existing whole university-wide drainage network by properly incorporating them into the existing system; stormwater management/drainage components associated with new construction projects should be constructed in accordance with adopted level-of-service standards.

x). An underground drainage system with catch basins (for collecting runoff from curb and gutter roads, parking lots, and rooftop drainage) is recommended to be placed where provision of open ditches is not feasible; however, adequate capacity, proper maintenance and uninterrupted flow connectivity to the main network should always be ensured.

xi). Precautions are recommended to avoid direct discharge or mixing of animal/farm waste with runoff flows during storm events. Disposal only after necessary treatments or diverting to a biological treatment site is recommended.

xii). Further capacity enhancements as necessary and regular maintenance of the drainage network and other related facilities to be carried out on a routine basis.

4. Other Considerations

4.1 Buildings and Infrastructure

In almost all the EUSL premises, a significant inundation is observed due to storm events larger than 25-year design return period, caused by backwater effect as a result of the downstream control conditions in extremely flat terrain. This is most severe in the cases of EUSL Main Campus premises and EUSL Trincomalee Campus where inundation can last for several days longer. For EUSL Main Campus premises, it has been observed that the backwater curve extends far beyond the university premises for about 5.0 km upstream and inundation is very severe (up to 2.0 m high) in the Black Bridge (1.6 km downstream in Chenaikkuddiyiruppu across Kadiraveli Aru) and Red Bridge (5.2 km upstream in Mylavethuan across Varakatto Aru) areas, despite the huge retention capacity available in the areas of paddies and vast extents of floodplain. The stream channel widening, re-direction/diversion of discontinued streams (ending in the floodplain and connected to nowhere) and proper/regular maintenance of downstream stream stretches clearing stream

lagoon outfalls of accumulated sandbars would ease the flood damage but implementing such proposals are presumed to be highly expensive and need national/regional government level involvements and policy decisions. Therefore, the following recommendations are made for further consideration, especially for future development of infrastructure facilities.

i). Flood avoidance: Constructing the buildings and their surrounds (at site level) in such a way to avoid them being flooded (e.g. by raising it above flood level, re-siting, outside flood risk area, use ground floor for parking, etc.)

ii). Flood resistance: Constructing a building in such a way to prevent floodwater entering the building and damaging its internal/peripheral walls etc.

iii). Flood resilience: Constructing a building in such a way that although flood water may enter the building its impact is reduced (i.e. no permanent damage is caused, structural integrity is maintained and drying and cleaning are facilitated).

iv). Flood repairable: Constructing a building in such a way that although flood water enters a building, elements that are damaged by flood water can be easily repaired or replaced. This is also a form of flood resilience.

4.2 Access Roads and Internal Road Network

i). All access roads and internal roads should be adequately raised above the design flood level with sufficient freeboard up to the road-base, allowing sub-base and sub-grade to stay above minor floods, protecting constituent materials against weakening and degrading due to over-saturation.

ii). However, these levels should be checked against the proposed landscapes/slopes and adjusted accordingly not to obstruct accessibility to existing buildings/disturb continuity of landscape.

iii). Side drains and toe drains alongside existing roads and cross drainage culverts should be regularly maintained clear of debris and silt.

iv). Side drains and toe drains of adequate design capacity should be provided alongside of roads as required and proper cross drainage structures should be provided where necessary to divert accumulated flows to the main drains via properly aligned lead away canals.

4.3 Stormwater Retention and Detention

i). A stormwater retention/detention facility of approximately 1.5~2.0 ha (10,000 m^3) is proposed near the existing main culvert (north of play ground area).

ii). Culvert sizes, spill levels, and minimum flow releases should be estimated based on the design storm return period.

iii). This facility can be effectively merged into proposed landscape plan.

4.4 Proposed Stormwater Management Plan

i). The improvements to be incorporated to the existing network is given in Annex 6.8, and provided separately (AutoCAD).

ii). The layout and sizes/slopes provided are only indicative and exact capacities, dimensions and slopes should be decided based on a detailed analysis.

5. Conclusions

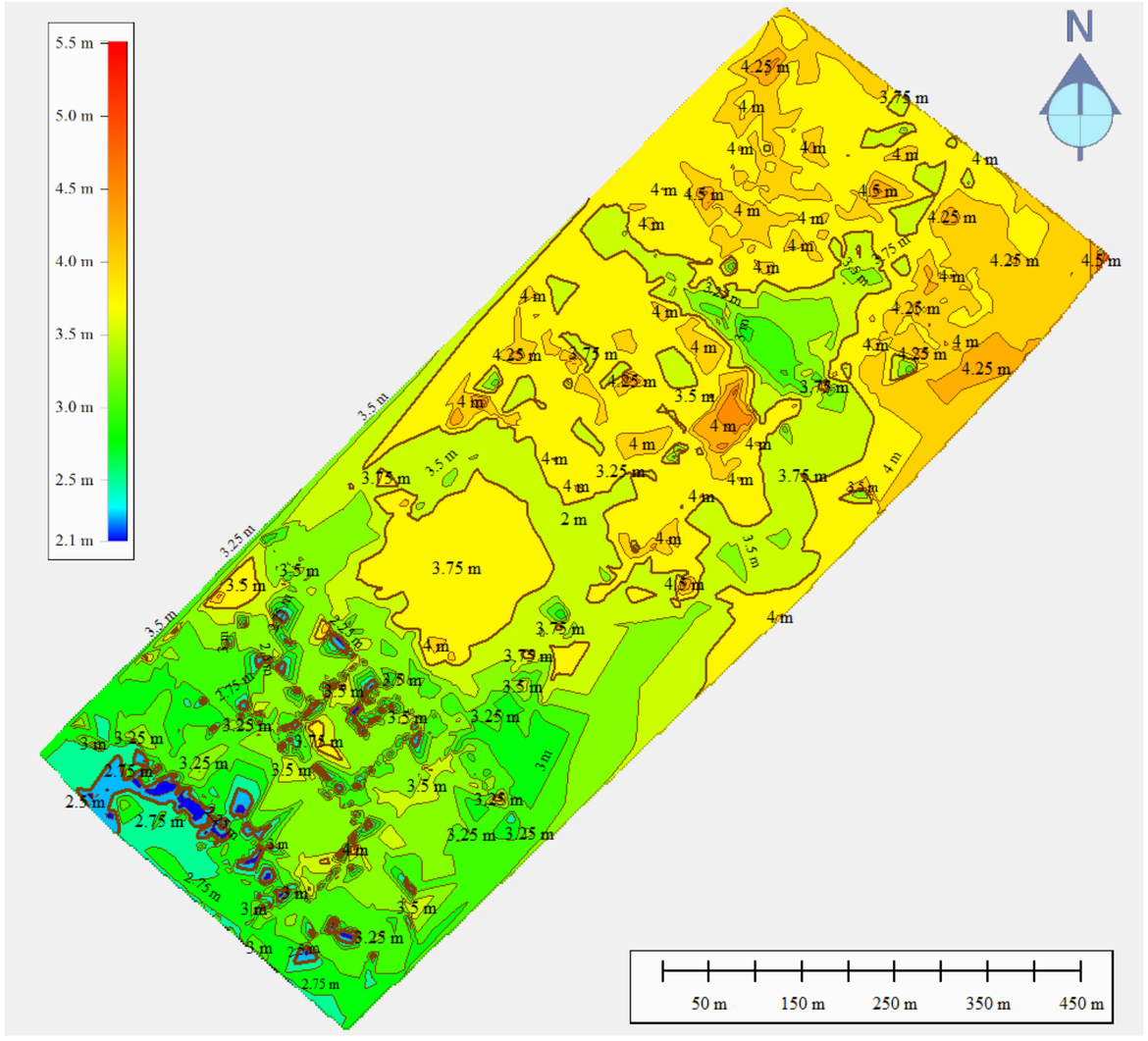
Drainage improvement and flood protection measures to Vantharumoolai Main Campus and SVIAS in Kallady, Batticaloa have been proposed herein under this Drainage Management Plan.

It has been noted that minor flood conditions and localized flooding due to annual and 2-year, and up to 10-year design return period flood/storm events can be adequately addressed through drainage enhancement, provision of proper landscaping and best management options and routine/regular maintenance of drainage networks.

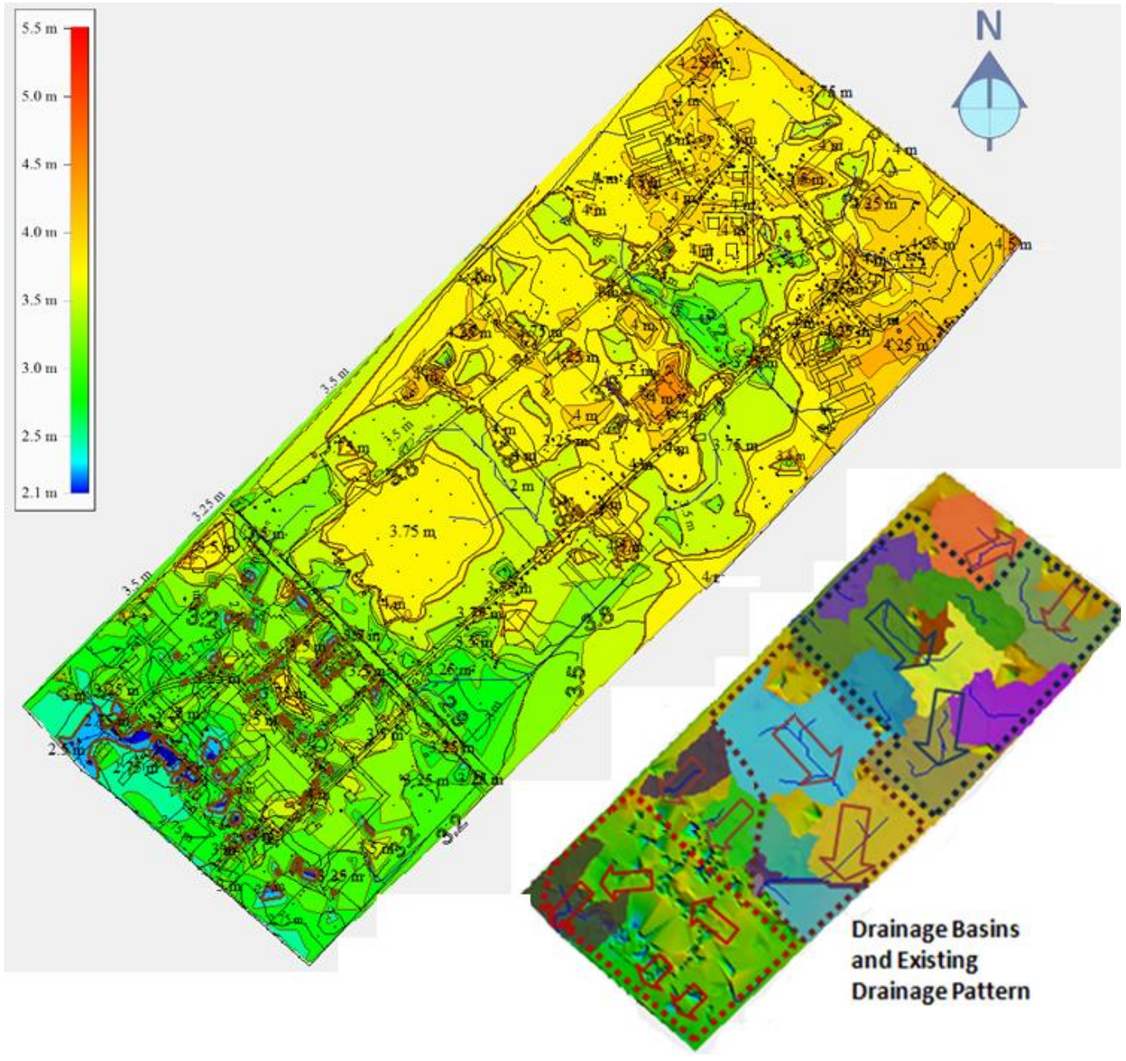
Adequate precautions should be taken considering flood avoidance/flood resistance/flood resilience during Master Plan implementation to address flood events exceeding these limits.

6. Annexes

ANNEX 3-1a: EUSL Main Camps Site Contour Layout and Existing Drainage Pattern



i). EUSL Main Camps Site Contour Layout

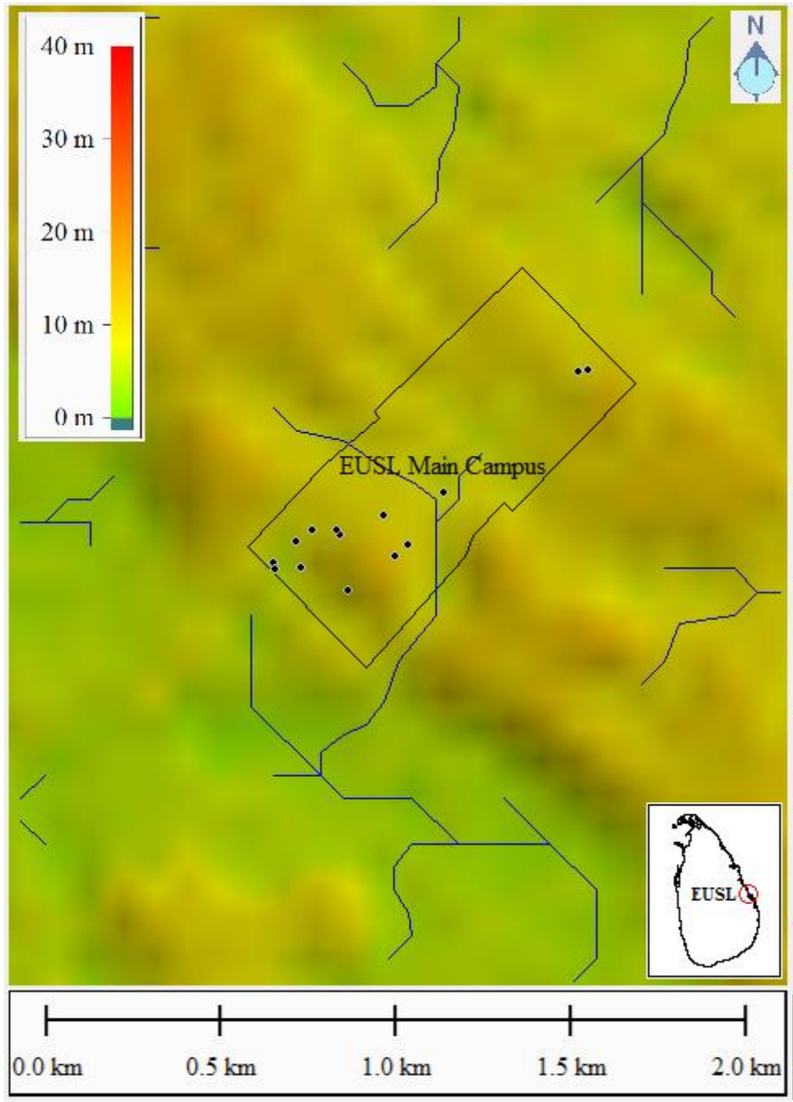


ii). Existing Drainage Pattern

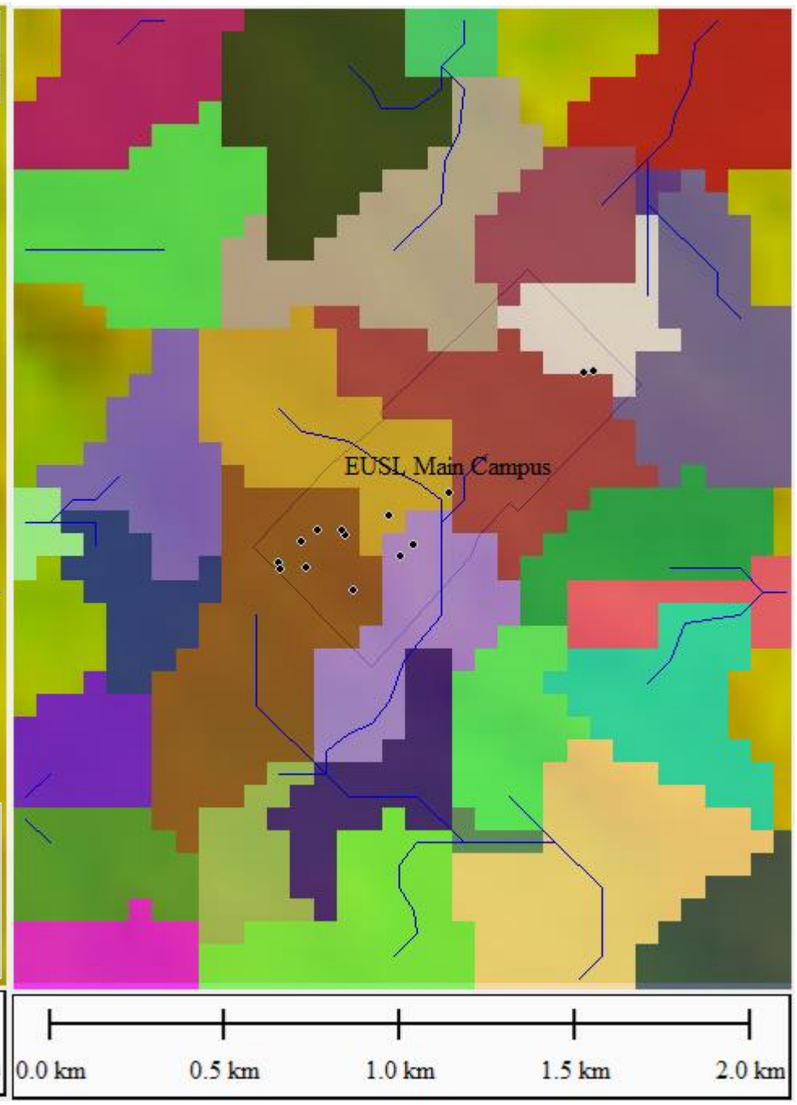
Note: *Spot heights for contour generation were based on field survey data.*

The catchment and sub catchment boundaries were delineated using SRTM/GTOPO30 Satellite DEM data, 1:50,000 topographical sheets and collected information in the field (1:10,000 maps are not available for this area).

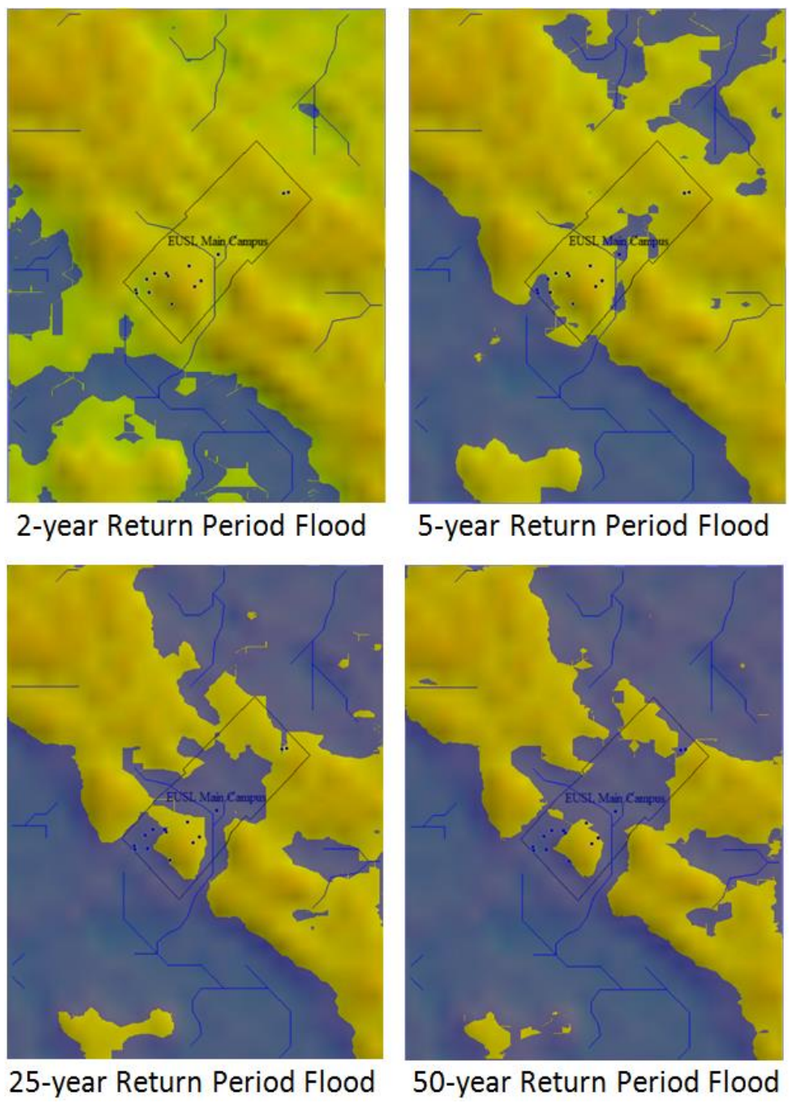
ANNEX 3-2a: EUSL Main Camps Off-site Runoff Flows and Inundation Patterns



a). Identified Off-site Runoff/Overland Flows



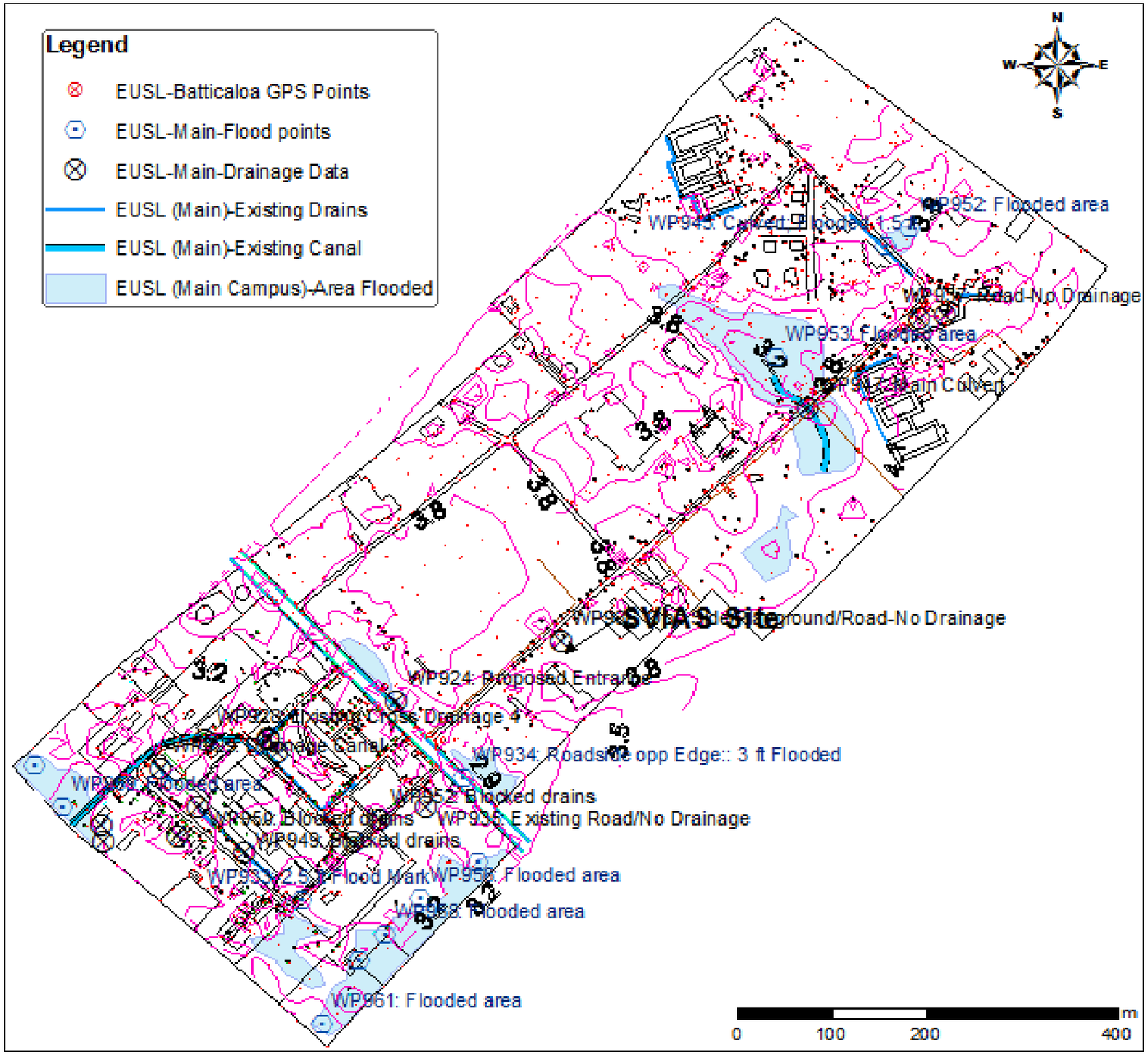
b). Contributing Catchments



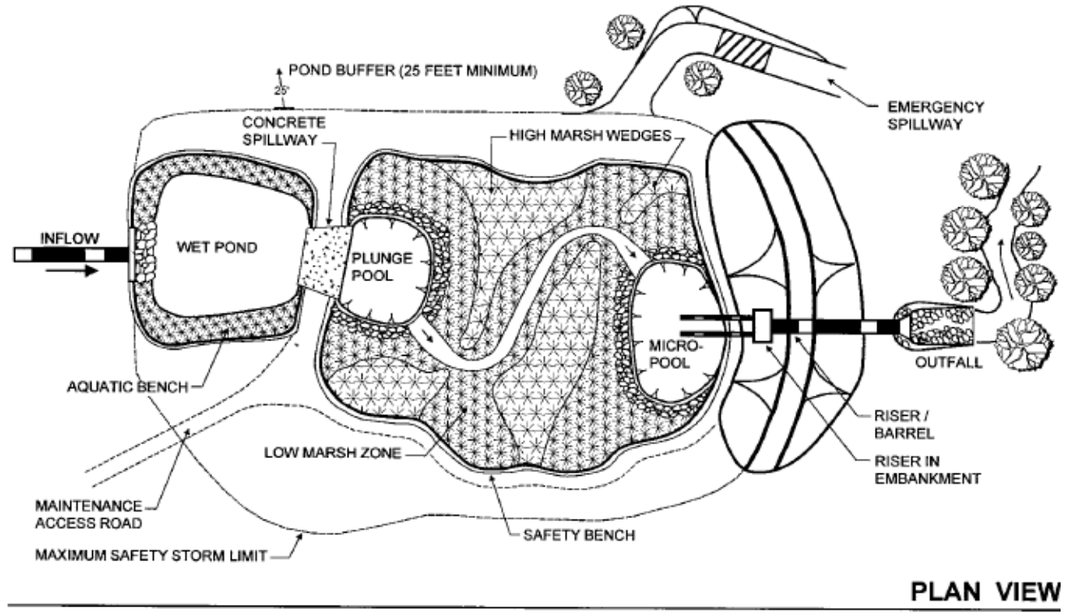
c). Identified Flood Inundation Patterns

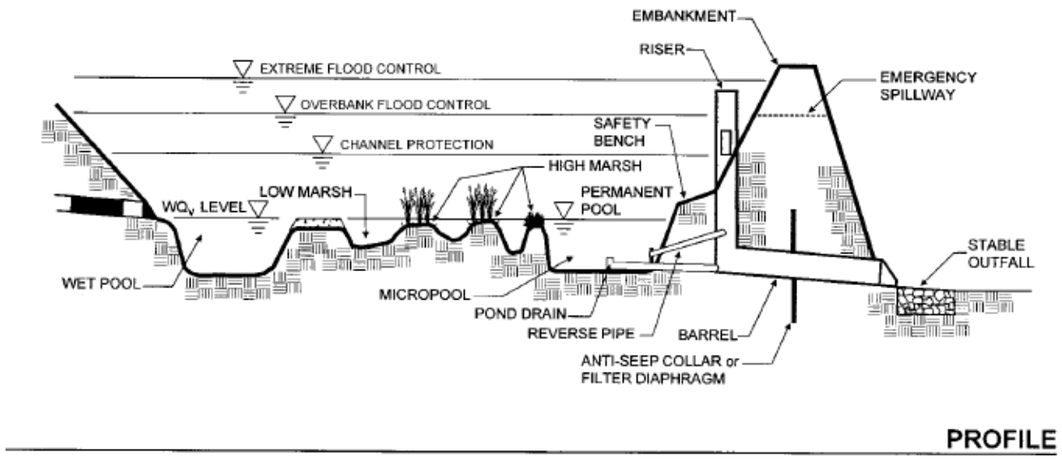
Note: The catchment and sub catchment boundaries were delineated using SRTM/GTOPO30 Satellite DEM data, 1:50,000 topographical sheets and collected information in the field (1:10,000 maps are not available for this area).

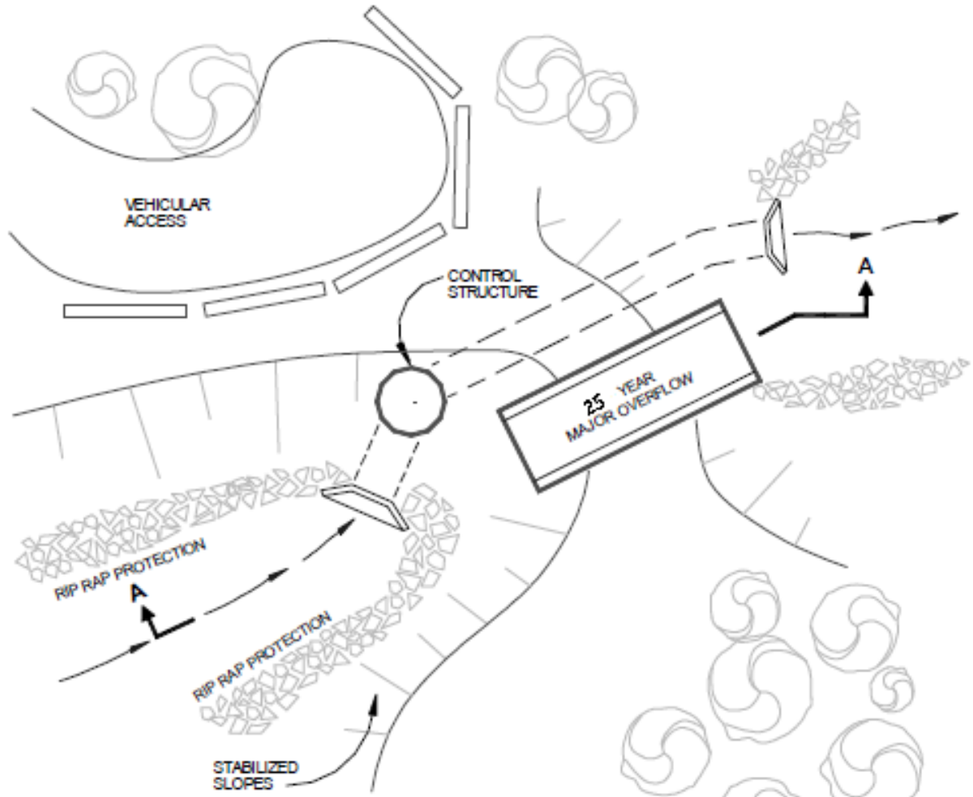
ANNEX 3-3a: EUSL Main Campus - Existing Drainage Layout and Flood Record Data

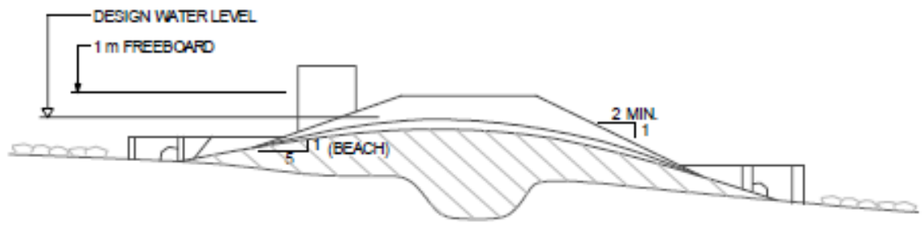


ANNEX 3-4: Examples of Ponding Facilities (Bio-swales) for Drainage Management

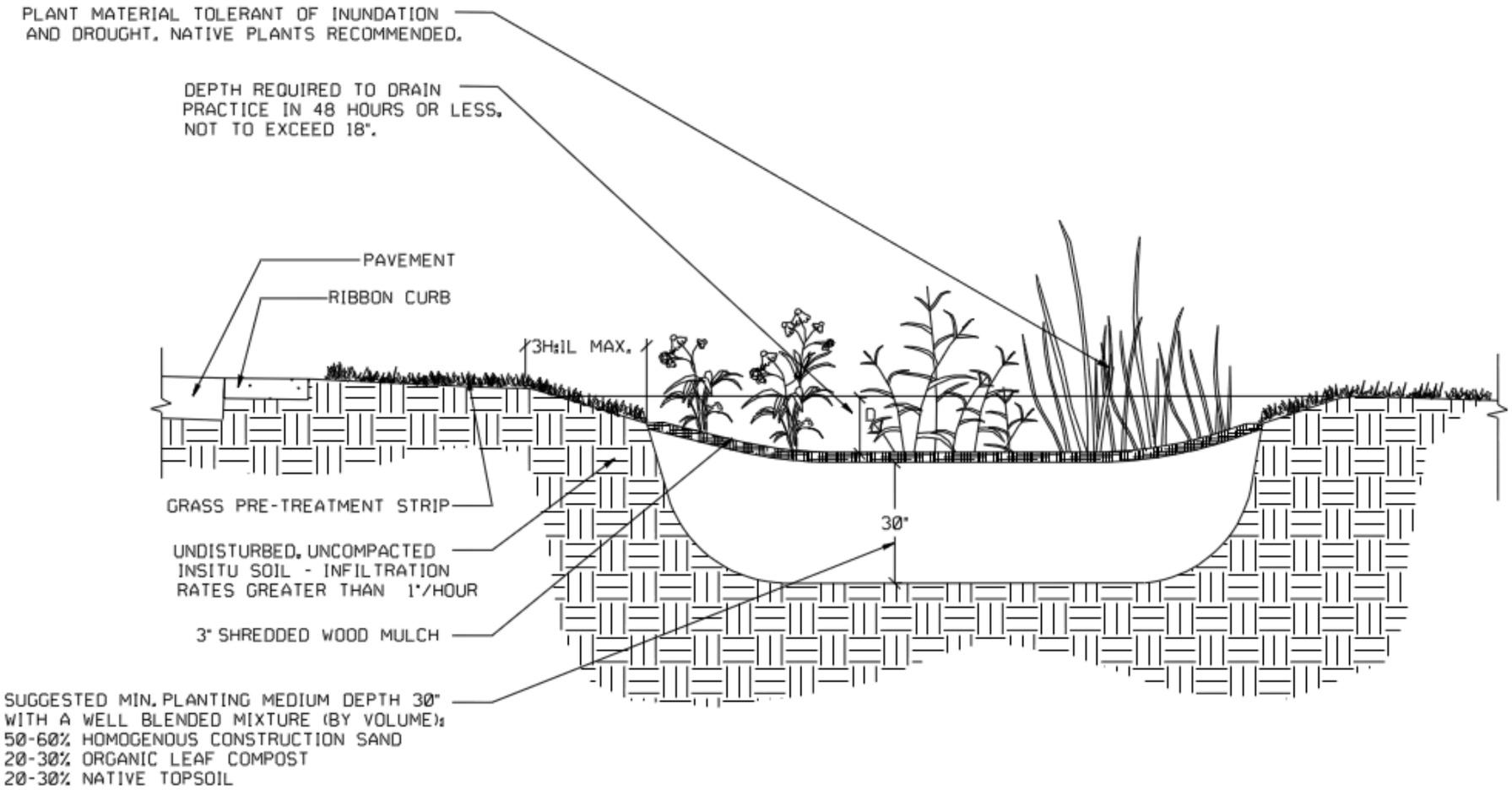








ANNEX 3-5: Examples of Engineered Channelway to Promote Groundwater Recharge



Not to scale: Channel depth should be selected according to the estimated flood/peak discharge.
Rubblestone lined bed profile is preferred for high discharges and velocities above 2.0 m/s.

ANNEX 3-6a: Estimation (sample) for Rectangular Channel Sections and Bio-swales in Catchment 1

NAME/ID: Catchment 1 for Channel in Admin Area							
Parameter	Unit	Return Period					
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Peak Flow Estimate [Rational Method]							
A	ha	9.2					
Lc	m	343.16					
V	m/s	0.45					
Tch	min	12.71					
Tc	min	27.71					
X		90.10	84.65	79.20	73.75	88.91	87.27
Y		0.82	0.78	0.75	0.71	0.72	0.70
I	mm/hr	151.68	160.07	168.23	175.97	205.90	213.84
C		0.42					
Q_0	**m^3/s**	1.63	1.72	1.81	1.89	2.21	2.30
Channel Design [Manning's Equation]							
Canal Section		Rectangular					
Reqd Base WD	m	1.55	1.60	1.65	1.70	1.90	2.00
D	m	1.00	1.00	1.00	1.00	1.00	1.00
Top W	m	—	—	—	—	—	—
A	m^2	1.55	1.60	1.65	1.70	1.90	2.00
P	m	3.55	3.60	3.65	3.70	3.90	4.00
R		0.44	0.44	0.45	0.46	0.49	0.50
n		0.013					
S		0.0006					
V	m/s	1.08	1.10	1.11	1.12	1.17	1.19
Q_d	**m^3/s**	1.68	1.76	1.83	1.91	2.22	2.37
Q_0 (Imperial)	**cfs**	57.50	60.68	63.78	66.71	78.05	81.07
V	ft/s	3.56	3.60	3.64	3.68	3.83	3.89
Q_d	**cfs**	59.37	62.01	64.68	67.36	78.29	83.85

NAME/ID: Catchment 1 for Channel in Admin Area							
Parameter	Unit	Return Period					
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Peak Flow Estimate [Rational Method]							
A	ha	9.2					
Lc	m	343.16					
V	m/s	0.45					
Tch	min	12.71					
Tc	min	27.71					
X		90.10	84.65	79.20	73.75	88.91	87.27
Y		0.82	0.78	0.75	0.71	0.72	0.70
I	mm/hr	151.68	160.07	168.23	175.97	205.90	213.84
C		0.42					
Q_0	**m^3/s**	1.63	1.72	1.81	1.89	2.21	2.30
Channel Design [Manning's Equation]							
Canal Section		Trapezoidal					
Reqd Base WD	m	1.40	1.55	1.65	1.80	2.30	2.45
D	m	1.00	1.00	1.00	1.00	1.00	1.00
Top W	m	5.40	5.55	5.65	5.80	6.30	6.45
A	m^2	3.40	3.55	3.65	3.80	4.30	4.45
P	m	5.87	6.02	6.12	6.27	6.77	6.92
R		0.58	0.59	0.60	0.61	0.63	0.64
n		0.035					
S		0.0006					
V	m/s	0.49	0.49	0.50	0.50	0.52	0.52
Q_d	**m^3/s**	1.65	1.75	1.81	1.90	2.22	2.32
Q_0 (Imperial)	**cfs**	57.50	60.68	63.78	66.71	78.05	81.07
V	ft/s	1.60	1.61	1.63	1.64	1.70	1.71
Q_d	**cfs**	58.38	61.69	63.91	67.25	78.52	81.93

Note: For bio-swales, trapezoidal section with 1 : 2 (v : h) slopes are assumed.

Adequate freeboard (300 mm minimum) should be allowed on top of above estimated channel depths.

ANNEX 3-7a: Estimation (sample) for Rectangular Channel Sections and Bio-swales in Catchment2

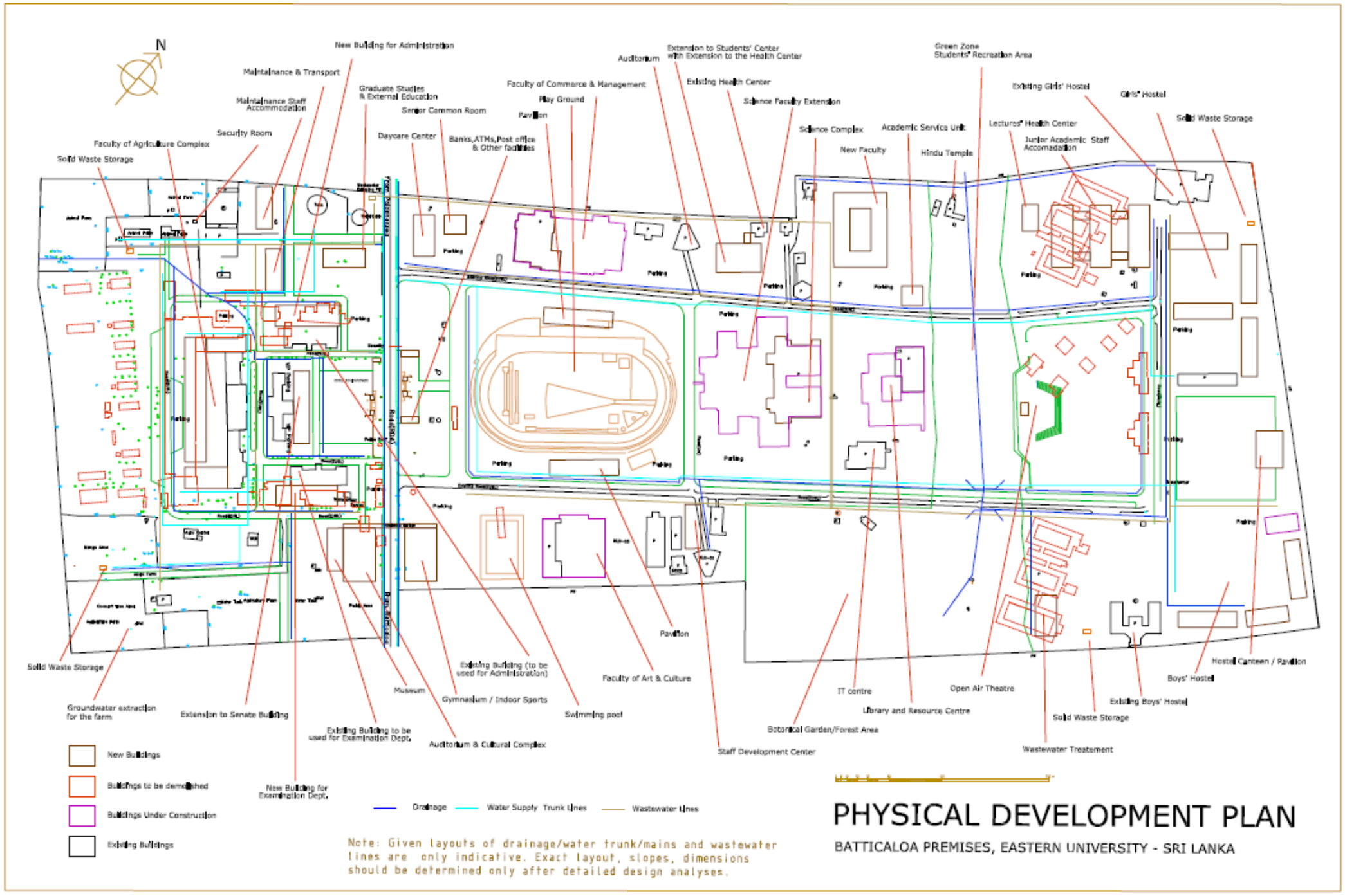
NAME/ID: Catchment 2 for Channel North of Playground Area							
Parameter	Unit	Return Period					
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Peak Flow Estimate [Rational Method]							
A	ha	14.2					
Lc	m	426.33					
V	m/s	0.45					
Tch	min	15.79					
Tc	min	30.79					
X		90.10	84.65	79.20	73.75	88.91	87.27
Y		0.82	0.78	0.75	0.71	0.72	0.70
I	mm/hr	139.16	147.41	155.49	163.25	190.83	198.54
C		0.42					
Q_0	**m^3/s**	**2.31**	**2.44**	**2.58**	**2.70**	**3.16**	**3.29**
Channel Design [Manning's Equation]							
Canal Section		Rectangular					
Reqd Base WD	m	2.00	2.05	2.15	2.25	2.50	2.60
D	m	1.00	1.00	1.00	1.00	1.00	1.00
Top W	m	—	—	—	—	—	—
A	m^2	2.00	2.05	2.15	2.25	2.50	2.60
P	m	4.00	4.05	4.15	4.25	4.50	4.60
R		0.50	0.51	0.52	0.53	0.56	0.57
n		0.013					
S		0.0006					
V	m/s	1.19	1.20	1.22	1.23	1.27	1.29
Q_d	**m^3/s**	**2.37**	**2.45**	**2.61**	**2.77**	**3.18**	**3.35**
Q_0 (Imperial)	**cfs**	**81.43**	**86.25**	**90.98**	**95.52**	**111.66**	**116.17**
V	ft/s	3.89	3.93	3.99	4.05	4.18	4.23
Q_d	**cfs**	**83.85**	**86.65**	**92.29**	**97.99**	**112.43**	**118.28**

NAME/ID: Catchment 2 for Channel North of Playground Area							
Parameter	Unit	Return Period					
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
Peak Flow Estimate [Rational Method]							
A	ha	14.2					
Lc	m	426.33					
V	m/s	0.45					
Tch	min	15.79					
Tc	min	30.79					
X		90.10	84.65	79.20	73.75	88.91	87.27
Y		0.82	0.78	0.75	0.71	0.72	0.70
I	mm/hr	139.16	147.41	155.49	163.25	190.83	198.54
C		0.42					
Q_0	**m^3/s**	**2.31**	**2.44**	**2.58**	**2.70**	**3.16**	**3.29**
Channel Design [Manning's Equation]							
Canal Section		Trapezoidal					
Reqd Base WD	m	2.45	2.65	2.85	3.05	3.75	3.95
D	m	1.00	1.00	1.00	1.00	1.00	1.00
Top W	m	6.45	6.65	6.85	7.05	7.75	7.95
A	m^2	4.45	4.65	4.85	5.05	5.75	5.95
P	m	6.92	7.12	7.32	7.52	8.22	8.42
R		0.64	0.65	0.66	0.67	0.70	0.71
n		0.035					
S		0.0006					
V	m/s	0.52	0.53	0.53	0.54	0.55	0.56
Q_d	**m^3/s**	**2.32**	**2.45**	**2.58**	**2.71**	**3.17**	**3.30**
Q_0 (Imperial)	**cfs**	**81.43**	**86.25**	**90.98**	**95.52**	**111.66**	**116.17**
V	ft/s	1.71	1.73	1.74	1.76	1.81	1.82
Q_d	**cfs**	**81.93**	**86.50**	**91.10**	**95.71**	**111.98**	**116.66**

Note: For bio-swales, trapezoidal section with 1 : 2 (v : h) slopes are assumed.

Adequate freeboard (300 mm minimum) should be allowed on top of above estimated channel depths.

ANNEX 3-8a: Layout for Drainage, Water Trunk Lines (Mains) & WastewaterLines



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Section 4

PROPOSAL FOR LANDSCAPE IMPROVEMENTS

IN

VANTHARUMOOLAI MAIN CAMPUS

EASTERN UNIVERSITY, SRI LANKA

Contents

1. Introduction

This proposal consists of general concepts and guidelines for the landscape as well as some specific landscape concepts for the specific premises of the EUSL, and should be used in tandem with the master plan in all occasions.

The landscape proposal includes separate planning and management proposals for selected areas of each of the premises of EUSL.

The selected areas are as follows :

(i) Entry environment.
(ii) Road side landscape, including parking.
(iii) Geographical and water features.
(iv) Immediate surroundings of the building edges and courtyards.
(i) Gardens, parks and protected areas.

2. General Concept for the Landscape:

The students are the primary users of the University landscape. Age, sex, ethnic group and religion need to be considered as important demographic factors to offer appropriate landscape solutions.
As landscape provides a multitude of interesting environments and experiences, there is the need for a uniting thread throughout the university to knit these and future landscapes into a cohesive complementary whole. The master plan study recognized the need for a landscape concept to provide this sense of organization and identity. The concept organizes the landscape features into three general categories as:

Rustic landscape

Discrete landscape

Transitional landscape

The **rustic landscape**, which encompasses the remaining vegetation, would give character of native vegetation in reserved areas and parks. This landscape character sets the special identity and theme for the university.

In contrast, the **discrete landscape** consists of more formal, flowing trees associated with buildings, building courtyards, and entry environments. This landscape character mainly gives the primary identity to the University.

The **transitional landscape** encompasses the play fields, ground covered areas (turf) and major walks that link the rustic landscape to the discrete landscape. The composition of the above three concepts depends on the availability of land extent and existing landscape resources at particular premises.

3. General Guidelines for the Landscape

The guidelines outlined here are made for the improvement of existing landscape and for the proposed (new) landscape. The primary intent is to improve and convey the character of the landscape envisioned for the various areas of the premises under consideration rather than prescribe static design solutions. A degree of flexibility is anticipated to allow for landscape development that is creative and responsive to specific site conditions. However, adherence to the spirit of these guidelines is necessary to ensure a desirable level of cohesion in the landscape .

The underlying guidelines common to all premises of Eastern University, Sri Lanka, and covering the principles, planning considerations, and design criteria that will influence the creation of new and renovated landscape areas, are as follows,

- The soft landscape of the premises can be maintained by the use of native trees, shrubs and ground covers.
- Proposed plant material need to be compatible with the existing landscape, buildings, and usage characteristics, and should include species with colorful foliage or flowers that will add visual interest to the campus.
- The rustic landscape should involve low water usage and low maintenance effort. Irrigated lawns are discouraged, unless located in areas frequently used by the campus community, such as play grounds, outdoor recreation areas and outdoor study areas.
- Native and drought-tolerant plant material are encouraged. Some supplemental irrigation method is necessary to establish new planting and maintain the landscape at a healthy condition. Water conserving irrigation systems (drip irrigation) and alternative water sources (de-ionized laboratory water, reclaimed waste water, and storm run-off) are encouraged.
- Trees should be planted along pedestrian-walks, and cycle paths (bike-ways). Parking areas and student gathering areas need to be pruned and maintained on a regular basis in order to control branch dropping. It is recommended to preserve and protect existing native dominant trees, whenever new developments are planned and set-out.
- Planting-pots, well-pruned trees, bushes and hedges are not recommended in the rustic landscape areas.
- Hard landscape paving material should be used optimally in order to minimize heat gain.

4. Landscape Proposal for the Main Campus Premises at Vantharumoolai

4.1 Existing landscape

The main campus premises in Vantharumoolai is situated facing Polonnaruwa-Batticaloa main road. The entry environment consists of formally planted accesia, two raws of king coconut trees, and well-pruned plant hedges.

Figure 4.1: Pruned hedges and king coconut tree lines at the existing entrance

The area surrounding the administrative building has comparatively more trees and shady areas. The back garden of the campus is structured as a farmland for fruit and vegetable plots and farm animals, for the Faculty of Agriculture. There is a considerable number of large trees near the central area.

The Faculty of Management, Faculty of Science and Faculty of Cultural Studies are currently situated on the land of the main Campus on the opposite side of the main road. A ring road is connected to the main road by using two entrances having manually operated gates. The matured palm tree line at the right side entrance and matured Mango trees near the hostel can be identified as existing dominant trees.

Figure 4.2: Bamboo trees along the internal road side offer a shady path and remain in memory

Figure 4.3 : Matured Mango trees give the sense of rest near the main access road.

The Hindu temple located within the University premises is a culturally and socially important landscape element. The various functions and community participation at the temple accord additional value to the campus. The landscape of that particular area should cater to the students of the campus as well as the community.

There are possibilities to activate seasonal streams (Aara) in areas of low elevation of the site, during the rainy season.

4.2 Proposed Landscape

The landscape proposal for the premises of the Main Campus of the Eastern University, Sri Lanka, is as shown in the **Figure 4**.

The proposal is made in accordance with the guidelines listed earlier for landscape design, and in tandem with the Master Plan for Physical Development of the Eastern University, Sri Lanka.

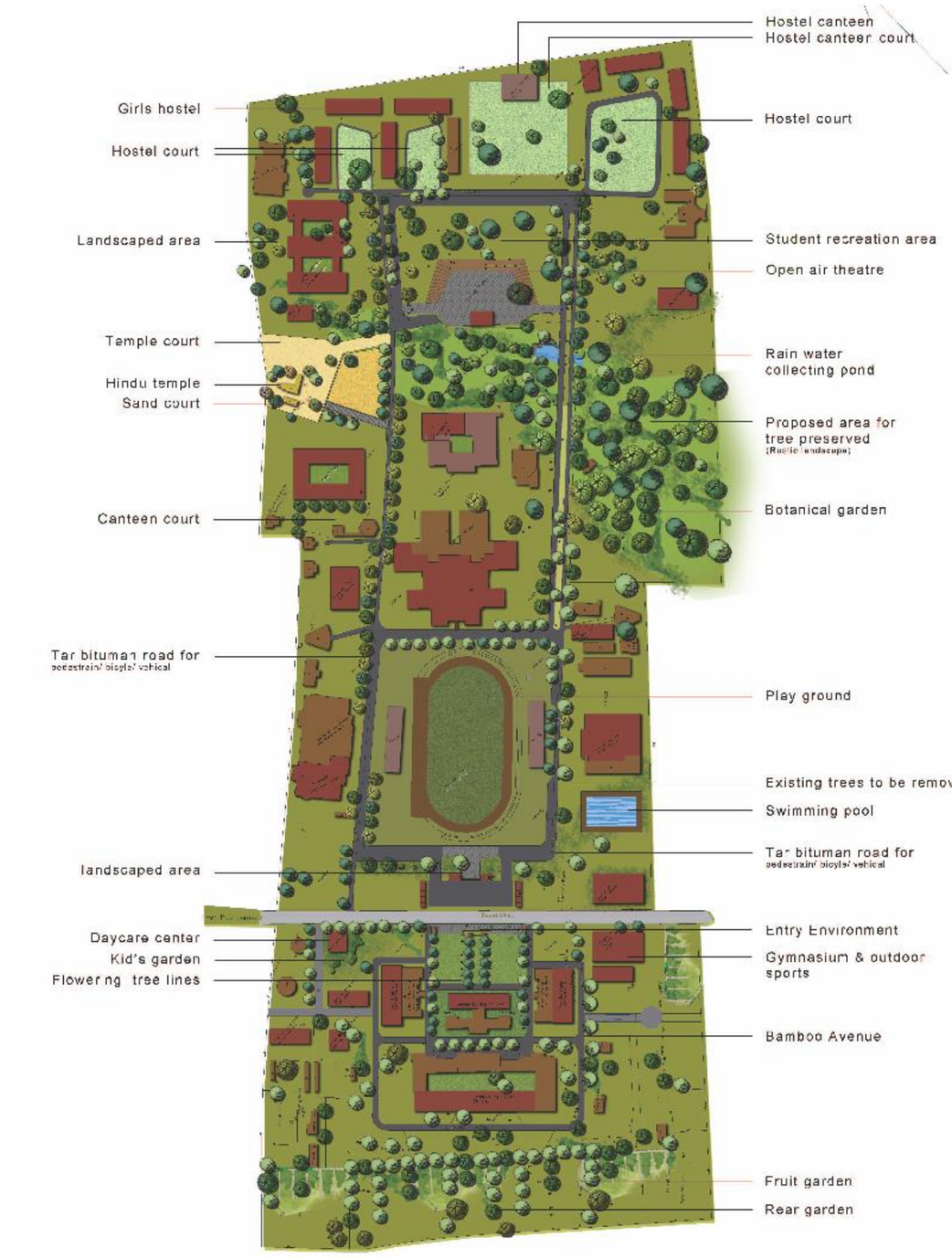

Figure 4.4 : Landscape proposal for the premises of the Main Campus of the Eastern University, Sri Lanka

4.3 Entry environment

The common landscaped court with supportive activities is proposed for the pedestrian in both part of the campus. The architecture and details of landscape will give the image and identity to the campus. The ring road, with two entrance gates is proposed for vehicular entrance for the north and south premises.

The large canopy native trees and flowering bushes are suitable for the front pedestrian entry court to give shady and attractive environment.

4.4 List of proposed plants

The following list recommends plant material appropriate within the landscape areas of the campus. This list is not inclusive, but is meant to identify the type of plant material and characteristics that can be considered when developing a plant palette for a specific landscape project in the university.

Botanical Name	**Common Name**
Azadirachta indica	Kohommba
Bauhinia racemosa	Maila
Bauhinia tomentosa	Yellow pethan
Calophyllum inophyllum	Domba
Cassia fistula	Ehela
Cassia nodosa	
Cassia roxburghil	rRedwaa
Cassia spectabilis	Yellow Koona
Delonix regia	Famboyant
Madhuca longifolia	Mee
Plumeria obtuse	Frangipani
Saraca asoca	Asoka
Tabebuia rosea	Robarosea
Tamarindus indica	Siyamballa
Borassus flabellifer	Palm

Section 5

ARCHITECTURAL LANGUAGE FOR PHYSICAL DEVELOPMENTS

IN

VANTHARUMOOLAI MAIN CAMPUS

Architectural Language

Vantharumoolai Main Campus Premises

The Architecture of the buildings shall respond to the climatic conditions and the socio-cultural elements of human activities on the landscape of the area. There are three principle responses expected in designing the built form:

1. Avoiding direct solar radiation as much as possible .
2. Integrating the traditional built forms of the area
3. Forming interfaces for student interactions

All new buildings are proposed to have minimum of 04 stories, and the ground floor could preferably provided for parking facilities. The buildings shall be oriented in East-West direction to avoid excessive solar heat gain and to access vistas of natural landscape.

The overall external form of the building shall be as given in Figure 1 below. The dominant constituents of the building shall be the gable roof, preferably covered with Roof Tiles, and the single storey high base, connected to the upper layer with two storey high grid structure.

The building shall also contain:

* Double height passage on the ground level
* Two-storied timber trellis work façade on cement rendered double height podium
* Calicut tile gable roof with decorative finales

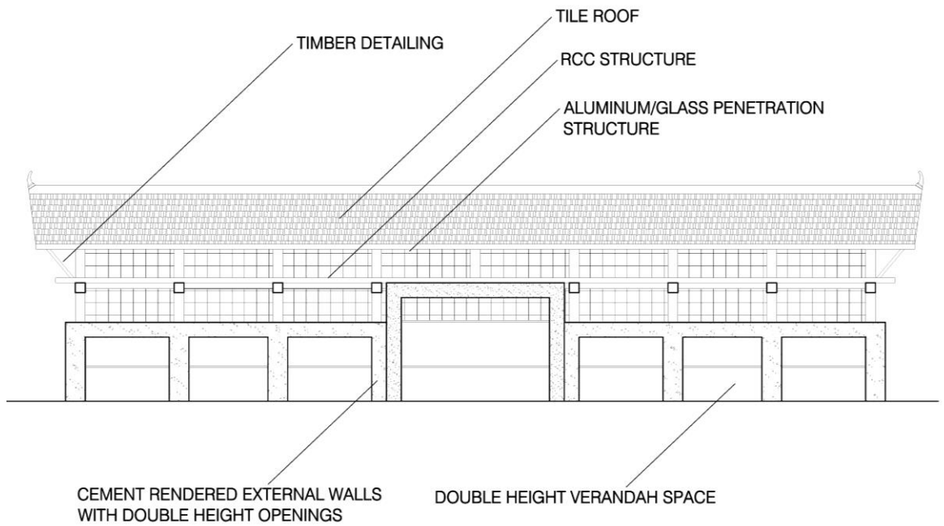

Figure 5.1: Typical Front View of a Building proposed for Vantharumoolai Main Campus

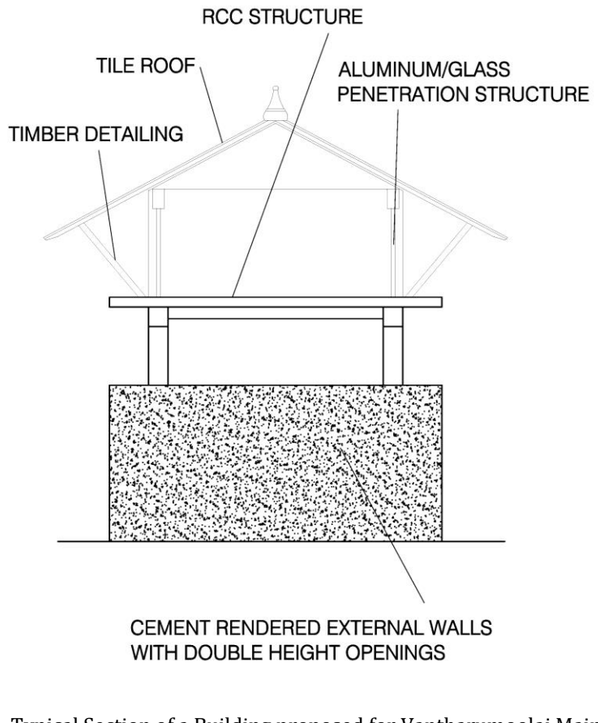

Figure 5.2: Typical Section of a Building proposed for Vantharumoolai Main Campus

Figure 5.3: Proposed Architectural Character: Vantharumoolai Main Campus