SUSTAINABLE DESIGN REPORT

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INTRODUCTION

This report is designed to be a concise guide to the structural and functional details of the Grevillea Auditorium project in the Royal Botanical Gardens, Sydney, Australia. It outlines how the structural elements inside the building work with details on materials and design choices. There are references to external content that covers material outside the scope of this document to keep things concise. Plans, elevations and sections of the building can be found in the appendix.

1: THE PROPOSED BUILDING IN CONTEXT

1.1: CONSTRUCTION

The roof is constructed from prefabricated reinforced concrete panels that are assembled on site [see figure 3]. This element is held by a system of steel columns within the auditorium walls, two sandstone columns in the lobby and the walls of the rehearsal rooms. The roof is cantilevered over three sides of the auditorium to form the lobby and corridor spaces, with the glazed curtain walls suspended from the roof by lightweight aluminium mullions that do not bear any structural loads aside from the dead weight of the window element. Wind loads are transferred to the roof and foundation. [See Figure 1]

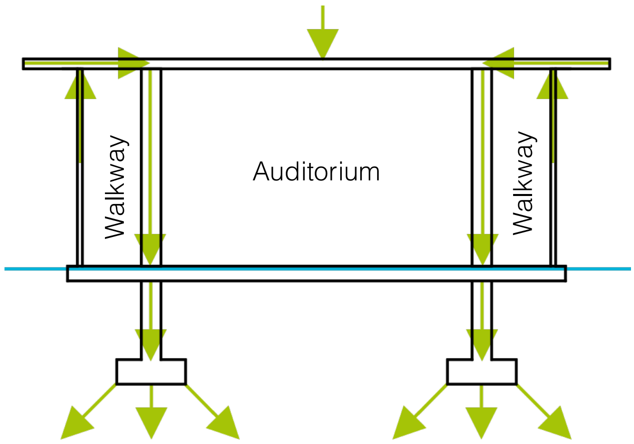

Figure1: Transfer of Loads

The building is built upon a combination concrete foundation that is split into two sections; the main foundation is comprised of individual footings underneath structural columns and structural walls of the auditorium. The adjoining rehearsal room and walkway is on a raft foundation due to the smaller structural loads. Walls inside the building are comprised of steel, plaster, timber and insulation. Steel and plaster walls rank highly when looking at the life cycle analysis for those materials. (Lawson, B. 1998)

1.2: MATERIALS

The material palette for the outside of the building consists of 5 elements: local Blackbutt timber cladding, insulated glass panels, concrete (roof), Sydney sandstone (amphitheatre) and a grey render (rehearsal annex). The decision to use concrete despite its arguably lacklustre sustainability reputation is outlined in section 2.2 The building's primary structure is the steel frame concealed within the auditorium walls. The internal walls use flexible plasterboard nailed to a freeform timber frame that forms to the building's curves. The landscaping around the project is formed of a few different shaded asphalts to compliment the surrounding paths, and the outdoor auditorium is formed from polished Sydney sandstone to help the building connect with its surroundings.

1.3: ORIENTATION + SHADING + SHELTERING

The building is orientated on the site with glazed façades facing North, East and South, with a smaller glazed façade facing West. The roof design provides solar shading that keeps out the summer sun and lets the winter sun in [see figure 2], ensuring that the temperature is maintained around the year.

The nature of the surrounding site means that it offers little in the way of sheltering so the cantilevered roof is an important element of the design. Glare from the sun reflecting on the ocean is also a consideration, so the windows are slightly tinted and polarised to reduce the intensity of this glare. This is often used in sunglasses (Morgan, E. 2014) but more research is needed to establish if it has been used in windows before.

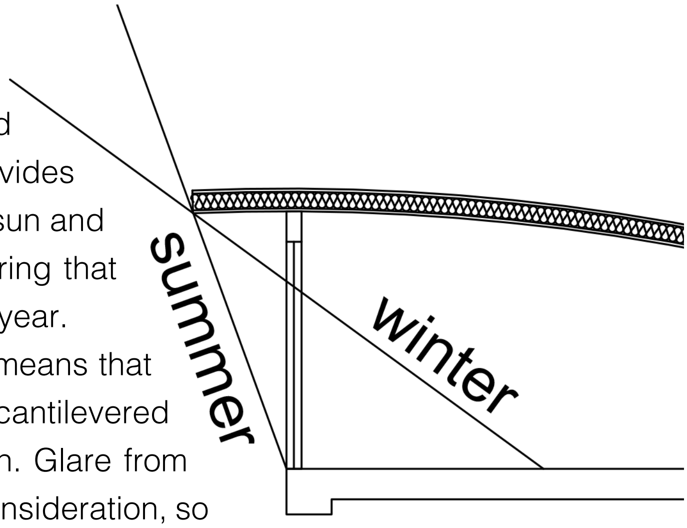

Figure 2: Solar Shading Diagram

1.4: CIRCULATION + ENTRANCE

The Royal Botanical Park is made up of a network of paths that guide pedestrians across the landscape. The building is situated just off the coastline path, one of the most connected pathways in the park. Pedestrians can access the building from all sides as it was placed to intersect an already existing path to entice people in. There is hard landscaping around the building's perimeter, shaded by the roof, to enable circulation around the building.

2: ENVIRONMENTAL CONSIDERATIONS

2.1: PASSIVE DESIGN

The building is designed to maintain its temperature passively during the entire year, the concrete in the roof acts as a thermal mass to regulate temperature and its shape means that during the summer months the solar shading protects the interior from the sun, whereas in the winter, the sun is lower so can penetrate further in. In addition to this, the building needs to be sealed to ensure there is no thermal leaking; this can be achieved by using air pressure testing and sealing up gaps on the spot.

2.2: CONCRETE COMPROMISE

Concrete has a stigma amongst environmentalists for being very unsustainable, in fact cement - a key ingredient's - production accounts for 4% of CO2 emissions worldwide (Patience, S. 2014), but when used sparingly it can be very beneficial for passive building design due to its thermal properties; it regulates temperature in the building during hotter and cooler periods. Reinforced concrete panels are used in the roof design to facilitate its freeform shape and assist its thermal properties.

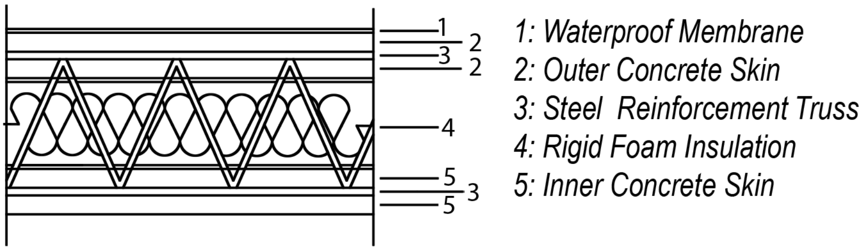

Figure 3: Roof Section Detail [1:10]

2.3: THE ENVIRONMENTAL IMPACT OF THE CONSTRUCTION PROCESS

The transport of materials can be a large contributing factor here, so local Blackbutt timber, Sydney sandstone and concrete have been implemented in the design instead of more typical, cheaper imports to reduce the impact of transporting materials to site. Construction will also involve some heavy machinery such as cranes and diggers; the pathways around the park are sufficiently wide enough to allow these to move onto site without damaging the landscape during construction. In addition to this, the building has been orientated and designed so that no trees need to be removed from site during construction.

3: MECHANICAL SERVICE SYSTEMS

3.1: HEATING

The building is entirely passively heated. The foundation and roof act as thermal masses which heat the building during cold spells, and cool it during hotter ones. Refer to section 1.3 for details on solar heating.

3.2: COOLING & VENTILATION

The auditorium is vented and cooled through a system in the false roof, replacing the air as needed within the auditorium with fresher air from the lobby and walkways, which themselves are ventilated by air vents concealed within the window frames that can be opened and closed automatically when needed. During cooler hours in the evening, the front and rear doors can be retained in the open position to create through draughts to refresh the air inside – cooling down and refreshing the building for the following day.

3.3: LIGHTING

The building is to be lit only by LED lighting. LED bulbs have a large number of benefits such as longer lifespan and lower energy usage, even over 'Energy Saving' CFL bulbs. (US Department of Energy, 2015)

The projector used in the auditorium should be a Laser model, as these use less energy than traditional bulb projectors and last much longer (Audio Visual Technologies Group, 2016), whilst also offering additional benefits outside the scope of this document.

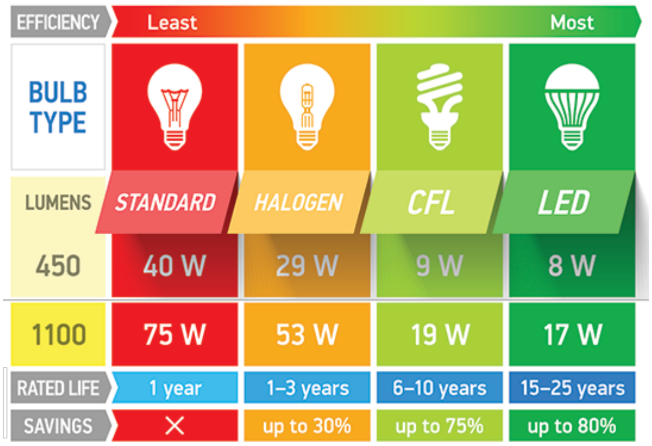

Figure 4: Bulb Comparison Chart

3.4: DRAINAGE

Drainage for the landscape is handled through a direct outflow pipe to the sea from the lowest point on the terrain, which is in the centre of the amphitheatre. The roof has a subtle ridge that, when combined with the sloping, directs water to the rear of the building where it flows off and onto the landscape at the rear of the building.

SUMMARY

To conclude, this report has outlined the structural details of the Grevillea Auditorium, including the roof makeup, wall construction and basement details, with relevant sustainability information as required. It has also touched on human aspects; how the building should be used every day to minimise energy usage, such as the use of LED lights and passive ventilation. This building represents the culmination of research, attention to detail and experimentation. As a first complete project that focuses on sustainability it will be the starting point for future projects with increasingly important sustainable elements.

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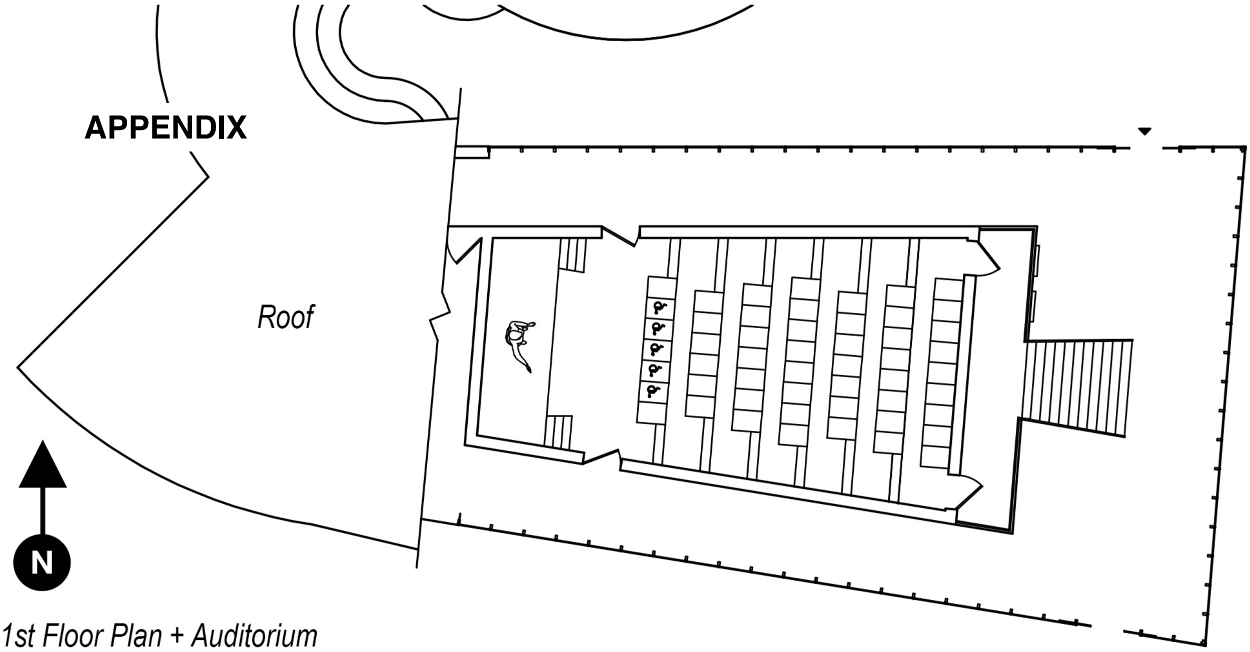
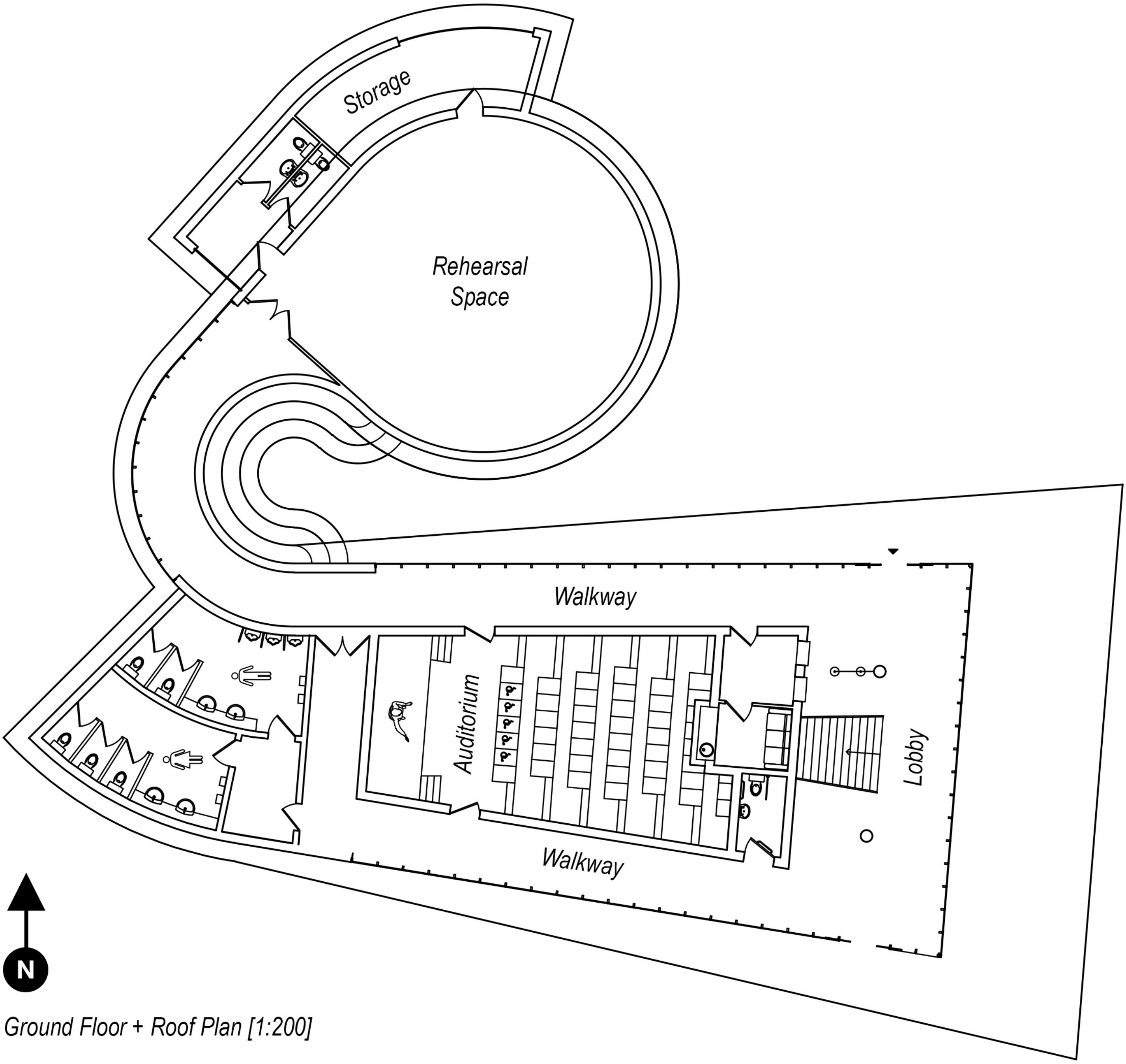
APPENDIX

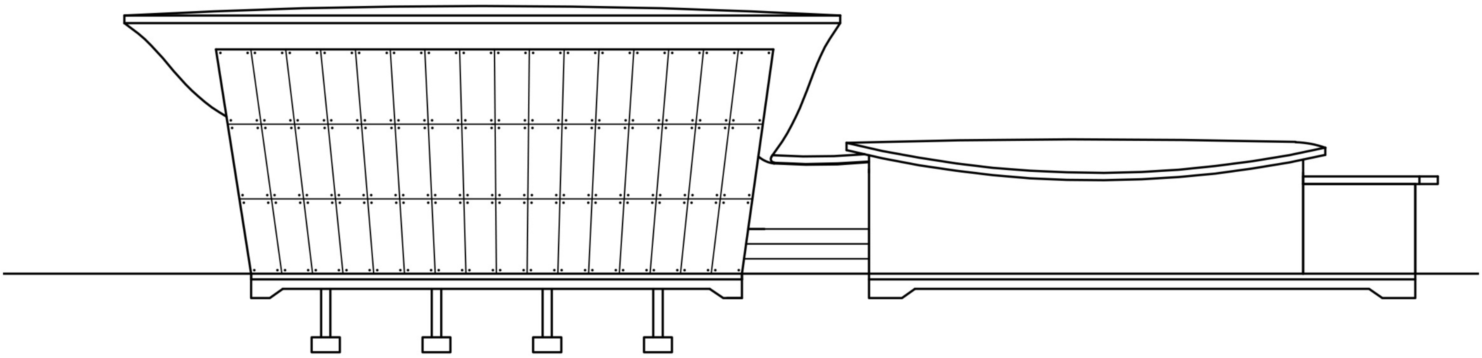


1st Floor Plan + Auditorium

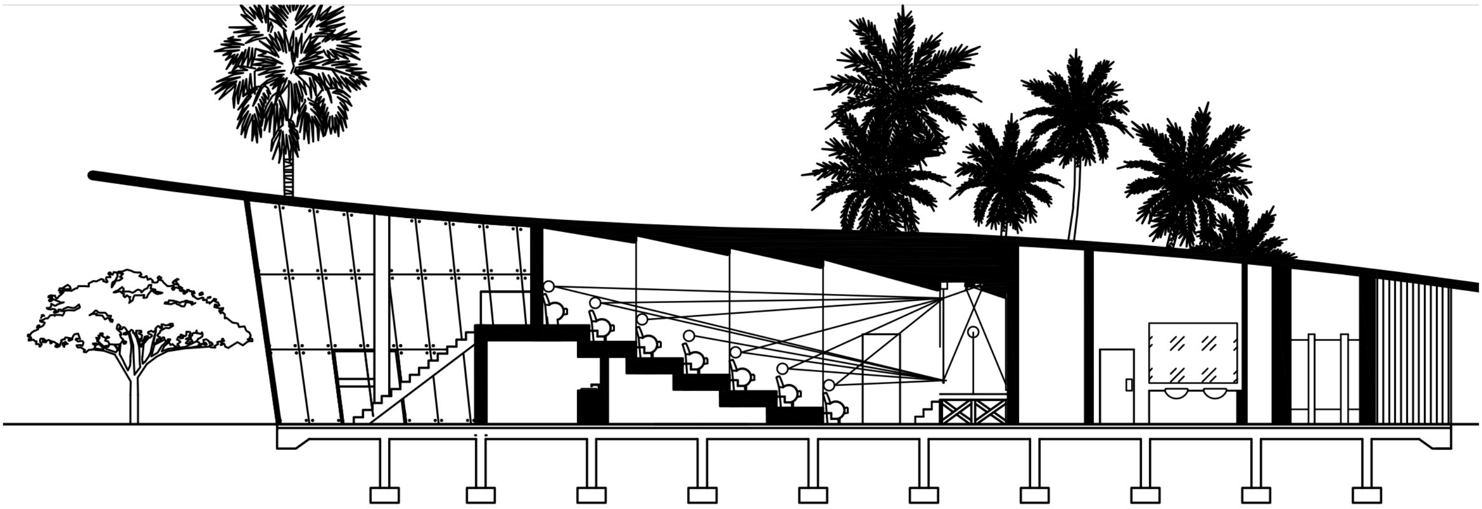


Ground Floor + Roof Plan [1:200]

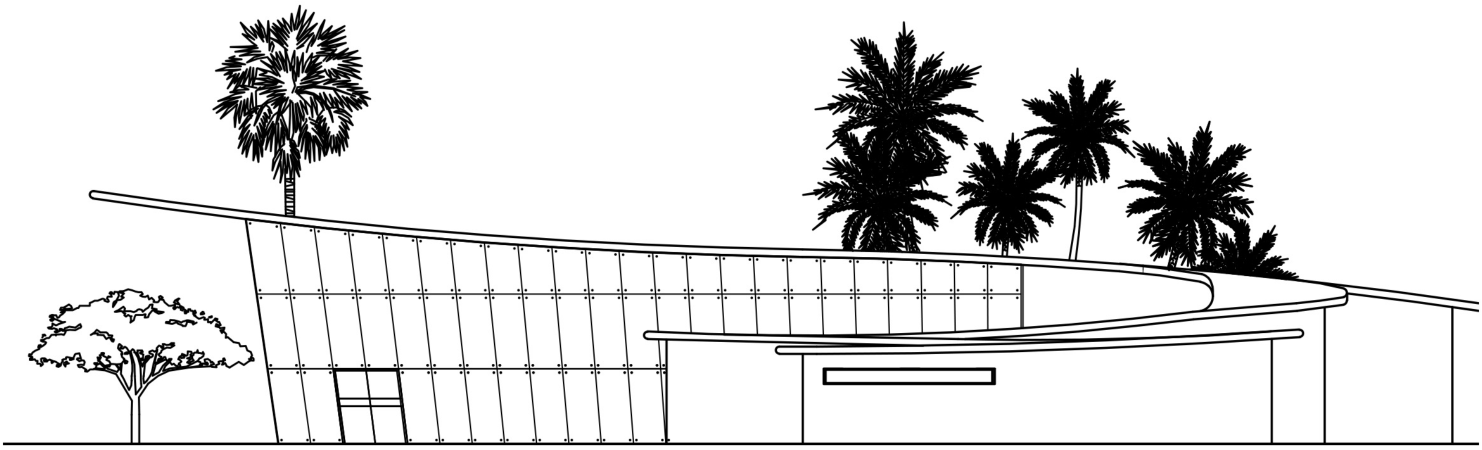
APPENDIX



East Section + Foundation Illustration [1:200]



North Section + Foundation illustration [1:200]



North Elevation [1:200]