

## SPECIFICATIONS

### CEMSEAL VERSICELL

#### ○ SUB-SURFACE DRAINAGE

#### 1 GENERAL

All work in this Section shall comply with the requirements of the Contract Documents. Supply and install sub-surface drainage as shown on the drawings or specified herein.

#### 2 MATERIALS

##### 2.1 Sub-surface Drainage

The sub-surface drainage shall be CEMSEAL VERSICELL cellular drainage modules supplied by Cemseal Industries Sdn Bhd (Tel: +607-558 3320, Fax: +607-556 9127, E-mail: [info@cemseal.com.my](mailto:info@cemseal.com.my)) or an approved equivalent.

##### GENERIC SPECIFICATION

The sub-surface drainage shall be 30 mm thick cellular drainage modules ('draincells'). They shall have a compressive strength of at least 80t/m<sup>2</sup> to accommodate both static and dynamic loads during and after installation. They shall have good resistance to petroleum-based chemicals and naturally occurring soil chemicals.

The draincells shall have surface perforations each not exceeding 20 mm to prevent entry of large fill aggregates and adjacent modules shall be able to interlock along connecting edges to form a continuous entity.

The draincells shall comprise of one or more layers to ensure a total flow rate of at least 16.5 l/m.s to cater for high water volume from heavy rainfall under Singapore Code of Practice SS 525 :2006

Typical properties of the draincells are:

| PROPERTY                | VALUE  |
|-------------------------|--|
| Material                | polypropylene                                |
| Dimensions              | 500 (L) x 250 (W) mm<br>500 (L) x 500 (W) mm |
| Height                  | 30 mm  |
| Weight                  | ~ 3 kg/m <sup>2</sup>                        |
| Maximum hole size       | ≤ 20 mm                                      |
| Void horizontal area    | ≥ 65%  |
| Void internal volume    | ≥ 95%  |
| Compressive strength    | ≥ 100 t/m <sup>2</sup>                       |
| Drainage capacity       | ≥ 16.5 l/ms                                  |
| @ 1% hydraulic gradient |  |

**SPECIFICATIONS**

**2 MATERIALS (cont'd)**

**2.2 Geotextile Filter Fabric**

The geotextile filter fabric shall be an approved non-woven needle-punched fabric consisting of polypropylene, polyethylene, polyester or any of these combinations.

Typical properties of the geotextile filter fabric are:

| <b>PROPERTY</b>                   | <b>VALUE</b>           |
|-----------------------------------|------------------------|
| Minimum weight                    | ≥ 100 g/m <sup>2</sup> |
| Pore size                         | ≤ 190 microns          |
| Tensile strength @ 40% elongation | ≥ 4 kN                 |
| Grab strength @ 60% elongation    | ≥ 440 N                |
| Puncture resistance               | ≥ 800 N                |
| Trapezoidal tear strength         | ≥ 270 N                |
| Flow rate                         | ≥ 50 l/ms              |

**2.3 Growth Media**

The growth media shall be a pH-stabilised mix comprising of peat, compost, expanded clay aggregate/vermiculite, washed coarse river sand, free-draining loamy soil, slow release N-P-K fertilizer etc. as specified by the Landscape Architect.

Unless specified otherwise, the planting mix for all trees, palms, shrub beds and turfed areas of the intensive rooftop garden and on top of basement structures shall include the components listed below. It shall be mechanically mixed to the correct proportions, prior to placement on site.

The planting mix shall have the following properties:

- contain less than 20% silt and clay by volume
- retain more than 45% (volumetric) moisture at maximum water capacity
- contain more than 20% air content at field capacity
- contain less than 12% organic matter (by mass)
- have a pH between 6 to 7
- have a cation exchange capacity higher than 10 cmol/kg soil
- have an apparent density of between 1200 – 1800 kg/m<sup>3</sup> when wet

## **SPECIFICATIONS**

### **2 MATERIALS (cont'd)**

#### **2.3 Growth Media (cont'd)**

The planting mix can comprise the following:

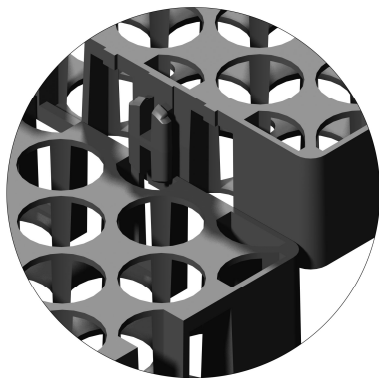
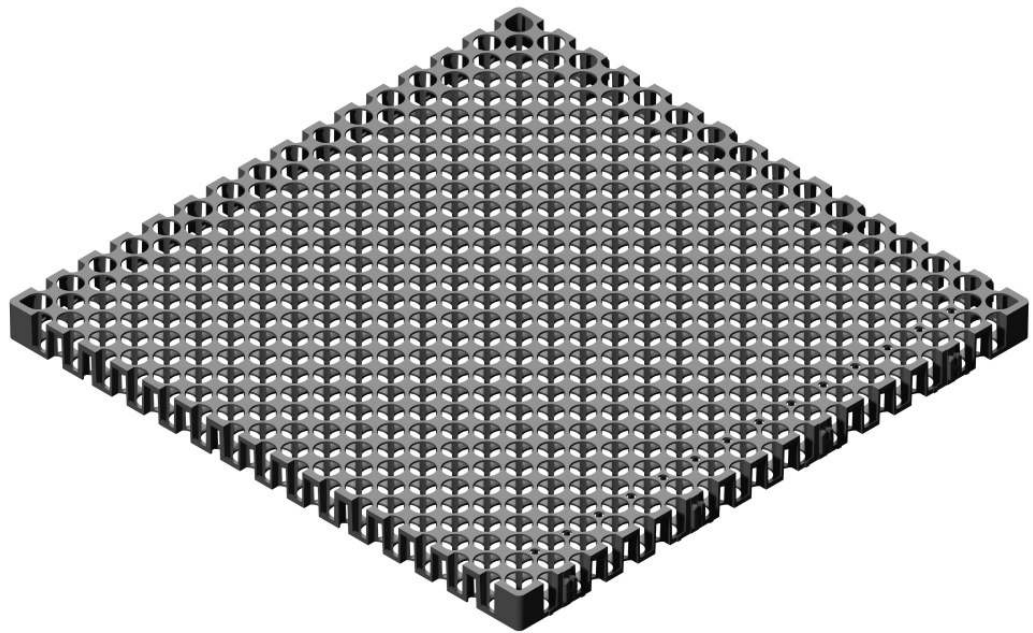
- topsoil
- washed coarse river sand
- lightweight aggregate: expanded clay, shale, volcanic cinder, perlite
- soil conditioner 1 kg/m<sup>3</sup> of slow release NPK 15-15-15 fertilizer (coarse granule)
- any other additives to balance pH and organic matter content as determined by the soil test
- mixed thoroughly before placing in the planting pit

## SPECIFICATIONS

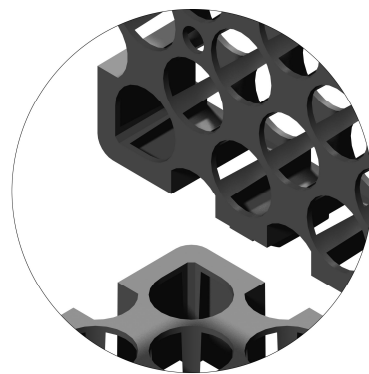
### 3 EXECUTION

- 3.1 The proprietary materials specified herein shall be provided/installed in accordance to the project requirement as approved by the Superintending Officer.
- 3.2 Proprietary materials supplied shall be identified clearly with the product name and production information.
- 3.3 The draincells shall be connected by interlocking, cable ties or other approved equivalent with adjacent draincells along connecting edges to form a continuous entity whether as panels, conduits or tanks.
- 3.4 The ends of all installed draincells shall be properly sealed with geotextile/geomesh to ensure that soil particles/aggregates cannot enter the draincells.
- 3.5 Prior to installation, the Contractor shall submit Test Reports (not more than 1 year old), Method Statements and Shop Drawings for the installation of the draincell system. The latter shall be on at least A3 size paper or larger and in a CAD-recognisable format.
- 3.6 Where the draincell quantity exceeds 1,000 m<sup>2</sup>, the Superintending Officer shall randomly select 3 samples to be placed in a sealed package and sent for compression load conformity tests by an independent test authority. The test report shall indicate if the samples were delivered in the sealed untampered package. The costs of such tests shall be borne by the installer.
- 3.7 For trench applications, where the draincells are installed vertically, they shall be temporarily supported in position by props during backfilling.
- 3.8 Sand or other suitable backfill material shall be used and compacted in layers by hand for a maximum depth of 300 mm. Backfilling may then be completed mechanically with vibratory compacting equipment. Care should be taken not to damage the draincells or the geotextile / geomesh covering during backfilling.
- 3.9 Clay material shall not be used as backfill. The displaced clay soil shall be replaced with aggregates / sand backfill. Sharp stones that may puncture the geotextile/geomesh shall be removed from the backfill material before backfilling.
- 3.10 The Contractor shall inspect the draincells installation prior to completing the installation of other drainage works and backfilling unless otherwise directed.
- 3.11 The installed draincell shall be protected from construction traffic, be maintained free from silt, debris or other foreign material.

**SPECIFICATIONS**



Interlocking at same plane



Interlocking at right angle

**CEMSEAL VERSICELL**

## PROJECT REFERENCES

### Commercial Projects

ASMARA BISHAN *Formwerkz Architects*  
ALEXANDRA TECHNO PARK (PHASE I & II) *PDAA Design*  
ALEXANDRA DISTRI PARK *Design International*  
BIOPOLIS *Jurong Consultants*  
BIOPOLIS PHRASE 2 *Jurong Consultants*  
BOON LAY WAY ROAD IMPROVEMENT *Land Transport Authority*  
BT. BATOK CIVIL SERVICE CLUB HOUSE COMPLEX *Studio Steed*  
CATHAY BUILDING REDEVELOPEMENT *RDC Architects*  
CHANGI NAVAL BASE C66 *ST Architects & Engineers*  
CHANGI AIRPORT *PDAA Design*  
CHANGI AIRPORT TERMINAL 1 UPGRADING *Indeco Consultants*  
CHANGI AIRPORT TERMINAL 3 *Tierra Design*  
CHATSWORTH COURT *Mirage International*  
CHINESE SWIMMING CLUB *S.H. Lim Architects*  
CHOA CHU KANG SPORTS & RECREATION CENTRE *PWD Consultants*  
CIVIL SERVICES CLUBHOUSE *CPG Consultants*  
CLEMENTI NURSING HOME *C Y Wu Architects*  
CLEMENTI ROAD IMPROVEMENT *Land Transport Authority*  
CLIFFORD PIER NEW *Surbana Consultants*  
CRAWFORD MRT / LRT *Land Transport Authority*  
CAPELLA SENTOSA *Belt Collins International*  
ECP SERVICE ROAD *Land Transport Authority*  
THE ESPLANADE - THEATRES ON THE BAY *DP Architects*  
EUREKA *DCA Architects*  
FOUR SEASONS HOTEL *Belt Collins International*  
GIRLS' COMPLEX *CPG Consultants*  
GREAT WORLD CITY *Tierra Design*  
GURKHA CAMP PHASE 3 *Stephen Caffyn Landscape Design*  
GURKHA CAMP PHASE 3A *CPG Consultants*  
HORTICULTURE PARK *MKPL*  
HDB CENTRE *RSP Architects Planners & Engineers*

## PROJECT REFERENCES

### Commercial Projects

HENDON CAMP *DSTA*

IMM BUILDING *DLQ*

JURONG CENTRAL PARK *National Parks Board*

JURONG ISLAND PROJECT PHASE 3A *Jurong Town Corporation*

JURONG WEST SPORTS STADIUM *Singapore Sports Council*

KK WOMEN'S & CHILDREN'S HOSPITAL *PWD Consultants*

KRANJI TURF CLUB *Belt Collins International*

LABRADOR PARK *National Parks Board*

LAW ENFORCEMENT ACADEMY *CPG Consultants*

MANDAI COLUMBARIUM & CREMATORIUM *CPG Consultants*

MASS RAPID TRANSIT C502 *Land Transport Authority*

MASS RAPID TRANSIT C704 *Land Transport Authority*

MARINA SQUARE *DP Architects*

NATIONAL UNIVERSITY HOSPITAL *Indeco Consultants*

NEW CHANGI HOSPITAL *Indeco Consultants*

NEW SUPREME COURT *CPG Consultants*

NEW PARK SHELTER 7 *Housing Development Board*

NTUC CENTRE *DP Architects*

ONE DEGREE 15 MARINA CLUB HOUSE *Maps Design*

ONE RAFFLES QUAY *Studio Steed*

ORIENTAL HOTEL *DP Architects*

ORIX CAR RENTAL BUILDING *Design Connections International*

PAN PACIFIC HOTEL *DP Architects*

PLAZA SINGAPURA UPGRADING *SAA Partnership*

REVENUE HOUSE *PWD Consultants*

SCDF BASIC RESCUE TRAINING CENTRE *Ministry of Home Affairs*

SENGKANG N1 PARK *Housing Development Board*

SENTOSA COVE *Site Concepts International*

SENTOSA MARINA CLUB HOUSE *Belt Collins International*

SENTOSA TRANSPORT TERMINAL COMPLEX *Peridian Asia*

SIA CLUBHOUSE *RSP Architects Planners & Engineers*

## PROJECT REFERENCES

### Commercial Projects

SIEMEN CENTRE BUILDING *M+W Zander*

SINGAPORE FLYER *DP Architects*

SINGAPORE ISLAND COUNTRY CLUB *SAA Partnership*

SINGAPORE POLO CLUB *JGP Architecture*

SICC DRIVING RANGE *Planning & Landscape Associates*

SINGAPORE TOURIST PROMOTION BOARD HQ *Aspinwall Clouston*

ST ANDREW'S VILLAGE *DP Architects*

ST. REGIS HOTEL *Cicada*

TAI KENG GARDEN EUP *Nikken Sekkei International*

TAMPINES MALL *Nikken Sekkei International*

TAN TOCK SENG HOSPITAL *PWD Consultants*

TELECOMS HOLIDAY BUNGALOWS *Singapore Telecoms*

TELOK BLANGAH ROAD IMPROVEMENT *Land Transport Authority*

TOA PAYOH TOWN PARK *Lee & Lee Consultants*

UMCI FACTORY *Jurong Consultants*

VIVO CITY *DP Architects*

WOODLANDS SPECTRUM PHASE II *Jurong Consultants*

ONE LEICESTER



## PROJECT REFERENCES

### Residential Projects

ADAM PARK CONDOMINIUM *P.T.Wijaya Tribwana International*  
ADERDEEN CONDOMINIUM *Team Design Architects*  
ALESSANDREA CONDOMINIUM *Cyril K H Seah Architects*  
ANDERSON ROAD CONDOMINIUM *Tierra Design*  
ANG MO KIO AVENUE 4 UPGRADING *Housing Development Board*  
ARDMORE PARK CONDOMINIUM *RSP Architects Planners & Engineers*  
ASPEN HEIGHTS CONDOMINIUM *Site Concepts International*  
ASTON MANSION CONDOMINIUM *OTLA Design Partnership*  
AZALEA PARK CONDOMINIUM *Ong & Ong Architects*  
BALMORAL CRESCENT CONDOMINIUM *Site Concepts International*  
BALMORAL 8 CONDOMINIUM *Martin Lee Designs*  
BELMOND GREEN CONDOMINIUM *Sitetectonix*  
BEDOK COUNTRY PARK CONDOMINIUM *Belt Collins International*  
BENCOOLEN STREET SERVICE APARTMENTS *Stephen Caffyn Landscape Design*  
BINJAI CREST CLUSTER HOUSING *RSP Architects Planners & Engineers*  
BUTTERWORTH 8 CONDOMINIUM *Belt Collins International*  
BISHAN 8 CONDOMINIUM *Peridian Asia*  
CALLISTA CONDOMINIUM *DLQ*  
CAPELLA CONDOMINIUM *Belt Collins International*  
CALROSE CONDOMINIUM *Site Concepts International*  
CARPMEALINA CONDOMINIUM *Peridian Asia*  
CASABELLA *Belt Collins International*  
CASABLANCA CONDOMINIUM *OTLA Design Partnership*  
CASCADALE CONDOMINIUM *Peridian Asia*  
CASTLE GREEN CONDOMINIUM *Site Concepts International*  
CHANGI COURT CONDOMINIUM *PDAA Design*  
CHANGI GREEN CONDOMINIUM *PDAA Design*  
CHANGI RISE CONDOMINIUM *Cicada*  
CHERRYHILL CONDOMINIUM *Nikken Sekkei International*  
CLAYMORE CONDOMINIUM UPGRADING *Eco-id Design*  
CLYDESBUILT RESIDENCES *JGP Architecture*  
CLEARWATER CONDOMINIUM *ACL*  
COSTA DEL SOL CONDOMINIUM *Belt Collins International*

## PROJECT REFERENCES

### Residential Projects

COSTA RHU CONDOMINIUM *Peridian Asia*  
DAHLIA PARK CONDOMINIUM *Ong & Ong Architects*  
DRAYCOTT EIGHT CONDOMINIUM *Sitetectonix*  
DUCHESS AVENUE CONDOMINIUM *Site Concepts International*  
DUET CONDOMINIUM *Peridian Asia*  
EASTVALE CONDOMINIUM *Housing Development Board*  
ELYSIA CONDOMINIUM *DLQ*  
EMERALD GARDEN CONDOMINIUM *PDA Design*  
EQUATORIAL CONDOMINIUM *Cicada*  
ESPARIS CONDOMINIUM *Belt Collins International*  
FOREST HILLS CONDOMINIUM *Cicada*  
FLORIDA PARK CONDOMINIUM *Architects 61*  
FREESIA WOOD CONDOMINIUM *Site Concepts International*  
GARDEN VISTA CONDOMINIUM *Belt Collins International*  
GALLOP GARDEN CLUSTER HOUSING *Sitetectonix*  
GARLICK AVE CONDOMINIUM *Peridian Asia*  
GALLERY CONDOMINIUM *Belt Collins International*  
GLENDALE CONDOMINIUM *Belt Collins International*  
GLENTREE CONDOMINIUM *Studio Steed*  
GOLDENHILL VILLAS *ACLA*  
GRANDEUR 8 CONDOMINIUM *Chao Tse Ann & Partners*  
GUILIN VIEW CONDOMINIUM *Belt Collins International*  
HANA VILLAGE CONDOMINIUM *Ban Hin Leong Group*  
HILLCREST ARCADIA *Nature Landscapes*  
HOLLAND MEWS CONDOMINIUM *SCDA Architects*  
HUME PARK I CONDOMINIUM *Site Concepts International*  
HUME PARK II CONDOMINIUM *Site Concepts International*

## PROJECT REFERENCES

### Residential Projects

HILLBROOKS CONDOMINIUM *Site Concepts International*  
HILLSIDE CONDOMINIUM *Site Concepts International*  
HILLVIEW HEIGHTS CONDOMINIUM *Team Design Architects*  
KIM YAM CONDOMINIUM *Site Concepts International*  
KOVAN MELODY CONDOMINIUM *Sitetectonix*  
LA CASA CONDOMINIUM *DLQ*  
LAKEHOMZ CONDOMINIUM *Site Concepts International*  
LAKSHORE CONDOMINIUM *Belt Collins International*  
LE CRESCENDO CONDOMINIUM *Peridian Asia*  
LEEDON PARK NO. 25 & 27 *Apex Group Architect Planner*  
LINEAR CONDOMINIUM *Mirage International*  
LEONIE STUDIO CONDOMINIUM *Sitetectonix*  
MAPLEWOODS CONDOMINIUM *Belt Collins International*  
MARINA CLUBHOUSE @ SENTOSA *Maps Design Studio*  
MERA SAGA CONDOMINIUM *PDAA Design*  
MERAWOODS CONDOMINIUM *Site Concepts International*  
MILL POINT CONDOMINIUM *Peridian Asia*  
MONTEREY PARK CONDOMINIUM *Team Design Architects*  
MOONSTONE CONDOMINIUM *Site Concepts International*  
NOVENA SUITE CONDOMINIUM *RSP Architects Planners & Engineers*  
NEWTON SUITES CONDOMINIUM *Cicada*  
ONE FORT CONDOMINIUM *LandArt*  
PALM SPRINGS CONDOMINIUM *Site Concepts International*  
PARC OASIS CONDOMINIUM *Peridian Asia*  
PARC VISTA CONDOMINIUM *Peridian Asia*  
PARK GREEN EXECUTIVE CONDOMINIUM *DLQ Design*

## PROJECT REFERENCES

### Residential Projects

PARKSHORE CONDOMINIUM *Nikken Sekkei International*  
PARK INFINIA *Site Concepts International*  
PASIR PANJANG CONDOMINIUM *Liu & Wo Architects*  
PEBBLE BAY CONDOMINIUM *Site Concepts International*  
PECK HAY ROAD CONDOMINIUM *Belt Collins International*  
REGENT HEIGHTS CONDOMINIUM *Sitetectonix*  
RICHMOND PARK CONDOMINIUM *RSP Architects Planners & Engineers*  
RIS GRANDEUR CONDOMINIUM *Site Concepts International*  
RIVERVALE CREST CONDOMINIUM *Site Concepts International*  
ROCCA BALESTIER CONDOMINIUM *DLQ Design*  
ROSEWOOD CONDOMINIUM *Site Concepts International*  
SAVANNAH CONDOMINIUM *DLQ Cicada*  
SELETAR SPRINGS CONDOMINIUM *Site Concepts International*  
SEMBAWANG ROAD APARTMENTS *Architects 1990*  
SIMS VILLE CONDOMINIUM *Architects 61*  
SCENIC HEIGHTS CONDOMINIUM *DLQ Design*  
SPRING HILL CLUSTER HOUSES *ADDP Architects*  
SPRINGBLOOM CONDOMINIUM *Peridian Asia*  
SPRINGDALE CONDOMINIUM *Site Concepts International*  
STARVILLE CONDOMINIUM *Belt Collins International*  
STERLING CONDOMINIUM *Belt Collins International*  
ST. MARTIN'S DRIVE CONDOINIUM *W Architects*  
STRATA CONDOMINIUM *Sitetectonix*  
SUMMERVILLA CLUSTER HOUSES *DLQ Design*  
SUNHAVEN CONDOMINIUM *LandArt*  
SUNVILLE CONDOOMINIUM *Belt Collins International*  
SYMPHONY HEIGHTS CONDOMINIUM *Site Concepts International*  
TANAH MERAH CREST CONDOMINIUM *Peridian Asia*  
TESSARINA CONDOMINIUM *Site Concepts International*  
THE AZURECONDOMINIUM *Site Concepts International*  
THE BAYWATER CONDOMINIUM *Site Concepts International*

## PROJECT REFERENCES

### Residential Projects

THE BERTH CONDOMINIUM *Site Concepts International*  
THE CARIBBEAN CONDOMINIUM *Belt Collins International*  
THE EDGEWATER CONDOMINIUM *Site Concepts International*  
THE GARDENS CONDOMINIUM *Smallwood, Reynolds, Stewart & Associates*  
THE GARDENS AT GERALD DRIVE *TAB Architects*  
THE LIGHT CONDOMINIUM *P & T Architects*  
THE LINC CONDOMINIUM *ADDP Architects*  
THE MADEIRA CONDOMINIUM *Belt Collins International*  
THE MARBELLA CONDOMINIUM *Belt Collins International*  
THE MULBERRY TERRACE HOUSING *ACLA*  
THE NEXUS CONDOMINIUM *Sitetectonix*  
THE PATERSON *Colin K. Okashimo and Associates*  
THE SERENADE CONDOMINIUM *Sitetectonix*  
THE SEAVIEW *Sitetectonix*  
THE SHELFORD CONDOMINIUM *Belt Collins International*  
THE STRATA CONDOMINIUM *Sitetectonix*  
THE TRUMPH CONDOMINIUM *William Lim & Associates*  
THE YADLEY *Design Link Architects*  
THOMSON EUROASIA CONDOMINIUM *DCA Architects*  
THE WARREN CONDOMINIUM *Belt Collins International*  
TWIN REGENCY CONDOMINIUM *DP Architects*  
VENTANA CONDOMINIUM *DCA Architects*  
VISIONCREST CONDOMINIUM *RSP Architects Planners & Engineers*  
WESTCOVE CONDOMINIUM *OTLA Design Partnership*  
WESTMERE CONDOMINIUM *Housing Development Board*  
WHITEWATER CONDOMINIUM *OTLA Design Partnership*  
WHITEVILLA ROWS *TAA Architects*

## PROJECT REFERENCES

### Institutional Projects

ACS INTERNATIONAL *Consultants Incorporated*  
ACS INDEPENDENT SCHOOL *Consultants Incorporated*  
ALEXANDRA HILL SECONDARY SCHOOL *PWD Consultants*  
ANG MO KIO SECONDARY SCHOOL *PWD Consultants*  
BUKIT VIEW SECONDARY SCHOOL *CPG Consultants*  
BALESTIER PRIMARY SCHOOL *PWD Consultants*  
CEDAR GIRLS' SCHOOL *CPG Consultants*  
CATHOLIC HIGH PRIMARY SCHOOL *Andrew Tan Architects*  
CATHOLIC HIGH SECONDARY SCHOOL *Andrew Tan Architects*  
CHUA CHU KANG CRESENT SCHOOL *PWD Consultants*  
HWA CHONG INSTITUTION *Chartered Architects International*  
HILLGROVE SECONDARY SCHOOL *PWD Consultants*  
HOUGANG PRIMARY SCHOOL *PWD Consultants*  
INNOVA JUNIOR COLLEGE *CPG Consultants*  
JERVOIS SPECIAL SCHOOL *CPG Consultants*  
JINGSHAN PRIMARY SCHOOL *PWD Consultants*  
JURONG WEST PRIMARY SCHOOL *PWD Consultants*  
LASALLE SIA COLLEGE OF ART *RSP Architects Planners & Engineers*  
MANJUSRI SECONDARY SCHOOL *PWD Consultants*  
MINDS SPECIAL SCHOOL *DCA Architects*  
NANYANG PRIMARY SCHOOL *Ong & Ong Architects*  
NAVAL BASE SECONDARY SCHOOL *Architects Team 3*  
NGEE ANN POLYTECHNIC *PWD Consultants*  
NTU EXECUTIVE CENTRE *CPG Consultants*  
NTU PHASE 3B *PWD Consultants*  
NTU SCHOOL OF BIOLOGICAL SCIENCES *CPG Consultants*  
NORTH VIEW SECONDARY SCHOOL *Architects Team 3*  
NUS CENTRAL LIBRARY *CPG Consultants*  
NUS ARTS CENTRE *CPG Consultants*  
PASIR RIS JUNIOR COLLEGE *PWD Consultants*  
RADIN MAS PRIMARY SCHOOL *PWD Consultants*

## PROJECT REFERENCES

### **Institutional Projects**

REPUBLIC POLYETCHNIC *DP Architects*

RAFFLES INSTITUTION *CPG Consultants*

RIVER VALLEY PRIMARY SCHOOL *CPG Consultants*

SEMBAWANG CRESENT SECONDARY SCHOOL *PWD Consultants*

SIMEI ITE CAMPUS *RSP Architects Planners & Engineers*

TECK WHYE SECONDARY SCHOOL *PWD Consultants*

TEMASEK POLYTECHNIC PHASE III *PWD Consultants*

YANGZHENG PRIMARY SCHOOL *PWD Consultants*

YIO CHU KANG SECONDARY SCHOOL *PWD Consultants*