<table>
<thead>
<tr>
<th>TECHNICAL SPECIFICATIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAPTER 1</td>
<td>ROAD INFRASTRUCTURE WORKS</td>
</tr>
<tr>
<td>CHAPTER 2</td>
<td>PIPE INFRASTRUCTURE WORKS</td>
</tr>
</tbody>
</table>
CHAPTER 1 – ROAD INFRASTRUCTURE WORKS
TABLE OF CONTENTS

PART–1 PREPARATIONS / EARTHWORKS 5

PART–2 LAND CLEARING AND GRUBBING 13

PART–3 LAND LEVELLING 17

PART 4 – CANAL FILLING 20

PART 5 - WHITE SAND OR REEF SAND SUBGRADE-FILL 23

PART 6 - SAND CLAY/WHITE SAND BASE AND REEF-SAND/WHITE-SAND, BASE AND SUB-BASE 25

PART 7 – CRUSHED STONE / CRUSHER RUN 28

PART 8 - BAUXITE CAPPING 30

PART 9 – LATERITE/WHITE SAND SUB-BASE AND BASE 32

PART 10 – CEMENT STABILISED SUB- BASE AND BASE: LATERITE/WHITE SAND AND SAND CLAY/ WHITE SAND 35

PART 11 - SAND SEAL COAT 39

PART 12 - PRIME AND TACK COATS 42

PART 13 - TRIPLE/ DOUBLE/SINGLE BITUMINOUS SURFACE TREATMENT 45

PART 14 - ASPHALT CONCRETE AND SAND BITUMEN 51

PART 15 - CONCRETE FOR STRUCTURES AND OTHER USES 71

PART 16 - STRUCTURAL TIMBER 97

PART 17- REINFORCED CONCRETE AND TIMBER PILING 102
PART–1 PREPARATIONS / EARTHWORKS

1-1 CLEARING AND GRUBBING

1-1.1 Description

The work specified in this Section consists of clearing and grubbing, within the areas of the roadway right of way. Included in the work under this Section is the removal and disposal of all trees, stumps, roots and other such protruding objects, appurtenances, existing pavement, and other facilities necessary to prepare the area for the proposed construction, and the removal and disposal of all product and debris which are not required to be salvaged or not required to complete the construction.

1-1.2 Standard Clearing and Grubbing

This item of work shall consist of the complete removal and disposal of all brush, stumps, roots, rubbish and debris and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas, and of any other obstructions necessary to be removed and for which the removal thereof is not specified to be done under other items of contract. Clearing and grubbing shall be done within the following areas:

- All areas where excavation is to be done, including lateral ditches.
- All areas where roadway embankments will be constructed.
- All areas where structures will be construction, including pipe culverts.

1-2 EXCAVATION

1-2.1 Drain excavation

This work shall consist of clearing and excavation of drains and disposal of the material all in accordance with the specification and in close conformity with the lines, grades and dimensions shown on the plans or established by the Engineer.

Drains shall conform to the required cross sections and the Contractor shall maintain and keep open and free from leaves, sticks, weeds and other debris all drains dug by him until final acceptance of the work. Excavated material shall be removed from the Site or otherwise disposed as approved in writing by the Engineer.

The Contractor will take precautions to route his plant in such a manner as to minimise the likelihood of slips occurring due to vibrations or excessive surcharge from the working or movement of heavy machinery.

The tolerance of excavation for unlined drains shall be permitted as stated below:-
### Component Variation

- **Bed Level**: +/- 50mm
- **Side Slope**: +/- 150mm (from position shown on drawing)
- **Centre Line**: +/- 150mm. (from position shown on drawing)

All permanent excavation shall be trimmed to the slopes and batters shown on the drawings and the surface shall be smooth and even unless otherwise ordered by the Engineer.

#### 1-2.2 Structural Excavation

This work shall consist of the necessary excavating for revetments including disposal of surplus material left after the backfill is completed. All excavation for revetments shall be in accordance with this specification and in conformity with the Drawings or as established by the Engineer or his representative. No allowance will be made for classification of different types of materials encountered.

Filling shall consist of material excavated in the course of the work or from a borrow pit as directed by the Engineer.

All fill material is to be free from vegetable or other deleterious matter.

Filling shall be placed in layers of such thickness as will enable compaction to the required degree to be achieved throughout each layer. The thickness of any layer shall in no case exceed that which will give a compacted thickness of 300mm. Each layer shall be compacted to the degree specified and graded so as to make it self-draining. The finished surface of the filling shall be evenly graded and finished after compacted to the lines and levels shown on the drawings.

#### 1-2.3 Backfill

This work shall consist of the furnishing and placing of suitable clay backfill for revetments, compacted and shaped as show on the Drawings and specified herein.

Compacted fill shall be of suitable clay free from roots or other deleterious matter and shall contain no muck. The backfill material shall be placed in horizontal layers of not greater that 150mm thick and compacted to a uniform density of not less that 95% of the standard proctor density.
1-2.4 Embankments or Dams

Embankments and dams shall be formed with imported clay unless otherwise stated on drawings and approved by the Engineer. The spreading and compacting of the spoil shall be in accordance with the provisions of Clause 1:03 for filling i.e. (para 3.- para.5). Embankments and dams shall not exhibit any incipient seepage after prolonged retention of water at maximum level.

Tolerance of levels and dimensions for embankments and dams shall be permitted as stated below:

<table>
<thead>
<tr>
<th>Component</th>
<th>Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top Level</td>
<td>+/- 2in</td>
</tr>
<tr>
<td>Centre-line</td>
<td>+/- 6 in (from position shown on drawings)</td>
</tr>
<tr>
<td>Side slope</td>
<td>+/- 6 in (from position shown on drawings)</td>
</tr>
</tbody>
</table>

1-2.5 Cleaning of Drains

Cleaning of drains shall be executed by suitable machines equipped for such operations, unless otherwise approved by the Engineer in writing.

Cleaning shall be from bank to bank and all vegetation, rubbish, stumps, floating or submerged debris, obstacles and any other matter within the limits of drain likely to impeded the flow of water shall be removed and placed on the banks of the drains outside the limit of 2 meters from the edges of the drains, or otherwise disposed of in a dumping ground approved by the Engineer.

Cleaning shall be such as to expose the clay surface throughout the width of the drain up to 2 metres along each bank.

1-3 SCARIFYING, SHAPING AND COMPACTING ROADWAY

Where sections of the road have the pavement structure as specified by drawings requires re-shaping and compacting, the entire road will be scarified to a minimum depth of 6” moistened to near optimum moisture and re-compactd to 100% of the laboratory density obtained by the AASHTO T99 (Standard Proctor)

The thickness of the Material in the roadway will be verified in locations determined by the Engineer. Where it is found to be deficient in thickness, the Engineer will specify material to be added in such quantities to allow the desired thickness and profile of the road base as directed by the Engineer. The quantity of material supplied will be paid under the item in cubic metres at a rate specified in the Bill of quantity.
1-4 COMPACTION REQUIREMENTS

1-4.1 Compaction of Sub-grade

The sub-grade area shall be compacted to the density of at least 95 per cent of the maximum density as determined by AASHTO T 99, Method C

Where trenches for widening strips are not of sufficient width to permit the use of standard compaction equipment, any compaction effort required shall be accomplished by vibratory roller, trench rollers, or other type compaction equipment approved by the Engineer.

It shall be the Contractor's responsibility to maintain the required density until the base or pavement is placed on the Sub-grade.

1-5 CLAY BLANKET

1-5.1 Description

The work specified in this Section consists of placing of a layer of select material favourable to plant growth, over areas of the project which are to be grassed, grassed and mulched or sodded. This shall be accomplished by use of a clay blanket.

The Engineer may delete this work over areas of the project where a suitable growing medium for grass or sod is attained as a result of normal grading operations.

1-5.2 Materials

Clay material shall be suitable for plant growth and free from appreciable quantities of hard clods, stiff clay, hardpan, gravel, brush, large roots, refuse or other deleterious materials, and of reasonably uniform quality.

The clay material may be obtained from any or a combination of the following sources:

(a) Excavation within the road right of way
(b) Lateral ditch excavation
(c) Borrow pits provided by the Contractor.

The materials obtain from sources (a) or (b) may be stockpiled or windrowed on the project in areas approved by the Engineer. The Contractor shall prepare plans of borrow areas and obtain the Engineers approval prior to borrow excavation.
1-5.3 Construction Methods

The excavated material shall be placed and compacted to line and levels, and in layers not exceeding 300mm thick. The shoulder shall be rolled in conjunction with the layers of the road sub-base and base courses using a suitable size and type of roller.

The weather conditions and moisture content of the clay shall be conducive to such compaction, and care should be exerted to ensure form and shape is maintained. The contractor shall prevent contamination of the road base and sub-base by the clay and shall remove any such contamination immediately.

The Contractor is responsible for and make allowance for the draining of the road base during construction works. Any temporary drains excavated within the shoulder shall be made right at the end of the works at the Contractor’s expense. In addition, the Contractor shall “top up” the shoulder that has consolidated during the contract duration.

1-5.4 Preparation of Areas

Prior to placing the clay blanket, the surface of the earthwork shall have been constructed to such lines and elevations as will provide a surface conforming to the typical sections upon completion of the clay blanket or topsoil operations.

1-6 CLAY SHOULDERS

1-6.1 Description

The work specified in this Section consists of placing and compacting of clay and clayey material to form the road shoulder.

1-6.2 Materials

Clay material shall be suitable for retaining purposes, and shall be free from appreciable quantities of gravel, sand, silt and consists of reasonably uniform quality. Impurities such as brush, large roots, refuse or other deleterious materials shall be removed, prior to placement and compaction.

The clay material may be obtained from any or a combination of the following sources:

(a) Excavation within the road right of way
(b) Lateral ditch excavation
(d) Borrow pits provided by the Contractor.
The materials obtain from sources (a) or (b) may be stockpiled or windrowed on the project in areas approved by the Engineer. The Contractor shall prepare plans of borrow areas and obtain the Engineers approval prior to borrow excavation.

1-6.3 Preparation of Areas

Prior to placing the clay shoulder, the surface of the ground shall be grubbed and scarified, and free of vegetation and obstructions.

1-6.4 Construction Methods

The excavated material shall be placed and compacted to line and levels, and in layers not exceeding 300mm thick. The shoulder shall be rolled in conjunction with the layers of the road sub-base and base courses using a suitable size and type of roller.

The weather conditions and moisture content of the clay shall be conducive to such compaction, and care should be exerted to ensure form and shape is maintained. The contractor shall prevent contamination of the road base and sub-base by the clay and shall remove any such contamination immediately.

The Contractor is responsible for and make allowance for the draining of the road base during construction works. Any temporary drains excavated within the shoulder shall be made right at the end of the works at the Contractor’s expense. In addition, the Contractor shall “top up” the shoulder that has consolidated during the contract duration.

1-7 DISPOSAL OF SURPLUS AND UNSUITABLE MATERIAL

1.7.1 Ownership of Excavated Materials

Any surplus materials shall become the property of the Contractor and are to be disposed of by him, outside the right of way, to the satisfaction of the Engineer.

In urban or other areas where temporary storage of suitable materials within the right of way may be impracticable, the Contractor may stockpile the materials outside the right of way in areas provided by him, until such materials are needed in the job or are declared surplus. With the written approval of the Engineer, the Contractor may dispose of such apparent excess material with the stipulation that he shall replace any portion of the disposed material required to fulfill the actual job requirements, with equally suitable material, at his own expense.

No extra compensation will be allowed for any re-handling involved under the provisions of this Sub-article.
1-7.2 General Requirements for Disposal

Excavated much or other materials unsuitable for the roadway construction shall become the property of the Contractor and shall be disposed of by him outside the right of way.

1-7.3 Disposal Areas

Where the plans or specifications require the Contractor to dispose of excavated materials outside the right of way, and the disposal area is not indicated in the contract documents, the Contractor shall furnish the disposal area without additional compensation.

Areas provided by the Contractor for disposal of removed materials shall be out of sight of the project and at least 100m from the nearest roadway right of way line of any public road. The 100m limitation will not apply, however, if the materials are buried.

1-8 BORROW

1-8.1 Authorization for Use of Borrow

In no case shall material be borrowed until so ordered by the Engineer, and then only from designated borrow pits. No borrow pits shall be opened until the Engineer has approved their location.

1-8.2 Furnishing of Borrow Areas

Borrow material, as required, shall be obtained from areas furnished by the Contractor.

Approval for use of borrow areas furnished by the Contractor will not be given until the Contractor has notified the Ministry of the location of such areas.

No borrow material shall be obtained from any substitute areas until the Contractor has made written request for permission to use such areas and the Engineer has approved, in writing, the use of the particular areas and, where applicable, the Engineer has cross-sectioned the surface. Upon such written approval by the Engineer, the substitute areas shall be considered as designated borrow areas.

The Contractor shall supply the Ministry with evidence that he has secured the necessary permits, rights or waivers for the use of such areas.

Except for commercially operated sources all borrow areas furnished by the Contractor shall be located not closer than 100m from the right of way of the project.

Upon completion of excavation all exposed areas, including haul roads, shall be neatly shaped and dressed so as not to prevent an objectionable appearance. The cost of
grassing or other permanent erosion control measures directed by the Engineer will be compensated for as provided in the contract for similar items or roadway work.

A waiver of the 100m setback requirement will be considered only in rare and unusual circumstances where a definite public benefit will result. Each such request to encroach on the 100m setback must be accompanied by the Contractor's proposed plan of landscaping and restoring the disturbed area so as to blend with the surrounding terrain. The cost of all landscaping and restoration work required due to encroachment upon the 100m setback will be at the expense of the Contractor.

1-9 BASIS OF PAYMENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Excavation – Cubic Metre [cu.m or m³]</td>
</tr>
<tr>
<td></td>
<td>Clay Shoulders- Cubic metre [cu.m or m³]</td>
</tr>
<tr>
<td></td>
<td>Grubbing, Scarify, Shape and Re-compact- Square Metre [Sq.m or m²]</td>
</tr>
</tbody>
</table>

Excavation shall be paid based on the volume of material excavated as shown on the drawings or as ordered by the Engineer. Over excavation beyond the limits shown on the drawings or ordered by the Engineer shall not be paid for. The rate shall include for disposal of the excavated material.

The quantity of construction to be paid for clay shoulders shall be the number of cubic metres acceptably placed and compacted. The material shall be measured in its final position on a prepared foundation to level and grades as specified.
PART–2 LAND CLEARING AND GRUBBING

2-1.1 Description

The work specified in this Section consists of clearing of all vegetation, and grubbing/excavation of roots and stumps within the area specified. Included in the work under this Section is the removal and disposal of all trees, brush, grass, stumps, roots and other such protruding objects and appurtenances, along with other facilities necessary to prepare the area for the proposed construction. It also includes the removal and disposal of all waste product and debris which are not required to be salvaged. Disposal shall be done at an approved disposal area, located outside the project site.

2-1.2 Standard Clearing and Grubbing

This item of work shall consist of the complete removal and disposal of all brush, stumps, roots, rubbish and debris and all other obstructions resting on or protruding through the surface of the existing ground, and of any other obstructions necessary to be removed and for which the removal thereof is not specified to be done under other items of contract. Clearing and grubbing shall be done within the area specified in the block/ cadastral plan or as directed.

2-2 LAND CLEARING

2-2.1 Brush, Weeds and Other Vegetation

This work shall consist of clearing of the land by either mechanical and/or manual means, with full removal of all vegetation, roots and debris from within and above the ground, and disposal of the waste material all in accordance with the specification and in close conformity with the boundaries as shown on the plans or established by the Engineer. Roots shall be removed by grubbing or scarifying the ground to facilitate extraction.

No application of chemicals shall be used. Where necessary, only approved chemicals shall be applied, for the sole purpose to make area safe for work, i.e. to rid work area of pests, etc. All such chemicals shall be approved as environmentally safe.

Upon completion, the Contractor shall maintain and keep area open and free from leaves, sticks, weeds and other debris until final acceptance of the work.

2-2.2 Trees

This work shall consist of cutting, felling and clearing the work site of trees by either mechanical and/or manual means, with full removal of all parts therein, i.e. crown and branches, inclusive of leaves, trunk and the root/stump and other trash and debris from within the ground, and disposal of the material all in accordance with the specification and
in close conformity with the boundaries as shown on the plans or established by the Engineer.

The crown and trunk shall be cut to manageable sizes to facilitate easy transportation and removal. Roots and stumps shall be removed to a minimum depth of 1.50m below the ground level. All excavation done to remove such shall be backfilled as specified.

2-2.3 Removal of Trash and Debris

All trash and debris generated from the clearing works shall be gathered in small spoil heaps to facilitate removal. These shall be removed from the site via trucking to a dedicated spoil disposal area off site. Spoil shall be nominally free of earth/clay or indigenous soil.

No spoil shall be buried within the confines of the work site. No removal of earthen material/clay from the site shall be tolerated.

2-2.4 Backfill and Compaction

This work shall consist of the furnishing and placing of suitable clay backfill for any excavated areas as specified, e.g. existing or temporary drains, excavated tree stumps, etc.

Filling shall consist of material excavated in the course of the work or from a borrow pit as directed by the Engineer. All fill material is to be free from vegetable or other deleterious matter.

Filling shall be placed in layers of such thickness as will enable compaction to the required degree to be achieved throughout each layer. The thickness of any layer shall in no case exceed that which will give a compacted thickness of 300mm. Each layer shall be compacted to the degree specified and graded so as to make it self-draining. The finished surface of the filling shall be evenly graded and finished after compacted to the lines and levels shown on the drawings or as directed.

Compacted fill shall confirm to a uniform density of not less than 92% of the standard proctor density as determined by AASHTO T 99, Method C.

2-2.5 Embankments or Dams

All dams within the area shall be cleared as specified above. The integrity and structure of the dams and embankments shall be protected and maintained. Removal of earth/clay from such is forbidden unless otherwise instructed.

Embankments and dams shall be formed with imported clay unless otherwise stated on drawings and approved by the Engineer. The spreading and compacting of the spoil shall be in accordance with the provisions of Clause 1-2.4. Embankments and dams shall not exhibit any incipient seepage after prolonged retention of water at maximum level.
2-2.6 Clearing and Cleaning Of Drainage Canals

All drainage/irrigation canals within the limits of the work shall be cleared, de-weeded and de-silted to allow free flow of water. All spoil and trash shall be placed in manageable heaps and subsequently removed to the spoil area. Care shall be taken to prevent slippage of the banks by the traversing of machinery.

Cleaning of drains shall be executed by suitable machines equipped for such operations, unless otherwise approved by the Engineer in writing.

Cleaning shall be from bank to bank and all vegetation, rubbish, stumps, floating or submerged debris, obstacles and any other matter within the limits of drain likely to impeded the flow of water shall be removed and placed on the banks of the drains outside the limit of 2 metres from the edges of the drains, for subsequent disposal in a dumping ground approved by the Engineer.

Cleaning shall be such as to expose the clay surface throughout the width of the drain up to 2 metres along each bank.

2-2.7 Temporary Access and Drainage

The contractor is responsible for providing access to and within the project area, including the supply and subsequent removal of all temporary materials required therein. Temporary crossings of canals shall be constructed to facilitate passage of machinery and labour. These temporary crossings/coffer dams shall be so constructed so as to not prevent drainage of the area.

The provision of temporary drainage of the land prior to clearing shall be done. This shall be done by the excavation of temporary drainage channels if necessary to relieve ponded areas, and the clearing and de-silting of existing of drainage as specified. Where necessary, embankment and dams may be cut to facilitate thus.

All temporary accesses and shall be removed after completion of the works. Temporary drainage channels shall be backfilled and compacted as specified before final acceptance. The Contractor will take precautions to route his plant in such a manner as to minimise the likelihood of slips occurring due to vibrations or excessive surcharge from the working or movement of heavy machinery.
2-3 **DISPOSALS OF TRASH, SURPLUS AND UNSUITABLE MATERIAL**

2-3.1 **Ownership of Materials and General Requirements for Disposal**

All trash, Surplus and unsuitable materials shall become the property of the Contractor and are to be disposed of by him, outside the project area, to the satisfaction of the Engineer. The limits of disposal shall be within a 5.0Km from the outer boundaries of the site.

Unless written approval has been granted, the Contractor may not dispose of such apparent excess material identified by the Engineer, with the stipulation that he shall replace any portion of the disposed material required to fulfill the actual job requirements, with equally suitable material, at his own expense shall he dispose therewith.

No extra compensation will be allowed for any re-handling involved under the provisions of this Sub-article.

2-3.2 **Disposal Areas**

Where the plans or specifications require the Contractor to dispose of excavated materials outside the limits of the site, and the disposal area is not indicated in the contract documents, the Contractor shall furnish the disposal area without additional compensation.

Areas provided by the Contractor for disposal of removed materials shall be out of sight of the project and at least 300 metres from the nearest roadway right of way line of any public road. The 300-metre limitation will not apply, however, if the materials are buried or placed within an approved and existing disposal area.

2-4 **BASIS OF PAYMENT**

Item

- Clearing – Acre [ac] or Hectare [Hec]
- Canal Clearing and Cleaning – Linear metre [m]

Clearing shall be paid based on the area measurement of work as shown on the drawings or as ordered by the Engineer. Over clearing beyond the limits shown on the drawings or ordered by the Engineer shall not be paid for. The rate shall include for disposal of the trash and debris material off-site.

Canal Clearing and Cleaning shall be paid based on the length of the nominal centreline of the canals, irrespective of the width and depth of such, and only if identified as a separate item in the Bills of Quantities. Otherwise, the cost of clearing and cleaning of all canals within the limits of the work is included in the basic rate for General Land Clearing.
PART–3 LAND LEVELLING

3-1.1 Description

The work specified in this Section consists of the levelling of the land/ground within a tolerance to allow for the free draining of the levelled ground, after the removal/clearing of all vegetation, and grubbing/excavation of roots and stumps within the area as specified.

3-2 LEVELLING

3-2.1 Nominal Ground Levelling

This work shall consist of levelling of the land by either mechanical and/or manual means, after a land clearing would have been done. The levelling shall entail having a flat/level surface, free of indentations, gullies/ditches, humps or mounds. The levelling shall incorporate the breaking/excavation of humps and mounds and depositing within the gullies and low areas, and compacting as specified. These earthen/clay materials shall be free of vegetative and deleterious matter.

Temporary drains for the drainage of ponded areas shall also be filled and compacted to level. Notwithstanding, dams and clay embankments, and main drainage/irrigation canals shall remain intact, unless written approval has been given to level or fill such.

The tolerance for the level of the land shall be such that there is self-drainage/free runoff to the drainage canals, but not exceeding the lesser of 0.1% or +/- 0.30m in any direction.

The surface shall be nominally smooth and even, with lumps of earth/clay less than 0.30m diameter, unless otherwise ordered by the Engineer.

3-2.2 Backfill and Compaction

All fill material is to be free from vegetation or other deleterious matter (e.g. muck). Filling shall consist of material excavated in the course of the work or from a borrow pit within the limits of the site as directed by the Engineer.

Filling shall be placed in layers of such thickness as will enable compaction to the required degree to be achieved throughout each layer. The thickness of any layer shall in no case exceed that which will give a compacted thickness of 300mm. Each layer shall be compacted to the degree specified and graded so as to make it self-draining. The finished surface of the filling shall be evenly graded and finished after compacted to the lines and levels shown on the drawings.

The backfill material shall be compacted by mechanical means to a uniform density of not less than 92% of the standard proctor density.
3-2.3 Embankments or Dams

Embankments and dams shall remain, and shall not be used for borrow excavation, unless otherwise instructed.

3-2.4 Drainage/Irrigation Canals

Existing Drainage/Irrigation canals shall remain, and shall not be used for borrow excavation, unless otherwise instructed.

Temporary drainage canals excavated to provide drainage of the land shall also be backfilled as specified. Ditches and trenches that do not comprise the macro drainage network shall also be filled, unless otherwise instructed.

3-3 BORROW

3-3.1 Authorization for Use of Borrow

In no case shall material be borrowed until so ordered by the Engineer, and then only from designated borrow pits. No borrow pits shall be opened until the Engineer has approved their location.

3-3.2 Furnishing of Borrow Areas

Borrow material, as required, shall be obtained from areas furnished by the Contractor.

Approval for use of borrow areas furnished by the Contractor will not be given until the Contractor has notified the Ministry of the location of such areas.

No borrow material shall be obtained from any substitute areas until the Contractor has made written request for permission to use such areas and the Engineer has approved, in writing, the use of the particular areas and, where applicable, the Engineer has cross-sectioned the surface. Upon such written approval by the Engineer, the substituted areas shall be considered as designated borrow areas.

The Contractor shall supply the Ministry with evidence that he has secured the necessary permits, rights or waivers for the use of such areas.

Except for commercially operated sources all borrow areas furnished by the Contractor shall be located not closer than 300 metres from the right of way of the project.
Upon completion of excavation all exposed areas, including haul roads, shall be neatly shaped and dressed so as not to prevent an objectionable appearance. The cost of grassing or other permanent erosion control measures directed by the Engineer will be compensated for as provided in the contract for similar items or roadway work.

A waiver of the 300-metre setback requirement will be considered only in rare and unusual circumstances where a definite public benefit will result. Each such request to encroach on the 300 metre setback must be accompanied by the Contractor's proposed plan of landscaping and restoring the disturbed area so as to blend with the surrounding terrain. The cost of all landscaping and restoration work required due to encroachment upon the 300 metre setback will be at the expense of the Contractor.

3-3.3 Temporary Access and Drainage

The contractor is responsible for providing access to and within the project area, including the supply and subsequent removal of all temporary materials required therein. Temporary crossings of canals shall be constructed to facilitate passage of machinery and labour. These temporary crossings/coffer dams shall be so constructed so as to not prevent drainage of the area.

The provision of temporary drainage of the land prior to clearing shall be done. This shall be done by the excavation of temporary drainage channels if necessary to relieve ponded areas, and the clearing and de-silting of existing of drainage as specified. Where necessary, embankment and dams may be cut to facilitate thus.

All temporary accesses and shall be removed after completion of the works. Temporary drainage channels shall be backfilled and compacted as specified before final acceptance. The Contractor will take precautions to route his plant in such a manner as to minimise the likelihood of slips occurring due to vibrations or excessive surcharge from the working or movement of heavy machinery.

3-4 BASIS OF PAYMENT

Item  Land Levelling - Acre [ac] or Hectare [Hec]

Levelling shall be paid based on the plan area of project as shown on the drawings or as ordered by the Engineer. Levelling beyond the limits shown on the drawings or ordered by the Engineer shall not be paid for. The rate shall include for compaction of the excavated material.
PART 4 – CANAL FILLING

4.1 Description
The works specified under this specification consists of the filling of existing drainage and/or irrigation canals within a tolerance to allow for the free draining of the levelled ground, after the removal/clearing of all vegetation, and grubbing/excavation of roots and stumps within the area as specified. The fill materials may be granular, earthen/indigenous, or a combination of both as specified in the Bills.

It also includes the removal and disposal of all waste product and debris which are not required to be salvaged. Disposal shall be done at an approved disposal area, located outside the project site.

4.2 General Methodology
The methodology to be employed in the works is outlined as follows. The Contractor is responsible for providing access to the site, and the safety of equipment and personnel employed therein.

4.2.1 Clearing, Cleaning and Preparation of Drainage Canals
All drainage/irrigation canals within the limits of the work shall be cleared, de-weeded and de-silted to allow free flow of water as per the above. The canals shall then be drained of all water. There draining is impractical, the canal shall be apportioned into manageable sections and pumped dry.

After complete dewatering of canal is accomplished, any remaining silt, slush and loose materials shall be removed from the canal in accordance to the profile. The canal shall then be sun-dried to harden the natural clay.

All spoil and trash shall be placed in manageable heaps and subsequently removed to the spoil area. Care shall be taken to prevent slippage of the banks by the traversing of machinery. Cleaning of drains shall be executed by suitable machines equipped for such operations, unless otherwise approved by the Engineer in writing.

4.2.2 Surveying of Canal
The canal shall then be surveyed, with cross-sections and profiles in order to ascertain quantities. After the relevant layer thickness for the specific materials has been determined, survey mark shall be installed to guide placement of the materials.

4.2.3 Backfill and Compaction
All fill material is to be free from vegetation or other deleterious matter (e.g. muck). Filling shall consist of material excavated in the course of the work or from a borrow pit within the limits of the site as directed by the Engineer.
Filling shall be placed in layers of such thickness as will enable compaction to the required degree to be achieved throughout each layer. The thickness of any layer shall in no case exceed that which will give a compacted thickness of 300mm. Where more than one type of fill material is used, each material shall be verified by the Engineer prior to the placement of the overlying material.

Each layer shall be compacted to the degree specified and graded so as to make it self-draining. The finished surface of the filling shall be evenly graded and finished after compacted to the lines and levels shown on the drawings.

The backfill material shall be compacted by mechanical means to a uniform density of not less than 95% of the standard proctor density.

### 4.3 BORROW

#### 4-3.1 Authorization for Use of Borrow

In no case shall material be borrowed until so ordered by the Engineer, and then only from designated borrow pits. No borrow pits shall be opened until the Engineer has approved their location.

#### 4-3.2 Furnishing of Borrow Areas

Borrow material, as required, shall be obtained from areas furnished by the Contractor.

Approval for use of borrow areas furnished by the Contractor will not be given until the Contractor has notified the Ministry of the location of such areas.

No borrow material shall be obtained from any substitute areas until the Contractor has made written request for permission to use such areas and the Engineer has approved, in writing, the use of the particular areas and, where applicable, the Engineer has cross-sectioned the surface. Upon such written approval by the Engineer, the substituted areas shall be considered as designated borrow areas.

The Contractor shall supply the Ministry with evidence that he has secured the necessary permits, rights or waivers for the use of such areas.

Except for commercially operated sources all borrow areas furnished by the Contractor shall be located not closer than 300 metres from the right of way of the project.

Upon completion of excavation all exposed areas, including haul roads, shall be neatly shaped and dressed so as not to prevent an objectionable appearance. The cost of
grassing or other permanent erosion control measures directed by the Engineer will be compensated for as provided in the contract for similar items or roadway work.

A waiver of the 300-metre setback requirement will be considered only in rare and unusual circumstances where a definite public benefit will result. Each such request to encroach on the 300 metre setback must be accompanied by the Contractor's proposed plan of landscaping and restoring the disturbed area so as to blend with the surrounding terrain. The cost of all landscaping and restoration work required due to encroachment upon the 300 metre setback will be at the expense of the Contractor.

4-4 BASIS OF PAYMENT

Item Canal Filling – Cubic Metre [m$^3$]

Canal Filling shall be paid based on the volume of the respective materials used in the works, or as ordered by the Engineer. Filling beyond the limits as identified, or without the knowledge and approval of the Engineer shall not be paid for. The rate shall include for de-silting, dewatering, drying, excavation and disposal of slush, and compaction of the fill material.
PART 5 - WHITE SAND or REEF SAND SUBGRADE-FILL

5-1 DESCRIPTION

The work specified in this Section consists of the construction of a sub-base course composed of white sand, on the prepared sub-grade, in accordance with these specifications and in conformity with the lines, grades, notes and typical cross sections shown in the plans. When the specified compacted thickness of the sub-base is greater than 200mm, the sub-base shall be constructed in two or more courses; otherwise the base may be constructed in either one or two courses.

5-2 MATERIAL

5-2.1 General

The material used shall conform to the following:

For white sand not more than 15% passing the No. 200 sieve; C.B.R. value to be not less than 20% when compacted in accordance with AASHTO T180 and tested after soaking for four days. In addition, the white sand shall be non-plastic and the liquid limit must not exceed 25%.

Before any sub-base course material is used it shall first have been tested by the laboratory and approved by the Engineer.

5-2.2 Source of Materials

The Contractor shall submit to the Engineer at least four gradation curves at different locations and depths of the material at the borrow pit at least 14 days before the material is required on site.

5-3 PLACING MATERIALS

If the sub-base is to be constructed in two or more courses, the component courses shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 200 mm.

5-4 COMPACTION

The material shall have approximately the optimum moisture content and the proper loose consistency, as determined by the Engineer, before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to insure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disking the base course to its full depth. If the material contains an excess of moisture, it shall be cause to dry before being compacted. Wetting or drying
operations shall involve manipulation of the entire width and depth of the base as a unit. As soon as proper conditions of moisture are attained each course shall be compacted to a density not less than 98 per cent of the maximum density as determined by AASHTO T180.

Prior to the placing of material for the overlying course, the density tests shall have been made on the lower course and the Engineer shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, diskimg, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

5-5 TESTING SURFACE

The finished surface of the sub-base course shall be checked with a template cut to the required crown and with a 3 mm straightedge laid parallel to the centre-line of the road. All irregularities greater than 6 mm shall be corrected by scarifying, and removing or adding base material as may be required, after which the entire area shall be re-compacted to meet the specified density requirements.

5-6 THICKNESS OF SUB-BASE

A 10 mm under-tolerance in the thickness of the sub-base will be allowed. All areas where the thickness of the completed sub-base is less than the thickness required after such tolerance, shall be corrected by scarifying, adding base material and re-compacting as specified in 5-4.

5-7 DENSITY CONTROL

The in place density of each layer shall be determined as specified by the ASTM Standards D2922, D 3017 and/or C1040.

5-8 BASIS OF PAYMENT

The quantity of sub-base construction to be paid shall be the number of cubic metres acceptably placed and compacted. The material shall be measured in its final position and dimensions after acceptance on a prepared foundation to level and grades as specified.

White Sand or Reef Sand Fill – Cubic Metres [cu.m or m³]
PART 6 - SAND CLAY/WHITE SAND BASE AND REEF-SAND/WHITE-SAND, BASE AND SUB-BASE

6-1 DESCRIPTION

The work specified herewith consists of the construction of a base/sub-base composed of a mixture of suitable sand clay and white sand blended in the ratio of 60:40 or reef-sand and white-sand, blended in the ratio 75:25 (alternative 70:30 if instructed by the Engineer) to achieve the desired characteristics. The materials shall be free from roots, vegetation and other deleterious matter.

6-1 MATERIAL

The materials shall meet the following requirements:

6-1.1 General Requirements

Material for use in the construction shall be a suitable mixture of sand-clay and white sand or reef-sand and white sand as shown on drawings and shall be free of trash, foreign matter and other deleterious material. It shall not contain lumps or aggregate of such nature or in sufficient quantity to prevent the obtaining of a smooth surface, free from pits and pockets. It shall not contain particles of aggregate which will not pass a 25mm (1 inch) sieve.

6-1.2 C.B.R. and Plasticity

The CBR of the mixture shall not be less than 35 % when compacted in accordance with AASHTO T 180 and tested after soaking for four days. The Plasticity Index of the material shall not exceed 6, and the liquid limit must not be greater than 35 %.

6-1.3 Source of Material

The Contractor shall submit to the Engineer at least four gradation curves at different locations and depths of the material at the borrow pit at least 14 days before the material is required on site.

6-2 PLACING MATERIAL

The material may be dumped directly on the base/sub-base but shall be uniformly distributed by approved methods. The loose thickness shall be as designated by the Engineer prior to compaction, and shall be checked continuously by the Contractor to ensure that the finished base/sub-base will have the finished compacted thickness and shape required by the typical section.
6-3 CONSTRUCTION

If two or more materials have to be blended to produce the required base/sub-base material, it shall be ensured that uniformity of mix has been attained after the completion of mixing.

6-4 COMPACTATION

The material shall have approximately the optimum moisture content and the proper loose consistency, as determined by the Engineer, before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to insure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disking the base course to its full depth. If the material contains an excess of moisture, it shall be cause to dry before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the base as a unit. As soon as proper conditions of moisture are attained each course shall be compacted to a density not less than 98% of the maximum density as determined by AASHTO T180.

Prior to the placing of the subsequent course, the density tests shall have been made on the lower course and the Engineer shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, disking, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

6-5 TESTING SURFACE

The finished surface shall be checked with a template cut to the required crown and with a 4 m straightedge laid parallel to the centre-line of the road. All irregularities greater than 6 mm shall be corrected by scarifying, and removing or adding base material as may be required, after which the entire area shall be re-compacted to meet the specified density requirements.

6-6 THICKNESS OF BASE/SUB-BASE

A 10 mm under-tolerance in the thickness of the base/sub-base will be allowed. All areas where the thickness of the completed base/sub-base is less than the thickness required after such tolerance, shall be corrected by scarifying, adding base material and re-compacting as specified in 6-4.
6-7 BASIS OF PAYMENT

The quantity of sub-base construction to be paid shall be the number of cubic metres acceptably placed and compacted. The material shall be measured in its final position and dimensions after acceptance on a prepared foundation to level and grades as specified.

Sand Clay/White Sand or Reef Sand/White Sand – Cubic Metres [cu.m or m³]
PART 7 – CRUSHED STONE / CRUSHER RUN

7-1 DESCRIPTION

First Grade Crusher Run: The material shall consist of suitable crushed stone which shall be free from any deleterious or organic matter.

Second Grade Crusher Run: The material shall consist of suitable crushed stone and approved clayey material (i.e. Sand Clay). The proportion of Stone: Clay Binder shall be 2:1.

7-2.1 GRADATION REQUIREMENTS – FIRST GRADE

<table>
<thead>
<tr>
<th>A.S.T.M Sieve No.</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 mm</td>
<td>100</td>
</tr>
<tr>
<td>25 mm</td>
<td>80-100</td>
</tr>
<tr>
<td>19 mm</td>
<td>70-90</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>55 -80</td>
</tr>
<tr>
<td>No.4</td>
<td>35 –60</td>
</tr>
<tr>
<td>No.8</td>
<td>25 –50</td>
</tr>
<tr>
<td>No.30</td>
<td>12 - 30</td>
</tr>
<tr>
<td>No.200</td>
<td>5- 10</td>
</tr>
</tbody>
</table>

7-2.2 GRADATION REQUIREMENTS – SECOND GRADE

<table>
<thead>
<tr>
<th>A.S.T.M Sieve No.</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 mm</td>
<td>100</td>
</tr>
<tr>
<td>25 mm</td>
<td>85-100</td>
</tr>
<tr>
<td>19 mm</td>
<td>70-90</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>60 -80</td>
</tr>
<tr>
<td>No.4</td>
<td>40 –65</td>
</tr>
<tr>
<td>No.8</td>
<td>30 –55</td>
</tr>
<tr>
<td>No.30</td>
<td>15 - 40</td>
</tr>
<tr>
<td>No.200</td>
<td>5- 15</td>
</tr>
</tbody>
</table>

7-3 C.B.R. REQUIREMENTS

First Grade: not less than 65%, and Second Grade: not less than 50% when compacted in accordance with AASHTO T99, Method C, and tested after soaking for four days.
7-4 **COMPACTION**

All compaction shall be done at optimum moisture content, as determined by AASHTO T99, Method C. The density shall not be less after compaction than 98% of the maximum dry density as determined by AASHTO T99, Method C.

7-5 **TESTING SURFACE**

The finished surface shall be checked with a template. All irregularities greater than 6mm shall be corrected by scarifying, and removing and adding material as may be required, after which the entire area shall be re-compacted to meet the specified density requirements.

7-6 **THICKNESS**

A 10 mm under-tolerance in the thickness will be allowed. All areas where the thickness is less than required after such tolerance, shall be corrected by scarifying, adding material and re-compacting as specified in 7-4.

7-7 **METHOD OF MEASUREMENT**

The quantity of crushed stone to be paid for under this section shall be the volume in cubic metre completed and accepted.

7-8 **BASIS OF PAYMENT**

The quantity crusher run, determined as provided above, shall be paid for at the contract unit price per cubic metre. Such price and payment shall be full compensation for all the work specified in this section, and shall include all materials, equipment, hauling, etc.

Payment shall be made under:

Crusher run (General) – Cubic metre [cu.m or m³]
PART 8 - BAUXITE CAPPING

8-1 DESCRIPTION

The work to be performed under this Section consists of furnishing and placing one or more courses of bauxite capping on prepared sub-base in accordance with these Specifications, and in conformity with the lines, grades, thickness and typical cross-sections and dimensions shown on the Drawings.

8-2 MATERIALS

Materials for the road base course shall be of local bauxite capping conforming AASHTO M 147, or as approved by the Engineer. The material shall be free of organic and deleterious materials.

The materials shall be plasticity index of not greater than 13 as determined by AASHTO T90 and liquid limit of not greater that 33 as determined by AASHO T89. Where the limit is exceeded, white sand in proportion may be added to achieve the required property upon written approval of the Engineer, at the Contractor’s own expense.

8-3 C.B.R REQUIREMENTS

Not shall not be less than 50% when compacted in accordance with AASHO T 180-C and tested after soaking for four (4) days.

8-4 WORKMANSHIP

8-4.1 Preparation

Prior to placing bauxite capping the foundation area shall be prepared in accordance with Specifications.

8-4.2 Placing, Spreading and Compacting

Bauxite capping shall be placed and spread in layers to the thickness specified. If more than one layer is to be placed, each layer shall be shaped and compacted before the succeeding layer is placed. Compaction shall exceed 98% of the standard proctor density as per AASHTO T180.
The placing of bauxite capping shall begin at a point designated by the Engineer. Bauxite Capping shall be spread such that the final compacted thickness of each lift does not exceed 150mm. The final thickness shall be that specified to the grades and profile as shown on the drawings.

When hauling is done over previously placed bauxite capping, the hauling equipment shall be dispensed uniformly over the entire surface of the previously constructed layer.

Immediately following final spreading and smoothing, each layer shall be compacted in accordance with the Specification to the full width by means of smooth wheel power rollers, pneumatic tired rollers or other approved compaction equipment. Rolling shall progress gradually from the sides to the centre parallel to the centre line of the road, and shall continue until the entire surface has been rolled.

All irregularities or depressions that develop shall be corrected by loosening the bauxite capping at these places and adding or removing the bauxite capping until the surface is smooth and uniform.

Along kerbs, headers and walls and at all places not accessible to the roller, bauxite capping shall be compacted thoroughly with approved tampers or plate compactors. Bauxite capping shall be both bladed and rolled until a smooth, even surface has been obtained.

The Engineer will make measurements of test holes during progress of the work to determine the depth of the compacted layer to ensure the desired thickness specified as achieved.

Cutting of the test holes and refilling with materials properly compacted shall be done by the Contractor under the supervision of the Engineer.

8-5 Payment
The quantity of bauxite capping to be paid shall be the number of cubic metres acceptably placed and compacted. Bauxite capping shall be measured in its final position on a prepared foundation to levels and grades as specified. The rate shall include for the supply, placement and compaction. Pay items shall be as follows.
Bauxite Capping: Cubic Metre [cu.m or m3]
PART 9 – LATERITE/WHITE SAND SUB-BASE AND BASE

9-1 DESCRIPTION

The work specified herewith consists of the construction of a base composed of a mixture of suitable laterite and white sand. The materials shall be free from roots and other deleterious matter.

9-2 MATERIALS

9-2.1 General

The materials used shall conform to the following:

- **Laterite**
  
  For laterite 95% passing the 1 1/2, sieve and not more than 8% passing the No.200 sieve; CBR value to be not less than 40% when compacted in accordance with AASHTO T99, Method C and tested after soaking for four days. In addition, the laterite shall have a plasticity index not exceeding 10 and a liquid limit not exceeding 23%.

- **White Sand**
  
  For white sand, not more than 2.5% passing the No.200 sieve; CBR value to be not less than 20% when compacted in accordance with AASHTO T99, Method C and tested after soaking for four days.

- **Laterite/White Sand (2:1) Mix**
  
  The laterite/white sand blend shall comprise of two (2) parts laterite and one (1) part white sand by mass. The laterite/white sand mix must fit the following gradation:

<table>
<thead>
<tr>
<th>ASTM SIEVE</th>
<th>PERCENT PASSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 1/2 in</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>98-100</td>
</tr>
<tr>
<td>1/4</td>
<td>95-100</td>
</tr>
<tr>
<td>1/2</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8</td>
<td>80-100</td>
</tr>
<tr>
<td>No.4</td>
<td>55-85</td>
</tr>
<tr>
<td>10</td>
<td>35-65</td>
</tr>
<tr>
<td>40</td>
<td>15-40</td>
</tr>
<tr>
<td>200</td>
<td>10-25</td>
</tr>
</tbody>
</table>
The CBR value shall be not less than 50% when compacted in accordance with AASHTO T99, Method C and tested after soaking for four days. In addition, the laterite/white sand mix shall be non-plastic and the liquid limit must not exceed 13%.

9-3 SPECIFICATION OF PARTICULAR APPLICATION

This section covers the processing of materials which require special treatment to ensure maximum effectiveness in performance.

9-3.1 Excavation of Laterite from Borrow Areas

The method of utilizing and draining borrow pit areas is of special importance during rainy weather. If power shovels or front end loaders are used the pit should be excavated from a downhill position upwards. This would allow natural drainage and prevent ponding.

All stripped soil should be placed at a location outside the borrow area in order to prevent contamination of the laterite to be loaded. While the ironstone or concretionary gravel is being excavated, care should be taken to avoid digging into underlying soil which may not be laterite or lateritic. If this happens the undesirable material should be washed out prior to transportation. Ironstone laterite must be excavated with a bulldozer equipped with ripper teeth. Under no circumstances should blasting be used.

9-3.2 Storage and Mixing

The materials shall be stored in stock heaps prior to- and after mixing with sand to the required proportions. Mixing shall only be carried out when the moisture content of the laterite in the stock heap is less than the plastic limit of the laterite.

If the stock heap is allowed to stand for more than 14No. days, or has been soaked to beyond its liquid limit, it shall be re-mixed prior to spreading in order to loosen any lumps that may have formed.

9-3.3 Placing and Compacting

The material shall not be deposited and allowed to remain in small heaps on the roadway. Immediately after placing to the prepared surface, the material shall be shaped and graded to the appropriate loose thickness and compacted by mechanical means.

Compaction shall take place at the optimum moisture content of the material. Where necessary, wetting or drying to achieve the optimum moisture is permissible. Flooding or swamping of the layer will not be accepted. Rolling shall commence from the edge of the carriageway and proceed progressively towards the centre of the road.

9-3.4 Testing

Testing for compaction shall be done at the Optimum Moisture content. Tests shall be done at predetermined intervals, but not exceeding 300m. Where the road length is less
than 300m, at least 3No. tests shall be done. The test areas shall vary from the centre and the edges of the roadway. The approved compaction density shall not be less than 98 per cent of the maximum density, as determined by AASHTO T180.

Prior to the placing of material for the overlying course, the density tests shall have been made on the lower course and the Engineer shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, disking, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

The finished surface shall be checked with a template cut to the required crown and with a 4 m straightedge laid parallel to the centre-line of the road. All irregularities greater than 6 mm shall be corrected by scarifying, and removing or adding base material as may be required, after which the entire area shall be re-compacted to meet the specified density requirements.

9-4 Payment

The quantity of laterite: white sand to be paid shall be the number of cubic metres acceptably placed and compacted. Bauxite capping shall be measured in its final position on a prepared foundation to levels and grades as specified. The rate shall include for the supply, placement and compaction.

Pay items shall be as follows.
Laterite:White Sand mix: Cubic Metre [cu.m or m3]
PART 10 – CEMENT STABILISED SUB- BASE AND BASE: LATERITE/WHITE SAND AND SAND CLAY/ WHITE SAND

9-1 DESCRIPTION

The works specified herein consists of the sourcing, mixing, placing and compacting of cement-stabilised bases of Sand Clay: White Sand and/or Laterite: White Sand blends. The un-stabilised mixes shall be in accordance to the above specifications prior to stabilisation.

9-2 MATERIALS

9-2.1 Cement Stabilized Laterite /White Sand

The cement stabilized laterite/ white sand blend shall comprise of two (2) parts laterite, one (1) white sand (as specified in PART 9 above), and a specified percentage (%) of cement; all proportions by mass. The exact proportion of cement is as specified in Drawings or Bills, and may vary from 2% to 10% by dry mass of Material.

The CBR value shall be not less than 80% when compacted in accordance with AASHTO T99, Method C and tested after soaking for four days. In addition, the cement stabilized laterite/white sand mix shall be non-plastic and the liquid limit must not exceed 13%.

9-2.2 Cement Stabilised Sand Clay/ White Sand

The cement stabilised sand clay/ white sand shall comprise 60% sand clay, 40% white sand (as specified in PART 6 above), and a specified percentage (%) of cement; all proportions by mass. The exact proportion of cement is as specified in Drawings or Bills, and may vary from 2% to 10% by dry mass of Material.

The CBR value shall be not less than 80% when compacted in accordance with AASHTO T99, Method C and tested after soaking for four days. In addition, the cement stabilized laterite/white sand mix shall be non-plastic and the liquid limit must not exceed 15%.

9-3 WORKMANSHIP

9-3.1 General Preparation

The underlying base or sub-base shall be prepared, tested and accepted prior to the placement of stabilised layer. The weather conditions shall sunny in order to be conducive for placement. The base material to be treated shall be in accordance to the above proportions and specifications, and stored in stock heaps.

The underlying base shall be moistened, but not excessively soaked or wet.
9-3.2 Placing, Mixing and Compacting

The Cement treated bases (CTB) shall be placed in layers not exceeding 150mm thick. If the overall thickness of the desired compacted layer exceeds 150mm, the materials shall be placed in multiple equal layers, each not exceeding 150mm, nor shall any layer be less than 75mm.

The mixing of the material shall either be by mill/plant mix or in situ/road mixing. Where multiple layers are to be placed, the layers shall be mixed and placed separately.

9-3.2.1 Road Mix

The un-stabilised material shall be placed, spread and graded to the general shape and loose thickness required in order to achieve the final compacted thickness and shape. This layer shall not be pre-compact ed. The appropriate amount of cement as required shall be added to the laterite/white sand or sand clay/white sand base. The cement shall be spread uniformly over the surface of the base to be treated, and then mixed mechanically (by rota-vator). The cement shall not be allowed to stand more than four (4) hours before mixing and the addition of water.

At least a single pass shall be made over any section. The mixing shall progress until the entire surface has been thoroughly mixed when dry. The section shall then be wetted to at least the optimum moisture content and the entire surface mixed again. Excessive addition of water which leads to segregation, ponding and prevention of proper mixing shall not be permitted.

Alternatively, a mechanical mixer that applies water during the mixing shall be used, however, the rate of application shall be monitored such that the at least the there is no excessive wetting of the base.

The surface shall then be graded, compacted and allowed to cure. Additional wetting shall be allowed if there is a risk of the layer drying out and cracking, but not later than two (2) hours after the first wetting.

9-3.2.2 Plant Mix

If the base material is mixed using a mill/plant mixer, the constituent materials shall be dry. The mix shall be transported, placed and spread in a thickness such that the final compacted thickness will be achieved, but not exceeding 150mm.

If the plant is located onsite and immediate placement is intended, the mix may be wet, with the water content not exceeding the OMC. The mix shall then be immediately placed and compacted, and allowed to cure.
9-3.3 Compacting and Trimming

Compaction shall be by pneumatic rollers only. Compaction shall begin after adding of water and the initial grading to shape. The compaction shall proceed for up to two and a half hours (2.5) hours after first wetting of the cement treated base, but not exceeding this time. Perform final compaction in such a manner that no loose material remains on the surface and tear marks are eliminated.

Trimming and final shaping to grade shall be permitted only within the first two (2) hours after first wetting of the CTB. Following trimming, the trimmed areas must be re-compacted such that the entire layer of CTB complies with the specified compaction requirements.

Whenever CTB is spread and compacted in more than 1 layer, compact each lower layer to the required degree of compaction before placing the next layer. Trim only to comply with the specified layer thickness. When placed in more than 1 layer, keep the compacted material moist until covering with the next layer or curing seal.

9-3.4 Joints

Construct a contact joint at the end of each work day and whenever CTB operations are delayed or stopped for more than 2 hours. Contact joints must be constructed in thoroughly compacted material, normal to the roadbed centerline, with a vertical face. Do not place additional CTB until the contact joint is approved.

Where CTB has been finally compacted for more than 1 hour, construct longitudinal joints by cutting vertically into the existing edge approximately 75mm deep. Moisten the face of the cut joint in advance of placing adjacent base.

9-3.5 Curing

If required, apply curing seal to the surface of a lower layer that will not be covered with the next layer on the same day to ensure adequate moisture is retained within the CTB.

The completed CTB shall be with asphaltic emulsion curing seal. The asphaltic emulsion curing seal shall be Grade SS1 or CSS1. Dilute and thoroughly mix asphaltic emulsion for curing seal at a ratio of 1 part water to 1 part asphaltic emulsion. The water must not cause premature separation of the emulsion. Uniformly apply the diluted curing seal at a rate between 0.90 to 1.40 L/m² (0.25 to 0.35 US Gal/m²) of CTB surface.

Apply curing seal on the same day as completion of final compaction and as soon after final compaction is practicable. Keep the surface moist until curing seal is applied.
Do not allow traffic or equipment on the CTB for 72 hours after application of the curing seal. After 72 hours, limit traffic and equipment on the CTB to that used in paving operations or placing additional layers of CTB.

9-4 Testing

The finished CTB surface must be uniform and must not deviate at any point more than 6mm from the bottom of a 4.0m straight edge laid in any direction. Where there is a deviation greater than is acceptable, the section of base shall be removed and reinstated in accordance to the specifications.

The relative compaction of CTB must not be less than 98 percent. Each layer of CTB may be tested for compaction, or all layers may be tested together, at the option of the Engineer. Whenever all layers are tested together, you are not relieved of the responsibility to achieve the required compaction in each layer placed.

9-5 Payment

The quantity of Cement Stabilised Base to be paid shall be the number of cubic metres acceptably placed and compacted. The Material base shall be measured in its final position on a prepared foundation to levels and grades as specified. The rate shall include for the supply, placement, mixing and compaction.

Pay items shall be as follows:-
Cement Stabilised Laterite/White Sand: Cubic Metre [cu.m or m3]
Cement Stabilised Sand Clay/White Sand: Cubic Metre [cu.m or m3]
PART 11 - SAND SEAL COAT

11-1 DESCRIPTION

The sand seal coat consists of the application of bituminous material and the subsequent covering with sand cover material such that there is no exposed bitumen. This work can be applied on bases and cement-treated sub-grade or other surfaces as specified or where directed.

11-2 PROPORTIONING.

Use the approximate proportions for the sand seal coat as follows:

Bituminous Material: 0.65 to 1.15 L/m² (0.15 - 0.25 gal/yd²)

Cover Material: 0.005 to 0.007 m³/m²

The Engineer will designate the actual spread for each material.

11-3 MATERIALS.

11-3.1 Bituminous Material

The Bituminous Material shall be either cutback or emulsified asphalt meeting the following requirements:

Emulsified Asphalt: Grade CRS-2 to meet requirements of AASHTO M140.
Cut Back Asphalt: RC-250

Use asphalt cement or emulsified asphalt at Engineers’ option.

11-3.2 Cover Material

The cover material shall be clean and non-plastic sand composed of hard durable grains and free from loam, roots, clay balls, and other deleterious substances. The maximum size of grain shall not exceed 3.0mm, and not less than 15% shall be finer than 0.3mm. The Contractor may use local sand if it meets the above requirements. Obtain the Engineer's approval of the sand.

11-4 WEATHER LIMITATIONS

The bituminous material shall not be applied when the air temperature in the shade and away from artificial heat is less than 15°C (60°F) at the location where the application is to
be made, or when weather conditions or the surface conditions are otherwise unfavourable.

11-5 CONSTRUCTION METHODS

11-5.1 General Requirements

The surface to be treated shall be compacted and graded as per these specifications. Prior to the application, the surface shall be cleaned of all vegetation, deleterious and loose materials to the satisfaction of the Engineer.

11-5.2 Bitumen Distributor Pressure

The bituminous material shall be sprayed uniformly over the surface by means of a pressure distributor. When a surface constructed under this Section is on a paved shoulder, the Contractor shall use a string line or other approved method, to produce a uniform line along the edge of the applied bituminous material, adjacent to the traffic lanes. The distributor used for applying the bituminous material shall maintain a pressure of at least 140KPa (20psi), but not more than 520KPa (75 pounds per square inch).

11-5.3 Application Temperatures

The application temperature shall be between 40°C and 75°C for emulsified asphalt, and between 80°C and 135°C for cut-back asphalt.

11-5.4 Uniformity of Distribution

Special precautions shall be observed to assure that an even and uniform distribution of bituminous material will be obtained, and the distributor shall be so adjusted and operated as to maintain uniform, even distribution of the type of material being applied.

Excessive deposits of bituminous material upon the road surface, caused by stopping or starting the distributor, leakage, or otherwise, shall be immediately removed.

11-5.5 Limitations to Application

The area to be covered by any one application of bituminous material shall be not greater than can be covered with the aggregate without interruption due to limitations of hauling and spreading equipment or to any other cause.

For double application surface treatments, the second application of bituminous and cover materials may be applied the same day as the first application, providing that this second application is consistent with the curing requirements.

For CRS2, a 24 hours curing time is required, for RC250, at least 3 days.
11-5.6 Application of Cover Material

Apply sand uniformly at the rate designated by the Engineer. If the Engineer considers it necessary for the proper distribution of the spread, lightly drag the sand with a drag broom. Roll the entire area of the sand with at least ten passes of a traffic roller.

11-6 METHOD OF MEASUREMENT

11-7.1 General

This quantity of material actually applied and accepted shall be determined from measurements of area accepted by the Engineer.

Payment – Sand Seal Coat – Square Metre [sq.m or m²]
PART 12 - PRIME AND TACK COATS

12-1 DESCRIPTION

Apply bituminous prime coat on previously prepared non asphaltic bases and apply bituminous tack coat on previously prepared asphaltic or impervious bases and on existing pavement surfaces. All such work shall be accomplished in accordance with these specifications and in conformity with the lines, dimensions and notes shown in the plans or as directed by the Engineer.

12-2 MATERIALS

12-2.1 Prime Coat

The asphalt used shall be Emulsified Asphalt, Grades RS-2, SS-1 or SS-IH; or Cutback Asphalt, RC250, or as approved by the Engineer.

12-2.2 Cover Material for Prime Coat

The cover material shall be either sand (bare or hot-asphalt coated) or screenings, at the Contractor's option. The sand shall be non-plastic and free from any silt, clay balls and root particles, and from any noticeable sticks, trash, vegetation or other organic matter.

12-2.3 Tack Coat

Unless a specific type or grade of material is called for in the plans or special provisions, the material used for tack coat shall be shall be Emulsified Asphalt, Grades RS-2, SS-1 or SS-IH; or Cutback Asphalt, RC250, or as approved by the Engineer.

12-3 EQUIPMENT

12-3.1 Pressure Distributor

The Pressure distributor shall be equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface. The distance between the centres of openings of the outside nozzles of the spray bar shall be equal to the width of the application required, within an allowable variation of 50mm. The outside nozzle at each end of the spray bar shall have an area of opening not less than 25 per cent nor more than 75 per cent, in excess of the other nozzles. All other nozzles shall have uniform openings. When the application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzles.
12-3.2 Sampling Device on Transport Tanks

All transport tanks delivering bituminous materials for use on the project shall be equipped with an approved spigot-type sampling device.

12-4 CLEANING BASE AND PROTECTION ADJACENT WORK

Before any bituminous material is applied, all loose material, dust, dirt, caked clay and other foreign material which might prevent proper bond with the existing surface shall be removed for the full width of the application. Particular care shall be taken in cleaning the outer edges of the strip to be treated, to insure that the prime or tack coat will adhere.

The base material shall be compacted to grade and shape as specified prior to application of the prime coat. When the prime or tack coat is applied adjacent to curb and gutter, valley gutter or any other concrete surfaces, such concrete surfaces (except where they are to be covered with a bituminous wearing course) shall be covered with heavy paper, or otherwise protected as approved by the Engineer, while the prime or tack coat is being applied. Any bituminous material deposited on such concrete surfaces shall be removed.

12-5 WEATHER LIMITATIONS

Prime and tack coats shall be applied when all other weather conditions and the condition of the surface are suitable.

12-6 APPLICATION OF PRIME COAT

12-6.1 General

The surface to be primed shall be clean and the moisture content of the base shall not exceed 90 per cent of the optimum moisture. The temperature of the prime material shall be between 38° C (100° F) and 65° C (150° F). The actual temperature shall be that which will insure uniform distribution, and will be designated by the Engineer. The material shall be applied by means of a pressure distributor. The amount to be applied will be dependent on the character of the surface and shall be sufficient to coat the surface thoroughly and uniformly, with no excess.

12-6.2 Rate of Application of Prime Coat

The rate shall be not less than 0.90 to 1.15 L/m² (0.20 - 0.25 gal/m²) per square metre.

12-6.3 Sprinkling

If so required by the Engineer, the base shall be lightly sprinkled with water and rolled with a traffic roller, in advance of the application of the prime.
12-6.4 Sanding
The primed base shall be covered by a light uniform application of cover material. If considered necessary for proper distribution of spread, the cover material shall be lightly dragged with a drag broom, after which it shall be rolled with a traffic roller, for at least ten passes over the entire area. The rate of application of the cover shall be 0.005 to 0.007 m³/m².

12-7 APPLICATION OF TACK COAT

12-7.1 General
Where a bituminous surface is to be laid and a tack coat is required, the tack coat shall be applied as specified herein below. The surface shall be swept clean of all dust, loose sand and debris, and vegetative matter.

12-7.2 Method of Application
The tack coat shall be applied with a pressure distributor except that, on small jobs, if approved by the Engineer, application may be by other mechanical devices or by hand methods. The bituminous material shall be heated to a suitable temperature as per the prime coat, or as designated by the Engineer and shall be applied in a thin, uniform layer.

12-7.3 Rate of Application of Tack Coat
The rate shall be not less than 0.5–1.0 litres (0.1 to 0.2 Imp gallons) per square metre.

12-7.4 Curing and Time of Application
The Engineer will designate the curing period for the tack coat. The tack coat shall be applied sufficiently in advance of the laying of the bituminous mix to permit drying but shall not be applied so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material.

12-7.5 Protection
The tack coat surface shall be kept free from traffic until the subsequent layer of bituminous hot mix has been laid.

12-8 METHOD OF MEASUREMENT

12-8.1 General
This quantity of material actually applied and accepted shall be determined from measurements of area accepted by the Engineer.

Payment – Prime Coat- Square Metre [sq.m or m²]
Tack Coat- Square Metre [sq.m or m²]
PART 13 - TRIPLE/ DOUBLE/SINGLE BITUMINOUS SURFACE TREATMENT

13-1 DESCRIPTION

The work in this section consists of the construction of a wearing surface composed of separate applications of bituminous material covered in aggregate, either in single applications, double (alternate) applications.

13-2 MATERIALS COMPOSITIONS AND PROPORTIONING.

The materials used shall conform to the following requirements:

1) **Bituminous Material** – Bitumen binder shall be Cutback Asphalt - RC 250 or 60/70 Penetration Grade, or Asphalt Cement, Viscosity Grade AC-5.

2) **Cover Materials** - Uniform chipping of nominal size either 20mm, 16mm, 12mm, 8mm or 5mm (¾”, ½”, 3/8” or ¼” minus sifting) as required below:

The proportions are as follows:

<table>
<thead>
<tr>
<th>Applications</th>
<th>Chippings</th>
<th>Application Rate: Kg/m² (lbs/Sq.m²)</th>
<th>Bitumen Materials Rate: L/m²(USSgal/Sq.m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16mm (5/8”)</td>
<td>22 (48)</td>
<td>2.0 (0.55)</td>
</tr>
<tr>
<td></td>
<td>12mm (½”)</td>
<td>16 (36)</td>
<td>1.8 (0.50)</td>
</tr>
<tr>
<td></td>
<td>8mm (3/8”)</td>
<td>13.5 (30)</td>
<td>1.15 (0.30)</td>
</tr>
<tr>
<td>Double</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Layer</td>
<td>20mm (¾”)</td>
<td>22 (48)</td>
<td>2.0 (0.55)</td>
</tr>
<tr>
<td></td>
<td>16mm (5/8”)</td>
<td>19 (42)</td>
<td>1.8 (0.50)</td>
</tr>
<tr>
<td>Second layer</td>
<td>12mm (½”)</td>
<td>13.5 (30)</td>
<td>1.15 (0.30)</td>
</tr>
<tr>
<td></td>
<td>8mm (3/8”)</td>
<td>11 (24)</td>
<td>0.90 (0.24)</td>
</tr>
<tr>
<td>Triple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Layer</td>
<td>20mm (¾”)</td>
<td>22 (48)</td>
<td>1.8 (0.50)</td>
</tr>
<tr>
<td></td>
<td>16mm (5/8”)</td>
<td>19 (42)</td>
<td>1.6 (0.42)</td>
</tr>
<tr>
<td>Second layer</td>
<td>12mm (½”)</td>
<td>13.5 (30)</td>
<td>1.15 (0.30)</td>
</tr>
<tr>
<td></td>
<td>8mm (3/8”)</td>
<td>11 (24)</td>
<td>0.90 (0.24)</td>
</tr>
<tr>
<td>Third Layer</td>
<td>5mm (1/4” Sifting)</td>
<td>8 (18)</td>
<td>0.7 (0.18)</td>
</tr>
</tbody>
</table>

The size of chippings for each layer shall be specified by the Engineer.
13-3 SPREADING EQUIPMENT

Sufficient trucks and aggregate spreaders shall be at the site of the work to insure continuous spreading of the aggregate on the uncovered bituminous material. The spreader shall be of the mechanical type, shall be self-supported (towered), or self-propelled, and shall be capable of producing a smooth, uniform distribution of the cover material. Spreaders of the type attached directly to the rear of the truck body (tail gate spreaders) shall not be used.

13-4.1 Rollers

The rollers used for this surfacing shall be 5- to 8-ton steel-tires (or combination steel and rubber-tired) rollers, and self-propelled pneumatic-tired traffic type rollers equipped with at least seven smooth-tread, low pressure tires and capable of carrying a gross load of at least eight (8) tons. The inflation of the tires shall be maintained such that in no two tires shall the air pressure vary more than 35KPa (five pounds per square inch). The traffic roller shall be loaded as directed by the Engineer.

13-5 LIMITATIONS TO WIDTH OF APPLICATION

The application of bituminous cover shall be over the entire width to be treated unless, in the opinion of the Engineer, traffic conditions are not suitable for full width application, in which case the application shall be confined to one side of the road at one time, over such area as the economical distribution of the material form one delivery point will permit, leaving the opposite side open for traffic.

13-6 PREPARATION OF ROAD SURFACE

13-6.1 Cleaning

The surface to be covered shall be swept clean and free of sand, dirt, dust and other deleterious material, by means mechanical rotary sweepers, hand brooms or other approved methods, and shall be free from moisture.

13-6.2 Condition of Underlying Surface

Where a prime coat has previously been applied to the surface no bituminous material shall be applied until the prime coat has become thoroughly cured, as determined by the Engineer. Surface treatment shall not be applied over any pavement mixture when, due to heat from the sun or insufficient length of the curing period, the stability of the existing pavement is such as to allow penetration or displacement of the existing surface by the cover material during the rolling operations.
13-6.3 Weather Limitations

No bituminous material shall be applied when weather conditions are unfavourable or when the surface to be treated is wet.

13-6.4 Placement and Approval of Each Layer

The placement of the surface treatment shall be done in separate layers (i.e. a single application of bituminous materials and cover), rolled, compacted and allowed to cure before addition of subsequent layers. The Engineer shall inspect each layer and grant approval to proceed with the next once all criteria in the specifications have been met. Failure to allow for adequate compacting, curing and inspection will not be accepted, and any such work will be rejected and the sections removed and reinstated as per the these specifications at the Contractor’s own risk.

13-7 APPLICATION OF BITUMINOUS MATERIAL

13-7.1 Distributor Pressure

After the surface to be treated has been cleaned to satisfaction of the Engineer, the bituminous material shall be sprayed uniformly over the surface by means of a pressure distributor. When a surface constructed under this Section is on a paved shoulder, the Contractor shall use a string line or other approved method, to produce a uniform line along the edge of the applied bituminous material, adjacent to the traffic lanes. The distributor used for applying the bituminous material shall maintain a pressure of at least 140KPa (20psi), but not more than 520KPa (75 pounds per square inch).

13-7.2 Application Temperatures

For asphalt cement, Viscosity Grade AC-5 (and 60/70 Penetration Grade), the application temperature shall be between 120°C and 150°C (250°F and 300°F); for emulsified asphalt, between 50°C and 75°C (100°F and 170°F); and for cut-back asphalt, between 80°C and 135°C (175°F and 275°F).

13-7.3 Uniformity of distribution

Special precautions shall be observed to assure that an even and uniform distribution of bituminous material will be obtained, and the distributor shall be so adjusted and operated as to maintain uniform, even distribution of the type of material being applied. Excessive deposits of bituminous material upon the road surface, caused by the stopping or starting of the distributor, leakages, or otherwise, shall be immediately removed.
13-8 APPLICATION OF AGGREGATE CHIPPINGS.

13-8.1 Spreading

The spreading of the cover material shall follow immediately after each application of bituminous material. The cover material shall be distributed uniformly over the bituminous material in one or two courses, as specified. Spreading shall be done by means approved mechanical spreaders. Only drivers experienced in type of work shall be used in driving the spreaders (or trucks, when towed spreaders are used). Trucks or spreaders shall not be driven on the uncovered bituminous material.

13-8.2 Double/Triple Application

For double/triple application the cover shall be distributed alternately over the bituminous surface in separate courses. The coarse size shall be applied immediately after the first application of bituminous material and shall be distributed as specified in 13-2. The first application shall then be broomed as needed to obtain a uniform surface, assuring that no piece of cover material rests on top of another then rolled. After the first application has been rolled and cured the Engineer will determined when the second and third application of bituminous material shall be made, and immediately thereafter the finer size cover material shall be distributed uniformly over the surface in the quantity as specified in 13-2, or in an amount which will fill completely the voids of the first application. The finer size cover material shall then be broomed as needed to secure a smooth and uniform surface, and then shall be rolled as specified in 13-10.

13-9 BROOMING AND DRESSING

Immediately after each application of cover material, the surface shall be broomed, by experienced and skilled workmen, in order to secure a uniform distribution of cover material and a smooth surface. Additional aggregate shall be placed by hand on any areas not properly covered. If deemed necessary, the surface shall then be dragged with a light drag broom or other dragging equipment approved by the Engineer, of a type that will disturb the embedded aggregate. This operation shall be supplemented by additional hand brooming until a smooth and even surface is obtained. The dragging and brooming shall be repeated, in conjunction with the rolling, for as long as required, to insure a uniform surface. These dragging requirements shall apply for each application of cover material.

13-10 ROLLING AND CURING

Immediately after spreading and dragging of each application of cover material the entire surface shall be rolled. The rolling shall begin within 30 minutes after spreading of cover material. Rolling shall begin at the edges and progress to the centre of the surface, uniformly lapping each preceding track and covering thoroughly the entire surface. During rolling, additional dragging and hand brooming shall be done as specified in 8-9.
Rolling shall first be done with a traffic roller, followed immediately with a steel-wheeled roller. The entire surface shall be covered one time with the steel-wheeled roller. The cover material shall then be again rolled.

The rolling shall be continued as long as is necessary to insure thorough keying of the cover material into the bituminous material and to secure a uniformly closed surface.

### 13-11 SURFACE REQUIREMENTS

The finished surface shall be uniform and shall conform to the lines, grades, and typical cross section. Any portions of the completed surface which are defective, not properly finished, have fat joints, or are not in reasonably close conformance with these specifications, shall be replaced with a satisfactory surface laid in accordance with these specifications. In this case no compensation will be made for the replaced surface.

Each layer shall be independently inspected and approved before and further application of layers. An inspection of the surface shall reveal the following characteristics:

**I. Proper Rock Cover** – the surface shall reveal between 10-15% visible bitumen (black/asphalt) through the rock cover. Where there is too much asphalt visible (i.e. not enough cover), aggregate shall be added and rolled into the surface. If too much aggregate is located, these shall be broomed or removed from the surface.

**II. Proper Rock Embedment** - Each individual rock aggregate shall have at least 50-75% of its surface covered with bituminous material, and imbedded at least 50% into the surface and not be easily displaced. A typical rock aggregate that is coated less than 50% is indicative of inadequate asphalt spray rate and/or improper rolling and compaction. The Engineer shall determine measures to be taken to correct thus, or reject the layer altogether.

### 13-12 PROTECTION

After the application of bituminous material, traffic shall not be allowed to use the road until the cover material has been placed and thoroughly rolled. If practicable, traffic shall be kept off the finished surface for the first 48 hours after finishing is completed. Where it is impracticable to keep traffic off the finished surface for such a period, traffic shall be restricted to a maximum speed of 25 kilometres per hour during this time. For this purpose the Contractor shall furnish and maintain suitable barricades and lights, and shall provide watchmen and vehicles to lead traffic through the sections of the roadway being protected. At least two watchmen kept on duty continuously during this 48-hour restricted period and the number shall be sufficient to assure enforcement of the 25 kilometres per hour maximum speed.
13-13 PAYMENT ITEMS
Payment shall be made under:

Single Bituminous Surface Treatment – per Square Metre [sq.m or m²]
Double Bituminous Surface Treatment – per Square Metre [sq.m or m²]
Triple Bituminous Surface Treatment – per Square Metre [sq.m or m²]
PART 14 - ASPHALT CONCRETE AND SAND BITUMEN

14-1 DESCRIPTION

This Section specifies the materials, composition and job-mix formulae for Continuously Graded Asphalt Concrete and Hot Mix Sand Asphalt for use in road surfaces.

14-2 ASPHALT CONCRETE

14-2.1 Materials

The materials used shall conform to the following requirements.

14-2.1.1 Asphalt Cement (Bituminous Binders)

Bitumen Binder Viscosity Grade AC-20 OR 60/70

Each delivery of bituminous material shall be accompanied by a copy of recently (not more than 4 weeks) certified results of test on the material being delivered and a statement as to the type and amount of material contained in each carrier and the identification of the storage tanks from which the material is being delivered.

This statement shall be presented to the Employer’s Representative or his representative upon delivery.

The asphalt cement shall conform to the requirements of AASHTO M 226, Table 2 for Grade AC-20 and a maximum penetration in the range of 60 to 80 at 25°C (77°F) shall be required.

14-2.1.2 Aggregate

The aggregate shall be clean and shall contain no deleterious substances. Coarse or fine aggregate containing more than 0.5% of phosphate shall not be used.

All aggregate shall comply with the recommendations in:

- ASTM D1073 – Standard Specification for Course Aggregate for Bituminous Paving Mixes, and;
The aggregate shall comply with the recommendations specified in Table 1 and Table 2.

**Table 1 - Coarse Aggregate Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle Shape</td>
<td>Flakiness Index (BS 812, Part 105)</td>
<td>&lt;45%</td>
</tr>
<tr>
<td>Strength</td>
<td>Aggregate Crushing Value (ACV) (BS812, Part 3)</td>
<td>&lt;25</td>
</tr>
<tr>
<td></td>
<td>Los Angeles Abrasion (LAA) (ASTM C131 and C535)</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Abrasion</td>
<td>Aggregate Abrasion Value (AAV) (BS812, Part 3)</td>
<td>&lt;15</td>
</tr>
<tr>
<td>Polishing</td>
<td>Polished Stone Value (BS812, Part 3)</td>
<td>&gt;50</td>
</tr>
<tr>
<td>Durability</td>
<td>Soundness - Sodium Test (BS812, Part 121)</td>
<td>&lt;12%</td>
</tr>
<tr>
<td></td>
<td>Soundness - Magnesium Test (BS812, Part 121)</td>
<td>&lt;18%</td>
</tr>
<tr>
<td>Water Absorption</td>
<td>Water Absorption (BS812, Part 2)</td>
<td>&lt;2%</td>
</tr>
<tr>
<td>Bitumen Affinity</td>
<td>Immersion Tray Test (Shell Bitumen Handbook, D. Whiteoak)</td>
<td>Index of retained stability &gt;75%</td>
</tr>
</tbody>
</table>

**Table 2 - Fine Aggregate Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness</td>
<td>Sand Equivalent (AASHTO T208)</td>
<td>&gt;35%</td>
</tr>
<tr>
<td></td>
<td>Plasticity Index (AASHTO T90)</td>
<td>&lt;4</td>
</tr>
<tr>
<td>Durability</td>
<td>Soundness - Sodium Test (BS812, Part 121)</td>
<td>&lt;15%</td>
</tr>
<tr>
<td></td>
<td>Soundness - Magnesium Test (BS812, Part 121)</td>
<td>&lt;20%</td>
</tr>
</tbody>
</table>
14-2.1.3  Mineral Filler

In laboratory tests, and for the purpose of proportioning the paving mixes, all material passing a 2.0 mm sieve and retained on a 0.075 mm sieve shall be considered as fine aggregate. Material passing the 0.075 mm sieve shall be considered as mineral filler.

The mineral filler shall comply with the recommendations in:


14-2.1.4  Mix Composition

The aggregate shall be so graded, and the constituents combined in such proportions as to produce a mix conforming to the general composition limits as shown in below for combined Aggregate.

The gradation may be adjusted by the Employer’s Representative on the basis of mix design tests to obtain optimum flow and stability complying with the limits shown in table 4.

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Total Aggregate Passing by Weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>14</td>
<td>80 – 100</td>
</tr>
<tr>
<td>5</td>
<td>54 – 72</td>
</tr>
<tr>
<td>2.36</td>
<td>42 – 58</td>
</tr>
<tr>
<td>1.18</td>
<td>34 – 48</td>
</tr>
<tr>
<td>0.600</td>
<td>26 – 38</td>
</tr>
<tr>
<td>0.300</td>
<td>18 – 28</td>
</tr>
<tr>
<td>0.150</td>
<td>12 – 20</td>
</tr>
<tr>
<td>0.075</td>
<td>6 – 12</td>
</tr>
</tbody>
</table>

Table 4 - Marshall Test Criteria and Mix Proportions (Asphaltic concrete)

<table>
<thead>
<tr>
<th>Criteria</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen Content (% by mass of total mix)</td>
<td>5.0 – 7.0</td>
</tr>
<tr>
<td>Minimum Stability (lbs at 60°)</td>
<td>2000</td>
</tr>
<tr>
<td>Minimum Flow (0.01ins)</td>
<td>8-14</td>
</tr>
<tr>
<td>Air Voids (%)</td>
<td>3-5</td>
</tr>
<tr>
<td>Minimum VMA (%)</td>
<td>14</td>
</tr>
</tbody>
</table>
The asphalt concrete shall retain 75% of the specified Marshall stability when tested, after 48 hours of soaking according to immersion compression test. 1% lime and/or 2% Ordinary Portland cement should be added to the mix when the mix does not meet the minimum specified retained strength according to the immersion compression test.

The maximum flow value during production shall not exceed 1% more than value shown above.

The ratio of % by weight of total aggregate passing 0.075 mm sieve to the effective asphalt content expressed as a % by weight of total mix shall be in the range of 0.6 - 1.2.

Where hand placing and finishing of Asphalt Concrete is permitted for small and irregular areas, such as in intersection areas, acceleration and deceleration lanes, the portion of the coarse aggregate retained on a 4.75 mm sieve may be omitted from the mix and the % by weight of the coarse aggregate passing a 4.75 mm sieve and retained on a 2.0 mm sieve shall be within the range specified for the total coarse aggregate in the mix.

14-2.1.5 Screenings

Any screenings used in the combination of aggregates shall contain not more than 15% of material passing a 0.075 mm sieve. When two screenings are blended to produce the screening component of the aggregate, one of such screening product may contain up to 18% of material passing a 0.075 mm sieve, as long as the combination of the two does not contain over 15% of material passing a 0.075 mm sieve. Screenings may be washed to meet these requirements.

14-2.2 Formula for Job Mix

14-2.2.1 Mix Design

The Contractor shall submit mix design and representative samples of all component materials to the Employer’s Representative at least 30 days before the scheduled start of production.

No asphalt construction shall be started on the project until the Employer’s Representative has approved the job-mix formulae.

14-2.2.2 Modifications to Master Ranges

The general composition limits prescribed above are ‘master ranges’ of tolerance to govern mixes made from any materials meeting the Specifications. They are the maxima and minima in all cases.

14-2.2.3 Materials Exceeding Master Range
After the design mixes have been established from the materials submitted to the Employer’s Representative, all materials shipped to the plant or used in the mix shall not vary from the gradation of materials upon which the design was based sufficiently to cause the mix to fall outside the master range.

Any material that would cause the mix to fall outside these tolerances shall be rejected for use.

14-2.2.4 Materials Requiring Adjustment of Bituminous Material Content

Materials found to have characteristics requiring a content of bituminous material less than is indicated in the formula prescribed above shall be rejected, or shall be adjusted to provide a blend that will produce a balanced mix under the terms of the formula.

Where materials otherwise meeting specifications are found (because of highly absorptive or other special characteristics) to produce an acceptable balanced mix only if the bituminous material content is increased over the amount specified, the materials may be accepted provided that the design mix is adjusted to require the use of such an increased amount of bituminous material.

14-2.2.5 Laboratory-Compacted Density

Laboratory-compacted mix shall have a density of not less than 95% (nor more than 98%) of the calculated theoretical density of a void-less mix composed of the same materials and proportions.

14-2.2.6 Sampling of the Site Mix

Samples of the mix in use will be taken as many times daily as necessary and it shall be maintained uniformly throughout the project within the specified tolerances.

14-2.2.7 Change in Sources of Supply

If an additional or alternative source of supply for materials is approved, the Contractor will re-design the job-mix formula and seek approval as per the requirements for the original design mix.
14-3 SAND ASPHALT

14-3.1 Materials

The materials used shall conform to the following requirements.

14-3.1.1 Asphalt Cement (Bituminous Binders)

- **Bitumen Binder Viscosity Grade AC-20 OR 60/70**
  The bitumen binder for use in hot mix sand asphalt mixes shall comply with the requirements of Asphalt Concrete above.

14-3.1.2 Aggregate

13 mm crushed aggregate for use in sand asphalt surface mixes shall comply with the requirements of Asphalt Concrete above.

14-3.1.3 Sand

The sand for use in hot mix sand asphalt mixes may comprise local reef sand, white sand or rock screening obtained from a borrow source or a commercial supplier and blended to the correct proportions.

The sand shall be free from clay, organic and other deleterious material and shall comply with the properties in table 5.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleanliness</td>
<td>Sand Equivalent (AASHTO T176)</td>
<td>&gt;30%</td>
</tr>
<tr>
<td></td>
<td>Plasticity Index (AASHTO T90)</td>
<td>Non Plastic</td>
</tr>
<tr>
<td>Durability</td>
<td>Soundness - Sodium Test (BS812, Part 121)</td>
<td>&lt;15%</td>
</tr>
<tr>
<td></td>
<td>Soundness - Magnesium Test (BS812, Part 121)</td>
<td>&lt;20%</td>
</tr>
</tbody>
</table>

14-3.1.4 Mineral Filler:

Mineral filler shall consist of finely ground particles of limestone, hydrated lime, Ordinary Portland Cement or other non-plastic matter as approved by the Employer’s Representative. It shall be thoroughly dry and free from lumps. At least 75% (by weight) shall pass a 0.075 mm sieve and 100% shall pass a 0.425 mm sieve.
14-3.1.5 Mix Composition

The aggregate shall be so graded, and the constituents combined in such proportions as to produce a mix conforming to the general composition limits as follows:
- Between 25% and 40% of the combined aggregates shall consist of a nominal 14 mm aggregate;
- At least 60% of the combined aggregate shall pass the 2.0 mm sieve;
- The mean value of the percentage passing the 0.075 mm sieve for any construction lot (normally a day’s work) shall be between 6 and 9%.
- The grading uniformity coefficient shall be >5.

Table 6 - Marshall test Criteria and Mix Proportions

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bitumen Content (% by mass of total mix)</td>
<td>4.0-5.0</td>
</tr>
<tr>
<td>Minimum Stability (lbs)</td>
<td>1000</td>
</tr>
<tr>
<td>Minimum VMA</td>
<td>15</td>
</tr>
<tr>
<td>Flow (0.01in)</td>
<td>7-13</td>
</tr>
<tr>
<td>Air Voids (%)</td>
<td>5.0 – 10.0</td>
</tr>
</tbody>
</table>

The Sand Asphalt shall retain 75% of the specified Marshall Stability when tested after 48 hours of soaking according to the immersion compression test.

1% lime and/or 2% ordinary Portland cement should be added to the mix when the mix does not meet the minimum specified retained strength according to the immersion compression test.

14-3.1.6 Construction

The temperature of the sand asphalt mix on arrival on site shall not exceed 170°C and during compaction shall not be lower than 110°C.

14-4 COMPOSITION OF ASPHALT SURFACING MIXES

The rates of application and mix proportions of bituminous binder, aggregates and fillers which are given in the tables above are nominal rates and proportions and shall only be used for bidding purposes. The rates and proportions actually used shall be determined to suit the materials used and conditions prevailing during construction and any approved variation on a nominal mix in the bitumen content or active filler content shall not be the subject of an adjustment in payment.

Before production or delivery of the asphalt the Contractor shall submit samples of the materials he proposes to use in the mix, together with his proposed mix design as determined by an approved laboratory, to the Employer’s Representative so that the Employer’s Representative may test the materials and confirm the use of the proposed mix if he is satisfied that it meets the specified requirements. As soon as the materials become
available the Contractor shall produce a working mix in the plant in accordance with the
design mix. The working mix shall again be tested by him for compliance with the design
requirements. Samples of the working mix shall also be made available to the Employer’s
Representative, who will authorise the use of the working mix proportions finally
approved for use. The composition of the approved working mix shall be maintained
within the tolerances given above.

14-5  PLANT AND EQUIPMENT

14-5.1 General

All plant shall be so designed and operated to produce a mix complying with the
requirements of this Specification. The plant and equipment used shall be of adequate
rated capacity, in good working order and subject to the approval of the Employer’s
Representative. Obsolete or worn-out plant will not be allowed on site. Prior to the start
of the work the Contractor shall supply the Employer’s Representative with copies of the
manufacturer’s handbooks and copies of check lists prepared in terms of ISO 9002 where
applicable pertaining to the mixing, remixing and paving plants, containing details of the
correct settings and adjustments of the plant.

Any alteration which has been or is being effected to any constructional plant, and which
does not comply with the specifications of the manufacturer, shall be brought to the notice
of the Employer’s Representative.

14-5.2 Mixing Plant

Asphalt shall be mixed by means of an approved type mixer of proven suitability for
producing a mix complying with all the requirements of the Specifications.

The mixing plant may be either automatically or manually controlled but in the latter case,
two control operators shall be provided.

The heating system of the tanks storing the binder shall be so designed that the binder will
not be degraded during heating. A circulating system for the binder shall be provided
which shall be of adequate size to ensure the proper and continuous circulation between
storage tanks and mixer during the entire operating period.

Binder storage tanks shall be fitted with thermometers designed to provide a continuous
record of the temperature of the binder in the tank. Copies of these records shall be
supplied to the Employer’s Representative on a daily basis.

Satisfactory means shall be provided to obtain the proper amount of binder in the mix
within the tolerances specified, either by weighing or volumetric measurements. Suitable
means shall be provided for maintaining the specified temperatures of the binder in the
pipelines, weigh buckets, spray bars and other containers or flow-lines.
In the case of a drum type mixer, the system shall control the cold feeding of each aggregate fraction and of the filler by mass, by means of a load cell or another device regulating the feed automatically, and by immediately correcting any variation in mass which results from moisture or from any other cause. The cold feed shall be regulated automatically in regard to the binder feed so as to maintain the required mix proportion.

Suitable dust collecting equipment shall be fitted to prevent pollution of the atmosphere in accordance with the provisions of any local Act governing pollution.

The fuel chosen and control of the burner shall be such as to ensure the complete combustion of the fuel in order to prevent pollution of the atmosphere and the aggregate.

14-5.3 Spreading Equipment - Paver

The mix shall be laid by an approved type of self-propelled mechanical spreader and finisher capable of laying to the required widths, thicknesses, profile, camber or cross-fall, without causing segregation, dragging or other surface defects.

All pavers shall be fitted with automatic electronic screed controls to maintain the required levels, cambers and crossfalls. Where skids are used they shall be at least 9 m long or as specified by the Employer’s Representative. Where levelling beams on multiple skids or sliding beams are used they shall be at least 9 m long.

14-5.4 Rollers

Compaction shall be done by means of approved flat steel wheel vibratory or pneumatic-tired rollers. The frequency as well as the amplitude of vibratory rollers shall be adjustable. Vibratory rollers shall be used only where there is no danger of damage being done to the asphalt, structures of bridge decks, or other layers. It will be indicated in the Project Specifications whether vibratory compaction equipment may be used on bridge decks and what the constraining parameters will be. The rollers shall be self-propelled and in good working condition, free from back lash, faulty steering mechanism and worn parts. Rollers shall be equipped with adjustable scrapers to keep the drums clean and with efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers. No leakages of any nature may occur in the rollers. The mass and/or tyre pressures shall be such so as to ensure proper compaction to comply with the specifications of surface finish and density.

14-5.5 Vehicles

The asphalt shall be transported from the mixing plant to the spreader in trucks having tight, clean, smooth beds and sides which have been treated to prevent adhesion of the mix to the truck bodies. A thin film of soapy water or vegetable oil may be used to prevent
adhesion but petroleum products shall not be used for this purpose. All vehicles used for transporting hot asphalt shall be fitted with canvas (transport in excess of 10 km or cold windy conditions prevailing) or other suitable approved covers (less than 10 km and moderate climatic conditions prevailing) to minimise temperature loss. Such covers shall be securely fixed over the hot asphalt from time of departure at the mixing plant until immediately prior to discharge of the asphalt into the paver.

14-6 GENERAL REQUIREMENTS

14-6.1 Weather Conditions

Asphalt may be mixed and placed only under favourable weather conditions, and shall not be mixed or placed when rain is imminent or during misty or wet conditions. The following wind and temperature conditions are regarded as being suitable for paving work:

While the air temperature is rising, work may be performed at temperatures of:

- 6°C with an allowable wind velocity of less than 25 km/h;
- 10°C with an allowable wind velocity of less than 55 km/h;
- With falling air temperatures, work must be stopped when the temperature reaches 6°C regardless of the wind velocity and may not be restarted before the temperature is definitely rising.

14-6.2 Moisture Content

The mixing and placing of asphalt will not be allowed if the moisture content of the aggregate affects the uniformity of temperature or if free water is present on the working surface, or when the moisture content of the underlying layer, in the opinion of the Employer’s Representative, is too high. No surfacing shall be placed unless the moisture content of the upper 50 mm of the base is less than 50% of the optimum moisture content as determined by the Employer’s Representative.

No levelling course shall be placed immediately after a rainy spell on an existing partly cracked and/or highly permeable surfacing resulting in the trapping of moisture in the pavement structure. A minimum delay of 24 hours or such extended period as ordered by the Employer’s Representative shall apply.

14-6.3 Surface Requirements

14-6.3.1 Correction of Base

The base (after the prime coat has been applied) shall be checked for smoothness and accuracy of grade, elevation and cross section. Any portion of the base not complying with the specified requirements shall be corrected with asphalt at the Contractor’s own expense, until the specified requirements are met. The Employer’s Representative may
however, in his sole discretion, allow minor surface irregularities to remain, provided they can be taken up in the following asphalt layer without adversely affecting that layer.

Asphalt used for the correction of the base or sub-base, shall be the same mix as specified for the surfacing or as directed by the Employer’s Representative, and the maximum size of aggregate used shall be dictated by the required thickness of the correction in each case. Notwithstanding these provisions for the correction of the base, the Employer’s Representative reserves the right to order the removal and reconstruction of the layer or of portions of the base and sub-base layers not complying with the specified requirements, instead of allowing the correction of substandard work with asphalt material.

14-6.3.2 Cleaning of the Surface

Immediately before applying the prime or tack coat before the application of the asphalt, the surface shall be swept and cleaned of all loose or deleterious material.

Where the prime or tack coat has been damaged, it shall be repaired by hand brushing or spraying priming material over the damaged portions.

The prime or tack coat shall be sufficiently dry before the asphalt may be applied. The Contractor’s programme shall allow for delays that are a function of the type of prime, rate of application, base porosity and moisture content, and climatic conditions.

14-6.3.3 Storage

Mixing shall not be allowed to take place more than four hours before paving begins unless provision has been made for storage. Storage of mixed material will only be permitted in approved hoppers, which are capable of maintaining the temperature of the mix uniform throughout.

In any case storage will not be permitted for a period longer than 12 hours after mixing, unless otherwise approved by the Employer’s Representative.
14-7 PRODUCTION OF THE MIX

14-7.1 Mixing and Storage Temperatures
Bituminous binders shall be stored at temperatures not exceeding those given in and the aggregate and bituminous binders shall be heated at the mixing plant to such temperatures that the mixed product shall have a temperature within the range given in Table 6 - Temperature Ranges for Bitumen Binders.

<table>
<thead>
<tr>
<th>Material</th>
<th>Max Storage Temperature of Binder (°C)</th>
<th>Temperature Range of Mix (°C)</th>
<th>Continuously Graded Asphalt</th>
<th>Hot Sand Asphalt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Over 24 hours</td>
<td>Under 24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC-20</td>
<td>135</td>
<td>175</td>
<td>135 - 160</td>
<td>145 - 170</td>
</tr>
</tbody>
</table>

14-7.2 Batch Plants

14-7.2.1 Heating the Aggregate
The aggregate shall be dried and heated so that, when delivered to the mixer, its temperature shall be between 0°C and 20°C lower than the maximum temperature indicated in for the mix. The moisture content of the mix shall not exceed 0.5%.

14-7.2.2 Batching
Each fraction of the aggregate and binder shall be measured separately and accurately in the proportions by mass in which they are to be mixed. If filler is used, it shall be measured separately on a scale of suitable capacity and sensitivity. The error in the weighing apparatus used shall not exceed 2% for each batch.

14-7.2.3 Mixing
The aggregate, filler and binder shall be mixed until a homogeneous mix is obtained in which all particles are uniformly coated. Care shall be taken to avoid excessively long mixing times which can cause hardening of the binder.

14-7.3 Drum-Type Mixer Plant
The aggregate and filler shall be accurately proportioned and conveyed into the drum-mixing unit. The calibrated amount of binder shall be sprayed onto the aggregates at the correct position so that no hardening of the binder shall take place.

A homogeneous mix and uniform coating of binder must be achieved and the moisture content of the asphalt mix shall not exceed 0.5%. Once the final mix temperature has been
agreed upon it may not be altered without the prior consent of the Employer’s Representative. The moisture content of the asphalt mix shall be tested using a recognised method.

14-8 TRANSPORTING THE MIX

The mix shall be transported from the mixing plant to the Works in trucks complying with the above requirements. Loads shall be covered by waterproof canvas or metal sheets when the haul exceeds 10 km or during rainy weather. Deliveries shall be made so that spreading and rolling of all the mixes prepared for a day’s run, can be completed during daylight, unless artificial lighting, as approved by the Employer’s Representative, is provided.

Any asphalt which has become wet due to rain or any other cause will be rejected. Hauling over freshly laid asphalt material is not permitted.

14-9 SPREADING

14-9.1 General

The mix shall be delivered to the paver in such a manner that the paver will never be forced to stop for lack of asphalt. The temperature of the mix shall be controlled by measuring in a random pattern in the truck immediately before emptying, and shall not be more than 10°C below the minimum temperature specified for mixing in. The adjustment of the screed tamping bars, feed screws, hopper feed, etc, shall be checked frequently to ensure uniform spreading of the mix. If segregation occurs, the spreading operations shall immediately be suspended until the cause is determined and corrected.

The addition and removal of material behind the paver shall normally not be allowed and the paver shall be capable of spreading the mix to the correct amounts that will provide the required compacted thickness without resorting to spotting, picking-up or otherwise shifting or disturbing the mix.

Operators shall not be permitted to walk on un-compacted asphalt. Paving shall, if possible, commence at the bottom of the grades and the lower edges of super-elevated curves. Paving shall be done upgrade on grades steeper than 5%. Spreading shall be so arranged that longitudinal joints do not coincide with joints in lower layers of asphalt levelling course or surfacing.

The paver shall be equipped to provide automatic control of levels and cross section. In the case of asphalt levelling course construction, automatic control shall be run off guide-wires and in the case of surfacing and overlays skids or guide-wires shall be used.

On restricted areas, inaccessible to the paving equipment used, the mix may be placed by hand or other means to obtain the specified results. Paving shall be carried out in a manner which will avoid segregation and which will allow control of levels.
The mixer capacity and the operating speed of the paver are to be so co-ordinated as to ensure continuous laying and to avoid intermittent stopping of the paver. Paving shall cease when rain starts falling or when the surfaces to be paved are visibly wet.

14-9.2. Overlays

In the case of overlays, guide-wires will normally not be required during the placing of the mix unless specified requested by the Employer’s Representative. In all cases, including levelling courses, the paver shall be provided with skid beams with electronically controlled equipment which can ensure a constant cross-fall and can even out local irregularities.

14-9.3 Asphalt

Asphalt shall be placed in restricted areas with the aid of smaller specially equipped pavers, hand tools, or other approved equipment. The space concerned shall be properly filled with asphalt, without leaving any gaps between the fresh asphalt and the existing pavement layers. All the provisions in regard to temperature, mix composition, uniformity, etc, shall remain applicable, but layer thickness and control shall be such that the requirements for compaction and surface tolerances can still be attained.

14-9.4 Joints

All joints between adjacent sections of the work shall be made by cutting back the layer against which the material is to be placed. All loose and incompletely compacted material shall be removed. A cutting wheel shall be used for cutting longitudinal joints.

Joints shall be either at right angles or parallel to the centre line, and joints in the final layer of the surfacing shall, where possible, correspond with the lane markings. Joints in lower layers shall be offset not less than 150 mm on either side of the edges of the traffic lanes.

Before a new layer is placed next to an existing layer, the cut edge of the existing layer shall be painted with a thin coat of bituminous emulsion of the same type used for the tack coat, if so directed by the Employer’s Representative, or the paver must be fitted with a gas burner to heat the cut edge of the existing layer.

Joints shall be neat and shall have the same texture and density as the remainder of the asphalt course. All joints shall be marked out with chalk lines prior to cutting.

The outside edges of the completed asphalt course shall be trimmed along the shoulder, and parallel to the centre line, to give a finished width, as shown on the Drawings, within the tolerances specified.
Any fresh mix spread accidentally onto existing work at a joint shall be carefully removed by sweeping it back with stiff brooms onto the un-compacted work, so as to avoid the formation of irregularities at the joint. Whenever the paving operation is stopped due to lack of mix, the Contractor shall form a proper joint as specified above, if so directed by the Employer’s Representative.

14-9.5 Compaction

The mix shall be rolled as soon as possible after it has been laid by vibratory, steel wheel and pneumatic-tired rollers in a sequence predetermined and approved during the laying of trial sections. Such rolling shall commence and be continued only for so long as it is effective and does not have any detrimental effect. The use of pneumatic-tired rollers for continuously-graded non-homogeneous modified binders shall be assessed in the trial section.

As many rollers shall be used as is necessary to provide the specified pavement density and the required surface texture. During rolling of surfacing only, the roller wheels shall be kept moist with only sufficient water to avoid picking up the material.

After longitudinal joints and edges have been compacted, rolling shall start longitudinally at the sides and gradually progress towards the centre of the pavement, except on super-elevated curves, or where the area to be paved has a straight cross-fall, when rolling shall begin on the low side and progress to the higher side, uniformly lapping each preceding track, covering the entire surface. During breakdown rolling, the rollers shall move at a slow but uniform speed (not to exceed 5 km/h) with the drive roller nearest the paver, unless otherwise specified on account of steep gradients.

No movement of the asphalt layer shall occur under steel wheel rollers once the asphalt temperature has dropped to below 100°C. Three-wheeled steel rollers, with large diameter rear wheels are preferable to tandem rollers and may be used in conjunction with pneumatic tired rollers, provide pickup of the asphalt on the wheels does not occur.

For non-homogeneous binder mixes it is recommended that a commercial detergent at a concentration of 1 to 3,000, be added to the water used to wet the tyres of pneumatic tired rollers, to limit pick up. The sequence of rollers used in compaction is at the discretion of the Contractor provided the completed pavement shall have a density as measured on recovered core equal to or greater than 97%, minus the percentage voids in the approved production mix, of the theoretical maximum density.

The Contractor shall utilise a calibrated nuclear gauge for process control during compaction operations. Notwithstanding this requirement, the acceptance control carried out for compaction by the Employer’s Representative shall still be based on cores taken from the compacted layer.
The nuclear device shall:

- Be operated by a suitably trained technician;

- Comply with all the safety regulations of the Regulatory Authority (Radiation Control);

- Be certified to be suitably calibrated.

- The portion of trial section having the desired surface texture shall be designated as a reference for what is required in the permanent work.

- The following requirements shall apply to rolling and compacting generally:

  - The material shall not be excessively displaced in a longitudinal or transverse direction especially when changing gears, stopping or starting rollers.

  - No cracks or hair cracks shall be formed and the bond with the underlying layer shall not be broken.

  - The density shall be uniform over the whole area of the layer and extend over the full depth of the layer.

  - Rollers shall not be left standing on the asphalt layer before it has been fully compacted.

  - In restricted areas where the specified rollers cannot be used, compaction shall be carried out with hand-operated mechanical compaction equipment or approved smaller vibratory rollers. The prescribed density requirements remain applicable throughout, over the full layer thickness, irrespective of the method of compaction.

14-10 TRIAL SECTIONS

Before the Contractor commences with the construction of any asphalt levelling course or surfacing, he shall demonstrate, by laying a trial section 300 m² in area, that the equipment and processes that he proposes to use, will enable him to construct the particular asphalt course in accordance with the specified requirements.

The Employer’s Representative may require that up to three different binder contents be incorporated in one such trial section to verify the laboratory design phase.

The specified requirements shall include dynamic test results obtained from briquettes prepared from material obtained in a stratified randomly sampled manner at the manufacturing plant or behind the paver as directed by the Employer’s Representative.
and/or cores extracted from the completed trial section and in locations determined in a stratified randomly sampled manner.

A maximum period of 10 days shall be allowed to verify dynamic test results unless otherwise specified by the Employer’s Representative.

Only when such a trial section has been satisfactorily laid and finished, and complies with the specified requirements, will the Contractor be allowed to commence with construction of the permanent work.

If the Contractor should make any alterations in the methods, processes, equipment or materials used or if he is unable to comply consistently with the Specifications, the Employer’s Representative may require that further trial sections be laid before allowing the Contractor to continue with the permanent work. The intention of this Clause is to avoid any experimentation by the Contractor on the permanent work.

The trial sections shall be laid where indicated by the Employer’s Representative. The Contractor shall prepare the surface on which to lay the trial section and shall also, if required, remove the trial section after completion and restore the surfaces on which it was constructed.

Should the Contractor fail to produce a satisfactory product for at least a continuous 100 m² he shall lay additional areas, at his own cost and no additional payment, until a satisfactory product is obtained for a continuous 200 m².

14-11 PROTECTION AND MAINTENANCE

The Contractor shall protect the asphalt levelling course and asphalt surfacing from all damage until the work is finally accepted by the Employer and he shall maintain the surfacing work until the issue of the maintenance certificate. Any damage occurring to the completed surfacing; excepting fair wear and tear on surfacing during the maintenance period, or any defects which may develop due to faulty workmanship shall be made good by the Contractor at his own expense and to the satisfaction of the Employer’s Representative.

14-12 TOLERANCES AND FINISH REQUIREMENTS

14-12.1 Construction Tolerances

The completed sections of asphalt levelling course and surfacing shall comply with the requirements for grade, width, thickness, cross section and smoothness stated below.

14-12.2 Level and grade

The level tolerances referred to in Section 01040 of the Specification shall be as follows:
Deviation from the specified longitudinal grade due to deviations from the specified levels shall not exceed the values given in table 7.

<table>
<thead>
<tr>
<th>Length of section under review (m)</th>
<th>Maximum deviation of specified slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.354</td>
</tr>
<tr>
<td>5</td>
<td>0.224</td>
</tr>
<tr>
<td>10</td>
<td>0.158</td>
</tr>
<tr>
<td>20</td>
<td>0.112</td>
</tr>
<tr>
<td>30</td>
<td>0.091</td>
</tr>
</tbody>
</table>

14-12.2 Width

The average width of both asphalt levelling course and surfacing shall be at least equal to that shown on the Drawings and nowhere shall the outer edge of the layer be inside the lines shown on the Drawings by more than 15 mm.

14-12.3 Thickness

The thickness tolerances referred to in Section 01040 of the Specification shall be as follows:

- D90: levelling course = 15 mm/surfacing = 5 mm
- Dmax: levelling course = 20 mm/surfacing = 8 mm
- Dave: levelling course = 5 mm/surfacing = 2 mm

Thickness shall be determined from carefully controlled levels taken before and after construction in exactly the same position and/or from cores drilled from the completed layer.

14-12.4 Cross Section

When tested with a 3 m straight-edge laid at right angles to the road centre line the surface shall not deviate from the bottom of the straight-edge by more than 10 mm.

At any transverse section the difference in level between any two points shall not vary from their difference in level computed from the cross section shown on the Drawings by more than 20 mm.
14-12.5 Surface Regularity

When tested with a rolling straight-edge as described in Section 01040 of the Specification the number of surface irregularities shall not exceed those given below (applied to levelling course and surfacing).

(1) The average number of 6 mm irregularities per 100 m shall not equal or exceed 2 when taken over 600 m lengths of asphalt surfacing;

(2) The number of 6 mm irregularities shall not equal or exceed 3 when taken over 100 m sections;

(3) The maximum value of any individual irregularity when measured with the rolling straight-edge or a 3 m straight-edge laid parallel to the road centre line shall not exceed 10 mm.

14-12.6 Allowable Mix Proportion Tolerances

After the job-mix formulae have been established, all operations, handling, preparation and mixing shall be controlled such that the mix shall meet the approved formula for the project.

This shall be within the allowable tolerances (which are the maxima for any materials and may be applied only within the limits of the general composition range) shown in Table 8.

<table>
<thead>
<tr>
<th>Sieve Size (mm)</th>
<th>Tolerances (% by Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>+4%</td>
</tr>
<tr>
<td>14</td>
<td>+5%</td>
</tr>
<tr>
<td>5</td>
<td>+5%</td>
</tr>
<tr>
<td>2.36</td>
<td>+4%</td>
</tr>
<tr>
<td>1.18</td>
<td>+4%</td>
</tr>
<tr>
<td>0.600</td>
<td>+4%</td>
</tr>
<tr>
<td>0.300</td>
<td>+4%</td>
</tr>
<tr>
<td>0.150</td>
<td>+3%</td>
</tr>
<tr>
<td>0.075</td>
<td>+1.5%</td>
</tr>
<tr>
<td>Bitumen</td>
<td>+0.4%</td>
</tr>
</tbody>
</table>

For the percentages shown in the design mix for the total material retained on the 2.0 mm sieve and for the total material passing the 2.0 mm sieve, a tolerance of 4% will be allowed from the percentage specified as the design mix.
14-13 TESTING

14-13.1 Sampling

Sampling of asphalt mixes shall be carried out according to a recognised method as agreed by the Employer’s Representative.

14-13.2 Coring of asphalt layers

The Contractor shall provide suitable coring machines capable of cutting 100 mm diameter cores from the completed asphalt layers.

All core holes shall be neatly repaired by the contractor with asphalt and compacted to the specified density. The cores shall be filled with the same mix as used for the layer tested.

14-13 MEASUREMENT AND PAYMENT

14-14.1 General

This quantity of material actually applied and accepted shall be determined from measurements of area accepted by the Engineer.

Payment shall be made under;

Supply, place and compact: Asphaltic Concrete- Square Metre [sq.m or m²]
PART 15 - CONCRETE FOR STRUCTURES AND OTHER USES

15-1 SCOPE OF SECTION

This section covers the materials, design of mixes, mixing, transport, placing, consolidation and curing of concrete required in the Works. It also covers formwork and reinforcement for concrete.

15-2 DEFINITIONS

**Structural concrete** is any class of concrete used in reinforced, pre-stressed (pre- or post-tensioned) or un-reinforced concrete construction, which is subject to stress.

**Non-structural concrete** is composed of materials complying with the specification but for which no strength requirements are specified and which is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

**A formed surface** is a concrete face cast against formwork.

**An unformed surface** is a horizontal or nearly horizontal surface produced by hand or mechanical screeds, trowels or floats to the required level and finish.

**A pour** refers to the operation of placing concrete into a mold, casting bed, casting cell, bay or formwork, etc., and also to the volume to be filled. Pours in vertical succession are referred to as lifts.

**Formwork** means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.

**Falsework** means the structural elements supporting both the formwork and the concrete until the concrete becomes self-supporting.

**An exposed face** is one, which will remain visible when construction has been completed.

15-3 MATERIALS FOR CONCRETE

The Contractor shall submit to the Engineer, full details of all materials he proposes to use for making concrete. These details shall include, but shall not necessarily be limited to, type of material, complying standard or specification (AASHTO, ASTM, BS or CP), source of origin, (plant, quarry, or other) etc., all in accordance with the requirements of this specification. Materials incorporated in the concrete shall be certified from the source and shall conform to the requirements of this specification.

No concrete shall be placed in the structure until the Engineer has approved the materials of which it is composed. Approved materials shall not thereafter be altered or substituted by other materials without the written consent of the Engineer.
15-4 CEMENT

15-4.1 Types Permitted And Basic Material Specifications

The cement shall be Ordinary or Rapid Hardening Portland Cement and shall conform to the requirements of the following:

Either: BS No.12 Portland Cement (Ordinary and Rapid Hardening)
Or: AASHTO M85 Type I, II or III or AASHTO M24- Type 1 S (ASTM C150 & C11570)
ASTM C311 and ASTM C618-12: Pozzolan Portland Cement

Where environmental conditions warrant, Sulphate Resisting Cement or Pozzolannic Blends of Cement may be used with the written approval of the Engineer.

Acceptance of cement shall be based upon manufacturer's certified mill analysis of test results meeting the requirements of the above specifications for the particular type of cement.

Each consignment of cement intended for use in the project shall be accompanied by a manufacturer's test certificate showing that the cement has been tested and analyzed. The certificate shall show the date and results of such tests and analyses in order to confirm that the cement complies with the specification for the type of cement.

A certificate of test results shall be provided to the Engineer for each consignment. Where such a certificate is not available, or as required by the Engineer, the Contractor shall arrange for each consignment of cement to be tested and analyzed in accordance with the specification for that type of cement, all at no additional expense.

When requested by the Engineer, in addition to any tests required elsewhere in this specification, the Contractor shall arrange for corresponding samples of cement to be taken at the manufacturer's plant and subsequently tested by an independent testing agency, all at no additional expense.

No cement shall be used, and it shall be stored separately, until the results of such tests and analyses are known and have been approved in writing by the Engineer.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Works and shall provide the Engineer with a copy thereof.

Note: Different brands of cement, cement of the same brand from different mills, or different types of cement, shall not be mixed during any continuous concrete pour.
Only Portland cements containing less than 0.6% alkali, calculated as Na$_2$O (percent Na$_2$O plus 0.658% K$_2$O) shall be used in combination with any source of alkali reactive coarse or fine aggregate.

15-4.2 Packaging, Handling and Storing Cement

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed, unbroken bags or in bulk. Bagged cement shall be transported in vehicles provided with effective means of protecting bags from the weather. Bulk cement shall be transported in vehicles or containers equipped for the purpose.

Cement in bags shall be stored in a suitable, weatherproof building and kept dry and well ventilated at all times. The store shall be at a convenient location where the concrete is made. Bags of cement in storage shall be kept on a raised floor or platform above the level of the surrounding ground. Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation, but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed a height of 3 meters (10 feet). Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks. Cement from broken bags shall not be used and will be rejected.

Cement in bags shall be used in the order in which it is delivered.

Bulk Cement shall be stored in weatherproof silos, conveniently located for the production of concrete. Each silo shall bear a clear indication of the type of cement contained in it. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity to ensure that his anticipated program of work is not interrupted due to lack of cement.

Cement which has become hardened, which is partially set or has become lumpy or caked, or fails to comply with these specifications, shall be not be used. The entire contents of the bag of cement or the container of bulk cement shall be rejected. Cement salvaged from discarded, broken bags or partially used bags, shall not be used. All cement thus rejected shall be removed from the Works (project) and shall be disposed of by the Contractor in a manner acceptable to the Engineer, all at no additional expense. All cement delivered to site older than ninety - (90) days will be rejected.

15-5 AGGREGATES

15-5.1 General

All natural aggregates (fine, coarse and all in) for all grades of concrete and mortar shall comply in all respects with BS 882, or ASTM C33, and the Contractor shall test all samples as described therein and in BS 812 as often as the Engineer may require to ensure that they are continuously up to these standards.
All aggregates shall be hard, strong, durable, clean and free from organic matter and deleterious coatings such as clay. They shall contain no harmful material in such quantities as to affect adversely the strength or durability of the concrete, or attack the reinforcement, as ascertained by tests on concrete cubes hereafter described and by other tests as described in BS 882.

**Source**

The Sources of all Aggregates shall be approved by the Engineer. All aggregates whether fine or coarse if considered unsuitable by the Engineer shall be removed immediately from the Site by the Contractor and at the Contractor's expense.

**Testing**

As soon as possible after receiving the Engineer's authority to commence the Works (and before commencing any concreting) the Contractor shall have delivered upon the site sample loads of aggregates representative of those proposed for the Works, and shall forward samples prepared in accordance with the method laid down in BS 812 for testing.

Each sample shall consist of not less than 50Kg (110 pounds) weight of fine aggregate and 100kg (220 pounds) weight of coarse aggregate and shall be tested in accordance with the Specification. No aggregate shall be used in the Works until the results of these tests shall have been submitted to the Engineer and his approval in writing obtained.

**Washing**

Any aggregate having such impurities that is not detrimental to the concrete and in such proportions and condition that it can be removed by washing, shall be thoroughly washed with water until satisfactorily clean and approved by the Engineer.

Washing of aggregates may only be carried out using clean fresh water obtained from an approved source. The Contractor is to provide adequate storage facilities and arrange to obtain this water at times chosen so as to cause the minimum of inconvenience to other consumers.

**Storage of Aggregates**

The Contractor shall provide proper means of storing the aggregates at each point where concrete is made and in such a manner that there is no possibility of the various aggregates mixing one with the other. Effective precautions shall be taken to prevent the aggregates segregating in the storage heaps and from being contaminated by the ground and other foreign matter.

Storage heaps shall be capable of draining freely. Wet aggregates shall not be used until, in the Engineer's opinion they have completely drained. Where aggregates are damp, the Contractor must measure the moisture content of the aggregates and adjust the amounts of aggregates and added water in each batch of concrete mixed to allow for the water
contained in the aggregates. If necessary to meet the requirement of this Clause, the Contractor shall protect the heaps of aggregate from inclement weather.

15.5.2 Fine Aggregates

Fine aggregates shall be clean hard and durable and shall be natural sand, crushed gravel sand and crushed rock sand complying with BS 882. All material shall pass through a 10 mm BS sieve and the grading shall be in accordance with Zones 1, 2 or 3 of Table 15.1. In order to achieve an acceptable grading it may be necessary to blend materials from more than one source. Fine aggregate for mortar only shall comply with BS 1200.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials or organic matter unless the Contractor can show by comparative tests, on finished concrete as set out in BS 1881, that the presence of such materials does not adversely affect the properties of the concrete.

Content passing a 75 micron BS sieve shall not exceed 3 per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand.

15.5.3 Coarse Aggregates

General

Coarse aggregates shall consist of crushed rock, gravel, or crushed gravel, free from coating or clays or other deleterious material. It shall not contain harmful materials such as iron pyrites, coal mica, laminated material or any materials in sufficient quantity to adversely affect the strength and durability of the concrete. If necessary, coarse aggregate shall be washed to remove the deleterious material. In addition to the above, the coarse aggregate material shall have a flakiness index not exceeding 30%. The individual pieces shall be roughly cubical or spherical in shape and have neither glassy nor powdery surfaces.

Grading

The grading of the coarse aggregate particles is required to satisfy the percentages given in Table 1 with a content not exceeding 1% passing the 2.36mm sieve size. The percentage passing through the 75 microns sieve shall be determined by methods described in BS 812.

Alternatively the latest requirements of BS 882 for both coarse and fine grading may be adopted if agreed with by the Engineer.
Total chloride and Sulphate content

The total chloride content, expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following limits, expressed as a percentage of the weights of cement in the mix:

For reinforced concrete: 0.3 per cent in 95 per cent of all tests results provided no result is more than 0.5 per cent.

The total sulphate content expressed as SO₃ of all the ingredients in a mix including cement, water and admixture shall not exceed 0.4 per cent by weight of the aggregate or 4.0 per cent of the weight of cement in the mix, whichever is the lesser.

The Contractor shall ensure that the source rock for the coarse aggregate is properly selected and sufficiently processed to produce coarse aggregate that consistently complies with the Specifications.
TABLE 15.1 : GRADING OF COARSE AND FINE AGGREGATES

<table>
<thead>
<tr>
<th>BS 410 Sieve Tests</th>
<th>Percentage by weight passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fine Aggregates</td>
</tr>
<tr>
<td></td>
<td>Grading Zone 1</td>
</tr>
<tr>
<td>75 mm</td>
<td></td>
</tr>
<tr>
<td>63 mm</td>
<td></td>
</tr>
<tr>
<td>37.5 mm</td>
<td></td>
</tr>
<tr>
<td>20 mm</td>
<td></td>
</tr>
<tr>
<td>14 mm</td>
<td></td>
</tr>
<tr>
<td>10 mm</td>
<td>100</td>
</tr>
<tr>
<td>5 mm</td>
<td>90-100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>60-95</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>30-70</td>
</tr>
<tr>
<td>600 um</td>
<td>15-34</td>
</tr>
<tr>
<td>300 um</td>
<td>5-20</td>
</tr>
<tr>
<td>150 um</td>
<td>0-10</td>
</tr>
<tr>
<td>75 um</td>
<td>0-3</td>
</tr>
</tbody>
</table>

15-6 WATER

All water used for mixing of concrete shall comply with the potable water use in Guyana

15-6 PROPORTION OF CONCRETE MIXES

15-7.1 General

At the commencement of the Works the Contractor shall indicate the type of compaction equipment which he intends to use in the various parts of the Works, and obtain the approval of the Engineer thereto. The contractor shall produce mixes for concretes of grades as required, each design fulfilling the following requirements:

a) The cement, the aggregates and the water shall all comply with the appropriate Clauses of this Specification.

b) The cement content shall be not less than that shown in Table 15.2 of this Specification.
c) The water content for each mix shall be such as to give the required workability (compaction factor). Where different methods of compaction are to be employed for the same grade of concrete involving different compacting factors, then a separate design mix shall be prepared for each case, to satisfy the requirements of the appropriate clause of this Specification.

d) Concrete shall be in accordance with the following Table 15.2

**TABLE 15.2: 6" CONCRETE CUBE STRENGTH (BS 1881)**

<table>
<thead>
<tr>
<th>Grade (Class)</th>
<th>Minimum Cementitious Content</th>
<th>Maximum Water Cementitious Ratio</th>
<th>Design Strength at 28 Days</th>
<th>Min Cube Strength at 7 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lbs/Cu Yd</td>
<td>Lbs/Lbs</td>
<td>PSI</td>
<td>N/mm²</td>
</tr>
<tr>
<td>7 (E)</td>
<td>450</td>
<td>0.50</td>
<td>1000</td>
<td>7.0</td>
</tr>
<tr>
<td>15 (D)</td>
<td>500</td>
<td>0.48</td>
<td>2200</td>
<td>15.0</td>
</tr>
<tr>
<td>20 (C)</td>
<td>500</td>
<td>0.48</td>
<td>2900</td>
<td>20.0</td>
</tr>
<tr>
<td>25 (B)</td>
<td>550</td>
<td>0.45</td>
<td>3600</td>
<td>25.0</td>
</tr>
<tr>
<td>30 (A)</td>
<td>600</td>
<td>0.44</td>
<td>4350</td>
<td>30.0</td>
</tr>
<tr>
<td>35 (A)</td>
<td>650</td>
<td>0.42</td>
<td>5050</td>
<td>35.0</td>
</tr>
<tr>
<td>42 (S)</td>
<td>750</td>
<td>0.40</td>
<td>6100</td>
<td>42.0</td>
</tr>
<tr>
<td>50 (P)</td>
<td>750</td>
<td>0.37</td>
<td>7200</td>
<td>50.0</td>
</tr>
</tbody>
</table>

**15-7.2 Trial Mixes**

The Contractor shall prepare, in the presence of the Engineer, a trial mix of the required design grade of concrete. The actual proportions will be determined on the basis of trial mixes made by the Contractor and carried out with the materials to be used in the Works. Each batch shall be not less than half a cubic yard in bulk before mixing and shall be mixed as specified in this Specification in a mechanical mixer of the type approved for use in the Works. Three separate batches of concrete shall be prepared for each trial mix.

The compacting factor and slump of each batch shall be determined immediately after mixing as directed in BS 1881 and shall not exceed the maximum value required in the mix design. Each trial mix shall be handled and compacted by the methods, which the Contractor proposes to use for that mix in the Works, and the mixes shall show no tendency of inadequate compaction by the methods proposed. Six 6 inch compression test cubes shall be made from each batch of the trial mix. The cubes shall be made, cured, stored, and tested in accordance with the requirements of BS 1881. Three cubes shall be
tested 7 days after manufacture and no more than 28 days after manufacture. The strength requirements of the cubes at each age shall be considered to be satisfied if none of the strengths of the groups of three cubes tested at each age falls below the appropriate design strength or if the average strength of the three cubes is not less than the design strength and the difference between the greatest and least strengths is not more than 20 per cent of that average. Failing this, the Contractor shall re-design the mix and make such further trials mixes and test such further cubes as the Engineer may direct until the requirements of this Specification are satisfied.

The design mixes which fulfill the requirements of this Specification for a particular grade of concrete shall be called the approved mixes for that grade of concrete and the Contractor shall only use the approved mixes where that grade of concrete is specified, and shall not depart there from without the written permission of the Engineer. If a change is intended in the materials or in the proportions of the materials to be used the Engineer will require further trial mixes and further cube tests to be made before any permission is given.

The Contractor shall allow ample time in his program for designing and making trial mixes and for the preparation and testing of compression test cubes obtained there from. Should any design mix fail to satisfy the requirements of this Specification and should the Engineer consider that it is essential to commence the production of that grade of concrete before the results of the cube tests of a further design mix are available, he will consult with the Contractor and decide on an interim mix for use until such time as the results of the cube tests have become known, any extra cost involved being borne by the Contractor.

The Engineer will approve each concrete mix if it the trial mixes meet the specification mentioned above.

The Contractor shall be deemed to have satisfied himself that the materials on which he has quoted will produce a concrete which, with the specified nominal proportions and subsequent adjustments as indicated by the trial mixes, will develop the cube strengths specified and at the same time have the desired workability in the work itself.

15-8 MIXING OF CONCRETE

15-8.1 General

Concrete shall be mixed in approved mechanical mixers of the weigh-batch type, and fitted with an approved weight-measuring device. No hand mixing will be permitted. Mixing shall continue until there is a thorough distribution of the materials, and the mass is of uniform color and consistency. The period of mixing, judged from the time that all materials including the water are in the mixer, shall be not less than 2 minutes with a rotation of the mixer drum at least 10 revolutions per minute; or as ordered by the Engineer.
The entire contents of the drum shall be discharged before materials for the next batch are fed in. Should there, for any reason, be a stoppage of greater than 30 minutes duration, the drum of the mixer shall be thoroughly washed out with clean fresh water before mixing is resumed.

15-8.2 Re-mixing Concrete

No partly set concrete shall be placed in the Works. Concrete which has commenced initial set shall not be re-mixed either with or without additional water and in no case shall such concrete be used in the Works.

15-9 QUALITY CONTROL OF CONCRETE

15-9.1 Engineer Control and Approval of Materials, etc.

Before their use in the Works, the Contractor shall show to the satisfaction of the Engineer that all materials and methods of storage and mixing to be employed in the production of concrete conform in every way with the requirements of this Specification. Such deliveries of materials to the Site as the Engineer may designate shall be tested and analyzed to ensure that they do so comply and the tests shall be carried out sufficiently in advance of their intended use in the Works to allow the results to be studied and the materials approved, modified or rejected by the Engineer as the case may be. The Contractor shall remove all rejected materials from the Site without delay and at his own cost. Permission to use any material shall not be construed as an approval of its source, nor any acceptance as continued acceptance.

15-9.1.1 Compacting Factor

Workability of concrete shall be measured by compacting factor. The Contractor shall provide a compacting factor apparatus conveniently accessible to each concrete mixer and shall measure the compacting factor by the method described in BS 1881 at frequent intervals or as frequently as the Engineer may direct. Whenever the compacting factor varies from that of the approved mix the quantity of water added to the mix shall be immediately adjusted to counteract the variation. The successive values of the compacting factor and the quantity of water added shall be recorded on a suitable quality control chart, which shall be kept near the mixer and submitted to the Engineer for his inspection as he may direct.

In addition to the tests mentioned above, as frequently as the Engineer may decide and at least once each day when concreting is in progress, the Contractor shall sample and test the aggregate due shortly for incorporation into the Works as follows, the tests being carried out in Accordance with BS 812.
15-9.1.2 **Sieve Analysis of both Coarse and Fine Aggregate**

The grading of all aggregates must be within the respective limits specified in the Specifications. If this cannot be achieved, the Engineer shall instruct the Contractor to make such modifications to the proportions of aggregate in the mix as will allow for such difference, and the Contractor shall immediately do so.

15-9.1.3 **Determination of Clay, Fine Silt and Fine Dust in the Fine Aggregate Field Setting Test.**

Should the amount of clay, fine silt and fine dust exceed the limits specified, then the Contractor shall refrain from using the aggregate until he satisfies the Engineer of its suitability for making concrete of the quality required.

15-9.1.4 **Determination of Organic Impurities**

Should the color produced by this test be as dark as the standard solution, the aggregate shall not be used until the further comparative tests as/or AASHTO T21 have been carried out and given satisfactory results.

15-9.2 **Compressive (Cube) Strength**

15-9.2.1 **Works Cube Manufacture Test**

Work cubes, shall be made and cured in the manner described in BS 1881. Where the concrete is vibrated the cubes shall be compacted by similar means in such a way that full compaction of the concrete with neither segregation nor excessive laitance is obtained.

15-9.2.2 **Checking Works Cube Strength**

At the commencement of concreting work, a sample of the concrete shall be taken on each of the first four days and work cubes shall be made. Six cubes shall be made from each sample taken. Three for testing at 7 days and three for testing at 28 days. The average strength of the three cubes tested at each age will be taken as the Works Cube Strength of the concrete. This cube strength shall be accepted in complying with the specified requirements for works cube strength if none of the compressive strength or if the average strength is not less than the specified Works Cube Strength and the difference between the greatest and least strengths is not more than 20% of that average.

If the 7 day strengths deduced from these tests from the first four days of concreting do not reach the required value, the mix shall be re-designed. After the first four days, the frequency of sampling and the number of samples to be taken will be as directed by the Engineer but not less than 6 cubes for every 10 cu yd batched. If 7 days' results taken for early indication fail to satisfy the strength requirements the mix proportions and batching methods should be investigated immediately.

During daily concrete production six (6) cubes shall be taken at each site where concrete is cast. Three (3) cubes will be tested after seven (7) days and three (3) will be tested after twenty-eight (28) days.
15-9.2.3 Independent Test Cubes
The Contractor shall arrange for the Engineer to be present during the sampling of the concrete and the manufacture, storing and curing of the cubes to ensure that there is complete agreement between himself and the Engineer that the said cubes are entirely acceptable as test cubes. Should the Contractor fail to arrange for the Engineer to be present when required, or decline to do so, the cubes so manufactured will not be accepted as test cubes.

Should the Contractor wish to make independent test cubes he may do so at his own expense, but the results will not be valid unless the cubes are manufactured in the presence of the Engineer and tested by an approved agency, all in accordance with BS 1881.

The results of all the cube tests shall be shown on an approved form, giving the reference number of the cube, its size and weight, the grade of concrete from which it was made, the compaction factor, the date on which it was tested, the total load at which it failed, the stress in lbs/sq in. and the location of structure at which the sample concrete was taken. Two copies of each test certificate, containing all the information mentioned above, shall be forwarded to the Engineer for his retention and a third copy retained in the Laboratory.

15-9.2.4 Failure of Test Cubes for Strength Requirement
Should test cubes crushed at 7 days or those crushed at 28 days, fail to satisfy the specified requirements, the Contractor shall stop all concrete work until, on the Engineer's Instructions, one or more of the following steps have been taken:-

I. He shall alter the design of the mix to increase its average compressive strength.
II. He shall alter the methods of making the concrete and controlling its quality to reduce the variability of the concrete.
III. He shall cut out and replace all concrete placed in the Works on any day in which a cube was made and failed after 28 days if, in the opinion of the Engineer, such concrete is likely to be incapable of fulfilling its purpose.
IV. Correlation of Test
Tests on concrete materials and concrete shall be made as often as directed by the Engineer and at instances such that the test results can be directly correlated to the works test cubes for a particular batch of concrete.

15-10 TRANSPORTATION OF CONCRETE
Concrete shall be taken from the place of mixing to the place of deposition by methods which will prevent the drying-out and consolidation of the concrete, the segregation and loss of the ingredients, and which are sufficiently rapid to ensure that the concrete does not commence to set before it is finally consolidated in position. During the transportation the concrete shall be protected from any adverse effects of sun, wind, and rain.

The concrete shall be deposited as near as possible to its final position in the Works, and no concrete shall be dropped freely or deposited by means of chutes through a depth
exceeding 1.5m (5ft). All mixers, barrows, spades and other mixing and distribution equipment shall be thoroughly clean before commencing each period of use and shall be kept free of partly set concrete which shall not be used in the Works.

No concrete shall be transported over or near to new work that has insufficiently hardened, in order to prevent harmful vibration of the new work and no planks or ways for skips, etc. shall be supported on either formwork or reinforcement for the same reason.

15-11 PLACING AND CONSOLIDATION OF CONCRETE

15-11.1 General Placement and Consolidation

No concrete shall be placed on any part of the Works until written permission to do so has been obtained from the Engineer. Well in advance of the intention to place concrete, the Contractor shall forward to the Engineer for his approval full information about the order in which he proposes to place concrete in the various parts of the Works, the height of each lift of concrete and details of the shuttering which it is proposed to employ, with relevant calculations and positions of all construction joints.

All construction joints shall be formed as specified in Clause 818 and there shall be no stoppage of the placing of concrete except at such proper construction joints.

The Contractor will be required to furnish the Engineer with satisfactory evidence that all preparations, precautions and provisions have been made to ensure that the concrete shall be placed and compared in accordance with this Specification before the Engineer will give his permission for concreting to proceed.

For members involving "vertical" placing of the concrete (e.g. walls) each lift shall be deposited in layers extending for the full width between shuttering and of such depth that each layer can be easily and effectively incorporated with the layer below by the means of consolidation being employed. The layers shall be placed horizontally, sloping beds not being permitted unless particularly so specified.

For members involving "horizontal" placing of the concrete (e.g. floor and roof slabs) the concrete shall be placed along the line of the starting point in such quantities as will allow the member to be cast to its full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front, parallel to the starting line, the tampers for giving the required surface and compaction following as closely behind as practicable.

All members shall be concreted at such a rate as will eliminate any possibility of fresh batches of concrete being deposited immediately adjacent to batches which have commenced to set, and all members shall be poured in one continuous operation until completed, no interval being allowed to lapse while the work is in hand.

Care shall be taken to ensure that the process of placing concrete does not cause any harmful vibration to adjacent work that has insufficiently hardened.
Should any unforeseen occurrence result in a stoppage of concreting for such a time as might allow the concrete already placed to begin to set before the next batches can be consolidated in place the Contractor shall immediately insert, at his own cost, a proper end-shutter to form a proper tongue and groove construction joint, as specified in Clause 818 normal to the work at that point which will ensure that the section already cast is formed completely in accordance with this Specification. Any additional reinforcement required as a result of the joint shall be provided by the Contractor at his own expense.

Large, exposed (horizontal) concrete surfaces may require protection from the direct rays of the sun or other adverse weather effects. The Contractor shall take all reasonable precautions to protect the concrete surfaces in accordance with these specifications, or as approved by the Engineer. Failure to protect such surfaces may result in rejection of the work by the Engineer.

Consolidation of the concrete shall be affected by either hand or mechanical means and all consolidating tools must be approved by the Engineer before being used in the Works. The concrete shall be worked well up against whatever surface it adjoins and consolidated to such a degree that it reaches its maximum density as a homogenous mass, free from air and water holds, and penetrates to all corners of the molds and shuttering and completely surrounds the reinforcement. Care shall be taken to ensure that neither hand tampers or mechanical vibrators come into contact with the framework, reinforcement, or any embedded fittings and to prevent the operation of consolidation from transmitting any harmful vibrations or shocks to concrete which has not yet hardened sufficiently.

Compliance with the conditions of this Clause may require working longer hours than usual and the Contractor must allow for this in his program for concreting and in the rates for the work inserted by him in the Bill of Quantities.

**15-11.2 Concrete Placed Under Water**

Concrete shall be placed under water only where particularly so specified and approved by the Engineer. The quantity of cement in any concrete placed under water shall be increased by at least 25% above the cement content of the appropriate approved mix. Concrete shall be placed in still water only and every precaution shall be taken to prevent the cement and fine materials from being washed out of the concrete. Concrete shall be placed either with a tremie or a bottom-opening box of a type approved by the Engineer. Bottom opening boxes shall not be opened until they are resting on the work and the lower ends of tremie pipes shall always be kept below the surface of the wet concrete already deposited. No concrete shall be allowed to fall through water at any time. Concrete shall be placed evenly over the whole area closed by the shuttering and must not be raked over, only the minimum of screeding being allowed once the concrete has been placed.
15-11.3 Protection against Chemical Action

In cases where concrete is to be deposited against ground known or suspected to contain sulphate salts or other deleterious chemical agents, sulphate resisting Portland cement shall be used instead of ordinary Portland cement. The sulphate resisting Portland cement shall be approved manufacture and in accordance with BS 4027 and in such situations where its use is required, particular care shall be taken to keep the ground water level below the level of the concrete being placed until that concrete has hardened and has been cured as specified.

15-11.4 Attendance of Joiner and Steel Fixer

During all concreting operations, the Contractor shall ensure that a competent joiner and a competent steel fixer (in the case of reinforced work and work in which fittings are embedded) are in attendance on each concreting gang. It shall be their duty to ensure that the formwork is maintained in accordance with the Specification, temporary construction joints inserted as necessary, and reinforcement and fittings maintained in place as the work proceeds.

15-11.5 Construction Joints

All construction joints in all classes of work shall be formed by inserting stopping-off boards normal to the work to form a tongue and groove joint as required and against which the concrete can be properly consolidated. They shall be formed in the position shown on the Drawings or as directed and approved by the Engineer. There shall be no construction joints in pre-cast members not in the reinforced concrete deck slabs of minor spans. In the case of T-beams the rib and slab shall be cast together in one continuous operation. In other work, construction joints shall be located at points where shear stresses or tensile concrete stresses are a minimum and at places where they will least affect the appearance and properties of the finished works. No construction joint may be inserted without the written approval of the Engineer. Any proposed construction joint shall be provided by the Contractor at his own cost.

When work is resumed against a horizontal surface, which has hardened or recently set, the surface of the concrete shall be roughened by hacking and all laitance, loose and porous material and poorly consolidated concrete shall be removed from it. Where reinforcement or fittings project from the older concrete, these shall be carefully cleaned, the utmost care being taken to break the bond, and freed from all adherent coatings of concrete and other matter likely to reduce the bond between the steel and the concrete to be poured. The surface of the concrete (and steel if applicable) shall then be swept clean, brushed with a steel wire brush to remove all loose material, saturated with water, thoroughly cleaned and all surplus water removed.
Existing concrete surfaces shall be washed with clean potable water and allowed to dry and be damp prior to placing fresh concrete. Fresh concrete shall be thoroughly consolidated against all surfaces.

15-11.6 **Joints to Prevent Bonding of Adjacent Surfaces**

Where it is specified on the Drawings that a joint is to be inserted to prevent bonding between two adjacent parts of the structure, the Contractor shall insert two layers of approved waterproof building paper between those parts of the structure in the positions specified. The paper shall be tailored to fit the surfaces accurately without any folding or wrinkling, and cut overlapping edges shall be covered with adhesive tape to prevent any turning or movement during concreting operations. Throughout the area of the joint there must be not less than two thicknesses of approved waterproof building paper. Concreting operations shall be carried out carefully to ensure that no damage shall be done to the paper.

Instead of waterproof building paper the Contractor can used bond breaker, which will be applied in two layers. The second layer can only be applied after the first layer has dried.

15-12 **REMEDIAL WORK TO DEFECTIVE SURFACES**

If, on stripping any formwork the concrete surface is found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions, which the Engineer may give.

Defective surfaces of structural members shall not be made good by plastering.

Areas of honeycombing, which the Engineer agrees may be repaired, shall be cut back to sound concrete or to 75mm (3 inches) whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm (1-inch) clear distance behind the reinforcement or to 75mm (3 inches), whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete class as the main body but with aggregate smaller than 20mm (3/4-inch) nominal size. If repairs are made two weeks after the concrete has been cast the repair concrete should be epoxy concrete. The amount of epoxy added to the concrete shall comply with the epoxy manufacturer's specification. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth.

Surface irregularities, which are outside the limits of acceptable tolerance, shall be ground down in the manner and to the extent instructed by the Engineer.
Defects other than those mentioned above shall be dealt with as instructed by the Engineer.

15-13 CURING OF CONCRETE

15-13.1 General

During curing of the concrete all precautions shall be taken to ensure a slow heat evolution and the absence of cracks. The temperature of the hot concrete surfaces shall not be subjected to sudden changes by spraying of cold water and the concrete must be protected from sunshine and wind. Freshly placed concrete must be protected from rain.

15-13.2 Water Curing

Very great importance is attached to the proper curing of the freshly placed concrete and the Contractor must ensure that it is effectively done. All newly placed concrete shall be protected from the effect of rain, drying winds and the sun by suitable screens of damp Hessian, etc., supported on frames until the concrete has hardened sufficiently to support them directly without marking. The ends of and sides of the screens shall be held down at the edges to prevent drafts from getting underneath. As soon as the concrete has hardened sufficiently to support the covering without marking, it shall be covered with clean sacks, Hessian, or a 2-inch thick layer of clean sand or other approved material which shall be kept continuously in a wet condition. When the shuttering is removed, the damp Hessian or sacks shall be hung directly around the concrete ember and kept continuously wet by spraying with clean fresh water.

Providing that the shuttering has been covered with approved mold oil which will prevent the timber from absorbing water from the concrete, the time that the concrete remains in formwork under the conditions herein specified shall count as part of the curing period. Curing of all concrete shall continue for at least 7 days, or as directed by the Engineer or as otherwise specified. On no account must the surrounding sacks, Hessian, sand, etc., be allowed to dry out during the curing period.

15-13.3 Resinous Curing

As an alternative method of curing, the surface may be protected, where approved by the Engineer, by treating with an approved resinous curing compound, mechanically sprayed on to the surface of the finished concrete at a rate approved by the Engineer as soon as it is possible to produce a membrane of uniform thickness.

Unless otherwise directed by the Engineer the compound shall be applied immediately after completion of the laying and finishing of the concrete. Any groove over a joint shall be protected from the entry of curing liquid.

15-14 FORMWORK TO CONCRETE
15-14.1 General

Formwork shall include all temporary or permanent forms required for forming the concrete, together with all temporary construction (e.g. braces and shoring) required for their support.

All formwork shall be so constructed that there shall be no loss of material (Solid or Liquid) from the concrete. After hardening, the concrete shall be in the position and of the shape, dimensions and surface finish described in the Contract. All concrete failing to conform to the sizes, shapes, position and thickness required by the drawings shall be removed and replaced at the Contractor’s own expense despite approval being granted to proceed with pouring.

Forms for the Reinforced piles shall be of made entirely of steel, and should be rigid enough to prevent warping or displacement of the reinforcement during placing and compaction.

Where internal metal ties are permitted, they or their removable parts shall be extracted without damage to the concrete and the remaining holes filled with mortar. No permanently embedded metal part shall have less than 2 inches cover to the finished concrete surface.

15-14.2 Formed Surfaces - Classes of Finish

The requirements extra to those given above to provide the class of finish required shall be:

Class F1 - These shall consist of Steel/metal forms to provide a smooth and uniform finish. These are required for heavy structural members, or where the concrete may be subject to pre- or post- tensioning/stress. No remedial work to the concrete shall be allowed when this class of forms is being utilized.

Class F2 - The formwork shall be lined with a material approved by the Engineer to provide a smooth finish of uniform texture and appearance. This material shall leave no stain on the concrete and shall be so joined and fixed to its backing that it imparts no blemishes. It shall be of the same type and obtained from only one source throughout any one structure. The Contractor shall make good any imperfections in the resulting finish as required by the Engineer. Internal ties and embedded metal parts will be allowed only with the Engineer's specific approval. (Fair-Faced Form)
Class F3 - The irregularities in the finish shall be no greater than those obtained from the use of wrought thickness square edged boards arranged in a uniform pattern. The finish is intended to be left as struck but imperfections such as fins and surface discoloration shall, if required, be made good by methods approved by the Engineer. (Rough Form)

The Contractor shall ensure that permanently exposed concrete surfaces to Class F2 and F3 finish are protected from rust marks, spillage and stains of all kinds.

Class F2 and F3 forms shall not be reused unless they have been inspected and approval has been granted by the Engineer.

15-14.3 Required Formed Surface Finishes

All formed surfaces of piles shall be finished to a Class F1 finish. Underside of soffits of decking and beams shall receive a class F2 or F3 finish, as indicated in the contract.

All exposed edges in piles shall be chamfered 25mm.

15-14.4 Preparation of Formwork before Concreting

The inside surfaces of forms shall, except for permanent formwork, or unless otherwise agreed by the Engineer, be coated with an approved material to prevent adhesion of the concrete. Release agents shall be applied strictly in accordance with the manufacturer's instructions and shall not come into contact with the reinforcement or pre-stressing tendons and anchorages. Different release agents shall not be used on formwork for concrete, which will be visible on the finished Works.

Immediately before concreting, all forms shall be thoroughly cleaned out.

15-14.5 Removal of Formwork

a. The Engineer shall be informed in advance when the Contractor intends to strike any formwork.
b. Attention is drawn to any provisions against early loading.
c. The time at which the formwork is struck shall be the Contractor's responsibility, but the minimum periods between concreting and the removal of forms shall be as follows:

<table>
<thead>
<tr>
<th>Part of Structure</th>
<th>Ordinary Portland Cement</th>
<th>Rapid Hardening Portland Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side of beams</td>
<td>1 day</td>
<td>0.5 day</td>
</tr>
<tr>
<td>Soffit of slabs and beams</td>
<td>7 days</td>
<td>5 days</td>
</tr>
<tr>
<td>Props under slabs</td>
<td>14 days</td>
<td>10 days</td>
</tr>
<tr>
<td>------------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Columns</td>
<td>1 day</td>
<td>0.5 day</td>
</tr>
<tr>
<td>Piles</td>
<td>1 days</td>
<td>1 day</td>
</tr>
</tbody>
</table>

d. The periods stated above are based on a constant surface temperature of the concrete of 16 °C (61 °F) and the use of Portland cement. They shall be increased during colder weather as directed by the Engineer, and may be changed if other types of cement are used, subject to the Engineer's agreement.
e. Formwork shall be constructed so that the side forms of members can be removed without disturbing the soffit forms and, if props are to be left in place when the soffit forms are removed, these props shall not be disturbed during the striking.
f. For pre-stressed units the side forms shall be eased as early as possible and the soffit forms shall permit deformation of the member when the pre-stress is applied.
g. All formwork shall be removed without damage to the concrete.
h. Where it is intended that formwork is to be re-used it shall be cleaned and made good to the satisfaction of the Engineer.

15-15 Unformed Surfaces - Classes Of Finish

a) Class U1 - The concrete shall be uniformly leveled and screeded to produce a plain or ridged surface as described in the Contract. No further work shall be applied to the surface unless it is used as the first stage for a Class U2 or Class U3 finish.

b) Class U2 - After the concrete has hardened sufficiently, the concrete Class U2 surface shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

c) Class U3 - When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, a Class U3 surface shall be steel-toweled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

15-15.1 Required Finish for Unformed Surfaces;

The top surfaces of pre-cast concrete piles, cast-in-place deck concrete, abutment and pier caps shall receive a class U3 finish.

15-16 Remedial Treatment of Surfaces

Any remedial treatment to surfaces shall be agreed with the Engineer in accordance with Clause 15-12 following inspection immediately after removing the formwork and shall be carried out without delay.
Any concrete, the surface of which has been treated before being inspected by the Engineer, shall be liable to rejection.

15-16 REINFORCEMENT FOR CONCRETE

15-16.1 General

Reinforcement used shall be in conformity with that specified in the Drawing or Bills. Any reinforcement, which does not comply with the Specification, shall be removed from Site.

The reinforcement shall comply with the following Standards that cover plain and deformed bar reinforcement and steel fabric to be cast into concrete in any part of the Works but do not include pre-stressing tendons or any other embedded steel.

ASTM A 615 Grade 60 or BS 4449 for hot rolled steel bars for the reinforcement of concrete BS 4482 for cold reduced steel wire for the reinforcement of concrete BS 4483 for steel mesh fabric for the reinforcement of concrete. Stainless steel dowel bars and stainless steel reinforcing bars, where required and as shown on the plans, shall conform to BS 6744(1986) or ASTM A955 (1996) and shall be at least grade 420 MPa(60 ksi).

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate from the manufacturer.

All reinforcement for use in the Works shall be tested for compliance with the appropriate Standard in a laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. The frequency of testing shall be as set out in the Standard.

In addition to the testing requirements described above, the Contractor may be required to carry out additional tests as instructed by the Engineer.

15-16.2 Storage of Reinforcement

All reinforcement shall be delivered to Site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths, which have been transported bent over double.

Any reinforcement, which is likely to remain in storage for a long period, shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Engineer, will affect its properties shall either be removed from Site or may be tested for compliance with the appropriate Standard in accordance with Clause 15-16.1 of this Specification at the Contractor's expense.
15-16.3 **Bending Of Reinforcement**

Unless otherwise shown on the Drawings, bending and cutting shall comply with BS 4466.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the Drawings.

Bars shall be bent cold by the application of slow steady pressure. At temperature below 5°C the rate of bending shall be reduced if necessary to prevent fracture of the steel.

After bending, bars shall be securely tied together in bundles or groups and legibly labeled as set out in BS 4466.

Reinforcement shall be thoroughly cleaned and all dirt, scale, loose rust, oil and over contaminants removed before it is placed in the Works.

15-16.4 **Placing Of Reinforcement**

Reinforcement shall be placed and maintained in the position shown in the Contract. Unless otherwise permitted by the Engineer, all intersecting bars shall be tied together and the ends of the tying wire shall be turned into the main body of the concrete.

No splices shall be made in the reinforcement except where described in the Contract or where approved by the Engineer.

15-16.5 **Cover Blocks**

Cover blocks required for ensuring that the reinforcement is correctly positioned, shall be as small as possible consistent with their purpose, shape acceptable to the Engineer, and designed so that they will not overturn when the concrete is placed. They shall be made of concrete with 8mm (5/16 inch) maximum aggregate size and the mix proportions shall comply with the Specification to produce the same strength as the adjacent concrete. Wire shall be cast in the block for the purpose of tying it to the reinforcement.

15-16.6 **Welding Of Reinforcement**

Reinforcement in structures shall not be welded except where permitted in the contract. All welding procedures shall be subject to the prior approval of the Engineer in writing.

15-17 **WATERPROOFING TO STRUCTURES**

Waterproofing shall be applied to structural concrete surfaces in contact with fill material or cut soil surfaces wherever detailed on the Drawings or instructed by the Engineer in writing.
Prior to application the surface shall be clean and completely free from damp, moisture, dust, membrane curing compounds, projecting tying wire, nails and the like.

Waterproofing materials shall consist of either bitumen emulsion or cutback bitumen or bitumen/rubber latex emulsion.

Bitumen emulsion shall comply with the requirements of BS 434, Type A160. Two coats shall be applied, the first coat at a minimum rate of 0.1 gallons per square yard. The first coat shall be allowed to dry before the second coat is applied.

Cutback bitumen shall be type MC 30. Two coats shall be applied, the application rates being as described for bitumen emulsion. The first coat shall be allowed to dry before the second is applied.

Bitumen/rubber latex emulsion shall contain a minimum of 10% rubber. Two coats shall be applied, the application rates being as described for bitumen emulsion. The second coat shall be applied when the first coat is touch dry. Bitumen/rubber latex emulsion shall not be applied during wet weather and should rain occur and cause damage before the rubber has dried the membrane shall be repaired or replaced as approved by the Engineer at the Contractor's expense.

Where concrete is cast against existing ground the waterproofing membrane shall be single layer polythene sheet 0.03 inches thick laid with minimum laps between sheets of 6 inches.

15-18 MOVEMENT JOINTS AND SEALS

15-18.1 General

The term "movement joint" includes all types of permanent joint of hinge throat which allow expansion, contraction, shrinkage or angular rotation to take place.

Movement joints shall be constructed all in accordance with the Contract Plans and Manufacturer's instructions.

The size of the gap shall be compatible with the mean structure temperature at the time of installation. This temperature shall be determined in accordance with arrangements agreed with the Engineer. An approved, preformed expansion joint filler shall be installed at approach slab to deck joints and similar locations all as required on the Contract Plans.

The position of all bolts cast into concrete and holes drilled in plates shall be accurately determined from templates.
15-18.2 Prevention of Damage

During the placing and hardening of concrete or mortar under expansion joint components, relative movement shall be prevented between them and the supports to which they are being fixed.

When one half of the joint is being set, the other half shall be completely free from longitudinal restraint. In particular where strong backs or templates are used to locate the two sides of a joint, they shall not be fixed simultaneously to both sides.

Screw threads shall be kept clean and free from rust. Ramps shall be provided and maintained to protect all expansion joints from vehicular loading. Vehicles shall cross the joints only by means of the ramps until the Engineer permits their removal.

15-18.3 Sealing Of Deck Joints and Overlay

The sealant shall be hot poured rubber bitumen sealant or poly-sulphide sealant as approved by the Engineer. Both shall be used in accordance with the manufacturer's recommendations. Joints shall be clean and dry before sealing. There shall be no separate payment for the provision and installation of sealed deck joints and joints in the overlay at the ends of bridge decks or over intermediate piers (as indicated on the Contract Plans). All costs for this work shall be deemed to be included in the costs for all other structure and overlay items.

Approved pre-molded compression strip seal joints (i.e., "Jeene" joints or other approved joints) shall be installed carefully to the lines and grades required on the plans. All installation shall be in strict accordance with the Manufacturer's recommendations and needs of the Contract Plans. Payment shall be made for the length, size and type of joint installed.

15-19 MEASUREMENT AND PAYMENT

15-19.1 Blinding Concrete

Blinding concrete shall be measured by the square metre as calculated from the plan area of the foundation as shown on the Drawings and the instructed thickness. No deduction shall be made for openings provided that the area of each is less than 0.5 square metres.

The rate for blinding concrete shall include for all costs associated with the work in this Specification.

Item: Blinding concrete
Unit: Square Meter (Sq.m or m²)
15-19.2 Structural or Mass Concrete

Concrete shall be measured by the cubic metre of each class calculated from the dimensions given on the Drawings or instructed by the Engineer. No deduction shall be made in the measurement for:

(i) bolt holes, pockets, box outs and cast in components provided that the volume of each is less than 0.2 cubic metres;

(ii) mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 4 inches total width or less.

The rate for Structural/mass concrete shall include for the cost of the following:

(i) Provision and transport of cement, aggregates and water.

(ii) Admixtures and workability agents including submission of details unless specified.

(iii) Mortar beds, fillets, drips, rebates, recesses, grooves, chamfers and the like of 4 inches total width or less.

(iv) batching, mixing, transporting, placing, compacting and curing.

(v) Providing a Class U1, U2 and U3 finish as required.

(vi) Laying to sloping surfaces not exceeding 15° from the horizontal and to falls.

(vii) Placing and consolidating against excavated surfaces where required including any additional concrete to fill over break or working space.

(viii) Providing, shaping and installing all preformed joint filler material for expansion joints and the like.

(ix) Making right any defects and remedial works as instructed by the Engineer.

Item : Structural/Mass Concrete
Unit : Cubic Metre (Cu.m or m³)

15-19.3 Formwork

The formwork shall be measure by the square area of the form in contact with the concrete as specified in the drawings. The different class of forms used shall be measured differently. The rate provided shall include for:

(i) the provision, installation of the formwork Class F1, F2 and F3

(ii) provision and application of adhesion resistant material to forms

(iii) provision, installation of all required braces, ties and supports

(iv) removal of all temporary forms after casting as specified

The rates shall not take into account the re-use of any forms, Class F2 and F3.
15-19.4 Reinforcement

Plain steel and deformed bar reinforcement shall be measured the calculated weight of the steel required including splice lengths shown on the Drawings. No allowance shall be made in the measurement for rolling margin or cutting waste.

The rates for reinforcement shall include for the cost of providing, cleaning if required, cutting to length, splice lengths additional to those shown on the Drawings, laps, bending, hooking, waste incurred by cutting, cleaning, spacer blocks, provision and fixing of chairs or other types of supports, welding, fixing the reinforcement in position including the provision of wire or other material for supporting and tying the reinforcement in place, bending reinforcement aside temporarily and straightening, placing and compacting concrete around reinforcement and for complying with the requirements of this Specification.

Item: Reinforcement (Bars)
Unit: Kilograms or Metric tonnes (Kg or M.ton) of each type of reinforcement for all ranges of diameters.

15-19.5 Fabric Reinforcement

Steel fabric reinforcement shall be measured by the square metre and shall be the calculated area excluding any allowance for laps.

The rate for steel fabric reinforcement shall include for the costs associated with the provision, cutting, bending, spacer blocks, and supports, complying with this Specification.

Item: Steel Fabric Reinforcement
Unit: Square Metre (Sq.m or m²)
PART 16 - STRUCTURAL TIMBER

16-1 DESCRIPTION

This work shall consist of timber structures and the timber portions of composite structures constructed in conformity with the lines, grades, dimensions and designs shown on the drawings or ordered in writing by the Engineer and in accordance with these Specifications.

This work shall include the furnishing, preparing, erecting, fixing, painting and tarring of structural timber of the type, sizes, and dimensions specified, and for all hardware, bituminous felt and cotton; duct) in accordance with the drawings or ordered in writing by the Engineer.

16-2 MATERIALS

All timber for structural timberwork shall be grade A Greenheart Ocotea Rodiaei (Mez), or Nectandra Rodiaei (Schomb), free from sap, splits, checks, shakes, large loose knots, or other defects, air-seasoned, and with a minimum unit weight of 1080Kg/m³ (65 pounds per cubic foot) at 25 per cent moisture content. All timber shall be approved by the Engineer's Representative before being used in the permanent work.

Machine bolts, drift bolts and dowels may be either wrought iron or medium steel. Washers shall be cast ogee gray iron castings or malleable castings, unless washers cut from medium steel or wrought-iron plate are indicated on the plans. Bolts shall have square /hexagonal heads and nuts, unless otherwise stipulated. Nails shall be cut or round nails of standard form. Spikes shall be cut or round spikes or boat spikes as specified. All this hardware shall be galvanized in conformity with ASTM A153.

16-3 HANDLING AND STORAGE OF TIMBER

All timber to be used for the permanent structure shall be handled with care and shall not be used for purposes other than those indicated on the drawings except by written permission of the Engineer.

Such timber when stored on the site shall be kept in orderly stacks. Untreated timber shall be open-stacked on supports at least 300mm (12 inches) above the ground surface to avoid absorption of ground moisture and permit free circulation of air between the tiers. The stacked timber shall be protected from the weather by a suitable covering to the approval of the Engineer's Representative.

16-4 WORKMANSHIP

Workmanship shall be first class throughout. None but competent bridge carpenters shall be employed and all framing shall be true and exact. Unless otherwise specified, nails and spikes shall be driven with just sufficient force to set the head flush with the surface of the wood. Deep hammer marks in wood surfaces shall be considered evidence of poor workmanship and sufficient cause for removal of the workman responsible for them.
16-5 HOLES FOR NAILS AND SPIKES

Nails and spikes shall not be driven into permanent structural timberwork without first drilling holes unless otherwise directed by the Engineer's Representative.

Holes for nails shall be drilled with a bit 1mm (one thirty second inch) smaller in diameter than the nails to be used. Such holes shall be drilled to a depth three quarters the length of the nail or three-quarters the combined thickness of the members to be fastened together whichever is the smaller.

Holes for spikes shall be drilled with a bit 1.5mm (one-sixteenth inch) smaller in diameter than the circle inscribed in the cross-section of spike. Such holes shall be drilled to a depth three-quarters the length of the spike.

16-6 HOLES FOR BOLTS, DRIFT BOLTS, DOWELS, TIE-RODS AND LAG/COACH SCREWS

Holes for bolts, round drift bolts and dowels shall be drilled with a bit 1.5mm (one sixteenth inch) smaller in diameter than the bolt, drift bolt-or dowel to be used.

Holes for tie-rod shall be drilled with a bit 1.5mm (one sixteenth inch) greater in diameter than the tie-rod. Holes for lag screws shall be drilled with a bit not larger in diameter than that of the body of the screw at the base of the tread. If required to prevent splitting, the hole for the shank shall be drilled to the same diameter as that of the shank. The depth of the holes for lag screws shall be approximately 25mm (one inch) less than the length under the head.

16-7 HARDWARE

Bolts shall be of the sizes shown on the drawings unless the written permission of the Engineer is obtained for using other sizes. The length specified shall be measured under the head.

Lag/coach screws shall be installed by turning them in place. They may be driven sufficiently to start them in the holes and hold them firmly in place for turning, but shall not be driven beyond the depth that will be physically occupied by the shank.

Washers shall be used under all nuts and bolt heads that would otherwise come into contact with wood. Standard mild steel washers shall be used at all locations unless otherwise specified.

All nuts shall be tightened sufficiently to prevent bolts from becoming loose during service.

Nails and spikes shall not project beyond the surfaces of the wood into which they are driven except where shown on the drawings or approved by the Engineer.

All steel for fabricated hardware shall conform to ASTM A36 Steel. Unless otherwise specified, all hardware shall be galvanized or cadmium plated.
16-8 COUNTERSINKING

Countersinking shall be done wherever shown on the drawings.

16-7 CAPS

Timber caps shall be placed with ends aligned in a manner to secure an even and uniform bearing on the shoulders of the tenons cut in the tops of the supporting piles. The cap shall be bolted to the tenons at the top of the piles so that the faces of the cap are parallel to the plane continuing the longitudinal axes of the piles. The top surfaces of the caps shall be cut to dimensions as shown on the drawings.

16-10 STRINGERS

Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the top portions of the stringers.

Outside stringers shall be butted over supports but interior stringers shall be lapped as shown on the drawings.

The top surfaces of the stringers shall lie on a plane as shown on the drawings and no point on such surfaces shall be more than 1.5mm (one sixteenth inch) away from this place. This condition must be met to the approval of the Engineer before deck planks are laid on the stringers.

Cross bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails in each end. All cross bridging shall have full bearing at each end against the sides of the stringers.

16-11 PLANK FLOORS

The decking shall consist of liner boards laid longitudinally over planks laid transversely across the stringers.

The planks shall be carefully selected for size and no planks shall vary in thickness by more than 1.5mm (one sixteenth inch) from the thickness shown on the drawings. The planks shall be laid on the stringers without space between adjacent planks and these planks shall be drawn together with a clamp before being fastened to the stringers. Each plank shall be attached with at least two (2No.) coach screws to each stringer that it crosses. The difference in elevation between the top surfaces of adjacent planks shall not be more than 1.5mm (one sixteenth inch). Before laying the liner boards the top of the deck planks shall be painted with two coats of tar.

Liner boards shall be dressed with groove and tongue edges. The thickness shown on the drawings is a nominal thickness and refers to the thickness of the boards before machining: The liner boards shall be laid parallel to the stringers on the deck planks. They shall be drawn together with a clamp before being securely fastened to the planks as indicated on the drawings.
16-12 WHEEL GUARDS AND RAILINGS

Wheel guards and railings shall be accurately framed in accordance with the plans and erected true to line and grade. Unless otherwise specified, wheel guards, rails and posts shall be surfaced on four sides. Wheel guards shall be laid in sections not less than 4.0m (13 feet) long. All rails shall be squarely butt-jointed at the posts and the rails shall have break-joints.

16-13 SURFACES IN CONTACT

A layer of bituminous felt shall be placed between all wooden surfaces in contact between liner boards and deck planks.

Two layers of twelve ounce cotton duck thoroughly saturated and coated with one or more applications of red lead shall be placed between wood and steel surfaces in contact.

16-14 PAINTING

All exposed timber surfaces including the undersides of wheel guards and the top surfaces of retainers shall be primed with an approved primer and painted with two coats of an approved paint. Both primer and paint shall be approved by the Engineer with respect to type and colour before being used, and such primer and paint shall be inspected and approved by the Engineer's Representative before being used. No painting shall be done during wet weather, and the Contractor shall ensure that all surfaces are free from dampness and condensation particularly when painting is to be commenced early in the morning.

16-15 TARRING

The top and bottom surfaces of the deck planks and all the sides of the cross-bridging and stringers shall be carefully tarred with two coats of tar.

All tar shall be approved by the Engineer. The tar shall be inspected and approved by the Engineer's Representative before being used.

Tie-rods connected to wing walls shall be thoroughly cleaned, descaled and painted with two coats of tar and lagged with strips cut from jute bags and thoroughly impregnated with tar.

All tarring shall be done after the member being tarred is erected and/or fixed in place, except where otherwise directed by the Engineer.
16-16 METHOD OF MEASUREMENT

Structural timberwork shall be measured for payment by the foot board measurement. The quantities to be paid for shall be computed from the nominal cross-section and actual lengths of timber remaining in place in the structure as shown on the drawings and/or as directed by the Engineer. Such quantities shall not included timber used for erection and temporary purposes. The nominal cross-sections are the cross-sections, shown on the drawings and the dimensions of such cross-sections shall be used in computing quantities even though the actual cross-sections used may vary slightly from the nominal cross-sections.

No portion of any pile shall be included in the measurement for payment for structural timberwork.

16-17 BASIS OF PAYMENT

The quantities of structural timberwork measured as provided above shall be paid for at the contract unit prices per foot board measure under the heading “Structural Timberwork” in the Bill of Quantities.

All prices and payment for structural timberwork shall be full compensation for furnishing and placing all materials and for all labour, tools, equipment and incidentals necessary to complete the work prescribed in this Section.

Payment shall be made under: Structural Timber- Fbm
PART 17- REINFORCED CONCRETE AND TIMBER PILING

17-1 TIMBER PILING

17-1.1 GENERAL

The surface of the piles shall not contain kinks greater than 25mm in 1.5m (one inch in five feet), as measured by a straight edge or straight string line. Also, a straight line drawn from the centre of the butt to the centre of the tip shall not, at any point, fall further away from the centre of the pile than a distance equal to one half percent of the length of the pile. The piles should have an even taper from butt to tip. A spiral grain or twist in excess of ¼ turn in 10-feet of length will be cause for rejection.

Permissible knots will be sound knots of diameter not exceeding one-third the diameter of the pile at the point where the knot occurs. In these specifications a sound knot shall be defined as a knot, which is solid across its face, is as hard as the surrounding wood, does not move/shake, and shows no indication of decay.

Any defect or combination of defects will result in the rejection of the pile. Any pile that is rejected shall be removed from the site immediately and replaced with one that adheres to these specifications.

Piles shall be of timber as specified in the Bills or drawings, which will stand the driving for which they are intended. Any substitution must be granted in writing by the Engineer. They shall be free of: bird holes; cracks; decay; nails, spikes and other foreign substances; plugged holes; shakes in the tip; splits or through cracks in the tip; insect damage; any abnormal change in cross-sections; knot clusters; short crooks; and reverse sweep.

17-2 DESCRIPTION

This work shall consist of furnishing, driving and cutting off piles of the kind, shape and dimensions as shown on the drawings and in accordance with these specifications. Each pile shall be driven in the location and to the elevation and penetration shown on the drawings, or as directed by the Engineer. Piling is divided into two classes - bearing piles and sheet piles - for which measurement and payment shall be as specified.

All piling shall be of untreated timber. This timber shall be Greenheart Grade A, Ocotea Rodiae (Mez), or Nectandra Rodiae (Schomb), of mature growth, free from gross defects, and having a minimum weight of 1250Kg/m³ (78 pounds per cubic feet) at 42 percent moisture content. Bearing piles shall consist of round piles. The natural taper for round piles shall not exceed 1:120 (1 inch in 10 feet). The mean diameter at the butt and tip shall be as specified on the drawings. Sheet piling shall be of sawn timber with cross-section as shown on the drawings.

Piles shall be debarked and smooth and all knot trimmed close to the surface of the pile. Sapwood shall not exceed 50mm (2 inches) maximum. They shall be free from short or reversed bends.

Sweep is permitted provided that it cannot be classified as short crook or reverse sweep and provided that:
1) For piles less than 21.5m (70 feet) in length, a straight line joining the mid-point of the butt and the mid-point of the tip does not at any intermediate point pass through the surface of the pile;

2) For piles 21.5m to 24.5m (70 feet and up to 80 feet) in length, a similar straight line does not lie more than 25mm (1 inch) outside the surface of the pile; or

3) For piles over 24.5m (80 feet) in length, a similar line does not lie more than 50mm (2 inches) outside the surface of the pile.

17-3 ORDERING PILES

The pile lengths mentioned on the contract drawings are estimates only and are not to be used by the Contractor in ordering piles. Instead the Contractor shall, at each bridge site where piles are required, drive at least one test pile and the safe bearing value of this test pile will be determined by the Engineer. When the safe-bearing value of this test pile conforms to that required on the contract drawings, the resultant length may be used by the Contractor, with the approval of the Engineer, in ordering the remainder of the piles required for that bridge site. Test piles shall remain in place as bearing piles and no extra compensation will be allowed for driving the test piles. The Contractor shall allow at least 7 days for the Engineer to determine and establish the pile lengths after the Contractor has provided the Engineer with the results of the test pile.

17-4 HANDLING AND STORING

The Contractor shall store and handle piles in ways that protect them from damage by avoiding the dropping, bruising or breaking of wood fibers.

All piles shall be handled with care during loading and unloading. They must not be used for purposes other than those indicated on the drawings except by written permission of the Engineer.

Piles shall be stacked six inches above the ground on dry ground, which is above high water level, and shall be stacked closely and in a manner to prevent warping. The ground beneath and around stored piles shall be cleared of weeds, brush, and rubbish. The location for stacking shall be approved by the Engineer's representative before piles are brought to the site. Piles shall not be stored in a location which will interfere with the free flow of traffic or drainage flow through the site. Piling shall be covered against the weather if the Engineer requires it.

The Contractor shall take special care to avoid breaking the surface of treated piles. They shall be lifted and moved with equipment, tools, and lifting devices which do not penetrate or damage the piles. If timber piles are rafted, any attachments shall be within 3-feet of the butts or tips. Any surface cut or break shall be repaired. The Engineer may reject any pile because of a cut or break.
17-5 PREPARATION FOR DRIVING PILES

In general, no piles shall be driven before all specified excavation in the vicinity of the pile location is complete. All material forced up between bearing piles as a result of driving shall be removed by the contractor to the specified elevation without additional compensation before the substructure above the piles is built, unless the Engineer directs that such material need not be removed.

Bearing piles shall not be driven without the use of a closely fitting cap or driving head of design approved by the Engineer. This cap or driving head shall be of such design as to distribute the blow of the hammer over the cross-section of the pile and thus avoid as far as possible the tendency to split, shatter, crimp or otherwise damage the pile.

Collars, bands, rings or other devices to protect the piles against splitting or brooming shall be provided by the Contractor and fitted on the piles without additional compensation.

Full-length piles shall be used where practicable. Piles shall not be spliced without written permission of the Engineer. The method of splicing shall be approved by the Engineer. Extensions for piles shall be furnished and driven by the Contractor in accordance with these Specifications. Unless authorized by the Engineer, follower piles shall not be used.

17-5.1 Steel Pile Tips and Shoes
Where required, or as instructed by the Engineer, the Contractor shall fabricate and provide steel pile tips and shoes to facilitate the pile driving at no additional cost. Steel pile tips and shoes shall be fabricated of cast steel conforming to ASTM A 148 Grade 60-90 or ASTM A 27 Grade 65-35 and be free from any obvious defects. Pile tips shall be accompanied by a mill test report stating the chemical and physical properties (tensile and yield) of the steel.

17-5.2 Straps
If required or instructed by the Engineer, timber piles shall be strapped with at least three straps: one approximately 0.45m (18-inches) from the butt, one approximately 0.6m (24-inches) from the butt, and one approximately 0.3m (12-inches) from the tip. Strapping shall encircle the pile once and be tensioned as tightly as possible. Straps shall be 32mm (1 ¼-inches) wide, 8mm (0.31 –inch) thick, cold rolled, frilly heat treated, high tensile strapping, painted, and waxed, with an ultimate tensile strength of 23KN (5,100 pounds). The seal shall be 60mm (2¼-inches) long, 20 gauge, crimped with a notch type sealer to furnish a joint yielding minimum 80 percent of the strap tensile strength. Treated or tarred timber piles shall be strapped after treatment or tarring.

17-5.3 Tarring
As specified in the Drawings or Bills, all piles shall be tarred prior to driving. Tarring shall be done a full 24 hours prior to swamping/pitching, but not before it has been inspected and approved for use by the Engineer. The full length of the pile shall be tarred, after it has been pointed. After driving, removal of driving rings and the pile has been cut to its final
elevation, tenons notched, and bolts holes drilled, all exposed surfaces of the pile shall be tarred again.

17-6 DRIVING PILES

Piles may be driven with a gravity hammer. Any gravity hammer used shall weight not less than the combined weight of the driving head and pile, and in the case of bearing piles not less than 1500Kg (3000 pounds). The height of fall shall be such as to avoid injury to the pile and in no case shall exceed 1.5m (5 feet). During driving, the hammer and the pile shall be kept in accurate alignment with the use of fixed pile leads.

In case the required penetration is not obtained by use of a hammer complying with the minimum requirements specified herein, the Contractor shall provide a heavier hammer at his own expense. If the required penetration is not obtained by using the heaviest permissible hammer and the greatest height of fall that will not damage the piles, the Contractor shall report this to the Engineer who shall decide whether alternative means shall be used to obtain the required penetration or whether the penetration obtained is satisfactory.

Steam, air or diesel hammers may also be used for driving piles and in the case of bearing piles such hammers shall develop a minimum energy of 1385 metre-Kg (10,000 foot – pounds) per blow.

Before driving piles the Contractor shall inform the Engineer of the equipment and method to be used for driving piles and obtain his approval for the use of such equipment and method. In addition, no piles shall be driven before the Engineer inspects and approves the Contractor's pile-driving equipment and the piles.

No piles shall be driven without the use of fixed type leads. Pile driver leads shall be constructed in such a manner as to afford freedom of movement of the hammer and shall be rigged to ensure lateral support of the pile during driving. They shall be held in the required position by guys or stiff braces.

The travel of the hammer shall be accurately in line with the axis of the pile. The Contractor shall re-align the hammer at any point during the driving process should it come out of alignment with the pile.

Except where piles are driven through water to a cut-off level below the surface of the water, the leads shall be of sufficient length to make the use of follower unnecessary.

The Contractor shall make marks on the pile and keep a log of the blow-count of each pile during the driving operations. The pile-driving logs shall be supplied to the Engineer for approval of each pile driven. Failure to do so shall result in the Engineer rejecting the pile or request a pile-load test, at the cost of the Contractor.
17-7 LOAD TESTS

When called for in the bid schedule, load tests shall be made where shown on the plans or in the special provisions. When diesel or other types of hammers requiring calibration are to be used, the Contractor shall make load tests even though no load tests are called for in the bid schedule, except that load tests will not be required when the hammer is to be used only for driving piles to refusal on rock or to a fixed tip elevation or the hammer is of a type and model that has been previously calibrated for similar type, size and length of pile, and foundation material. Calibration data must have been obtained from sources acceptable to the Engineer.

Load tests shall be made by methods approved by the Engineer. The contractor shall submit to the Engineer for approval detailed plans of the loading apparatus he intends to use. The apparatus shall be so constructed as to allow the various increments of the load to be placed gradually without causing vibration to the test piles. If the approved method requires the use of tension (anchor) piles, such tension piles may be of the same type and diameter as the permanent piles and in such case, shall be driven in the location of permanent piles. Alternatively, other pile types can be used but they must be driven at least 1 m from any permanent piles location and at a distance of at least 7 feet or five times the maximum diameter of the pile away from the test pile. If permanent piles are used as reaction piles, they must be re-driven to the required penetration after the completion of the test.

Suitable approved apparatus for determining accurately the load on the pile and the settlement of the pile under each increment of load shall be supplied by the Contractor. The loading apparatus shall have a working capacity of three times the design load shown on the plans for the pile being tested.

Reference points for measuring pile settlement shall be sufficiently removed from the test pile to preclude all possibility of disturbance. All pile load settlements shall be measured by adequate devices, such as gauges, and shall be checked by means of an engineer's level.

Increments of deflection will be read in accordance with Part 17-13.8. The safe allowable load will be considered as 50 percent of the load as defined by the Offset Limit Load Criterion. The test load shall be twice the design load shown on the plans.

The load increment to be applied to the test pile shall be in accordance with those stated in Part 17-13.8. If there is a question as to whether the test pile will support the test load, the load increments shall be reduced by 50 percent, at the direction of the Engineer, in order that a more closely controlled failure curve may be plotted.

At the discretion of the Engineer, loading shall continue beyond the double design load in 10-metric-tonne (10-ton) increments until the pile fails or the capacity of the loading apparatus is reached, whichever is the lesser. The pile may be considered to have plunging failure when there is continuous settlement without any increase in loading.
After the completion of loading tests the load used shall be removed in accordance with Part 17-13.8 and the piles, including tension piles, utilized in the structure if found by the Engineer to be satisfactory for such use. All tension piles shall be re-driven to the required penetration. Test piles not loaded shall be utilized similarly. If any pile, after serving its purpose as a test or tension pile, is found unsatisfactory for utilization in the structure, it shall be removed if so ordered by the Engineer or shall be cut off below the ground line or footings, whichever is applicable.

17-8 ACCURACY OF PILE DRIVING

Piles shall be driven with a direction, which does not vary more than 6mm in 300mm or 20mm in a metre (1/4 inch per foot) of pile length from the vertical or from the batter line indicated, and with a total deviation of the head of the pile from the position shown in the plans, of not more than 75mm (3 inches).

Piles not driven accurately shall be removed upon instruction of the Engineer, and new pile re-driven in place at the expense of the Contractor. If impractical, the Contractor shall make any modifications as necessary without compromising the structure and the integrity of the design as instructed by the Engineer at his own expense.

17-9 DEFECTIVE PILES

The method used in driving piles shall not subject them to excessive and undue abuse producing injurious splitting, splintering and brooming of the wood. Manipulation of piles to force them into proper position, if considered by the Engineer to be excessive, will not be permitted. Any pile damaged during driving by reason of internal defects, or by improper driving, or driven out of its proper location, or driven and/or cut off below the elevation fixed by the drawings or the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved in writing by the Engineer for the pile in question.

(a) The pile shall be withdrawn and replaced by a new and, when necessary longer pile.

(b) A second pile shall be driven adjacent to the defective pile.

(c) The pile shall be spliced or built up as otherwise provided herein or a sufficient portion of the footing extended to properly embed the pile.

All piles pushed up by the driving of adjacent piles or by any other cause shall be driven down to their original elevation at no additional cost.

17-10 INCREASING THE PENETRATION OF BEARING PILES

If as a result of the behaviour of bearing piles during driving, or for any other reason the Engineer decides that the bearing capacity of the piles driven to the specified penetration is insufficient, the Engineer may direct that the pile be spliced and driven to a deeper
penetration. The length of the pile extension and the design of the splice shall be determined by the Engineer.

17-11 CUTTING OFF PILES

The tops of all piles shall be sawed to a true plane at the elevation shown on the drawings. Bearing piles which support timber caps shall be sawed to conform to the plane of the bottom of the superimposed structure, and tenons cut in the tops of the piles to take the caps as shown on the drawings. The faces of the tenons shall be cut to a true plane. The length of pile above the elevation of cut-off shall be sufficient to permit the complete removal of all material injured by driving.

17-12 MEASUREMENT AND PAYMENT

17-12.1 Bearing Piles

Item: Supply and drive greenheart timber pile
Unit: Linear Metre (Lin. M or m)

The quantities of pile to be paid for will be the sum of the length of the piles indicated on the plans or ordered in writing by the Engineer, supplied in compliance with the material requirements of these specifications. When extensions of piles are necessary, the extension length ordered in writing by the Engineer will be included in the linear metre of piling supplied. The rate shall include for supplying, debarking, transporting, pitching, pointing, driving in place and cutting off to the desired elevations and logging blow count. Where instructed in the Drawings and Bills, piles shall be tarred.

17-12.2 Sheet Pile

Item: Supply and drive greenheart timber Sheet pile
Unit: Foot-Board Measurement (Fbm)

The quantities of pile to be paid for will be the foot-board-measurement the piles installed in the ground in compliance with the material requirements of these specifications and drawings. The rate shall include for supplying, transporting, pitching, pointing, driving in place and cutting off to the desired elevations and logging blow count. Where instructed in the Drawings and Bills, piles shall be tarred.
17-13 RINFORCED CONCRETE PILEWORKS

17-13.1 General Scope

The scope covers the supply, construction, materials, Handling, transport, driving into place, and trimming of Reinforced Concrete Piles required in the Works. It also covers formwork and reinforcement for the concrete and other associated works are included.

17-13.2 Concrete and Concreting

The part describes the design of mixes, mixing, transport, placing, consolidation and curing of concrete required in the Works, and covers formwork and reinforcement for the concrete.

All concrete and concreting used in the construction of Piles, whether pre-cast or cast-in-place shall conform to Part 15 of these specifications unless otherwise specified below; as applicable to Reinforced Concrete Piles only.

17-13.3 Piling Equipment and Workmanship

Before any piling work is commenced the Contractor shall submit to the Engineer full details of the pile driving equipment and the method of carrying out the work he intends to use throughout the project. Such information shall include a full description of the piling frame, hammer, helmet and packing and a method of handling and pitching piles and supporting them during driving, and of the proposed driving procedure to give penetration to the required level, and of the proposed set for the working load on the pile and the method of calculating it. Any revisions to these proposals, which, in the light on ensuing experience appear desirable, shall also be submitted for the approval of the Engineer.

The piling frame shall be of sturdy construction supported on an adjustable base; securely guyed and with ample toggle connections to leaders so that the pile is firmly held at all times. No swinging type leads are allowed. The type and weight of hammer shall be to the approval of the Engineer. Steam, air or diesel hammers may also be used for driving piles and in the case of bearing piles such hammers shall develop a minimum energy of 1385 metre-Kg (10,000 foot – pounds) per blow.

In general, a heavy hammer with a short drop should be used in preference to a light hammer with a longer drop. All plant being used shall be maintained in a satisfactory condition and any items suffering wastage or damage shall be promptly replaced or repaired.

No piling work shall be carried out without the approval in writing of the Engineer of the equipment and method of working and any revisions to these as described above. The Contractor shall submit all his proposals at least six weeks before the date on which he intends to use the plant on Site.

The Contractor shall submit the proposed driving criteria for each of hammer-pile-cushion combination to the Engineer for review at least 2 weeks prior to the commencement of pile driving operations.

A Registered Professional Land Surveyor or Registered Civil Engineer shall establish lines and levels and stake pile locations. After all piles are driven, a field survey of completed
piling work shall be carried out. Drawings showing actual pile locations with respect to planned pile locations and indicating plumb-ness of piles shall be submitted.

Pile Markings: Prior to driving, mark or paint depth markings at 1.0m intervals throughout pile length and label distance of each mark from tip of pile. In addition, the uppermost 6m feet of each pile shall have secondary marks at 0.3m (one-foot) intervals.

A proper anvil and cushion to prevent pile butt damage shall be provided. Failure to provide adequate cushioning which results in the damage to the pile is sufficient grounds for rejection of the pile. Any driven pile that is rejected shall be removed and replaced with one that is acceptable in accordance with these specifications.

17-13.4 Manufacture of Piles

The Contractor shall indicate to the Engineer in advance whether the piles shall be manufactured, or procure through a third party. The Contractor shall inform the Engineer in writing of the following:
(i) the location of the casting operations
(ii) the Equipment used cast the piles
(iii) the materials and materials specifications used (in accordance with Part 15 above)
(iv) Mix design and test cubes

The Engineer shall inspect and approve of the above prior to commencement of the Works. If the Contractor imports the piles, the Engineer shall be so informed, and provide the Manufacturer’s Certification for each pile or batch of piles supplied to the site. Nonetheless, piles inspected shall be rejected if not in accordance with these specifications.

17-13.5 Handling and Inspection of Piles

The Contractor shall exercise the greatest care in the lifting and handling of piles, and no concrete pile shall be lifted otherwise than by slinging from the lifting points, the positions of which shall be as directed or approved by the Engineer.

Piles supplied to the site shall be inspected and approved by the Engineer for use in the Works. Any pile that was rejected shall be immediately removed from the site and replaced with one that is in conformity with the specifications. Piles shall be rejected under the following criteria:
(i) If cracks or defects are evident in the pile that, in the opinion of the Engineer are deemed to compromise the structural integrity of the pile.
(ii) The pile does not conform to the shape and size as specified in the Drawings and Bills.
17-13.6 Pitching and Driving

1) The Engineer shall be notified 24 hours before the commencement of pitching and pile driving.

2) Piles shall be pitched accurately in the positions and driven to the lines shown on the Drawings. Piles shall be driven with a direction, which does not vary more than 6mm in 300mm or 20mm in a metre (1/4 inch per foot or 2%) of pile length from the vertical or from the batter line indicated, and with a total deviation of the head of the pile from the position shown in the plans, of not more than 75mm (3 inches).

3) Piles deflected from the proper lines shall, where ordered by the Engineer, be withdrawn and re-pitched until the proper line is obtained. No forcible method of correction of the position or line of any pile will be permitted. Any holes from which piles are withdrawn shall be packed with approved non-plastic Material before re-driving. Open voids left by the removal of a pile shall be filled to the previous ground level with non-plastic materials and all costs shall be borne by the Contractor.

4) The tolerance in Cut-off elevation of top of pile shall be 25mm (1 inch).

5) Where piles have to be driven below the level of the bottom of the leaders, extension leaders shall be fitted. The use of a follower or other device will not be permitted except with the written approval of the Engineer.

6) The use of water jetting may be proposed by the Contractor but will not necessarily be approved. If jetting is allowed or ordered by the Engineer it shall be carried out in all respects with rigorous control and not to the detriment of the surrounding ground or any part of the Works and to the entire satisfaction of the Engineer.

7) During driving the heads of piles shall be held securely and protected by a helmet and cushioning of an approved type and thickness. All piles cracked or otherwise damaged during handling or driving shall be repaired or replaced, as directed by the Engineer and without additional charge. The Engineer shall be the sole judge of the acceptability of a damaged pile.

8) Concrete piles shall be protected from impact and tension loads with appropriate cushion material placed on top of the pile head.

9) Individual piles in a pile cluster shall be driven in such a way as to minimize the generation of increased driving resistance by compaction and displacement of soil.
10) All piles shall be driven to levels determined by the engineer as driving of the group of piles proceeds and, in addition, all bearing piles shall have achieved sets which indicate that they are capable of carrying with a suitable factor of safety at least the working load indicated on the Drawings, in the Specifications, or Bill of Quantities.

11) Should the approved set be achieved before the approved penetration and vice versa driving shall be continued until both requirements are met. The Contractor's rates shall be deemed to include for complying in all respects with the requirements specified herein. Piles, which have risen as a result of the driving of adjacent piles, shall be re-driven to the original depth or set, unless otherwise directed by the Engineer.

12) A detailed record of driving of all piles shall be furnished by the Contractor and given to the Engineer daily and he shall give every assistance to the Engineer to enable him to check measurements during the progress of the work.

17-13.7 Pilot Piles

1) If required by the Engineer, the Contractor shall construct pilot piles to the lengths indicated on the Drawings, in the Bill of Quantities, or directed by the Engineer, and these pilot piles shall be driven in the position selected by the Engineer who shall be notified in advance of the Contractor's intention of driving such piles.

2) The Contractor shall furnish the Engineer daily with a detailed record of the driving of pilot piles throughout the full depth of driving and after attaining the approved set driving shall be continued until the Engineer directs that it shall cease. Driving beyond the point at which the approved set is obtained will be called for to demonstrate that driving resistance continues to increase.

3) The results of the driving of such pilot piles will be used by the Engineer to determine the lengths of the remaining piles at the location or in the area.

17-13.8 Testing of Piles

1) Where the Engineer directs that test loads shall be applied to certain selected piles, the Contractor shall make all the necessary arrangements for carrying out the tests and clearing away on completion.

2) Unless otherwise directed by the Engineer, the following loading and unloading increments shall be carried out:
I. Load to one-quarter part of working load at intervals of time until the settlement rate is less than 0.01 inch per hour or 2 hours maximum or as approved by the Engineer.

II. Increase the load to 1.25 times the working load, repeat time interval as above.

III. Increase the load to 1.50 times the working load, repeat time interval as above.

IV. Increase the load to 1.75 times the working load, repeat time interval as above.

V. Increase the load to twice the working load as above, if the butt settlement over a one-hour period is not greater than 0.01 inch, the test load can be removed. Otherwise, allow the total load to remain on the pile for 24 hours or as directed by the Engineer.

VI. Unload in four equal decrements and hold for 1 hour for each increment.

3) The loads shall be applied and removed gradually and without shock. Piling and all other work that might cause vibration or any other disturbances to the ground conditions at the test site or affect the plant or apparatus being used in the test shall be suspended during the period of the test.

4) For each increment, settlement and load readings shall be taken, where appropriate, at the following times; 1, 5, 10, 15, 20, 30, 45, 60, 75, 90, 105 and 120 minutes.

5) For each decrement, settlement and load readings shall be taken at the following times: 1, 5, 10, 15, 20, 30, 45 and 60 minutes.

6) Settlement shall be measured by the use of four dial gauges mounted on reference beams with supports located at least 8 feet from the test pile or reaction piles or cribbing. The gauges shall have a travel of three inches and accuracy to one-hundredth of an inch.

7) Test load shall be measured by the use of pressure gauge calibrated no more than one month prior to the testing. Calibration shall be carried out with the gauge-pump-jack units connected similar to the set up for the load test.

8) Failure of the nominated piles to pass the loading test may result, at the discretion of the Engineer, and at the contractor's expense, in the testing of additional piles.
driven to that date; in the rejection of the piles, which have failed the Load Test; and/or in the installation of additional piles.

9) In addition to Load Tests or as an alternative to the Load Tests, dynamic pile testing using the Pile Driving Analyzer may be performed at the sites. Dynamic testing will require the attachment of two strain transducers and two accelerometers by the testing engineer at a minimum distance from the pile head of 2 times the pile head diameter. After the gauges are attached and ready for testing, the driving shall then be commenced and/or continued until the termination of driving. Interruption of driving may be required during the testing as directed by the testing Engineer. The testing will be performed during the driving and/or re-striking of the piles. The number of tests shall be directed by the Engineer. When carrying out dynamic testing, the Contractor shall co-operate and assist the testing Engineer as required. Elevated devise, which will allow the full mobility of a personnel to the pile top for the attachment of the gauges, shall be supplied by the Contractor to the testing engineer with no additional cost.

10) The Contractor shall submit for the Engineer's approval a full description of the method he proposes to use for carrying out the tests.

17-13.9 Setting Out

The main setting out for piles is to be completed and approved prior to commencement of pitching and driving. Secondary or individual pile setting out is to be completed and agreed not less than 8 hours prior to commencing work on the piles concerned. All main setting out points, lines, stations, and the like are to be maintained safe and undisturbed.

17-13.10 Acceptance of Piles

If a pile appears to be unsatisfactory the Engineer will agree that driving may cease. Further driving may however be ordered in the light of information obtained from driving of subsequent piles and in these circumstances shall be paid for at the rates entered against items for re-driving provided in the Bill of Quantities. Piles will be accepted by the Engineer only when each group is completed. No payment will be made for rejected piles, including piles driven out of place, imperfect piles, or piles damaged in driving or handling.

17-13.11 Inspection and Testing

An independent inspection and testing company shall be retained by the Engineer to monitor the pile driving operation and to record relevant information about the driving for each pile. This, in no way, shall relieve the piling contractor's responsibility to provide piles acceptable to the Engineer.
17-13.12 Pile Driving Log and Record

A pile driving log for each pile and a pile driving record shall be kept during pile driving and submitted to the Project Engineer upon completion of pile driving. The record shall indicate, for each pile driven, the following information: (i) layout drawings showing the proposed sequence of driving the piles (on the sequential layout, show each pile identification as indicated on the Contract Drawings), its driving sequence number, type, size, load bearing capacity and pile tip elevation planned; and the type and rating of driving equipment, overall blow count per foot, number of blows per inch penetration for the last 0.3m (12 inches), and any unusual conditions encountered during driving.

17-13.13 Test Piles

Test piles shall be driven as requested by the Project Engineer. From the test pile data and behaviour and the subsurface exploration data, the Design Engineer will determine the lengths and penetration required. The Design Engineer may also determine the required penetration based upon settlement criteria or any other factors which in the opinion of the Design Engineer are applicable to the work. The Contractor shall assume all responsibility for buying more or longer piles than those shown on the list provided by the Engineer. All piles purchased on the basis of the Engineer’s list but not used in the finished Structure shall become the property of the Contracting Agency. The Contractor shall deliver these as the Engineer directs.

17-14 PRECAST REINFORCED CONCRETE PILE CONSTRUCTION

17-14.1 Concrete

Concrete shall have a minimum 28-day cube strength of 45 Mpa (6500 psi), but shall be constructed as otherwise indicated in the Drawings or Bills. Cement used shall be in accordance with Part 15.

17-14.2 Reinforcement

Reinforcement shall consist of high tensile steel (460N/mm²) and mild steel bars and binding links bent and fixed as shown on the Drawings. Main reinforcing bars shall be supplied in one complete length; should this prove impractical, separate lengths shall be effectively spliced by a method approved by the Engineer. Pre-stressing strands shall be high tensile steel.

17-14.3 Manufacture of Pre-cast RC Piles

Piles should be cast in a central casting yard to the specified lengths and then transported to the worksite. The manufacture, handling and delivery of pre-cast concrete piles shall be in accordance with Specifications and as shown on the Plans and/or approved Shop
Drawings. All piles should be able to resist the bending moments and forces associated transport, driving and design lateral and vertical loadings under working conditions.

17-14.4 Ready-Made Piles

Subject to obtaining the approval of the Engineer in writing, the Contractor may use ready-made piles. In such cases he shall supply the Engineer with the names of the makers together with full details of the piles, which he proposes to use and which shall be manufactured in accordance with these Specifications. It will be necessary for the Contractor to satisfy the Engineer that the ready-made piles comply with the Specification and he shall be deemed to have allowed in his rates for all costs for doing so.

17-14.5 Delivery, Handling, Storage And Pitching Of Pre-cast RC Piles

Care shall be exercised in the delivery, handling and pitching so as not to damage the piles. Piles should not be moved for storage until a minimum period of two (2) weeks after casting, and not be driven until the full design strength has been attained. All methods shall be subject to the approval of the Engineer.

17-14.6 Lengthening of Piles

Where it becomes necessary to lengthen a pile the reinforcement at the head of the pile shall be stripped of all surrounding concrete and additional reinforcement shall be spliced or butt-welded in position as directed by the Engineer. The length stripped shall be, for a spliced joint, at least 40 times the diameter of the longitudinal reinforcement and for a butt-welded joint at least 0.3m (12 inches). New Binders of the same size and at the same spacings as the original pile shall be fixed in the extension and the pile extended by concreting in properly formed and supported molds to the length required.

Care shall be taken to form the joint between the old and new concrete in accordance with the requirements of Specifications. Jointing and lengthening shall be properly aligned and to ensure integrity of the extended pile across the joint. After piles have been lengthened driving shall not resume until the approval of the Engineer has been given.

As an alternative, mechanical splices, which are capable of transferring the ultimate compression and tension loads, may be used subject to the approval of the Engineer.

17-14.7 Stripping of Pile Heads

After piles have been driven to the required penetration and set to the satisfaction of the Engineer, the pile cut distance of 0.6m (2ft) above the desired finish elevation of the pile head. Within this 0.6m section from the head, the concrete shall be cut and stripped away, exposing the main reinforcing bars, which shall turned over for incorporation in the footing of the supported structure as shown on the Drawings or directed by the Engineer. All surplus concrete and reinforcement shall be disposed of to the satisfaction of the Engineer.
17-15  MEASUREMENT AND PAYMENT

17-15.1 Supply and Installation of Reinforced Concrete Piles

Unit: Linear metre (Lin.m or m)

The quantities of pile to be paid for will be the total length of the piles supplied and driven or as indicated in the Drawings, or as instructed in writing by the Engineer, supplied in compliance with the material requirements of these specifications. When extensions of piles are necessary, the extension length ordered in writing by the Engineer will be included in the linear measurement of piling supplied.

The rate shall include for the all costs involved in the mobilization of the necessary equipment and associated materials, supply and delivery of piles to site and compliance with the requirements of this Specification, and the cutting off and demolition of the pile head.

Pre-boring, jetting, and other methods used for facilitating pile-driving procedures when either required or permitted will not be measured, and payment will be considered included in the unit price paid for the Piles driven.

17-15.2 Test Piles and Testing of PPC Piles (Pile Driving Analyzer) - Provisional

In-place test piles will be measured and paid for by the linear foot at the same unit price as Supply of pre-cast, pre-stressed concrete piles, Driving of pre-cast, pre-stressed concrete piles, Splicing of Piles, Reinforced Concrete Pile Build-Up (Provisional)

Payment for testing includes the cost of supplying, installing, and performing test monitoring of piles as designated or as otherwise approved by the Engineer as piles to be tested. This shall include all necessary skilled and unskilled labour, plant and equipment, instrumentation, logs, reports and records in accordance with the Plans and Specifications. Unit: Lump Sum (Provisional)
PART 18 - STRUCTURAL STEELWORK

18-1 GENERAL

1. Inspection
   All steelwork shall be inspected by the Contractor immediately after it is received and any steelwork with surface defects shall be remedied or rejected. Final approval of all materials shall be given by the Engineer.

2. Site Connections
   Site connections shall be generally made with Grade 8.8 High Strength bolts, with a minimum of two bolts to each connection.

3. Holes
   No holes shall be formed by burning. All holes shall be left free from burrs and sharp edges.

4. Erection Bracing
   The Contractor shall be responsible for the safety of the structural steelwork during the erection and shall supply and erect at his own expense and temporary ties, scaffolding, shoring or bracing that may be necessary to ensure such safety.

5. Materials
   1. Structural Steel shall comply with B.S. 1210(Grade 43) AASHTO M 270, in equivalent Grade Strength, or BS 5400.
   2. Bolts shall comply with B.S. 449 or AASHTO M 164.
   3. Anchor bolts shall meet the requirements of ASTM F 1554 and, unless otherwise specified, shall be Grade 105 and shall conform to Supplemental Requirements S2, S3, and S4.
   4. Metal Bridge Railing shall conform to the type and material Specifications set forth in the Plans and Special Provisions. Steel used for metal railings, when galvanized after fabrication in accordance with AASHTO M ill, shall have a controlled silicon content of either 0.00 to 0.04 percent or 0.15 to 0.25 percent. Mill test certificates verifying the silicon content of the steel shall be submitted to both the galvanizer and the Engineer prior to beginning galvanizing operations.
   5. All components shall be stacked under cover and clear off the ground surface. Galvanized components shall not be stacked on rough surfaces.

6. Welds
   All welds and electrodes shall comply with BS5950 or BS 5400. No weld shall be less than 6mm, unless otherwise stated. Surfaces to be welded shall be free of rust, dirt, grease
and oil. All joints shall be painted with the specified anti-corrosive treatment. Joints must be free of flux and impurities before painting.

18-2 PAINTING

18-2.1 General

(1) No painting shall be done until the surfaces to be protected have been made absolutely clean and free from all dust, rust, grease, mill-scale or other injurious materials. The work of cleaning steel is to be carried out with great thoroughness. No paint shall be applied to metal surfaces which are to be embedded in concrete, except where otherwise specified. All galvanised surfaces required to be painted are to be cleaned of oil, grease, and dirty by means of a degreasing fluid before being primed and painted as specified.

(2) All cleaning and painting shall be done by skilled operatives. Paint shall be applied by brushing or spraying in accordance with the manufacturer's instructions and except where otherwise specified in accordance with C.P. 231, "Painting of Buildings". Except as herein specified no paint shall be applied to any surface when it is in the slightest degree damp and any paint applied to such damp surfaces shall be removed and the surface repainted at the Contractor's expense. The Contractor shall take any precautions necessary to prevent dust and dirt coming into contact with freshly painted surfaces or with surfaces being coated. Particular care shall be taken to maintain a strong paint film on all arises, bolt-heads, etc. Second and subsequent coats of paint shall only be applied when the previous coats have dried and hardened.

(3) All paints are to be from an approved manufacturer and are to be supplied ready-mixed and delivered to site in the maker's sealed containers; no thinners shall be added except with the prior approval of the Engineer. All tints and colours shall be to the approval of the Engineer.

(4) The Contractor may propose alternative painting systems for the Engineer's approval.

(5) Painting New Steel Structures
All material classified as structural steel shall be painted with a shop applied, inorganic zinc silicate primer, followed by a field applied 2 coat paint system after field erection, cleaning, and spot priming have been completed. Except as otherwise specified, all steel surfaces shall be painted with 3 coats of paint. Steel surfaces embedded in concrete and faying (contact) surfaces of bolted connections (including all surfaces internal to the connection and all filler plates) shall receive the prime coat only. Stainless steel surfaces shall not be painted. Galvanized surfaces shall not be painted unless specified in the Plans or Special Provisions.
The painting system shall consist of 3 coats as follows:

<table>
<thead>
<tr>
<th></th>
<th>Method A</th>
<th>Method B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer Coat</td>
<td>Inorganic zinc</td>
<td>Inorganic zinc</td>
</tr>
<tr>
<td>2nd Coat</td>
<td>Epoxy</td>
<td>B-11-99 Field applied</td>
</tr>
<tr>
<td>3rd Coat</td>
<td>Aliphatic Urethane</td>
<td>C-11-99 Field applied</td>
</tr>
</tbody>
</table>

Once a paint system has been selected, that system shall be used throughout the Structure.

(6) Applying the Shop Coating
After the surface to be coated has been cleaned, and has received the Engineer’s approval, the primer coat shall be applied so as to produce a uniform, even coating that has fully bonded with the metal. The coatings shall be applied with the spray nozzles and pressures recommended by the manufacturer of the paint system, so as to attain the film thicknesses specified.

The top surfaces of the top flanges of the steel girders shall not be primed until the welded shear connectors are placed, unless the welded shear connectors are to be placed in the field. Welded shear connectors are not required to be painted except for the weld area.

If the welded shear connectors are to be placed in the field, the area to be welded shall be cleaned of primer by abrasive grinding just prior to welding. After welding, the ground area and the weld shall be cleaned and primed. Surfaces which are inaccessible for painting after erection shall be painted with the 2 field coats of paint before erection.

(7) Field Coating after Erection

When the erection Work has been completed, including all connections and the straightening of any bent metal, all steel surfaces and bolts shall be prepared for painting. All adhering scale, dirt, grease, form oil, or other foreign matter shall be removed by appropriate means and all rusted or uncoated areas including the bolts, nuts, washers and splice plates shall be abrasive blasted to a near-white (SSPC-SP10) condition. All uncoated areas shall be field primed with an organic zinc paint coating selected from the same approved coating system and paint manufacturer as the other coatings for the Structure.

After all field priming has been completed the surfaces shall be prepared to receive the final 2 field coats. The intermediate coat shall be mixed and applied per the manufacturer’s written recommendations. The top coat shall also be mixed and applied per the
manufacturer’s written recommendations. The minimum drying time between coats shall be as shown in the approved product data sheets, but not less than 12-hours. Depending on site conditions, additional time may be required for proper curing before applying succeeding coats. The Contractor shall determine if the coating has cured sufficiently for proper application of succeeding coats. The maximum time between coats shall be in accordance with the manufacturer’s written recommendations. If the maximum time between coats is exceeded, all newly coated surfaces shall be completely blast-cleaned again to a near white finish (SSPC-SP10) and re-coated at no additional cost to the Contracting Agency.

Note: Temporary attachments or supports for scaffolding or forms shall not damage the coating system. All paint damage that occurs shall be repaired in accordance with the manufacturer’s written recommendations and as follows. On bare areas or areas of insufficient primer thickness, the repair shall include the application of the field applied organic zinc primer system, and the final 2 coats of the Method A or Method B paint system. On areas where the primer is at least equal to the minimum required dry film thickness, the repair shall include the application of the final 2 coats of the Method A or Method B paint system.
PART 19 - SETTING OUT AND TOLERANCES

19-1  SETTING OUT

(a)  General- Surveying

Prior to commencing construction, the Contractor shall establish the road reserve boundary posts or, if no boundary posts are instructed, then the Contractor shall establish reference points to define the road reserve at least 30 Metre intervals on both sides of the carriageway, indicating the required finished level to be achieved on each. Where curves are to be laid out, the interval shall be reduced to capture the changes in elevations within the interval of 0.05m.

The Contractor shall establish temporary benchmarks along the road at intervals not exceeding 500 metres and shall provide the Engineer with a schedule of their levels and locations.

The Contractor shall be responsible for setting out all necessary reference points and for the maintenance thereof. In addition, the Engineer at any time can make request to the contractor to provide elevations of any layers.

The contractor will provide sufficient basic survey in the form of longitudinal profiles, plans at 30m intervals, and cross section at 100 metre intervals. Plans and cross section shall be submitted by the contractor to the Engineer for verification prior to commencement of construction.

The Engineer shall satisfy himself as to the accuracy in line, level and dimension of the basic survey and setting out details provided and should the Engineer discover any error in the information provided by the contractor, he shall at once notify the contractor. If the information is confirmed to be in error, the contractor will issue amended drawings or instructions regarding the correction of the error.

The Contractor shall not remove, damage, alter or destroy in any way, existing plot beacons or survey beacons. Should the Contractor consider that any beacon will be interfered with by the Works he shall notify the Engineer who, if he considers necessary, will make arrangements for the removal and replacement of the beacon.

If the Contractor removes or disturbs a beacon without permission of the Engineer, he shall be liable for the full cost of its replacement.

(b)  Detailed Setting Out

In addition to the requirements of the Contractor shall set out the line and level of the Works at intervals of not more than 30m or such lesser intervals as are required to construct the Works to the tolerances. Reference pegs and batter rails clearly and indelibly marked with all the relevant information shall be provided clear of the road and at right angles to it from which the centreline, level and batter slope can be directly established at any time. These shall be maintained by the
Contractor for as long as they are needed to check the work. After completion of the setting out and site clearance the Contractor shall take ground cross sections at intervals of 30m along the road centreline and along the centreline of all culverts and structures. These shall be plotted to a natural scale of 1:100 on a stable transparent material and a copy of the plot submitted to the Engineer by other alternative methods provided that procedures proposed are approved by the Engineer prior to their use.

The Contractor shall program for a period of 30 days between submitting the ground cross-sections and being issued with final road, culvert and structure levels. A minimum 5-km section of road shall be submitted, but where the Contractor submits cross-sections for more than 10km of road within the same 30 day period, the initial 30 day period shall be extended by 30 days for each additional 10km or part thereof. Final road, culvert or structure levels will be determined by the Engineer and may be different from the levels shown on the Drawings.

On receipt of the final road levels, the Contractor shall mark up the details on the transparencies and the original and one print of the cross-sections shall be provided free of charge by the Contractor for the Engineer.

On completion of the earthworks, but before starting formation or pavement layers, the Contractor shall establish steel pins at a constant offset to the edges of the carriageway shoulders. The offset may, however, vary between sections in cut and those in fill. The steel pins will be clearly and indelibly marked with all the relevant information necessary to directly establish the centreline and level at any point across the roadway by using either boning rods or a string line.

The interval between pins shall not be more than 15m and the pins shall be maintained by the Contractor for as long as they are needed by the Engineer to check the work.

The Contractor/Surveyor shall replace pins that have removed or displaced immediately. Failure to replace pins in a timely manner hinders monitoring and control of the work, and the Engineer shall order the Contractor to cease works within the affected section until the control marks are replaced to the satisfaction of the Engineer with no extension/additional time thus granted to the Contractor.

19-2 TOLERANCES

(a) Horizontal Alignments

Horizontal alignments shall be determined from the centreline of the pavement surface as shown on or calculated from the Drawings. The centreline of the pavement surface as constructed, and all other parallel alignments, shall be correct within a tolerance of ± 10mm there from.

(b) Thickness of Pavement Layers
The average thickness of any pavement layer measured at five points in any length of 100m shall not be less than 100% nor more than 120% of the thickness specified or ordered by the Engineer. In addition, the thickness of any pavement layer measured at any point shall not be less than 90% nor more than 125% of the thickness specified or ordered by the Engineer.

(c) Surface Levels of Pavement Layers and Formation

The level measured at any point on the surface of a pavement layer or the formation level shall not deviate from the corresponding level calculated from the Drawings by more than the tolerances shown in Table 19-1.

For checking compliance with Table 19-1, measurements of surface levels will be taken at points to be selected by the Engineer at 15m centres longitudinally and at 1.5m centres transversely. At junctions and curves, the grid point spacing shall be determined by the Engineer.

(d) Surface Regularity

The surface regularity of pavement layers and the formation shall be tested at points decided by the Engineer with a rigid, steel straight edge 4m long placed parallel to or at right angles to the centreline of the road. The maximum allowable deviation of the surface below the straight edge shall be as given in Table 19-1.

In addition, the longitudinal slope or transverse cross fall shall not deviate from that shown on the Drawings by more than the tolerances shown in Table 19-1.

(e) Shoulders

Shoulders shall be constructed to the same thickness, level and surface regularity requirements as for the adjacent pavement layers.

(f) Cutting and Embankment Slopes

In the final trimmed slope of cuttings a tolerance of +0.25 will be permitted, i.e., if a slope of 1 in 2 is specified, the acceptable slope shall be not steeper than 1 in 2 or slacker than 2 in 2.25.

In the final trimmed slopes of embankments, a tolerance of +0.25 will be permitted, i.e., if the specified slope is 1 in 2, the acceptance slope shall be not steeper than 1 in 2 or slacker than 1 in 2.25.

(g) Width of Cuttings and Embankments

The tolerance permitted in the width of the bottom of cuttings shall be 150mm between the centreline of the road and the toe of the cutting slope.
The width of embankments measured as the horizontal distance from the centreline of the road to the top of the embankment shall not be less than that shown on the Drawings or more than that shown on the Drawings plus 250mm.

(h) Depth of Side Drains

The depth of side drains measured, as the vertical height difference from the centreline of the finished pavement and the invert of the side drain shall not be less than that shown on the Drawings nor more than that shown on the Drawings plus 150mm.

(i) Construction Control Testing

Unless otherwise directed, values given in this Specification are minimum values and the workmanship will only be considered as satisfactory if all tests, taken at the frequency specified in Part 19 of this Specification are at least equal to that specified in the relevant section.

<table>
<thead>
<tr>
<th>LAYER</th>
<th>LEVEL MILLIMETRES</th>
<th>STRAIGHT EDGE MILLIMETERS</th>
<th>SLOPE OR CROSSFALL %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltic Concrete Wearing Course</td>
<td>+/-</td>
<td>6</td>
<td>±0.25</td>
</tr>
<tr>
<td>Bituminous Binder Course (DBST, etc)</td>
<td>+/-</td>
<td>6</td>
<td>±0.25</td>
</tr>
<tr>
<td>Base</td>
<td>+/-</td>
<td>6</td>
<td>±0.25</td>
</tr>
<tr>
<td>Sub-base</td>
<td>+/-</td>
<td>6</td>
<td>±0.50</td>
</tr>
<tr>
<td>Gravel Wearing Course</td>
<td>+/-</td>
<td>6</td>
<td>±0.25</td>
</tr>
<tr>
<td>Formation/Sub-grade</td>
<td>+/-</td>
<td>15</td>
<td>±0.50</td>
</tr>
</tbody>
</table>

19-3 RECTIFICATION OF EARTHWORKS AND PAVEMENT LAYERS OUTSIDE PERMITTED TOLERANCE

Where any tolerances in Clause 19-2 are exceeded, the Contractor shall determine the full extent of the areas which is out of tolerance and shall make good the surface of the pavement course, earthworks or formation in the manner described below.

(a) Earthworks
Where a cutting slope is steeper, and an embankment slope is slacker than the specified slope, then the slope shall be trimmed to the specified slope. Where a cutting slope is slacker, and an embankment slope is steeper than the specified slope, then the slope shall be benched and fill material placed and compacted and the slope shall be trimmed all in accordance with the requirements of this Specification.

Where the width of a cutting is less than -and the width of an embankment more than- the specified width, then the cutting or embankment shall be trimmed to the specified width. Where the width of a cutting is more than, and the width of an embankment is less than the specified width, then the embankment or cutting shall be benched and fill material placed and compacted and the slopes shall be trimmed all in accordance with the requirements of this Specification.

Where the depth of a side drain is less than that specified, the side drain shall be trimmed to the specified depth. Where the depth of side drain is more than specified the side drain shall be backfilled with fill material compacted to a dry density of at least 95% MDD (AASHTO T99) up to the specified depth.

Where the results of the construction control tests are less than that specified the full depth of the layer shall be reworked to specification. The area tested shall be the whole section submitted for approval or, following a re-test, a length of at least 50m both sides of each test and re-test failure or such area to be determined by the Engineer as necessary to obtain compliance with this Specification.

(b) The 300mm Layer Below Formation Level

Where the levels or widths are out of tolerance then the full depth of the layer shall be reworked to specification. The area treated shall be at least 15m long and 4.0m wide or such area to be determined by the Engineer as necessary to obtain compliance with this Specification.

Where the results of the construction control tests are less than that specified, the full depth of the layer shall be reworked to specification. The area treated shall be the whole section submitted for approval or following a re-test, a length of at least 50m both sides of each test and re-test failure.

(c) Base and Sub base

Where these consist of unbound (i.e. natural or graded stone) material the full depth of the material shall be removed from the pavement and replaced to specification. The area treated shall be at least 30m long and 6m wide or such area to be determined by the Engineer as necessary to obtain compliance with the Specification.

Where the courses consist of cement, lime treated material, or lean concrete, the full depth of the layer shall be removed from the pavement and replaced to specification. The area treated shall be at least 5m long and the full width of the
paving laid in one operation. If areas are corrected within 7 days of laying, no construction traffic or compaction plant shall use the surrounding satisfactory areas.

For bituminous bases, the full depth of layer shall be removed and replaced with fresh material laid and compacted to specification. Any area so treated shall be at least 5m long and the full width of the paving laid on one operation.

Where the results of the construction control tests for any of the base or sub base materials are less than that specified, the full depth of the layer shall be removed and replaced to specification. The area treated shall be the whole section submitted for approval or, following a re-test, a length of at least 50m both sides of each test and re-test failure, or such area to be determined by the Engineer as necessary to obtain compliance with the Specification.

(d) Wearing Course

These shall have the full depth of the layer removed and replaced with fresh material laid and compacted to specification. The area rectified shall be the full width of the paving laid in one operation and at least 15m long.

Where the results of the construction control test for the wearing course are less than that specified, the full depth of the layer shall be removed and replaced to specification. The area treated shall be the whole section submitted for approval or, following a re-test, a length of at least 50m both sides of each test and re-test failure, or such area to be determined by the Engineer as necessary to obtain compliance with this Specification.

19-4 MEASUREMENT AND PAYMENT

Payment shall be made under Surveying and setting out of works – Sum.
PART 20 - SCHEDULE OF DAYWORKS RATES

20-1 LABOUR

<table>
<thead>
<tr>
<th>GRADE</th>
<th>DAYWORK RATE G$ PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Engineer</td>
<td></td>
</tr>
<tr>
<td>Surveyor</td>
<td></td>
</tr>
<tr>
<td>Supervisor/Foreman</td>
<td></td>
</tr>
<tr>
<td>Checker</td>
<td></td>
</tr>
<tr>
<td>Operator</td>
<td></td>
</tr>
<tr>
<td>Driver</td>
<td></td>
</tr>
<tr>
<td>Skilled Labourer</td>
<td></td>
</tr>
<tr>
<td>Labourer</td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td></td>
</tr>
</tbody>
</table>

20-2 MATERIALS (Delivered to site)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>UNIT</th>
<th>RATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Sand</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>Reef Sand</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>Sand Clay</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>Laterite</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>1st grade Crusher run</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>Second Grade Crusher run</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>3/4” nominal size chippings 20(mm)</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>1/2” nominal size chippings (13mm)</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>3/8” nominal size chippings (8mm)</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>1/4” minus sifting (&lt;5mm)</td>
<td>cu. m</td>
<td></td>
</tr>
<tr>
<td>RC 250 / AC 20 / 60/70 Bitumen</td>
<td>Drum (50-Gal)</td>
<td></td>
</tr>
<tr>
<td>CRS 2</td>
<td>Drum (50-Gal)</td>
<td></td>
</tr>
<tr>
<td>Material</td>
<td>Unit</td>
<td></td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>Asphaltic Concrete</td>
<td>Ton</td>
<td></td>
</tr>
<tr>
<td>Portland/ Pozzolan Cement</td>
<td>Sacks</td>
<td></td>
</tr>
<tr>
<td>Green heart Structural timber</td>
<td>Fbm</td>
<td></td>
</tr>
<tr>
<td>Green hear timber piles</td>
<td>lin.ft</td>
<td></td>
</tr>
<tr>
<td>Formboard</td>
<td>Fbm</td>
<td></td>
</tr>
<tr>
<td>¼” MS Reinforcement</td>
<td>Length</td>
<td></td>
</tr>
<tr>
<td>3/8 ” MS Reinforcement</td>
<td>Length</td>
<td></td>
</tr>
<tr>
<td>½ ” MS Reinforcement</td>
<td>Length</td>
<td></td>
</tr>
<tr>
<td>5/8” MS Reinforcement</td>
<td>Length</td>
<td></td>
</tr>
</tbody>
</table>

### 20-3 EQUIPMENT

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>DAYWORK RATE G$ PER HOUR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td></td>
</tr>
<tr>
<td>Pneumatic Roller</td>
<td></td>
</tr>
<tr>
<td>Steel Roller</td>
<td></td>
</tr>
<tr>
<td>Excavator</td>
<td></td>
</tr>
<tr>
<td>Grader</td>
<td></td>
</tr>
<tr>
<td>Bitumen Distributor</td>
<td></td>
</tr>
<tr>
<td>Water Tender</td>
<td></td>
</tr>
<tr>
<td>Asphalt Paver</td>
<td></td>
</tr>
<tr>
<td>Front end loader</td>
<td></td>
</tr>
<tr>
<td>Bobcat</td>
<td></td>
</tr>
<tr>
<td>Pressure Pump</td>
<td></td>
</tr>
</tbody>
</table>
PART 21 – SITE FACILITIES AND AMENITIES

21-1  GENERAL

(a) Site Office as Shown in the Following Drawing. Rate to cater for removal after the project has been completed. NOTE: the Site Office shall be provided with a lock with the Engineer and Representatives having the only copies of the keys.

(b) Water closet with complete plumbing and Water Supply, and purified drinking throughout the duration of the project.

(c) 1 #. Hard Cover Log Book

21-2  SUPERVISORY STAFF

(a) 1# High Visibility Safety Vest
(b) 1# 30m Measuring Tape
(c) 1 Pair Long Boots
(d) 1 # Rain Coat and Umbrella
(e) 1# Digital Camera: Minimum 10.1 megapixels and 5X optical zoom, complete with 4GB Memory card and Weather-proof carrying case

All items listed must be submitted on/before the official commencement date of the Project.
26 Gauge corr. sheets on 2" x 4" rafters @ 2'-6" crs.

2"x4" wall plate

1'x3" facing around window 1" thk. lap edge boarding on 2"x3" studs.

2"x6" ridge

Ridge flashing

2"x3" window head

2"x 8" window cill

1"x 8" fascia board

2'x4" joists on 4'x4" beam.

Pillar block columns.

1" thk. g&t boarding on 2"x4" boarding.

High level louvres.
CHAPTER 2 – PIPE INFRASTRUCTURE WORKS
## TABLE OF CONTENTS

**PREAMBLES TO ALL WORK SECTIONS** .......................................................... 141
  - DESCRIPTION TO APPLY ................................................................. 141
  - RATES .................................................................................................. 141
  - DEFINITIONS ......................................................................................... 141
  - DEFECTIVE WORK ............................................................................... 141
  - MATERIALS AND WORKMANSHIP .................................................... 141
  - CALCULATION OF QUANTITIES ......................................................... 141
  - PROPRIETARY PRODUCTS .................................................................. 142

**PROVISIONAL AND PRIME COST SUMS** .................................................. 142
  - GENERAL ATTENDANCE ...................................................................... 142
  - PRIME COST SUMS .............................................................................. 142
  - PROVISIONAL NET SUMS ................................................................. 143

**DEMOLITIONS AND ALTERATIONS** ......................................................... 143
  - GENERAL .............................................................................................. 143
  - DEFINITIONS ........................................................................................ 143
  - SHORING AND SCAFFOLDING ............................................................ 143

**MATERIALS AND WORKMANSHIP** ....................................................... 144
  - GENERAL .............................................................................................. 144

**SECTION 100 - GENERAL** ...................................................................... 146
  - 101 REQUIREMENTS OF SPECIFICATION, STANDARDS ..................... 146
  - 102 MOBILIZATION AND DEMOBILIZATION ........................................ 146
  - 103 SURVEY AND SETTING OUT ......................................................... 147
  - 104 PROJECT SCHEDULE .................................................................... 147
  - 105 SUBMITTALS ................................................................................... 149
    - GENERAL .............................................................................................. 149
    - CONTRACTOR'S DRAWINGS .............................................................. 149
    - RECORDS ............................................................................................ 150
    - OPERATION AND MAINTENANCE MANUALS ...................................... 151
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>106</td>
<td><strong>TRAFFIC SAFETY AND CONTROL</strong></td>
</tr>
<tr>
<td>107</td>
<td><strong>TEMPORARY DIVERSION OF TRAFFIC</strong></td>
</tr>
<tr>
<td>108</td>
<td><strong>PROGRESS PHOTOGRAPHS</strong></td>
</tr>
<tr>
<td>109</td>
<td><strong>SCHEME SIGNBOARDS</strong></td>
</tr>
<tr>
<td>110</td>
<td><strong>TESTING LABORATORY SERVICES</strong></td>
</tr>
<tr>
<td>111</td>
<td><strong>ENVIRONMENTAL CONTROL</strong></td>
</tr>
<tr>
<td></td>
<td><strong>GENERAL</strong></td>
</tr>
<tr>
<td></td>
<td><strong>OCCUPATIONAL SAFETY APPLICABLE FOR CONSTRUCTION ACTIVITIES</strong></td>
</tr>
<tr>
<td></td>
<td><strong>DEMARCATION AND SIGNING OF CONSTRUCTION SITES AND HAZARDS</strong></td>
</tr>
<tr>
<td></td>
<td><strong>COMMUNICATION AND ADVANCE NOTICE OF CONSTRUCTION ACTIVITIES</strong></td>
</tr>
<tr>
<td></td>
<td><strong>PROPER CONSTRUCTION METHODS AND HOUSEKEEPING</strong></td>
</tr>
<tr>
<td></td>
<td><strong>CONTINGENCY PLANS</strong></td>
</tr>
<tr>
<td></td>
<td><strong>PAYMENT</strong></td>
</tr>
<tr>
<td>112</td>
<td><strong>PROGRESS REPORTS AND PAY REQUEST</strong></td>
</tr>
<tr>
<td>200</td>
<td><strong>SITE CLEARANCE</strong></td>
</tr>
<tr>
<td>201</td>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>202</td>
<td><strong>CLEARING AND GRUBBING</strong></td>
</tr>
<tr>
<td>203</td>
<td><strong>PROTECTION</strong></td>
</tr>
<tr>
<td>204</td>
<td><strong>DISPOSAL OF REFUSE</strong></td>
</tr>
<tr>
<td>205</td>
<td><strong>UTILITIES</strong></td>
</tr>
<tr>
<td>300</td>
<td><strong>EARTHWORKS</strong></td>
</tr>
<tr>
<td>301</td>
<td><strong>DESCRIPTION</strong></td>
</tr>
<tr>
<td>302</td>
<td><strong>MATERIALS</strong></td>
</tr>
<tr>
<td>303</td>
<td><strong>SAFETY AND PROTECTION OF PROPERTY</strong></td>
</tr>
</tbody>
</table>
304 EXCAVATION ................................................................................................................ 160
  OPEN EXCAVATION .......................................................................................................... 160
  TRENCH EXCAVATION ..................................................................................................... 160
  TRENCH LIMITS .................................................................................................................. 161
  TRENCH BACKFILL ........................................................................................................... 162
  REMOVAL OF WATER ....................................................................................................... 162

305 MATERIAL STORAGE .................................................................................................... 163

306 DISPOSAL OF WASTE MATERIAL .............................................................................. 163

307 BRACING ...................................................................................................................... 163

308 BRACING LEFT IN PLACE ............................................................................................ 163

SECT 400-PIPES, FITTINGS AND APPARATUS, METERS AND APPURTE NANCES ................................................................. 165

401 GENERAL ..................................................................................................................... 165

402 STANDARDS .................................................................................................................. 165

403 UNDERGROUND PIPING ............................................................................................. 166
  POLYVINYL CHLORIDE (PVC) PIPE ............................................................................. 166
  MEDIUM DENSITY POLYETHYLENE PIPE (MDPE) .................................................... 166
  DUCTILE IRON PIPE AND FITTINGS ............................................................................ 166
  DUCTILE IRON PIPE LININGS AND COATINGS ......................................................... 167

404 PIPE JOINTS AND COUPLINGS .................................................................................. 167

405 ABOVE GROUND PIPING ........................................................................................... 167
  General ............................................................................................................................... 167
  Ductile Iron Pipe and Fittings .......................................................................................... 168

406 VALVES AND APPURTE NANCES ............................................................................. 168
  GATE VALVES:.................................................................................................................... 168
  VENTURI METER WITH FLOW CONTROL VALVE ........................................................ 169
  BUTTERFLY VALVES ........................................................................................................ 169
  PLUG VALVES .................................................................................................................... 169
  BALL VALVES .................................................................................................................... 169
  VALVE BOXES ................................................................................................................... 170
407 HANDLING AND CUTTING PIPE ................................................................. 170

408 INSTALLATION............................................................................................ 170

409 PRESSURE TESTING..................................................................................... 172

410 DISINFECTION.............................................................................................. 174

SECTION 500 - ROADWORKS........................................................................ 176

501 CLEARING, GRUBBING AND EXCAVATION ........................................... 176
   DESCRIPTION .................................................................................................. 176
   STANDARD CLEARING AND GRUBBING..................................................... 176
   SELECTIVE CLEARING AND GRUBBING..................................................... 177
   DISPOSAL OF MATERIALS ............................................................................ 177
   MISCELLANEOUS OPERATIONS ................................................................... 178

502 CLAY BLANKET ........................................................................................ 178
   DESCRIPTION .................................................................................................. 178
   MATERIALS ...................................................................................................... 179
   CONSTRUCTION METHODS ........................................................................... 179
   BASIS OF PAYMENT ...................................................................................... 179

503 WHITE SAND SUBBASE ........................................................................... 179
   DESCRIPTION .................................................................................................. 179
   MATERIAL ........................................................................................................ 179
   PLACING MATERIALS ...................................................................................... 180
   COMPACTION ................................................................................................... 180
   TESTING SURFACE ........................................................................................ 180
   THICKNESS OF SUB-BASE .............................................................................. 180
   DENSITY CONTROL ........................................................................................... 181
   BASIS OF PAYMENT ...................................................................................... 181

504 SAND CLAY/WHITE AND REEF-SAND/WHITE BASE AND SUB-BASE .... 181
   DESCRIPTION .................................................................................................. 181
   MATERIAL ........................................................................................................ 181
   TESTING SURFACE ........................................................................................ 182
   BASIS OF PAYMENT ...................................................................................... 183
505 CRUSHED STONE

DESCRIPTION

506 SAND SEAL COAT

DESCRIPTION

PROPORTIONING

MATERIALS

COVER MATERIAL

WEATHER LIMITATIONS

CONSTRUCTION METHODS

507 PRIME AND TACK COATS

DESCRIPTION

MATERIALS

EQUIPMENT

CLEANING BASE AND PROTECTION ADJACENT WORK

WEATHER LIMITATIONS

APPLICATION OF PRIME COAT

APPLICATION OF TACK COAT

METHOD OF MEASUREMENT

SINGLE BITUMINOUS SURFACE TREATMENT

508 APPLICATION OF BITUMINOUS MATERIAL

DISTRIBUTOR PRESSURE

APPLICATION TEMPERATURES

UNIFORMITY OF DISTRIBUTION

509 APPLICATION OF AGGREGATE CHIPPINGS

SPREADING

BROOMING AND DRESSING

ROLLING AND CURING

SURFACE REQUIREMENTS

PROTECTION

PAYMENT ITEMS

SECTION 600 - CONCRETE FOR STRUCTURES

601 DESCRIPTION

602 MATERIALS
CEMENT .................................................................................................................................. 192
AGGREGATES........................................................................................................................ 192
TEST REQUIREMENTS ........................................................................................................ 194
GRADATION .......................................................................................................................... 194

603 COVER OVER REINFORCEMENT .................................................................................. 195

604 CONSTRUCTION REQUIREMENTS ............................................................................... 196
GRADING OF AGGREGATES .............................................................................................. 196
CONCRETE MIX DESIGNS .................................................................................................. 196
FORM ................................................................................................................................... 196
DEPOSITING CONCRETE ...................................................................................................... 197
CURING CONCRETE ............................................................................................................ 197

SECTION 700 – SERVICE CONNECTIONS AND METERING .............................................. 198

SERVICE CONNECTION MATERIALS ................................................................................. 198
SCOPE ................................................................................................................................. 198
STANDARD .......................................................................................................................... 198
COMPONENTS .................................................................................................................... 198

SERVICE CONNECTIONS INSTALLATION ......................................................................... 200
TASKS TO BE CARRIED OUT ........................................................................................... 200
INSTALLATION OF FERRULE STRAP ................................................................................. 200
POLY HOSE CONNECTION .................................................................................................. 200

METERS AND METER BOXES INSTALLATION ................................................................... 201
GENERAL ............................................................................................................................... 201
METER INSTALLATION ......................................................................................................... 201

SERVICE CONNECTION MATERIALS .................................................................................. 201

HIGH DENSITY / MEDIUM DENSITY POLYETHYLENE PIPE ( POLYHOSE) .................... 201

POLYETHYLENE PUSH FITTINGS (POLY-FITTINGS) .......................................................... 202
MALE POLY- ADAPTOR (25MM Push-fit End x ¾” Male End) .......................................... 202
FEMALE POLY- ADAPTOR (25MM Push-fit End x ¾” Female End) ................................. 202
POLY-CONNECTOR (25MM Push-fit End x 25MM Push-fit End) ...................................... 202
SECTION 800 - TIMBER AND PILING ................................................................. 204

801 TIMBER .................................................................................................. 204
   MATERIAL ................................................................................................ 204
   HANDLING AND STORAGE ..................................................................... 204
   JOINTING .............................................................................................. 204
   PRESERVATIVES .................................................................................. 205

802 TIMBER PILES ...................................................................................... 205
   GENERAL .............................................................................................. 205
   TOLERANCE OF TIMBER PILES .......................................................... 205
   SHOES FOR TIMBER PILES ................................................................. 205
   INSPECTION, HANDLING AND STORAGE OF TIMBER PILES .......... 206
   HEADS OF TIMBER PILES ................................................................. 206
   SPLICING OF TIMBER LENGTHS ......................................................... 206

803 PILING .................................................................................................. 207
   GENERAL .............................................................................................. 207
   SETTING OUT ...................................................................................... 207
   DISTURBANCE AND DAMAGE ............................................................ 207
   LENGTHS OF PILES ........................................................................... 208
   OBSTRUCTIONS .................................................................................. 208
   PROGRAMME AND PROGRESS REPORTS ......................................... 208
   RECORDS ........................................................................................... 208
   TOLERANCES ..................................................................................... 208
   DRIVING .............................................................................................. 208
   ACCEPTANCE OF PILES ..................................................................... 209
   RE-DRIVING PILES ............................................................................ 210

804 TIMBER WALERS .................................................................................. 210

805 PROTECTION OF STRUCTURAL TIMBER .............................................. 210

806 TOP ELEVATION AND ALIGNMENT OF PILES ..................................... 210

807 TIMBER SHEET PILES ......................................................................... 210

808 TIE RODS AND HARDWARE ................................................................ 211

809 PROTECTION OF THE RODS .............................................................. 211
SECTION 900 - WELLS

GENERAL
LOCATION OF THE BOREHOLES
MATERIALS
DRILLING FLUID
GROUT
TEST PUMPING OF WELL
TEST HOLES AND FORMATION SAMPLES

CONSTRUCTION OF THE WELLS

GENERAL
DRILLING FOR OUTER CASING
DRILLING HOLE FOR CASINGS AND SCREENS
SETTING THE SCREEN AND CASING
GROUTING THE SPACE CASING AND DRILLED HOLE
DEVELOPMENT OF THE WELL
TESTING THE PRODUCTION OF THE WELL
CAPPING THE WELL
GUARANTEES
ABANDONED WELLS
DISINFECTION OF WELL

SECTION 1000: STANDARD PIPEWORK DRAWINGS
PRELIMINARIES

PREAMBLES TO ALL WORK SECTIONS

DESCRIPTION TO APPLY
Description of materials and workmanship referring to items, which are not included or required in the Works described in the Bills of Quantities, shall be disregarded unless subsequently introduced as a variation.

RATES
The rates inserted by the Contractor shall include for complying with all provisions of this section unless specifically otherwise stated or measured.

DEFINITIONS
“Engineer” herein shall mean the individual, partner, company or firm appointed by the Employee to supervise the construction of the Works. The term "the Works" shall mean, "The whole of the Works envisaged by the Contract" Words importing the singular only shall also include the plural and vice versa.

DEFECTIVE WORK
The Engineer reserves the right to check the work executed by the Contractor at such times as he deems fit; there is however, no duty on the part of the Engineer to make such checks and any failure by him to observe errors shall not relieve the Contractor of his responsibilities in these respects.

MATERIALS AND WORKMANSHIP
All materials and workmanship shall conform to the highest standard and quality, and shall always be to the approval of the Engineer. Materials rejected by the Engineer shall be removed immediately from the site and replaced with that in accordance with these specifications. Workmanship rejected by the Engineer shall be taken down/demolished immediately, and the work re-done to the approval of the Engineer.

CALCULATION OF QUANTITIES
All Work unless otherwise described are final measured quantities installed, constructed and/or delivered and the Contractor is to allow in his prices for wastage, laps etc. The bill of quantities therefore, is NOT suitable for the ordering of materials.

Throughout these Bills of Quantities, the following abbreviations have been used.

Cu.m   -   Cubic Meter
BM     -   Board measurement
All weights and measurements mentioned in these Bills of Quantities are those normally used in Guyana.
Description of materials and workmanship given in any one-work section shall apply equally to all work sections, unless otherwise described.

_Notwithstanding any of the foregoing the whole of the materials and workmanship shall be subject to the approval of the Engineer._

**PROPRIETARY PRODUCTS**

All proprietary products shall be used strictly in accordance with the manufacturer's instructions unless otherwise described or instructed in writing by the Engineer.

**PROVISIONAL AND PRIME COST SUMS**

**GENERAL ATTENDANCE**

General attendance on Nominated Sub-Contractors, Local Authorities and Public Undertaking shall be as defined in the SMM 6 - Clause B 19-21, that is including "the use of Contractor's temporary roads, paving and paths, standing scaffolding, standing power operated hoisting plant, the provision of temporary lighting and water supplied, clearing away rubbish, provision of space for the sub-contractor's own offices and for the storage of his plant and materials and the use of mess rooms, sanitary accommodation and welfare facilities"

In addition, general attendance shall be deemed to include arranging with Local Authorities, Public Undertakings, Nominated Sub-Contractors and Nominated Suppliers the time for commencement of their work on the site or manufacture and delivery of their goods and materials, obtaining particulars of holes, mortises, chases, recesses, fixing and the like and supplying them with all dimensions and other information required for the proper execution of the Works.

**PRIME COST SUMS**

**NOMINATED SUB-CONTRACTORS**

The P.C. Sums given are for which the terms of GCC will apply.
Except for loss or damage by causes listed in GCC the Nominated Sub-Contractor shall be responsible for loss and damage and insurance against such loss or damage to any materials and goods brought onto or delivered to the site for his own use until such materials and goods have been fully, finally and properly incorporated in the Works except also for any loss or damage due to any negligence, omission or default of the Contractor, his servants or agents, or any other Sub-Contractor of the Contractor, or of the Employer of any person for whom the Employer is responsible.
The Contractor shall make arrangements with the various Nominated Sub-contractors so that their work proceeds in accordance with the agreed programme and shall furnish to them all necessary dimensions, marks, lines, levels, pegs, etc., for setting out and shall be responsible for the accuracy of same.

Nominated Sub-contractors will be responsible for covering up and protecting their Works during its execution but immediately upon its completion the Contractor shall assume this responsibility.

**NOMINATED SUPPLIES**
The P.C. sums given are for goods and materials to which the terms of Contract Condition 28 apply.
Notwithstanding the provisions of SMM 6 - Clause B 21(b) the cost required to be paid by the Contractor of conveying goods and materials to the site, of any special packing and the like, included in the appropriate prime cost sums and particulars are not given in the measured items.

**PROVISIONAL NET SUMS**
Notwithstanding SMM Clause A.8., the Provisional net sums given are exclusive of any profit or cash discounts to the Main Contractor. An item of Profit is therefore included which the Contractor should price accordingly as part of his tender.

**TEST OF MATERIALS**
The provisional net sum is for charges for testing materials, which will be executed by the Laboratory named by the Engineer and to which the terms of Contract Conditions 6(3) will apply.
The term Contractor's services in connection with these tests is to be read as take test sections of the work when required, store, pack, label, record details and dispatch carriage paid to the testing laboratory.

**DEMOLITIONS AND ALTERATIONS**

**GENERAL**
The Contractor is advised to read the following clauses with care and to price the relevant items of the Bill.

**DEFINITIONS**
The term "remove" as used in this section shall mean the demolition of the structures by any means except the use of explosives and shall include grubbing up foundations and concrete beds and the grubbing up and sealing off of drains and services.

**SHORING AND SCAFFOLDING**
Shoring and scaffolding incidental to demolitions and alterations and making good all work disturbed thereby, shall be deemed to be included in the description.
Shoring and scaffolding incidental to demolitions of individual structures and making good all work disturbed by such shoring and scaffolding shall be deemed to be included in the description.

**MATERIALS AND WORKMANSHIP**

**GENERAL**

Description of materials and workmanship together with relevant preambles and pricing notes given elsewhere in these Bills shall be read as applying equally to the Works described in these sections of the Bills.

All materials used in the making good or extending are, unless otherwise described, to be of equal quality to the old work and to match the original in appearance as nearly as possible.

Credit for old materials removed or suitable for re-use are to be given separately for each item in the column provided. If no credit amount is shown, it will be assumed that the Contractor considers them to be of no value to him.

*The Employer reserves the right to acquire from the Contractor any of the old materials arising from these Works at the rates quoted in the credit column.*

All sound materials arising from the pulling down and alteration work may, if properly stacked, cleaned, reduced or adapted, etc., and subject to the approval of the Engineer, be used in appropriate positions in the new work. Rates for cutting openings in brick or block walls shall include for cutting out thresholds, cutting away over openings as necessary and providing and installing suitable lintels, pinning up between lintels and work over with slates in cement mortar and properly quoining up jambs.

All work shall be executed with as little noise and disturbance as possible.

*The Contractor shall obtain the Engineer permission before switching off, shutting off, or disconnecting any live services to the existing public facility and shall include for all incidental expenses and temporary reconnection of the services to the public facility during the construction period.*

Rates for all works shall include for providing and erecting all necessary temporary casings and protection for works likely to be damaged during the alterations and all necessary tarpaulins, dust screens, temporary coverings, fans, temporary gutters, down pipes, chutes, etc required for the protection of the general public, staff, etc., to the entire satisfaction of the Engineer and Local Authority.

Rates for all Works shall include for the making good and reinstatement of damage or disturbance caused by their execution and the clearing away of all rubbish arising. *The Contractor at his own cost reinstate to match the existing any part or parts of the existing building which may suffer damage due to his building operations.*
The whole of the Works shall be done at such times during the progress of the Works as may be convenient and expedient and the Contractor must take responsibility for damage due to premature removal of brickwork, timber, etc.

Dimensions given in the Bills of Quantities are approximate and are for the guidance of the Contractor in identification of the particular item and/or the extent of the work and do not relieve the Contractor in any way of his responsibility to assess the whole of the work involved.
SECTION 100 - GENERAL

101 REQUIREMENTS OF SPECIFICATION, STANDARDS

The Contractor shall fulfill all requirements and obligations under all Clauses of the Specification. Neither the following clauses of this Specification nor the detailed description therein or the quantities shall limit the obligation of the Contractor under the Conditions of Contract. Where items are not included in the Bill of Quantities for any such requirements or obligations, the cost of such requirements or obligations shall be deemed to be spread over all the items of the Bills of Quantities.

All American, British or other Standards, including Codes of Practice, mentioned herein shall be deemed to form part of this Specification. All reference to such standards shall be to the latest edition or revision thereof unless otherwise stated. Where a specific standard is referred to in this Specification, another standard will be acceptable provided that it ensures an equal or higher quality of material and workmanship as compared with the standard referred to. If the Contractor intends to use such alternative standard, he shall notify the Engineer thereof, submitting with his notice 1 original copy, in English, of the proposed standard, and shall not order any material or perform any work unless and until he has obtained the Engineer's approval of such standard.

Brand names where used in the Specification or on the Drawings are only intended to define a standard of quality and performance and the Contractor may use alternative products of at least equal quality and capacity. When alternatives are offered, the Contractor shall submit to the Engineer for approval a statement detailing the alternatives, and shall include full technical descriptions, drawings, and specifications, and shall provide such full information as is required to enable the Contractor to demonstrate to the Engineer that the alternative is equivalent to the item specified. Any further information that the Engineer may require shall be produced by the Contractor when called for.

102 MOBILIZATION AND DEMOBILIZATION

1. Mobilization shall consist of initiating the Contract and includes the following: transporting to site and setting up the Contractor's plant - required on and off the site - offices, storage areas, etc. providing access to the project site, obtaining necessary permits and licenses, and payments of fees, protecting existing utilities, lighting work areas, providing working drawings, sampling and testing materials, providing required insurance, etc., as may be additional to that specified in the Condition of the Contract.

2. Demobilization shall consist of all clearing up, dismantling operations and removal off site of all plant and equipment.

3. Such materials as are required, that are not to be a part of the completed contract, shall be determined by the Contractor.
4. All work done in providing the facilities and services under this item shall be done in a safe and workmanlike manner.

103 SURVEY AND SETTING OUT

1. The Contractor shall establish reference base lines, reference benchmarks and monuments for the Work covered in this Contract based on the survey information provided by the Engineer. Using this reference control, the Contractor shall take the necessary topography, locate all earthwork and structures, and establish all grades necessary for the accomplishment of the Work. The Contractor shall carefully preserve all marks, reference points and stakes established, and in the case of negligent or careless removal, damage or destruction, such points, marks or stakes shall be replaced by the Contractor at its expense. The Contractor shall also be responsible for any mistakes caused by their loss or disturbance.

2. Any monuments not referenced by the Engineer that are disturbed by construction operations shall be reset by the Contractor in accordance with recognized engineering and surveying practice. Property corners, fences, or any other indications of property lines shall be referenced by the Contractor prior to construction and reset after completion of construction in accordance with recognized engineering and surveying practice.

3. All working control established by the Contractor may be checked by the Engineer. Prior to establishing the working control, the Contractor shall provide, at the Engineer's request, sufficient copies of an illustration of the working control relative to pertinent construction. When the Contractor has established the working control, the Engineer shall be notified for a survey check 24 hours before any Work is started. The Engineer will check all forms prior to placing concrete. All checking by the Engineer will be independent. The responsibility for correctness and adequacy of control shall be borne by the Contractor.

4. Where the precise information as to line and level of the water pipe lines is not indicated on the drawings the position of the center line and levels of such work shall be agreed on Site with the Engineer before the commencement of such works.

5. The contractor shall set out sections of the work at such times as may be necessary to enable Public Utilities to carry out temporary or permanent alterations to their services and approaches.

104 PROJECT SCHEDULE

CONSTRUCTION SCHEDULE

Within 7 days unless specified otherwise in the SCC after the receipt of the letter to proceed the Contractor shall prepare and submit to the Engineer for review, a feasible and reasonable schedule, showing the order in which the Contractor proposes to carry on the Work, and the dates upon which he proposes to start and complete each of the salient features,
including the dates for SUBMITTALS and approval of samples and Contractor's drawings, and the procurement of materials, plant and equipment. **Lump sum items shall be shown itemized by activity and monetary value for payment purposes.** The construction schedule shall be in chart form showing contemplated completion percentages and arranged to record actual completion percentages at stated intervals.

**The construction schedule shall be kept up to date** and the **current updated schedule shall be submitted** to the Engineer as specified in the condition of contract **with each request for payment or as requested by the Engineer.**

The construction schedule shall in general determine the order in which the Work is to proceed. The Engineer, however, may order and authorize minor changes of this schedule whenever such changes are of definite advantage to the Employer or necessary for the operations of the Employer.

The Contractor shall furnish sufficient forces, construction equipment and plant as may be necessary to ensure the expedited completion of the Work in accordance with the submitted schedule. If the Contractor in the opinion of the Engineer lags in any activity listed in the construction schedule, then **the Contractor shall the obligated to implement additional resources as approved by the Engineer in order to compensate for lost time and achieve the completion of works in a timely manner.**

As determined by the Engineer, **costs incurred by the Employer or any other Entity arising from such provision of additional resources by the contractor shall be the Contractor's responsibility and shall be deducted from monies due him.** Failure of the Contractor to comply with the requirements of the Engineer may be grounds for determination by the Engineer that the Contractor is not proceeding at such rates that will ensure completion within the specified time and may result in the termination of the right of the Contractor to continue the Work.

**METHOD OF CONSTRUCTION**

When so specified or directed by the Engineer, the Contractor shall submit the proposed method of construction for specific portions of the Work for review. This submittal shall include detailed description of all phases of the construction operation to fully explain to the Engineer the proposed method of construction. If required by the Specifications, submit working drawings to supplement description. Review and approval by the Engineer will be in accordance with approval process herein and shall not relieve the Contractor from his responsibility with regard to fulfillment of the terms of the Contract. All risks associated with the proposed method remain the Contractor's responsibility and the Engineer shall have no responsibility therefore. After review if in the opinion of the Contractor, modifications are necessary, submit such modifications in detail including reasons for the modifications. Modifications shall not be implemented without review by the Engineer.
105 SUBMITTALS

GENERAL
This Section includes general requirements and procedures related to the Contractor's responsibilities for preparing and transmitting SUBMITTALS to the Engineer to demonstrate that the performance of the Work will be in accordance with the Contract requirements. SUBMITTALS include schedules, Contractor's drawings, calculations, samples, manuals, methods of construction, and record drawings. Other requirements for SUBMITTALS are specified under applicable Sections of the Specifications.

CONTRACTOR'S DRAWINGS
(a) Identification. Data - All SUBMITTALS for approval shall have the following identification data, as applicable, contained thereon or permanently adhered thereto:

- Owner Contract Number.
- Project name and location.
- Submittal Numbers. Resubmittals shall bear original submittal number and be lettered.
- Product identification.
- Drawing title, drawing number, revision number, and date of drawing and revision.
- Applicable Contract Drawing numbers and Specification Section and paragraph numbers.
- Subcontractor's, vendor's, and/or manufacturer's name, address and phone number.
- Contractor's verification statement as required by the General Conditions.
- Catalog Data - each submittal of catalog data shall have the identification required as hereinbefore stated.

  (i) Catalogs or brochures submitted in packages of multiple items for approval need the identification only on the exterior. In such instances the identification shall include page and catalog item numbers for items submitted for approval. If one or more of the items in such a submittal are not approved, resubmittal of only the un-approved items is required.

  (ii) Catalog cuts containing various products, sizes and materials shall be highlighted to show particular items being submitted.

(b) Working Drawings. Submit working drawings as required for changes, substitutions, Contractor design items, and designed methods of construction. Requirements for working drawings will be listed in appropriate Specification Sections. Drawings shall be accompanied by calculations or other information to completely explain the structure, machine or system described and its intended use. Review and approval of such drawings by the Engineer shall not relieve the Contractor from its responsibility with regard to the fulfillment of the terms of the Contract. All risks of error are assumed by the Contractor, and the Engineer shall have no responsibility for errors by the Contractor.
Working drawings and calculations as submitted shall be dated and signed by a Professional Engineer.

(c) Approval Process. Original Submittal - Copies of catalog data as specified in the General Conditions. Three copies of all Contractor's drawings will be returned. Contractor's drawings will be returned, stamped with one of the following classifications:
- APPROVED: no corrections, no marks.
- APPROVED AS CORRECTED: a few minor corrections. All items may be fabricated as marked without further resubmission. Resubmit a corrected copy to the Engineer.
- REVISE AND RESUBMIT: Contractor shall make the necessary corrections and resubmit drawings as per original submission. Thirty days will be allowed for checking and appropriate action by the Engineer. Only one stamped drawing will be returned.
- NOT APPROVED: Submittal requires corrections or is otherwise not in accordance with the Contract Documents. Contractor shall correct and resubmit drawings as per original submission. Thirty days will be allowed for checking and appropriate action by the Engineer. Only one stamped drawing will be returned.
- INFORMATION ONLY: Items not reviewed or items for which SUBMITTALS are not required.

RECORDS
At the discretion of the Engineer:

(a) The Contractor shall keep one record copy of all Contract Documents, reference documents, and all Required Submittals at the Work Site in good order and annotated to show all revisions made during the construction process. Such annotations shall be kept current and will be inspected monthly by Employer and Engineer. Failure to maintain current record drawings will be cause to delay progress payments. Record drawings shall be available to the Engineer at all times during the performance of the Contract and the Contract Time.

(b) All of the following documents and Contractor's Required Submittals shall be made a part of the record drawings.
- Contract Drawings - Contractor shall annotate or redraft, as required, to show all revisions, substitutions, variations, omissions and discrepancies made or discovered during construction concerning location and depth of utilities, piping, duct banks, conduits, manholes, pumps, valves, vaults and other equipment. Revisions shall be made and shown on, all drawing views with actual dimensions established to permanent points.

- Contractor's Drawings - Same as above. Include, for example, actual layouts of piping and valves with references to landmarks. Sections and details shall be added as required, for clarity. Drawings shall be revised to show actual installations. Prior to preliminary inspection, furnish a reproducible of the record drawings. At the completion of the Contract and before Final Payment is made, furnish to the Engineer one set of reproducible and three sets of copies of the finally approved record drawings reflecting all revisions herein described. If drawings are available in digital format, also include one complete set on CD.
(c) The Contractor shall keep a complete to-date record of the actual construction of all Work called for under the Contract Drawings and Specifications of this Contract and as ordered by the Engineer. The Engineer will make available to the Contractor one set of full size prints of the original Contract Drawings and one set of digital files, when available, on which the Contractor shall make the necessary changes to indicate the major changes. The changes shall be made with opaque Higgins carmine red ink, or approved equal, using standard drafting procedures.

Record drawings on Mylar will be prepared by the Engineer based on the changes indicated by the Contractor. All record drawings on Mylar for this Contract shall be signed by the Contractor certifying to its major corrections.

**OPERATION AND MAINTENANCE MANUALS**

(a) The Contractor shall furnish operation and maintenance catalog information and Operation and Maintenance Manuals for the valves, fire hydrants and other appurtenances as required by the Contract Documents. Unless otherwise indicated, a separate manual shall be furnished for each piece of equipment and/or system. The manual shall include complete information necessary to operate, maintain and repair the equipment. Specifically the manual shall include detailed assembly drawings with parts list and numbers, and recommended spare parts list with recommended quantity, manufacturer's price, supplier's address and telephone number.

(b) Contractor shall provide a minimum of three copies of each complete manual.

**106 TRAFFIC SAFETY AND CONTROL**

1. The contractor shall provide erect and maintain such traffic signs lamps barriers and traffic control and such other measures as may become necessary as a result of the construction of the Works. Compliance with this Clause shall not relieve the Contractor of any of his obligations and liabilities under this Contract and under the relevant Highway and Police requirements.

2. The Contractor after consultation with statutory and other authorities concerned shall submit to the Engineer for approval a Programme based on such consultation that shows the scheme of traffic control he proposes for carrying out the construction of the Works and before commencing any work that affects the use of public or private roadways and thereafter he shall furnish any additional details and information as may become necessary as the construction of the Works progress or as may be required by the Engineer.

3. The Contractor shall not commence any work that will affect public and private roadways until all the necessary traffic safety measures required are fully operational. The Contractor shall keep clean and legible at all times all traffic signs, lamps, barriers, and traffic control signals and he shall position reposition cover or remove them as may be required by the progress of the Works.
107 TEMPORARY DIVERSION OF TRAFFIC

1. The Contractor shall construct temporary diversion ways (detours) wherever the Works will interfere with existing public or private right-of-way for any kind of traffic (subject to the requirements of the Traffic Division of the Police). Interruption of access to adjacent private property shall be held to a minimum during working hours. Acceptable access shall be restored for all non-working periods.

2. The standards of lighting and signing for such temporary diversions (detours) shall be suitable in all respects for the class or classes of traffic using the existing ways and the width and capacity of the diversion shall not be less than that of the existing way unless otherwise described in this Contract or permitted by the Engineer.

3. The Contractor shall submit diversion details to the Engineer, Mayor’s Office, and Police, with sufficient advance notice before the start of construction of any proposed diversion. Details of the proposed diversion shall include lighting, signing, and any other information required by the Municipality or the Police. The Contractor shall not commence the Construction of the diversion until he has received all required approvals and permits, and presented these to the Engineer. By reviewing the diversion plan the Owner neither accepts any responsibility for the adequacy of the plan nor any damages to public or private property resulting from the Contractor’s activities.

4. Diversion ways must be constructed and be ready for use in advance of any interference with existing ways and shall be maintained so as to provide adequately for the required traffic flows.

5. The Contractor's attention is drawn to the presence of existing underground and overhead services. The Contractor shall accurately locate these services and adequately protect the same so as to prevent any damage to the service by traffic using the diversion all to the approval of the Engineer.

108 PROGRESS PHOTOGRAPHS

1. The Contractor shall arrange as described in the Contract to have record photographs of the Works taken at monthly intervals or at such other intervals as the Engineer shall direct by a professional photographer approved by the Engineer. These photographs shall cover the extent of the Works as determined by the Engineer.

2. All prints shall be marked on the reverse side with the date of exposure, name and address of photographer, identification reference number, and brief description of the particular work.

3. The copyrights of all photographs shall remain the property of the Employer and the negatives and prints shall be delivered within four (4) weeks of exposure. The photographs shall not be used for any purpose whatsoever without the approval of the Engineer.
109 SCHEME SIGNBOARDS
1. The Contractor shall erect and maintain signboards as described in the Contract at sites to be selected by the Engineer.

2. On or before the expiration of the Period of Maintenance and when directed by the Engineer the Contractor shall dismantle and remove the signboards together with all supports and foundations and reinstate those sites.

110 TESTING LABORATORY SERVICES
1. The Contractor shall arrange and pay for independent testing as specified in these Specifications or any other part of the Contract Documents.

2. Contractor shall ensure that, and shall require the laboratory to:
   (a) Perform specified tests and services.
   (b) Comply with specified standards, other recognized authorities, and as specified.
   (c) Ascertain compliance of items tested with requirements of Contract Documents and so note in writing on all reports.
   (d) Promptly notify Engineer and Contractor of irregularities or deficiencies of work observed during performance of laboratory services.
   (e) Promptly submit three copies of reports of inspections and tests to Engineer.
   (f) Include in the reports, date, project title and number, name and signature of inspector, date of inspection or sample, record of temperature and weather, date of test, identification of product and Specification Section, location in project, type of test, and observations regarding compliance with requirements.

3. Contractor shall, and shall require all of its subcontractors and suppliers to:
   (a) Cooperate with laboratory personnel.
   (b) Provide laboratory with samples of materials to be tested in required quantities.
   (c) Furnish to the Engineer three copies of all test results.
   (d) Provide facilities for storage and curing of test samples.
   (e) Notify Engineer sufficiently in advance of time and place of tests to be made at point of manufacture, assembly, or fabrication to permit Engineer to witness tests if it so desires.

4. Frequency of Testing

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TYPE OF TEST/TEST METHOD</th>
<th>NUMBER AND FREQUENCY OF TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) SOIL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trench</td>
<td>Sieve Analysis, ASTM D422</td>
<td>Min. 1 per source and if material changes</td>
</tr>
<tr>
<td>Bedding</td>
<td>Proctor density, ASTM D1557</td>
<td>Min. 1 per source and if material changes</td>
</tr>
<tr>
<td>Granular</td>
<td>Sieve analysis, ASTM D422</td>
<td>Min. 1 per source and if material changes</td>
</tr>
</tbody>
</table>
Backfill

- Proctor density, ASTM D1557
  - Min. 1 per source and if material changes
- In-place density, ASTM D2922
  - Min. 1 per every 1000 Lm of trench.

(b) ASPHALTIC CONCRETE PAVEMENT

- Subbase, ASTM D2922
  - Min. 1 per every 250 square meters placed
- Asphaltic Concrete Base Course, ASTM D2922
  - Min. 1 per every 250 square meters placed
- Asphaltic Concrete Surface Course, ASTM C192
  - Min. 1 per every 250 square meters placed

(c) CONCRETE

- Concrete, ASTM C192
  - Min. 1-set of 6 for each concrete pour greater than 7 cubic meters

(d) OTHER TESTS

As required in Specifications, this Section, or other parts of the Contract Documents.

111 ENVIRONMENTAL CONTROL

GENERAL

The Contractor shall be responsible for furnishing all necessary items for fulfilling the Work described herein for environmental protection including prevention and control of erosion and sedimentation that results directly or indirectly from the Work. Contractor is responsible for all requirements and provisions of any permits required for the Work.

OCCUPATIONAL SAFETY APPLICABLE FOR CONSTRUCTION ACTIVITIES

The Contractor shall provide workers with all equipment and protective clothing to safeguard their health and safety. These include, but are not limited to:

(i) hearing protection for working around machinery where noise exceeds 60 decibels;
(ii) dust masks and eye protection for dust and splintered materials;
(iii) impermeable gloves and boots where workers will be exposed to sewage and/or other toxic substances;
(iv) protective helmets; and where appropriate
(v) gas masks and methane detectors for working in closed areas such as access/manholes, sewerage pump chambers and other confined areas.
Excavated areas, trenches and canal crossings shall be clearly marked and temporary bridges, platforms and fences shall be constructed to facilitate access and avoid accidental falls into these areas.

**DEMARcation AND SIGNING OF CONSTRUCTION SITES AND HAZARDS**

The Contractor shall demarcate and sign the construction area before activities begin. Legible warning signs, barriers and signals shall be placed at strategic locations in sufficient number and spacing for all prominent access ways to the sites. Special emphasis shall be given to placement of warning signs, barriers and protective fences to prevent accidents to citizens in relation to open ditches, road and pedestrian hazards and movement of heavy machinery and construction vehicles. Flagmen shall be used to warn and direct vehicle traffic around construction sites and hazards during working hours. Outside of working hours, especially at night, all barriers and signs will remain at sites, with lighting and/or lighted signs placed as required to warn both vehicular and pedestrian traffic.

**COMMUNICATION AND ADVANCE NOTICE OF CONSTRUCTION ACTIVITIES**

The Contractor shall advise citizens in advance concerning road closures, rerouting of vehicle and pedestrian traffic, and interruptions in water and sewerage services. Closures and interruptions in services shall be announced according to the following procedures:

(i) announcements will be placed in local newspapers for two consecutive days before beginning construction activities;

(ii) signs announcing the closures of roads and/or temporary shutoff of services will be placed in the vicinity of the intended construction sites within one week of initiating activities, and include a telephone number and contact address for further information;

(iii) a one-page circular shall be delivered to each residence or business in areas where services will be interrupted at least one week before activities begin, in which the location, nature and duration of the interruptions will be disclosed, and in the case of shutoff of water services, the Engineer shall be inform; and

(iv) the Contractor shall advise residents when reconnected water supplies are safe to use.

**PROPER CONSTRUCTION METHODS AND HOUSEKEEPING**

The Contractor shall contain excavated materials adjacent to the work site within berms to prevent erosion, dispersion and sedimentation of canals, streets and adjacent properties. If materials are to be left for longer period of time, these should be covered or wetted to prevent dispersion of dust. Should materials enter drainage canals, streets or adjacent properties, they should be removed and properly placed within protective berms or returned to excavated areas. No materials shall be stored in such a way as to be carried away by rains or drainage canals.
The Contractor will maintain sanitary bathroom facilities at the site for workers use. The Contractor shall maintain any and all liquid or solid construction wastes and/or garbage in its proper receptacles and dispose of these at legally licensed dumpsites; no inappropriate liquid or solid wastes shall be disposed of in drainage canals.

**CONTINGENCY PLANS**

The Contractor shall have presented to the Engineer evidence that it has developed plans and procedures to deal with contingencies. The following should be covered under the Contractor’s contingency plans:

(i) procedures for dealing with occupational accidents, including provision of first aid at the construction site and plans for emergency medical services, both for workers and for accidents to third-party citizens;

(ii) protocols for dealing with accidental water or sewage spills, including measures for shutting off these services and clean-up of spills;

(iii) The Contractor shall have developed with Guyana Water Inc. procedures to deal with complaints from citizens in construction areas, including referrals to appropriate authorities and use on-site of a simple form to document and/or report the nature of such complaints.

**PAYMENT**

The work specified in this Section shall be considered incidental and no separate payment will be made. Payment for the work will be included as part of the appropriate lump sum amounts or unit prices stated in the Bid.

**112 PROGRESS REPORTS AND PAY REQUEST**

1. A monthly progress report shall be prepared by the Contractor at the close of each calendar month in a form approved by the Engineer and it shall be submitted by the Contractor together with its Monthly Pay Request in accordance with the condition of GCC.

2. The monthly progress report shall show the amount of the Work completed, materials actually used, materials in storage, and the cumulative results of all operations completed or in progress and shall be summarized in terms of percentage of completion.

3. **Monthly Pay Request shall be presented in the format of the Bill of Quantities with an addendum to each Bill for any additional item that requires a rate agreement and shall include a format to be agreed with the Engineer.**
SECTION 200 - SITE CLEARANCE

201 DESCRIPTION
The Contractor shall clear and dispose of shrubs, plant material and debris within the areas where trenching and related construction work is accomplished or within work areas defined on the Contract Drawings, except as otherwise designated to remain or be relocated.

Adjoining property and existing trees, shrubs, plants, site improvements, buildings or structures and utilities to remain shall be protected from damage.

202 CLEARING AND GRUBBING
The Contractor shall clear and grub trees, shrubs, trunks, stumps, branches, root systems, brush, vegetation, rubbish and debris, except as otherwise designated to remain or be relocated. Trees and shrubs designated to remain shall be marked by the Engineer, the Owner, and Owner of the Work Site.

The trees greater than 3" in diameter within any construction area shall be transplanted as directed by the Engineer. Stumps and root systems shall be substantially grubbed out. Remaining depressions shall be completely filled with satisfactory material placed and compacted in accordance with Section 300, Earthwork. Materials which might float or obstruct any pipe or waterway shall be removed and disposed in accordance with Item 204.

203 PROTECTION
Protect adjoining property from damage. Existing trees, shrubs and plant materials to remain shall be protected by barricades, planking, fencing or other acceptable means. Damage to plant material to remain shall be repaired or replaced with approved equal material.

Existing site improvements shall be adequately protected. Damage to site improvements shall be repaired to former condition or replaced with approved equal work. Existing structures to remain shall be protected from settlement or other damage. Damages shall be repaired to former condition or replaced with approved equal work.

Existing utilities to remain shall be protected and maintained to prevent leakage, settlement or other damage. Damage shall be repaired or replaced to former condition and as required by the utility company, municipal company or land owner affected. Damages shall be reported to the Engineer and repairs made immediately by the Contractor at his expense.

204 DISPOSAL OF REFUSE
Refuse material removed shall be disposed of by removal from the site, except as permitted by law and as approved by the Engineer. The Contractor shall be responsible for compliance with all local laws and regulations concerning the disposal of waste materials.
205 UTILITIES

The Contractor shall prevent damage to pipes, conduits, wire, cables or structures above or below ground that are the property of the Utility Authorities or concern the Utility Authorities. The Contractor must consult the appropriate Utility Authority to determine the exact location and extent of all services that are likely to be affected by the Works. The drawings are provided only as a guide to the general location of major services. The Contractor is to take the necessary care and precautionary measures and provide the necessary protection as required by the Utility Authorities. The Contractor will be required to bear the cost of such protection and other measures unless specifically stated otherwise.
SECTION 300 - EARTHWORKS

301 DESCRIPTION

The Contractor shall perform all work for earthwork in accordance with these Specifications. Earthwork shall include stripping, excavation, backfilling, compacting, testing, site drainage and dewatering, disposal of excess excavated material and grading of all areas necessary to complete the work as shown on the Contract Drawings and as herein specified.

302 MATERIALS

1. Granular Bedding
   Granular bedding material around pipes shall be properly graded White Sand.

2. Granular Backfill
   Granular backfill material for trenches shall be properly graded White Sand.

3. Select Clay Backfill
   Select clay backfill material excavated from the trench shall be placed back into the trench above the granular backfill in unpaved areas. Only select clay material free of organics, rocks, and debris will be placed in the trench as approved by the Engineer.

303 SAFETY AND PROTECTION OF PROPERTY

For purposes of these specifications, "Bracing" shall mean and include any or all sheeting, shoring, trench jacks, poling boards, sheet piling, lagging, walers, tiebacks, struts, boxes, and all other devices for maintaining the shape and safety of excavations.

The Contractor shall carry out excavation, dewatering and installation of bracing in such a manner as to eliminate all possibilities of disturbing or undermining foundations of existing structures or Work previously completed under this Contract.

He shall furnish and place well-points, pumps, and bracing to ensure safety. Design and placement of necessary bracing shall be the Contractor's responsibility.

Existing utilities, fencing, curbing, property line markers and other structures that are disturbed or damaged shall be reported to the Engineer and repairs shall be made immediately by the Contractor at his expense. The Contractor shall notify the utility companies for relocation of utilities and for temporary service until permanent facilities can be restored in the areas requiring continued uninterrupted service.

The Contractor shall not use or operate equipment, having treads or wheels, on pavement which can be damaged by their use, unless he repairs all such damage and protects traffic until repairs are completed in which case he shall secure the permission of the appropriate agency having jurisdiction over the pavement and traffic control.
304 EXCAVATION

OPEN EXCAVATION
All excavation for the structures and Work shown on the Contract Drawings or directed by the Engineer shall be open excavation. Open excavation shall be open overburden excavation.

Open overburden excavation shall consist of all open excavation which may be accomplished by hand, power shovel, dozers, rippers or other earth moving equipment without continuous and systematic blasting.

Open excavation shall be made to the widths and depths necessary for constructing all structures, pipelines and conduits included in the Contract.

The Contractor shall organize his excavation procedure so that no slide and cave in occurs due to his excavation. If a failure at excavation slope occurs, all slide and cave in materials shall be moved to a stable slope at or outside of the lines and grades shown on the Drawings.

TRENCH EXCAVATION
Before starting excavation, all obstructions which are to be removed or relocated shall be cleared away in accordance with Section 200 "SITE CLEARANCE”.

Existing utilities, service connections, fencing, plants, curbing, property line markers and other structures, either aboveground or underground, that are disturbed or damaged shall be reported to the Engineer and restoration, repairs shall be made immediately by the Contractor at his expense. Contractor shall notify the utility companies for relocation of utilities and for temporary service until permanent facilities can be restored in the areas requiring continued uninterrupted service.

The extent of excavation open at any one time will be limited so that traffic is impeded the least amount possible. If in the opinion of the Engineer the Contractor has too much trench open, and too much surface restoration incomplete, the Engineer may require that new trenching be stopped until the pressure test, backfill and surface restoration has been sufficiently completed. Full credit on partial payments will not be allowed for buried piping where backfill and surface restoration are not completed.

Trenches shall be excavated by open slope as nearly vertical as possible above the top of pipe. Where required for protection of the Work, for safety of personnel, for protection of new construction or adjacent property, bracing shall be used. In general, only braced and vertical trenches will be permitted in traveled streets, alleys or narrow easements. Materials excavated from the trench shall be stockpiled a sufficient distance from the trench or off-site to prevent slides or cave-in of sides.
All excavation shall be unclassified and shall include, but not be limited to, all soil and rock materials, unforeseen obstacles, abandoned underground conduits and pipes, and buried masonry or concrete structures. Unsuitable material as determined by the Engineer at bottom of trenches shall be removed and replaced with compacted granular material or concrete cradle. Contractor shall dewater trenches in accordance with the "Removal of Water" specified in the Section.

Excavation for water pipe may be either by hand or machinery but in no case shall such excavated trench bottom be below the grade at which the proposed water pipe is to be laid to ensure the pipe will rest on undisturbed soil. Excavation carried beyond or below the grade shown on the Contract Drawings shall be backfilled at the Contractor's expense with granular material, or 2500 psi strength concrete bedded with granular material as directed by the Engineer, and thoroughly compacted.

### TRENCH LIMITS

Width of trench is measured between faces of earth wall or faces of sheeting. Width shall be constant from the bottom of the trench to the top of grade in the pavement areas and width shall be constant from the bottom of trench to one foot above the crown of the pipe in the remaining places. In accordance to the following table:

<table>
<thead>
<tr>
<th>Nominal Internal Diameter (mm)</th>
<th>Minimum Trench Width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>430</td>
</tr>
<tr>
<td>150</td>
<td>490</td>
</tr>
<tr>
<td>225</td>
<td>580</td>
</tr>
<tr>
<td>300</td>
<td>680</td>
</tr>
<tr>
<td>375</td>
<td>950</td>
</tr>
<tr>
<td>450</td>
<td>1030</td>
</tr>
<tr>
<td>525</td>
<td>1120</td>
</tr>
<tr>
<td>600</td>
<td>1240</td>
</tr>
<tr>
<td>675</td>
<td>1330</td>
</tr>
<tr>
<td>750</td>
<td>1400</td>
</tr>
<tr>
<td>825</td>
<td>1490</td>
</tr>
<tr>
<td>900</td>
<td>1920</td>
</tr>
<tr>
<td>1050</td>
<td>2100</td>
</tr>
<tr>
<td>1200</td>
<td>2290</td>
</tr>
<tr>
<td>Above 1200</td>
<td>Outside diameter of pipe plus 800 mm</td>
</tr>
</tbody>
</table>

Should the Contractor exceed the maximum trench width and depth specified above, without written approval of the Engineer, he may be required to provide, at his own expense, concrete cradle or granular material for the pipe as directed by Engineer and no separate payment will be made therefore.
TRENCH BACKFILL
Trenches shall be backfilled with specified materials deposited in 150mm maximum layers, loose depth and compacted by approved mechanical or hand tamping. Bedding shall be brought up evenly on both sides of pipe to a height of 300mm above the top of the pipe.

The intent of this specification is to achieve compaction of not less than 75 percent relative density as determined by ASTM D 4253, or not less than 95 percent of the maximum dry density as determined by AASHTO T180, as applicable.

Those trenches which are located in unpaved areas shall be backfilled with select clay backfill material placed in 300mm layers and compacted by mechanical means from the top of the Bedding or 300mm above the top of pipe, to 150mm of the bottom of required topsoil. The intent of this specification is to achieve compaction of not less than 75 percent relative density as determined by ASTM D4253.

Those trenches which are located on or across paved streets and private driveways, or in the shoulders of streets and which must be made safe quickly for vehicular traffic shall be backfilled with properly graded white sand placed in 300mm layers and compacted by mechanical means from the top of the Bedding or 300mm above the top of pipe, to the bottom of required subgrade and pavement. The intent of this specification is to achieve compaction of not less than 75 percent relative density as determined by ASTM D4253. Where permanent type pavement is required, stone, and gravel may be used as a temporary fill in the upper 300mm of the trench. Compaction shall be in accordance with herein above.

Should settlements occur in excess of 25mm below the street grade, the Contractor shall furnish and install additional material to maintain the surface at street grade. Where the Contractor's operations destroy permanent type sidewalk, he shall replace same with new surface materials equal to those which were destroyed.

Where temporary patches are made in any hard surfaced roadway before the permanent surface can be restored, such patches shall be surfaced with not less than 50mm of a suitable bituminous patching material and the surface maintained until the permanent surface can be restored.

REMOVAL OF WATER
At all times during the excavation period and until completion and acceptance of the Work at Final Inspection, ample means and equipment shall be provided with which to remove promptly and dispose of properly all water entering any excavation or other parts of the work.

The excavation shall be kept dry. No water shall be allowed to rise over or come in contact with masonry and concrete until the concrete and mortar have attained a set satisfactory to the Engineer and, in any event, not sooner than 12 hours after placing the masonry or concrete. Water pumped or drained from the Work hereunder shall be disposed of in a safe and suitable manner without damage to adjacent property or streets or to other work under construction. Water shall not be discharged onto streets without adequate protection of the surface at the
point of discharge. No water shall be discharged into sanitary sewers. No water containing settle able solids shall be discharged into storm sewers. The Contractor shall promptly repair any and all damages caused by dewatering the Work.

305 MATERIAL STORAGE
Excavated soil suitable for backfilling that has no immediate use shall be stored separately in on-site areas approved by the Engineer. As far as possible, all excavated material, except that required for backfill, shall be removed from the site of work as soon as excavated.

306 DISPOSAL OF WASTE MATERIAL
Prior to disposing surplus waste material at an off-site location, the Contractor shall obtain a written agreement between himself and the operator of the disposal site before dumping. The agreement shall state that the operator of the disposal site gives permission to the Contractor to enter and deposit waste material on the site. There shall be no additional cost to the Owner.

The Contractor shall dispose of excess excavated and waste material rejected by the Engineer. Disposition of waste material shall comply with all National and local laws and regulations.

307 BRACING
The Contractor shall furnish and install all bracing, as defined in Item 303, required to maintain the excavation in a condition to furnish safe working conditions and to permit the safe and efficient installation of all items of the work. The Contractor shall further, at his own expense, shore up, or otherwise protect all fences, building walls, walks, curbs, or other property adjacent to any excavation which might be disturbed during the progress of the work. The Contractor will be held liable for any damage which may result to neighboring property from excavation or construction operations.

The Contractor shall comply with all National and local codes regulating the design and construction of bracing.

The Contract Price for priced items shall include the cost of all kind of temporary bracing necessary to secure a safe prosecution of the work until the permanent structures are complete; such temporary supports must in all cases be removed by the Contractor at his own expense after or concurrently with the completion of the permanent structures.

308 BRACING LEFT IN PLACE
Bracing for open trenches and excavations may be ordered left-in-place by the Engineer when, in his opinion, such is necessary for the purpose of preventing injury to the structures, pipelines or to other property or to persons. Bracing left in place shall be cut off at the elevation ordered, but, in general, such cut offs shall be at least 18 inches below the final ground surface. Bracing remaining in place shall be driven up tight.
The right of the Engineer to order bracing left in place shall not be construed as creating any obligation on his part to issue such orders.

Bracing left in place, by written order of the Engineer, will be paid for as provided in the General Conditions.
SECTION 400-PIPES, FITTINGS AND APPARATUS, METERS AND APPURTEINANCES

401 GENERAL

1. Work under this Section consists of furnishing all things necessary to furnish and install complete, ready for operation all piping, valves and operators, and related items as shown on the Contract Drawings or specified unless specifically excepted.

2. In general, piping consists of furnishing, installing and testing all piping, fittings, joint materials and couplings, bolts, nuts, gaskets, all shown or required pipe supports, supporting the pipes, valves, and fittings. Appropriate concrete piers, cradles, and thrust blocks shall be provided to support certain pipes and fittings shown on the Contract Drawings or as required, and as approved by the Engineer.

3. The Contract Drawings indicate the general design and arrangement of the proposed installations and are not exact unless dimensions are shown. The exact locations of the facilities and of the required piping is subject to minor changes necessitated by field conditions, and shall be verified and coordinated with space requirements by the Contractor.

4. SUBMITTALS: Contractor shall submit shop drawings for all water main piping, valves, hydrants, and appurtenances to the Engineer for review and approval prior to ordering and installing the facilities.

402 STANDARDS

a) Materials supplied in this section are required to meet the standards set by the American Water Works Association (AWWA), American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), or other such institutions. Materials which conform with equivalent British, Japanese, French or other Standards will also be acceptable.

b) It is the intent of the contract to supply materials that are of uniform standards throughout, from a dimensional and a performance perspective, to facilitate standards for replacements, spares, additions, joining of parts, or extensions. All components of the pressure piping system should be compatible in that regard, and no special adapters, or conversions from one "standard" to another shall be acceptable.
403 UNDERGROUND PIPING

Pipes of diameter 300mm and less shall be of PVC, Medium Density Polyethylene (MDPE), OR Ductile Iron (DI) and conform to the specifications below:

POLYVINYL CHLORIDE (PVC) PIPE
PVC pressure pipe shall conform to the requirements of GYS 107: 2002 SDR 26 or equivalent. Supplier to provide all necessary rubber gaskets and lubricant for pipes purchased under this contract. All PVC fittings shall be of the same material as those of the pipes. Dimensions to ASTM D 2241 or equivalent.

The pressure rating of fittings to be 1380 kPa (200 psi). Bends or elbows and tees to have bell (socket) ends and be supplied with rubber gaskets. Flange adapters to have bell (gasket joint) on one end, and PVC flange with Standard class 125 lb. template rating and bolt hole drill pattern.

MEDIUM DENSITY POLYETHYLENE PIPE (MDPE)
Polyethylene (HDPE/MDPE) straight pipe for electrofusion shall comply with the requirements of BS 6572, WIS 4-32-03 or AWWA C906 and ASTM D1248 for 7.5 bar pressure rating with a standard Dimension Ratio SDR of 17. Polyethylene fittings comply with the requirements of BS 6572, WIS 4-32-06 and/or AWWA C906 for 10 bar pressure rating.

Sections of polyethylene pipe shall be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed by the manufacturer’s representative and in strict accordance with pipe manufacturer’s recommendations. The butt fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements, alignment and fusion pressures.

Fusion equipment shall be capable of recording and reproducing temperatures, pressures and other data during the fusing process to demonstrate the condition of joints made. If MDPE Pipes are utilized, one set of Fusion equipment utilized on the project is to be handed over to the employer at no additional cost at the end of the contract.

DUCTILE IRON PIPE AND FITTINGS
Ductile iron pipe to be installed underground shall be k9 of ISO 2531 or BS 4772 for all pipe diameters or pressure class 350 per AWWA C151 for pipes with diameters less than or equal to 350 mm and pressure class 300 per AWWA C151 for pipes with diameters 400 mm and greater. Pipe joints shall be push fit spigot and socket type to meet the requirements of AWWA C111 or equal.
Ductile iron pipe fittings to be installed underground shall be compact type that comply with AWWA C153, latest revision and shall confirm to class K12 of ISO 2531 or class 350 per ANSI/AWWA C153.

Ductile iron pipe and fittings for buried services shall be provided with Sulphate resistant cement (Type V Portland Cement) lining with AWWA C104, latest revision, and shall be epoxy tar coated outside for high corrosion resistance. Cement shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement. The dry film thickness and coats shall be in accordance with manufacturer’s recommendation.

**DUCTILE IRON PIPE LININGS AND COATINGS**

Ductile iron pipe and fittings for above ground services shall be provided with Sulphate resistant cement (Type V Portland Cement) lining in accordance with AWWA C104, latest revision, and shall be coated with an epoxy paint system. Cement shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement. The exterior of pipe shall be thoroughly cleaned to remove all loose scale, grease, rust, and other impurities and then given a coat of rust-inhibitive primer. Finish painting shall consist of a polyamide epoxy paint system. The dry film thickness and coats shall be in accordance with manufacturer’s recommendation.

Ductile iron pipes shall be installed with polyethylene encasement in accordance with AWWA C105/A21.9 and AWWA C600.

**404 PIPE JOINTS AND COUPLINGS**

1. Restrained joints where specified shall be Series 1350 Uni-Flange Block Buster Device for PVC pipe bell joints or equivalent.
2. Mechanical and push-on joints where required on the plans shall conform to ANSI/AWWA A21.11/C111.
3. Flange joints where required on the plans shall conform to ANSI/ AWWA A21.10/C110.
4. Bolts, Studs, Tie Rods, Nuts and Washers. All bolts, studs, tie rods and nuts for all pipe, valves and accessories shall be stainless steel and have American National form right-hand machine cut threads which shall conform with ANSI B1.1, "Screw Threads", Coarse Thread Series, Class 2 Fit, unless otherwise specified.

Bolt heads and nuts shall be semifinished and shall conform with ANSI B18.2 "Wrench-head Bolts and Nuts and Wrench Openings", Heavy Series, unless otherwise specified. All nuts shall be hexagonal in shape.

The Contractor is required to use bolts conforming to AWWA C111 for all Flange and mechanical joints for compact fittings. The bolt threads shall be lengthened according to AWWA C153 to allow for proper nut installation.

**405 ABOVE GROUND PIPING**

**General**

All above ground piping shall be flanged Ductile Iron.
Ductile Iron Pipe and Fittings
Ductile Iron Pipe and Fittings to be installed above ground or in structures shall be flanged, except as shown on the drawings and shall comply with ANSI/AWWA A21.10/C110, and ANSI Class 125 B16.1. Standard class 125 template for drilling shall be used for all flanges.

Ductile iron pipe and fittings shall be sulfate resistant cement-lined (Type V Portland Cement) and the lining shall comply with AWWA C104, latest revision. The exterior surfaces of the pipe and fittings shall be factory coated complying with AWWA C115. After installation, the pipe shall be coated with two coats of aluminum paint.

406 VALVES AND APPURTENANCES
All packing and gaskets shall be of non-asbestos materials.

GATE VALVES:
Gate valves shall be resilient wedge type, manufactured to meet or exceed the requirements of AWWA C509 and in accordance with the following Specifications. Valves shall be flanged. Valves shall have an unobstructed waterway equal to or greater than the full nominal diameter of the valve. Valves shall be suitable for passage of a pipeline cleaning device (Pig).

The valves are to be non-rising stem with the stem made of cast, forged, or rolled bronze or stainless steel as per AWWA C509. Two stem seals shall be provided and shall be of the O-ring type.

The stem nut, also made of bronze, may be independent of the gate or cast integrally with the gate. If the stem nut is cast integrally, the threads shall be straight and true with the axis of the stem to avoid binding during the opening or closing cycle.

The sealing mechanism shall consist of a cast iron gate having a vulcanized synthetic rubber coating or a rubber seat mechanically retained on the gate. The resilient sealing mechanism shall provide zero leakage at the design water pressure of 150 psi when installed with the line flow in either direction.

The valve body bonnet cover shall be cast iron ASTM A126, Class B. All internal and external surfaces shall be coated with epoxy to a minimum thickness of 8 mils.

Valves shall turn counterclockwise, or to the left, to open and shall be designed for manual operation with a valve wrench (2" square operating nut).

All bolts and nuts on valves shall be stainless steel.
All valves are to be tested in strict accordance with AWWA C509.
VENTURI METER WITH FLOW CONTROL VALVE

Meters shall be purchased as a complete unit to ensure suitable design for the conditions. The venturi shall have a flanged iron body and a stainless steel throat. The venturi shall include inspection ports. The meter shall be provided with fusion bonded epoxy lining and coating systems installed per the manufacturer’s recommendations. The venturi shall have a Beta ratio of 0.5 and a turn-down of 10:1. The Butterfly flow control valve shall be in accordance with AWWA C504. The valve shall include an electric motor operator or a pneumatic operator to suit the system, and suitable for modulating service. The venturi shall have a standard 25-year warranty and the valve/operator combination a 5-year warranty.

BUTTERFLY VALVES

Butterfly valves shall conform to AWWA C504, latest revision, with rubber seat, tight closing. Valves shall be bubble-tight at rated pressures in either direction and shall be satisfactory to applications involving throttling service and/or operation and for applications involving valve operation after long periods of inactivity. Valves shall be flanged 125 psi ANSI standard where specified. Valve bodies shall be close grained high tensile strength cast iron (ASTM A126-Class B) with a one-piece stainless steel type 304 shaft. Discs shall be Ni-Resist bronze or cast iron (ASTM A48-Class 40) with an attached bronze disc ring. All seats shall be of synthetic rubber compound. Seats shall be retained in the valve body by mechanical means. The bearings shall be self-lubricating and corrosion resistant. Valve operations shall conform to AWWA standard C504 and shall be designed to hold the valve in any intermediate position between full open and fully closed without creeping or fluttering. Traveling nut or worm gear operators with extension shaft and 2" square AWWA nut suitable for buried service shall be provided. All buried operators shall be lubricated for the life of the valve. All bolts, nuts, studs and washers, except for internal components, shall be stainless steel.

PLUG VALVES

Plug valves shall be non-lubricated, eccentric type with resilient seats. Bodies shall be of cast iron with bolted bonnets. Plug valves shall be rated for 12 bar working pressure. Plug valve port area shall not be less than 80 percent of pipe’s area. Valve seats shall be neoprene or Buna-N rubber, held by means of 316 stainless steel seat ring and screws. Plugs shall be coated and mating seats shall be at least 90 percent pure nickel welded into the body. Upper and lower journal bearings shall be permanently lubricated 316 stainless steel and shall be removable. Stem seals shall be replaceable without valve disassembly. Each valve shall be equipped with a gear operated handwheel, including totally enclosed worm gear, adjustable open and close stops, permanent lubrication, and watertight enclosure.

BALL VALVES

Ball valves shall be type 316 stainless steel body with screwed or flanged ends. Ball and stem shall be type 316 stainless steel and seat shall be TFE.
VALVE BOXES

Valve boxes shall be provided of sufficient diameter and length to operate all valves buried in the ground shall be marked "WATER". The boxes shall rest on the valve and be adjusted so that the cover may be set flush with existing ground surface sidewalk, or paved street. The base shall be centered over the valve, and the top of the base section shall be approximately on line with nut at top of valve stem. Valve boxes shall be Mueller Co. No. H10360, or equal.

407 HANDLING AND CUTTING PIPE

Any fitting showing a crack and any fitting or pipe which has received a blow that may have caused incipient fracture even though no such fracture can be seen, as determined by the Engineer, shall be marked as rejected and removed from the Work.

Any pipe showing a distinct crack in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved, may be cut off by and at the expense of the Contractor before the pipe is laid so that the pipe used will be perfectly sound, if approved by the Engineer. The cut shall be made in the sound barrel at a point at least 12 inches from the visible limits of the crack. The use of such pipe is at the Contractor's risk.

All cutting shall be done with a machine having steel cutters or knives adapted to the purpose. All cut ends shall be examined for possible cracks caused by cutting.

408 INSTALLATION

General

(a) All required pipe fittings are NOT shown on the Drawings. The Contractor shall determine the required fittings for a complete operating unit and shall furnish and install all pipe and fittings as necessary to provide a complete and operable installation.

(b) The Contractor may make minor adjustments to the piping layouts to suit field conditions, however, if the Contractor desires to make a major change to the piping layouts shown on the Contract Drawings, Contractor shall submit to the Engineer for approval its reasons for the change and a detailed layout of the proposed change.

(c) All pipe must have burrs removed from the ends and no bending will be allowed where fittings can be used. All piping shall be erected to accurate lines and grades and shall be supported as shown on the Contract Drawings or as specified herein. Where temporary supports are used, they shall be sufficiently rigid to prevent any shifting or distortion of the pipe.

(d) All pipe and fittings shall be installed with the insides free of any dirt, rocks, construction material or debris of any kind, and if any pipe system is found to contain such material, the Contractor may be required to remove, clean, and reinstall the entire system.
(e) The Contractor shall take special care to see that all piping is installed complete before the final connections to the equipment are bolted together so that after such final connections are made, no undue strain will be placed on the equipment. Castings to be encased in concrete shall be accurately set with bolt holes, if any, carefully aligned.

(f) Earthwork for buried pipes shall be as specified in Section 300.

(g) The water main valve boxes shall be constructed and installed at the locations shown on the drawings.

MECHANICAL AND PUSH-ON JOINTS.

(a) Mechanical and push-on joints shall be made up according to AWWA C600.

THRUST BLOCKS AND RESTRAINING JOINTS (ANCHORING FITTINGS).

(a) All plugs, caps, tees, bends, fire hydrants, etc., shall be provided with concrete thrust blocks. 500 psi soil pressure shall be used for sizing of concrete blocks.

(b) Restraining joint device shall be used when soil conditions do not allow the use of concrete thrust blocks in the opinion of the Engineer.

PLUGS, CAPS AND BLIND FLANGES.

(a) Standard restrained plugs shall be inserted into the bells of all dead end pipes, tees or crosses, spigot ends shall have restrained caps, flange ends shall have suitable blind flanges except where thrust blocks are indicated on the Contract Drawings.

PIPE SUPPORTS

Aboveground piping shall be suspended and supported to prevent sagging or over stressing of the pipe or its connections and to prevent the transfer of loads and strain to connected equipment.

Hangers and supports for exposed piping shall be provided at the base of all risers and in close proximity to all flexible joints.

Where concrete supports are used to support the pipe, the supports shall be constructed 25mm lower than the pipe and the pipe grouted in place with non shrink grout. Non shrink grout shall also be used under floor flanges to provide a level bearing and floor flanges shall be fastened to the floor with anchor bolts. Pipes supported on concrete supports shall be clamped to the concrete with stainless steel straps and anchor bolts.
All pipes which are not able to resist axial tension shall be properly blocked or supported with steel struts whenever the pipeline changes direction or size or is terminated. Exposed pipe shall be blocked or tied.

409 PRESSURE TESTING

TESTING OF PIPELINES

1 Testing of pipelines shall be strictly in accordance with these specifications.

2 All anchor blocks, thrust blocks etc., shall be complete and thrust blocks shall be provided at test points. The section of main should be backfilled over the middle of the pipes, leaving the joints exposed, before testing.

3 It is recommended that a short section of pipeline be tested at the commencement of pipe laying so that any faults in laying or jointing techniques can be detected and corrected at an early stage.

4 The cost of thrust blocks provided at pipe ends for testing purposes only shall be deemed to be included in the pipeline rates.

5. The contractor should ensure that his pressure testing apparatus can accommodate a pressure logger provided by GWI. It is the contractor’s responsibility to obtain the logger requirements. This Logger is to be used for all pressure tests and should be installed 30mins before the commencement of the test period and remain installed 60mins after the completion of the test period. No tests will be accepted without the logger information is retrieved for the period of the tests.

TESTING PRESSURE LINES

1 Pipelines shall be tested hydraulically in sections during the course of construction. Testing shall follow immediately after pipe laying and in no circumstances will pipe laying be permitted in excess of 1000 metres ahead of a satisfactory Interim Test.

2 Testing shall be applied to prove the structural soundness of the various units in the line, including pipes, valves and anchorages and to prove the water tightness of the line.

3 The Contractor shall provide pumps, gauges, jacks, struts and all apparatus necessary for carrying out the tests and shall keep them in good order. The gauges shall not be less than 75 mm diameter, calibrated in metres head of water or psi, and a dated certificate of its accuracy shall be provided.

4 The Contractor shall provide for transmitting the unsupported end thrusts to solid ground at the ends or into the sides of trenches. Before testing, he shall ensure that the anchorage of bends is complete and that all branch outlets taking end thrust are properly stayed.
5 Testing shall not be permitted against a closed valve. In-line valves shall be left open. Terminal valves, hydrants, scour valves and the isolating of air valves shall be open, and shall be fitted with blank flanges except that where air valves are already fitted they shall be in service during the test. Scourtail pipes shall be connected only after pipeline testing is complete.

6 Water required for filling and testing the main shall be obtained from an approved source.

7 The Contractor shall give GWI not less than 48 (forty eight) hours notice of his intention to test a section of main.

8 The test pressure shall be as the minimum of 1.5 times the maximum operating pressure or 65 metres head whichever is greater.

9 When testing, the pipeline shall be charged with water and all air released. Care shall be taken during the charging of the mains to provide free outlets for air to prevent surging and water-hammer. The pipeline shall be brought up to and maintained at operating pressure and left for a period of 24 hours to allow for absorption and to achieve stable conditions. Thereafter water shall be added by pumping until the test pressure is reached in the lowest part of the section. The pump shall then be disconnected and no further water shall be pumped into the pipeline for the period of the test. One hour shall be used as the test period for an interim test and four hours shall be used as the test period for a final test. At the end of each of these periods the original pressure shall be restored by pumping, and the loss measured by drawing off water from the pipeline until the pressure as at the end of the test is reached.

The permissible loss shall not exceed 2 litres per metre nominal bore per kilometre length per metre head (calculate as the average head applied to the section) per 24 hours. The pressure information shall be used from the pressure loggers.

10 Interim tests shall be applied to sections of all continuous pipelines in lengths not exceeding 1000 metres before pipe-laying on the next section may commence. After the satisfactory completion of the first such sectional test on each continuous pipeline, such length may, at the Engineer’s discretion be increased to 1500 metres. The first Sectional Interim Test on each continuous length of pipeline shall be carried out after the bedding of the pipeline and after such partial backfilling as is necessary to provide 300 mm depth of material over the crown of the pipe, subject to the joints being left exposed.

Subsequent interim tests may, at the discretion of the Supervisor, be carried out with the trench backfilled (except for the replacement of soil or turf).

In the case that a section of the network needs to be placed in service, then the Engineer may approve that this section be tested as a final test and no further tests may be needed for the section. Once the test is successful and disinfection completed, the
pipelines may be placed into service with guidance from the Engineer. The costs associated with interconnection to the network shall be borne by the Contractor.

11 On completion of each continuous length of pipeline and completion of service connections, the pipeline shall be subject to a final test as a whole or such parts of the whole as the Engineer may require.

12 If in the course of any test, the amount of make-up water in the specified test period exceeds the specified quantity, the Contractor shall locate and remedy the leaks causing such exceedence and shall repeat any such test until the specified degree of water tightness shall have been obtained. Remedial measures to stop leakage shall not infringe or be inconsistent with any relevant part of the Specification.

13 The Contractor shall ensure that no erosion or silting occurs in water courses from the discharge of test water.

14 On completion of the interim test the pipeline shall remain full of water and a minimum of 1 bar shall be maintained until the pipeline is handed over to the Employer.

**410 DISINFECTION**

1. All new water pipe, fittings, and valves shall be disinfected with chlorine after the pressure test has been completed.

2. The disinfection shall be in conformance with the standard of AWWA A651, latest revision.

3. Flushing. Sections of pipe to be disinfected shall first be flushed to remove any solids or contaminated material that may have become lodged in the pipe. If no hydrant is installed at the end of the main, then a tap should be provided large enough to develop a velocity of at least 2.5 feet per second in the main.

4. Point of Application. The preferred point of application of the chlorinating agent is at the beginning of the pipe line extension or any valved section of it and through a corporation stop inserted in the pipe. The water injector for delivering the chlorine-bearing water into the pipe should be supplied from a tap made on the pressure side of the gate valve controlling the flow into the pipe in extension. Alternate points of application may be used when approved or directed by the Engineer.

5. Preventing Reverse Flow. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valve may be used if desired.

6. Retention Period. Treated water shall be retained in the pipe at least 24 hours. After the period, the free chlorine residual at pipe extremities and at other representative points shall be at least 10 mg/l.
7. Chlorinating Valves and Hydrants. In the process of chlorinating newly laid-pipe, all valves or other appurtenances shall be operated while the pipe line is filled with the chlorinating agent and under normal operating pressure.

8. Final Flushing and Testing. Following chlorination, all treated water shall be thoroughly flushed from new laid pipe at its extremity until the replacement water throughout its lengths shows upon test, a chlorine residual of less than 1 mg/l. In the event chlorine is normally used in the source of supply, then the test shall show a residual of not in excess of that carried in the system. After flushing, water samples collect on 2 successive days from the treated piping system, directed by the Engineer, shall show satisfactory bacteriological results.

A laboratory certified by the Guyana Water Inc. at the Contractor’s expense must perform the bacteriological analysis. Should the initial treatment result in an unsatisfactory bacterial test, the Contractor shall repeat the original chlorination procedure until satisfactory results are obtained.

9. Chlorinated flushing water shall be disposed of in accordance with applicable laws and regulations.

WARRANTY

All items of equipment provided shall have Guarantees/Warranties from the supplier and manufacturer. However, the Contractor shall have sole responsibility for the replacement/repair of defective items for the period of defects liability specified in the Special Conditions of Contract.
SECTION 500 - ROADWORKS

501 CLEARING, GRUBBING AND EXCAVATION

DESCRIPTION
The work specified in this Section consists of clearing and grubbing, within the areas of the roadway right of way and of borrow pits. Included in the work under this Section is the removal and disposal of all trees, stumps, roots and other such protruding objects, appurtenances, existing pavement, and structures and other facilities necessary to prepare the area for the proposed construction, and the removal and disposal of all products, materials and debris which are not required to be salvaged or not required to complete the construction.

STANDARD CLEARING AND GRUBBING

WORK INCLUDED
Standard Clearing and Grubbing shall consist of the complete removal and disposal of all timber, brush, stumps, roots, rubbish and debris and all other obstructions resting on or protruding through the surface of the existing ground and the surface of excavated areas, and of all other obstructions necessary to be removed and for which the removal thereof is not specified to be done under other items of the contract.
Standard Clearing and Grubbing shall be done within the following areas:

A. All areas where excavation is to be done, including borrow pits, lateral ditches, right of way ditches, etc.
B. All areas where roadway embankments will be constructed.
C. All areas where structures will be constructed, including pipe culverts.

All Grubbing and excavation for roadway preparation shall be conform to the grades and lines as per cross section.

DEPTHS OF REMOVAL OF ROOTS, STUMPS AND OTHER DEBRIS
In all areas where excavation is to be done and where the excavated material is to be used in the construction of roadway embankment or roadway base or pavement; also in all areas where roadway embankments will be constructed; roots and other debris shall be removed to a depth of at least 300 mm below the existing ground surface. The surface shall then be plowed to a depth of at least 150mm and all roots thereby exposed shall be removed to a depth of at least 300mm. All stumps within the roadway right of way shall be completely removed and disposed of by the Contractor.

Where excavation is done within the roadway area and where excavation for structures is done, all roots, etc., protruding through or appearing on the surface of the completed excavation shall be removed to a depth of at least 300mm below the excavation surface.
In borrow pits, material pits and lateral ditches, all stumps, roots, etc., protruding through or appearing on the surface of the completed excavation shall be removed or cut off below the finished excavation surface.

Within all other areas where Standard Clearing and Grubbing is to be done, roots and other debris, projecting through or appearing on the surface of the original ground, shall be removed to a depth of 300mm below the surface, but no plowing and harrowing will be required in these areas.

**TREES TO REMAIN**

As an exception to the above provisions, where so directed by the Engineer, desirable trees within the roadway area shall be trimmed, protected and left standing. Branches of trees extending over the area occupied by the roadway shall be trimmed as directed, to give a clear height of 5 meters above the roadway.

**BOULDERS**

Any boulders encountered in the roadway excavation, or found on the surface of the ground, shall be removed and placed in neat piles inside the right of way and adjacent to the right of way line. Boulders encountered in Ministry-furnished borrow areas, which are not suitable for use in the embankment construction, may be stockpiled within the borrow area.

**SELECTIVE CLEARING AND GRUBBING**

Selective Clearing and Grubbing shall consist of removing and disposing of all vegetation, obstructions, etc. as provided above except that, where the Contractor so elects, roots, etc., may be cut off flush with the ground surface. Stumps 80mm in diameter or larger shall be completely removed and disposed of by the Contractor. Undergrowth shall be entirely removed except in specific areas designated by the Engineer to remain for aesthetic purposes. Desirable trees shall be trimmed, protected and left standing, with the exception of such trees as the Engineer may designate to be removed in order to facilitate right of way maintenance. Undesirable or damaged trees (as so designated by the Engineer), shall be removed.

**DISPOSAL OF MATERIALS**

**GENERAL DISPOSAL**

Timber, stumps, brush, roots, rubbish, and other objectionable material resulting from clearing and grubbing shall be disposed of by the Contractor in locations and by methods approved by the Engineer and in conformity with the requirements of the Environmental Management Plan. Waterways shall not be blocked by the disposal of debris.

**BURNING DEBRIS**

Where burning of such materials is permitted all such burning shall be subject to applicable laws, ordinances and regulations and shall be done at locations where trees and shrubs adjacent to the cleared area will not be harmed.
Where burning is prohibited by law, ordinance, or regulation, the Contractor shall dispose of the materials within areas provided by him and approved by the Engineer.

**DISPOSAL IN AREAS ADJACENT TO PROJECT**

Materials may be disposed of on private property, provided the Engineer is furnished with a written statement from the owner of the property giving permission for the disposal of the materials on his property. All disposal areas for materials resulting from clearing and grubbing, both on private property and on property owned by the Contractor, shall be in areas out of sight of the project and at least 100m from the nearest roadway right of way line of the project, unless such materials are buried, in which case the requirement that the areas be 100m distant will be waived.

**MISCELLANEOUS OPERATIONS**

**LEVELING OF TERRAIN**

Within the areas between the limits of construction and the outer limits of clearing and grubbing, all holes and other depressions shall be filled and all mounds and ridges cut down, and the area shall be brought to sufficiently uniform contour that the Ministry's subsequent mowing and cutting operations will not be hindered by irregularity of terrain. This work shall be done regardless of whether the irregularities were the result of the Contractor's operations or existed originally. Permanent ponds or other permanent water areas, as so designated by the Engineer, will not be required to be filled.

**BASIS OF PAYMENT**

The quantity of Clearing and grubbing to be paid shall be the number of square metres. Payments items will be as follows:

a. site clearing – sqm.
b. Grub and excavate to formation level and compact subgrade-Sqm

### 502 CLAY BLANKET

**DESCRIPTION**

The work specified in this Section consists of placing of a layer of select material favorable to plant growth, over areas of the project which are to be grassed, grassed and mulched or sodded. This shall be accomplished by use of a clay blanket.

The Engineer may delete this work over areas of the project where a suitable growing medium for grass or sod is attained as a result of normal grading operations.
MATERIALS
Clay material shall be suitable for plant growth and free from appreciable quantities of hard clods, stiff clay, hardpan, gravel, brush, large roots, refuse or other deleterious materials, and of reasonably uniform quality.

The clay material may be obtained from any or a combination of the following sources:

(a) Excavation within the road right of way
(b) Lateral ditch excavation
(c) Borrow pits provided by the Contractor.

The materials obtain from sources (a) or (b) may be stockpiled or windrowed on the project in areas approved by the Engineer. The Contractor shall prepare plans of borrow areas and obtain the Engineers approval prior to borrow excavation.

CONSTRUCTION METHODS

PREPARATION OF AREAS
Prior to placing the clay blanket, the surface of the earthwork shall have been constructed to such lines and elevations as will provide a surface conforming to the typical sections upon completion of the clay blanket or topsoil operations.

BASIS OF PAYMENT
The quantity of construction to be paid shall be the number of cubic metres acceptably placed and compacted. The material shall be measured in its final position on a prepared foundation to level and grades as specified.

503 WHITE SAND SUBBASE

DESCRIPTION
The work specified in this Section consists of the construction of a sub- base course composed of white sand, on the prepared sub-grade, in accordance with these specifications and in conformity with the lines, grades, notes and typical cross sections shown in the plans. When the specified compacted thickness of the sub-base is greater than 150 mm the sub-base shall be constructed in two or more courses; otherwise the base may be constructed in either one or two courses.

MATERIAL

GENERAL
The material used shall conform to the following:
For white sand not more than 15% passing the No. 200 sieve; C.B.R. value to be not less than 25% when compacted in accordance with AASHTO T180 and tested after soaking for four days. In addition, the white sand shall be non-plastic and the liquid limit must not exceed 25%.

Before any sub-base course material is used it shall first have been tested by the laboratory and approved by the Engineer.

PLACING MATERIALS
Sub-base is to be constructed in two or more courses, the component courses shall be approximately equal in thickness and the compacted thickness of any layer laid, processed and compacted at one time shall not exceed 150 mm.

COMPACTION
The material shall have approximately the optimum moisture content and the proper loose consistency, as determined by the Engineer, before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to insure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by diskng the base course to its full depth. If the material contains an excess of moisture, it shall be cause to dry before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the base as a unit. As soon as proper conditions of moisture are attained each course shall be compacted to a density not less than 98 per cent of the maximum density as determined by AASHTO T180. The minimum density which will be acceptable at any location outside the traveled roadway (such as intersection turnroads, etc.,) shall be 95% of such maximum.

Prior to the placing of material for the overlying course, the density tests shall have been made on the lower course and the Engineer shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, diskng, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

TESTING SURFACE
The finished surface of the sub-base course shall be checked with a template cut to the required crown and with a 3 mm straightedge laid parallel to the center line of the road. All irregularities greater than 6 mm shall be corrected by scarifying, and removing or adding base material as may be required, after which the entire area shall be re-compacted to meet the specified density requirements.

THICKNESS OF SUB-BASE
A 10 mm under-tolerance in the thickness of the sub-base will be allowed. All areas where the thickness of the completed sub-base is less than the thickness required after such tolerance, shall be corrected by scarifying, adding base material and recompacting as specified in 3-4.
DENSITY CONTROL
The in place density of each layer shall be determined as specified by the ASTM Standards D2922, D 3017 and/or C1040.

BASIS OF PAYMENT
The quantity of subbase construction to be paid shall be the number of cubic metres acceptably placed and compacted. The material shall be measured in its final position on a prepared foundation to level and grades ass specified.

504 SAND CLAY/WHITE AND REEF-SAND/WHITE BASE AND SUB-BASE

DESCRIPTION
The work specified herewith consists of the construction of a base/sub-base composed of a mixture of suitable sand clay and white sand or reef-sand and white-sand, blended in suitable proportions to achieve the desired characteristics. The materials shall be free from roots and other deleterious matter.

MATERIAL
The materials shall meet the following requirements:

GENERAL REQUIREMENTS
Material for use in the construction shall be a suitable mixture of sand-clay and white sand or reef-sand or white sand as shown on drawings and shall be free of trash, foreign matter and other deleterious material. It shall not contain lumps or aggregate of such nature or in sufficient quantity to prevent the obtaining of a smooth surface, free from pits and pockets. It shall not contain particles of aggregate which will not pass a 25mm (1 inch) sieve.

C.B.R. AND PLASTICITY
The CBR of the mixture shall not be less than 25 % when compacted in accordance with AASHTO T 180 and tested after soaking for four days. The Plasticity Index of the material shall not exceed 6, and the liquid limit must not be greater than 25 %.
SOURCE OF MATERIAL

PLACING MATERIAL
The material may be dumped directly on the base/subbase but shall be uniformly distributed by approved methods. The loose thickness shall be as designated by the Engineer and shall be checked continuously by the Contractor to ensure that the finished base/subbase will have the thickness and shape required by the typical section.

CONSTRUCTION
If two or more materials have to be blended to produce the required base/subbase material, it shall be ensured that uniformity of mix has been attained after the completion of mixing.

COMPACTION
The material shall have approximately the optimum moisture content and the proper loose consistency, as determined by the Engineer, before being compacted. Wetting or drying will be required when the material does not have the proper moisture content to insure the required density. If the material is deficient in moisture, water shall be added and uniformly mixed-in by disk ing the base course to its full depth. If the material contains an excess of moisture, it shall be cause to dry before being compacted. Wetting or drying operations shall involve manipulation of the entire width and depth of the base as a unit. As soon as proper conditions of moisture are attained each course shall be compacted to a density not less than 95% of the maximum density as determined by AASHTO T180. The Engineer may permit lower densities at any location outside the traveled roadway (such as intersection turn-roads, etc.,).

Prior to the placing of the subsequent course, the density tests shall have been made on the lower course and the Engineer shall have determined that the specified compaction requirements have been met. In the compaction of the upper course the operations of wetting, disk ing, etc., shall not be such as to disturb the density in the lower course. The density shall be determined separately for each layer.

TESTING SURFACE
The finished surface shall be checked with a template cut to the required crown and with a 4 m straightedge laid parallel to the center line of the road. All irregularities greater than 6 mm shall be corrected by scarifying, and removing or adding base material as may be required, after which the entire area shall be recompacted to meet the specified density requirements.

THICKNESS OF BASE/SUBBASE
A 10 mm under-tolerance in the thickness of the base/subbase will be allowed. All areas where the thickness of the completed base/subbase is less than the thickness required after such tolerance, shall be corrected by scarifying, adding base material and recompacting as specified in 4-4.
BASIS OF PAYMENT
The quantity of subbase construction to be paid shall be the number of cubic metres acceptably placed and compacted. The material shall be measured in its final position on a prepared foundation to level and grades as specified.

505 CRUSHED STONE

DESCRIPTION
The material shall consist of suitable crushed stone which shall be free from any deleterious matter.

GRADATION REQUIREMENTS

<table>
<thead>
<tr>
<th>A.S.T.M Sieve No.</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 mm</td>
<td>100</td>
</tr>
<tr>
<td>25 mm</td>
<td>80-100</td>
</tr>
<tr>
<td>19 mm</td>
<td>70-90</td>
</tr>
<tr>
<td>12.5 mm</td>
<td>55-80</td>
</tr>
<tr>
<td>No.4</td>
<td>35-60</td>
</tr>
<tr>
<td>No.8</td>
<td>25-50</td>
</tr>
<tr>
<td>No.30</td>
<td>12-30</td>
</tr>
<tr>
<td>No.200</td>
<td>5-10</td>
</tr>
</tbody>
</table>

C.B.R. REQUIREMENTS
Not less than 61% when compacted in accordance with AASHTO T99, Method C, and tested after soaking for four days.

COMPACTION
All compaction shall be done at optimum moisture content, as determined by AASHTO T99, Method C. The density shall not be less after compaction than 96% of the maximum dry density as determined by AASHTO T99, Method C.

TESTING SURFACE
The finished surface shall be checked with a template. All irregularities greater than 6mm shall be corrected by scarifying, and removing and adding material as may be required, after which the entire area shall be recompressed to meet the specified density requirements.
THICKNESS
A 12 mm under-tolerance in the thickness will be allowed. All areas where the thickness is less than required after such tolerance, shall be corrected by scarifying, adding material and recompacting as specified in 6.4.

METHOD OF MEASUREMENT
The quantity of crushed stone to be paid for under this section shall be the volume in cubic metre completed and accepted.

BASIS OF PAYMENT
The quantity crusher run, determined as provided above, shall be paid for at the contract unit price per Ton. Such price and payment shall be full compensation for all the work specified in this section, and shall include all materials, equipment, hauling, etc.

Payment shall be made under:
Crushed stone - Ton.

SAND SEAL COAT

DESCRIPTION
Provide and construct sand seal coat composed of bituminous material applied in one application and covered with sand cover material applied in a single application. Construct this work on cement-treated sub-grade or other surfaces as specified or where directed.

PROPORTIONING
Use the approximate proportions for the sand seal coat as follows:
Bituminous Material..0.6 to 1.0 L/yd2 (0.15 - 0.25 gal/yd2)
Cover Material........0.003 to 0.007 m3/m2 (0.10 - 0.20 ft3/yd2)]
The Engineer will designate the actual spread for each material.

MATERIALS
Bituminous material to meet the following requirements:
Asphalt cement: viscosity grade AC-5 to meet requirements of AASHTOM226.
Emulsified asphalt: grade RS-2 to meet requirements of AASHTOM140.
Cut back asphalt: RC-250
Use asphalt cement or emulsified asphalt at Engineers’ option.
COVER MATERIAL
Use clean and nonplastic sand composed of hard durable grains and free from loam, roots, clay balls, and other deleterious substances. The Contractor may use local sand if it meets the above requirements. Obtain the Engineer's approval of the sand.

WEATHER LIMITATIONS
Do not apply bituminous material when the air temperature in the shade and away from artificial heat is less than 15ºC (60ºF) at the location where the application is to be made, or when weather conditions or the surface conditions are otherwise unfavorable.

Construction Methods

APPLICATION OF BITUMINOUS MATERIAL
Distributor Pressure
After the surface to be treated has been cleaned to the satisfaction of the Engineer, the bituminous material shall be sprayed uniformly over the surface by means of a pressure distributor. When a surface constructed under this Section is on a paved shoulder, the Contractor shall use a string line or other approved method, to produce a uniform line along the edge of the applied bituminous material, adjacent to the traffic lanes. The distributor used for applying the bituminous material shall maintain a pressure of at least 20, but not more than 75, pounds per square inch.

Application Temperatures
For asphalt cement, Viscosity Grade AC-5, the application temperature shall be between 300 and 350º F; for emulsified asphalt, between 100º and 170º F; and for cut-back asphalt, between 175º and 275ºF.

Uniformity of Distribution
Special precautions shall be observed to assure that an even and uniform distribution of bituminous material will be obtained, and the distributor shall be so adjusted and operated as to maintain uniform, even distribution of the type of material being applied. Excessive deposits of bituminous material upon the road surface, caused by stopping or starting the distributor, but leakage, or otherwise, shall be immediately removed.

Limitations to Application
The area to be covered by any one application of bituminous material shall be not greater than can be covered with the aggregate without interruption due to limitations of hauling and spreading equipment or to any other cause.

For double application surface treatments, the second application of bituminous and cover materials shall be applied the same day as the first application, as far as is practicable and consistent with the curing requirements specified in 12-11.
APPLICATION OF COVER MATERIAL
Apply sand uniformly at the rate designated by the Engineer. If the Engineer considers it necessary for the proper distribution of the spread, lightly drag the sand with a drag broom. Roll the entire area of the sand with at least ten passes of a traffic roller.

PRIME AND TACK COATS

DESCRIPTION
Apply bituminous prime coat on previously prepared non asphaltic bases and apply bituminous tack coat on previously prepared asphaltic or impervious bases and on existing pavement surfaces. All such work shall be accomplished in accordance with these specifications and in conformity with the lines, dimensions and notes shown in the plans or as directed by the Engineer.

MATERIALS

PRIME COAT
The asphalt shall be shall be Emulsified Asphalt, Grades RS-2, SS-1 or SS-IH, meeting the requirements of 20-4 or as approved by the Engineer

COVER MATERIAL FOR PRIME COAT
The cover material shall be either sand (bare or hot-asphalt coated) or screenings, at the Contractor's opinion. The sand shall be nonplastic and free from any appreciable amount of silt, clay balls and root particles, and from any noticeable sticks, trash, vegetation or other organic matter. Screenings shall be rock screenings, or other rock screenings approved by the Engineer for this use.

TACK COAT
Unless a specific type or grade of material is called for in the plans or special provisions, the material used for tack coat shall be Emulsified Asphalt, Grades RS-2, SS-1 or SS-IH, meeting the requirements of 20-4 or as approved by the Engineer.

EQUIPMENT

PRESSURE DISTRIBUTOR
The Pressure distributor shall be equipped with pneumatic tires having a sufficient width of rubber in contact with the road surface to avoid breaking the bond or forming a rut in the surface. The distance between the centers of openings of the outside nozzles of the spray bar shall be equal to the width of the application required, within an allowable variation of two inches. The outside nozzle at each end of the spray bar shall have an area of opening not less than 25 per cent nor more than 75 per cent, in excess of the other nozzles. All other nozzles shall have uniform openings. When the application covers less than the full width, the normal opening of the end nozzle at the junction line may remain the same as those of the interior nozzles.
SAMPLING DEVICE ON TRANSPORT TANKS
All transport tanks delivering bituminous materials for use on the project shall be equipped with an approved spigot-type sampling device.

CLEANING BASE AND PROTECTION ADJACENT WORK
Before any bituminous material is applied, all loose material, dust, dirt, caked clay and other foreign material which might prevent proper bond with the existing surface shall be removed for the full width of the application. Particular care shall be taken in cleaning the outer edges of the strip to be treated, to insure that the prime or tack coat will adhere.

When the prime or tack coat is applied adjacent to curb and gutter, valley gutter or any other concrete surfaces, such concrete surfaces (except where they are to be covered with a bituminous wearing course) shall be covered with heavy paper, or otherwise protected as approved by the Engineer, while the prime or tack coat is being applied. Any bituminous material deposited on such concrete surfaces shall be removed.

WEATHER LIMITATIONS
Prime and tack coats shall be applied when all other weather conditions and the condition of the surface are suitable.

APPLICATION OF PRIME COAT

GENERAL
The surface to be primed shall be clean and the moisture content of the base shall not exceed 90 per cent of the optimum moisture. The temperature of the prime material shall be between 380 °C (100 °F) and 650 °C (150 °F). The actual temperature shall be that which will insure uniform distribution, and will be designated by the Engineer. The material shall be applied by means of a pressure distributor. The amount to be applied will be dependent on the character of the surface and shall be sufficient to coat the surface thoroughly and uniformly, with no excess.

RATE OF APPLICATION OF PRIME COAT
The rate shall be not less than 1.2–1.6 liters (0.3 to 0.4 Imp gallons) per square Yard.

SPRINKLING
If so required by the Engineer the base shall be lightly sprinkled with water and rolled with a traffic roller, in advance of the application of the prime.

SANDING
The primed base shall be covered by a light uniform application of cover material. If considered necessary for proper distribution of spread, the cover material shall be lightly dragged with a drag broom, after which it shall be rolled with a traffic roller, for at least ten passes over the entire area.
APPLICATION OF TACK COAT

GENERAL
Where a bituminous surface is to be laid and a tack coat is required, the tack coat shall be applied as specified herein below.

METHOD OF APPLICATION
The tack coat shall be applied with a pressure distributor except that, on small jobs, if approved by the Engineer, application may be by other mechanical devices or by hand methods. The bituminous material shall be heated to a suitable temperature as designated by the Engineer and shall be applied in a thin, uniform layer.

RATE OF APPLICATION OF TACK COAT
The rate shall be not less than 1.2–1.6 liters (0.3 to 0.4 Imp gallons) per square Yard.

CURING AND TIME OF APPLICATION
The Engineer will designate the curing period for the tack coat. The tack coat shall be applied sufficiently in advance of the laying of the bituminous mix to permit drying but shall not be applied so far in advance that it might lose its adhesiveness as a result of being covered with dust or other foreign material.

PROTECTION
The tack coat surface shall be kept free from traffic until the subsequent layer of bituminous hot mix has been laid.

METHOD OF MEASUREMENT

GENERAL
This quantity of material actually applied and accepted shall be determined from measurements made by the Engineer.

SINGLE BITUMINOUS SURFACE TREATMENT

DESCRIPTION
The work in this section consists of the construction of a wearing surface composed of separate applications of bituminous material covered in aggregate, either in single applications, double (alternate) applications.

MATERIALS COMPOSITIONS AND PROPORTIONING
The materials used shall conform with the following requirements:
1) Bituminous Material – Bitumen binder shall be RC 250 or Asphalt Cement, Viscosity Grade AC-5 applied at a rate of 0.35 to 0.4 Imp. Gal per square yard.

2) Cover Materials- Uniform chipping of 3/8” nominal size spread at 35lbs per square yard or 60 square yard per ton.

**SPREADING EQUIPMENT**

Sufficient trucks and aggregate spreaders shall be at the site of the work to insure continuous spreading of the aggregate on the uncovered bituminous material. The spreader shall be of the mechanical type, shall be self-supported (towered), or self-propelled, and shall be capable of producing a smooth, uniform distribution of the cover material. Spreaders of the type attached directly to the rear of the truck body (tail gate spreaders) shall not be used.

**ROLLERS**

The rollers used for this surfacing shall be 3- to 5-ton steel-tires (or combination steel and rubber-tired) rollers, and self-propelled pneumatic-tired traffic type rollers equipped with at least seven smooth-tread, low pressure tires and capable of carrying a gross load of at least eight (8) tons. The inflation of the tires shall be maintained such that in no two tires shall the air pressure vary more than five pounds per square inch. The traffic roller shall be loaded as directed by the Engineer.

**LIMITATIONS TO WIDTH OF APPLICATION**

The application of bituminous cover shall be over the entire width to be treated unless, in the opinion of the Engineer, traffic conditions are not suitable for full width application, in which case the application shall be confined to one side of the road at one time, over such area as the economical distribution of the material form one delivery point will permit, leaving the opposite side open for traffic.

**PREPARATION OF ROAD SURFACE**

**CLEANING**

The surface to be covered shall be swept clean and free of sand, dirt, dust and other deleterious material, by means mechanical rotary sweepers, hand brooms or other approved methods, and shall be free from moisture.

**CONDITION OF UNDERLYING SURFACE**

Where a prime coat has previously been applied to the surface no bituminous material shall be applied until the prime coat has become thoroughly cured, as determined by the Engineer. Surface treatment shall not be applied over any pavement mixture when, due to heat from the sun or insufficient length of the curing period, the stability of the existing pavement is such as to allow penetration or displacement of the existing surface by the cover material during the rolling operations.
WEATHER LIMITATIONS
No bituminous material shall be applied when weather conditions are unfavorable or when the surface to be treated is wet.

APPLICATION OF BITUMINOUS MATERIAL

DISTRIBUTOR PRESSURE
After the surface to be treated has been cleaned to satisfaction of the Engineer, the bituminous material shall be sprayed uniformly over the surface by means of a pressure distributor. When a surface constructed under this Section is on a paved shoulder, the Contractor shall use a string line or other approved method, to produce a uniform line along the edge of the applied bituminous material, adjacent to the traffic lanes. The distributor used for applying the bituminous material shall maintain a pressure of at least 20, but not more than 75 pounds per square inch.

APPLICATION TEMPERATURES
For asphalt cement, Viscosity Grade AC-5, the application temperature shall be between 3000 and 2500 F; for emulsified asphalt, between 1000 and 1700 F; and for cut-back asphalt, between 1750 and 2750 F.

UNIFORMITY OF DISTRIBUTION
Special precautions shall be observed to assure that an even and uniform distribution of bituminous material will be obtained, and the distributor shall be so adjusted and operated as to maintain uniform, even distribution of the type of material being applied. Excessive deposits of bituminous material upon the road surface, caused by the stopping or starting of the distributor, leakages, or otherwise, shall be immediately removed.

APPLICATION OF AGGREGATE CHIPPINGS

SPREADING
The spreading of the cover material shall follow immediately after each application of bituminous material. The cover material shall be distributed uniformly over the bituminous material in one or two course, as specified. Spreading shall be done by means approved mechanical spreaders. Only drivers experienced in type of work shall be used in driving the spreaders (or trucks, when towed spreaders are used). Trucks or spreaders shall not be driven on the uncovered bituminous material.

BROOMING AND DRESSING
Immediately after each application of cover material, the surface shall be broomed, by experienced and skilled workmen, in order to secure a uniform distribution of cover material and a smooth surface. Additional aggregate shall be placed by hand on any areas not properly covered. If deemed necessary, the surface shall then be dragged with a light drag broom or other dragging equipment approved by the Engineer, of a type that will disturb the embedded aggregate. This operation shall be supplemented by additional hand brooming until a smooth and even surface is obtained. The dragging and brooming shall be repeated, in conjunction with the rolling, for as
long as required, to insure a uniform surface. These dragging requirements shall apply for each application of cover material.

ROLLING AND CURING
Immediately after spreading and dragging of each application of cover material the entire surface shall be rolled. The rolling shall begin within 30 minutes after spreading of cover material. Rolling shall begin at the edges and progress to the center of the surface, uniformly lapping each preceding track and covering thoroughly the entire surface. During rolling, additional dragging and hand brooming shall be done as specified in 7.8.

Rolling shall first be done with a traffic roller, followed immediately with a steel-wheeled roller. The entire surface shall be covered one time with the steel-wheeled roller. The cover material shall then be again rolled.

The rolling shall be continued as long as is necessary to insure thorough keying of the cover material into the bituminous material and to secure a uniformly closed surface.

SURFACE REQUIREMENTS
The finished surface shall be uniform and shall conform to the lines, grades, and typical cross section. Any portions of the completed surface which are defective, not properly finished, have fat joints, or are not in reasonably close conformance with these specifications, shall be replaced with satisfactory a surface laid in accordance with these specifications. In this care no compensation will be made for the replaced surface.

PROTECTION
After the application of bituminous material, traffic shall not be allowed to use the road until the cover material has been placed and thoroughly rolled. If practicable, traffic shall be kept off the finished surface for the first 48 hours after finishing is completed. Where it is impracticable to keep traffic off the finished surface for such a period, traffic shall be restricted to a maximum speed of 25 kilometres per hour during this time. For this purpose the Contractor shall furnish and maintain suitable barricades and lights, and shall provide watchmen and vehicles to lead traffic through the sections of the roadway being protected. At least two watchmen kept on duty continuously during this 48-hour restricted period and the number shall be sufficient to assure enforcement of the 25 kilometres per hour maximum speed.

PAYMENT ITEMS
Payment shall be made under:
Single Bituminous Surface Treatment – per Square Yard
SECTION 600 - CONCRETE FOR STRUCTURES

601 DESCRIPTION
This work shall consist of furnishing and placing Portland cement concrete for structures and incidental construction in accordance with these Specifications and in reasonably close conformity with the lines, grades and dimensions as shown on the drawings or established by the Engineer.

602 MATERIALS

CEMENT
All cement shall be Portland cement and shall conform to the requirements of AASHTO Specifications for Portland Cement, Type 1 (AASHTO M 85).

AGGREGATES

COARSE AGGREGATE

General
All course aggregate shall be washed and shall be free from disintegrated pieces, salt, alkali, vegetable matter and adherent coatings. The weight of extraneous substances shall not exceed the following percentages:

- Coal and lignite.................................1.00
- Coal lumps...........................................0.05
- Soft fragments..................................10.00
- Cinders and clinkers.........................0.50
- Free shells......................................1.00
- Sticks (wet).......................................0.03
- Material passing the No. 200 sieve........1.75

In addition, the sum of the percentage of all substances listed above shall not exceed ten.

Gravel
Stone shall be composed of clean, durable rock. The loss, when the stone is subjected to the Los Angeles Abrasion Test, shall not exceed 45 per cent.
The stone shall also comply with the soundness requirements as set out in Article 6.1 of AASHTO M 80; however, the test for soundness shall be made at the option of the Engineer.

The dry-rodded weight per cubic foot of the gravel, tested according to AASHTO T 19 shall be not less than 95 pounds.

**Grades of Coarse Aggregate**
The gradations for the various grades of coarse aggregate are as shown in the following table.

**COARSE AGGREGATE GRADATION**

Percent by weight of coarse aggregate passing square-opening laboratory sieves

<table>
<thead>
<tr>
<th>Square Mesh</th>
<th>Percentage by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>¾ inch</td>
<td>100</td>
</tr>
<tr>
<td>½ inch</td>
<td>90-100</td>
</tr>
<tr>
<td>3/8 inch</td>
<td>70-90</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-50</td>
</tr>
<tr>
<td>No. 10</td>
<td>0-8</td>
</tr>
<tr>
<td>No. 16</td>
<td>0-5</td>
</tr>
</tbody>
</table>

The above gradations represent the extreme limits for the various sizes indicated, which will be used in the determining the stability for use of coarse aggregate from all sources of supply. For any grade from any source, the gradation shall be held reasonably uniform and not subject to the extreme percentages of gradation specified above.

**FINE AGGREGATE**

Composition

Fine aggregate shall consist of approved sand composed only of hard, strong, durable, uncoated grains.

All fine aggregate shall be reasonably free from lumps of clay, soft or flaky particles, salt, alkali, organic matter, loam or other extraneous substances. The weight of extraneous substances shall not exceed the following percentages:

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material passing the No. 200 sieve</td>
<td>4.0</td>
</tr>
<tr>
<td>Shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Coal and lignite</td>
<td>1.0</td>
</tr>
<tr>
<td>Clay lumps</td>
<td>1.0</td>
</tr>
<tr>
<td>Cinders and clinkers</td>
<td>0.5</td>
</tr>
</tbody>
</table>
In addition, the sum of the percentages of all materials listed in the above table shall not exceed five.

**TEST REQUIREMENTS**

The fine aggregate shall be subjected to the calorimetric test for organic impurities, and if the color produced is darker than the standard solution, the aggregate shall be rejected unless it can be shown by appropriate tests that the impurities causing the color are not of a type that would be detrimental to the concrete. Such tests shall be in accordance with AASHTO Methods T 71 and M 6.

**GRADATION**

**Sand**

Fine aggregate shall be reasonably well graded from coarse to fine and when tested by means of laboratory sieves, it shall meet the following requirements, in percent of total weight:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>0 to 5</td>
</tr>
<tr>
<td>No. 8</td>
<td>0 to 15</td>
</tr>
<tr>
<td>No. 16</td>
<td>3 to 35</td>
</tr>
<tr>
<td>No. 30</td>
<td>30 to 75</td>
</tr>
<tr>
<td>No. 50</td>
<td>65 to 95</td>
</tr>
<tr>
<td>No. 100</td>
<td>93 to 100</td>
</tr>
</tbody>
</table>

The above gradation represents the extreme limits which will be used in determining the suitability for use from all sources of supply. The gradation from any one source shall be reasonably uniform, and not subject to the extreme range of gradation specified above. For the purpose of determining the degree of uniformity a fineness modulus determination shall be made upon representative samples, submitted by the contractor, from sources as he proposes to use.

Fine aggregate from any one source, having a variation in the fineness modulus greater than 0.20 either way from the fineness modulus of the representative sample submitted by the contractor, may be rejected.

**Water**

Water for mixing and for curing concrete, mortar and grout shall be free from objectionable quantities of oil, acid, chlorides, salts, organic matter, and other deleterious matter. The source of the water to be used shall be subjected to the Engineer's approval. Water from city water supplies or other sources which are approved by a public health
Acidity and alkalinity calculated in term of
Calcium carbonate 0.05%
Total organic solids 0.05%
Total inorganic solids 0.08%
Total chlorides as sodium chloride 0.05%

A period of ten days shall be allowed for tests on water after the sample has been received in the laboratory. Sea water is not to be used under any circumstances.

**Reinforcing Steel**

Reinforcement steel shall be plain or deformed mild steel or high yield deformed type bars meeting the requirements of ASTM A-305. The type of steel bars to be used shall be as shown on the drawings.

The steel shall be free from oil, dirt, and paint and any loose rust shall be removed before use. Except as specified below, all bending must be done cold.

The Contractor shall not pour any concrete before the Engineer has inspected and approved the placed and fixed reinforcement.

Such approval shall however not affect the Contractor's responsibility for the correctness of the reinforcement in accordance with the Drawings, Specification and/or directions given by the Engineer.

Any bars found on erection not full-filling their functions in the work shall be replaced at the Contractor's expense.

**Reinforcing Fabric**

The reinforcing fabric shall be No. 65 BRC fabric or equivalent laid in the bottom of the slab. The fabric shall be free from oil, dust and paint and any loose rust shall be removed.

**603 COVER OVER REINFORCEMENT**

Unless otherwise shown on the Drawings or directed by the Engineer the concrete cover to reinforcing bars shall be 2 inches.
604 CONSTRUCTION REQUIREMENTS

GRADING OF AGGREGATES

The grading of all aggregates shall be such as will produce an economic, plastic, practical, smooth, workable mix which when placed, set and cured will produce a concrete of the best character possible.

To secure such grading, the Engineer may require the Contractor to modify the aggregate by the addition or subtraction of proportions of specific sizes of material. The cost of making such modifications by screening or otherwise shall be included in the price bid by the Contractor.

CONCRETE MIX DESIGNS

The concrete mixture shall be proportioned so as to secure a workable, finishable, durable, watertight and wear resistant concrete of desired strength. Preliminary tests are to be carried out jointly by the Contractor and the Engineer to determine the mixes which will satisfy the Specification with the available material. In all cases and under all circumstances the contractor shall be solely responsible for the quality of the concrete.

Compliance with the requirements shall be determined in accordance with the following standard methods of AASHTO.
(a) Sampling fresh concrete- T141 (ASTM C172)
(b) Sieve analysis of fine and coarse aggregate - T127
(c) Slump of Portland Cement Concrete - T119 (ASTM C31)

Tests for strength shall be made in accordance with the following:
(d) Making and curing concrete comprehensive and flexural test specimens in the field - AASHTO T23 (ASTM C31)
(e) Compressive strength of molded concrete cylinders.
AASHTO T22 (ASTM C39)

FORM

Forms shall be so constructed that the finished concrete will conform with the shapes, lines, grade and dimensions indicated on the Plans.

Lumber used in forms shall be free from warp. For exposed surfaces it shall be dressed to a uniform width and thickness, and be free from lose knots, decay or other defects. For unexposed surfaces and rough work, undressed lumber may be used if means are taken to prevent leakage of mortar.
DEPOSITING CONCRETE
Concrete shall not be placed until all trades have completed their work and the Engineer has given his approval.

Concrete shall be deposited in form as nearly as practicable in its final position, to avoid rehandling and in approximately uniform horizontal layers. Depositing shall be continuous until the unit of operation, as approved by the Engineer is complete and as rapid as practicable to ensure bonding of the successive layers. All attempts should be made to avoid cold joint. When this cannot be avoided the Contractor shall provide construction joints as directed by the Engineer.

Concrete shall be thoroughly worked around reinforcement and embedded fixtures, and into all parts of the forms using a vibrator. Coarser particles shall be worked back from the face of the forms.

No concrete shall be deposited from a height of greater than 4ft. When the need arises suitable equipment shall be utilised to prevent segregation.

CURING CONCRETE
Concrete surfaces exposed to conditions causing premature drying shall be protected by covering as soon as possible with canvas, straw, burlap, sand or other satisfactory material and kept moist; or if the surfaces are not covered, they shall be kept moist; by flushing or sprinkling. Curing shall continue for a period of not less than seven (7) days after placing the concrete. If high-early strength cement is used, this period may be reduced as directed by the Engineer. Other precautions to ensure the development of strength shall be taken as the Engineer may direct. Any curing agents to be used instead of above methods must have prior approval of the Engineer in writing.
SECTION 700 – SERVICE CONNECTIONS AND METERING

SERVICE CONNECTION MATERIALS

SCOPE
This section specifies the general requirements for the supply of service connection materials and their installation.

STANDARD
It is the intent of the contract to supply materials that are of uniform standards throughout, from a dimensional and a performance perspective, to facilitate standards for replacements, spares, additions, joining of parts, or extensions.

COMPONENTS

GENERAL
The materials should be plastic and should not deteriorate easily when exposed to excess sunlight and it must be leak proof. Locking device must be present on male adapter and poly connector so as to secure the fitting when used from tamper.

All fittings must be tested to ensure integrity before handing over to the Guyana Water Inc.

POLYETHYLENE PUSH FIT MALE ADAPTOR (25MM PE X ¾” ME)
Manufactured to BS 6572 or BS 6730
This item should possess a push fit end for connecting 25mm HDPE pipe and a male NTP (IPS) threaded end (40 BS 21Taper) for connecting 25mm stop valve. Material to be delrin 107 black acetal homopolymer, ultra violet resistant UK WFBS listed. Male Poly Adaptor must be supplied with polyacetal gripping ring and ‘O’ ring EPDM or Nitrile elastomer UK WFBS listed.

POLYETHYLENE PUSH FIT FEMALE ADAPTOR (25MM PE X ¾” FE)
Manufactured to BS 6572 or Bs 6730
This item possesses a push fit end for connecting 25mm HDPE pipe and a female ¾” NTP (IPS) threaded end (40 BS 21Taper) for connecting to meter box or male push fit adaptor. Material to be delrin 107 black acetal homopolymer, ultra violet resistant UK WFBS listed. Female Poly Adaptor must be supplied with polyacetal gripping ring, ‘O’ ring EPDM or Nitrile elastomer UK WFBS listed and polyacetal brace support for connecting push fit end with female NTP (IPS) threaded end and limiting polyacetal gripping ring from movement.

POLYETHYLENE POLY CONNECTOR (25MM PE X 25MM PE)
Manufactured to BS 6572 or BS 6730.
This item should possess two push fit ends for connecting to 25mm HDPE pipe. Material to be delrin 107 black acetal homopolymer, ultra violet resistant UK WFBS listed. Connector
must be supplied with polyacetal gripping ring and ‘O’ ring EPDM or Nitrile elastomer UK WFBS listed.

110-118MM SELF-TAPPING FERRULE STRAPS
Self Tapping Ferrule Straps with top and bottom half made of cast gunmetal to BS 1400 LG2 cast, with A2 Grade stainless steel bolts and M12 nuts and FPDM rubber ‘O’ rings seal under Boss. Top and bottom half to fit UPVC water mains with outside diameter of 110/118mm.

Ferrule stem in Bronze with integral aluminum bronze or stainless steel cutter, Acetal Banjo with 25mm push fit connection for HDPE pipe. Acetal top cap and EPDM sealing washers.

165-173MM SELF-TAPPING FERRULE STRAPS
Self Tapping Ferrule Straps with top and bottom half made of cast gunmetal to BS 1400 LG2 cast, with A2 Grade stainless steel bolts and M12 nuts and FPDM rubber ‘O’ rings seal under Boss. Top and bottom half to fit UPVC water mains with outside diameter of 165/173mm.

Ferrule stem in Bronze with integral aluminum bronze or stainless steel cutter, Acetal Banjo with 25mm pushfit connection for HDPE pipe. Acetal top cap and EPDM sealing washers.

200MM SELF-TAPPING FERRULE STRAPS
Self Tapping Ferrule Straps with top and bottom half made of cast gunmetal to BS 1400 LG2 cast, with A2 Grade stainless steel bolts and M12 nuts and FPDM rubber ‘O’ rings seal under Boss. Top and bottom half to fit UPVC water mains with outside diameter of 200mm.

Ferrule stem in Bronze with integral aluminum bronze or stainless steel cutter, Acetal Banjo with 25mm pushfit connection for HDPE pipe. Acetal top cap and EPDM sealing washers.

HIGH DENSITY / MEDIUM DENSITY POLYETHYLENE WATER SERVICE PIPING ( BLUE)
This item must be in accordance with BS 6572, designed for underground potable water services. It must be suitable for connection to a 25mm adaptor, the inner diameter to be 19mm and the outer diameter not to exceed 25mm and must be supplied in coil lengths of 100m or 150m.

BRASS STOP VALVE NOMINAL SIZE –20MM (3/4”)
Female thread x female thread (to BS21 Taper).
NB: Brass Stop Valve must be restricted for one way flow and should be clearly indicated on the valve.
Stop valve type must be the loose jumper version.
The pressure ratings of the valve should be no less than 3 Bars.
THREADED GALVANISED PIPES
32 mm diameter light weight galvanized coated steel pipes having a nominal length of 5.8 meters, wall thickness of 2.6mm, must be male threaded ends with a coupling, and should be capable of being used for sleeving 25 mm HDPE tubing. Outer diameter must be approximately 42mm. Pipe must not bend easily and must be in accordance with BS 1387/ASTM A -120 standards.

BALL VALVES
Ball valves shall be PVC with solvent welded Joints to accommodate (¾”) 20mm PVC service pipe.

SERVICE CONNECTIONS INSTALLATION

TASKS TO BE CARRIED OUT
- Install self-tapping ferrule strap on service main
- Connect poly hose to ferrule strap
- Install standpipe at the end of poly hose

INSTALLATION OF FERRULE STRAP
Ferrule strap shall be of appropriate size for compatibility with water main diameter and shall be installed using standard installation practices.

Ferrule strap shall be installed complete with no part or component lacking.

Ferrule strap shall be secured to water main to ensure a leak proof installation after tapping of the water main is completed.

POLY HOSE CONNECTION
The length of poly hose to be installed shall be sized to extend one foot (1’) beyond the customer’s fence but shall not exceed a total length of two feet (2’); any extension beyond forty feet (2’) shall be paid for by the customer.

The length of poly hose that has been sized for installation shall be thoroughly examined for any visible defects that are likely to cause leakage.

The ends of the length of poly hose shall be finished free of any defects and irregularities to ensure leak proof connections with relevant components.

Poly hose shall at all times be installed free of kinks and torsions (twists).
METERS AND METER BOXES INSTALLATION

GENERAL
The Contractor shall supply all materials, labour, transportation and equipment required to install meters and meter boxes on new or existing water service connections. The contractor shall include in his rates the assembling of meter and boxes and the testing of the completed unit so that it must be free from leaks.

The Contractor shall notify the customers of the work to be performed within their properties. The contractor shall make reasonable efforts to minimize the impact on the customers by keeping the work sites clean and restoring the site to an acceptable condition after all installations are complete.

METER INSTALLATION
The meters and meter boxes shall be installed within the customer’s property in a location that is convenient to the meter reader but not susceptible to damage.

The Contractor shall install all pipe, pipe sleeves, reducers, elbows, thread tape and adapters required to install the meters and meter boxes from the main to the existing customer service line. This assemble i.e. (water meter, water meter box pipes and fittings) must be plumbed horizontally and vertically so as to ensure maximum accuracy and minimize degradation.

Once the meters are installed on and pinned to the required reinforced concrete base, all excavations shall be back-filled and disturbed concrete slabs shall be restored.

The Contractor shall submit meter installation reports to Guyana Water Inc. in the form of an excel database, the format of which must be pre-approved by the client.

Completed Installations shall be free from leaks.
Meter Vaults shall be constructed as shown in the plan details.

SERVICE CONNECTION MATERIALS

HIGH DENSITY / MEDIUM DENSITY POLYETHYLENE PIPE (POLYHOSE)
This item must be manufactured in accordance with BS 6572, designed for underground potable water services. It must be suitable for connection to a 25mm poly-adaptor, the inner diameter to be 19mm and the outer diameter not to exceed 25mm and must be supplied in coil lengths of 100m or 150m.
POLYETHYLENE PUSH FIT FITTINGS (POLY-FITTINGS)

Manufactured to BS 6572 or BS 6730. Material to be delrin 107 black acetal homopolymer, ultra violet resistant UK WFBS listed. Fittings must be supplied with polyacetal gripping ring and ‘O’ ring EPDM or Nitrile elastomer UK WFBS listed.

**MALE POLY- ADAPTOR (25MM Push-fit End x ¾” Male End)**

This item should posses a push fit end for connecting 25mm HDPE pipe and a male NTP (IPS) threaded end (40 BS 21Taper) for connecting 20mm stop valve.

**FEMALE POLY- ADAPTOR (25MM Push-fit End x ¾” Female End)**

This item posses a push fit end for connecting 25mm HDPE pipe and a female 20mm NTP (IPS) threaded end (40 BS 21Taper) for connecting to meter box or male poly-adaptor adaptor. Female Poly-adaptor must possess polyacetal brace support for connecting push fit end with female NTP (IPS) threaded end and limiting polyacetal gripping ring from movement.

**POLY-CONNECTOR (25MM Push-fit End x 25MM Push-fit End)**

This item should posses two push fit ends for connecting to 25mm HDPE pipe.

FERRULE STRAPS

Self Tapping Ferrule Straps with top and bottom half made of cast gunmetal to BS1400 LG2 cast, with A2 Grade stainless steel bolts and M12 nuts and FPDM rubber ‘O’ rings seal under Boss.

Ferrule stem in Bronze with integral aluminum bronze or stainless steel cutter, gunmetal banjo with 25mm pushfit connection for HDPE pipe. Gunmetal top cap and EPDM or equivalent sealing washers.

**100MM (4”) FERRULE STRAPS**

Top and bottom half to fit uPVC water mains with outside diameter of 110/118mm.

**150MM (6”) FERRULE STRAPS**

Top and bottom half to fit uPVC water mains with outside diameter of 165/173mm.

**200MM (8”) FERRULE STRAPS**

Top and bottom half to fit uPVC water mains with outside diameter of 227/241mm

BRASS BALL VALVE

20mm (3/4”) Brass Ball Valve (Chrome coated) PN16 with female thread x female thread (to BS21 Taper). The pressure ratings of the valve should be no less than 3 Bars.
SLEEVES FOR SERVICE CONNECTIONS

32mm THREADED GALVANISED PIPES
Light weight galvanized coated steel pipes conforming to the requirements of “BS 1387/ASTM A -120 standards” or equivalent. Outer diameter approximately 42mm, nominal diameter of 32 mm, nominal length of 5.8 meters, wall thickness of 2.6mm, must be male threaded ends with a coupling, and should be capable of being used for sleeving 25 mm HDPE tubing.

50mm POLYVINYL CHLORIDE Schedule 40 (uPVC) PIPE
PVC pipes shall conform to the requirements of “GYS 99: 1998 Schedule 40” or equivalent.

POLYVINYL CHLORIDE SDR26 (uPVC) PIPE
PVC pipes shall conform to the requirements of “GYS 107: 2002 SDR 26” or equivalent. PVC pipes must have a pressure rating of at least 160 psi. Supplier to provide all necessary rubber gaskets and lubricant for pipes purchased under this contract.
800    TIMBER AND PILING

801    TIMBER

MATERIAL
Timber used in the Permanent Works shall be Greenheart or approved Hardwood of
best quality of its respective kind, thoroughly seasoned and matured, sawn square, sound,
straight and fine in grain, free from sapwood, shakes, large or loose knots, worm holes, wanes
cranks and other defects. Timber shall be sawn to the dimensions shown on the Drawings.

The structural use of timber shall be in accordance with BS 5268. All work shall be in
accordance with BS 5268. All work shall be put together in the best possible manner by
craftsmen to the satisfaction or the Engineer. Timber that splits, shrinks, or warps from want
of seasoning, unsoundness or bad workmanship shall be removed and replaced at the expense
of the Contractor.

HANDLING AND STORAGE
All timber to be used in the Permanent Works shall be handled with care and shall not be used
for purposes other than those indicated on the Drawing except by written permission of the
Engineer. Such timber, when stored on site, shall be kept in orderly stacks. Untreated timber
shall be open stacked on supports at least 12 inches above the ground surface to avoid
absorption of ground moisture and permit free circulation of air between tiers. The stacked
timber shall be protected from the weather by a suitable covering to the approval of the
Engineer.

JOINTING
All bolted joints shall be coated with coal tar creosote prior to fixing.

No bolt hole, unless other wise indicated, shall be drilled nearer than 4 inches from the end of
the timber. Where spiking or nailing is approved the timber is to be drilled before hand to
prevent splitting.

Washers shall be used under all nuts and bolt heads that would otherwise come into contract
with wood. Mild steel washers shall be used at all locations unless otherwise specified. All
nuts shall be tightened sufficiently to prevent bolts coming loose during service.

Nails and spikes shall not project beyond the surface of the wood into which they are driven
except where shown on the Drawings or approved by the Engineer.

Where recess and countersinks are to be formed in the timbers they shall be plugged with
bitumen after tightening the bolts and prior to covering with subsequent timbers or surfacing.
PRESERVATIVES
All timbers shall be treated with coal tar creosote to BS 144. Treatment shall be carried out in accordance with BS 913. Cutting and boring of timber shall be done as far as possible before treatment, but where this is impractical all surfaces subsequently cut or bored shall be heavily coated with preservatives applied on site.

802 TIMBER PILES

GENERAL
All timber supplied for use as piles shall be Greenheart or approved Hardwood thoroughly seasoned, straight grained and free from cracks, shakes, fungal or pest attack and from other defects, complying with grade stress for Green heart as specified by BS 5756 grading rules. Piles shall be one length unless otherwise approved by the Engineer.

The Contractor shall submit copies of consignment notes and certificates from suppliers, giving such information on deliveries of timber as the Engineer may require.

Tree trunks where approved for use as round piles shall have the bark removed but the sapwood left in place and shall be treated with a preservative as specified.

Where timber is damaged during handling and installation, all damaged areas shall be over coated with two coats of approved preservative, well brushed in. All pile heads, whether or not trimmed to level shall be given three heavy coats of approved preservative, sufficient time between coats being allowed to ensure maximum penetration into timber.

TOLERANCE OF TIMBER PILES
For a round pile, the following characteristics are required: maximum deviation from a straight line should not be greater than 4 inches in any plane through the pile parallel to the vertical axis.

SHOES FOR TIMBER PILES
Pile shoes shall be manufactured by an approved supplier and consist of cast iron, cast steel or fabricated steel.

Cast iron shoes shall be formed from chill hardened iron grade 10 in accordance with BS 1452 "Specification for grey iron castings."

Cast iron shoes shall be formed from steel to grade A, of BS 3100 “Specification for Steel castings for general engineering purposes.”

Fabricating steel shoes shall be formed from steel grade 43 A1 and steel straps and fastenings to grade 43 A of BS 4360 “Weldable structural steel.”
Castings shall be free from sand, honey combing, porosity, blow holes or other defects. For cast shoes, straps and fastenings shall be of mild steel or wrought iron, cast into and running continuously through base.

Details of all pile shoes shall be submitted to the Engineer for approval to fabrication or supply.

Pile shoes shall be firmly bedded to and coaxial with the pile.

**INSPECTION, HANDLING AND STORAGE OF TIMBER PILES**

The Contractor shall notify the Engineer of the delivery of timber to the site or to the place where preservation treatment is to be carried out and shall provide all necessary labour and materials to enable the Engineer to inspect and measure each piece at the time of delivery and immediately prior to driving.

Accepted timber shall be stacked and protected to the satisfaction of the Engineer. Care shall be taken during handling to prevent the surface of treated piles from being broken and any cuts or breaks which may result from the use of hooks or chains shall be well brushed with two coats of preservative before driving.

**HEADS OF TIMBER PILES**

The pile head shall be flat and at right angle to the axis of the piles.

Except where specified to the contrary, the head of each pile shall be trimmed to a round cross section and fitted with a tight steel ring. The ring shall not be less than 2 inches by 3/4 inches cross section and the ring joint shall be welded for its full section. The external diameter of the ring shall be that of the least transverse diameter of the firm head of the pile. The top of the ring shall be between 4 inches and 3/4 inches from the top of the pile.

If the ring is displaced during driving, it shall be refitted and if broken a new ring shall be fitted. If during driving the head becomes excessively broomed or otherwise damaged, the damaged part shall be cut off, the head re-trimmed and the ring refitted.

After driving, the heads shall be cut off square at the designed cut off level of the piles. In estimating the required lengths of timber piles, the Contractor shall make due allowance for the removal of broomed or split timber as well as for cutting off the heads of piles at the required levels.

**SPLICING OF TIMBER LENGTHS**

Where lengthening of timber piles is approved by the Engineer, the position and details of splice shall be as shown on Drawings or as directed or agreed by the Engineer.

Where it is necessary to partly extend a partly driven pile, the upper part shall be securely supported during the making of splice.
Spliced joints shall be observed by the Contractor continuously during driving to detect any departure in true alignment between the lengths of pile on each side of the joint or for any signs of distress or damage to the splice.

If any such departure in alignment, distress or damage is observed, the Contractor shall suspend driving and inform the Engineer.

803 PILING

GENERAL
Before any piling work is commenced the Contractor shall, in amplification of information accompanying his tender, submit to the Engineer for approval full details of his proposed piling plant including any floating plant and detailed method statements for carrying out works. Such details shall include where applicable a full description of the piling frame, hammer, helmet and packing, method of handling, pitching and supporting the piles before and during driving, the proposed driving procedure to obtain the required penetration and/or the proposed set for the working load on the pile, and the method of calculation.

The Contractor shall not commence any piling until the plant and methods which he proposed to use have been approved by the Engineer but such approval shall not relieve the Contractor from any of his obligations and responsibilities under the Contract. If for any reason the Contractor wishes to make any change in the plant and methods of working which have been approved by the Engineer, he shall not make any such change without having first obtained the Engineer’s approval thereof.

SETTING OUT
The Contractors shall establish and maintain permanent datum level points, base lines and grid lines to the satisfaction of the Engineer, and shall set out with a suitable pin or marker the position of each pile. The setting out of each pile shall be agreed with the Engineer at least 8 working hours prior to commencing work on a pile and adequate notice for checking shall be given by the Contractor.

Notwithstanding such checking and agreement, the contractor shall be responsible for the correct and proper setting out of the piles and for the correctness of the positions, levels, dimensions, and alignment of the piles.

DISTURBANCE AND DAMAGE
The Contractor shall carry out the piling work in such a manner and at such times as to minimise noise and disturbance.

If during the execution of the Works, damage is likely to be caused to mains, services or adjacent structures, the Contractor shall submit to the Engineer his proposals for avoidance of such damage.
The Contractor shall ensure that damage does not occur to completed piling works and shall submit to the Engineer for approval his proposed sequence and timing for driving, having regard to the avoidance of damage to the adjacent piles.

**LENGTHS OF PILES**

The lengths of piles indicated on the Drawings or Bills of Quantities are based on investigations carried out prior to commencement of the Contract. The Engineer may decide to extend those lengths should he consider this to be necessary based on information obtained during the pile installation, e.g. penetration per blow using specified hammer, etc.

The Contractors shall make allowance in his fabrication length for damage to pile heads that may occur during driving.

**OBSTRUCTIONS**

If during the execution of the works the Contractor should encounter obstructions in the ground whether or not they were foreseeable, he shall forthwith notify the Engineer detailed plans for overcoming the obstruction and proceed according to the Engineer’s instructions.

**PROGRAMME AND PROGRESS REPORTS**

The Contractors shall inform the Engineer each day of the programme of piling for the following day and shall give adequate notice of his intention to work outside normal working hours and weekends, where approved.

The Contractor shall submit to the Engineer on the first day of each week or on such other date as the Engineer may decide, a progress report showing the rate of progress to that date and progress during the previous week or period of all main items of piling work as required by the Engineer.

**RECORDS**

Contractor shall keep complete records of all data required by the Engineer covering installation of each pile and shall submit two signed copies of these records to the Engineer not later than noon of the next working day after installation of the piles.

**TOLERANCES**

Piles shall be driven as accurately as possible to the vertical. The permitted deviation of the pile centre from the centre point shown on the drawings or setting out plan shall not exceed 3 inches measured at the working level of the piling or as otherwise agreed by the Engineer.

**DRIVING**

Piles shall be accurately pitched and driven in the position and to the lines shown on the Drawings within the specified tolerances. The lengths of piles driven shall be as shown on the Drawings or such other lengths as the Engineer may direct as provided in clause “4." hereof. The length of pile to be driven in any position shall be approved. Piles shall be driven in sequence approved by the Engineer.
At the stages during driving, piles shall be adequately supported and restrained without damage to the piles or any coatings or preservative treatment, by means of ladders, trestles, temporary supports or other guide arrangements to maintain position and alignments and prevent buckling. Where necessary in the opinion of the Engineer, extension leaders shall be fitted. Handling, slinging and pitching of piles and shall be by means or methods approved by the Engineer.

Piles shall be driven by means of plant and methods approved by the Engineer in accordance with clause “1.” hereof. Helmets or anvil blocks of the approved type shall be used for preventing damage to the heads and use of a follower or dolly shall not be permitted except with the agreement of the Engineer. Driving shall be carried out continuously until the specified depth and/or penetration per blow is reached, except that the Engineer may permit suspension of driving if he is satisfied that the suspension is beyond the control of the Contractor.

The contractor shall report to the Engineer without delay any unforeseen change in driving characteristics which may be noted. Detailed records of the driving of all piles shall be kept by the Contractor in a form required by the Engineer to whom they shall be submitted the day following the pile driving. The Contractor shall give adequate notice of driving and provide facilities to the Engineer to enable him to check driving resistance. A set of pile data shall be taken only in the presence of the Engineer unless otherwise agreed.

The final set of each pile shall be recorded as the number of blows to produce a penetration of 1 inch agreed by the Engineer who will need to be satisfied when a final set is measured as to the condition of the pile.

The Contractor shall ensure that piles are temporarily braced or stayed to the satisfaction of the Engineer immediately after driving to prevent loosening of the piles in the ground to ensure that no damage resulting from oscillation, vibration or movement of any free standing pile can occur.

**ACCEPTANCE OF PILES**

If a pile appears to be satisfactory, the Engineer will agree to the cessation of driving but such agreement shall not constitute acceptance of the pile and he may order retrieving as a result of information obtained from subsequent driving of piles.

A pile meeting the specification requirements and driven within the specified tolerances or as otherwise agreed by the Engineer, will be accepted only when each defined row, of which the pile forms a part has been completed.

Where additional piles or extra works are necessary as a result of incorrectly placed or inaccurately driven piles or other defective work or damage which in the opinion of the Engineer are attributed to the Contractor, such additional piles or extra works instructed by the Engineer shall be carried out at the Contractor’s expense.
Piles driven or deflected outside the specified tolerances shall, if required by the Engineer, be withdrawn, re-pitched and re-driven by the Contractor at his expense. In carrying out such work, any resulting holes due to withdrawal of the pile or of measures for moving the pile shall be packed with approved non-plastic material prior to replacing pile. Procedures and records in respect of such retrieving shall be in accordance with “Clause No. “7." hereof.

**RE-DRIVING PILES**

The Contractor shall, where instructed by the Engineer, take levels and measurements to determine any movement of the ground or any pile driving. Piles which have risen as a result of driving adjacent piles shall be re-driven to the original depth or set, unless otherwise directed by the Engineer who may require the Contractor to carry out such approved corrective measures as are necessary in his opinion. During re-driving, checks where required shall be carried out to an approved procedure.

**804 TIMBER WALERS**

Timber for waling shall be Green Heart thoroughly seasoned, straight grained and free from cracks, shakes, fungal or pest attack and from other defects, complying with grade stress for Green heart as specified by BS 5756 grading rules.

Sheet piles shall be driven to the alignment and depths shown on the Drawings or as directed by the Engineer, with maximum allowable deviation from the required line of 2 inches from vertical measured both in the plane of driving and perpendicular to the plane of driving.

**805 PROTECTION OF STRUCTURAL TIMBER**

Unless specified otherwise all structural timber used shall be coated with two coats of an approved bituminous paint.

For all joints, all timber to timber surfaces shall be coated with two coats of approved bituminous paint before assembling.

**806 TOP ELEVATION AND ALIGNMENT OF PILES**

The top elevation of the timber and steel sheet pile revetment will be approximately to the same elevation as the crown of the adjacent existing public road but the final elevation shall be confirmed on the site by the Engineer with maximum allowable deviation from the required line of 2 inches from vertical measured both in the plane of driving and perpendicular to the plane of driving. The alignment of piles shall be determined on site by the Engineer.

**807 TIMBER SHEET PILES**
Timber sheet piles shall be fabricated from good quality green heart timber boards as specified herein, the boards shall be coated with two coats of approved bituminous tar prior to assembling. In assembling the boards care shall be taken to ensure that boards do not split, if necessary preboring shall be done with drill 1/16 in less than the diameter of the nails to be driven.

All piles shall be driven to the alignment and depth shown on the Drawings or as directed by the Engineer. They shall be driven singly, and care shall be taken to ensure that the piles are properly interlocked during the whole extent of the driving.

808 TIE RODS AND HARDWARE

Tie rods, nuts, bolts, washers, bearing plates and turnbuckles shall except where otherwise specified be mild steel.

809 PROTECTION OF THE RODS

The tie rods, and connections shall be cleaned by brushing with wire brush before receiving one coat of bituminous paint followed by two layers of bitumenised Hessian wrapping bound around in opposite direction with laps not less than 1 in. A further coat of bituminous paint shall cover the Hessian.
SECTION 900 WELLS

GENERAL

LOCATION OF THE BOREHOLES
These locations are to be carefully mapped and final locality agreed upon by the Project Manager.

MATERIALS
The Contractor will be responsible for supplying the well casings and screens and providing test pumping equipment. The contractor will be responsible for the supplying of drilling fluid (drilling mud). The materials used for the construction of the wells are Fiberglass and stainless steel.

DRILLING FLUID
It is the Contractor’s responsibility to procure and provide appropriate drilling fluid to be used in the drilling and construction of the water well. The Contractor shall use the proper drilling techniques of drilling fluid control and well development in order to obtain maximum efficiency and safety.

GROUT
The grout shall be a mixture of Portland cement (ASTM C150, Type 1 or APT-10A, Class A), sand and water in proportion of one bag cement to not more than 26 liters of clean water and equal volumes of dry sand and cement.

TEST PUMPING OF WELL
The wells shall be step-tested in accordance with BS 6316:1983 code of practice or equivalent standard to demonstrate that the design capacities have been achieved and that the water quality meets the required criteria.

Circular orifice meters shall be installed on the end of the pump discharge lines to determine the discharge rates. Control valves shall be installed so that the discharges will not vary more than five percent from the average. Additionally, at least ten water samples must be taken at each well to demonstrate acceptable water quality.

TEST HOLES AND FORMATION SAMPLES
Test hole (pilot hole) shall be drilled by the Contractor to determine the formation and identify the aquifers to be screened in each area. After a suitable aquifer for the screens has been identified in each case, the test hole shall then be developed into a production borehole to be cased and screened.
An accurate log of the materials penetrated shall be recorded by the driller to determine the depths and thickness of the various underlying formation in each areas.

Formation samples from the test holes shall be collected and handled in appropriate manner. Formation samples must be available to the project manager or his representative for inspection and proper identification.

A resistivity log of the test holes shall be recorded by the driller to determine the depths and thickness of the various underlying formation and to identify the most suitable formation for the installation of the well screens.

**CONSTRUCTION OF THE WELLS**

**GENERAL**

The Contractor shall drill at the locations designated by the Employer. The Contractor shall use direct rotary drilling equipment to drill the holes and shall install the materials previously described so that the finished wells conforms to the general design illustrated on drawing numbered MS0037 and to any applicable standards. The mud pits required shall be positioned at least 3 meters from the proposed pump foundation pad or pump house floor.

The Contractor shall dispose of drilling fluid, cuttings and discharge water in a manner to be approved by the Project Manager so as not to create damage to public or private property. During the test pumping the water discharge shall be piped to a point of overland drainage sufficiently far from the well to prevent recharge effect.

**DRILLING FOR OUTER CASING**

The Contractor shall drill suitable holes to accommodate outer casings to depth specified in the bills. This depth may be adjusted because of underground conditions at the sites.

Payment for the outer casing will be based on the unit price per linear feet of the outer casings installed and shall include the cost of drilling, installation, setting and grouting and other items for complete installations of the outer casing.

**DRILLING HOLE FOR CASINGS AND SCREENS**

Suitable holes should be drilled to a minimum depth specified by the project manager.

**SETTING THE SCREEN AND CASING**

The screen and casing assemblies shall be jointed properly as recommended by the manufacturer and lowered into the well. The screens may be lowered using temporary string of pipes attached at the top of the casings and the bottom of the screens. The assembly shall be supported so that the screen bottom is slightly above the bottom of the hole so as to ensure that the entire assembly
is under tension during placement in each case. Centering guides shall be placed on the screen as recommended by the manufacturer and as required.

GROUTING THE SPACE CASING AN DRILLED HOLE
The spacing between the casings and the outer borehole walls shall be grouted with sand and cement grout in accordance with AWWA standard A100-84 or equivalent.

DEVELOPMENT OF THE WELL
The development of the wells shall remove the native silts and clays and drilling fluid residue deposited on the borehole face in adjacent portions of the aquifer during the drilling processes. If organic drilling fluids are used, they must be broken down chemically according to the manufacturer’s recommendations before and during development. The objective of the development process is to assure the maximum specific capacity of the well obtained. The minimum specific capacity as specified in the scope must be achieved.

The development process shall be carried out by surging and bailing the wells. When surging in the screen, surging shall start slowly just above the static water level and continue at a faster rate once free flow into the screen is assured.

Sediments falling to the bottom of the screen, during the jetting process, shall be removed by either pumping or bailing.

1. Development shall continue until the Project Manager insists that further development is unnecessary.

TESTING THE PRODUCTION OF THE WELL
After development, the wells shall be pumped in accordance to BS 6316:1983 code of practice for test pumping water wells to verify that the expected specific capacities and the well efficiencies have been achieved. The discharge of the test pump will be measured by timing how long it takes to fill a container of known volume, by a circular orifice meter, flume, or by other devices and the pumping level measured by a suitable measuring instrument to the nearest inch. The Engineer shall compare this figure with the specific capacity determined from the pumping test and decides whether development is needed to further improve the yield.

Payment for this item and test pumping of the wells will be made at the lump sum price in the contract.

CAPPING THE WELL
During the well construction and completion, the Contractor shall use all reasonable measures to prevent the entrance of foreign matter into the well. The contractor shall be responsible for any
objectionable material that may fall into the wells and any effect it may have on water quality or quantity until completion and acceptance of the work by the Engineer.

Upon completion of the wells, the Contractor shall install a suitable screwed flange or welded cap to prevent any pollutants from entering the well.

**GUARANTEES**
The contractor shall guarantee that all materials, equipment, structures and work performed are free from defects in workmanship for a period of 180 days after completion, and if any part of the work shall fail within the period, it shall be replaced and restored to operation at no cost to the Employer. The performance bond and insurance against well failure shall cover this guarantee.

**ABANDONED WELLS**
If the well fails to conform to these specifications and the Contractor is unable to correct the conditions or negotiate mutually acceptable cost reduction for specification deviations it shall be considered as an abandoned borehole, and the Contractor shall immediately start a new well at a nearby location designated by the Employer. The Contractor shall be responsible for supplying all materials required for the replacement well.

The abandoned borehole shall be treated as follows:

The Contractor may salvage as much casings and screens from the initial well as possible, and shall use it in a new well after obtaining approval from the Employer. Any casing remaining in the borehole must be perforated with a casing ripper. The upper 10 feet of casing shall be completely removed from the borehole.

The salvaged material shall remain the property of the Employer.

The well shall be sealed by cement grout or neat cement shall be placed from the bottom upward by methods that will avoid segregation or dilution of material and approved by the Employer.

The upper 2 meters of the borehole shall be filled with native topsoil.

**DISINFECTION OF WELL**
The wells are to be disinfected at a chlorine concentration of 25ppm. The Contractor would be required to provide all materials to effect the disinfection.
SECTION 1000: STANDARD PIPEWORK DRAWINGS