VOLUME 4 - SECTOR III

SOIL AND GEOLOGY

THE STUDY ON INTEGRATED URBAN DRAINAGE IMPROVEMENT FOR MELAKA AND SUNGAI PETANI IN MALAYSIA

FINAL REPORT

VOLUME 4: SUPPORTING REPORT ON FEASIBILITY STUDY

SECTOR III: SOIL AND GEOLOGY

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SECTOR III

SOIL AND GEOLOGY

1. TOPOGRAPHY AND SURFACE SOIL CONDITIONS

1.1 Drainage Basin of Sg. Air Mendidih in Sungai Petani

The drainage area tends to slope gently as a whole in the western and southwestern parts, except for the northern part and the alluvial plain along the watercourse. The topographical features in the northern part correspond to the erosion remnants of the former original ground.

Most of this gently sloping area was previously covered with lateritic soils. These lateritic soils are classified into the 'Gajah Mati Series' on the soil classification, which mostly show granular structure and have high permeable characteristics. In addition, they are characterized with a bright red colour due to oxidation of the contained iron to a ferric state (hematite) under the humid tropical surface conditions.

However, most of the lateritic soils have been removed, and/or compacted due to the recent extensive land development and road construction. As a result, the variegated and/or pallid layer, which correspond to the transitional zone between lateritic soils and basement rocks, are exposed on the ground surface. In this case, both layers are characterized by low permeable characteristics; therefore, infiltration measures for storm water are hardly applied to the land development in this gently sloping area.

As for the northeastern part, which corresponds to Sub-basin No. 7, 8 and 12, its topography is rather undulating with ground levels of less than 10 m in elevation. This area takes above 87 ha or about 24% of the entire drainage area and still remains as natural land preserving lateritic soils on the surface with thickness of more than 3 m. Accordingly, a high permeability is expected in this area. This area is projected to be developed by the year 2020, and the infiltration measures for storm water could be applied should the land development be made maintaining the lateritic soil as the infiltration layer.

In addition to the above gently sloping area and the undulating area, there is the alluvial plain along Sg. Air Mendidih and its tributaries. This alluvial plain, which is represented by dominantly soft gley soils (clayey soils) including organic materials, has a soft ground condition with high water content and shows an extremely low permeability. In addition, the groundwater tables are located at shallow depths; therefore, infiltration measures for storm water are also hardly applied to the distributed area of these deposits.

1.2 Drainage Basin of Line G in Sungai Petani

This drainage area has hilly and/or gently sloping features. The hills as represented by Bukit Tok Acheh (EL. 73 m) are located in the northeastern part of the drainage area where the original topography still remains without any intensive land development. On the contrary, the intensive land development has brought about a dynamic topographic change in the present gently sloping area that spread out in the southwestern part.

The hilly areas are covered with surface soils, which are represented by the lateritic soils, but the thickness is rather limited ranging about 1 to 2 m. A substantial part of these hilly areas is subject to future land development, and the existing thin lateritic soils have to be removed due to the slope gradient of hills, hence, the subsurface weathered rock will be exposed. The weathered rock has a low permeability owing to the parent rocks consisting of argillaceous sedimentary rocks such as phyllitic shale, shale and mudstone; therefore, the infiltration measures for storm water are hardly applied to the land development in this hilly area.

As for the gently sloping area, the surface ground had been formerly covered by lateritic soils of reworked type, in other words, transported type. As in the aforesaid drainage area of Sg. Air Mendidih, these lateritic soils are classified into 'Gajah Mati Series' on the soil classification and have high permeable characteristics as a whole.

However, a greater part of these lateritic soils has been removed and/or compacted due to the recent extensive land development and road construction. As a result, the variegated and/or pallid layers are exposed on the ground as in the aforesaid drainage area of Sg. Air Mendidih, and they have low permeable characteristics. Therefore, infiltration measures for storm water are hardly applied to the land development in this gently sloping area.

Furthermore, the previous topographical map reveals that lowland areas had been widely distributed and utilized as paddy field in the lower reaches of the gently sloping area. However, most of them are filled up and only a few of them remain as swamp area at present. Alluvial deposits on this lowland area and along the watercourse show a soft ground condition, and has low permeable characteristics. In addition, the groundwater tables are located at shallow depths; therefore, infiltration measures for storm waters are also hardly applied to these distributed areas of alluvial deposits.

1.3 Drainage Basin of Parit Pokok Mangga in Melaka

The topography of the entire drainage area shows a typical coastal plain feature, which contains an extremely flat ground level and a high groundwater level (less than 1m below the

ground level). Paddy fields had extensively spread out in this drainage area; however, a greater part has been reclaimed for the sake of land development.

The surface soil of the area except for the reclamation area is classified as alluvial soils, gley soil and acid sulphate soil, which generally show clayey and silty facies. Furthermore, as for the reclamation area, the lateritic soils are generally used as filling materials. Due to the soil condition and the high groundwater level, the entire drainage area has a low infiltration capacity and the application of infiltration measures is difficult.

1.4 Drainage Basin of Sg. Ayer Salak in Melaka

The topography of this drainage area is classified into the moderately sloping hill in the northern part and the coastal plain in the southern part. The surface soil of the hilly area is mostly lateritic soils of reworked type, which are known as "Melaka Series" on the soil classification. The lateritic soil characteristics, including soil texture, are similar to those of the Sungai Petani area except for the accompanying large ferruginous boulders in the soil (20 to 50cm in diameter). The thickness of lateritic soil is about 2 m as a whole and hardly exceeds 3 m. The lateritic soils have high void ratio due to the accompanying granular structure and show high permeable characteristics as a whole. A part of the hilly area is, however, now being transformed into a flat terrain due to the intensive land development. As a result, the layer of lateritic soils has been removed and/or compacted due to the land leveling works, leading to the low permeable ground. Therefore, infiltration measures for storm water are hardly applied to the land development in this hilly area.

Extensive land reclamation was also recently made through a large-scale land development in the coastal plain formerly utilized as paddy field. A part of the former paddy field is now abandoned and turned into a swamp area (marsh area). Moreover, the topographical map published in 1974 reveals that there was also a broad swamp around the confluence point of Sg. Ayer Salak and Sg. Ayer Hitam. It is inferred that this swamp was formed due to the insufficient drainage capacity of both rivers. However, most of this swamp area is also now reclaimed by land development.

The surface soils of the coastal plain, including former swamp areas, are composed of alluvial soils (gley soils), which show soft clayey and silty facies containing somewhat kaolin mineral with extremely low permeability. Furthermore, the groundwater condition is located at a shallow depth (1m or less in depth); therefore, infiltration measures for storm water are also hardly applied to the land development in the coastal plain area.

2. GEOLOGICAL CONDITION

2.1 Drainage Basin of Sg. Air Mendidih in Sungai Petani

The basement rocks of the drainage area are made up of the Sungai Petani formation that belongs to Paleozoic sedimentary rocks, and thick alluvial deposits including surface soils (lateritic soils) overlie these basement rocks. In the drainage area, the basement rocks are exposed in extremely limited places such as cutting planes at the foot of hills.

The Sungai Petani formation of the area is characterized by a predominant argillaceous facies, and is composed of phylitic shale, shale and mudstone, etc. In this case, these basement rocks are easily subject to lateritization. The rocks of this formation are initially hard on the unweathered rock conditions, and they have low permeable characteristics as a whole.

The alluvial deposits of the area consist of loose and soft unconsolidated clay, as well as silt with high water content, and are characterized by an extremely poor ground condition.

2.2 Drainage Basin of Line G in Sungai Petani

The major basement rocks are composed of the Sungai Petani formation that belongs to Paleozoic sedimentary rocks, and thick alluvial deposits including surface soils overlie the basement rocks at/around the watercourse and its tributaries. In this case, the typical outcrops of basement rocks are easily observable at the hilly area, especially at/around the summit of Bukit Tok Acheh and cutting planes along the highway, etc.

At the hilly area, the Sungai Petani formation can be classified into two rock units. The first rock unit includes a greatly predominant argillaceous facies, which are commonly ferruginous. This rock unit is subject to lateritization and frequently changes to phyllitic shale, which is derived from shale or mudstone. The second rock unit is made up of arenaceous facies of sandstone and orthoquartzite, and the distributed areas generally produce prominent topographic features. Furthermore, the results of field reconnaissance reveal that the distribution of the former (argillaceous facies) predominates in comparison with that of the latter (arenaceous facies). Nevertheless, these facies inter-bed conformably with one another. The rocks of this formation are initially hard, but frequently altered to be soft under humid tropical surface conditions, and in this case, they have low permeable characteristics as a whole.

The alluvial deposits of the area consist of loose and soft unconsolidated clay, silt with high water content and are characterized by extremely poor ground condition.

2.3 Drainage Basin of Parit Pokok Mangga in Melaka

In this drainage area, the geological condition is characterized by the wide distribution of coastal plain deposits as alluvial deposits. The coastal plain deposits consist of unconsolidated clay and silty/sandy clay, including organic materials, with thinner intercalated layers and lenses of sand, peat and rare gravel.

2.4 Drainage Basin of Sg. Ayer Salak in Melaka

The basement rocks of the drainage area are composed of the Pilar formation, which belongs to Paleozoic metamorphic rocks, and are covered by thick alluvial deposits at the coastal plain and along the watercourse, etc.

The Pilar formation is located on the hilly area in the northern part of the drainage area. The outcrops of this formation are well exposed at the recent land development area. This formation is mainly composed of quartz-mica schist and graphite schist, and most of the parent rocks of this formation are likely to be argillaceous rocks such as shale and mudstone. The rock facies of this formation are initially hard, but frequently transformed to be soft by humid tropical conditions and weathering; therefore, the surface of hills is frequently covered by lateritic soils and strongly weathered rocks. In this case, at the land development area, if the basement rocks are directly exposed on the ground after excavation, it is considered that the application of infiltration measures is unfavorable because these are basically low permeable characteristics due to the argillaceous rocks.

The alluvial deposits are classified into the coastal plain deposits and the river deposits. The coastal plain deposits are composed of unconsolidated clay and silty/sandy clay, with thinner intercalated layers and lenses of sand, peat and rare gravel. On the other hand, the river deposits spread out along the watercourse in the inland area. The river deposits consist of loose and soft unconsolidated clay, silt and locally very clayey or silty sand. Moreover, at the former swamp area in the drainage area, the river deposits are composed of loose and soft unconsolidated clay and they are characterized by extremely poor ground condition, in other words, soft ground condition.