## 3-5 Detailed field surveys (test drillings, permeability tests, and observations of groundwater level)

At the two sites (Tangapore and Nare) selected on the basis of the results of the field exploration and the electric soundings, the following detailed field surveys were carried out to confirm the geological structure, to identify hydrogeological characteristics and to estimate rainfall within the drainage basin.

- Test drillings
- Permeability tests in boreholes
- Observations of the groundwater level in boreholes

In parallel with these surveys, meteorological observations (see Section 6-2) and a socio-economic study were carried out (see Section 3-6).

(1) Test drillings

To confirm the geological structure estimated from the results of the electric soundings, test drillings were carried out along the survey lines of the electric soundings.

In this project, boreholes were drilled using a drilling machine for deep wells, and rubble samples (slime) taken during drilling were used to estimate the geological structure. However, it was particularly difficult to distinguish the heavily weathered basement rock (argillized part) from the clayey or silty layers of fluvial deposits. Therefore, it is preferable, for at least half of the boreholes, to use a test drilling machine for geological survey that enables the collection of undisturbed samples.

The number of boreholes was as follows:

- at Tangapore: 3 boreholes of 60-m depth, 3 boreholes of 20-m depth
- at Nare: 2 boreholes of 60-m depth, 19 boreholes of 20-m depth

(2) Permeability tests in boreholes

To determine the permeability of the ground, permeability tests were carried out in the boreholes.

The tests were carried out by observing the lowering speed of the water injected into the boreholes using a tank-lorry or jerry cans to obtain the permeability coefficient of the ground according to the depth. The permeability tests were carried out in:

- 3 boreholes at Tangapore
- 12 boreholes at Nare

(3) Observations of groundwater level in boreholes

To determine seasonal fluctuation in shallow groundwater level, observations of groundwater level were carried out in 3 boreholes at Tangapore and 5 at Nare.

The groundwater level was measured irregularly using a manual water-level sounder at Tangapore, whereas it was measured continuously with automatic water level recorders at Nare.

The observation was carried out for about 6 months before the final selection of the subsurface dam site (from the middle of the rainy season to the first half of the dry season).

However, a longer period of observation is desirable, given the considerable seasonal and annual fluctuation in groundwater level. In addition, as described below in Section 6-4, there is a risk that the level of perched water is mistaken for that of the real groundwater. Therefore, attention should be paid to the observation method of groundwater level.

From the results of the test drillings, permeability tests and observations of the groundwater level, the hydrogeological characteristics of the 2 candidate sites, Tangapore and Nare, were estimated as follows (see also Fig. 3.8 and Fig. 3.9):

**Tangapore**
The results of the electric soundings suggested the presence of a fossil valley. However, the test drillings did not reveal fossil valley sediment (fluvial deposits). No geological difference was observed between the inside and outside of the supposed fossil valley. The groundwater levels of the inside and outside were almost the same, and seasonal fluctuation in the groundwater level of the inside and outside corresponded with each other. Namely, between the inside and outside of the fossil valley assumed from the results of the electric soundings, there was no obvious geological difference, and hydraulic continuity was practically ensured. This shows that there is no fossil valley at Tangapore.

The reason the electric soundings suggested the presence of a fossil valley was probably the presence of a large fracture zone in the basement rock.

**Nare**
All the results of the examination of the surplus soil produced by digging of the existing wells, of the electric soundings and of the test drillings showed the presence of a fossil valley beneath the Kolongo River at Nare. The permeability coefficient determined by the permeability tests were $10^{-3}$ to $10^{-4}$cm/sec inside the fossil valley and $10^{-5}$ to $10^{-6}$cm/sec at the valley sides. This shows a geological structure in which the permeable fossil valley sediment is surrounded by impermeable basement rock. In addition, the presence of groundwater was confirmed inside the fossil valley, with no groundwater outside the fossil valley. It was thus deduced that the fossil valley constitutes a groundwater channel.

The observation of groundwater level inside the fossil valley showed seasonal fluctuation in the groundwater level between the rainy season and the dry season, indicating the large fluidity of groundwater.

Figure 3.8 and Fig. 3.9 are schematic figures showing the results of the detailed field surveys.

The site assumed suitable for the subsurface dam, a narrow part of a fossil valley, was immediately upstream of the point where the Kolongo River flowed into its trunk, the Gouaya River. There was thus little risk that the construction of the subsurface dam would "exhaust the groundwater in the downstream area".

All these results showed that Nare Village is hydrogeologically best as a subsurface dam site.

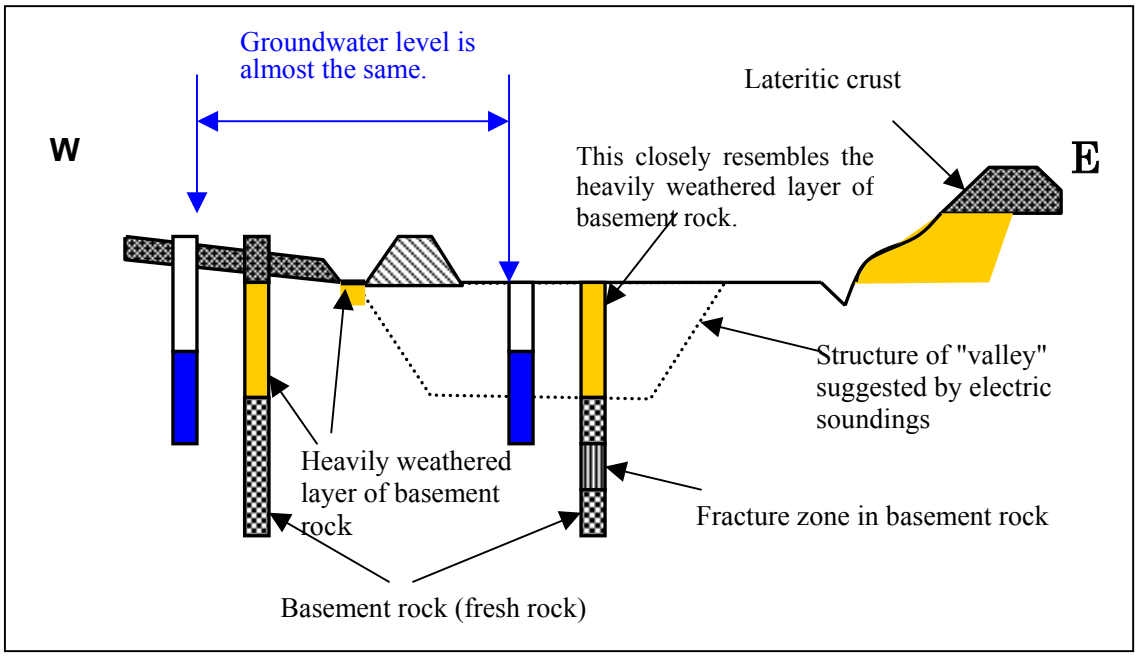


Fig. 3.8: Schematic diagram of the results of the detailed field survey at Tangapore

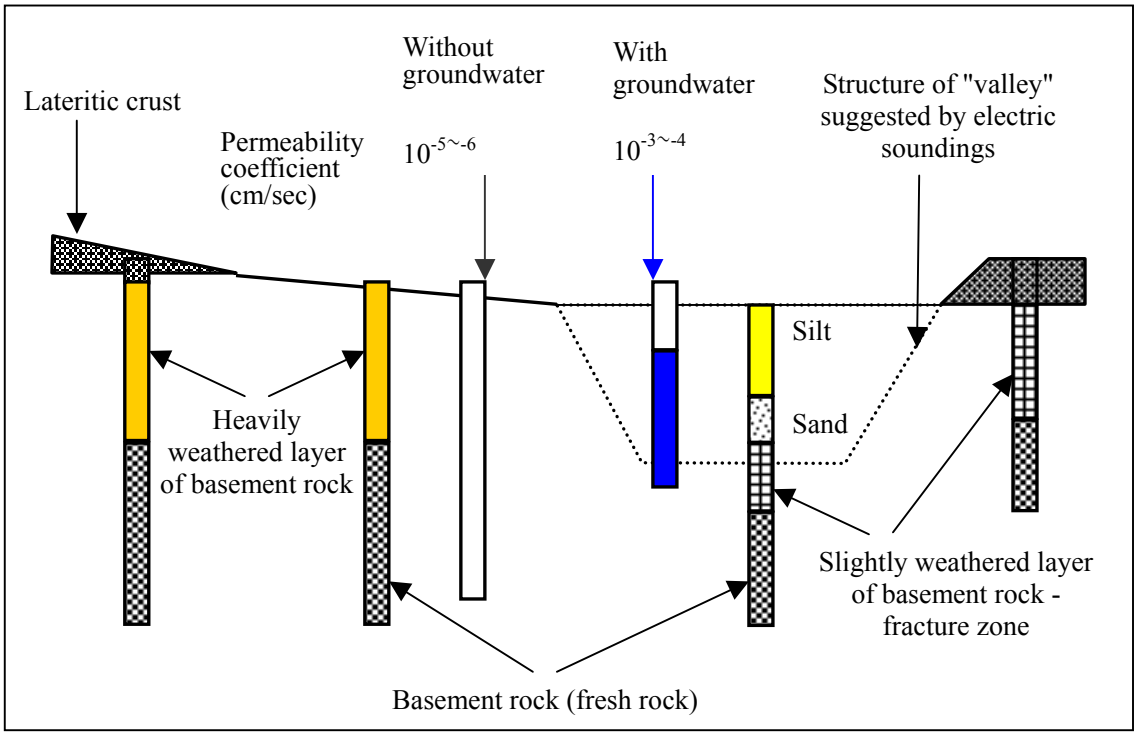


Fig. 3.9: Schematic diagram of the results of the detailed field survey at Nare