

**The Study on Groundwater Development in Central Cambodia
Final Report**

Summary Report

LOCATION MAP

EXCHANGE RATE AND LIST OF ABBREVIATION

EXECUTIVE SUMMARY

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4.4 Groundwater Resource Evaluation

4.4.1 Hydrogeological Map

A hydrogeological map was prepared for presentation of groundwater conditions of the Study area (Figure 4.4.1). The map presents information on the topography, geology, depth of the basement rocks, groundwater levels and aquifer parameters etc.

4.4.2 Quantitative Evaluation

The Study area was divided into several districts according to hydrogeological conditions. Main aquifer, specific capacity, water quality and groundwater potential of each district are summarized in Table 4.4.1. Groundwater potential is high in the eastern section of the Study area (Eastern Kg. Cham Province) and low in Kg. Chhnang Province.

Productivity of the alluvial aquifer is poor in Kg. Cham Province as same as in Kg. Chhnang. Plio-Pleistocene sand and gravel layers form excellent aquifers as well as basalt in Kg. Cham Province. According to the pumping test, the pumping rate ranged from several ten m³/day ~ to several hundred m³/day. Yield of the basement rock aquifer which is lying beneath the basalt is also high in Memot district. From the points of the specific capacity, a large amount of groundwater can be pumped from these aquifers by using motorized pump.

4.4.3 Qualitative Evaluation

Based on the field measurement and laboratory analysis of groundwater, water quality by district and by aquifer can be summarized as follows:

(1) Basement rock area in Kg. Chhnang

Iron and manganese are higher than the WHO guideline value in many test wells. This tendency could be seen in the existing tube wells. Fluoride was detected in 3 test wells. However, the concentration is higher than the WHO guideline value only 0.3mg/l. It is judged that this does not affect the human's health directly.

(2) Alluvial lowland in Kg. Chhnang and Kg. Cham

Iron and manganese are high in the hand dug well and tube well drilled in the alluvial and

Pleistocene aquifers. Arsenic was also detected at the test well and the existing tube wells in the area along the Tonle Sap River and the Mekong River. Groundwater potential in the alluvial aquifer is low from the points of water quality as chloride, nitrate and ammonia are high.

(3) Plio-Pleistocene Sediments in Kg.Cham

High nitrate concentration was detected at existing dug wells in some areas. Iron and manganese are high in the existing dug wells and tube wells in the area along the Mekong River. However, arsenic and fluoride are not detected. Water quality is generally good as the salinity is also low.

4.5 Water Balance Analysis

The groundwater recharge from the rainfall was estimated based on the water balance computation using the meteorological data collected in and around the study area. It is necessary to obtain daily data of rainfall, temperature, etc. for the estimation of groundwater recharge. However, the daily data at two (2) meteorological stations in Kg. Chhnang and Kg. Cham are not available. Therefore, the groundwater recharge was estimated using the long-term daily data recorded at Pochenton airport in Phnom Penh.

(1) Methodology of Water Balance Computation

There are several methods to estimate the groundwater recharge such as tank model method and water balance equation analysis considering soil moisture capacity, etc. In the study, the SCS method was employed to estimate groundwater recharge because the tank model method cannot be applied without a long-term daily record of unconfined groundwater level. The SCS method can be applied easily with consideration of land use and geomorphological conditions. The input data are daily rainfall data for a period from January 1986 to December 1995 and long-term average of monthly pan-evaporation values. It was assumed in the SCS method for selecting the suitable type curves that the typical soil in the study area is sandy loam.

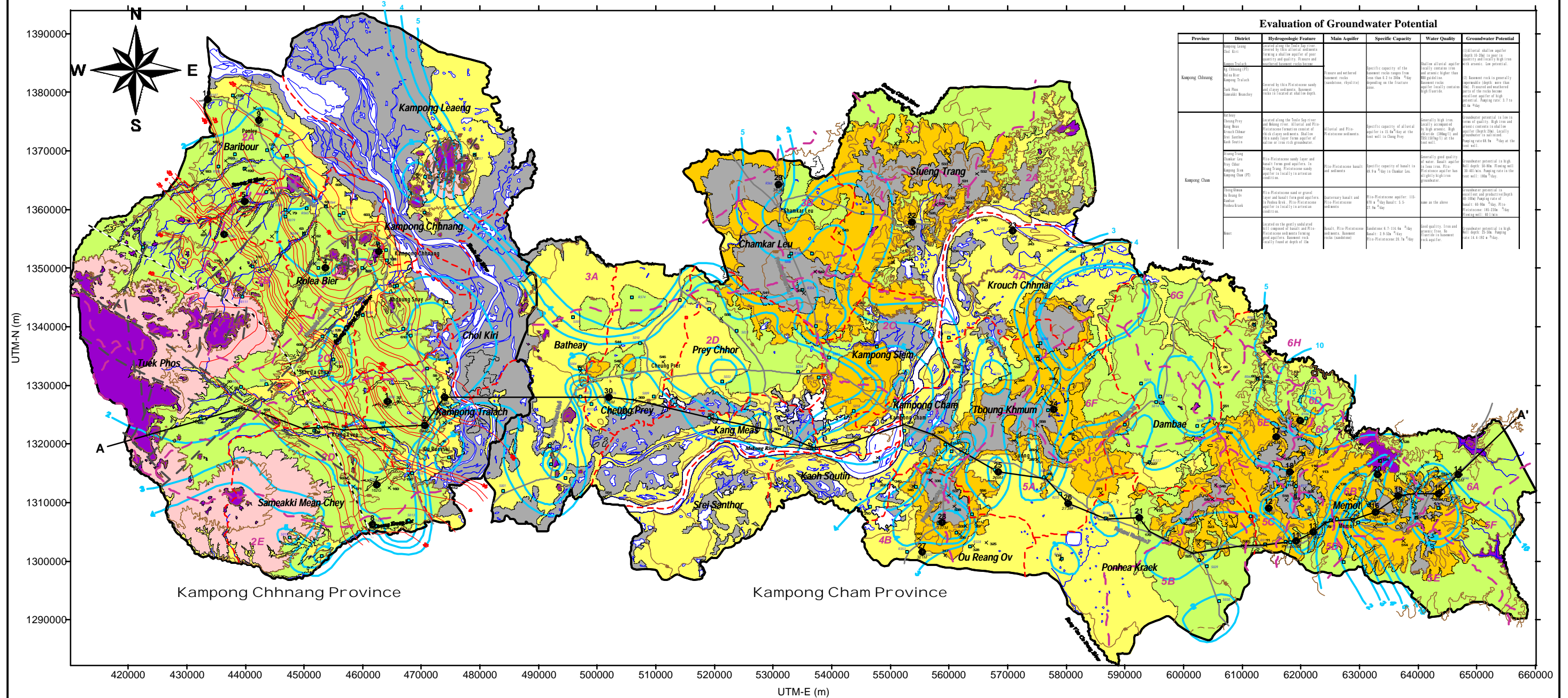
(2) Results of Water Balance Computation

Based on the daily water balance computation for the period of 10 years, the average annual groundwater recharge is estimated as 448 mm, which occupies 34% of the average annual

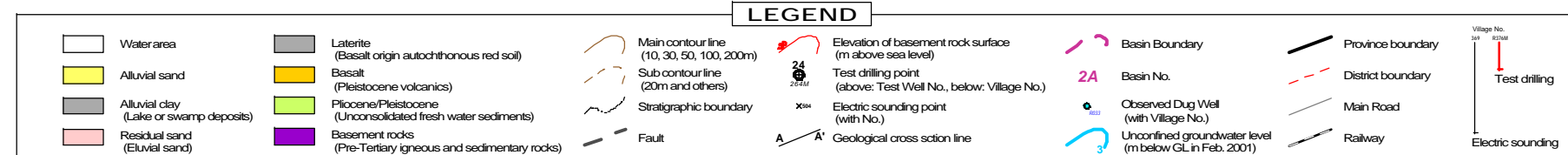
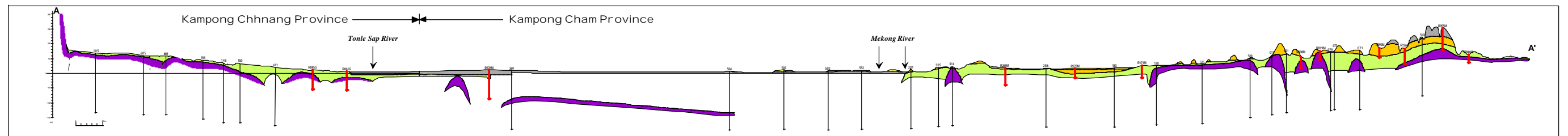
rainfall. The average monthly recharge values show that there is no groundwater recharge from December to February in the dry season. On the other hand, the maximum monthly recharge of 137 mm occurs in September. The result of daily recharge estimate shows that the occurrence of daily groundwater recharge depends on the daily rainfall pattern and rainfall intensity. Therefore, the percentages of average monthly recharge to the monthly average rainfall are about 10% in March and April, about 35% in May, 20 to 30% in June to August, and 42 to 47% in September to November.

The estimated annual average amounts of other water balance components with the percentages to the average annual rainfall (=1,316 mm) are 511 mm (38.8%) of actual transpiration, 231 mm (17.6%) of actual evaporation, 102 mm (7.7%) of surface runoff, and 22 mm (1.7%) of interception loss by vegetation cover.

Figure 4.4.1 HYDROGEOLOGICAL MAP OF CENTRAL CAMBODIA (Kampong Chhnang Province and Kampong Cham Province)



GEOLOGICAL CROSS SECTION ALONG A-A' LINE



THE STUDY ON GROUNDWATER DEVELOPMENT
IN
CENTRAL CAMBODIA
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Table 4.4.1 Evaluation of Groundwater Potential

Province	District	Hydrogeologic Feature	Main Aquifer	Specific Capacity	Water Quality	Groundwater Potential
Kampong Chhnang	Kampong Leng Chul Kiri Baribo Kg.Chhnang (PT) Rolea Phier Kampong Tralach	Located along the Tonle Sap river. Covered by thin alluvial sediments forming a shallow aquifer of poor quantity and quality. Fissure and weathered basement rocks become an aquifer.	Fissure and wethered basement rocks (sandstone, rhyolite)	Specific capacity of the basement rocks ranges from less than 0.2 to 200m ² /day depending on the fracture zone.	Shallow alluvial aquifer locally contains iron and arsenic higher than WHO guideline. Basement rocks aquifer locally contains high fluoride.	(1)Alluvial shallow aquifer (depth:10-20m) is poor in quantity and locally high iron with arsenic. Low potential.
	Tuk Phos Samaki Meanchey	Covered by thin Pleistocene sandy and clayey sediments. Basement rocks is located at shallow depth.				(2) Basement rock is generally impermeable (depth: more than 10m). Fissured and weathered parts of the rocks become excellent aquifer of high potential. Pumping rate: 3.7 to 63.4m ³ /day
Kampong Cham	Bateay Cheng Prey Kang Meas Kroch Chma Srei Santhor Kok Sotin	Located along the Tonle Sap river and Mekong river. Alluvial and Plio-Pleistocene formation consist of thick clayey sediments. Shallow thin sandy layer forms aquifer of saline or iron rich groundwater.	Alluvial and Plio-Pleistocene sediments.	Specific capacity of alluvial aquifer is 15.6m ² /day at the test well in Cheng Prey	Generally high iron. Locally accompanied by high arsenic. High chloride (386mg/l) and TDS(1507mg/l) at the test well.	Groundwater potential is low in terms of quality. High iron and arsenic contents in shallow aquifer (Depth:20m). Locally groundwater is salinized. Pumping rate 68.9m ³ /day at the test well.
	Stung Trang Chamkar Leu Prey Chhor Kampong Siem Kampong Cham (PT)	Plio-Pleistocene sandy layer and basalt forms good aquifers. In Stung Trang, Pleistocene sandy aquifer is locally in artesian condition.	Plio-Pleistocene basalt and sediments	Specific capacity of basalt is 49.9 m ² /day in Chamkar Leu.	Generally good quality of water. Basalt aquifer is less iron. Plio-Pleistocene aquifer has slightly high iron groundwater.	Groundwater potential is high. Well depth: 50-80m. Flowing well :30-40l/min. Pumping rate in the test well: 180m ³ /day.
	Tbong Khmum O Reang Ov Dambe Ponhea Krek	Plio-Pleistocene sand or gravel layer and basalt form good aquifers. In Ponhea Krek , Plio-Pleistocene aquifer is locally in artesian condition.	Quaternary basalt and Plio-Pleistocene sediments	Plio-Pleistocene aquifer: 115-670 m ² /day Basalt: 5.5-27.9m ² /day	same as the above	Groundwater potential is excellent and productive(Depth 40-100m) Pumping rate of basalt: 60-90m ³ /day, Plio-Pleistocene: 185-230m ³ /day Flowing well: 60 l/min
	Memot	Located on the gently undulated hill composed of basalt and Plio-Pleistocene sediments forming good aquifers. Basement rock locally found at depth of 15m	Basalt, Plio-Pleistocene sediments, Basement rocks (sandstone)	Sandstone:6.7-114.6m ² /day Basalt: 2.9-52m ² /day Plio-Pleistocene:20.7m ² /day	Good quality. Iron and arsenic free. No fluoride in basement rock aquifer.	Groundwater potential is high. Well depth: 25-50m. Pumping rate:14.4-192 m ³ /day.