CHAPTER 5

Summary and Conclusion

The existence of water on the surface of the earth distinguishes this planet from others in the solar system. Water is the most essential natural resource for life next to air and water of adequate quantity and quality is essential for healthy life. The present study is described in five chapters.

The first chapter describes the importance of water as a natural resource, the mode of occurrence groundwater and an introduction of West Jaintia Hills District in general along with the study area, with regard to its location, climate, physiography, land- use and its water resources.

The study area falls within the Thadlaskein C&RD Block of West Jaintia Hills District and lies between the latitudes North 25°26’40” to 25°29’40” and the longitudes East 92°11’57” to 92°12’11” in the Survey of India Toposheet no. 83 C/3. Jowai, the district headquarters of the West Jaintia Hills is located at latitude 25°26’32” N and longitude 92°12’00” E about 64 kilometers east of Shillong, the capital of Meghalaya along the National Highway-44. The area features a subtropical highland climate with temperature varying from 2°C to 14°C in winter and 16°C to 24°C in summer and receives a fairly high rainfall between April and October. It is part of the Shillong plateau, which represents a remnant of an ancient plateau of Pre-Cambrian Indian shield block consisting of hard rock formation, and exposes different suites of Precambrian gneisses and Shillong Group quartzite along with younger intrusive and sedimentary rocks. Besides piped water supply and spot source water supply maintained by Public Health Engineering Department Meghalaya,
groundwater is a major source of water supply for domestic purposes for many households through shallow, open hand-dug wells, seepage wells and springs. Bore holes and tube wells are also now being sunk.

The second chapter is a review of literature and work carried out earlier in similar areas and also pertaining to the study area with regard to the geological, geophysical and groundwater studies. Other than geological studies, there are very few detailed published and unpublished works on the geophysical, physicochemical and bacteriological analyses, pumping test analysis, groundwater potential and management of water resources in Jaintia Hills. The geological studies have been carried out mainly by the Geological Survey of India while the Central Ground Water Board has conducted groundwater studies during the past twenty years. Studies have also been carried out by Geologists of the Assam Oil Co. Ltd. who gave a broad account on the geology and have carried out geological mapping in different parts of Jaintia Hills, officers of the Directorate of Mineral Resources, Meghalaya and various research workers from Universities from within and outside the state who are working in the region in various fields related to geology, geophysics and groundwater.

The third chapter gives a description of the different methods carried out during the study which include geological, surface geophysical and hydrogeological surveys.

A preliminary geological field work was carried out prior to the geophysical and hydrogeological investigations to have first-hand knowledge of the stratigraphy, structure and lithology of the study area since the occurrence and distribution of groundwater are controlled by these factors.
Geophysical methods detect differences or anomalies of physical properties within the earth’s crust. Amongst the various geophysical methods, the Electrical Resistivity Method has the widest adoption in groundwater exploration and has assumed considerable importance in subsurface exploration because of very good resistivity contrasts among the lithologic units, controlled depth of investigation, ease of field operations, low cost of instrumentation and operation, and accessibility to modern communication systems. This method is highly useful to investigate the nature of subsurface formations by studying the variations in their electrical properties. The Vertical Electrical Sounding is used to estimate the resistivity and thickness of various subsurface layers at a given location and is mainly employed in groundwater exploration to determine the disposition of the aquifers. In this study, Schlumberger resistivity soundings were performed at thirteen locations within the study area using a microprocessor based signal stacking digital resistivity meter and the sounding curves are interpreted using the WinGLink® software which display sounding curves as resistivity versus AB/2 and compute 1D smooth model.

Geological and geophysical surveys help to decipher the groundwater prospects of the study area and to delineate the aquifers.

The occurrence and distribution of groundwater depend on the geohydrological characteristics of the subsurface formations, controlled by various geological factors such as stratigraphy, structure and lithology and the movement of groundwater is established by hydraulic properties. The evaluation of groundwater resource needs the study of occurrence, availability and behaviour of groundwater systems of area. Estimating the hydraulic characters of water bearing layers is an essential part of groundwater studies and pumping test is an important tool that
provides information on the hydraulic properties of water-bearing layers. In most groundwater assessment studies, evaluation of the quality is as important as the quantity and the usability of groundwater available is determined by its physical, chemical and bacteriological properties.

The prime objective of the hydrogeological study is to characterize the groundwater flow and evaluate the parameters and yield characteristics through pumping and recovery tests of dug wells. Water samples from the dug wells and springs were collected, analysed, and the different water quality parameters compared against the Bureau of Indian Standards (IS 10500: 2012), and World Health Organization (WHO 2011) standards to evaluate its suitability for use.

The fourth chapter contain details of the findings obtained by the geological, geophysical and hydrogeological investigations carried out during the present study, along with description, interpretation and discussions. The findings of the present work are summarised as follows:

Geological studies show that the study area is part of the Shillong plateau. It is made up mainly of hard, crystalline rock formation of Precambrian gneisses and the Shillong Group of meta-sediments along with intrusive and younger sedimentary rocks. Based on the geological studies carried out the area can be divided into two sub-divisions:

(i) The older Precambrian rock formations including the basement gneiss together with the meta-sediments of the Shillong Group and the acid intrusive covering about 85% of the study area. The common rock types include gneiss, mica-schist, quartzite, granite and granitoids, pegmatite, quartz veins; and,
(ii) The younger sedimentary rocks, sandstone and conglomerate, occurring as an outlier capping the older rock formations and concentrated mainly in and around Jowai town.

The pink quartzo-feldspathic granite gneiss and biotite-gneiss represent the oldest rocks within the study area and form the basement. A thick sequence of quartzite with minor phyllite and quartz-mica-schist, designated as the Shillong Group overlie the gneissic rocks. Granite and granitoids occur as intrusive rocks within the older rock sequence; pegmatite and quartz veins are also present cutting across the older rocks.

In and around Jowai, the older rock formations remain concealed under a medium to coarse grained sandstone of Tertiary age. Conglomerate bed is observed at places demarcating the base of the sedimentary cover.

Two sets of joints are common in the older group of rocks and occur in a rhombohedral pattern. Satellite imagery reveals the presence of a NE-SW trending fault in the south-eastern part of the study area.

An unconformable relationship marked by an angular unconformity exists between the younger sedimentary sequence and the underlying Precambrian rock formations. The regional strike of the younger sedimentary formation varies from ENE-WSW to NE-SW with southerly dips up to 15°.

The loamy soil is the most prevalent one and varies from sandy to clayey-loam. Red soils are also common. The soil have been formed by the weathering of rocks like quartzite, schist, gneisses and granites which are rich in iron and impart the red and reddish brown color to these soils. It was observed during the field study
that the soil layer overlying the quartzite and schistose rocks are comparatively thinner than the soil over the granitic rocks.

Weathering along geologic features, such as lithologic contacts, foliation, joints, fractures, quartz veins, and pegmatite, produces openings that enhance permeability and enable the storage and flow of ground water within the rocks which initially have very little or no primary porosity, and low intrinsic permeability. The depth of weathering along with fracturing and the presence of a network of joints dictate the depth and location of subsurface water and facilitate storage and movement of groundwater locally.

The Resistivity survey reveals three to four geo-electric resistive layers, roughly corresponding to the topsoil, the less weathered rock and the fractured basement rock in a three-layer sequence, and, the topsoil, the weathered crystalline rocks, the less weathered rock and the fractured basement rock in a four-layer sequence respectively.

On the basis of the VES data acquired, two probable aquifer units could be delineated:

(i) An upper aquifer occurring at depths ranging from 1.6 to 7m, with a thickness of up to 2.5m, corresponding to the weathered zone; and,
(ii) A lower aquifer occurring at depths varying from 16 to 41m, indicative of a layer boundary and fractured formation, and is a potential groundwater zone.

The occurrence of ground water in within the study area is well manifested in the form of shallow hand-dug wells, seepage wells, bore wells and springs which are common within the area.
Based on the comparative study of the inter-relationship between groundwater level fluctuation and rainfall, which reveals a similar graph pattern, it can be safely ascertained that rainfall is the main source of groundwater recharge and also indicate shallow groundwater conditions.

The water level contour map shows that, the local groundwater flow directions appear to follow surface drainage pattern which in general flow towards the Myntdu River.

Analysis of data from Recovery tests reveal that the Transmissivity, Specific Capacity and Specific Yield values obtained show wide variations indicating the heterogeneous nature of the water bearing formation. Estimated transmissivity values fall within classes III to VI of transmissivity magnitude (Krásný, 1993), ranging from intermediate to imperceptible. This suggest that the groundwater supply potential is difficult to ensure in the places where transmissivity value is very low (Class VI), whereas in the other wells, there is enough scope of groundwater withdrawal for private consumption and small community, etc. Yields of wells inventoried range from 0.2 to 25.6 $\text{m}^3$/day and discharge of the springs varies from 0.5 to 18 litres per minute.

The depth to water level is shallow in the weathered granite, sandstone and conglomerate and varies from few centimeters to 3.65 m bgl. Wells dug within the quartzite and schist range from 4.5 to 10.7 m bgl in depth. Wells in granite, sandstone and conglomerate hold water throughout the year, whereas some wells in quartzite and schist dry up during the lean period.

Results of the analyses of the physico-chemical parameters of the water samples collected from the wells and springs show that the water in general is,
colourless, odourless, with low pH values indicating that the waters are acidic in nature. While humans have a higher tolerance for pH levels there are still concerns. The implications of low pH may include corrosion, solubility of heavy metals and it imparts bitter and metallic taste to the water.

Other than the low pH, the chemical constituents present in the groundwater samples are within permissible limit for drinking as set by BIS and WHO.

Bacterial contamination, however, is a major concern with most of the water sources. Although coliforms are harmless, their presence in groundwater indicates the possibility of the presence of pathogenic bacteria. Bacteria have been reported in 76.66% of the samples tested; 23.33% of the samples are graded as ‘Excellent’, 20% as ‘Satisfactory’, 6.67 % as ‘Suspicious’, 50% of the samples are found unsatisfactory for human consumption.

Near-surface seepage wells, shallow wells and springs which are located very close distance to residential areas and at a comparatively lower level than the surroundings show higher incidences of bacterial contamination compared to the deeper dug and drilled wells. It was also observed that in comparison to single-user private water sources, common water sources such as public wells and springs used are those most affected by bacterial contamination. It is advisable that water should not be consumed directly unless properly boiled.

Proper hygiene and sanitation of the areas surrounding the drinking water sources need to be maintained by the well owners and the local community as well. Proper well construction and maintenance are important for the purpose of safe and regular water supply. The wells should be located as far as possible from sources of
contamination and ensure that rainwater flow away from the water sources as rainwater can pick up harmful bacteria and chemicals on the land surface.

It was that in some localities like Chutwakhu, almost every household has a dug well which is very convenient. But when the wells are too close to one another, problems may arise; the purpose of well spacing requirements is to promote groundwater conservation, provide for long-term availability of groundwater resources, reduce localized depletion of groundwater, prevent interference between wells, and prevent the degradation of groundwater quality.

In case of community wells, using a single-common bucket system would be more convenient instead of a user collecting water with their own water containers. This will help reduce contaminating the source.

While groundwater is an immensely important resource, it will become even more so as Jowai and its suburbs develop and the population continue to grow in the coming years. Therefore, water, not only in sufficient quantity but also of good quality will be a primary requisite and groundwater will play a very important role. Groundwater, even when located at depths is still susceptible to pollution and excessive withdrawals. Therefore, it must be protected and properly managed.

It is important that people become aware of the types of activities that are taking place near the drinking water sources which could potentially impact the water quality and quantity. Human activities such as quarrying, sand mining etc. need to be regulated to ensure that the water sources are not affected. Such activities can disturb the groundwater flow and may lead to lowering of the water table and even dry up the water sources.
Awareness through capacity building among the local people is necessary on issues like development, groundwater quality improvement measures, rainwater conservation and artificial recharge methods.

It is envisaged that the findings of this work will provide reliable background information and a useful guide for elaborate groundwater development in the area and future research works.