

Chapter 2

Physical Features

2.0 General

The proposed Cauvery (Kattalai) - Vaigai - Gundar Link Project is conceived to irrigate the drought prone areas of Central and Southern regions of Tamil Nadu. The link Project envisages diversion of 2252 Mcum of water from the existing Kattalai barrage across river Cauvery in Tirumanimuttar sub-basin of Cauvery basin to provide irrigation, domestic and industrial water supply in seven districts of Tamil Nadu viz. Tiruchirappalli, Karur, Pudukkottai, Sivaganga, Ramanathapuram, Virudhunagar and Thoothukudi. The link project will extend irrigation for 3,37,717 ha. utilizing 1746 Mcum of water besides provision of 131 Mcum and 197 Mcum of water towards domestic and industrial use.

This chapter deals with the physical features, such as Geographical disposition, Topography and Physiography. Geology of the basin areas, river system and command area proposed to be benefitted under the link canal.

2.1 Geographical disposition

The project area of Cauvery (Kattalai) – Vaigai - Gundar link canal is located in Tirumanimuttar sub-basin of Cauvery basin, basin area of the streams between Cauvery and Vaigai, Vaigai basin and basin area of the streams between Vaigai and Vaippar in Tamil Nadu. The Cauvery (Kattalai)-Vaigai-Gundar link canal is proposed to take off from the existing Kattalai barrage on its right bank near Mayanur village in Krishnarayapuram taluk of Karur district at latitude $10^{\circ} 57' 11''$ N and longitude $78^{\circ} 13' 56''$ E. The proposed link canal passes through the districts of Karur, Tiruchirappalli, Pudukkottai, Sivaganga and Virudhunagar. The link canal terminates at Gundar river in Tiruchuli taluk of Virudhunagar district at latitude $9^{\circ} 38'$ N and longitude $78^{\circ} 08'$ E. The total length of the link canal is about 256.820 Km. The important rivers crossed by the link canal alignment are NapiliAr, Ariyar, Koraiyar, Vallar, Virisalar, Manimuttar, SaruganiAr, Uppar, Vaigai and Gridhamalnadi. The command area under the link canal project is spread over Karur, Tiruchchirappalli, Pudukkottai, Sivaganga, Ramanathapuram,

Virudhunagar and Thoothukudi districts of Tamil Nadu. The whole project area falls between latitudes $9^{\circ} 12' N$ & $10^{\circ} 58' N$ and longitudes $78^{\circ} 13' E$ & $79^{\circ} 12' E$ in Tamil Nadu State.

The index map of the link project showing rivers, basin boundary, district boundary, important towns, off take, link alignment, out fall, existing and proposed command areas etc. is appended at **Plate 1.3** in **Vol. IV**.

2.2 Topography of the basin, reservoir and command area

The Cauvery (Kattalai)-Vaigai-Gundar link canal passes through Tirumanimuttar sub-basin of Cauvery basin, basin area of the streams between Cauvery and Vaigai, Vaigai basin and basin area of the streams between Vaigai and Vaippar. The link canal off takes from the existing Kattalai barrage on Cauvery. The proposed command area under the link canal falls in the Tirumanimuttar sub-basins of Cauvery basin, basin area of the streams between Cauvery and Vaigai, Vaigai basin and basin area of the streams between Vaigai and Vaippar. The topography of these sub-basins/basins is described briefly in the following paragraphs:

2.2.1 Cauvery basin

The Cauvery river is one of the major rivers of the Peninsular India extending over an area of $81,155 \text{ km}^2$ in the states of Kerala, Karnataka and Tamil Nadu. It rises in the Coorg district of Karnataka at an elevation of about 1340 m and falls in the Bay of Bengal in Tamil Nadu traversing a distance of about 800 km in the south-east direction. In size it ranks fourth, next to Godavari, Mahanadi and Krishna in the Peninsular India. The basin lies between longitudes $75^{\circ} 30' E$ & $79^{\circ} 45' E$ and latitudes $10^{\circ} 05' N$ and $13^{\circ} 30' N$. It is bounded in the west by the Western Ghats, in the east and south by the Eastern Ghats and in the North by the ridges separating it from the Krishna and Pennar basins.

The percentage of catchment area of the Cauvery basin in the States of Kerala, Karnataka and Tamil Nadu are 3.5, 42.2 and 54.3 respectively. The principle tributaries of the Cauvery are Harangi, Hemavathi, Shimsha, Arkavathi, Lakshmanathirtha, Kabini and Suvarnavathi in Karnataka and

Bhavani, Noyil and Amaravathi in Tamil Nadu. The Cauvery basin can be broadly divided into three main physiographic regions viz. (i) the Western Ghats (ii) the plateau of Karnataka and (iii) the delta.

The Cauvery basin is taken to comprise 16 sub-basins for the purposes of NWDA studies. These are (1) Upper Cauvery (2) Kabini (3) Suvarnavathy (4) Shimsha (5) Arkavathi (6) Middle Cauvery (7) Palar (8) Chinnar (9) Bhavani (10) Noyil (11) Amaravathi (12) Tirumanimuttar (13) Ponnanaiar (14) Upper Coleroon (15) Lower Coleroon (16) Cauvery delta. The Cauvery basin map is appended at **Plate 2.1**.

2.2.1.1 Tirumanimuttar sub-basin of Cauvery basin

The Tirumanimuttar sub-basin comprises the catchment of Cauvery river below Mettur dam on both sides upto Upper Anicut including the sub-catchments of Sarabhangandi, Tirumanimuttar, Pungar and Ayyar but excluding the catchment of Bhavani, Noyil and Amaravathi rivers. The sub-basin lies between north latitudes $10^{\circ} 36' 10''$ and $11^{\circ} 55' 50''$ and east longitudes $77^{\circ} 27' 30''$ and $78^{\circ} 41' 35''$. The independent catchment area of Tirumanimuttar sub-basin is 8429 km^2 and the catchment area of Cauvery river upto Kattalai barrage is $63,694 \text{ km}^2$. The sub-basin lies in Salem, Namakkal, Tiruchirappalli, Karur, Erode and Dindigul districts of Tamil Nadu.

The Tirumanimuttar sub-basin lies in the uplands at elevation ranging from 100 to 300 meters, excluding the Yercaud hill region. The height of the Shevaroya hills situated in Yercaud taluk range from 1220 to 1463 meters. The Kollimalai and few isolated hills and ridges are strewn over the taluks of Namakkal and Rasipuram. The catchment of Tirumanimuttar sub-basin can be classified as 'Rectangular Type' based on the shape and stream pattern. It has an average length of about 130 km from north – west to south – east and an average width of 100 km from north-east to south-west. This sub-basin is mainly commanded by the Mettur canals, Kattalai canals, Kalingarayan channel and part of Lower Bhavani Project canal and Salem – Tiruchi channels.

2.2.2 Basin area of streams between Cauvery and Vaigai

The basin area covered by the streams between Cauvery and Vaigai comprises the catchment of 7 small to medium streams viz. Agniyaru, Ambuliyaru, Vellar, Koluvanaru, Pambar, Manimuttar and Kottakaraiaru draining independently with their outfall in the Bay of Bengal. Vellar, and Manimuttar rivers with their tributaries are the important streams in this basin area. The basin area lies between latitudes $09^{\circ} 36'$ & $10^{\circ} 44'$ N and longitudes $78^{\circ} 07'$ & $79^{\circ} 27'$ E. It is bounded on the north and west by the Cauvery basin, on the south by the Vaigai basin and on the east by the Bay of Bengal. The river Vellar rises in the Velamalai near Marungapuri in Tiruchirappalli district and the river Manimuttar rises in the Perumalai (839 m), Alagarmalai (830m) and Karanandamalai (912 m) in the Madurai district. The lengths of these two rivers from the origin to the outfall are about 136 km and 150 km respectively.

The catchment area of the basin is $10,040 \text{ km}^2$ covering parts of Madurai, Dindugal, Tiruchirappalli, Thanjavur, Pudukkottai, Sivaganga and Ramanathapuram districts of Tamil Nadu. Except for a few hillocks in the extreme west, the basin is almost flat, gently sloping from about 200 m elevation in the west to the sea level in the east. The eastern part of the basin is comparatively wider which gradually narrows down towards the western side. The maximum width of the basin in the eastern portion is about 130 km and the minimum width in the western side is about 30 km. The vellar and Manimuttar, which are the main rivers of this basin have average bed slope of 1 in 210 and 1 in 180 respectively. Most of the rivers in this basin are flowing in the south east direction. The basin map of streams between Cauvery and Vaigai is appended at **Plate 2.2**.

2.2.3 Vaigai basin

The river Vaigai rises in the western slopes of the Varushanad hills near Kottimalai in Periyakulam taluk of Theni district in Tamil Nadu State and flows in a northerly and north easterly direction upto the confluence with Varahanadi and flows through the Madurai and Ramanathapuram districts and falls into the Bay of Bengal close to the Palk Strait. During its course, the river travels over a distance of about 258 km. Suruliarnadi, Varahanadi,

Manjalar and Marudhanadi are its principal tributaries. The basin area lies between latitudes $09^{\circ} 18' N$ & $10^{\circ} 19' N$ and longitudes $77^{\circ} 10' E$ & $79^{\circ} 01' E$. The catchment area of the basin is 7741 Km^2 and covers parts of Theni, Madurai, Dindigul, Sivaganga, Virudhunagar and Ramanathapuram districts of Tamil Nadu State.

The shape of the catchment of the Vaigai basin is like an arch with eastern side little longer than western side. The western periphery of the basin lies in the Southern part of the Western Ghats. The part of the basin from the foot hills upto sea slopes south easterly and the terrain is of undulating plains with stray hillocks. The Vaigai basin map is appended at **Plate 2.3**.

2.2.4 Basin area of streams between the Vaigai and Vaippar

The basin area comprises the catchments of all streams between Vaigai and Vaippar, draining independently and falling into the Bay of Bengal. The Gundar river is one of the important streams and Terku Ar, Kanal Odai, Gridhamal Nadhi and Paralai Ar are the main tributaries of Gundar river. Two more rivers viz. Uttarakosamangai Aru and Vembar also drain this area. The catchment area lies between latitudes $09^{\circ} 01' N$ & $10^{\circ} 04' N$ and longitudes $77^{\circ} 36' E$ and $79^{\circ} 11' E$. The Gundar river rises from the foot of the Andipatti hills at an elevation of about 260 m in the west and the other streams originate from the plains. They all flow in a south easterly direction and drain into the Bay of Bengal. The catchment area of the basin is 5409 km^2 covering parts of Madurai, Ramanathapuram, Virudhunagar, Sivaganga and Thoothukudi districts of Tamil Nadu. Except for a few hillocks in the extreme west, this area is either flat or gently sloping from about 260 m elevation in the west to the sea level in the east. The basin map of streams between the Vaigai and Vaippar is appended at **Plate 2.4**.

2.2.5 Topography of Kattalai barrage

The Kattalai barrage is situated across river Cauvery in Mayanur village of Krishnarayapuram Taluk in Karur district. The barrage is located at latitude $10^{\circ} 57' 11'' N$ and longitude $78^{\circ} 13' 56'' E$. The full pond level of the barrage is 101.20 m and the submergence at FPL is 910 ha which is confined to the river bank only.

2.2.6 Topography of Command area

The Cauvery (Kattalai)-Vaigai-Gundar link canal project envisages diversion of 2252 Mcum of water from the existing Kattalai barrage across river Cauvery out of 3855 Mcum delivered at Grand Anicut through the preceding link of Pennar (Somasila) – Palar – Cauvery (Grand Anicut) link project on substitution and exchange basis. It is proposed to provide irrigation, domestic and industrial water supply to the drought prone areas of Tamil Nadu as detailed below:

Sl.No.	District	Taluks benefitted
1.	Tiruchirappalli	Srirangam
2.	Karur	Krishnarayapuram & Kulithalai
3.	Sivaganga	Tirupattur, Karaikudi, Devakottai, Sivaganga, Manamadurai & Ilaiyankudi
4.	Virudhunagar	Aruppukkottai, Kariyapatti & Tiruchuli
5.	Ramanathapuram	Kadaladi, Kamudi, Mudukulathur, Paramakudi, Ramanathapuram and Tiruvadanai
6.	Thoothukudi	Ettayapuram and Vilathikulam
7.	Pudukkottai	Gandarvakkottai, Kulathur, Pudukkottai, Arantangi, Karambakudi, Thirumayam and Alangudi

The major rivers draining in the command area are Agni Ar, Vellar, Manimuttar, Vaigai and Gundar. The topography of the command is flat with gentle slope.

2.3 Geology of the basins, reservoirs and command area

Tirumanimuttar, basin area of the streams between Cauvery and Vaigai, Vaigai and basin area of the streams between Vaigai and Vaippar are the rivers

draining in the project area. The geology of these river basins is described in the following paras:

2.3.1. Geology of Tirumanimuttar sub-basin

Crystalline rocks of Archaean metamorphic complex are found in this sub-basin which can be divided into four main groups viz. (1) the older granulite group consisting of Charnockite, basic granulites, magnetite, quartzite and their migmatitic equivalents (2) Metasedimentary group comprising of crystalline limestone, quartzite, calc-gneiss etc. (3) Ultramafic and basic intrusives consisting of Pyroxenite, Periodatite, dunite, gabbro, onorthosite and dolerite dykes and (4) Younger pegmataidal granite. Bauxite and laterite cappings are mostly seen on plateau topped hills like Shevaroya and Kollimalais.

Hydrogeological investigations have been carried out by the Central Ground Water Board in Salem, Namakkal, Tiruchirappalli, Karur, Erode and Dindigul districts. In Salem district, Recent and sub-Recent Colluvium, Alumina – rich laterites and river alluvium are present in the foot hills, flat-topped hills and river courses respectively. Ground Water occurs under water table conditions in weathered zone, semi-confined to confined conditions in areas of thick alluvial cover and deep-seated fracture zones. The yield of open wells is low in hill areas and in plains it varies from 200 to 1000 liters/minutes. The geological formations met with in the Tiruchirappalli district comprise of the Archaean Crystalline, Jurassic, Cretaceous and tertiary sediments and alluvium of recent age. The weathered, jointed, fractured and sheared zones of the crystalline rocks are most favorable for ground water development by large diameter open wells. In the sedimentaries, there are many promising granular zones having potentialities for development by open wells, dug-cum-bore wells and tube wells. The chemical quality of ground water in the district in general is good. However, in the area underlain by cretaceous sediments, the ground water at shallow depths is saline in many parts owing to the prevailing hydrogeological conditions.

2.3.2 Geology of basin area of the streams between Cauvery and Vaigai

The main rock types encountered in the basin fall into two groups viz. Charnockite and Khondalites of Archaean age. The Charnockite group of rocks consists of the acide charnockite and related migmatites with bands of basic granulite and magnetite quartzite. The Khondalite groups of rocks consists of crystalline lime stone, colegness, calogranulite, Garnet – sillimanite gneiss, horn blends and biotite gneiss and related migmatites with bands of quartzite.

Hydrogeological investigations have been carried out by Central Ground Water Board in Madurai, Tiruchirappalli, Thanjavur, Pudukkottai and Ramanathapuram districts. The geological formations met within Madurai district comprise hard rocks of archean age and river alluvium. Ground water occurs under phreatic to semi-confined conditions and the depth of dug wells ranges from 2 to 20 m. The yield from open wells varies from 100 to 350 m³/day. The chemical quality of ground water is suitable for both irrigation and domestic purpose. The geological formation met within Tiruchirappalli district comprises the archean, complete Jurassic, cretaceous and tertiary sediments and alluvium of recent age. The weathered, jointed, fractured and sheared zones of the crystalline rock formations are most favorable for ground water development by large diameter open wells. The western part of the Thanjavur district which is falling in the basin is covered by the formations of archean and cretaceous age.

The Pudukkottai district is chiefly occupied by the crystalline rock of the archaean age in western part and sedimentary formations of the cretaceous, tertiary and quaternary age in the eastern part. Ground water occurs under water table conditions in the weathered, jointed and fractured zone of the crystalline rocks. Ramanathapuram district is chiefly occupied by crystalline rocks in the western part, upper Gondwanas and Cuddalore sand, stones capped by laterite in the central part and alluvium in the eastern part. The yield of the bore wells of 60 m to 90 m depth per minute for a drawdown of 10 to 12 m. The chemical quality of ground water is generally good.

2.3.3 Geology of Vaigai basin

Hydrogeological investigations carried out by Central Ground Water Board indicate that the area is underlain by geological formations ranging in age from Archaean to recent. The Archaean formations comprise of Khondalite and Charnockite group and Garnetiferous granulite biotite gneisses. The Garnetiferous sillimanite gneiss occurs as isolated lenses and calc-granulites occur as bands and lenses with the biotite-gneiss. It is generally medium grained and weathered. Concordant bands of quartzite occupy prominent hills, ridges, low lying mounds in the area. The quartzite is compact and coarse grained and occurs in varying shades of colour from white to dull white.

The Charnockites occur as massive out crops in the hills and plains of the area. They are generally coarse grained and gray in colour. The associated rocks namely pyroxene-granulites and amphibolites occur as linear bands within the Charnockites. Biotite gneiss is one of the predominant units occurring in a large part of the area and confined mostly to the plains. These are generally grey in colour, at places pink bands are also noticed. They are highly weathered. A number of veins (pegmatic and quartz) traverse the area both in Charnockites and granitic gneisses.

The recent alluvium consists of clay sand and gravel or their admixture confined to Vaigai river course. From the hydrogeological point of view ground water occurs both in crystalline rocks as well as quaternary sediments represented by alluvium and valley filled sediments consisting of sand, Kankar and weathered material. In the crystalline terrain consisting of gneisses with bands of granite and Charnockite, ground water occurs under water table conditions mostly in the weathered portion and to a lesser extent in the jointed and fractured and fissured zones under semi-confined conditions. The alluvium consisting of sands, clays and gravels are well developed along Vaigai river. The ground water occurs in this formation under water table and at some places under semi-confined conditions and is developed mostly by dug well and at places by dug cum bore wells.

2.3.4 Geology of the basin area of the streams between Vaigai and Vaippar

The geological formations met within the basin in Madurai district comprise of Precambrian Charnockites. The basin area is chiefly occupied by crystalline rocks in the western, upper gondwanas and Cuddalore sand-stone capped by laterites in the central part and alluvium in the eastern part. The saline aquifers in costal tracts occur to the depth range of 80 m from ground level followed by fresh water aquifers. Major part of the Thoothukudi district is covered by crystalline rocks, Recent and Tertiary sediments occur along the coast and a narrow belt of alluvium along the river course.

Hydrogeological investigations have been carried out by the Central Ground Water Board in Madurai, Ramanathapuram, Virudhunagar, Sivaganga and Thoothukudi districts. Ground water occurs under phreatic to semi-confined conditions and the depth of dug wells ranges from 2 to 20 m. The yield from open well varies from 100 to 350 m³/day. The chemical quality of ground water is suitable for both irrigation and domestic purposes. The yield of bore wells of 60 to 90 m depth Piercing crystalline formations vary from 3 to 400 liters/minute for a drawdown of 10 to 12 m. The chemical quality of ground water is generally good in hard rock areas. Ground water occurs under water table conditions in hard rock areas and both under water table and confined conditions in the sedimentaries. The depth of open wells in the “Teri Sands” are generally deep (10 to 20 m below ground level) and are shallow (6 to 10 m below ground level) in the areas occupied by sandstones, limestone and alluvium. The chemical quality of ground water is highly variable from fresh to brackish. Poor quality water is seen in black soil areas and certain coastal tracts.

2.3.5 Geology of the command area

The proposed command area under Cauvery (Kattalai) – Vaigai-Gundar link project is spread in Tiruchirappalli, Karur, Pudukkottai, Sivaganga, Virudhunagar, Ramanathapuram and Thoothukudi districts of Tamil Nadu. The geology of these districts based on the respective District Resources Maps of GSI is furnished in the following paragraphs.

2.3.5.1 Tiruchirappalli and Karur districts

The Tiruchirappalli and Karur districts are broadly divided into five geological domains viz. (i) domain to the north of Cauvery containing large areas of Charnockite with fissile hornblende gneiss (ii) domain to the south of Cauvery. The Cauvery river is a major east-west trending lineament demarcating the above two lithological domains (iii) the cretaceous rocks in the northeastern areas, around Ariyalur (iv) the Palaeocene and Tertiary formation in the northeastern part of the district overlapping the Ariyalurs of Upper Cretaceous formations (v) the quaternary formations along the Cauvery and Kollidam rivers and the laterite cappings over the Cretaceous Tertiary Formations.

The plains to the south of Cauvery comprise the migmatite complex made up of biotite gneiss, grey granites, granulites and pink migmatites and trending NE-SW to ENE-WSW. Lenses and pods of sillimanite gneisses, quartzites, calc granulites are seen around Manapparai, ChinnaDharapuram and Kadavur in the migmatite country south of Cauvery. The Satyamangalam Group of rocks occur as isolated outcrops in the gneissic country southwest of Thuraiyur, ChinnaDharapuram and Kadavur and area made up of quartzites, fuchsite-kyanite-quartzite, magnetite-quartzite, sillimanite-sericite quartzite, sillimanite-kyanite-corundum schists, amphibolites and ultrabasic complex (mostly anorthosites and gabbros). The area west of Thuraiyur, east of Musiri areas adjoining northern banks of Cauvery comprises fissile hornblende gneisses (with NE-SW trend), garnet ferrous quartzite-feldspathic gneisses, augen gneisses, representing the Peninsular Gneissic complex. Granites, basic dykes, pegmatites, represent the younger intrusives. The Quaternary formations are restricted to the alluvium of Cauvery, Kollidam, and their distributaries and laterites occurs as an isolated remnant patch over Cuddalore formation.

Three generations of tight isoclinal folds are seen in the southern part of the district. Two major parallel shears trending NNE-SSW to NE-SW are noted in the Kolli-Pachaimalai hills. The crystalline-sedimentary contact is marked by a boundary fault in an enechelon pattern. As regards mineral resources, the district is endowed with number of minerals of which limestone, gypsum, clay and feldspar are of economic importance.

2.3.5.2 Pudukkottai district

The western part of the district mainly exposes the rocks of Archaean to Proterozoic. The Tertiary to Quaternary sedimentaries occur as cover rocks in the east and south-east respectively. The Archaeans are mainly represented by the rocks of Migmatite complex (grey migmatite, hornblende biotite gneiss, grey granulite and garret granulite) with numerous enclaves belonging to Khondalite group (calc-gneiss/calc-grenulite and quartzite) and Charnockite Group (Charnockite and Pyroxene granulite). These rocks in turn are intruded by the Pudukkottai granite of Proterozoic age, which is made up of pink granite and granite gneiss associated with Pegmatite/quartz veins. In addition, garnet/sillimanite/cordierite bearing gneisses and quartz-magnetite rock, amphibolite, garnet-pyroxene rock, pyroxenite and anorthosite occur as small enclaves of unmappable dimension within the grey granitic gneiss and greasy charnockitic gneiss.

The eastern part of the district is covered by the vast stretches of hard laterite and lateritic soils within which isolated patches of Cuddalore sandstone (Tertiary) occur. The Cuddalore sandstone also occurs as patches unconformably overlying the Archaeans at places. The south-eastern part of the area is covered by fluvial fluvio-marine and marine sediments of Quaternary age. The fluvial deposits which are made up of sand, silt and clay in varying degree of admixtures occur along the active channels of Vellar, Pambar and Agniar rivers. They comprise levee, channel bar, point bar, back swamp, palaeo channel and terraces. The marine deposits are made up of fine to medium sands and black clays. These deposits are seen as beach, tidal flats mangrove swamps, creeks, spits cusps and bars. Aeolean deposits in the form of reddish brown / grey brown sands occur along the coast. The district is not endowed with rich mineral deposits. Kanker, Ocherous clay, laterite and building stones have only been recorded.

2.3.5.3 Sivaganga District

The northern part of Sivaganga and Tirupattur talus is made up of rocks of Charnockite-Khondalite groups and Migmatite complex of Archaean age and comprises Charnockite, Garnet-sillimanitegneiss, Hornblende-biotite

gneiss and Garnetiferous quartzofeldspathic gneiss, numerous bands and lenses of (i) metabasic rocks viz. amphibolite, pyroxenite and biotite schist, (ii) quartzite, (iii) crystalline limestone and calc-granulite and (iv) grey and pink granite occur within the groups. All these are intruded by quartz and pegmatite veins.

Migmatite Complex is represented by garnetiferous quartzofeldspathic gneiss, hornblende-biotite gneiss, pink augen gneiss, pink granite and granite gneiss. They are very coarse grained and highly feldspathic.

Sillimanite bearing gneiss is seen in association with the quartzite. The gneiss occurs at places as residual hillocks and knolls with gneissosity trending NW to NS having steep dip. The quartzite forms long ridges and folded. Calc-gneiss and calc-granulite occur as thin bands within the garnet sillimanite gneiss and hornblende – biotite gneiss and intensely folded.

The close of Archaean era was followed by a long hiatus marked by erosion. The Archaean rocks are overlain by the Sivaganga Formation of Upper Gondwana age (upper Jurassic to Lower Cretaceous). It extends in a NE-SW direction from Karaikudi in the northeast to Sivaganga in the southwest. Sivaganga Formation comprising the rock types such as coarse sandstone, siltstone and claystone. Marine sandstone and limestone of Quaternary age occurs to the south and west of Sivaganga overlying the sedimentary rocks of Cuddalore Formation and Migmatite Complex. 1 to 5.5 m thick laterite, consisting of ferruginous pebbles and gravel, caps the Archaeans and Sivaganga Formation in areas of relative high relief. The important minerals available in the district are clay, graphite, ochre, shale and baryte.

2.3.5.4 Virudhunagar District

The rock types belong to Khondalite Group, Charnockite Group, Migmatite Complex and acid intrusives of Archaean-Proterozoic age overlain by sedimentary rocks belonging to Tertiary age and recent alluvium.

Rocks of Khondalite-Charnockite groups occupy the western part of the district, bordering Kerala. The rocks include Charnockite (hypersthene

granite), garnetiferous sillimanite gneiss and composite gneiss such as pink and grey granite gneiss with numerous bands and lenses of basic rock, amphibolite and Pyroxenite, quartzite, crystalline limestone, calc-granulites and intruded by Pegmatite and quartz veins.

Hornblende-biotite gneiss of Migmatite Complex with residual hills of quartzite is occupied in major part of the district from north to south and from east of Aruppukkottai to west of Rajapalayam forming high ground. Many irregular bands and lenticular outcrops of crystalline limestone, calc-granulite and calc gneiss are found amongst the gneiss. Bands of fairly good quality lime stone are found around Pandalgudi, Karisalkulam and Ramasamipuram. The lime stone contains coarse crystals of calcite and medium grained green cocolite. But fine grained saccharoidal limestone and marble occur around Pandalkudi. The quartzite is mainly massive and resembles quartz veins. Sheared quartz veins are widely distributed within the hornblende biotite gneiss country. The trend of foliation of the gneiss varies from EW to NNE-SSW and the dip from 50° to 60° due east. Charnockite is also exposed as small hills and knolls, especially northeast of Kallupatti, around Kalluranni, Mallaikinar, Vaiyampatti and Mudalipatti. Many thin veins of pegmatite and quartz veins occur in the eastern part of sattur and Srivilliputtur taluks. Granite occurs as small bodies near Rajapalayam and Aruppukkottai.

In the east Tertiary sandstone with clay occur around Kovilur and Mangiri. The sandstone is deep brown or buff in colour and coarse, soft and gritty.

Recent and sub-recent laterite and lateritic soil extends to a depth of 3 to 6 meters below ground level, as seen in the high ground about 3 km north of Maraneri extending upto the Srivilliputtur road. Red soil is also found near Samsikapuram and in the high ground northeast of Rajapalayam. Most of the areas in Sattur and Srivilliputtur taluks is covered by black cotton soil, which is, on an average about 3 meters thick and appears to be insitu. Large quantities of crystalline limestone suitable for cement manufacture occur at many places in Sattur and Aruppukkottai taluks.

2.3.5.5 Ramanathapuram district

Most of the area is covered by the unconsolidated sediments of Quaternary age except in the north-western part, where isolated patches of Archaean crystalline and Tertiary sandstones are exposed. The Archaeans are mainly represented by the Charnockite Group of rocks comprising granetiferous granulite and the Khondalite Group of rocks made up of quartzites and gneisses.

The Tertiary sandstones (Cuddalore Formation) comprise pinkish, yellowish, reddish (Variegated colours) medium to coarse grained sandstone and claystone. It is overlain by this alluvium and exposed towards north of Vaigai river. Detached exposures of laterite and lateritic soil are seen in the north-western part of the district.

A major part of the district is covered with the fluvial, fluvio-marine, aeolian and marine sediments of Quaternary age. The fluvial deposits which are made up of sand, silt and clay in varying degree of admixture occur along the active channels of Vaigai, Gundar, Manimuttar and Pambar rivers. They have been categorized into levee, flood basin, channel bar/point bar and paleo-channel deposits. The paleo-channel deposits comprise brown coloured, fine to medium sands with well preserved cross-beddings. The fluvio-marine deposits are exposed in the Vaigai delta as deltaic plain, Paleo-tidal and dune flat deposits. The deltaic plain and dune flats comprise medium, grey brown sands. The paleo tidal flat deposits include black silty clay, black clay and muds. The Aeolian deposits comprise red sands which are in the nature of ancient dunes and occur over a 3.2 km wide and 8.0 km long stretch and lie parallel to the sea coast. These are separated by marshy deposits of black clays. The sands are underlain by calcareous hardpan. The marine formation comprises coastal plain deposits of sand and clay in varied proportion. Marine calcareous hardpan occurs as low terraces and platforms, with admixture of quartz, ilmenite and garnet concentration. Gypsum, ilmenite, garnet sands, lime shells, salt, clays and building stones are the known mineral potential of the area.

2.3.5.6 Thoothukudi district

Rock types in this area belong to the Khondalite and Charnockite groups and Migmatite Complex of Eastern Ghats Supergroup (Archaean age), which are un-conformably overlain by Tertiary and Quaternary sediments. Garnet-biotite-Sillimanite gneiss, quartzite, calc-granulite and limestone of Khondalite Group with epidiorite occurring as narrow linear bands. Charnockite Group is represented by acid variants. These rock types occur as xenoliths within the Migmatite Complex. The Migmatite Complex occupies a major part of the area, comprising medium grained hornblende-biotite gneiss and garnet-biotite gneiss. Gray and pink granite represent the last phase of granitic activity and occur as concordant intrusive bodies.

Fine grained marine, calcareous sandstone and limestone and gritty sandstone intercalated with a pebble bed of Mio-pliocene (Cuddalore Sandstone) un-conformably overlies the Archaean. The pebble bed generally marks the contact between the sandstone and the gneiss. An interesting assemblage of fossils such as lemelibranchs gastropods, corals and foraminifera is found in the sedimentary rocks. The beds are more or less horizontal or dip generally towards east.

Quaternary sediments occur along the river valleys and the east coast. They are grouped into fluvial, fluvio-marine, Aeolian and marine. Calcareous sandstone and siliceous limestone of quaternary age un-conformably overlies the Tertiary sediments marked by a conglomerate. The calcareous sandstone is interbedded with limestone. The rocks are coarse grained, poorly consolidated and friable with recent marine shells of which *Ostrea Sp* is the most common. A conglomerate bed is noticed at the base of these sediments in contact with Archaeans. Kankar and tuffaceous limestone occurs in number of detached outcrops. The rocks occur as massive beds of shut tufa resulting from segregation of lime bleached out of the underlying garnet gneiss. Thick alluvium occurs along the banks of Tambraparani and Vaippar rivers and along the coast. Red 'Teri' sands represent Aeolian deposits. They occur as small dunes and cappings.

The general trend of the foliation in Archaean rocks is NNW-SSE to NNE-SSW with moderate to steep dips towards east. The foliation is the result of tight folding. The gneiss of migmatite complex is folded along NNW-SSE axis. Rocks of Miocene age are nearly horizontal. Gypsum, limestone, beach sand, Kankar and shale limestone are the economic minerals of the district.

The geological maps of the project area are appended at **Plate 2.5.1 to 2.5.4.**

2.4 River system and catchment area

The schematic diagram illustrating on overview of the river system of the Cauvery (Kattalai) - Vaigai - Gundar link project is given in **Chapter - 5: Hydrology and Water Assessment** at **Fig. 5.1.** The major river system intercepted by the Cauvery (Kattalai) - Vaigai - Gundar link project is described below:

2.4.1 Tirumanimuttar sub-basin of Cauvery basin

The Tirumanimuttar sub-basin comprises the catchment of Cauvery river below Mettur dam on both sides upto Upper Anicut including the sub-catchments of Sarabhangandi, Tirumanimuttar, Pungar and Ayyar but excluding the catchments of Bhavani, Noyil and Amaravathi rivers. Leaving the Mettur dam, the river Cauvery enters this sub-basin and flows in the South-western direction along the boundary of Tiruchengodu and Bhavani taluks. It receives Chittar river (a small tributary) on its right and then the Sarabhangandi near Kaveripatti on its left. After receiving the Bhavani river on the right at Bhavani opposite to Kumarapalayam it sharply turns south – eastwards and flows along the boundary of the Tiruchengodu taluk with the Erode taluk. After Sedarpalayam bed regulator, it receives the Kurangupallam stream, a small tributary of main Cauvery and then Noyil river on its right. By changing its course in the easterly direction for a short distance, again it continuous to flow south – eastwards upto Kattalai barrage. In the part of its course, it receives the Tirumanimuttar in Namakkal taluk near velur on its left and the Amaravathi in Karur taluk on its right. The river, then continuous to flow in the same direction and leaves this sub-basin at Upper Anicut. Below Kattalai barrage it receives the Pungar on its right near Kulithalai and the

Ayyar river on its left near Upper Anicut. Through out its course of about 185 km length from Mettur to Upper Anicut, the river Cauvery receives a number of small streams.

2.4.2 Basin area of streams between Cauvery and Vaigai

This basin area comprises the catchment of a number of small and medium streams each draining independently with their out fall in the Bay of Bengal. The important streams are Ariyar, Koraiyar, Agniyar, Ambuliyar, Vellar, Koluvanaru, Pambar, Manimuttar and Kottakariaru.

Ariyar

The river Ariyar originates from Pallivellimukku in Manapparai taluk of Tiruchirappalli district and flows through Srirangam taluk and confluences with Koraiyar within Tiruchirappalli Urban limit. The initial stretch of Ariyar is called as Therkkumalaiyar and subsequent stretches are called Thombattichiyar and Mamudiyar. Ponnaniyar, a major tributary of Ariyar joins on the left flank and KannuthuOdai joins on the right flank.

Koraiyar

The river Koraiyar originates in Rediyapatti hills in Manaparai taluk of Tiruchirappalli district and flows through Srirangam and Tiruchirappalli taluks of Tiruchirappalli district and Kulathur, Illupur taluks of Pudukkottai district. This river is then called Kudamurutti which traverse the Uyyakondan canal through Puthur weir. PeramburVari and KattuVari are the two major tributaries of Koraiyar. Of this PeramburVari originates from the Perambureri and joins with Koraiyar at upstream of Kolukkattakudi village of Srirangam Taluk. KattuVari originates from the Neerpalanieri and Avaiyapattieri of Kulathur taluk and joins with Koraiyar at Thirumaalaisamudram village of Srirangam taluk.

Agniyar

The Agniyar otherwise known as "Agnanavimochana Aru" originates from the surplus of Kulathur big tank and flows through Kulathur, Alangudi

taluks of Pudukkottai district and Pattukkottai, Orathanadu and Peravurani taluks of Thanjavur district with a total distance of 80 km from its origin and joins with Bay of Bengal near Rajamadam village of Pattukkottai taluk. The other minor tributaries confluence with Agniyar river are Nariyar drain (left), Nariyar drain (Right) and Maharaja Samudram river on the left side of Agniyar.

Vellar

The Vellar river raises in Velamalai near Marungapuri in Tiruchirappalli district and confluences in the Bay of Bengal and the length of this river is 136 km. The river Vellar known as South Vellar is one of the important streams of the basin area covered by streams between Cauvery and Vaigai. The river Narasinga Cauvery, a tributary of Vellar has its origin from the surplus of Narpavalakudi tank in Narpavalakudi village of Pudukkottai district. It runs for a distance of 31 km in Pudukkottai district and confluence with sea near Kattumavadi village.

Pambar

The Pambar originates from the surplus of Thamaraikanmai in Thirumayam taluk of Pudukkottai district. It runs for a length of 65 km in southeast direction and falls into the Palk Straight.

Koluvanaru

The river Koluvanaru originates from the surplus of Mangalathu tank and Kamalakkudi tank in Avudaiyarkoil taluk of Pudukkottai district. It runs for a distance of about 18 km and joins Bay of Bengal at Mimisal village. The Koluvanaru river receives the surplus of many other tanks along its run.

Manimuttar

The surplus of Eriyur tank is the origin of Manimuttar river and traverses to a distance of 65 km in Tirupattur, Karaikudi, Devakottai taluks of Sivaganga district and Tiruvadana taluk of Ramanathapuram district and confluences with Pambar near Sirukambaiyur village in Ramanathapuram

district and finally join Bay of Bengal near S.P. Pattinam village. The important tributaries of Manimuttar are Thirumanimuttar, Palar and Virisalar river.

Thirumanimuttar originates in Mulaiyur hills in Natham taluk of Dindigul district. The river bifurcates into two arms after it traverses a length of 40 km in its course. The left arm is called Uppar river and it confluences with Palar river in Singampunari village. The right arm is called Uppodai and it empties into Eriyur Big Tank in Eriyur village.

The river Palar has its origin from Mudhumalai of Natham taluk and Karanthamalai in Dindigul taluk. It traverses to a distance of 60 km and empties into Tirupattur Big Tank.

The river Virisalar originates from the surplus of Murukku Kanmoi in Tirupattur taluk of Sivaganga district and traverses to a distance of about 35 km in south west direction through Thirumayam, Tirupattur and Karaikudi taluks and finally join Manimuttar river just upstream of Poyyalur anicut across Manimuttar river.

Kottakariaru

The river Kottakariaru is formed by the two rivulets Nattar and Saruganiar near Maruthavayal village, 3 km upstream of R.S. Mangalam Big Tank and runs for a distance of about 35 km in east direction before its confluence with Palk Strait.

2.4.3 Vaigai basin

The river Vaigai raises in the western slopes of the Varushanad hills near Kottinalai in Periyakulam taluk of Theni district in Tamil Nadu and flows in a northerly direction upto Vaigai dam. VairavanAr which raises in Uttamapalayam taluk of Theni district joins Suruliarnadi which is a major tributary of Vaigai. The Suruliarnadi which flows in a northerly direction receives KottakudiAr on its left flank below Vaigai dam. The Suruliarnadi joins Vaigai river on its left flank near Theni. The Varahanadi which originates in Kodaikanal taluk of Dindigul district flows in north easterly direction and

joins Vaigai on its left flank downstream of Vaigai dam. The Manjalar river and MarudhanadiAr which originates in Kodaikanal taluk flows in north easterly direction and confluence with river Vaigai on its left flank upstream of Peranai regulator. After Peranai regulator, the river Vaigai flows in south easterly direction and drains into Bay of Bengal. During its course, the river travels over a distance of 258 km from its origin to confluence with Bay of Bengal.

2.4.4 Basin area of Streams between Vaigai and Vaippar

The Gundar river which is known as Uppar river in the upper reaches originates from the foot of the Andipatti hills in the west at an elevation of 260 m flows in easterly and south easterly direction. The Therku Ar which originates in Kariyapatti taluk of Virudhunagar district joins Gundar in its left flank near Pudupatti village in Kariyapatti taluk. The river Gundar continuous to flow in south easterly direction and receives KanalOdai on its left flank near Kamudi in Ramanathapuram district. The ParalaiAr joins GridhamalNadi and the GridhamalNadi flows in south easterly direction and joins Gundar on its left flank below Kamudi. Two other independent streams viz. Vembar river and Uttarakosamangal Ar drains into Bay of Bengal in this basin.

2.5. Basin Characteristics

The basin characteristics of various river basins pertaining to the Cauvery-Vaigai-Gundar link project are described as per the respective Revised/Updated WBS reports and based on the data of IMD publication ‘Climatological Tables of Observatories in India (1981-2010).

2.5.1 Tirumanimuttar sub-basin of Cauvery basin

The Tirumanimuttar sub-basin lies between latitudes $10^{\circ}36' 10''$ & $11^{\circ}55' 50''$ N and longitudes $77^{\circ} 27' 30''$ & $78^{\circ} 41' 35''$ E. The basin extends over an area of 8429 Km^2 which constitutes 10.39% of the total catchment of the Cauvery basin. The entire catchment area lies in Tamil Nadu State.

2.5.1.1 Rainfall

The basin experiences both south-west monsoon from June to September and North-east monsoon from October to December. The rainfall during non-monsoon period is not significant. The average annual rainfall of the sub-basin is 791 mm. The annual rainfall over the catchment varies from 591 mm to 977 mm.

2.5.1.2 Temperature

The mean daily maximum temperature in the basin varies from 37.4 °C to 29.2 °C and the mean daily minimum temperature varies from 26.5 °C to 20.3 °C

2.5.1.3 Relative humidity

The mean relative humidity is high during the monsoon period and comparatively low during the post-monsoon period. In summer the weather is dry and the humidity is low. The relative humidity in the basin ranges from 43% to 80%.

2.5.1.4 Wind speed

Winds blow mainly from the directions between west and north-west during the south-west monsoon season and between north and north-east during the north-east monsoon season and post-monsoon season. During rest of the year, wind blows from east-south east and west-south west. The mean wind speed in the basin varies from 8.0 to 16.1 kmph.

2.5.1.5 Cloud cover

Sky is generally heavily clouded during the monsoon season. During the post-monsoon season, cloudiness decrease. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the basin varies from 3.0 to 5.9 oktas.

2.5.2 Basin area of streams between Cauvery and Vaigai

The basin area lies between latitudes $9^{\circ}36'$ N to $10^{\circ}44'$ N and longitudes $78^{\circ}07'$ to $79^{\circ}27'$ E. The total catchment area of the basin is 10040 km^2 and lies entirely in Tamil Nadu State.

2.5.2.1 Rainfall

The catchment receives rainfall both during the south-west monsoon (June to September) and the north-east monsoon (October to December). The rainfall during the non-monsoon period is not significant. The average annual rainfall of the basin is 904 mm. The annual average rainfall of the catchment varies from 706 mm to 1240 mm.

2.5.2.2 Temperature

The normal daily maximum temperature in the basin is 38.2°C during May and the normal daily minimum temperature in the basin is 20.6°C during January. The climate in this basin is cool from December to February and the hottest period is from March to May.

2.5.2.3 Relative humidity

The coastal region is humid throughout the year, while in the interior, the relative humidity is highest during November. The maximum and minimum values of relative humidity observed in the basin area 86% and 41% respectively.

2.5.2.4 Wind speed

The catchment is influenced by winds during south-west and north-east monsoon season. A maximum normal wind speed of 16.1 kmph occurs in July. The minimum normal wind speed of 5.3 kmph occurs in November.

2.5.2.5 Cloud cover

The sky is generally heavily clouded to over cast during the monsoon season. In the rest of the year the sky is mostly clear or lightly clouded. The cloud cover in the basin varies from 5.9 oktas in the month of October to 2.8 oktas in the month of February.

2.5.3 Vaigai basin

The Vaigai basin lies between latitudes $9^{\circ} 18' N$ to $10^{\circ} 19' N$ and longitudes $77^{\circ} 10' E$ to $79^{\circ} 01' E$. The catchment area of the basin is 7741 km^2 covering parts of Theni, Madurai, Dindigul, Sivaganga, Virudhunagar and Ramanathapuram districts of Tamil Nadu State.

2.5.3.1 Rainfall

The catchment receives rainfall both during south-west (June to September) and north-east (October to December) monsoons. The rainfall during the non-monsoon period is not significant. The average annual rainfall of the basin is 924 mm. The average annual rainfall of the basin varies from 604 mm at Virapandi to 2848 mm at Devikulam.

2.5.3.2 Temperature

The mean daily temperature is highest during the month of May and it is lowest in the month of January. The mean daily maximum and minimum temperature observed at Madurai IMD station are 38.3°C during the month of May and 21.1°C during January.

2.5.3.3 Relative humidity

In general, the humidity is high and is highest during the month of November. The relative humidity in the catchment ranges from 41% to 78%.

2.5.3.4 Wind speed

Winds are generally high during the south-west monsoon season and during the post-monsoon of north-east monsoon. The catchment is influenced by winds from south-west and north-west during June to September and from north and north-east during October to May. The average wind speed in the catchment varies from 4.6 kmph to 6.7 kmph.

2.5.3.5 Cloud cover

Sky is generally heavily clouded during the monsoon months. In the post-monsoon months, cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the catchment ranges from 3.0 to 6.1 oktas.

2.5.4 Basin area of streams between Vaigai and Vaippar

The basin area lies between latitudes $9^{\circ} 01' N$ & $10^{\circ} 04' N$ and longitudes $77^{\circ} 36' E$ & $79^{\circ} 11' E$. The total catchment area of the basin is 5409.4 km^2 and lies entirely within Tamil Nadu State.

2.5.4.1 Rainfall

The catchment receives rainfall both during south-west (June to September) and north - east (October to December) monsoons. The rainfall during the non-monsoon period is not significant. The average rainfall of the basin is 815 mm. The average annual rainfall varies from 635 mm at Vilathikulam to 932 mm at Usilampatti.

2.5.4.2 Temperature

The mean daily maximum temperature in the basin varies from $38.3^{\circ} C$ to $30.6^{\circ} C$ and the mean daily minimum temperature varies from $26.1^{\circ} C$ to $21.1^{\circ} C$ as observed at Madurai IMD station.

2.5.4.3 Relative humidity

In general, the humidity is high and the relative humidity in the catchment varies from 41% to 78%.

2.5.4.4 Wind Speed

The catchment is influenced by winds from south-west during the monsoon season. The average wind speed in the catchment varies from 4.6 kmph during October to 6.7 kmph during January.

2.5.4.5 Cloud cover

The sky is generally heavily clouded during the monsoon months. In the post monsoon months cloudiness decreases. During the rest of the year, the sky is clear or lightly clouded. The cloud cover in the catchment ranges from 3.0 oktas during February and March to 6.1 oktas during July.