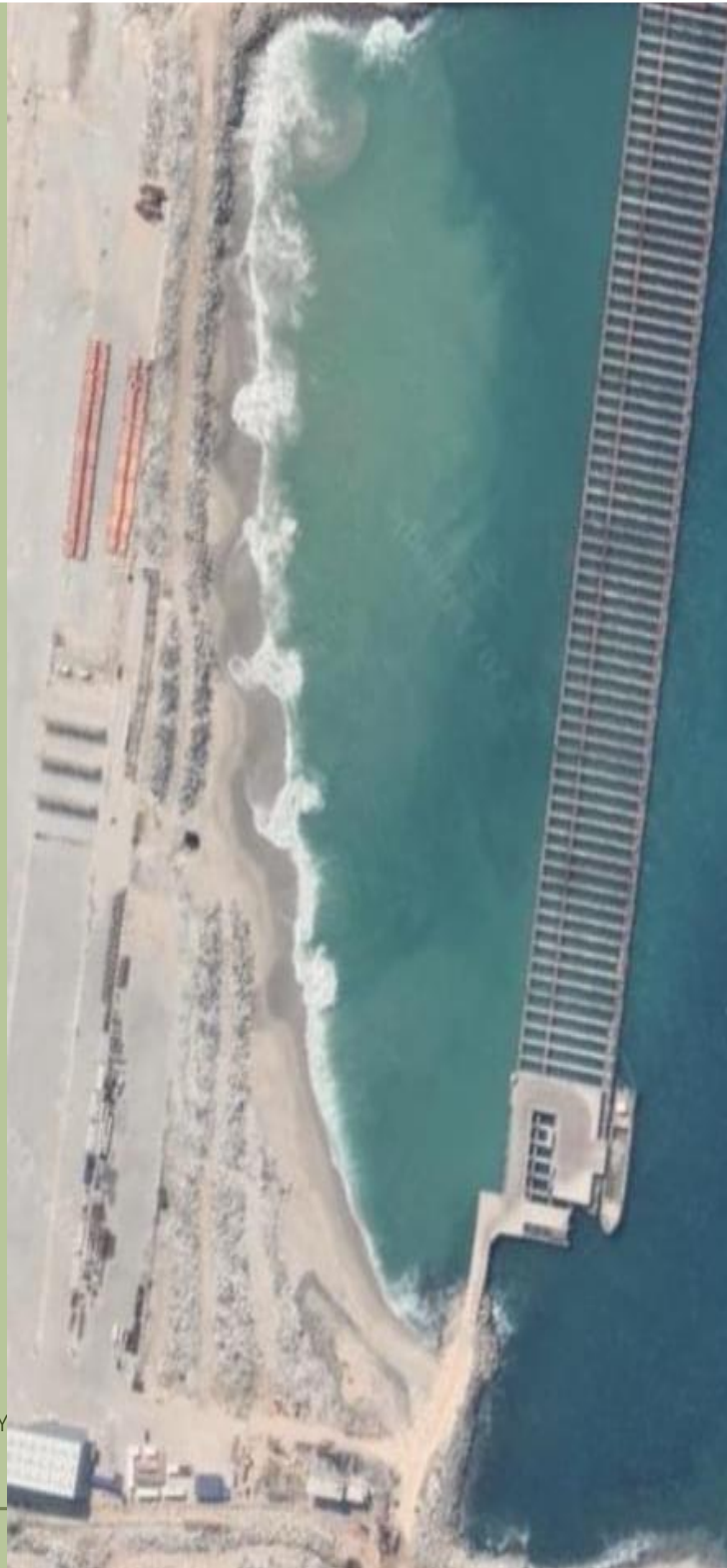


GROUNDWATER DEPARTMENT, GOVERNMENT OF KERALA

# REPORT

## HYDROGEOLOGICAL AND GEO-HYDROLOGICAL STUDY FOR THE PROPOSED RAILWAY TUNNEL



SUBMITTED BY  
[GROUNDWATER  
DEPARTMENT,  
GOVERNMENT OF  
KERALA]  
[DECEMBER- 2021]

**HYDROGEOLOGICAL AND GEOHYDROLOGICAL STUDIES IN AND  
AROUND THE PROPOSED RAILWAY TUNNEL CONNECTING  
VIZHINJAM AND BALARAMAPURAM OF  
THIRUVANANTHAPURAM DISTRICT, KERALA**

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Report on

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AROUND THE PROPOSED RAILWAY TUNNEL CONNECTING  
VIZHINJAM AND BALARAMAPURAM OF THIRUVANANTHAPURAM  
DISTRICT, KERALA

Submitted by

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**STUDY TEAM**

*(Ltr.No. T(4)/7109/2018/DGW dated 14-10-2020 and  
Order No. T(4)/7109/2018/DGW dated 22-10-2021)*

**Co-ordinator**

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**Investigator**

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**Team Members**

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7. *Smt. Prathibha Raveendran, Geological Assistant, Groundwater Department, Ernakulam*

## Acknowledgement

*The study was taken up by Groundwater Department by constituting a special team led by Smt.Ancy Joseph, Superintending Hydrogeologist(G) vide Ltr.No. T(4)/7109/2018/DGW dated 14-10-2020). The study team thank Er. Sri. Jeyakumar, Managing Director and CEO Vizhinjam International Sea Port Limited for having approached Groundwater Department to take up this demand-based study. He is also thanked for his extreme patience, support and encouragements throughout the period of study especially while going through 1<sup>st</sup> and 2<sup>nd</sup> Covid lock down. The whole study team are privileged to have the opportunity to get associated with VISL on this prestigious project. The team is grateful to Er. Sanooj, Er.Narayanan, Er.Santhosh of VISL and Er.Muralidhar, Er.Viswanathan of KRCL for their keen encouragements and support at various stages of the work. Er.Birendra Kumar, Deputy Chief Engineer, Konkan Railway is thanked for sharing valuable information and also deputing his staff to accompany groundwater department officials during the course of field work.*

*Sri.B.Pradeep, District officer, Thiruvananthapuram is thanked for all logistic supports and encouragements including sparing of staff for the field investigation which helped smooth mobilisation of activities to complete this study. Smt. Rini Rani, District officer, Alapuzha is also thanked for sparing the services of staff whenever required*

*We are also grateful to Dr. Subbraj, Regional Director, CGWB for his positive approach throughout the period of study. He is also thanked for arranging a team of officers to work with Groundwater Department for conducting infiltration studies and also for providing assistance to GWD officials to complete the Groundwater Resource Estimation of the region. The team thank Dr.Vinayachandran, Scientist.F, Smt.Rani.V.R, Scientist-D, Sree.Sree.Hari, Scientist-D, Sri.Vijeesh Scientist-D and Sri.Roopesh Scientist-D for their help and contributions.*

*The team is grateful to Sri.Venketesapathy, IAS, former Director, GWD for constituting a special team for this study that formed the basic spadework for this special investigation. The team also wishes to place on record Sri. John.V.Samuel, IAS, Director, Groundwater for his support.*

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**EXECUTIVE SUMMARY**

1. The Government of Kerala, has identified an ambitious project to develop an International Deepwater Multipurpose Seaport at Vizhinjam, Thiruvananthapuram, Kerala. The port is now under construction and the present phase is expected to get completed by December 2023. It is proposed to follow the landlord port model with the intention of catering for passenger, container and other cargo shipping for which the Rail connectivity is one of the critical components of the Project.
2. The implementation of the Project was entrusted with Vizhinjam International Seaport Limited (VISL) under Government of Kerala (GoK). The private partner, the Concessionaire M/s Adani Vizhinjam Port Private Limited has commenced the construction on 5<sup>th</sup> December 2015.
3. The work of rail connectivity is entrusted to M/s Konkan Railway Corporation Ltd (KRCL). They have conducted the preliminary geotechnical studies for tunnel engineering. The core samples extracted from the bore holes were physically verified and documented for the study.
4. The Managing Director, Vizhinjam International Seaport Ltd (VIZL) had approached Member Secretary, Kerala State Groundwater Authority to take up a study addressing Hydrogeological and Hydrological aspects to revise/obtain clearance from MoEF as a new underground route is envisaged from Vizhinjam to Balaramapuram for rail connectivity.

5. The purpose of the study is to submit a detailed report which would help them to apply for the required amendments and also to obtain necessary clearances to take up tunneling process.
6. Groundwater department had already collaborated with KSREC in 2019 to conduct the “Study on possible environmental impact on Groundwater system” in connection with the new road connecting National Highway to Vizhinjam”.
7. The Secretary, Fisheries and Ports Department had a discussion with State Groundwater Department, Central Groundwater Board officials on 25.07.2019 and requested Groundwater Department to conduct a Hydrogeological/Hydrological study for which CGWB agreed to share all the required documents in connection with the tunnel construction.
8. The team had a joint inspection with Konkan Railway Corporation Limited (KRCL) on 11.12.2020 and had consulted the Draft Detailed Project Report (DDPR) prepared by them.
9. Accordingly, Director Groundwater Department has constituted a special team, vide Ltr. No. T(4)/7109/2018/DGW dated 14.10.2020 to carry out the required field study and report preparation.
10. After carrying out a detailed literature study on the earlier works in the area, inspection of samples collected by Qmax Techno Consultants Pvt. Ltd (QTCPL) was carried out., then the approach of the study was discussed, and a detailed work plan was later finalised.
11. The field data collection for Hydrogeological study started during the month of December-2020. After the initial field data collection from 123 wells, the data from the monitoring wells of CGWB and GWD was further compared. Though

seasonal monitoring during pre-monsoon was planned, the travel restrictions during the 1<sup>st</sup> lock down affected field work and hence had to be cancelled.

12. The matter was discussed with Director, GWD and also informed Managing Director, VIZIL and decided to complete the monitoring cycle by using the representative well monitored by GWD under NHP in the region.
13. To fill the data gap and also to generate some additional base line information four new sites were selected for exploratory bore hole drilling and four sites for conducting aquifer test and another six sites were selected for infiltration studies.
14. The infiltration studies though started on 8<sup>th</sup> October 2021, the same was delayed due to unfavourable climatic conditions prevailed till November, which was later completed during December 2021 in which one site was excluded due to technical reason.
15. The limitations in the filed activities and the progress of the work were discussed/updated with Managing Director, VISL and Regional Director, CGWB on 22<sup>nd</sup> July 2021 and 3<sup>rd</sup> November 2021 via google meet.
16. The Managing Director and CEO informed the pressing need of report from GWD to prepare environmental impact report, the following findings are summarised herewith.
17. The detailed hydrogeological assessment of 100sq.km area was carried out through field mapping in and around the proposed railway tunnel by dividing the area in to small grids having 1sq.km size and also creating a buffer of 500m radius on both sides to abstract sensitive details close to the tunnel alignment.
18. From detailed study on the surface and sub-surface geology, it is found that the area covered by sedimentary and crystalline group of rocks almost on equal proportion from Vizhinjam to Balaramapuram (Fig-6). The prominent



presence of thick layer of laterite ranging in thickness from 20m to 50m is noticed throughout the region (Fig-14).

19. The thick clayey formation in the coastal segment is identified with the presence of three distinct aquifer layers comprised of 5m thick fine sand, 2m thick medium sand and 6m thick coarse sand. The coarse sand and fine sand are limited along the coastal basin but the medium sand is seen extended towards the NE side for about 5km from the coast line.
20. There are about 86 farm ponds mapped in the area in which majority of these ponds are used for irrigating coconut trees, rubber, vegetables, banana etc. The ponds contribute a gross storage volume of 46.6542 Ha.m are acting as major water conservation structures in the area.
21. The water level in these wells is perennial in nature ranges from 1.07m to 37.47m.bgl. The spatial analysis indicates the deeper water levels ranging from 10-20 m found sandwiched between the western coastal and eastern crystalline terrain.
22. A rising trend of 0.08m is noted from the monitoring well (Fig-12) near Vizhinjam, whereas a falling trend of 0.05m noticed in the well (Fig-13) near Balaramapuram side indicating the recharge-discharge conditions in the area is also different.
23. From the study it may be concluded that almost half of the tunnel stretch is situated in well drained lateritic soil, whereas the western coastal segment is situated in clay enriched laterite which has low hydraulic conductivity.
24. The study indicates that the excavation of tunnel across the thick lateritic profile would cut the water table along the tunnel stretch. It is also found that due to the presence of thick clayey laterite the draining capacity of soil would be minimum.

25. From the digital elevation model (DEM) and physiographic features indicates that most of the area falls in the mid land zone having an altitude ranging from 7.6 to 76m.aml. However high land zone was demarcated along the tunnel stretch where the altitude is exceeding > 76m above mean sea level.
26. Vellayani Lake is the main topographic depression found in the area. The lowest and highest point of elevation within the study area is near Vellayani lake (2 m) and near Aruvippuram (133 m) above mean sea level.
27. The drainage system around the Vellayani lake on the NE segment is of sub radial type. Whereas, the drainage on the other areas is dendritic in nature. The drainage systems are largely controlled by the structural features associated with neo tectonic activities.
28. The flow direction map prepared from the overlay of thematic maps shows major flow diversion is observed in the Neyyar watershed where flow is largely diverted along SE side. Whereas the flow on the Karamana basin indicates multiple flow diversions seen along SW, East and North directions.
29. The total groundwater availability in the assessment unit as on March 31, 2021 is found to be 41.46 Ha.m. The study identifies that the rainfall recharge accounts for 17.86 Ham of the annual recharge in the assessment unit.
30. The total annual extraction of groundwater in the area is found to be 15.05% Ha.m. From the existing gross groundwater draft the stage of groundwater extraction in the unit is found to be 86.18%, this falls in the semi-critical category.
31. The Landforms in the study area are formed largely due the combined effect of fluvial, marine and denudational process and hence infiltration capacity of the soil is distinctly different on soils of different origin.

32. The infiltration rate at any time worked out from the data indicates the lateritic formation exhibits low infiltration values of 2.811 cm/hr on the eastern side whereas the red teri sands indicate a higher infiltration of 6.723 cm/hr near Kattachakuzhy area.
33. The study concludes, the tunnelling is to be carried out with mining of sedimentary (soft) and crystalline group (hard) of rocks. The presence of soft rocks is more towards the coastal segment.
34. The high “N” values around 100 noticed at a depth of 25m below the subsurface along the length of the tunnel except at the coastal segment indicates the presence of thick hard compacted layer (clay) having poor hydraulic properties.
35. The thick clayey formation in the coastal segment is identified with the presence of three aquifer layers comprised of 5m thick fine sand, 2m thick medium sand and 6m thick coarse sand below 50m depth. Traversing in this formation would encounter groundwater seepage/loss as the formation is in semi-confined condition.
36. As half of the area falls in the uplifted coastal sedimentary terrain, highly irregular hard rock crystalline basement (Khondalite rocks) could be expected at depth especially at the eastern and western coastal segments.
37. A large number of domestic groundwater abstraction structures (bore wells) in the Balaramapuram township may directly affect during tunneling process as the penetration depth of several borewell that crosses underground tunnel alignment near Balaramapuram township.
38. The tunneling may also impact collapse of wells and induce land subsidence, hence care should be taken during tunnelling process in an around 100 m radius of the proposed alignment.