

Chapter 1

Introduction

1.1 Purpose of the Report

Cairn Energy India Pty. Ltd. (CEIL) has been exploring hydrocarbon resources in the state of Rajasthan for the last eight years. The massive exploration programmes undertaken by CEIL have resulted in a number of oil and gas field discoveries. In order to facilitate the early production from these discovered fields, CEIL in partnership with Oil and Natural Gas Corporation (ONGC) propose to lay an onshore oil evacuation pipeline of approximately 600 km length with associated facilities from Mangala terminal, Barmer district, Rajasthan to Salaya terminal in Jamnagar district via Viramgam. Out of the total 600 km pipeline proposed, the pipeline will traverse about 150 km in Rajasthan and 450 km in Gujarat.

The overall pipeline project envisages setting up of the following facilities.

- ◆ Laying of approximately 600 km buried oil evacuation pipeline (24" Insulated oil pipeline and 8" gas pipeline) from Mangala Terminal to Salaya in Gujarat via Viramgam
- ◆ Establishment of associated facilities such as heating stations (32 Nos.) and pigging stations along the pipeline route.
- ◆ Establishment of storage, handling and pumping stations and diluent's mixing facilities at Viramgam terminal of 10,000 m³ crude oil

capacity and at Salaya terminal of 300,000 m³ crude oil capacity in Gujarat state.

- ◆ Establishment of captive power generating facilities at all heating stations and Viramgam and Salaya terminals. The total power requirement for the entire pipeline and associated facilities project is estimated at 50 MW.

As the crude oil is waxy by nature, heating of the crude along the pipeline is essential for the continuous flow of liquids. This will be achieved through Skin Effect Heat Tracing System and/or contingency gas fired indirect heating system and blending of diluents. The crude oil pipeline will be insulated with 90 mm Poly Urethane Foam (PUF) and 8 mm High Density Polyethylene (HDPE) jacket to arrest the heat loss from pipeline to the surrounding soil. Power requirement will be met by dual fired generator based on gas and/or oil. Gas will be preferably used for power generation and oil is an alternative option. A parallel gas pipeline of 8" diameter from Raageshwari gas terminal will be laid along the main crude oil pipeline corridor for supply of natural gas.

With a view to assessing the environmental impacts arising due to the proposed crude oil , Gas pipeline and associated facilities, CEIL retained National Environmental Engineering Research Institute (NEERI), Nagpur to undertake a Environmental Impact Assessment (EIA) study.

This report contains description of EIA study for baseline conditions of various components viz. air, noise, water, land and biology surrounding the proposed developmental facilities. The Report also describes assessment of the impacts on the environment due to the construction and operation of pipeline and storage facilities and details recommendations on the preventive measures to be taken, to minimize the impact on the environment to acceptable levels. The primary and secondary field data around proposed storage terminals and along the infield pipeline route have also been collected and incorporated in the report. Environmental quality monitoring has been carried out within 10 km radius of Viramgam and Salaya terminals over a period of one season (summer) and at important environmental sensitive locations.

1.2 Identification of Project and Project Proponent

Cairn Energy India Pty. Ltd. (CEIL) has been exploring acreage, as well as operating development and production assets in India for over 12 years. The Cairn India Group has long and proven expertise, having made several significant

hydrocarbon discoveries in its operating blocks at PKGM-1 (Rawva), CB/OS-2 (Suvali), RJ-ON-90/1 (Rajasthan) Block. There have been over 20 proven discoveries in the Rajasthan block and have put the state of Rajasthan in the oil and gas map of the world. The estimated oil in place is over 2000 million barrels and recoverable reserves are estimated to be over 500 million barrels of oil.

Cairn Energy India Pty Limited (CEIL) is the principal operating subsidiary of Cairn India and is a party to and operator of the RJ-ON-90/1 Production Sharing Contract (PSC). Following the acceptance of the declaration of commercial discovery, the Oil and Natural Gas Corporation of India (ONGC), a majority state owned enterprise, exercised its right to take a 30% interest in the discovered fields of Mangala, Aishwarya, Raageshwari, and Saraswati (MARS). The MARS field development is being undertaken by the Rajasthan Joint Venture (Rajasthan JV) comprising of 70% equity by Cairn India and 30% by ONGC, the licensee of the block "RJ-ON-90/1". Field Development Plans were subsequently approved for the MARS fields. The MARS fields are now under active development

The peak crude oil production envisaged from RJ-ON-90/1 Block is 150,000 Barrels of Oil Per Day (BOPD). The natural and associated gas generated from this field will be used for captive power generation and heating requirements.

The gap between supply and demand of hydrocarbons is fast leveling off in the country with existing refineries undergoing expansion and new refineries being set up in the country. There is a large demand for crude oil in western Gujarat, which is presently being catered to by means of road and rail transport. This generally results in interrupted/intermittent supplies of the hydrocarbons to the consumers. This pipeline and associated facilities project will be useful for continuous supply of hydrocarbons to various parts of India.

The crude oil thus produced from RJ-ON-90/1 Block needs to be evacuated to the refineries for processing into petroleum products. Mangalore Refinery and Petrochemicals Ltd. (MRPL), Indian Oil Corporation (IOC) and other refineries are potential buyers of the crude. Evacuating the crude via the coast offers possibility for the crude to be sent to any of the refineries based along the western, southern and eastern coast of India

1.3 Brief Description of Project

The proposed crude oil export pipeline extends from Mangala terminal of Barmer district in Rajasthan state to Salaya terminal near Jamnagar via Viramgam in

Gujarat state. The pipeline enroute will pass through Barmer and Jalore Districts in Rajasthan state and Banaskantha, Patan, Ahmedabad, Surendranagar, Rajkot and Jamnagar districts in Gujarat state.

The alignment of Mangala – Salaya crude oil export pipeline is presented in **Fig. 1.1**. The pipeline has been divided in two phases stretches viz. Mangala to Viramgam and Viramgam to Salaya terminal. The length of pipeline from Mangala to Viramgam terminal will be approximately 340 km, whereas pipeline between Viramgam and Salaya terminal shall have length of approximately 260 Km. Total length of pipeline will be about 600 km. The pipeline route will be so aligned to avoid built-up areas, environmentally sensitive areas, and rugged terrain and will have minimum number of crossings of state and national highways, railway routes, rivers, streams and canals.

The present route has been finalized based on least disturbance to the environment, human habitations, forest, aquatic bodies and avoid sanctuary, archaeological monuments and other sensitive locations. The route is optimized considering the above factors and connectivity between supply and crude sale point.

As the crude oil is waxy by nature, heating of the crude along the pipeline is essential for the continuous flow of liquids. Skin Effect Heat Tracing System will be installed all along the periphery of the pipeline. PUF Insulation system with HDPE jacket will be installed along the periphery of the crude oil pipeline to prevent the heat loss from pipeline to surrounding environment. The heating stations consisting of maximum 1.0 MW power generating units will be installed at every 18 km interval. Thus a total of 32 heating stations cumulating to 32 MW electricity capacities will be installed along the pipeline route. Storage, heating and pumping stations and diluent's mixing terminals will be established at Viramgam and Salaya terminals in Gujarat State. Viramgam and Salaya terminal requires 8 MW and 10 MW power respectively for heating, diluents mixing and pumping the crude. Thus the total energy requirement for the evacuation pipeline project is estimated as 50 MW spread across several location. Viramgam and Salaya terminals will have 10,000 m³ and 300,000 m³ storage and handling capacity of crude oil respectively.

The land required for the pipeline project will be obtained on Right of Use (ROU) basis. The pipeline will be buried all along its length (minimum 1.0 m below the ground level). The land required for heating and storage facilities of about 157 ha. spread over several parcels will be acquired on permanent basis directly from the

land owners. Dual fired generators based on gas and/or oil will meet power requirement. Gas will be preferably used for power generation. A parallel gas pipeline of 8" diameter from Raageshwari gas terminal will be laid along the main crude oil pipeline corridor for supply of natural gas for heating and pumping stations. The total estimated cost for the development of pipeline project including associated facilities is about Rs. 3500 Crores.

Transportation of crude oil by pipeline is comparatively less expensive than the other modes of transport both in the capital and operating costs. If a good network of pipelines is implemented throughout the country, this will ensure that the pipeline transported products will be available to the consumers at a lower cost than alternate modes of transport.

The environmental impact of crude transportation is the minimum for the pipeline mode of transportation. There is virtually no adverse impact on the existing road infrastructure as there is no additional load on the road network due to tanker movement. One of the additional advantages of pipeline transportation is that the scope of economic offences like theft / pilferage and adulteration of products is almost negligible.

The pipeline transportation would avoid movement of equivalent fuel energy by road or rail, resulting in savings in petroleum products. These savings in petroleum products and road/rail vehicles would be available for movement of alternate products. Any savings in petroleum products would reduce country's dependence on imports, thus saving valuable foreign exchange.

1.4 Scope of the Study

Major environmental issues related to storage and handling capacities at Viramgam and Salaya terminals and power generating capacity at Salaya along the pipeline route vis-à-vis the pipeline construction have been considered while carrying out Environment Impact Assessment (EIA) for Mangala-Salaya pipeline and associated facilities project. The environmental baseline monitoring has been carried out during pre-monsoon season of year 2007 (15 March – 15 June, 2007) and used to identify potential significant impacts.

As the proposed pipeline is not envisaged to be passing through any environmental sensitive area, the pipeline project as such do not require Environmental Clearance (EC) as per the EIA Notification 2006. However, as the proposed storage and handling capacities at Viramgam and Salaya terminals and

power generating capacity at Salaya exceeds the threshold limits (Category B), the storage terminals requires Environmental Clearance.

1.4.1 Objectives of the Study

- ◆ Determination of baseline conditions using primary data generation and secondary data available from existing reports and studies and historical data from government published reports
- ◆ Detailed description of all elements of the project activities during the pre-construction, construction and operational phases. The elements that have been analyzed include the infrastructures of the project including drainage features, roads, waste collection, disposal and management and utility requirements.
- ◆ Identifying the sources of pollution and assessing the impacts on the environment due to proposed hydrocarbon development project. Analysis and assessment of designs to ensure environmental soundness, sustainability and regulatory compliance of the designs has been studied
- ◆ Preparation of EIA and Environment Management Programme (EMP) documents with recommendations on preventive and mitigative measures for limiting the impact on environment to the desired level during various stages of project. Development of a suitable post study-monitoring program to comply with various environmental regulations has also been done
- ◆ Risk Assessment (RA) and Disaster Management Plan (DMP) describing the probable risks and preventive and precautionary measures to be followed in the event of emergency situations.

1.4.2 Components of Environment Study

1.4.2.1 Air Environment

- ◆ Establishing existing status of ambient air quality with respect to SPM, and hydrocarbons around storage and pumping locations and around pipeline route
- ◆ Prediction of impacts on ambient air quality using appropriate mathematical models

- ◆ ISCST or FDM Model has been used for Air Quality Impact Prediction
- ◆ Predictions for fugitive dust emission due to construction activities at storage terminals, pumping terminals and along pipeline route
- ◆ 24 hourly concentrations at all monitoring stations
- ◆ Isopleth distribution of major pollutants of concern over 10 km radius study area
- ◆ Mitigation measures to lower the emission of pollutants
- ◆ Primary/secondary data with respect to impact of fugitive emissions on flora and fauna

1.4.2.2 Noise Environment

- ◆ Establishing existing status of noise levels in residential/ commercial/ silence zones along the pipeline route and around storage and pumping locations stations
- ◆ Impact of noise levels from storage, handling and pumping locations on the surrounding environment
- ◆ Prediction of noise levels through modeling at different monitoring stations during the construction and operation phase of the project
- ◆ Impacts due to noise levels generated by existing and proposed activities in relation to human environment and wild life
- ◆ Impacts due to present and future transportation activity
- ◆ Impact of noise levels on occupational health
- ◆ Identification of mitigation measures for noise abatement including noise barriers for point sources and pipeline routes

1.4.2.3 Water Environment

- ◆ Impacts of water withdrawal on surface water / groundwater resources
- ◆ Optimum exploitation of surface/ground water to protect aquatic biodiversity
- ◆ Delineation of proper planning for withdrawal of surface/groundwater below the threshold level of replenishment

- ◆ Establishing information on groundwater quality along the pipeline route at select locations and around storage and pumping locations stations
- ◆ Impact due to generation and disposal of effluent and domestic sewage from the pigging stations
- ◆ Model study for prediction of groundwater contamination and suggestion of mitigation measures to minimize the pollution level
- ◆ Suitable spillage handling procedures for any oil spillages during routine maintenance / operations and their disposal to suitable locations

1.4.2.4 Land Environment

- ◆ Estimation of anticipated impacts of proposed oil evacuation activity on topography, water drainage pattern, land use pattern with respect to agriculture, forestry and fisheries
- ◆ Collection of information on intersection with roads, railway lines, drinking water mains, sewage pipelines, crude oil pipelines, petroleum product pipelines, gas pipelines, river, cooling water and effluent discharge pipelines
- ◆ Collection of information on reserved forest, wildlife habitat, habitat of endangered/endemic species, mangroves, lakes/reservoirs/dams, historical/archaeologically important monuments within 1 km of the either side of pipeline/right of way
- ◆ Study of topographic features of pipeline corridor
- ◆ Study of landuse pattern, cropping pattern, vegetation cover along the pipeline route employing remote sensing techniques and ground truthing and also through secondary data sources
- ◆ Analysis of data (Toposheet) available with Survey of India/National Bureau of Soil Survey and Landuse Planning related to proposed pipeline corridor
- ◆ Study of the problem of landslides, and assessment of soil erosion potential and their impact

- ◆ Management plan for checking soil erosion
- ◆ Impact of oil exportation on local biodiversity
- ◆ Methods for treatment and disposal of domestic solid waste
- ◆ Selection of suitable local plant species for greenbelt development at and around storage and pumping stations

1.4.2.5 Biological Environment

- ◆ Impact of oil evacuation activity on terrestrial and aquatic biodiversity and proposed mitigation measures
- ◆ Impact of oil evacuation activity on wild life and proposed mitigation measures
- ◆ Prediction of biological stress in the study region and delineation of measures for abatement/reduction of biological stress
- ◆ Impacts of oil evacuation activity wildlife habitats, migratory corridors, migratory avi-fauna, rare and endangered species, medicinal plants and suggest mitigation measures
- ◆ Assessment of potential impact on flora and fauna due to laying of pipeline
- ◆ Impact of oil evacuation activity on fishery resource and agricultural production
- ◆ Identification of rare plants of economic importance including medicinal plants and wildlife species which require protection and conservation
- ◆ Improvement of biodiversity, wildlife and forest cover due to adoption of scientific oil exportation methods
- ◆ Identification of measures for protection and conservation of flora, fauna including wildlife, migratory avi-fauna, rare and endangered species, medicinal plants etc.
- ◆ Collection of secondary data on agricultural activity, crops and their productivity, and irrigation facilities

1.4.2.6 Socio-economic and Health Environment

- ◆ Study of the existing socio-economic profile along the pipeline corridor with reference to:
 - Demographic Structure, viz. total households, total population and population density, literacy and employment
 - Infrastructure and economic resource base
 - Cultural and Aesthetic attributes including places of historical/ archaeological importance
- ◆ Socio-economic survey to assess the Quality of Life (QoL) of the people in the study area and their perceptions about the proposed project
- ◆ Review of rehabilitation and resettlement plan prepared for the project
- ◆ Projection of anticipated changes due to the proposed project, and delineation of measures to minimise the impacts
- ◆ Assessment of economic benefits to community and environment arising out of the project

1.4.2.7 Environmental Monitoring Programme

- ◆ To examine the effectiveness of adopted EMP and to enable to take corrective actions
- ◆ To delineate Technical aspects of environmental monitoring to examine the effectiveness of adopted EMP
- ◆ Regular and adequate surveillance of pipeline particularly at its joints and along the length of water crossing and close to transport network
- ◆ Monitoring of entire length of pipeline at pumping and heating stations for various parameters like temperature, pressure and other pipeline conditions
- ◆ To perform stress and surge analysis where pipeline is crossing at rivers, railways, highways / roads
- ◆ Monitoring of voltage, current and other important parameters associated with the skin effect tracing system

1.4.2.8 Risk Assessment

- ◆ The pipeline will convey crude oil, which will require heating to keep crude oil in fluid condition. It is proposed to use electric coil for heating the crude. The captive generators will be kept at select intervals for supply of power. The potential hazards due to operation and maintenance of the pipeline heating system has been identified and the resultant risk assessed and suitable mitigation measures has been suggested
- ◆ Hazard identification through computation of Fire and Explosion Indices (FEI) and inventory analysis
- ◆ Generation of credible and worst case scenarios for accidental release of natural gas and crude oil during transportation, handling and storage
- ◆ Computation of damage distances based on consequence analysis for credible and worst case scenarios including heat load contours
- ◆ Assessment of risk and suggesting risk mitigation measures
- ◆ Delineation of approach to Disaster Management Plan (DMP).

1.4.2.9 Project Benefits

- ◆ Improvement in the physical infrastructure
- ◆ Improvement in the social infrastructure
- ◆ Employment potential – skilled; semi-skilled and unskilled
- ◆ Other tangible benefits

1.4.2.10 Environmental Management Plan

- ◆ Description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the Environmental Impact Assessment

1.4.2.11 Summary and Conclusion

- ◆ Overall justification for implementation of the project
- ◆ Explanation of how, adverse effects have been mitigated

CEIL has presented the project details to MoEF Expert Appraisal Committee on 26th April 2007 to seek the Terms of Reference (TOR) for the preparation of EIA report. MoEF has examined the proposed TOR as submitted by

CEIL and offered the following TOR for preparation of EIA vide their letter dated May 24, 2007, a copy of the TOR is given in **Annexure-II**.

In addition to the scope of work proposed by CEIL, MoEF has suggested the following additional TOR and compliance to the TOR recommended by MoEF is presented in **Table 1.1**.

Table 1.1
Compliance to TOR Recommended by MoEF

Sr. No.	Particulars of Recommendations in TOR	Report Reference
1	To determine baseline conditions surrounding the proposed developmental facilities; assessment of the impacts on the environment due to the construction and operation of pipeline; and storage facilities and making recommendations on the preventive measures to be taken, to minimize the impact on the environment to acceptable levels; to generate primary and secondary field data around proposed storage terminals and along the infield pipeline route; environmental quality monitoring within 10 km radius of Viramgam and Salaya terminals over period of one season; and risk assessment & Disaster Management Plan.	The study area for the field data monitoring includes proposed storage facilities at Viramgam and Salaya and other sensitive locations along the pipeline route. The baseline data for the study area has been carried out during pre-monsoon of 2007 and incorporated in Chapter 3 Qualitative and quantitative assessment of pollution aspects of the project activities such environmental risk due storage terminals, power generating units, and pipeline construction have been carried out by using standard predictive tools for various environmental attributes and included in Chapter 4
2	Detailed composition of the crude oil.	The composition of crude is presented in section 7.2 of Chapter 7 and same has been used for carrying out risk assessment
3	Selection of the shortest route for the pipeline to minimize the impact on the environment.	CEIL has engaged M/s SECON Private Limited, Bangalore to carrying out detailed pipeline route surveys and suggest shortest and optimum pipeline for evacuation of crude oil

Sr. No.	Particulars of Recommendations in TOR	Report Reference
		from Barmer in Rajasthan to Jamnagar in Gujarat via Viramgam. M/s SECON has conducted reconnaissance and detailed field verification surveys and finalized the pipeline alignment based on environmental and other developmental constraints. The proposed evacuation pipeline route would not pass through any environmentally sensitive areas, human habitations, coastal and estuarine areas, archeological monuments nor reserved forests. The major land use along the proposed pipeline is agricultural / barren land. There are no established breeding grounds and migratory routes along the pipeline route and in the proposed storage terminals. The pipeline survey report is enclosed as separate volume.
4	Water sprinkling & quenching system for fire fighting.	Water sprinkling & quenching system are part of fire fighting system and will be provided as per the OISD standards and details are included in 7.6.2.2. Section of Chapter 7.
5	Public hearing separately for two Districts i.e. Viramgam and Salaya where the storage terminals are located.	As per the MoEF guidance, the Public hearing will be conducted at both the locations as per the EIA notification 2007 and proceedings will be obtained.

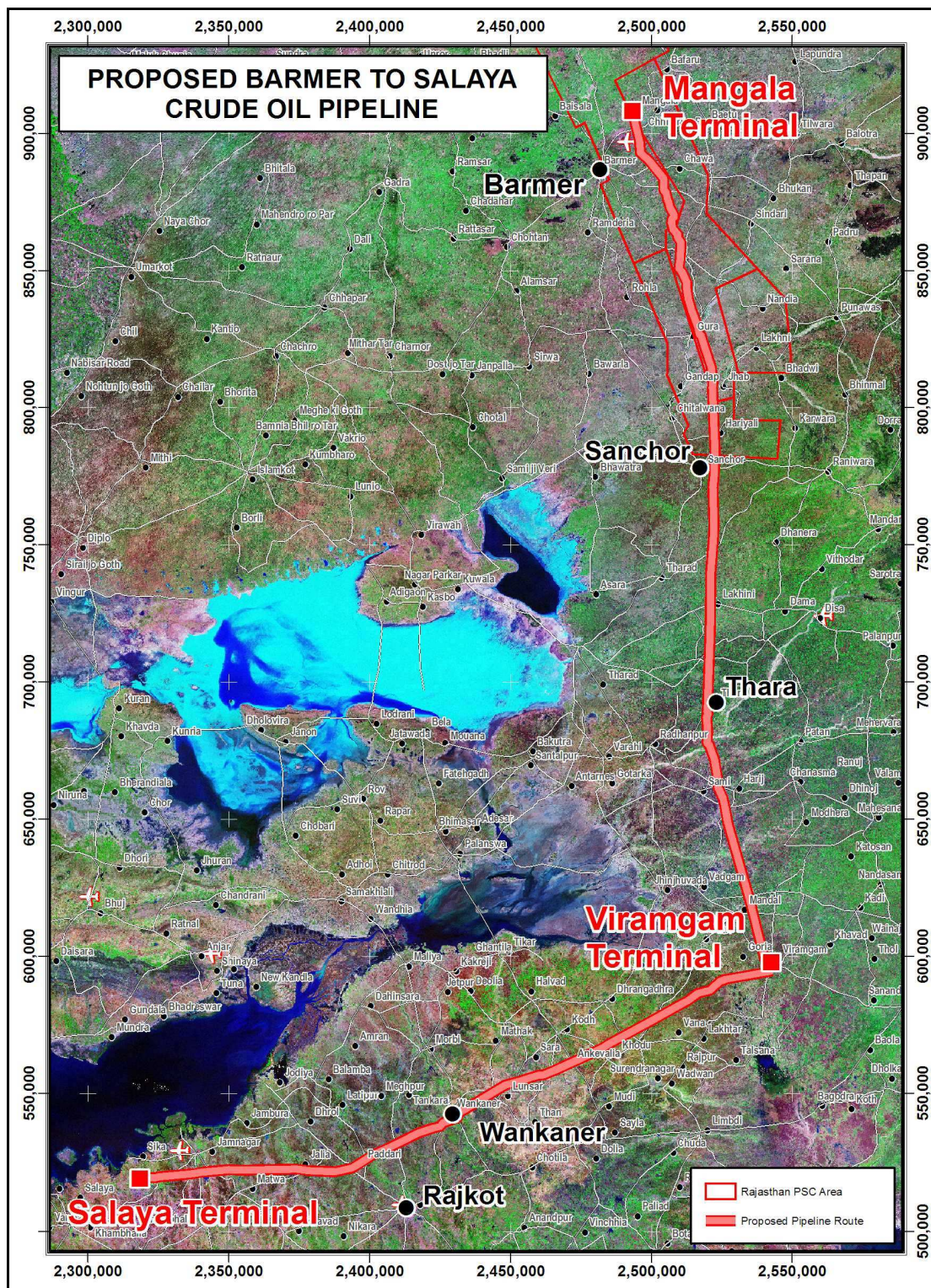


Fig. 1.1: Alignment of Mangala – Viramgam - Salaya Crude Oil Pipeline