1.5 IN

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project

Final Report

AEC

IPC

Office of Transport and Traffic Policy and Planning

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project

Final Report



Submitted by : AEC IPC

- Asian Engineering Consultants Crop., Ltd.
- Infra Plus Consulting Co.,Ltd.
- Enrich Consultants Co.,Ltd.

February 2018

Office of Transport and Traffic Policy and Planning

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project

Final Report

Submitted by :

- Asian Engineering Consultants Crop., Ltd.
- Infra Plus Consulting Co.,Ltd.
- Enrich Consultants Co.,Ltd.

February 2018

Content

			Page
Chapter 1	**Introduction**		**1-1**
	1.1	Project background	1-1
	1.2	Project objectives	1-1
	1.3	Scope of consultant services	1-2
		1.3.1 Task 1 : Study, survey, collect and analyze data for the development and extension of new railway network from Chumphon-Ranong deep sea port	1-2
		1.3.2 Task 2 : Design and prepare an initial environmental examination (IEE) report	1-2
		1.3.3 Task 3 : Feasibility study on economy, finance and investment option	1-2
		1.3.4 Task 4 : Create people's awareness processes and people's participation in area development along the railway from Chumphon-Ranong deep sea port	1-2
Chapter 2	**Study, Survey, Collect and Analyze Data in Various Fields for Network Development and Expand the New Railway Line from Chumphon Province – Ranong Province**		**2-1**
	2.1	The review of policy and investment strategy for developing of infrastructure and transport System Services	2-1
		2.1.1 The review of policy, strategy and plan for infrastructure development	2-1
		2.1.2 Review of various project plans related to the development of transport networks	2-24
		2.1.3 Review of the study results related to the development of transport network	2-30
	2.2	Compilation and analysis of basic socio-economic data	2-55
		2.2.1 Compilation of basic socio-economic data	2-55
		2.2.2 Study and analysis of future change trends for socio-economic conditions	2-71
	2.3	Study on trade conditions between Thailand and BIMSTEC	2-74
		2.3.1 Overview of Thailand's Trade	2-74
		2.3.2 Trade overview between Thailand and BIMSTEC	2-76
		2.3.3 Analysis of potential export and import goods in BIMSTEC countries	2-87
	2.4	Conclusion	2-90
		2.4.1 Policy compliance and the development strategy of the transportation infrastructure of the country	2-90
		2.4.2 Compilation and analysis of basic Socio-Economic data	2-92
		2.4.3 Trade Between Thailand and BIMSTEC	2-92
Chapter 3	**Analysis/Evaluation/Selection of Appropriate Route Alignment**		**3-1**
	3.1	Preparation of basemap	3-1
	3.2	Consideration of the feasibility of route alignment	3-1
		3.2.1 Origin-Destination	3-1
		3.2.2 Criteria for selection of alternative route alignments	3-4

Content (Cont'd)

		Page
3.2.3	Alternative route alignments	3-6
3.3	Station location and model	3-16
3.4	Selection of appropriate route alignment	3-22
3.4.1	Criteria for selection	3-22
3.4.2	Engineering comparison (30 weighting)	3-25
3.4.3	Economic and investment comparison (30 weighting)	3-42
3.4.4	Environmental and social comparison (40 weighting)	3-87
3.4.5	Result of alternative route alignments selection	3-102
Chapter 4	**Study and Forecast of Traffic and Transportation**	**4-1**
4.1	Study and forecast of traffic and transportation	4-1
4.2	Traffic and transportation survey and collection	4-15
4.2.1	Traffic and transportation data collection	4-15
4.2.2	Survey and analysis of traffic and transportation data	4-24
4.3	Analysis and forecast of passenger volume	4-58
4.3.1	Guidelines and procedures	4-58
4.3.2	Traffic forecasts emerging due to ease of travel	4-68
4.3.3	Forecast of passenger volume	4-72
4.4	Analysis and forecast of product volume	4-80
4.4.1	Guidance for forecasting	4-80
4.4.2	Export volume forecasts for rail freight through Ranong Port to BIMSTEC countries	4-81
4.4.3	Forecasting the volume of product imported from BIMSTEC countries by rail through Ranong Port	4-98
4.5	Conclusions of the study and forecast of traffic and transportation	4-107
4.5.1	Collection and survey of traffic and transportation information	4-107
4.5.2	Projected passenger volume forecast	4-108
4.5.3	Forecasting the volume of product transported by train through Ranong Port	4-108
Chapter 5	**Engineering Design**	5-1
5.1	Engineering design	5-1
5.1.1	Route alignment design	5-1
5.1.2	Track layout	5-14
5.1.3	Trackwork design	5-17
5.1.4	Drainage design	5-22
5.1.5	Railway station design	5-45
5.1.6	Level crossing design	5-53
5.1.7	geotechnical engineering design	5-61

Content (Cont'd)

		Page
5.1.8	Structural design	5-108
5.1.9	Design of entrance-exit to station	5-120
5.1.10	Signaling and telecommunication system design	5-121
5.2	Infrastructure design	5-127
5.2.1	Electrical engineering design	5-127
5.2.2	Mechanical engineering design	5-130
5.3	Train operation plan	5-133
5.3.1	Concept for service operation plan	5-134
5.3.2	Train service operation plan	5-135
5.4	The preparation of right of way plan and land acquisition	5-158
5.4.1	Land expropriation cost	5-158
5.4.2	Building compensation cost	5-158
5.4.3	Summary of land cost and building compensation cost	5-158
5.5	Preliminary cost estimation	5-159
Chapter 6	**Initial Environmental Examination: IEE**	**6-1**
6.1	Guideline of environmental study	6-1
6.1.1	Study of existing environmental condition	6-1
6.1.2	Initial impact examination	6-1
6.1.3	Measures of mitigation	6-2
6.1.4	Measures of monitoring	6-2
6.2	Location of project and study area	6-2
6.3	The Result of initial environment examination	6-4
Chapter 7	**Economic Feasibility Study**	**7-1**
7.1	Economic analysis	7-1
7.1.1	Analysis of economic suitability	7-1
7.1.2	Assumptions in economic analysis	7-2
7.2	Estimation of project investment costs and operations	7-3
7.3	Economic benefits evaluation of passenger transport	7-7
7.3.1	Direct benefits assessment	7-7
7.3.2	Indirect benefits assessment	7-28
7.4	Freight benefit assessment	7-28
7.4.1	Benefit from total cost savings in transportation	7-28
7.4.2	Benefit from reducing air pollution	7-30
7.5	Analysis of economic returns	7-31
7.5.1	Project's economic return	7-31
7.5.2	Sensitivity analysis	7-34

Content (Cont'd)

		Page
7.6	conclusion	7-35
7.6.1	Costs and project benefits	7-35
7.6.2	Summary of economic analysis	7-36
Chapter 8	**Study on Financial Feasibility and Investment Model**	**8-1**
8.1	Guidelines for financial analysis of the project	8-1
8.2	Financial benefits of the project	8-4
8.3	Results of financial analysis of the project	8-7
8.4	Analysis and suggestion of investment model and sources of funds	8-10
8.4.1	Comparative study of forms of Co-Investment between public and private sector	8-10
8.4.2	Analysis and evaluation of guidelines of co-investment between public and private sector	8-11
8.4.3	Source of investment	8-22
8.5	Recommendations for private investment	8-22
8.5.1	Request for investment promotion	8-23
8.5.2	Supplying land	8-24
8.5.3	Requesting state to join capital	8-24
8.6	Sensitivity analysis	8-25
8.7	Conclusion	8-26
8.7.1	Financial benefits of the project	8-26
8.7.2	Results of financial analysis of the project	8-26
8.7.3	Analysis of the investment model of the project	8-26
8.7.4	Sources of funding	8-27
8.7.5	Private sector demands that the state perform	8-28
Chapter 9	**Process of Creating People Perception and People Participation**	**9-1**
9.1	Introduction	9-1
9.2	Target groups	9-1
9.3	Target areas	9-1
9.4	Work plan for creating people perception and people participation	9-2
9.5	Result of the Activities of People Perception and People Participation	9-5
9.6	Summary of Public Relations	9-7
Chapter10	**Development Guidelines for Surrounding Areas around the Station**	**10-1**
10.1	Concepts and development guidelines for surrounding areas of railway station along Chumphon - Ranong route	10-1
10.1.1	Concepts for developing areas surrounding the station	10-1
10.1.2	Development guidelines for surrounding areas of railway station along Chumphon – Ranong route	10-2

Content (Cont'd)

		Page
10.1.3	impact on the city from the development of the Chumphon - Ranong railway line	10-19
10.2	Tourist attraction nearby railway station along the Chumphon - Ranong route and connection with the nearby highway network	10-20
10.3	Economic impact of tourism in Chumphon and Ranong	10-27
10.3.1	The concept of space development and the economic impact of tourism	10-27
10.3.2	Tourism situation overview in Chumphon province and Ranong province	10-28
10.4	Conclusion	10-30
10.4.1	Concepts and development guidelines for surrounding areas of Railway station along Chumphon - Ranong route	10-30
10.4.2	Economic impact from Ttourism in Chumphon province and Ranong province	10-31
Chapter 11 Conclusion and Recommendation		11-1
11.1	Conclusion	11-1
11.2	Additional comments and recommendations	11-2
11.2.1	Recommendations on traffic and transportation	11-2
11.2.2	Recommendations on engineering	11-3
11.2.3	Recommendations on environment and social	11-3
11.2.4	Recommendations on tourism management of Ranong province	11-5
11.3	Guidelines for implementation	11-9

Figure

		Page
2.1.1-1	Strategic development of transport infrastructure of Thailand (2015-2022)	2-12
2.1.1-2	Map of tourism development zone	2-14
2.1.1-3	Thailand development policy framework (Year 2057)	2-16
2.1.1-4	Southern development concept Chart, year 2057	2-18
2.1.1-5	Framework for regional and sub-regional economic cooperation	2-23
2.1.1-6	Bay of Bengal initiative for Multi-Sectoral Technical and Economic Cooperation: BIMSTEC	2-24
2.1.2-1	Highway network development at the study area	2-25
2.1.3-1	Economic development bridge linking the gulf of Thailand and the Andaman coast	2-32
2.1.3-2	Pak Bara deep sea port construction project	2-33
2.1.3-3	Songkhla deep sea port 2 construction project	2-35
2.1.3-4	Key development based on alternative development direction two plus (2+)	2-38
2.1.3-5	Plan to upgrade Thailand's coastal transport service and infrastructure system efficiency	2-39
2.1.3-6	Chumphon port construction project	2-42
2.1.3-7	Strategic location	2-43
2.1.3-8	Project layout – zoning layout plan	2-44
2.1.3-9	Railway construction project Surat Thani - Tha Nun	2-45
2.1.3-10	Overview of rail network development in Surat Thani, Phang Nga, Krabi and Phuket	2-46
2.1.3-11	Overview of the railway network development under the master plan for the development of rail and high speed rail systems	2-48
2.1.3-12	Multi-modal transport infrastructure project in line with the master plan for the development of rail and high-speed rail systems	2-49
2.2.1-1	Project area	2-55
2.2.1-2	Population in study area, year 2013-2017	2-5 6
2.2.1-3	Population in study area Chumphon province, classified by district, year 2017	2-57
2.2.1-4	Population in study area Ranong province, classified by district, year 2017	2-58
2.2.1-5	Gross domestic product-chain volume measures at the provincial level in the study area, year 2011-2015	2-60
2.2.1-6	Average income per capita in the study area, Year 2011-2015	2-61
2.2.1-7	Number of employed persons in provincial area at the provincial level in study area, year 2012-2016	2-63
2.2.1-8	Number of vehicles registered at the provincial level in the study area, year 2013-2017	2-64
2.2.1-9	Thai-Myanmar border trade information, Ranong province, year 2013 - 2016	2-65
2.2.1-10	Number of visitors in the southern provinces in 2016	2-67
2.2.1-11	Number of visitors in the study area, year 2012-2016	2-68
2.3.1-1	Structure of export and import market of Thailand in 2016	2-75
2.3.2-1	Imports and exports of BIMSTEC products in 2016	2-79
2.3.2-2	Key export categories for BIMSTEC countries in 2016	2-81

Figure (Cont'd)

		Page
2.3.2-3	Imports of key products from BIMSTEC countries in 2016	2-845
3.1-1	L7018 maps of the Royal Thai survey department on the scale of 1:50,000	3-2
3.1-2	Satellite images with the minimum resolution of 1 meter per pixel	3-3
3.2.3.-1	Alternative route alignments on each corridor	3-11
3.2.3-2	Screened alternative route alignment	3-15
3.3-1	The current area of each station	3-17
3.4.2-1	Tunnel location and Ranong fault line	3-38
3.4.2-2	Multiplying factor of engineering parameters	3-41
3.4.2-3	Scores of engineering parameters	3-42
3.4.3-1	Sample of alternative route alignment 1 (from Sta. 5+000 to Sta. 12+000) placement on UTM grids of the department of lands	3-48
3.4.3-2	Search sample of title deed No., Mapsheet No., parcel No. and province (1)	3-49
3.4.3-3	Search sample of title deed No., Mapsheet No., parcel No. and province (2)	3-49
3.4.3-4	Search sample of land parcel location from title deed No. (1)	3-50
3.4.3-5	Search sample of land parcel location from title deed No. (2)	3-50
3.4.3-6	Multiplying factor of economic and investment parameters	3-86
3.4.3-7	Scores of economic and investment parameters	3-87
3.4.4-1	Multiplying factor of environmental and social parameters	3-100
3.4.4-2	Scores of environmental and social parameters	3-101
4.1-1	Road network in the study area	4-3
4.1-2	Southern railway network	4-5
4.1-3	The container terminal (CY) and the container and cargo terminal (ICD)	4-6
4.1-4	Chumphon bus terminal	4-7
4.1-5	Choke Anan and Rungkit tour bus	4-7
4.1-6	Chumphon – Ranong bus terminal	4-8
4.1-7	Ranong bus terminal	4-8
4.1-8	Port in Chumphon	4-10
4.1-9	Port in Ranong	4-11
4.1-10	Ranong port	4-12
4.1-11	Ranong port link network	4-12
4.1-12	Private port located on the banks of the Kraburi River Ranong	4-13
4.1-13	Ranong airport	4-14
4.1-14	Chumphon airport	4-14
4.2.1-1	Average daily traffic volume throughout the year (AADT) in the project area in 2016	4-19
4.2.1-2	Passenger up - down each station in Chumphon Province, 2016	4-21
4.2.2-1	Traffic information survey points	4-24
4.2.2-2	Atmosphere in traffic volume survey	4-25
4.2.2-3	Origin - Destination and travel data survey and travel behavior	4-26

Figure (Cont'd)

		Page
4.2.2-4	Road traffic volume survey	4-31
4.2.2-5	Traffic volume fluctuations on weekdays	4-32
4.2.2-6	Variance of road traffic volume on holiday	4-33
4.2.2-7	Proportion of vehicles on the road on weekdays	4-34
4.2.2-8	Proportion of vehicles on the road on Holiday	4-35
4.2.2-9	Survey of origin – destination of travelers (O-D Survey)	4-37
4.2.2-10	Proportion of vehicles survey	4-38
4.2.2-11	Origin point - destination, departure, exit, area by car	4-39
4.2.2-12	points of origin - destination separated by survey point OD	4-40
4.2.2-13	Point of origin - destination of entry / exit of truck area	4-41
4.2.2-14	Purpose of the survey by OD survey point	4-42
4.2.2-15	Proportion of cargo types	4-43
4.2.2-16	Weighted ratio	4-44
4.2.2-17	The purpose of the bus	4-45
4.2.2-18	Destination of bus passenger	4-45
4.2.2-19	Travel expenses for those traveling by bus	4-46
4.2.2-20	Traveling time of passengers by bus	4-46
4.2.2-21	Objectives of air travel	4-47
4.2.2-22	Destination of air travelers	4-47
4.2.2-23	Average speed on main highways	4-48
4.2.2-24	Port Location on the banks of the river Kraburi Ranong Province	4-49
4.2.2-25	Description of berths and map of Ranong Port	4-50
4.2.2-26	Ranong port facilities	4-50
4.2.2-27	GATI Vessel	4-51
4.2.2-28	Hem Rueng Ngern berth	4-52
4.2.2-29	Manit Berth	4-53
4.2.2-30	Yong Chao Berth 1	4-53
4.2.2-31	Yong Chao Berth 2	4-54
4.2.2-32	Kijpaisan Berth	4-54
4.2.2-33	Go Guad Berth	4-55
4.2.2-34	Saeng Thong Berth	4-55
4.2.2-35	Leng Seng Chan Berth	4-56
4.3.1-1	Four-Step Model	4-58
4.3.1-2	Transport and passenger traffic model structure	4-59
4.3.1-3	Sub-level subsystems and subsets	4-60
4.3.1-4	Sub-system at the sub-district level	4-61
4.3.1-5	Various transport network models	4-63

Figure (Cont'd)

		Page
4.3.1-6	Transportation network model in the study area	4-64
4.3.1-7	Trip Length distribution	4-65
4.3.2-1	Shows the predictions of traffic volume.	4-70
4.3.2-2	Induced Trips from the cost of travel changes.	4-71
4.3.3-1	Forecast of passenger volume by station on the Chumphon – Ranong railway project (Direction: Chumphon - Ranong)	4-76
4.3.3-2	Forecast of passenger volume by station on the Chumphon – Ranong railway project (Direction: Ranong - Chumphon)	4-77
4.3.3-3	Forecast of passenger on the line load on the Chumphon - Ranong railway project Direction: Chumphon – Ranong)	4-78
4.3.3-4	Forecast of passenger on the line load on the Chumphon - Ranong railway project (Direction: Ranong – Chumphon)	4-79
4.4.1-1	Comparison of shipment periods to BIMSTEC countries between Ranong port and Laem Chabang port / Bangkok	4-81
4.4.2-1	Source of potential product and transport opportunities to BIMSTEC countries through Ranong port	4-85
4.4.2-2	Proportion of each type of product and proportion of transport through the southern border of Thailand to BIMSTEC countries in 2016	4-97
5.1.1-1	Safety distance of structural gauge	5-5
5.1.1-2	At-Grade railway	5-5
5.1.1-3	Elevated railway	5-6
5.1.1-4	Single tunnel for double track	5-7
5.1.1-5	Double tunnel for single track	5-7
5.1.1-6	Sample of plan and profile and longitudinal section of the alignment (1)	5-9
5.1.1-7	Sample of plan and profile and longitudinal section of the alignment (2)	5-10
5.1.2-1	Station that has main track and siding track	5-14
5.1.2-2	Siding track	5-14
5.1.2-3	Connecting to the southern railway	5-15
5.1.2-4	Ranong Terminal Station	5-16
5.1.2-5	Container yard track layout	5-16
5.1.3-1	Ballasted track	5-19
5.1.3-2	Non-ballasted track	5-20
5.1.3-3	Transition track	5-21
5.1.4-1	Meteorological Data at Chumphon Weather and Rain Gauge Station	5-23
5.1.4-2	Meteorological Data at Ranong Weather and Rain Gauge Station	5-24
5.1.4-3	Rainfall intensity – duration – frequency curve at station 10013, Chumphon province	5-25
5.1.4-4	Rainfall intensity – duration – frequency curve at station 46013, Ranong province	5-26
5.1.4-5	The east of southern watershed	5-27
5.1.4-6	The west of southern watershed	5-28
5.1.4-7	Time of concentration graph	5-30

Figure (Cont'd)

		Page
5.1.4-8	Rainfall reduction factor for large area	5-32
5.1.4-9	typical cross-section of the preliminary drainage system design along the railway	5-36
5.1.4-10	Watershed area and flow direction	5-40
5.1.5-1	Kromluang Chumporn Shrine	5-46
5.1.5-2	Rattanarangsan Palace	5-46
5.1.5-3	Layout of type a station	5-49
5.1.5-4	Perspective of type A station	5-50
5.1.5-5	Layout of type B station	5-51
5.1.5-6	Perspective of type B station	5-52
5.1.6-1	Guidelines for design of grade separation structure	5-54
5.1.6-2	Grade separation structures	5-56
5.1.7-1	Geological map of the project area and its vicinity	5-62
5.1.7-2	Active fault line map of Thailand	5-64
5.1.7-3	Sample of soil investigation Works	5-66
5.1.7-4	Sample of test results from soil boring	5-68
5.1.7-5	Sample of test results from test pits	5-69
5.1.7-6	Construction Material Source Map	5-70
5.1.7-7	Distribution of train weight from wheels into subsoil	5-72
5.1.7-8	Typical cross-section of trackbed embankment structure	5-73
5.1.7-9	calculation of the minimum thickness (e) of trackbed	5-76
5.1.7-10	Percentile of CBR of subgrade along the at-grade track	5-81
5.1.7-11	Typical cross-section of trackbed embankment fill	5-82
5.1.7-12	Typical Cross-section of trackbed embankment cut	5-82
5.1.7-13	Dynamic amplification within the stiffness transition	5-83
5.1.7-14	Design graph for a transition structure	5-84
5.1.7-15	Sample of transition structure (Ref: transition from aerial structure to embankment drawing of california high-speed train project)	5-85
5.1.7-16	Typical cross-section of transition structure between bridge abutment and embankment of the project	5-85
5.1.7-17	A Schematic of various forces on the soil mass	5-91
5.1.7-18	Embankment stability analysis for clay having SPT N = 6	5-92
5.1.7-19	Embankment stability analysis for clay having SPT N = 7	5-93
5.1.7-20	Embankment stability analysis for clay having SPT N = 8	5-93
5.1.7-21	Embankment stability analysis for sand having SPT N = 16	5-94
5.1.7-22	Tunnel design processes	5-101
5.1.7-23	Cross-section of size and position of longitudinal ventilation fan	5-102
5.1.7-24	Longitudinal ventilation system	5-103
5.1.7-25	Transverse ventilation system	5-103

Figure (Cont'd)

		Page
5.1.7-26	Tunnel categories according to tunnel length	5-104
5.1.7-27	Drainage system in tunnel	5-105
5.1.7-28	Typical cross-section of tunnel portal	5-106
5.1.7-29	Typical cross-section of tunnel portal support	5-106
5.1.7-30	Typical cross-section of main tunnel support	5-107
5.1.7-31	Typical cross-section of tunnel cross passage	5-107
5.1.8-1	Short span railway bridge, type rs - single span	5-109
5.1.8-2	Short span railway bridge, type rs – multi span	5-110
5.1.8-3	Short span railway bridge, type bg – single span	5-110
5.1.8.4	Short span railway bridge, type bg - multi span	5-111
5.1.8-5	Medium span railway bridge, type ig – single span	5-111
5.1.8-6	Medium span railway bridge, type ig - multi span	5-112
5.1.8-7	Long span railway bridge, type u-girder – single span	5-112
5.1.8-8	Long span railway bridge, type u-girder - multi span	5-113
5.1.8-9	Elevated railway bridge, type sg - multi span	5-113
5.1.8-10	Plan and profile of overpass	5-117
5.1.8-11	Plan and profile of u-turn bridge	5-117
5.1.8-12	Box underpass	5-118
5.1.10-1	Sample of colour light signal	5-122
5.1.10-2	Transmission backbone ring	5-123
5.1.10-3	Communication system within the station	5-125
5.3-1	Train operation route of the project	5-134
5.3.1-1	Service operation plan flow	5-135
5.3.2-1	Locomotive for passenger train	5-140
5.3.2-2	Locomotive for freight train	5-141
5.3.2-3	Diesel multiple unit (ordinary train or commuter train)	5-142
5.3.2-4	Train diagram for year 2025	5-147
5.3.2-5	Train diagram for year 2034	5-150
5.3.2-6	Train diagram for year 2044	5-153
5.3.2-7	Train diagram for year 2054	5-156
5.6-1	Project implementation plan (for feasibility study project)	5-164
6.2-1	Project location and sensitive areas	6-3
7.1.1-1	Guidelines for economic feasibility analysis	7-2
7.3.1-1	Guide to calculate the cost of using a car using hdm-voc.	7-8
7.3.1-2	Relationship between the cost of using a vehicle at various speeds	7-9
7.3.1-3	Time estimation procedure	7-12
7.3.1-4	Average consumer price index (southern region) in the years 2004 – 2017	7-20

Figure (Cont'd)

		Page
8.1-1	Financial analysis approach	8-1
9.6-1	Media Relations	9-8
10.1.2-1	Model for developing areas surrounding the station along the Chumphon – Ranong railway route	10-8
10.1.2-2	Area 500 and 1,000 meters around the railway station	10-11
10.1.2-3	Land use around Chumphon railway station at 500 - 1,000 meters	10-12
10.1.2-4	Empty space in the surrounding community may develop in form of "infill-development" and examples of adding pedestrian and bicycle pathways within the building blocks	10-13
10.1.2-5	Location of New Suburban Railway Station and Saeng Daet Station	10-14
10.1.2-6	Land use in the areas southern of town	10-15
10.1.2-7	Current settlement model of Ranong	10-17
10.1.2-8	The area around railway stations in Ranong can be developed and bus stations according to tod guidelines	10-18
10.2-1	Network linking Pak Chan railway station with nearby attractions	10-20
10.2-2	Network linking Kra Buri railway station with nearby attractions	10-21
10.2-3	Network linking Bang Yai railway station with nearby attractions	10-22
10.2-4	Network linking La-Un railway station with nearby attractions	10-23
10.2-5	Network linking Ranong station with nearby attractions	10-26
10.3.2-1	Number of visitors, average day of stay, income and expenses of visitors in Chumphon and Ranong province in the year 2012-2016	10-29
10.3.2-2	Proportion of expenditure on tourism in Chumphon and Ranong province in year 2016	10-30
11.2-1	Next process of environmental execution of the project	11-4
11.2-2	Workshop with Ranong tourism representatives on Friday, 2 February, 2018 at Tinidee hotel @ Ranong	11-6
11.3-1	Project implementation plan (guideline)	11-10

Table

		Page
2.1.1-1	Duration for development	2-11
2.1.2-1	Highway network development project in the study area	2-26
2.1.2-2	Infrastructure development and railway transport system	2-27
2.1.2-3	Coastal transport development plan	2-29
2.1.2-4	Air transport development plan	2-30
2.1.3-1	Comparison of economic growth rates of three options of southern coastal development	2-36
2.1.3-2	Development plan for transportation and logistics	2-37
2.1.3-3	Summary of economic feasibility analysis	2-46
2.1.3-4	Results of forecasting maximum passengers number in the route	2-51
2.1.3-5	Forecast of freight volume (tonnes per year)	2-51
2.2.1-1	Population of Thailand, south and study area, year 2013-2017	2-56
2.2.1-2	Population in Chumphon province, classified by district, year 2013-2017	2-57
2.2.1-3	Population in Ranong Province, Classified by District, Year 2013-2017	2-58
2.2.1-4	population, household and population density in the study area, year 2017	2-59
2.2-1-5	Gross domestic product-chain volume measures at the national, regional and provincial levels in the study area, year 2011-2015	2-60
2.2.1-6	Average income per capita of Thailand, south and provinces in study area, year 2011-2015	2-61
2.2.1-7	Statistics of employed persons in Thailand, south and provinces in study area, year 2012-2016	2-62
2.2.1-8	Number of vehicles registered in Thailand, south and provinces in the study area, year 2013-2017	2-63
2.2.1-9	Thai-Myanmar border trade information, Ranong province, year 2013 - 2016	2-64
2.2.1-10	Thai-Myanmar border trade, Ranong province (top 10 imports) in 2016	2-65
2.2.1-11	Thai-Myanmar border trade, Ranong province (top 10 exports) in 2016	2-66
2.2.1-12	Number of visitors in Thailand, south and provinces in the study area	2-67
2.2.1-13	Number of visitors in the study area, year 2012-2016	2-68
2.2.2-1	Forecasting of socio-economic data in the study area	2-73
2.3.1-1	Thailand's export market structure	2-74
2.3.1-2	Thailand's import market structure	2-75
2.3.2-1	Thai export market with BIMSTEC countries	2-77
2.3.2-2	Import market of Thailand with BIMSTEC countries	2-78
2.3.2-3	Major export items to BIMSTEC countries in the years 2007-2016	2-80
2.3.2-4	List of goods exported to BIMSTEC countries by volume (kg) and (liter) top 10 in 2016	2-82
2.3.2-5	Major imports from BIMSTEC 2007-2016	2-83
2.3.2-6	List of products imported from countries in the BIMSTEC group by volume (kg and liter) top 10 in 2016	2-85

Table (Cont'd)

		Page
2.3.3-1	Exports of 10 major products to BIMSTEC countries in 2016	2-87
2.3.3-2	Imports of 5 key products from BIMSTEC countries in 2016	2-89
3.4.1-1	Sample of different weighting of each project	3-22
3.4.1-2	Designated weighting of important parameters	3-24
3.4.2-1	Route length scores	3-26
3.4.2-2	Curve radius lengths after multiplying the coefficient	3-28
3.4.2-3	Scores of horizontal characteristic of alternative route alignments	3-29
3.4.2-4	Slope lengths after multiplying the coefficient	3-30
3.4.2-5	Scores of vertical characteristic of alternative route alignments	3-31
3.4.2-6	Structure lengths after multiplying the coefficient	3-33
3.4.2-7	Scores of difficulty and ease in construction	3-34
3.4.2-8	Coefficient for safety in train operation	3-35
3.4.2-9	Scores of safety in train operation	3-35
3.4.2-10	Coefficient of geological conditions	3-37
3.4.2-11	Scores of geological conditions	3-39
3.4.2-12	Summary of engineering comparison	3-40
3.4.3-1	Criteria for weighting economic and investment parameters	3-43
3.4.3-2	Scores of immovable property expropriation cost	3-45
3.4.3-3	Immovable property expropriation cost of alternative route alignment 1	3-45
3.4.3-4	Immovable property expropriation cost of alternative route alignment 2	3-46
3.4.3-5	Immovable property expropriation cost of alternative route alignment 3	3-46
3.4.3-6	Immovable property expropriation cost of alternative route alignment 4	3-47
3.4.3-7	Immovable property expropriation cost of spur line of alternative route alignments 1, 2 and 3	3-47
3.4.3-8	Land acquisition cost of alternative route alignment 1	3-51
3.4.3-9	Land acquisition cost of alternative route alignment 2	3-53
3.4.3-10	Land acquisition cost of alternative route alignment 3	3-54
3.4.3-11	Land acquisition cost of alternative route alignment 4	3-55
3.4.3-12	Land acquisition cost of spur line of alternative route alignments 1, 2 and 3	3-56
3.4.3-13	Building appraisal cost	3-57
3.4.3-14	Compensation cost for demolition of buildings and structures of alternative route alignment 1	3-58
3.4.3-15	Compensation cost for demolition of buildings and structures of alternative route alignment 2	3-63
3.4.3-16	Compensation cost for demolition of buildings and structures of alternative route alignment 3	3-67
3.4.3-17	Compensation cost for demolition of buildings and structures of alternative route alignment 4	3-71

Table (Cont'd)

		Page
3.4.3-18	Compensation cost for demolition of Buildings and Structures of Spur Line	3-76
3.4.3-19	Scores of construction cost	3-78
3.4.3-20	Construction cost of alternative route alignment 1	3-79
3.4.3-21	Construction cost of alternative route alignment 2	3-80
3.4.3-22	Construction cost of alternative route alignment 3	3-81
3.4.3-23	Construction cost of alternative route alignment 4	3-82
3.4.3-24	Multiplying factor of potential population for each station along the alternative route alignments	3-83
3.4.3-25	Scores of potential population for each station along the alternative route alignments	3-83
3.4.3-26	Multiplying factor of distance to access each station along the alternative route alignments	3-84
3.4.3-27	Scores of Distance to Access each Station along the Alternative Route Alignments	3-84
3.4.3-28	Summary of economic and investment comparison	3-84
3.4.4-1	Environmental and social parameters from expert adjustment	3-89
3.4.4-2	Designated weighting of environmental and social parameters	3-94
3.4.4-3	Criteria for considering impact levels and the multiplying factor according to the impact levels	3-95
3.4.4-4	Criteria for determination of multiplying factor (mf) for environmental and social parameters	3-96
3.4.4-5	Result of determination of multiplying factor, mf, for environmental and social parameters	3-98
3.4.4-6	Scores of environmental and social parameters	3-99
3.4.5-1	Total scores of alternative route alignments	3-102
4.1-1	Service route between Chumphon - Ranong province of bus 2 and 3	4-9
4.2.1-1	Average day traffic volume throughout the year (AADT) the project area period 2011-2016	4-16
4.2.1-2	Railway passenger volume during 2011 – 2016	4-20
4.2.1-3	Volume of rail freight across the country during 2011-2016	4-20
4.2.1-4	Passenger numbers up - down each station in Chumphon province	4-22
4.2.1-5	Passenger and air cargo volume statistics in study area	4-23
4.2.1-6	Ranong ports through 2009-2016	4-23
4.2.2-1	Traffic volume survey results on the segment road	4-29
4.2.2-2	Proportion of vehicles on the road	4-30
4.2.2-3	Purpose of travel classified by bus type.	4-41
4.2.2-4	Purpose of travel by truck type	4-42
4.2.2-5	Number of riders and passengers for various vehicles	4-43
4.2.2-6	Truck load ratio of each type of truck	4-44

Table (Cont'd)

		Page
4.2.2-7	Private port on the banks of the river Kra Buri Ranong	4-57
4.3.1-1	Sub-area details in Ranong and Chumphon	4-62
4.3.1-2	The coefficient of utility equations derived from the behavioral analysis of passenger travel patterns	4-65
4.3.1-3	Summarizes the features of traffic and transportation models in education	4-66
4.3.1-4	Tolerances allowed for model calibration	4-68
4.3.1-5	Model calibration results	4-68
4.3.2-1	Assumptions for predicting passenger volume	4-69
4.3.2-2	Elasticity of induced trips	4-72
4.3.2-3	Percentage of increased train volume (induced trips)	4-72
4.3.3-1	Forecasting railway volume on the Chumphon-Ranong railway project	4-72
4.3.3-2	Travel volume separated by the form of travel to Ranong.	4-73
4.3.3-3	Travel volume by trip model the entrance to the city of Ranong	4-74
4.3.3-4	Forecast of passenger volume by station on the Chumphon – Ranong railway project	4-75
4.4.2-1	Export volume to BIMSTEC countries classified by product, 2016	4-82
4.4.2-2	Export volume of key product to BIMSTEC countries in 2016	4-83
4.4.2-3	Production area to export to BIMSTEC countries through Ranong multi-purpose port and area of the container storage	4-84
4.4.2-4	The cost of shipping in Laem Chabang / Bangkok and Ranong ports to BIMSTEC countries	4-86
4.4.2-5	The cost of transporting domestic links to transport product through Laem Chabang / Bangkok port and Ranong port to BIMSTEC countries	4-87
4.4.2-6	Compare the cost and time of export cargo. through Laem Chabang / Bangkok port and Ranong port overall, domestic land transportation	4-87
4.4.2-7	Export volume to BIMSTEC countries for year 2012-2016 (export data included from every checkpoint.)	4-89
4.4.2-8	Average growth rate used to forecast export volume to BIMSTEC countries	4-94
4.4.2-9	Analysis of the proportion of containers to be used for Ranong port. classified by product group and destination country.	4-94
4.4.2-10	Forecasts on the volume of containers exported to BIMSTEC countries to be used for Ranong port services in 2025-2054 (classification by product)	4-95
4.4.2-11	Forecasts of export volume to BIMSTEC countries to be used for Ranong port services in 2025-2054 (classified by country)	4-96
4.4.2-12	Exports to BIMSTEC countries in 2016 from the southern border of Thailand	4-97
4.4.3-1	Imports of BIMSTEC products classified by country in 2016	4-98
4.4.3-2	Consumption of imported product from BIMSTEC countries	4-100
4.4.3-3	Imports volume of key products from BIMSTEC countries by country in 2016	4-100
4.4.3-4	Domestic transport costs for BIMSTEC imports through Laem Chabang / Bangkok port and Ranong port	4-101
4.4.3-5	Comparison of cost and time of freight import through Laem Chabang port / Bangkok And Ranong pier overall, domestic land transportation	4-101

Table (Cont'd)

		Page
4.4.3-6	Import volume from BIMSTEC countries for 2012-2016	4-102
4.4.3-7	Average growth rate used to estimate the import volume from BIMSTEC countries	4-105
4.4.3-8	Analysis of the proportion of containers to be used for Ranong port classified by product group and country of origin	4-105
4.4.3-9	Forecasts of volume of imported containers from BIMSTEC countries to be used for Ranong port services in 2025-2054 (classification by products)	4-106
4.4.3-10	Forecast of the volume of imported containers from BIMSTEC countries to be used for Ranong port services in 2025-2054 (classified by country)	4-106
4.5.2-1	Forecast of total passenger volume using the Chumphon-Ranong railway project	4-108
4.5.3-1	Forecasts of the volume of export and import containers from BIMSTEC countries to be converted to rail transport through Ranong port in 2025-2054	4-109
5.1.1-1	Design Criteria of the Route Alignment	5-2
5.1.1-2	Horizontal curve radius and design speed of the alignment	5-11
5.1.1-3	Slope and vertical curve radius of the alignment	5-12
5.1.4-1	Value of c (run off coefficient)	5-29
5.1.4-2	Peak discharge coefficient	5-31
5.1.4-3	Infiltration capacity according to types of soil and grass covered	5-31
5.1.4-4	Calculation of the flood peak for watershed area less than 25 km^2 (by rational method)	5-41
5.1.4-5	Calculation of the flood peak for watershed area between 25-1,000 km^2 (by snyder's equations)	5-42
5.1.4-6	Design of watershed outlet which passes the railway	5-43
5.1.5-1	List of stations, type and chainage	5-47
5.1.5-2	List of station area and other details	5-47
5.1.6-1	Clearance design specifications	5-57
5.1.6-2	Solution of level crossing problems	5-58
5.1.7-1	Details of boreholes locations	5-65
5.1.7-2	Details of test pits locations	5-66
5.1.7-3	Laboratory tests and standards	5-67
5.1.7-4	Summary of soil profile along the alignment	5-67
5.1.7-5	Subgrade categories according to quality classes (ref: uic 719r)	5-74
5.1.7-6	Subgrade categories according to bearing capacity classes (ref: uic 719r)	5-75
5.1.7-7	Types and quality of materials to be used for railway embankment	5-79
5.1.7-8	Calculation for blanket layer thickness (unit: millimeter, mm)	5-80
5.1.7-9	Design thickness of each layer of trackbed embankment	5-80
5.1.7-10	Soil bearing capacity under embankment for clay	5-87
5.1.7-11	Soil bearing capacity under embankment for sand	5-89
5.1.7-12	Summary of simplified slope stability	5-94
5.1.7-13	Settlement calculation of boreholes along the alignment	5-96
5.1.7-14	Soil bearing capacity and slope stability of boreholes along the alignment	5-96

Table (Cont'd)

		Page
5.1.7-15	Summary of pile tip level at design load	5-98
5.1.7-16	Pavement structures according to traffic volumes	5-98
5.1.7-17	Rock mass rating (RMR) and the recommended tunnel support (BIENIAWSKI, 1989)	5-100
5.1.7-18	Japanese standard for emergency equipment design	5-104
5.1.7-19	Locations and sizes of project tunnels	5-108
5.1.8-1	Location and type of railway bridges	5-114
5.1.8-2	Location of overpass	5-118
5.1.8-3	Location of box underpass	5-119
5.2.1-1	Electrical loads for type a station	5-129
5.2.1-2	Electrical loads for type b station	5-130
5.2.2-1	Cooling load calculation for type a station	5-131
5.2.2-2	Cooling load calculation for type b station	5-131
5.2.2-3	Water and wastewater calculation for type a and type b stations	5-133
5.3.2-1	Passenger volumes forecast	5-137
5.3.2-2	Expected volume of export containers to BIMSTEC countries to use the Ranong port service in 2025-2054	5-138
5.3.2-3	Expected volume of import containers from BIMSTEC countries to use the Ranong port service in 2025-2054	5-139
5.3.2-4	Stations and train service in the Chumphon- Ranong project	5-140
5.3.2-5	Train formation for commuter train	5-142
5.3.2-6	Long haul train formation and capacity	5-143
5.3.2-7	Commuter train journey time	5-143
5.3.2-8	Long haul train journey time	5-144
5.3.2-9	Freight train journey time	5-144
5.3.2-10	Train trips, fleet size and line capacity for passenger train	5-145
5.3.2-11	Train trips, fleet size and line capacity for freight train	5-145
5.3.2-12	Number of rolling stocks required	5-146
5.3.2-13	Additional rolling stocks required	5-146
5.3.2-14	Commuter train timetable for year 2025	5-148
5.3.2-15	Special express train timetable for year 2025	5-149
5.3.2-16	Commuter train timetable for year 2034	5-151
5.3.2-17	Special express train timetable for year 2034	5-152
5.3.2-18	Commuter train timetable for year 2044	5-154
5.3.2-19	Special express train timetable for year 2044	5-155
5.3.2-20	Commuter train timetable for year 2054	5-157
5.3.2-21	Special express train timetable for year 2054	5-158
5.5-1	Preliminary cost estimation	5-162

Table (Cont'd)

		Page
6.3-1	Summary of magnitude and direction of environmental impacts	6-4
6.3-2	Summary of major environmental impacts and environmental measures of the new railway project for Chumphon – Ranong port	6-5
7.2-1	Economic price calculation of the project	7-3
7.2-2	Investment cost of the railway construction project Chumphon - Ranong deep sea port	7-4
7.2-3	Assumption on distribution of investment value of the railway construction project Chumphon - Ranong deep sea port	7-4
7.2-4	Investment value and project implementation costs	7-6
7.3.1-1	Vehicle agents	7-8
7.3.1-2	Cost of using the vehicle for agent vehicles at current year (2017)	7-9
7.3.1-3	Proportion of various types of vehicles in the study area	7-10
7.3.1-4	Costs of using a vehicle at various speeds by personal car equivalent units	7-10
7.3.1-5	Average time value per car (baht / pcu-hour) in future years	7-10
7.3.1-6	Population and labor status in 2016	7-13
7.3.1-7	Average household income per capita, 2016	7-13
7.3.1-8	Average number of working hours per week	7-13
7.3.1-9	Average income per working hours	7-14
7.3.1-10	Average income per working hour classified by travel proportion.	7-14
7.3.1-11	Average time value per vehicle – hour	7-15
7.3.1-12	Average time value per passenger car – hour	7-15
7.3.1-13	Average time value per passenger car - hour in future year	7-16
7.3.1-14	The average passenger train time per person in future year	7-16
7.3.1-15	Average time value per passenger car - hour (baht /pcu-hour) in future year	7-17
7.3.1-16	Accident victim rate per average travel volume on highway	7-18
7.3.1-17	Accident victim rate per travel volume	7-18
7.3.1-18	Accident rates on highways in the years 2014-2016	7-19
7.3.1-19	Accident rate per travel volume	7-19
7.3.1-20	Cost of loss of production capability (baht per case)	7-20
7.3.1-21	Costs of qualitative loss of life (baht per case)	7-21
7.3.1-22	Cost of medical treatment (baht per case)	7-21
7.3.1-23	Costs of emergency medical unit (baht per case)	7-21
7.3.1-24	Cost of long-term care expenses (baht per case)	7-22
7.3.1-25	Costs related to damaged vehicles (baht per time)	7-22
7.3.1-26	Costs related to damaged property (baht per time)	7-23
7.3.1-27	Costs, general costs associated with collisions. (baht per time)	7-23
7.3.1-28	Proportion of travel volume in area	7-23
7.3.1-29	Average cost of medical treatment classified by severity of injury	7-24
7.3.1-30	Accident and accident victims' rates per travel volume	7-24

Table (cont'd)

		page
7.3.1-31	Average cost of medical treatment classified by severity of injury	7-24
7.3.1-32	Accident loss per travel volume in 2017	7-25
7.3.1-33	Accident loss per trip volume in 2017 (baht / 100 million pcu-km)	7-25
7.3.1-34	Value of accidental loss on travel volume	7-26
7.3.1-35	Benefits of accidental loss reduction	7-26
7.3.1-36	Benefit from reducing emissions from transportation	7-27
7.3.1-37	Travel benefits of the passengers of the project	7-27
7.4.1-1	Growth rate of the gross domestic product index 2007-2016	7-29
7.4.1-2	Benefits of total cost savings. (freight and time) to be transformed into rail freight by railway line project through the Ranong port.	7-29
7.4.2-1	Amount of carbon dioxide emissions of vehicles.	7-30
7.4.2-2	Carbon price (value 2017)	7-30
7.4.2-3	Benefits of reducing air pollution in the transition to rail freight by railway project through Ranong port	7-31
7.5.1-1	Analysis of economic feasibility	7-33
7.5.2-1	Economic sensitivity analysis of the project	7-34
7.6.1-1	Investment cost of the railway construction project Chumphon - Ranong deep sea port	7-35
7.6.1-2	Benefits of railway development - Chumphon - Ranong deep sea port route	7-35
8.1-1	Financial project analysis requirements	8-2
8.2-1	Train fares with origin or destination at Chumphon or Ranong	8-5
8.2-2	Rate of train ticket	8-5
8.2-3	Air conditioning fee	8-6
8.2-4	Fee rate of car seat and sleeper car	8-6
8.2-5	Forecasting the 20-foot container volume using the new railway line in Chumphon - Ranong classified by import and export at Ranong port	8-6
8.2-6	Container freight rates sort by distance (unit: baht / container (1 way))	8-7
8.3-1	Investment, expenses and total revenues throughout the project life new railway line Chumphon – Ranong	8-9
8.3-2	the results of the financial analysis of the project new railway line Chumphon – Ranong	8-10
8.4.1-1	Possible investment forms	8-11
8.4.2-1	Financial return of investment form 1 (all SRT investment)	8-12
8.4.2-2	Financial return of investment form 2 (state infrastructure support and the signal system)	8-12
8.4.2-3	Financial return of investment form 3 (private sector will invest in train)	8-13
8.4.2-4	Financial Analysis of the State Railway of Thailand of the investment model 1	8-14
8.4.2-5	Financial analysis of the state railway of Thailand of the investment model 2	8-16
8.4.2-6	Financial analysis of private sector bus routes in Chumphon - Ranong of the investment model 3	8-18

Table (cont'd)

		page
8.4.2-7	Financial analysis of private who operate passenger train routes icd lat krabang - Ranong of the investment model 3	8-20
8.6-1	Sensitivity analysis of new rail project in Chumphon – Ranong in the form that the railway of Thailand is responsible	8-25
8.7.3-1	Possible investment forms	8-26
8.7-2	The results of analysis of investment model	8-27
9.3-1	Target areas	9-2
9.4-1	Summarize of People Participation and Public Relation Work Plans	9-3
9.5-1	Suspicious issues and recommendations from the public participation	9-5
10.1.2-1	Tourist attractions nearby Chumphon - Ranong railway station and connect to the nearby highway network	10-5
10.1.2-2	Summary of proposals for development guidelines for areas surrounding the station	10-7
10.1.2-3	Proposal for developing areas surrounding the station along the Chumphon – Ranong railway route	10-9
10.1.2-4	Volume of buildings area according to minimum development criteria of the areas surrounding the station along the Chumphon – Ranong railway route	10-10
10.3.1-1	Tourism multiplier in each business	10-27
10.3.2-1	Number of visitors, average day of stay, income and expenses of visitors in Chumphon and Ranong province in the years 2012-2016	10-28
11.1-1	Forecasted passenger and freight volumes in years 2025-2054	11-1

Chapter 1

Introduction

Chapter 1
Introduction

1.1 Project Background

The cabinet meeting on 11 October, 2016 acknowledged the outcome of the meeting on 16 September, 2016 between the Prime Minister and Joint Committee between Public and Private Sectors to Solve Economic Problems of Central Region and Southern Andaman Provincial Cluster that the Ministry of Transport was appointed to follow the recommendation of the Joint Committee on developing and extending the southern railway network from Chumphon to Ranong Provinces, totaling 125 km long, by developing another railway from the Gulf of Thailand to the Andaman Sea for transportation and tourism purposes including linking to Ranong Deep Sea Port to function as a gateway to BIMSTEC in the future.

The development and extension of new railway network from Chumphon to Ranong linking the Gulf of Thailand to the Andaman Sea is consistent with Article 6 of the government policies on enhancing the economic potential of the country in terms of transportation development to be more convenient, faster and safer to upgrade the people's quality of life. It is also consistent with Strategy 7: Strategy for Advancing Infrastructure and Logistics as stated in the 12th National Economic and Social Development Plan in terms of railway network development that feasibility studies should be conducted for routes that could act as feeder lines from economic and industrial areas in different provinces to the main railway network. Thus, the Ministry of Transport has included the project in the main mission of the Ministry of Transport under the draft of the 20-year Transport Development Strategy (2017-2036).

Southern provincial cluster has a potential for economic and tourism development due to the advantage of the geographical location that transportation linkages between the Gulf of Thailand and the Andaman Sea could be developed to be a world class marine tourism center and an economic gateway to South Asia. The government has focused on transportation development linking the 2 coasts to enhance the competitive potential to southern provincial cluster.

The Office of Transport and Traffic Policy and Planning (OTP) deems it is necessary to conduct the feasibility study on economy, engineering and environment for railway Chumphon-Ranong to develop a new railway linking the Gulf of Thailand and the Andaman Sea to enhance transportation and tourism of the country.

1.2 Project Objectives

The objectives of the Feasibility Study for Railway from Chumphon-Ranong Deep Sea Port are as follows:

1) To study the development and extension of new railway network from Chumphon-Ranong Deep Sea Port to develop transportation system.
2) To design and prepare an initial environmental examination (IEE) report.
3) To conduct the feasibility study on economy, finance and investment option.
4) To create people's awareness processes and people's participation in area development along the railway from Chumphon-Ranong Deep Sea Port.

1.3 Scope Of Consultant Services

1.3.1 Task 1: Study, Survey, Collect and Analyze Data for the Development and Extension of New Railway Network from Chumphon-Ranong Deep Sea Port include

1) To review an investment strategic policy on infrastructure and transportation development.
2) To collect basic data.
3) To survey and collect transportation data and problems in the project area.

1.3.2 Task 2: Design and Prepare an Initial Environmental Examination (IEE) Report include

1) To study the feasibility of route.
2) To conduct a conceptual design.
3) To analyze and recommend station locations, container yard and inland container depot.
4) To conduct an initial environmental examination (IEE).
5) To conduct an initial cost estimation.
6) To analyze/evaluate/select the most appropriate route.
7) To prepare the right-of-way plan and land acquisition data.
8) To conduct a preliminary design.
9) To conduct a preliminary design for infrastructure.
10) To conduct a preliminary cost estimation.

1.3.3 Task 3: Feasibility Study on Economy, Finance and Investment Option include

1) To conduct the economic and financial analysis.
2) To prepare guidelines for public-private partnerships.
3) To prepare the project feasibility report for private investment, analyze financial and economic returns.

1.3.4 Task 4: Create People's Awareness Processes and People's Participation in Area Development along the Railway from Chumphon-Ranong Deep Sea Port include

1) To assign key personnel.
2) To arrange public participation activities.
3) To prepare public relations work plans.

Chapter 2

Study, Survey, Collect and Analyze Data in Various Fields for Network Development and Expand the New Railway Line from Chumphon Province – Ranong Province

Chapter 2
Study, Survey, Collect and Analyze Data in Various Fields for Network Development and Expand the New Railway Line from Chumphon Province – Ranong Province

2.1 The Review of Policy and Investment Strategy for Developing of Infrastructure and Transport System Services

2.1.1 The Review of Policy, Strategy and Plan for Infrastructure Development

The consultant has conducted a study to analysis, review policy, investment strategy for developing of infrastructure and transport system of the country to be a guideline for the project implementation to be consistent and integrated with the projects include;

1) The 20-Year National Strategy (2017–2036)

Assignment "National Strategy" as a strategy for long-term development of the country, along with the reform and development of government systems and mechanisms to drive the strategy to lead to serious action will improve the quality of Thailand in all sectors and bring the country out or alleviate the severity of the current problems, as well as deal with threats and manage the risks that will occur in the future and can be transformed through Thailand along with the changing landscape of the world.

The Constitution of the Kingdom of Thailand, BE 2560, requires that the State establish a national strategy as a long-term sustainable development goal for the country in accordance with good governance to use as a framework for consistent and integrated planning to achieve a common goal. ***"The 20-Year National Strategy (2017–2036)" By the vision of "Thailand, a nation of Stability, Prosperity, and Sustainability, is a developed nation according to the economic philosophy", or to achieve as the slogan of "Stability, Prosperity, Sustainability"*** to provide the country with a competitive edge in manufacturing and services based on modern technology and innovation, high income in developed countries. Thai people are quality people who are happy, eat well, social stability, equally and fairly, the National Strategy that will be used as a framework for development in the next 20 years will consist of six strategies;

Strategy 1 : Security

It aims to build security at all levels, from national, social, community, and human security to all threats and security in all aspects. The major development guidelines are as follows.

- Keeping the peace within the country
- Development of defense capabilities, ready to deal with both military threats and other threats

- Integrating international cooperation that promotes security, economic wealth, preventing transnational threats and the quality of life in the people
- Maintaining security and the benefits of natural resources and marine resources
- Stable security management in line with other development plans to help people and jointly develop the country

Strategy 2 : Competitiveness enhancement

The goal is to increase productivity by using science, technology, research & development and innovation in all branches of the manufacturing and service sectors that are the base of revenue and the new revenue base with the following major development approaches:

- Development of the manufacturing sector and services
- Development of entrepreneurial society to create a business entrepreneur
- Development of supporting factors and development of infrastructure to increase the competitiveness enhancement
- A strong foundation to support increased competitiveness enhancement

Strategy 3 : Development and Empowerment of Human Resources

Targeted for Thais in the future must be a complete human, be ready for the body, mind and intellect, can learn throughout life, have skills in the 21st century with major development guidelines as follows.

- Transformation of culture to create Thai people with quality, morality, ethics, discipline, and respect for the law
- Development of potential of man throughout life
- Transforming of learning
- Develop and maintain a talented group
- Strengthening Thai people's well-being
- Creating the happiness of the Thai Family

Strategy 4 : Social equality

The goal is to solve the problems of inequality and social justice. It is based on the principles and fundamental principles of creating a society. Social quality in every side by side, the major development guidelines are as follows.

- Creating economic and social security including the security of life and property of people in society
- Creating opportunities to access social services thoroughly
- Social Empowerment
- Creating social solidarity

Strategy 5 : Green growth

The goal is sustainable consumption and sustainable production by developing effective production and develop eco-industrial cities & eco-friendly cities by effectively managing waste, toxic and hazardous waste. The major development guidelines are as follows.

- Organize conservation, restore and prevent the destruction of natural resources
- Implement integrated water management in 25 Watersheds both in demand and supply
- Develop and use environmentally friendly energy in all economic sectors
- Develop eco-friendly cities and eco-friendly cities
- Reduce global warming and adapt to climate change.
- Use economic tools and fiscal policy for the environment.

Strategy 6 : Rebalancing and public sector development

Action Goals: Modifying the Government based on "Public sector for the people" and the clearly identification of roles of the government agencies in regulating and providing services in markets that are competitive with the private sector. The government must have the right size for the mission, high performance, adjusting the work culture to the achievement of the common good, modern and ready to adapt to the change of the world at any time. The major development guidelines are as follows.

- Integrated government administration management
- Upgrading Public Service and Facilitating Government to Excellence
- Improvement of the role, mission and structure of government agencies
- Development of personnel management system and development of government personnel in government service and professionalism
- Anti-Corruption and Misconduct
- Revision of laws, regulations and regulations to be clear, up-to-date, fair and in line with international regulations or international agreements

2) Development Strategies under the Twelfth National Economic and Social Development Plan

Currently, the Office of the National Economic and Social Development Board (NESDB) has prepared the Twelfth National Economic and Social Development Plan (2017-2021) on the basis of the 20-year National Strategy framework (2017-2036), which is the master plan of national development and the country's Sustainable Development Goals (SDGs), including the restructuring of Thailand to Thailand 4.0 Policy, as well as other reform agendas. In addition, it also focus on the participation of all development actors, whether at the professional level, regional level and national level in all stages of the plan with extensive and continuous to share the vision and direction of national development. It also includes a detailed description of the strategy of the plan to achieve the objectives of "Security, Prosperity, and Sustainability".

The National Strategy is to be translated into action through the five-year National Economic and Social Development Plans, commencing with the Twelfth Plan. Each strategy within the Twelfth Plan lays out development agendas as well as flagship projects which need to be accomplished in order to prepare human capital, society and the economy for future challenges. Clear implementation mechanisms as well as monitoring and evaluation procedures are also identified to bring about genuine development that is effective, beneficial, and sustainable for all.

The Twelfth National Economic and Social Development Plan (2017-2021) has defined 10 strategies of national development strategies as follows:

- Strategy 1 : Strengthening and Realizing the Potential of Human Capital
- Strategy 2 : Creating a Just Society and Reducing Inequality
- Strategy 3 : Strengthening Sustainable Economic Development and Competitiveness
- Strategy 4 : Green Growth for Sustainable Development
- Strategy 5 : National Security for the Country's Development towards Prosperity and Sustainability
- Strategy 6 : Public Administration, Corruption Prevention, and Good Governance in Thai Society
- Strategy 7 : Advancing Infrastructure and Logistics
- Strategy 8 : Science, Technology, Research, and Innovation Development
- Strategy 9 : Regional, Urban, and Economic Zone Development
- Strategy 10 : International Cooperation for Development.

Strategies related to the development of transport infrastructure in Thailand are as follows.

Strategy 7 Advancing Infrastructure and Logistics

Transportation Infrastructure Development consists of development of rail tranport system, development of public transport in urban areas, development of road network, development of air transport and development of water transport system. The development of the rail transport system is as follows.

- Improving the meter-gauge railway network to become the main transportation network by accelerating the advancement of the existing rail, signaling and telecommunications infrastructure, as well as upgrading locomotives and rolling stock. Further, the country should implement the next phase of its dual-track railways development, starting with the construction of routes within a 500 - kilometer radius of Bangkok, such as Pak Nam Pho - Den Chai, Chira - Ubon Ratchathani and Chumphon - Surat Thani. In addition, feasibility studies should be conducted for routes along the economic corridors connecting to other ASEAN countries, as well as routes that could act as feeder lines from economic and industrial areas in different provinces to the main rail network and develops cooperation in international rail services as well.
- Devising a road map to shift from diesel to electrical locomotives in order to accommodate future changes in railway technology, which will help decrease the costs of operations and services and increase the capability of the meter-gauge railway to cater for a larger volume of passenger and freight transportation, both domestic and international.
- Developing the high-speed rail network as a principal means of passenger transportation, while the meter-gauge network feeds passenger traffic to the high speed rail network. During the course of the Twelfth Plan, at least one high-speed railway route should be constructed, while urban development plans for areas along the route should be devised in order to decentralize development to regional cities, raise the standard of public transportation services, and create opportunities for the Thai people to be familiar with the advanced rail technology.

- Standardizing the meter-gauge and standard-gauge railway systems as well as the mass-transit city-rail system to help streamline the procurement bidding process and to ensure a higher quality of services, which will thereby help reduce operation and maintenance costs for railway operators.
- Developing logistics facilities and service centers (e.g. distribution centers, cargo terminals, and container lifting equipment) to serve multimodal transportation along the strategic routes connecting industrial and agricultural manufacturing bases to major trade gateways, especially international ports and important border areas.

Key inter-city rail projects are as follows:

- A total of 14 routes of meter-gauge double-track railway projects covering 2,500 kilometers, including 7 cabinet-approved routes (Chachoengsao - Khlong Sip Kao - Kaeng Khoi section, Thanon Chira Junction - Khon Kaen section, Map Kabao - Thanon Chira Junction section, Prachuap Khiri Khan - Chumphon section, Lopburi - Pak Nam Pho section, Nakhon Pathom - Hua Hin section, and Hua Hin - Prachuap Khiri Khan section) and 7 routes undergoing project approval are: Pak Nam Pho - Den Chai section, Thanon Chira Junction - Ubon Ratchathani section, Khon Kaen - Nong Khai section, Chumphon - Surat Thani section, Surat Thani - Hat Yai -Songkhla section, Hat Yai - Padang Besar section (driven by electric energy), and Den Chai - Chiang Mai section). The main agency responsible for carrying out the projects is the State Railway of Thailand (SRT), with a timeline of 6 years from 2016 to 2021.
- High speed 1.435 meter high speed railway project at least 1 route. The main agencies responsible for carrying out the project are the Ministry of Transport (MOT) and SRT, with a timeline of 6 years from 2016 to 2021.
- Projects constructing new railway routes along important economic corridors (Kanchanaburi – Bangkok - Aranyaprathet section, Kanchanaburi – Bangkok - Laem Chabang section, and Den Chai - Chiang Rai - Chiang Khong section). The main agency responsible for carrying out the projects is SRT, with a timeline of 5 years from 2017 to 2021.

<u>Strategy 9</u> Regional, Urban and Economic Zone Development

In the Development Strategies under the Twelfth National Economic and Social Development Plan, only the development strategy for the region and the city is proposed. This is an important strategy that is relevant to the tourism industry and services. In terms of education, the southern part of the country will aim to raise revenue from tourism to continue to grow and distribute income from the tourism to the link areas, including the community and the local thoroughly as follows.

(1) To strengthen the agricultural sectors to be fully capable of developing the value chain while continuously and sustainably contributing to regional revenue:

- **Strengthening the productivity of rubber and palm oil** by: (1) promoting and supporting technologies to increase productivity, (2) conducting research to create value-added products, and (3) promoting small-scale farmers to be able sustainably to improve productivity, such as mixed agricultural practices and New Theory Agriculture, to accentuate the Southern Region as Thailand's key producer of rubber and palm oil in order

to increase income and minimize the risk of fluctuating rubber and palm oil prices.

- **Developing and promoting the identity fruits of the Southern Region**, such as coconut, cavendish banana, mangosteen, and durian, to meet international standards for export by: (1) improving technologies concerning harvesting and fresh produce storage, and (2) supporting research and development on fruit production 215 and processing to create value-added products such as food supplements, medical and cosmetic products to meet international standards.
- **Developing high-potential areas with efficient transportation infrastructure to be the agro-processing base** by developing and promoting the establishment of: (1) a comprehensive palm oil processing industrial center as well as biodiesel production in Krabi and SuratThani, and (2) a rubber-processing industrial center in Songkhla.
- **Upgrading the environmentally-friendly industries of shrimp culture and marine culture in Surat Thani, Nakorn Si Thammarat, Songkhla, and Pattani** in order to promote the Southern Region as the main source of seafood products which meet international standards by: (1) supporting and promoting standardized farm management systems with efficient and hygienic production procedures in accordance with international standards, (2) developing market systems, and (3) enhancing the efficiency of seafood processing in order to create value-added products and generate income for local populations
- **Supporting and promoting the development of Srivichai beef cattle in Chumphon, Surat Thani, Nakhon Si Thammarat, and Patthalung** to become the production base for high-quality beef by: (1) improving breed development, (2) expanding farming areas, and (3) setting standards and developing beef product quality to support the tourist market as well as to be the key export products of the region.

(2) Continuously raise revenues derived from tourism and improve income distribution to local communities:

- **Supporting Phuket, Phang Nga, Krabi, and Koh Samui District, Surat Thani to attain continuously increasing income from tourism with due consideration to the carrying capacity of each area**, for the Southern Region to become a destination of yacht and cruise tourism by: (1) encouraging all stakeholders to create value for quality and environmentally-friendly tourism services, (2) developing the yacht and cruise tourism businesses in Krabi and Koh Samui District of Surat Thani, (3) improving public infrastructure and facilities to be standardized and adequate, and (4) developing security systems according to international standards.
- **Promoting and developing connectivity among tourist destinations along the coasts of the Andaman Sea and the Gulf of Thailand, including the high-potential inland tourist destinations,** by: supporting the development of new inland tourist destinations such as Rajjaprabha Dam in Surat Thani, Khao Luang Natural Park in Nakhon Si Thammarat, and other high-potential community attractions in order to create the tourist

routes networks in Phuket, Phang Nga, Krabi, Surat Thani (Koh Samui, Koh Pha-ngan, Koh Toa), Chumphon, and Nakhon Si Thammarat (Sichon and Khanom beaches).

- **Promoting and developing community-based tourism in Chumphon, Surat Thani, Patthalung, Ranong, Trang, and Satun** by: (1) supporting the development of diverse community attractions, (2) encouraging local communities to take action in community tourism management, and (3) strengthening the network of community-based tourism in association with large tourism service providers in order to create jobs and distribute income toward local communities
- **Developing potential tourism cities to create value added for the Southern Region** in order to attract domestic and foreign tourists while developing the economic base sustainably to generate income distribution for local communities by: (1) promoting Ranong to be the city of healthcare and spas, (2) promoting Chumphon to be the city of agricultural tourism, (3) promoting Nakhon Si Thammarat to be the city of world heritage and Srivichai historical sites, (4) improving and developing tourist attraction areas, tourism-related infrastructure and facilities, (5) developing diverse tourism businesses and services to attain international standards, and (6) enhancing efficient marketing and tourism administration

In terms of urban development, there will be key development for provincial city centers to become livable cities for all groups of people in the society. The intended livable cities shall be safe, environmentally friendly, economically vibrant, easy to travel within, accessible to high quality public utilities, consistent with local identity, diversity and potential, and based on inclusive participatory principles. The southern part focuses on urban areas in Phuket and Hat Yai to be developed as livable cities while accommodating economic expansion, including social and environmental transformations by: (1) improving public transportation systems and information technology infrastructure, and (2) developing residential areas to accommodate the growing population with appropriate waste management systems.

There is also a concept for the development of the area surrounding the key strategic cities with major railway stations, such as the cities of Ayutthaya, Nakorn Sawan, Khonkaen, Thung Song, as well as border cities, namely Betong, Sadao, Phu Nam Ron, Aranyaprathet, Nakorn Phanom, Nong Khai, and Chiang Khong, to be developed according to each area's potential for connectivity development.

The major plans and projects of the South are as follows:

- Southern Rubber Products Development and Promotion Project
- Project to increase oil palm and agricultural production in Southern Border Provinces.
- Sri Wichai Cattle Produce Development Project, Southern Gulf of Thailand
- World Heritage City Development and Historic Sites of Civilization Srivijaya Nakhon Sri Thammarat
- Shrimp and coastal aquaculture industry development project
- Tourism promotion project linking southern Andaman coast, Gulf of Thailand and potential tourism attractions

- Health Tourism Development Project
- The South Coastal Coastal Eradication and Prevention Project
- Urban Development and Improvement Program

3) The Strategic Plan for Logistics Development of Thailand No. 3 (2017-2021)

The Strategic Plan for Logistics Development of Thailand No. 3 (1960-2021) focus on "The upgrading of the logistics system of the country. Supporting the ASEAN Trade in Services Center Competitive Advantage "consists of three strategies and 11 tactics.

- Strategy 1: Development of Value Added Supply Chain
- Strategy 2: Development of Infrastructure and Facilities
- Strategy 3: Development of Logistics Supporting Factors

The relevant part of the project will be strategy 2: Infrastructure development and facilities. Focusing on the optimization of freight and logistics networks to connect throughout the origin and destination, promote and develop supply chain systems, trade routes that support each other among CLMV countries and Link with China It supports the transformation of transport into multimodal transport that can reduce logistics costs, energy saving and environmentally friendly. Including, develop and upgrade trade facilitation standards in line with global trade standards, with four main strategies that the strategies related to the project are: Strategy 1 as detailed below.

Strategy 1: Develop transport infrastructure and logistic networks along the strategic route to link the sub-region and trade gateways.

- Support the modification of transport modes to efficient transport. Modification of transport modes (Shift Mode) and multimodal transport. The development and improvement of 1 meter railway network to be the main transportation network of the country. Double track on dense transport routes. Transporter Line (Feeder Line) from the economic area. Borderline and industrial zones to the main railway network of the country. And the development of rail links with regional countries. As well as increasing the capacity of rail transport by supplying locomotives and lorries to meet the demand and increase the role of the private sector to participate in more diverse services. For waterways, focus on utilizing existing regional docks. Related agencies jointly study the integrated approach. Management Marketing Promotion Demand development of existing coastal ports and river ports. Development and management of the post area and establish a linkage network between the ports road and rail transport, interconnection between domestic and foreign ports

- Build a logistics network based on strategic routes and links to neighboring countries. Improve the highways of domestic transportation to neighboring countries, promote cooperation with neighboring countries to develop economic routes, link trade, service and investment, develop expressway networks and special highways between cities at the checkpoints. Trade and Trade Key Consider the appropriate route linking transportation between the West and East Coast. Improve the main roads linking the production base to the commercial gate and expand the capacity to accommodate traffic volume as appropriate. To accommodate the

increasing volume of travel and freight traffic from entering the ASEAN Economic Community

- Development of facilities and logistics service centers. Develop logistics activities such as collection and distribution center, land port, cargo storage and loading. As well as the procurement of rail transport equipment along the strategic route that can be linked to the industrial production base, especially industrial areas along the eastern economic corridor and the north-south-east-west economic corridor and the country's agriculture to the main gateway of the country, especially the airport, international port and the key checkpoints. It also encourages the private sector to participate in the investment, development and service of logistics centers such as distribution centers, transportation Center etc.

- Develop border areas to support transportation and logistics. Accelerate urban planning in the special economic zone and form the development of the border area to be able to support trade, investment and facilitation. It will also develop the bypass-city and linking the route between major cities in the region to support the expansion of economic and trade activities, investment promotion, the logistics industry and the logistics business. Supporting entrepreneurs in the area to create a logistics community to reap the added value of import-export activities at the border. Developing a viable trade barrier as a permanent international standard. In addition, the regulators should be responsible for integrating the development and use of border areas for unity in border management, can determine the consistency of development projects of each agency and solve problems happened in the area

4) (Draft) Strategic development of transport system in Thailand for 20 years (2017-2036)

The Ministry of Transport has formulated a strategy for the development of Thailand's transportation system for 20 years (2017-2036) to be framework for the long-term development of Thailand's transportation systems and the relevant agencies are driven in the same direction and towards the same goal. With vision "Towards Sustainable Transport", and the main goal is to improve the quality of people's lives in transportation and travel. And drive the economy and increase the competitiveness of the country. It consists of five strategies as follows.

- **Strategy 1 Integrated Transport Systems**

  Integration of the program / project of the various agencies from the planning stage to construction in line with the development of the entire transportation network to provide a complete and efficient transportation network. Key targets include interconnection, access and mobility. It focuses on infrastructure, railways and waterways as the main transportation modes and road transport is a complementary system to reduce transportation costs. Including the integration of existing infrastructure management to maximize utilization, promote cooperation in various fields and the development of the industry has the potential to encourage more investment in the country.

- **Strategy 2 Transportation Service**

  Freight Enhance service and management in trade facilitation and supply chain management by enhancing the efficiency of the logistics management system, promoting both domestic and international freight using rail and water transport as the main transportation modes.

  Passenger transport Provide transportation services to facilitate the travel in both quantity and quality, and can provide services to cover all people.

- **Strategy 3 Regulations and Institution**

  - The restructuring of the organization and agencies involved in transport has a clear role to play in regulating and regulating transportation to make the operation on each side clear with effective and international standards.
  - Improvements of relevant laws. It is very important to keep the law is in line with current situation.
  - The opportunity for the private sector to participate in infrastructure development and transport management.

- **Strategy 4 Human Resource Development**

  To provide transportation personnel with sufficient quality to support the growth of the transportation industry both domestically and regionally.

- **Strategy 5 Technology and Innovation**

  Promote research and development to introduce innovative technology innovations to develop infrastructure and manage transportation to be more efficient.

  The Ministry of Transport has prepared a strategy for the development of Thailand's transportation system for 20 years, divided into 4 periods, each period focusing on the action as detailed in **Table 2.1.1-1**.

Table 2.1.1-1 Duration of Development

Focus on action	Phase 1 (Year 2017-2021)	Phase 2 (Year 2022-2026)	Phase 3 (Year 2027-2031)	Phase 4 (Year 2032-2036)
• Resolve traffic problems in Bangkok Metropolitan Region and major cities in the region. Both physical and law enforcement.	√			
• Accelerate the development of public transport in Bangkok Metropolitan Region, including six major cities in the region (Chiang Mai, Phitsanulok, Khon Kaen, Nakhon Ratchasima, Phuket and Songkhla).	√	√	√	
• Resolve the problem of road accidents, it aims to reduce the number of deaths from road accidents by less than 10 per 100,000 population by 2020.	√	√		
• Development of inter-city rail system for freight and passengers.	√	√	√	√
• Development of the area along the railway and metro line.	√	√	√	√
• Develop a transportation system that promotes logistics and development of specific areas.	√	√		
• Develop energy-saving and environmentally friendly transport systems.	√	√	√	√
• Improve access to transportation systems of all groups.	√	√	√	√
• To enhance the quality of transportation services.	√	√	√	√

Source: Plans in the Ministry of Transport's main missions under (draft) the Strategic Plan for the Development of the Transport System in Thailand for the period of 20 years (2017-2036) Ministry of Transport

5) Strategic Development of Thai Transport Infrastructure (Year 2015 – 2022)

Thailand's Transport Infrastructure Development Plan 2015-2022 aims to provide a framework for the development of the transport sector in the 8-year period, which is the driving force behind economic and social development. Stimulate the economy, create jobs, distribute income, and create safety in the lives and property of the people. This is a factor that will lead to development goals in increasing the quality of life of people.

The Ministry of Transport has integrated the needs of Thailand's transportation infrastructure to build a foundation for economic security, social security, travel and transportation. Including opportunities for utilization of being ASEAN community according to infrastructure development and focus on the development challenge that will support the transformation of road-based freight transportation into lower-cost core transport and travel and transportation connections with neighboring countries. As well as upgrading mobility and transportation to regional centers throughout the country. The transport infrastructure development strategy will consist of five 4-target programs, as shown in **Figure 2.1.1-1**, of which the Peacekeeping Corps (KSC) has approved the Strategic Framework for the Development of the Transport Infrastructure of Thailand, 2015-2022, on 29 July 2014.

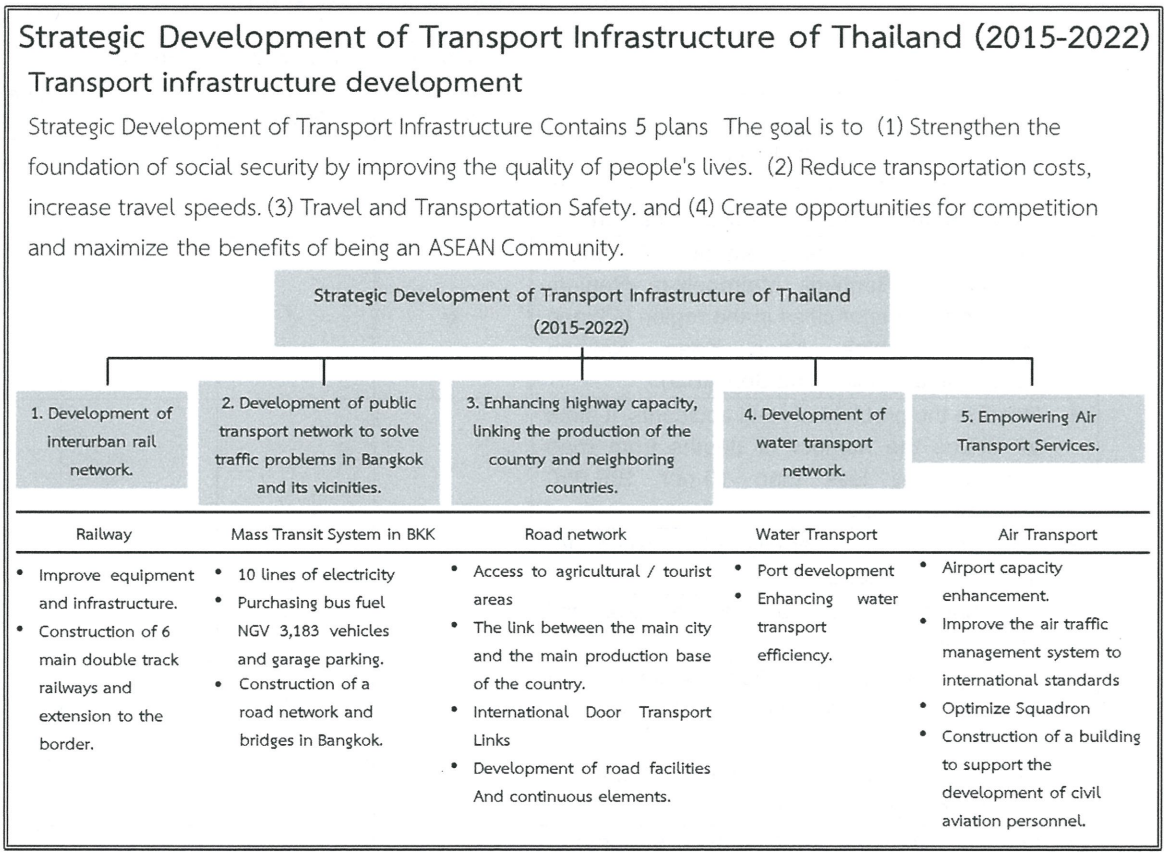


Figure 2.1.1-1 Strategic Development of Transport Infrastructure of Thailand (2015-2022)

The relevant strategy will be to develop a railway network between cities. It will continue to improve equipment and infrastructure for rail transit and developed the first two ready-to-run rail systems and accelerated the construction of standard gauges linked to neighboring countries and the People's Republic of China (South China) to make the train a new alternative to travel and create a competitive advantage in the country. The six express train routes are:

(1) Lop Buri - Pak Nam Po distance of 148 kilometers

(2) Mababa - Nakhon Ratchasima (Jira junction), distance of 132 kilometers

(3) Junction of Jira Road - Khon Kaen distance of 185 kilometers

(4) Nakhon Pathom – Hua Hin distance of 165 kilometers

(5) Prachuap Khiri Khan – Chumphon distance of 167 kilometers

(6) Hua Hin – Prachuap Khirikhan distance of 90 kilometers

6) National Tourism Development Plan No.2 (Year 2017 - 2021)

The National Tourism Policy Board (TAT) has implemented the National Tourism Development Plan No. 2 to serve as a framework for five-year development. 20 years in the national strategic framework. (2017-2036), based on that principle. The goal is to upgrade Thailand to a developed country. Managed efficiently and to be a sustainable tourist destination. Strategic development consists of 5 strategies as follows.

- **Strategy 1** The Development of quality tourism location, products and services for tourism are balanced and sustainable include:

(1) Improve the quality of tourist attractions; all products and services are standard. Promote and develop quality tourism products and services. Develop and improve tourism standards and services to cover all forms of tourism and consistent with the development of sustainable tourism, covering both the system and the related service industries.

(2) Tourism Development Sustainable Products and Services by encouraging all sectors to participate in the local identity, culture and tradition and environment including creative tourism development to increase economic value.

(3) Balancing the tourist attraction, goods and services In terms of time, seasons, and tourism patterns, such as the establishment of tourism development zones to develop tourism in the province and potential areas that have not been popular. Secondary tourism development, rural tourism development, outstanding product and service development and is unique to each locality and promotion of time and season balance in tourism.

- **Strategy 2** Development of infrastructure and facilities to support the expansion of tourism.

(1) Develop logistics system for tourism. The development of transportation system to travel to the country, land, water and air, including the development of land transport routes to reach the tourist. Elevate public transport to facilitate travel between destinations, develop water transport that can be linked to other modes of transportation.

(2) Development of tourism facilities by improving the immigration system, improve and facilitate transit through the system, provide a single ticket system that applies to all travel channels.

(3) Develop safety and hygiene in tourism by supporting tools and equipment to protect and assist tourists.

- **Strategy 3** Human Resources Development for Tourism and support the participation of people in tourism development.

(1) To develop the potential of tourism personnel in the system to be competitive in line with international standards and enough to meet the needs of the market

(2) Encourage people to participate in tourism management and benefit from tourism

- **Strategy 4** Balancing Thai tourism through niche marketing. Promotion of Thai way and the confidence of tourists.

(1) Enhancing the image of quality and safety for Thailand

(2) Promote niche marketing to attract travel and stimulate the spending of tourists groups

(3) Promote the identity of Thailand and of each locality

(4) Promote domestic tourism and spatially & time-balanced tourism

(5) Promote cooperation with those who are involved and use technology in marketing

- **Strategy 5** Integration of Tourism Management and Promotion of International Cooperation

  (1) Promote effective governance, development and management of tourism

  (2) Improve laws, regulations and standards that related to tourism and law enforcement seriously

  (3) Support for private sector investment and information center for tourism

  (4) Promote international cooperation for tourism development by coordinating with other countries to promote tourism development and networking within the framework of international cooperation

The National Tourism Development Plan No. 2 (2017 - 2021) is in line with the national and regional tourism development policy as shown in **Figure 2.1.1-2**.

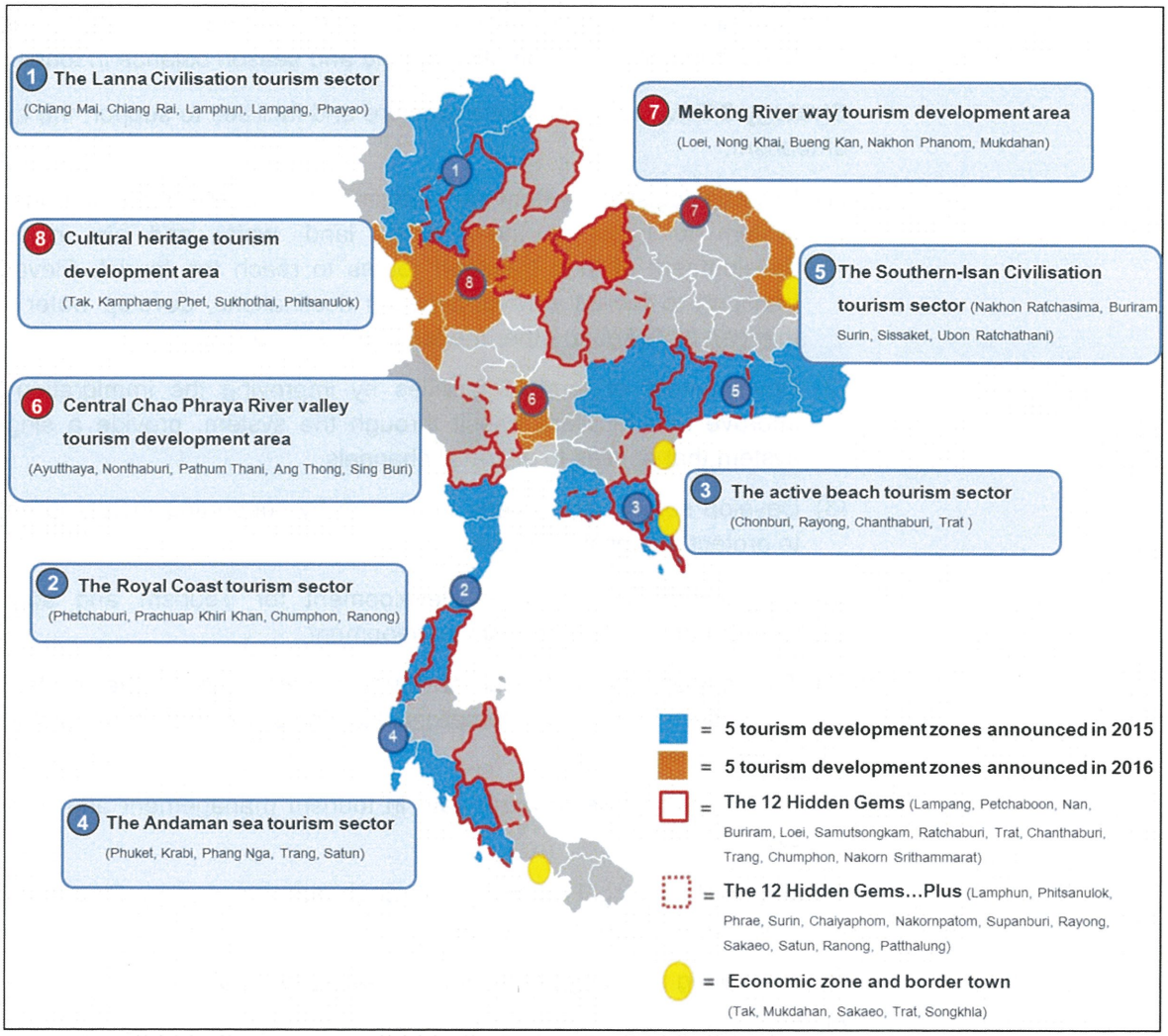


Figure 2.1.1-2 Map of Tourism Development Zone

In relation to the study area is the West Coast Tourism Development Area (Royal Coast) consists of Phetchaburi. Prachuap Khiri Khan, Chumphon and Ranong will focus on developing the world's leading health tourism. In addition, Chumphon Province included in the development policy 12 cities banned.....miss and Ranong Province is in the development policy 12 Forbidden City.....miss Plus.

On 15 January 2018, the Ministry of Tourism and Sports. Discussed with the Ministry of Transport. The development of transport links. The development of infrastructure to support tourism. Including the development of the main city-secondary link. To facilitate and secure travel. Transportation, land transport, water and air, as well as rail travel, which is a unique travel. Also, a joint statement was signed between the two ministries on the establishment of a joint committee for the development of transport links. The Chumphon-Ranong Deep Sea Port Project is a project that complies with the policy.

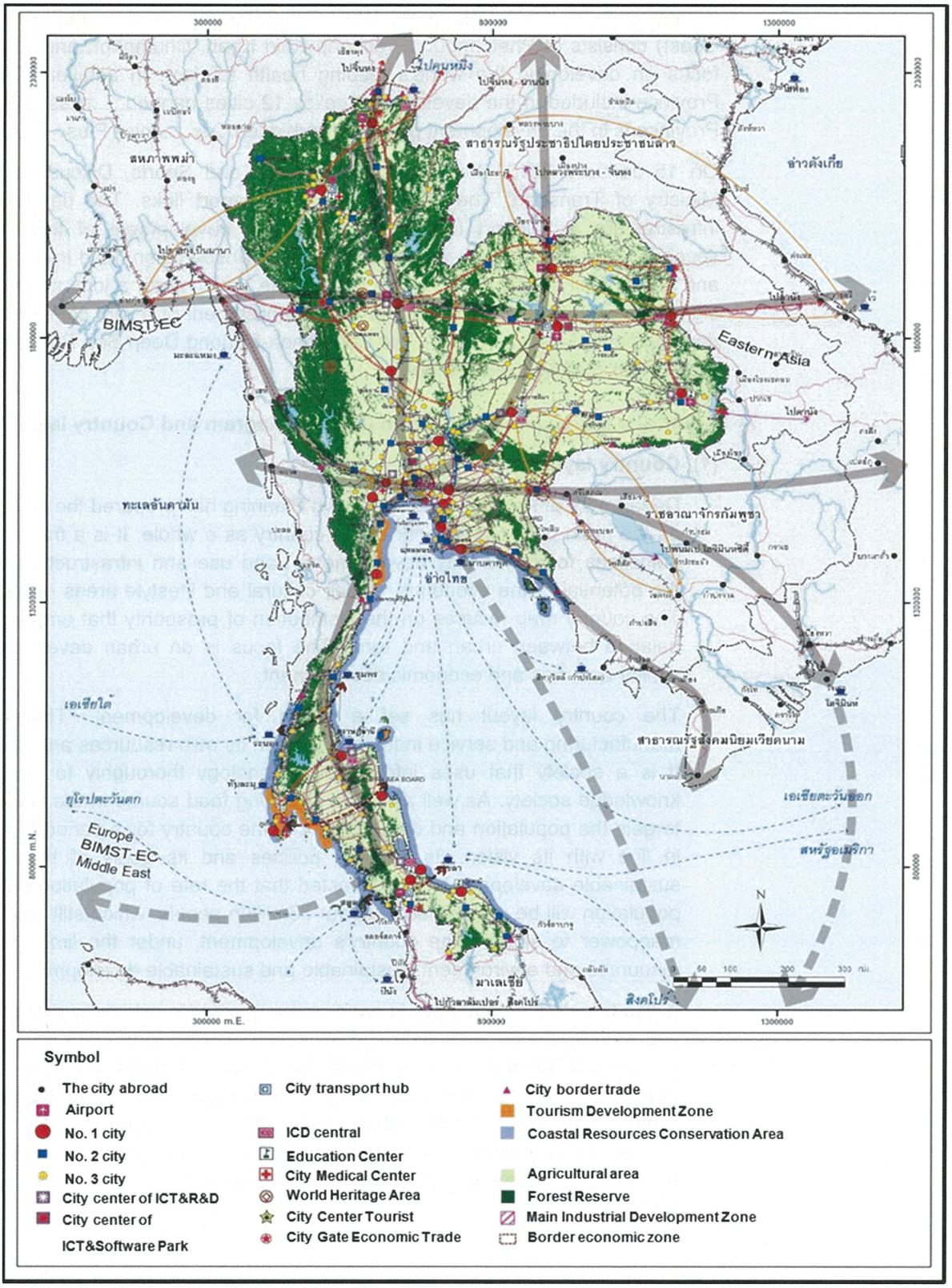
7) Country's Development Direction (Region diagram and Country layout)

(1) Country layout

Department of Public Works and Town Planning has prepared the National Plan as the main policy framework of the country as a whole. It is a framework and guidelines for community development. Land use and infrastructure to match the potential of the economic, social, cultural and lifestyle areas of the people. The country map focuses on the distribution of prosperity that emphasizes the balance between urban and rural. The focus is on urban development with similar activities and economic development.

The country layout has set a vision for development "Thailand is a manufacturing and service industry based on its own resources and knowledge. It is a society that uses information technology thoroughly to bring to the knowledge society. As well as being a leading food source in the world. It also targets the population and development of the country for a period of 50 years, in line with its vision, its role, its policies and its goals of balanced and sustainable development. It is expected that the rate of population growth and population will be maintained at about 73million people, which still have enough manpower to support the country's development, under the limits of natural resources and environment, sustainable and sustainable development.

It also targets the population in each sector in order to achieve a more balanced and well-developed workplace and education in order to prepare the population for appropriate work in that sector to ensure the stability of the country's development by spreading prosperity from Bangkok, and the metropolitan and central regions can accommodate more migration (Satellite Town). In addition, the northern and northeastern areas of relocation can serve the needs of tasks sources and income of population in the region sufficiently as shown in **Figure 2.1.1-3**.



Source: Department of Public Works and Town Planning

Figure 2.1.1-3 Thailand Development Policy Framework (Year 2057)

(2) Region diagram

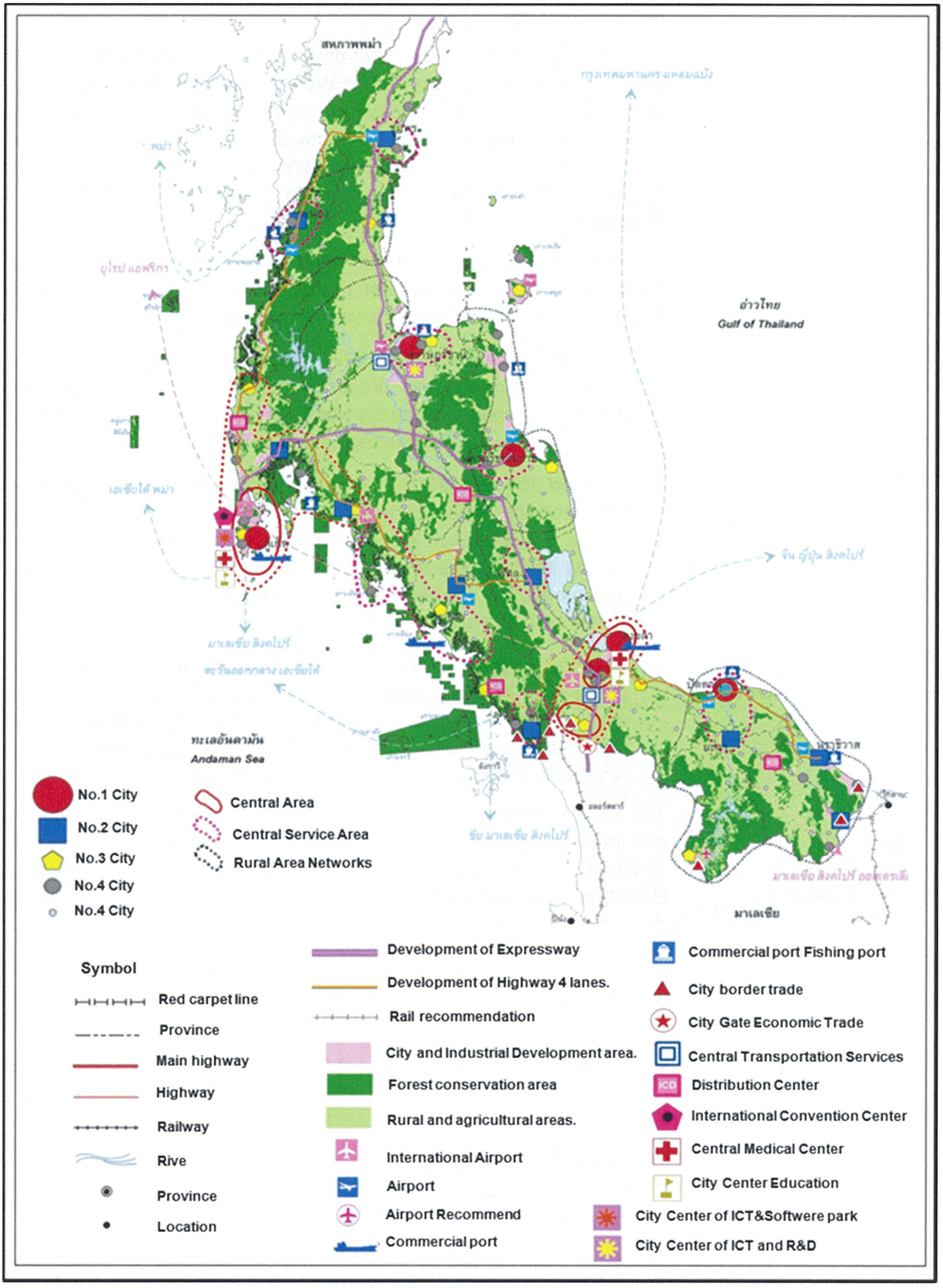
Thailand has developed a spatial development plan at the regional or sectoral level by the Department of Public Works and Town Planning during the year 2004-2006, to serve as a policy framework and strategy for the spatial country development in long-term 50 years between 2006 to 2057, the regional plan has been implemented in six regions, covering the whole country: Northern Chart, Central Chart, Northeast Chart, Eastern Chart, Southern Chart and Bangkok Metropolitan Chart.

According to the Southern Chart Study Report as shown in **Figure 2.1.1-4**, prepared by the Department of Public Works and Town Planning has set a vision of development during the various periods.

- In period 15 years (2008-2022), the southern region will be "a regional rubber production and processing base. Halal food production base Renewable energy production base and tourism services. It is a gateway linking sea transport to the region (Gateway). "
- In period 30 years (2008-2037), the southern part will be "rubber processing base and the major tourism services of the world. It is a gateway linking marine transportation and a major source of halal food in the region, a trading service base tourism high quality education, the base for research and production of renewable energy for the country to move towards a sustainable and stable society. "
- In period 50 years (2008-2057), the South will be the "main economic base of the IMT-GT main group, with a major role in tourism, trade in services and maritime transport. As a production base and processing high quality rubber and palm oil. World Halal Food Production Base It is a regional renewable energy research and production base. "

The Southern Plan has set important policies that affect economic development and transport. It is the economic bridge between the Andaman Sea and the Gulf of Thailand. The development of deep sea ports, railroad road systems, linking East Asian and South Asian countries, and the establishment of three horizontal development axes in the region.

- The upper economic development associated with lower central the development of coastal tourism. take care of your health Fisheries development and processing industry
- Central Economic Development Focus on linking two coastal tourism areas, developing high-investment petrochemical industries.
- Lower economic development links with Malaysia, focusing on the development of border trade. Export industry Agricultural and Horticultural Processing Take advantage of Songkhla deep sea port and Andaman Sea deep sea port.



Source: Department of Public Works and Town Planning

Figure 2.1.1-4 Southern Development Concept Chart, Year 2057

8) Development Strategy for the Southern Provinces

Southern development is defined as a development strategy. It is divided into 3 groups: (1) Southern Gulf Coast (2) Southern Andaman Coast; and (3) Southern Border Provinces. In the development strategy of the province. Will be under the supervision of "Provincial Strategic Management Office (OSM)", which is the Office of the Office of the Chief Administrative Officer and the Ministry of Interior. Discuss and agree that should be established. It will serve as a coordinating agency to coordinate strategic plans / projects at the provincial level. Including the strategy of the province. Coordinate with the national directorate. By setting the strategy for developing the southern provinces, the three provinces are as follows:

(1) Development Strategy for East Coast Southern Sub region, 2018-2021.[1]

East Coast Southern Sub region is comprised of four provinces, namely Chumphon, Surat Thani, Nakhon Si Thammarat and Phatthalung. International Travel Complete logistics system. Environmentally friendly.

- Strategy 1: Development, production, processing and management Main economic crops (palm oil, timber, fruit trees)
- Strategy 2: Increase productivity of coastal fishing. Economic aquaculture and the economic livestock are prominent in the area
- Strategy 3 develops into a quality international tourist destination. And a variety of tourism styles
- Strategy 4: Infrastructure Development Transportation and logistics to support the development of the province
- Strategy 5: Development into a Green City and social quality

Strategies and strategies related to transport development include Strategy 3: Strategies for upgrading tourist quality, community for foreign tourists. The project involved the development of community tourism network. (Round trip route) within the southern Gulf of Thailand and associated areas. Strategy 4: Development of Koh Samui Cruises. Strategy 4: Increasing rail transit by linking rails systems to land transport. Major projects include the development of the Southern Thungsong Distribution Center (Construction of the rail system phase 1), the construction of a road linking Chumphon and Surat Thani. The road linking Chumphon Province to Koh Hai District, Tanao Sri District, Myanmar to support the ASEAN Economic Community.

(2) Development Strategy for the Southern Andaman Coastal Region, 2018-2021[2]

The southern provinces of Andaman coast consists of 5 provinces: Ranong, Phang Nga, Phuket, Krabi, Trang with outstanding potential as an international marine tourism destination. In the development plan. It aims to bring development direction to prosperity, prosperity and sustainable development of the southern provinces of Andaman coast. The concept of tourism development

---

[1] Source: The Southern Gulf Coast Development Plan (2018-2021), South-Gulf Coast Strategy Development Office

[2] Source: The Southern Andaman Development Plan (2018-2021).

and the economy of the province together is to jointly support and link to lead. "World-class tourism. This is a great way to build on the strengths of agriculture and sustainable communities. "Strategic issues include three strategies:

- Strategy 1: Develop sustainable tourism quality.
- Strategy 2: Development of value added systems for agricultural, fishery and livestock products in the area. To make the community sustainable.
- Strategy 3: Enhancing and developing human capital potential to lead to sustainable development.

Strategies and strategies related to transport development include Strategy 1 Strategies to promote and develop the potential of the area to support the expansion of tourism is sufficient and appropriate. Important projects such as the development of historic roads. To promote tourism Road improvements to link destinations. The commercial route connecting the Andaman Sea and the Gulf of Thailand. Highway 4 to Ranong - Phang Nga to 4 traffic lanes. Connects provinces in southern Andaman Coast - Ranong Port and Ranong Port Improvement and Development Project. To support the tourism link Madi Dawei and the Andaman provinces.

(3) Development Strategy for the Southern Border Provinces, 2018-2021[3]

The southern border provinces consist of five provinces, namely Narathiwat, Pattani, Yala, Songkhla, Satun with the vision of "Rubber City, Border Trade and ASEAN Tourism. The strategic issue of the southern border provinces consists of 5 strategies:

- Strategy 1: Promote and develop natural and cultural tourism.
- Strategy 2: Promote trade, investment, development of transport network / logistics system. And put the fire protection system.
- Strategy 3 develops to increase production efficiency and value creation process for rubber products. And marketing is a complete system.

Strategies related to transportation development include Strategy 2, which includes the development of links to transport networks and logistics. Highway construction is a standard on the 1st floor and added to the traffic. Including highway construction projects to support spatial development. The major projects with high investment value are the construction of a special highway between Hat Yai - Thai-Malaysia border. By designating these development projects to support the support industry and the Linkage Industry, all fields are strengthened to create value added and enhance competitiveness.

[3] Source: The Southern Border Provinces Development Plan (2018-2021), The Southern Border Provinces Administrative Management Bureau

9) Provincial Development Strategy in the Project Area

(1) Chumphon Province Development Strategy (2018-2021)[4]

The vision of Chumphon is "Chumphon is a beautiful city. Based on agriculture and tourism. Linking the two seas development "by strategic issues and the goals are as follows.

- Strategy 1: Agriculture Development tourism and link regional development.
  Goal: Increasing income from agriculture and tourism.
- Strategy 2: Development of people, families, communities and society to ensure the stability of the philosophy of sufficiency economy.
  Goal: People have better quality of life, stronger families. And immune.
- Strategy 3: Sustainable management of natural resources and the environment.
  Goal: To conserve natural resources and the environment, to make good use of the ecological balance.
- Strategy 4 Enhancing the Integrated Management and Security Management System for Civil Society Development
  Goal: Government personnel are given the opportunity to connect, promote fairness and open up opportunities for people to participate.

Strategic issues and projects related to transport development are the strategy 1. Strategic development of provincial economic infrastructure consists of important projects such as:

- Improvement of bridge development to support agricultural development. Tourism. This is the construction of roads, bridges, risk points and other dangers in the community.
- Improvement Program for Chumphon Airport, Highway 3180, Highway 3201 (30.64 km distance).
- Coastal route
- Infrastructure Development and Transport Management System (Elevated road construction standards, road dirt road asphalt).

By developing this infrastructure, in addition to benefiting the public and the agricultural sector. It also contributes to the long-term tourism industry. The expected results are that infrastructure in Chumphon Province has been developed to be more convenient, faster and safer. It also reduces the time and cost of shipping, especially agricultural products.

---

[4] Source: Chumphon Provincial Development Plan (2018-2021), Strategy and Information for Provincial Development Chumphon Provincial Office

(2) Development Strategy of Ranong Province (2018-2021)[5]

The vision of Ranong is "the leading health tourism city, creative agriculture, the city is in good condition and the door to the Andaman trade".

By strategic issues and the goals are as follows.

- Strategy 1 is a leading health tourism destination.

  Goal: The health tourism of Ranong can compete both domestically and internationally and generate income for the community.

- Strategy 2: The economic development of the community is firmly established in the philosophy of sufficiency economy.

  Goal: The economy of Ranong grows sustainably and equitably. Linking the growth of the community economy with a stable occupation and income.

- Strategy 3 is a good city where people are in good health and secure, sustainable.

  Goal: - Ranong society is good, people have good hygiene and higher quality of education.

  - Ranong has a balance of natural and environmental standards.
  - The problem of crime, crime and drugs fell.

- Strategy 4 is a gateway through the Andaman coast.

  Goal: Ranong plays an important role in linking Thailand's trade and investment with BIMSTEC.

Strategic issues and projects related to transport development are the strategy 1. Strategic development of tourism infrastructure. The major projects are road development projects to promote tourism Strategies 2 and 3 include major projects such as road construction and improvement projects and villages to optimize the transport of agricultural produce. Strategy 4 includes a number of important projects, namely infrastructure development projects for border trade expansion, such as: Ranong – Kaw Thaung and the construction and renovation of the pier with the building (Tha Pho), Saeng Daeng, Mueang Ranong.

10) Framework for Regional Economic Cooperation

Thailand has joined the international, regional and sub-regional cooperation groups. The objectives are different in each group. International economic co-operation strengthens the single market economy, sharing the resources and economic advantages of each other. To bring about mutual benefit in the region. It also helps attract more trade and investment into the region. In other words Cross-border and cross-border flows to third countries have increased, and international trade, investment and investment will help boost investment in advanced processing industries in Thailand. It will increase the value of the supply chain (Value Chain), the international transport agreement. It is part of the Transport System Development Plan under Economic Cooperation Framework, so that member countries can travel easily linked to each other. This will help to equalize economic

---

5 Source: Ranong Development Plan (2018-2021), Provincial Development Strategy Group Ranong Office

development. Considering the regional and subregional framework for economic cooperation in Asia, it is clear that Thailand has joined almost every framework. The regional economic cooperation framework will have an impact on the volume of demand for goods transported through Thailand. In particular, the project will promote and develop the role of Ranong Port as an Andaman side door linking trade and transportation with neighboring countries as shown in **Figure 2.1.1-5**.

- ASEAN Community
- Greater Mekong Subregion: GMS
- Indonesia – Malaysia – Thailand Growth Triangle: IMT – GT
- Strategic Economic Cooperation Ayutthaya Chao Phraya Mekong (ACMECS)
- Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation: BIMSTEC)

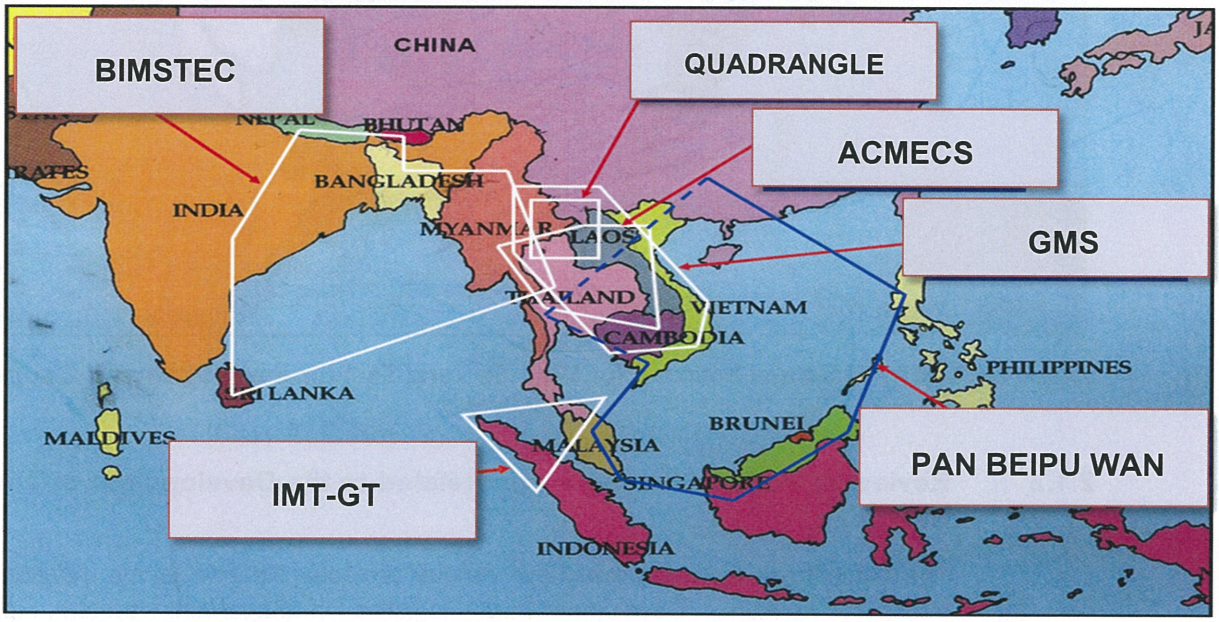


Figure 2.1.1-5 Framework for regional and sub-regional economic cooperation

In this study, the framework for major economic cooperation is: The Bay of Bengal Initiative for Multilateral Trade and Economic Cooperation (BIMSTEC) in seven countries in the Bay of Bengal includes Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka and Thailand, as shown in **Figure 2.1.1-6**. BIMSTEC is the only framework that links South Asia to Southeast Asia by the Thai and Myanmar is a two-member country of BIMSTEC, making Thailand a bridge between the two regions and a mechanism by which Thailand can expand its ties with South Asian countries, especially India, by South Asia. It's a big market. There are significant sources of raw materials and resources, such as natural gas and hydropower potential. And India will be one of the great economic powers in the future. The BIMSTEC framework links the South East Asian Look East policy with the Look West policy of Thailand and is a framework for Thailand's role as an ASEAN bridge between the two regions.

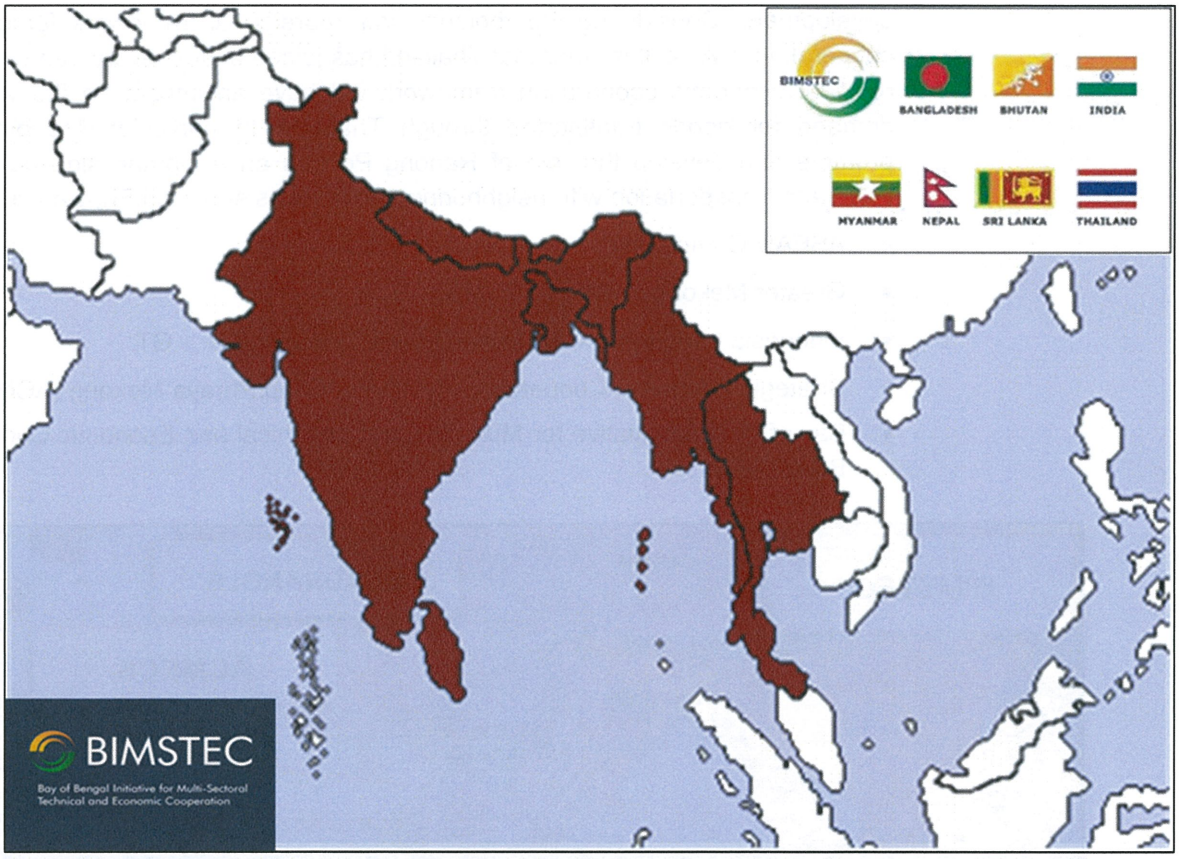


Figure 2.1.1-6 Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation: BIMSTEC

2.1.2 Review of Various Project Plans Related to the Development of Transport Networks

The consultants have reviewed the various projects. Related to the development of transport network. Development of logistics management system, provincial development plan and international cooperation plan, etc. Specifically, relevant plans are expected to affect the program, especially those of the Ministry of Transport and relevant, covering the development of various transportation networks in the future.

1) Road transport system

The Department of Highways is the main agency for the development and improvement of the national highway network to accommodate both people and goods between cities or regions, increased efficiency and safety in transportation. Major Development Projects / Projects: Construction Projects the Inter-City Motorway and the Main Road Construction Project are the four traffic lanes. Phase 2 is the result of the collection of the Highway Network Development Plan in the study area, as shown in **Figure 2.1.2-1** and **Table 2.1.2-1**.



Figure 2.1.2-1 Highway Network Development at the Study Area

Table 2.1.2-1 Highway Network Development Project in the Study Area

	Route	Distance (km)	Budget (Million Baht)	Project status	Agency responsible
Highway Network Development Project in the Study Area					
1	Ranong - Takuapa	68.670	2,500	Not budget	DOH
2	Ranong – Ratchakrud	10.700	370	Not budget	DOH
3	Route 4006 Ratchakrud - Langsuan	68.440	2,500	Not budget	DOH
4	Chumphon - Ranong Part 5	17.750	700	Under construction	DOH
5	Route 4091 Bang Si Kim – Khao Kai – Khao Peep	70.358	2,500	Not budget	DOH
6	Chumphon - Ranong Part 4	32.450	1,104	Under construction	DOH
7	Line จ Chumphon City Map	8.440	788	Under construction	DRR
8	Line จ Chumphon City Map and Highway 4	13	N/A	Under study	DRR
9	Coastal road network In Chumphon Province	225.5	2,551	Under construction (Construction completed. 39.65 กม.)	DRR
Highway Intercity Development Plan Related to the Project					
1	**Inter City Motorway Nakhon Prathom – Narathiwat (Su-ngai Kolok) (MB)**				DOH
1.1	- Nakhon Pathom – Cha Am	119	80,600	Plan to open in 2022	
1.2	- Cha Am – Chumphon	298	52,850	Plan to open in 2026	
1.3	- Chumphon – Surat Thani	166	34,470	Plan to open in 2034	
1.4	- Surat Thani – Songkhla (Hat Yai) – Narathiwat (Su-ngai Kolok)	523	114,717	Plan to open in 2036	

Remark : N/A : Not Applicable
DOH : Department of Highways
DRR : Department of Rural Roads
Source: compiled by consultants (as of February, 2018)

2) Rail Transport System

The State Railway of Thailand (SRT) is the main agency in developing and improving the country's rail network to accommodate both people and goods between cities and regions. Increased efficiency and safety in transportation. By implementing SRT's schemes / projects that are involved and supporting the development of major transport transformations as shown in **Table 2.1.2-2**.

Table 2.1.2-2 Infrastructure Development and Railway Transport System

	Project	Distance (km.)	Budget (Million Baht)	Project status Current	Expected year Completed
1	**Development of a 1,000 meter long double track train (OTP/SRT)**				
1.1	**Construction of Phase 1 of a double track railway**				
	1. * Chachoengsao - Khlong Sib Kao - Kaeng Khoi	106.00	11,348.38	Under construction	2019
	2. * Junction of Jira Road - Khon Kaen	185.00	26,007.20	Under construction	2019
	3. * Prachuap Khiri Khan - Chumphon	167.00	17,290.63	Signed 28 Dec 2017 Construction started 1 Feb 2018	2020
	4. * Lopburi - Pak Nam Po	148.00	24,722.28	Signed 28 Dec 2017 Construction started 1 Feb 2018	2020
	5. *Mabkabao-Junction of Jira Road	132.00	29,449.31	Signed 28 Dec 2017 Construction started 1 Feb 2018	2020
	6. Nakhon Pathom – Hua Hin	165.00	20,046.41	Signed 28 Dec 2017 Construction started 1 Feb 2018	2020
	7. Hua Hin- Prachuap Khiri Khan	90.00	10,239.58	Signed 28 Dec 2017 Construction started 1 Feb 2018	2020
1.2	**Construction of Phase 2 of a double track railway**				
	8. * Paknampho - Den Chai	285.00	62,624.17	During the project approval process and consider EIA	2022
	9. * Junction of Jira Road - Ubon Ratchathani	309.00	37,526.71	During the project approval process and consider EIA	2022
	10. * Khon Kaen - Nong Khai	174.00	26,662.4	During the project approval process and consider EIA	2021
	11. * Chumphon - Surat Thani	168.00	24,294.36	During the project approval process and consider EIA	2021
	12.*Surat Thani - Hat Yai Junction - Songkhla	339.00	57,375.43	During the project approval process and consider EIA	2022
	13. * Denchai - Chiang Mai (OTP Design)	217.00	59,915.99	During the project approval process and consider EIA	2022
	14. * Hatyai Junction - Padang Besar (Powered by electricity) (OTP Design)	48.00	7,937.80	During the project approval process and consider EIA	2022
1.3	**New Railway Construction Project**				
	15. Denchai - Chiang Rai - Chiang Khong	326.00	76,980.32	During the project approval process and EIA has been approved 16 Mar 2017	2023
	16. Ban Phai - Mukdahan - Nakhon Phanom	355.00	60,353.41	During the project approval process and consider EIA	2023
	17.Ban Pachi Junction – Nakhon Luang District	15.00	N/A	N/A	N/A
	18. Songkhla - Satun	142.00	N/A	OTP has completed the study and presented it to the SRT for further action. The EIA has been approved.	2021

Table 2.1.2-2 Infrastructure Development and Railway Transport System (Cont'd)

	Project	Distance (km.)	Budget (Million Baht)	Project status Current	Expected year Completed
2	**Development of a standard double track railway network of 1.435 meters (Standard gauge) (OTP / SRT)**				
	1. High-speed Rail Link Development Project Bangkok - Nong Khai	873.00	369,148.00	Cabinet approved the project. The first phase (Bangkok - Nakhon Ratchasima) was commenced in Klang Dong - Pang Asoke (3.5 km).	2021
	2. Bangkok - Phitsanulok - Chiang Mai	699.00	426,898.56	Conducted a preliminary feasibility study has been completed.	2021
	3. Bangkok - Hua Hin	211.00	94,673.16	EIA and PPP report updates	2021
	4. High-speed trains link 3 airports (Suvarnabhumi - Don Mueang - U Tapao)	220	113,303.88	The study, review and analysis of the suitability of the project has been completed. The request for comments from the relevant agencies. EIA report updates	2023
3	**Electric Diesel Engine and Commercial Bus (SRT)**				
	1. * 50 GE Electric Locomotive Replacement	N/A	6,562.50	tender procedure	2019
	2. * A new generation of bus service for 115 commercial vehicles.	N/A	4,981.05	Completed	2017
	3. * 308 trucks	N/A	770.00	Completed	2017

Note: * Project in the Strategic Plan for Transport Infrastructure Development in Thailand 2015-2022
Source: compiled by consultants (as of February, 2018)

3) Coastal and coastal transport system

Relevant agencies have developed programs and projects to promote more water transportation in accordance with the transportation policy and strategy of the country. Modal Shift: The Department of Harbor and Port Authority of Thailand. The Marine Department, which is the government agency responsible for the development and promotion of water transport. Several piers were constructed. Covering the deep water port. Coastal ports and river ports. The budget of the Department of the Harbor. When construction is completed, it will be forwarded to the relevant agencies for further processing.

The Port Authority of Thailand (PAT) is a state-owned public utility under the Ministry of Transport's responsibility to organize and promote the prosperity of the port business. The construction of Bangkok Port and Laem Chabang Port. It is a deep sea port for international transportation. As well as operating and improving the transportation service is fast and efficient. And was assigned to operate the Chiang Saen and Chiang Khong Commercial Ports and now Ranong. Infrastructure development in key responsibilities as shown in **Table 2.1.2-3**.

Table 2.1.2-3 Coastal transport development plan

ลำดับ	Project	Budget (Million Baht)	Project status Current	Expected year Completed
1	* Chumphon Port Construction	4,003.00	The results of the study reviewing the suitability. It is not worth the investment in the Harbor Department has concluded the cancellation.	-
2	* Songkhla Deep Sea Port 2 Construction	16,388.14	Temporarily Terminate the Study of Project Review	2023
3	* Deep Sea Port Construction, Satun (Pakbara)	20,322.90	Considering and discontinuing the study, reviewing and exploring detailed design and environmental impact studies (EHIA)	2023
4	Klong Yai Port Construction, Trat	1,295.00	Completed construction Currently in the process of procuring the operator.	2016
5	* Coastal Harbor Development Project (Pier A) at Laem Chabang Pier	1,864.22	Under construction	2018
6	* Development of the Railway Container Terminal at Laem Chabang Port (Phase 1)	2,944.93	Under construction	2018
7	* Laem Chabang Port Development Project Phase 3	88,132.00	Consider EHIA / Review of feasibility study to improve the effectiveness of the project in accordance with the EEC Resolution	N/A
8	20 G Coastal Improvement and Development Project	614.00	Under construction / procurement	2018

Note: * Project under the Transport Infrastructure Development Plan of Thailand, 2015-2022.
Source: compiled by consultants (as of February, 2018)

4) Air Transport Development Plan

There are 38 airports in Thailand which are under the responsibility of the Company. There are six airports in Suvarnabhumi, Don Mueang, Chiang Mai, Mae Fah Luang, Chiang Rai, Phuket and Hat Yai. The airport is under the responsibility of the Airports Authority of Thailand (TAT). There are 3 Bangkok airports, Sukhothai and Trat airports, and one of the navy's responsibilities (ie, U-Tapao), with a plan to increase the capacity of air transport services. It is the responsibility of AOT and THAI as shown in **Table 2.1.2-4**.

Table 2.1.2-4 Air Transport Development Plan

	Project	Budget (Million Baht)	Project status Current	Expected year Completed
1	*** Suvarnabhumi Airport (AOT)**			
	Suvarnabhumi Airport Development Phase 2	51,607.17	Under construction	2019
	3rd Runway Construction Project	20,243.11	AOT is in the process of procurement.	2020
	The second building of Terminal 2	27,684.39	AOT is in the process of setting up the scope of the TOR. And the concept of design to auction the next contractor.	2021
2	*** Don Mueang International Airport (AOT)**			
	DonMueang Airport Development Phase 3	N/A	AOT is in the process of documenting the project. AOT proposed the Cabinet and the NESDB to propose the Cabinet to approve the project.	2025
3	*** Mae Sot International Airport (Tak)**			
	Improvement project of Mae Sot International Airport Tak	840.00	Under construction and operation.	2018
4	*** Betong International Airport, Yala (Thailand)**			
	The construction of Betong Airport, Yala (construction of airport and passenger terminal building)	1,800.00	Under construction and operation.	2019
5	**U-Tapao International Airport**			
	Construction of U-Tapao Airport Terminal Building with Facilities	619.17	Completed by the commission hired to perform the task.	2559
	New Airport Parking Project U-Tapao Airport	102.90	Completed by the commission hired to perform the task.	2016
6	**Phuket International Airport (AOT)**			
	Phuket Airport Development Project	5,791.12	Most of the construction works have been completed. Under construction Renovation of the Terminal to Domestic Terminal	2019

Note: * Project under the Transport Infrastructure Development Plan of Thailand, 2015-2022.
Source: compiled by consultants (as of February, 2018)

2.1.3 Review of the Study Results Related to the Development of Transport Network

The consultants also reviewed relevant studies. This will be used to carry out important studies.

1) The study on the suitability and initial design of the rail link between the ports of Thailand and the Andaman coast.

Ministry of Transport The Office of Transport and Traffic Policy and Planning (OTP) has conducted a study on the suitability and initial design of the rail link between the Thai Gulf Coast and the Andaman coast (2010). The study of rail transport links between the Gulf of Thailand and the Andaman coast. Shorten the distance and reduce time to transport goods to be convenient, fast and efficient. Energy saving helps reduce pollution and the environment caused by road transport. This will be

the key to the construction of new Pak Bara deep sea port and Songkhla port. Economic value and fully utilized. Construction of this railway line is the main route for two major modes of transportation: freight from various regions. Go to the pier around the world via Pak Bara and new Songkhla and shipping from other regions. Via economic bridge route from the study of the suitability of the project in terms of engineering, economy, society and environment, it was found that the choice of 2A (Pakbara - Khuan Kalong - Hat Yai - Songkhla 2) was the appropriate choice. Route Construction safety Transportation efficiency Bus and time Quality of service, construction cost, land expropriation Community development is also the least environmentally sensitive choice. The route starts from the Pak Bara deep water port at Tambon La-ngu, Thapae, Khuan Kalong, Satun Province, Rattaphum, Hat Yai, Na Mom to Songkhla Deep Sea Port 2 at Amphoe Chana, Songkhla Province. The total distance is 142 kilometers.

The rail link between the Andaman coast and the Gulf of Thailand. Imports and exports to Europe, the Middle East and Africa will have the opportunity to redirect transport. Originally from Laem Chabang Port and Bangkok Port. Then shipped to Singapore and exported from Singapore. Land transport from various sectors. Arrive at Pak Bara. In addition, if the Land bridge is to be used as a bridge to transport cargo. It is necessary to develop the area behind the harbor (Hinterland) for activities and import of raw materials and goods. As well as export products. In order to achieve a sufficient volume of cargo to attract large vessels into the port, a large vessel is docked, resulting in over 50% of freight. Shipping on the way down. Overall, the cost of transportation through the Land bridge can be competitive with transportation through Singapore Port and the Tanjung Palepus Port.

The construction of an economic bridge linking the Gulf of Thailand and the Andaman Coast (Landbridge) will be developed alongside the development of Pakbara Pier and Songkhla Port 2 to be completed simultaneously, as shown in **Figure 2.1.3-1**, the development is divided into 3 phases.

Phase 1: Develop rail system for export and import of goods. Support Pakbara Deep Sea Port The construction is a single-track rail line. Hat Yai - Hat Yai Junction is a Meter Gauge system with a rail width of 1.00 meters to connect with the railway network of the State Railway of Thailand. At the southern end of Hat Yai Junction on the Hat Yai-Padangbaza Line.

Stage 2: Develop rail system for export and import of goods. The Songkhla 2 pier was constructed as a single-gauge train, the Meter Gauge extension from Phase 1 and connected to the railway network extends from Phase 1 and connects to the railway network of the State Railway of Thailand at the southern end of the Hat Yai junction on the Hat Yai-Sungai-Kolok route to Songkhla Deep Sea Port 2. That is Landbridge in the first phase.

Stage 3 development of mid-range land by installing the railways and improving the signal to double rail along the route. To complete the economic bridge in the medium term. And expand the capacity of the rail system to support the transportation of exports and imports, as well as Transshipment goods. Between the Gulf of Thailand and the Andaman coast.

However, in the long run more construction is a three way tram or the fourth in the area provided (50 meters), depending on the amount of goods used. After the 30 years used in the analysis of the suitability of the project. The new route may be a double rail system with a width of 1 meter or 1.43 meters to carry cargo. Transshipment There is no

connection to the railway network. State Railway of Thailand It is not permissible to operate a passenger train in this way for maximum efficiency in freight.

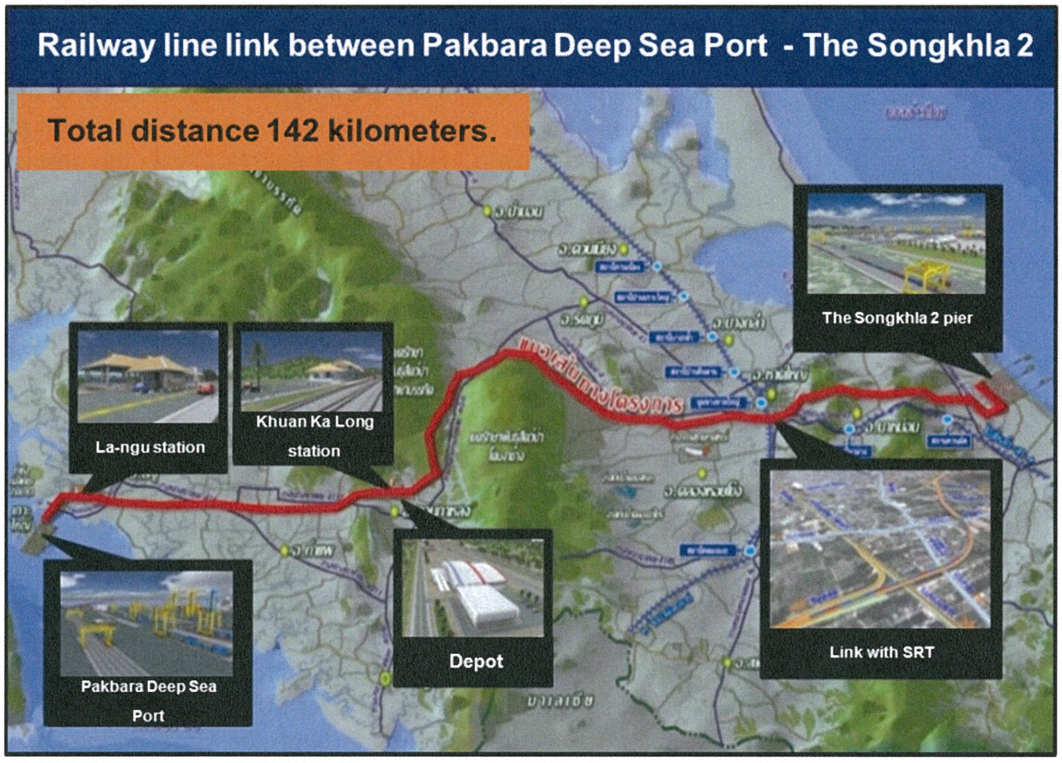


Figure 2.1.3-1 Economic Development Bridge linking the Gulf of Thailand and the Andaman Coast

2) Pakbara Deep Sea Port Project, Satun Province

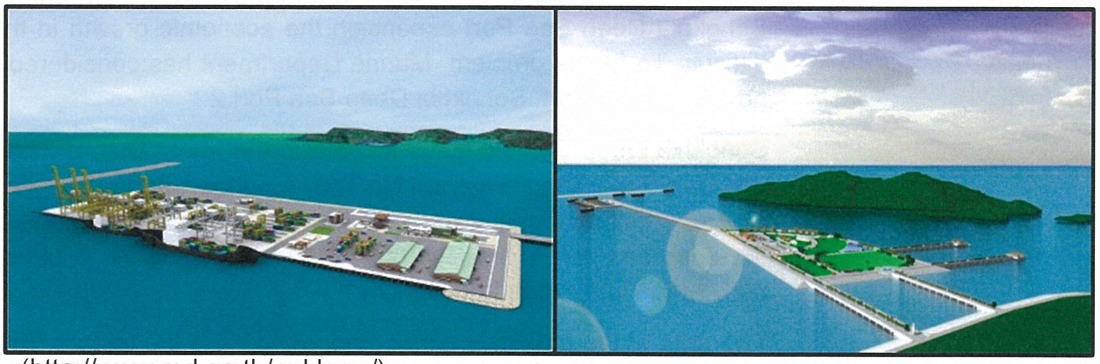
Pakbara is located on the lower west coast of the South. Pak Nam Sub-District, Laung District, Satun Province Location Pakbara Pier is located on the upper part of the Malacca Strait. It is located between the northern of Sumatra Island. And the Malay Peninsula about 40 kilometers from the Malaysian border, close to the main sea route of the world as shown in **Figure 2.1.3-2**, the Harbor Department has plans to develop Pakbara Deep Sea Port in three stages as follows.

Phase 1 targets 825,000 TEU per year, which is a container berth. The harbor is 430 meters wide, 1,086 meters long, with an area about 292 rai, about 4 kilometers from the shore. There are four concrete bridges, 4.5 kilometers long, connecting the coast to the harbor. And there is a deep-water navigation system, 16.2 meters above sea level. By digging a 180-meter wide canyon and 600 meters of hull back, the container berth has 3 berths, a total length of 750 meters, and a full length crane. For a container ship of 70,000 tonnes (6,000 TEUs), two vessels or three medium-sized vessels. A container yard, 280 meters wide, 700 meters long.

Phase 2 targets 1,375,000 TEU containers. There is an additional 500 meters in length and 1,250 meters in length. The length of the container compartment is 500 meters.

Phase 3 accommodates 2,475,000 TEU containers. The front of the pier has a length of 1,000 meters and a total of 1,250 meters. The container yard has a total length of 2,250 meters.

The products that will be used in Pak Bara Port are Southern and Halal food. Other Products (except Eastern) Products from Burma and Bangladesh.



(http://www.md.go.th/pakbara/)

Figure 2.1.3-2 Pakbara Deep Sea Port Construction Project

The Pakbara Deep Sea Port Project, Satun Province has been designed and tested for environmental impact (EIA), which has been approved by the Expert Committee and the National Environment Board.) In 2009, but while they were in the process of launching their pre-construction projects, EIA measures were resisted by the public until the project was abandoned and suspended.

Subsequently, a budget of 50 million Baht has been allocated to the Office of Transport and Traffic Policy and Planning (OIE) to study the strategic environmental impact (SEA). Completed by a SEA consultant in cooperation with the Information Operations Working Group (IO). And storage to use in the planning. And develop a strategy for the development of the southern area. The Department of Marine and Coastal Resources (EHIA) has set up a budget for 2016-2017, totaling 120 million Baht. The 18-month study period is used to study and understand the project's objections. The results of this study are re-considered that the project should move forward or terminate the project. The current status of the project. After the first hearing on March 16, 2017 people in the area protested the project. The Prime Minister ordered the project to slow down. Later the responsible company cancel contract, this is currently under consideration by the Harbor Department.

3) Study Design and Survey Design for Construction of Songkhla Deep Sea Port 2

Marine Department has carried out a detailed survey and study of the environmental impact to expand Songkhla deep sea port in 1997. The study showed that it should expand Songkhla deep sea port to add a container port for container ships. And propose to improve the area behind the original pier. To accommodate more containers and goods. It also proposed to organize a new container booth and set up a crane to lift the container. Both in the front and in the yard. The Department of Marine and Coastal Resources Songkhla Port Expansion Project the Office of Natural Resources and Environmental Policy and Planning (NRDP) has considered, but there are major issues that have not been approved. Due to the area of Songkhla Deep Sea Port, there are old moats and underwater archaeological sites nearby. It is a historic area that cannot be built more than 6 meters high and there is a problem of evacuation of people in the expropriation area. In addition to the physical characteristics of the channel, the sedimentation

rate has to be continuously maintained. Including fishing career problems and the imposition of navigational obstacles. This is a barrier to the development of the channel to stabilize and reduce sedimentation problems. Due to these limitations, Songkhla Deep Sea Port expansion the economic growth in the Lower South was difficult. To fix the problem. Marine Department has considered the development of new Songkhla Port, Songkhla Deep Sea Port 2.

Songkhla Deep Sea Port 2 is located in the lower Gulf of Thailand in Baan Klang and Ban Suan Kong, Tambon Na Tan, Amphoe Chana, Songkhla with the objective to support international trade. The trend is increasing. And increase the capacity of the deep sea port in the Gulf of Thailand, replacing the expansion of the Songkhla port, which has exceeded capacity.

The area of the project is public land adjacent to the beach. "Swamp from" the area of about 675 rai on the sea, about 1,200 meters long, 900 meters deep for the size of the wharf and the size of the navigational channel is studied.

Development Phase 1: Ports for 100 x 500 m (width × length) cargo and general cargo.

Development Phase 2: Construction More 1 x 85 x 650 m.

The size of the navigation channel in the development stage 1 will be about 120 meters wide and in the second development area will be about 180 meters wide. The size and shape of the navigation channel will be determined by the artificial reef at the navigation channel. Must pass (Na clerk the length of the posture is parallel to the coast line of about 1,200 meters and the width of the coastline is approximately 900 meters.

(1) Railway line The railway will be connected to the project by connecting with the southern railway line at the Kuan Ket Railway Station on the south side, close to Ban Sala. The distance is about 9 kilometers.

(2) Roads require road access to the harbor, running parallel to the rail line, using a shared path. The road that intersects the port begins at Highway 43.

Activities Songkhla 2 Port consists of import and export ports for general cargo such as timber, rubber, palm oil or packaged goods. It is an import / export port for packing goods. And importing empty containers for export packing. Including the dock for tourist boats. The characteristics of Songkhla Deep Sea Port 2 are shown in **Figure 2.1.3-3**. Current status has delayed the project implementation to promote and understand the project in the area.

Current status during the study, review and survey design for the construction of Songkhla Deep Sea Port 2 and the EHIA in Songkhla Port 2, although part of the Land Bridge Project. But to build or not build Pak Bara deep water port will not affect. This is what will happen. The Songkla port was over-loaded. It cannot be expanded because of objections and other issues. Being a land bridge between Pak Bara deep water port is only a supplement. The responsible company has temporarily ceased operations.

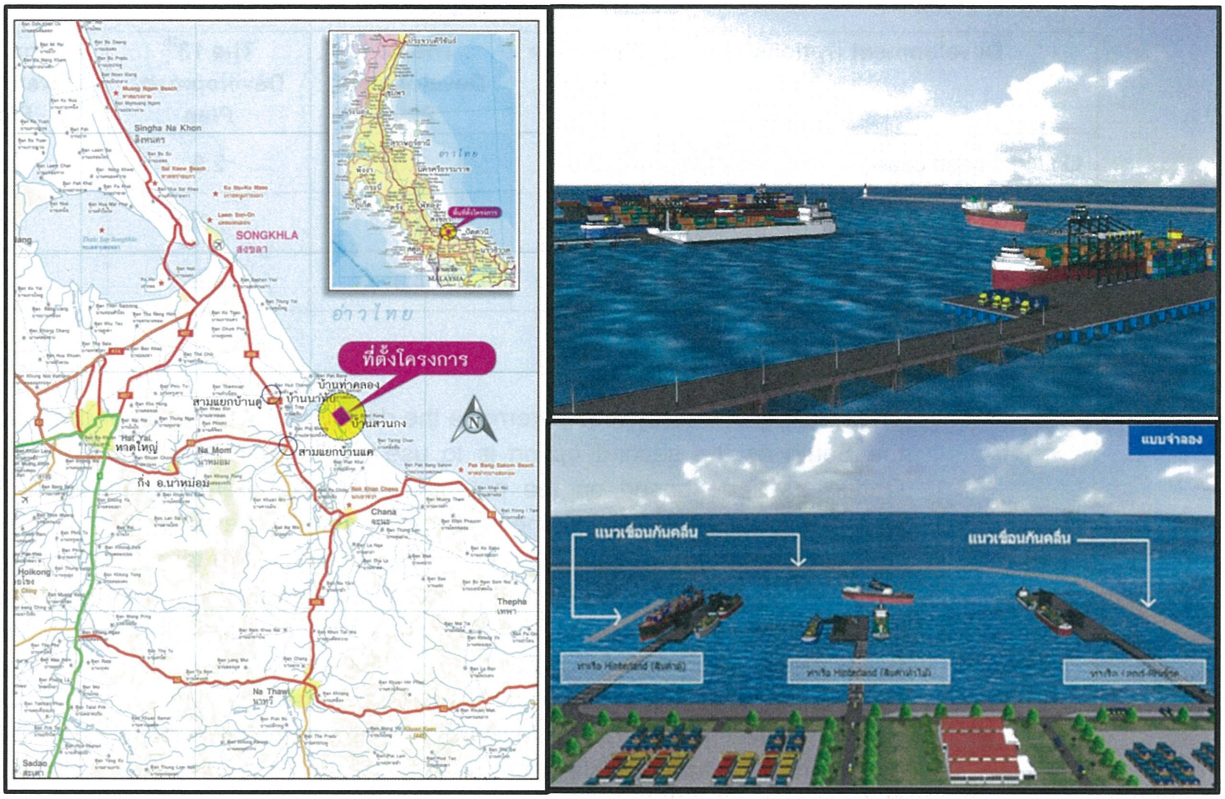


Figure 2.1.3-3 Songkhla Deep Sea Port 2 Construction Project

4) Strategic Environment Assessment : SEA

In 2016, the Office of Transport and Traffic Policy and Planning (OTP) undertook a strategic impact study or SEA for South Coastal Development. It covers the Gulf of Thailand and Andaman coast 6 provinces including Chumphon, Ranong, Nakhon Si Thammarat, Krabi, Songkhla and Satun.

Strategic Planning for Southern Coastal Development In order to achieve economic development in line with the potential, it is a policy that the government attaches importance to. The problem of inconsistency of the plan at various levels is the provincial level and the provincial level. It cannot integrate development between government agencies. As a result, the overall picture of coastal development is not clear. The lack of common learning processes for development between the government and stakeholders. Not getting enough information and facts. The result is not understood. In the end, there is a strong resistance from the stakeholders. From the above development problems. The Strategic Environmental Assessment (SEA) is an analysis of four dimensions: 1) economic dimensions, 2) environmental dimensions, 3) social dimensions, and 4) to develop the southern integrated.

The results of the study suggest that there are three options for the development of the southern coastal area: Option 1 Base case is the current economic development of the southern coastal area. Option 2 Full Potential Case is an economic development by enhancing the tourism and agro-processing industry and Option 3 Accelerated Gross Case is an economic development by industrial development with high economic added value, as shown in **Table 2.1.3-1**.

Table 2.1.3-1 Comparison of Economic Growth Rates of Three Options of Southern Coastal Development

Development Options	Base year 2013	The 12th Development Plan	The 13th Development Plan	The 14th Development Plan
Option 1 base case	2.0	2.5	2.5	2.5
Option 2 uses full potential	2.0	3.37	3.37	3.5
Option 3 accelerates the growth rate	2.0	4.0	4.8	5.0

Source: SEA Project Advisor

The result of this study is to determine the development direction of coastal areas in the South as the second option is to use the full potential. The development of Option 2 will be based on the potential of the southern region, which includes agricultural potential. Agribusiness And tourism the development of the existing space. However, in order to achieve the economic growth target of 5.0 per cent, as proposed by the 12th National Economic and Social Development Plan and in line with the Strategic Environmental Assessment of the South China Sea, Developed under Option 2, using full potential. Full-Potential Growth Case is the potential development of the area, including tourism and agro-industrial potential. Combined with the development of the existing tourism potential is to create new tourist attractions to attract tourists. Increasing tourist and spending per capita of tourists. Halal industry development and logistics hub under that option called. The two plus (2+) alternatives, which are the directions for the master plan for coastal development in the south.

The development direction of the southern coastal area. The two plus (2+) alternatives have been adopted to develop a master plan for coastal development. The 20-year development period of the National Strategic Framework is between 2017 and 2036. This division is divided into two phases.

(1) During the first 10 years (2017-2026), development projects were proposed in each economic field. Identify the characteristics or guidelines for implementing the project in four ways: accelerated projects. Project implemented by Action Plans Projects implemented under coastal development plan. And projects that should slow down / study more. The development projects in transportation and logistics are shown in **Table 2.1.3-2**.

Table 2.1.3-2 Development plan for transportation and logistics

Project	Project characteristics			
	Intensive	Planned	Plans for coastal development	Should delay / study more
Inter-city Highway Project Hat Yai – Malaysian Border	✓			
Phuket Airport Development Project	✓			
4-lane highway expansion project and highway enhancement Phase 2		✓		
Expressway Project Katoo – Patong Phuket		✓		
Station Development Project To optimize the road with a truck. Surat Thani, Songkhla and Narathiwat)		✓		
Rural Road Network Development Project connects tourism (Royal Coast)		✓		
Feasibility Study of the new highway project Baan Sakoo - Baan Koh Kaew		✓		
Motorway project Cha-am - Narathiwat (Phase 1 Cha-am)		✓		
Hatyai City Bypass Project East and west		✓		
Bridge over the Golok river Project (Su-ngai-Golok Bridge) 2		✓		
Expansion of passenger service for Phuket International Airport		✓		
Pak Bara Deep Sea Port, Satun Province				✓
Double Tracks Railway Construction Project Prachuap Khiri Khan - Chumphon		✓		
Study on the feasibility, design and analysis of environmental impacts of mass transit in Phuket. Phuket International Airport - Chalong Intersection (Light rail project)		✓		
Study and design of twin electric power systems. Hat Yai - Padang Besar		✓		
High speed train project Bangkok - Padang Besar		✓		
Double Tracks Railway Construction Project Chumphon - Surat Thani		✓		
Study and design railway for Surat Thani - Phang Nga - Phuket		✓		
Ranong Airport Improvement Project			✓	
Improvement project for lifting capacity for Songkhla port 1			✓	
Sumran Samui Pier Surat Thani			✓	
Sumran Phuket Pier Phuket			✓	
Sumran Krabi Pier Krabi			✓	
Samui Ferry Pier - Khanom			✓	
Krabi Ferry Pier - Phuket			✓	
Songkhla Deep Sea Port 2 (Advisory Board)			✓	

Note: The proposed development of the Pak Bara Deep Sea Port in Satun Province is based on the following conditions:

1. There are social and environmental possibilities.
2. Measures to address / remedy / monitor and monitor environmental impacts.
3. Development of the railway from the junction of Hat Yai - Pakbara.

(2) During the 10-year period (2027-2036), the consultant presented the concept of action plan in Appendix C, Master Plan for Coastal Development in Southern Thailand. This is a guideline that is provided to agencies. The application of the concept to the development of coastal areas in the South during this period. The two major plus (2+) alternative projects are shown in **Figure 2.1.3-4.**

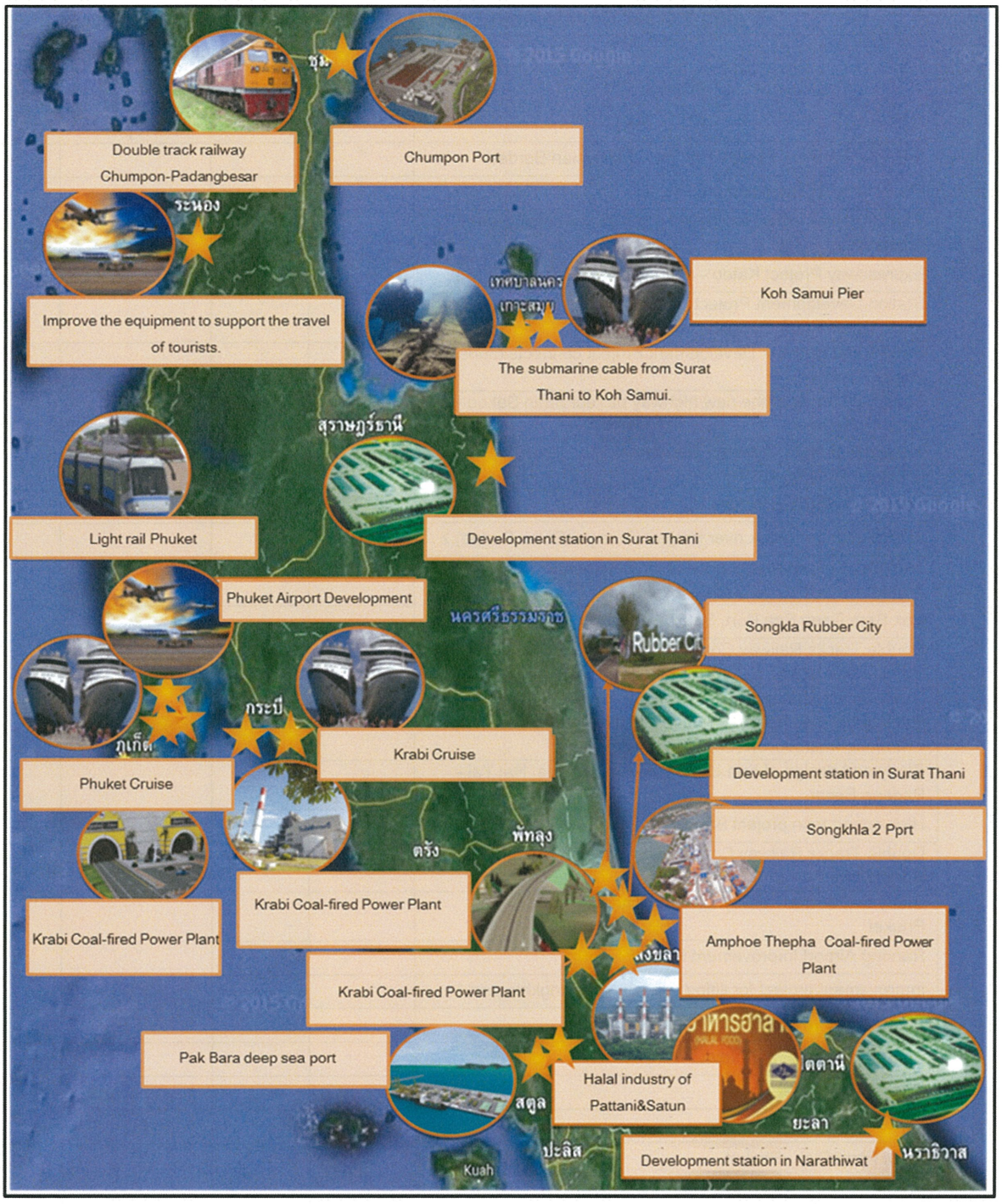


Figure 2.1.3-4 Key Development Based on Alternative Development Direction Two Plus (2+)

The study also analyzes the suitability and feasibility of transporting goods through the Land Bridge in the southern coastal area. Considering the total revenue from the transport service of the bridge's economic development, it is not worth the cost of operation and maintenance, which is not worth the investment. It is proposed to delay the development of economic bridges. However, it is recommended to develop only port projects. In particular, the Gulf of Thailand. The Songkhla Deep Sea Port 2 will be reviewed to accommodate the excess exports of Songkhla Deep Sea Port 1 and develop into a deep sea international port by increasing the capacity

of the port can change. (Transshipment Port) based on production and imports in the south. The Andaman coast continues to be a major transit point for the Indian Ocean. The only way to pass the Malacca Straits is to risk the Thai economy. In addition, if there is a threat to the existing main port, Bangkok Port, Laem Chabang Port, Map Ta Phut Port It is necessary to use the Andaman coast as the main port for transportation, so it should be planned to accommodate such a situation that may occur. Currently, the SEA project has completed the study, which OTP has presented to the Cabinet to consider presenting the cabinet for further information.

5) A Study on Upgrading Thailand's Coastal Transport Service and Infrastructure System Efficiency

In the year 2016, the Office of Transport and Traffic Policy and Planning (OTP) has conducted educational programs to improve the efficiency of Thailand's coastal transportation network. Based on current transportation problem analysis and the development trend, including the policies and strategies of the nation. Strategic planning for enhancing the efficiency of the network of coastal shipping in Thailand consists of 3 strategies and guidelines as shown in **Figure 2.1.3-5**. In addition, study of the problems and potential of the port development to define the role and direction of port development that is under the supervision of the government, taking into account other issues include policy and strategy. The availability and capability of the service, for example, will be analyzed in order to determine the direction of the development of ports, covering both the main port and regional port.

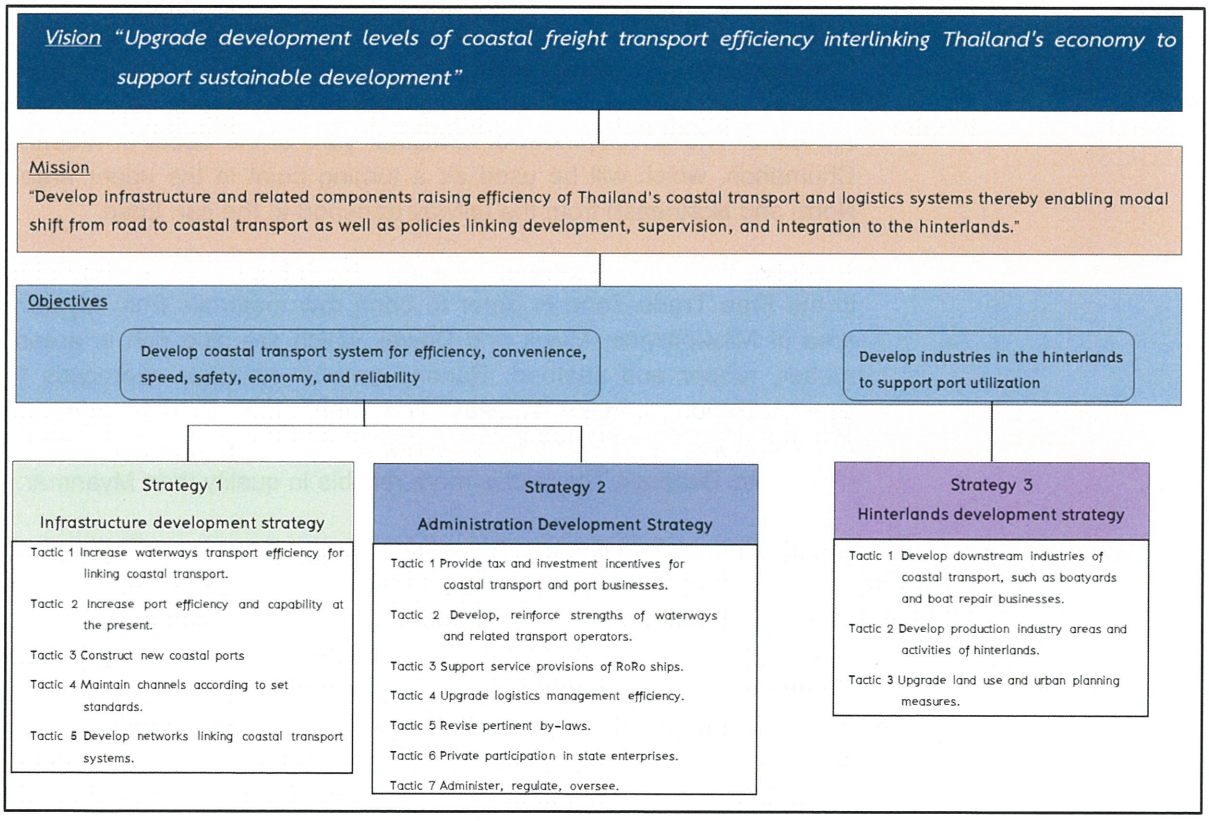


Figure 2.1.3-5 Plan to Upgrade Thailand's Coastal Transport Service and Infrastructure System Efficiency

Ranong Port is the main port on the Andaman Sea. The first phase of the terminal will accommodate up to two 500 GT cargo vessels and two container terminals capable of accommodating up to 12,000 vessels. DWT is currently under the management of the Port Authority of Thailand. Ranong Port 2 has been officially opened since July 2006 for the purpose of using Thai Andaman Sea freight. Linking the route between Ranong Port and Myanmar Port. The BIMSTEC is a framework for economic cooperation in Thailand with six other countries: Bangladesh, Bhutan, India, Myanmar, Nepal and Sri Lanka. According to the current statistics of international shipping. Products exported to BIMSTEC countries through all ports. There are not many. The amount of goods less than the mother ship to stop at the port of Ranong. Ranong Port is aiming to be the deep sea port of the region by using Ocean Ship to pick up cargo. However, this type of vessel, known as the Feeder Vessel, which has a tonnage of 1,000-1,200 TEU, will have to carry at least 60-75% of its cost. In the past, the volume of goods in the area is not enough. Therefore, the role of Ranong Port should be the main port in the Andaman region to link trade with BIMSTEC countries in order to utilize Ranong Port. The following guidelines should be developed.

- Promote trade with BIMSTEC countries to increase To increase the volume of trade. To maintain the role of Ranong Port as a regional port on the Andaman side, which supports transport between Thailand and BIMSTEC countries.
- It is advisable to promote the "Container Barge", which is a small vessel, capable of loading 150 TEU or 1,000 - 3,500 DWT vessels to transport Ranong Port to Burma. Or connect to the Ocean Ship at Penang Port.
- Development of a network linking post-landing areas, including accelerated highway construction. 4 (Petchakasem Road) to the royal port of 4 lanes along the route. The development of container yard at the depot of Mueang District, Chumphon, which will be used as a turning point in the upper area (Central, North and Northeast) from the railway transport to the car. Load
- Consideration should be given to the possibility of developing free trade zones in the Free Trade Zone in order to bring raw materials from Myanmar to the area of Mawlamyine, Myeik and Dawei, which are also rich in areas such as rubber, rubber and seafood. Ranong port to complete reprocess for export through Ranong port to overseas. The quality and standards are guaranteed. For example, the Department of Fisheries, Food and Drug Administration (FDA), etc. Because Thailand is more reliable in quality than Myanmar.

The study also selected the pilot route. "Enhancing the efficiency of coastal transportation along the route of the potential route between Surat Thani - Upper Gulf" will consist of 3 routes as follows: Surat Thani - Chonburi Province. Surat Thani - Phra Nakhon Si Ayutthaya Province and the province of Surat Thani - Chachoengsao. Surat Thani - Chonburi (Laem Chabang Port) will be shipping containers for export. The rest will be freight. It is a product that is located in the southern part of the country, which needs transportation to Laem Chabang Port for export, such as rubber and rubberwood, palm oil. From the upper Gulf of Thailand to Surat Thani. This will be the distribution center of the Upper South including cement, construction materials, rice, beverages and consumer goods.

Based on the survey and interviewed entrepreneurs. The main problem is the shallow embankment problem. At present, Ban Don River, Tapee River, Surat Thani Province. It looks like a muddy lane and shallow. As the water rises up and stabilizes. Average water depth of 3.0-3.5 meters, according to the criteria set by the Harbor Department. Must have a depth of 5 meters, thus affecting the navigation. In addition, it is a minor problem.

Development of coastal transport plan. The pilot program includes three strategic projects: Infrastructure Development Strategy Strategic Management Development and the development strategy behind the post. Infrastructure development strategy is an important strategy of the government. Here are three projects: 1. Coastal Port Development Project A at Laem Chabang Port. 2. Ban Don River Dredging Project, Surin Province The width of the standard width. 3. Boat landing area at Tha Thong junction Strategic management development will be a measure and guideline for promoting and enhancing the efficiency of coastal transport. The strategic development of the post-transition area will change the economic structure and take a long period of operation. In order to transport goods through the port of Surat Thani.

Currently, the project is to improve the efficiency of Thailand's coastal transportation network. The study was completed. It is in the process of preparing to present the Board of Directors to develop the transportation management system of goods and services of the country.

6) Study on Economic, Engineering and Detailed Design and detailed environmental impact study for Chumphon Port Construction

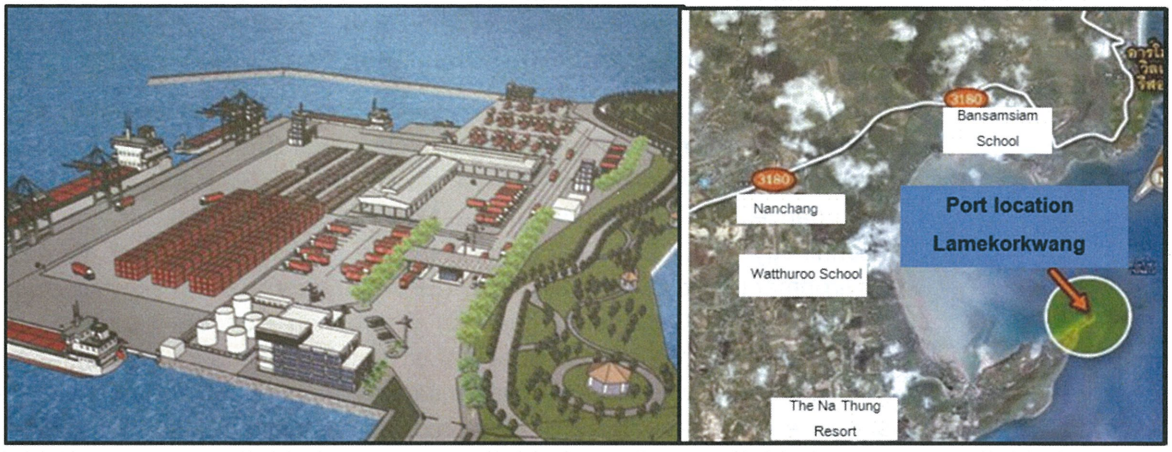
In 2006, the Harbor Department conducted a study and design study to develop a port at Chumphon Province. The results show that Chumphon berth development is appropriate. Environmental Impact Assessment (EIA) has been prepared in accordance with the scope of the Notification of the Ministry of Science and Technology (BE 2535) submitted to the Office of Natural Resources and Environmental Policy and Planning (EPPO). Carry out a review of environmental impact studies. Considering that the Chumphon Port development project is a project that requires the preparation of environmental impact assessment reports for projects or activities that may have a serious impact on the community. The quality of the environment. Natural Resources and Health (EHIA), announced by the Ministry of Natural Resources and Environment in 2010, so the Department of Harbor has hired consultants to conduct study, review of economic suitability, engineering and survey design details. The environmental impact of a project or project that may have a serious impact on the community. The quality of the environment. Natural Resources and Health (EHIA) to build a port in Chumphon. The project investigated the location of Chumphon Port, which is feasible and suitable for comparison. Considering the appropriateness of three main factors: engineering in economics. Environmentally, it is found that Laem Khok area is the most appropriate area. Secondly, the area of the Gulf of Thailand, Bang Son Bay and Huai Nam Bay area respectively.

The preliminary study has identified the role of Chumphon port as follows: (1) It is a support port for Bangkok Port and Laem Chabang Port. (2) It is an international deep sea port. (3) It is a coastal port connecting the Gulf of Thailand and Andaman Sea. Products from Laem Chabang Port to transfer to Ranong Port through the land bridge to the Andaman. (4) It is an international deep sea port connecting the Gulf of Thailand and the Andaman Sea to support the transportation of goods from other

countries from the Gulf of Thailand to the Andaman country. The main components of the Chumphon port include sea and land components. Chumphon Pier It is a multi-purpose port for loading agricultural products. General cargo and passengers are shown in **Figure 2.1.3-6** with a length of about 400 meters. The berth can accommodate the following types of vessels:

- Barge containers (Agriculture) Size 500-750 Cabinet length up to 180 meters, 8.80 meters deep
- 9,000 tonne (DWT) liquid fuel vessel with a length of up to 120 meters and a depth of 8.0 meters.
- General purpose general purpose fertilizer, chemical fertilizer 1,000-5,000 DWT, length up to 110 meters, 6.6 meters deep

The Chumphon pier will be 10 meters deep, measured from the lowest sea level. For on-site project components, including office buildings, product shelter. The total area is about 300 rai for potential cargoes to be transported through Chumphon port, including rubber, wood, rubber, palm oil, durian, mangosteen and pineapple about
2 million tons per year. The direct benefit is the transportation cost from land transport to water transport. The results of the study, review of the suitability and detailed design survey. It is not economically feasible. The Harbor Department has terminated the project.



Note: The Harbor Department has terminated the project

Figure 2.1.3-6 Chumphon Port Construction Project

7) Deep Sea Port Development and Dawei Industrial Estate

The Deep Sea Port Development Project and the Dawei Industrial Estate are projects under the cooperation between the Thai Government and Myanmar. The objective is to develop industry in various sectors. And to develop a route. By May 19, 2008, the Thai Government and the Government of Myanmar signed a memorandum of understanding (MOU) for the development of the Dawei Deep Sea Port and the Industrial Estate Project. Road connected to Thailand by Italian-Thai Development Public Company Limited ("ITD") has landed in the feasibility study of the project and the development plan. Maximum benefit.

This project is a large project with high priority. Under the international development framework such as Master Plan on ASEAN Connectivity, Greater Mekong Sub-region Cooperation (GMS) and Mekong-Japan, etc. The industrial estate is one of

the largest in the ASEAN region, it has the potential to open the western trade door of the ASEAN region to create an economic and trade link between ASEAN and Western markets, such as South Asia, Africa and Europe, without going through the Straits of Malacca, as shown in **Figure 2.1.3-7**, which can reduce the transit time between Bangkok and Chennai. India It supports economic integration by linking with regional transportation networks. It is also a new source of energy for the ASEAN region. Deep Sea Port Development and Dawei Industrial Estate, in addition to benefits to Myanmar, Thailand has the opportunity to benefit first by linking up with the deep sea port development project and the Dawei Industrial Estate, which will increase Thailand's GDP by 1.9 percent and provide an opportunity to shift from a labor-intensive economy to a value-based economy.

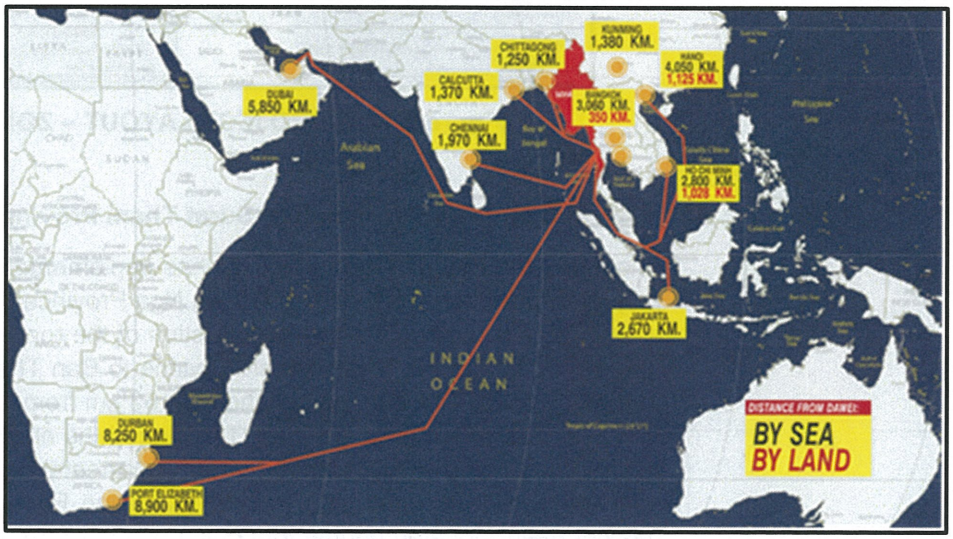


Figure 2.1.3-7 Strategic location

The Deep Sea Port Development Project and the Dawei Industrial Estate consist of (1) a dock capable of accommodating up to 300,000 DWT vessels, the maximum cargo throughput is 250 million tons per year. (2) Road connecting the border linking Thaiand to Dawei with a distance of about 132 kilometers, according to the ASEAN Highway and AASHTO standards, with 4 traffic lanes with full access control and only 330 km from Bangkok, which takes only 5 hours. (3) Power plants with clean coal technology, environmentally friendly, sufficient power for the industry (4) water management with a 400 million cubic meters-capacity reservoir at the center of a 1.05 million cubic meter (5) Eco-friendly industrial park and (6) Telecommunications with modern technology is shown in **Figure 2.1.3-8**.

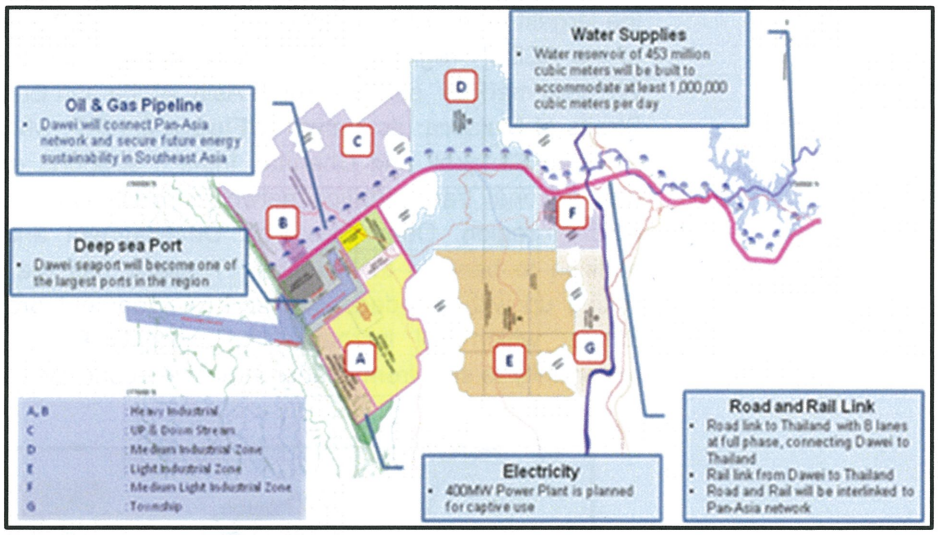


Figure 2.1.3-8 PROJECT LAYOUT – ZONING LAYOUT PLAN

8) New railway design study route Surat Thani Province to Phang Nga Province

The State Railway of Thailand (SRT) has implemented a new railway design study project, Surat Thani Province, to Phang Nga Province. In 1994, SRT has conducted a study on the suitability of the construction of the road from Maluan Station and the junction of Thung Po, Surat Thani Province to Ban Tha Nun, Phang Nga Province. The study concluded that the distance of 163 km from Thung Pho-Tha Nua Junction is the appropriate way. In 1996, SRT designed the engineering details, prepared the tender documents. Prepare report on environmental impact analysis. The route was completed in 1998 under the Phuket Extension Railway Construction Project, but has not been allocated budget for construction to date.

At present, this railway has been partially constructed and completed to Khiri Rat Nikhom District, Surat Thani Province, 31 km distance, which will be extended from Khiri Rat Nikhom Station and has designated 9 stations as Ban Ta Khun, Ban Benja, Ban Wieng, Thap Put, Bor Saen, Phang Nga, Takua Thung, Ta Yu and Ta Nun as shown in **Figure 2.1.3-9**.

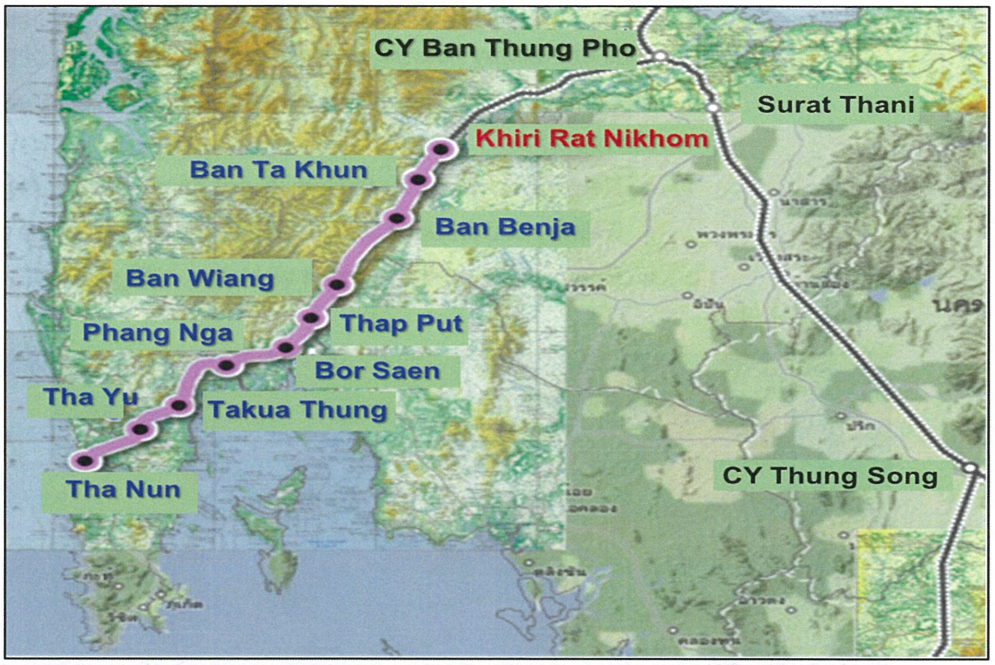


Figure 2.1.3-9 Railway Construction Project Surat Thani - Tha Nun

Currently in the two sides of this railway. Some have formed a dense community such as the area in the municipality of Phang Nga around of Sub-district of Krasom, Tha Yu and Tha Nun, including the bridge Sarasin. The present land is the problem of land encroachment and complaints from former land owners. In 2012, SRT has hired consultants to conduct geological surveys, utilities land survey and pin point proof to solve the invaders in the railway line. Surat Thani - Phang Nga (Tha Nun)

In 2012, the Cabinet has assigned the Ministry of Transport to consider the feasibility and implementation of the procedures and relevant laws and regulations and elaborate the plan / project of the project to strengthen the infrastructure of transport to support and accommodate the expansion of the tourism industry of the southern provinces both Gulf of Thailand (Surat Thani Province) and Andaman Coast (Phuket Province). OTP has conducted a study to expand and link the railway network for tourism between the Gulf of Thailand and the Andaman Sea area by connecting to the mass transit system of Phuket, the details are as follows.

(1) Development project of transportation center south east coast, connecting two sides of the sea (Andaman - Gulf of Thailand) in the area of Don Sak District, Surat Thani Province, composed of projects

- The construction of deep sea port in Don Sak District, Surat Thani Province
- The project to develop a transport link between the two coasts.
- The project development and construction of Don Sak Airport, Surat Thani Province

(2) Light rail project around Phuket Island and airport route

In order to meet the cabinet resolution, government policy and in line with the Ministry of Transport's strategy, OTP has conducted a study to expand and link the railway network for tourism between the gulf of Thailand and the Andaman Sea by connecting to the mass transit system of Phuket to increase the competitiveness of

tourism and facilitate travel to the people and tourists, strengthening of the existing southern railway network as a result of the expansion of the tourism industry.

The study on the project linking the Gulf of Thailand and the Andaman coast will consist of:

- New Railway Line for tourism, Surat Thani - Phang Nga - Phuket
- Railway in Don Sak District - Surat Thani (Connected to Southern Railway)
- Railway Link to Krabi Airport as shown in **Figure 2.1.3-10**.

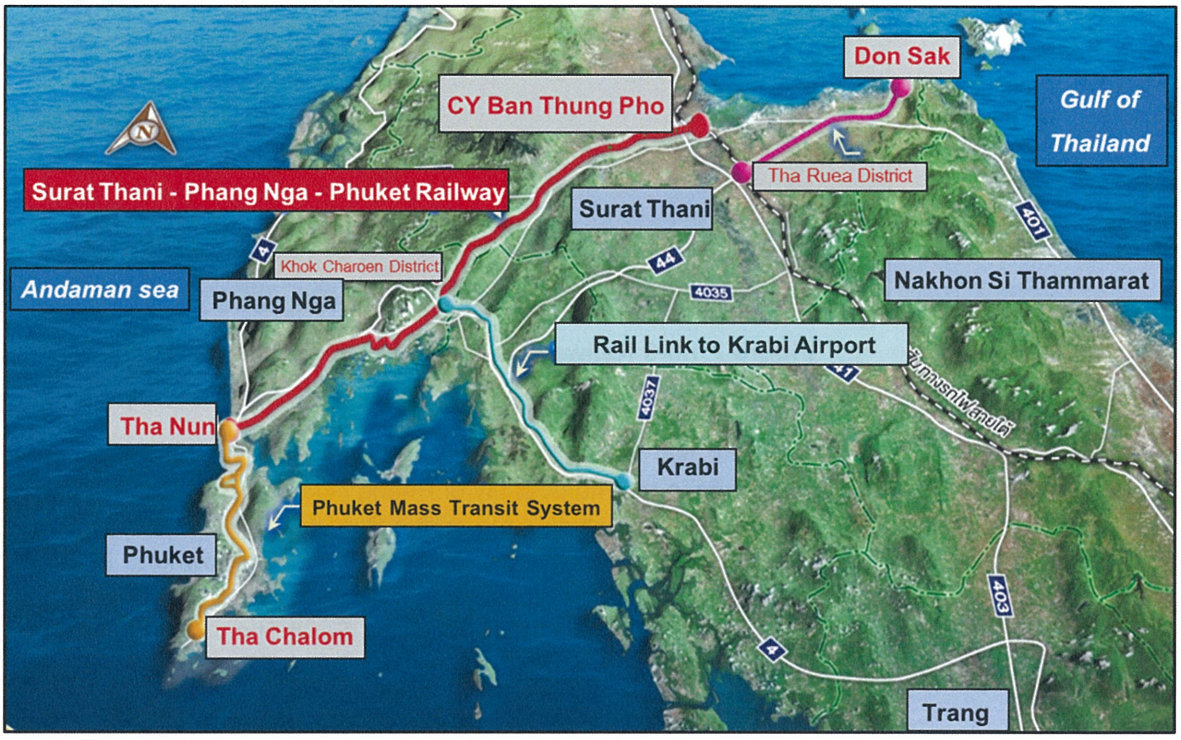


Figure 2.1.3-10 Overview of Rail Network Development in Surat Thani, Phang Nga, Krabi and Phuket

The analysis of the economic indicators of each project is summarized in **Table 2.1.3-3**, it is found that only the Surat Thani - Phang Nga - Phuket railway project is economically feasible. Railway projects in Don Sak - Surat Thani and the railway linking Krabi Airport will not be economically feasible.

Table 2.1.3-3 Summary of Economic Feasibility Analysis

Project	NPV (Million Baht)	B/C	EIRR
Railway Surat Thani - Phang Nga - Phuket	866	1.04	12.44%
Railway in Don Sak District - Surat Thani	-5,007	0.49	5.82%
Rail Link to Krabi Airport	-3,266	0.65	8.39%

The project of the Don Sak - Surat Thani Railway has commenced a detailed design study in 2017, which is expected to be completed in early 2018.

9) Study and Design of Double Track Railway and High Speed Trains

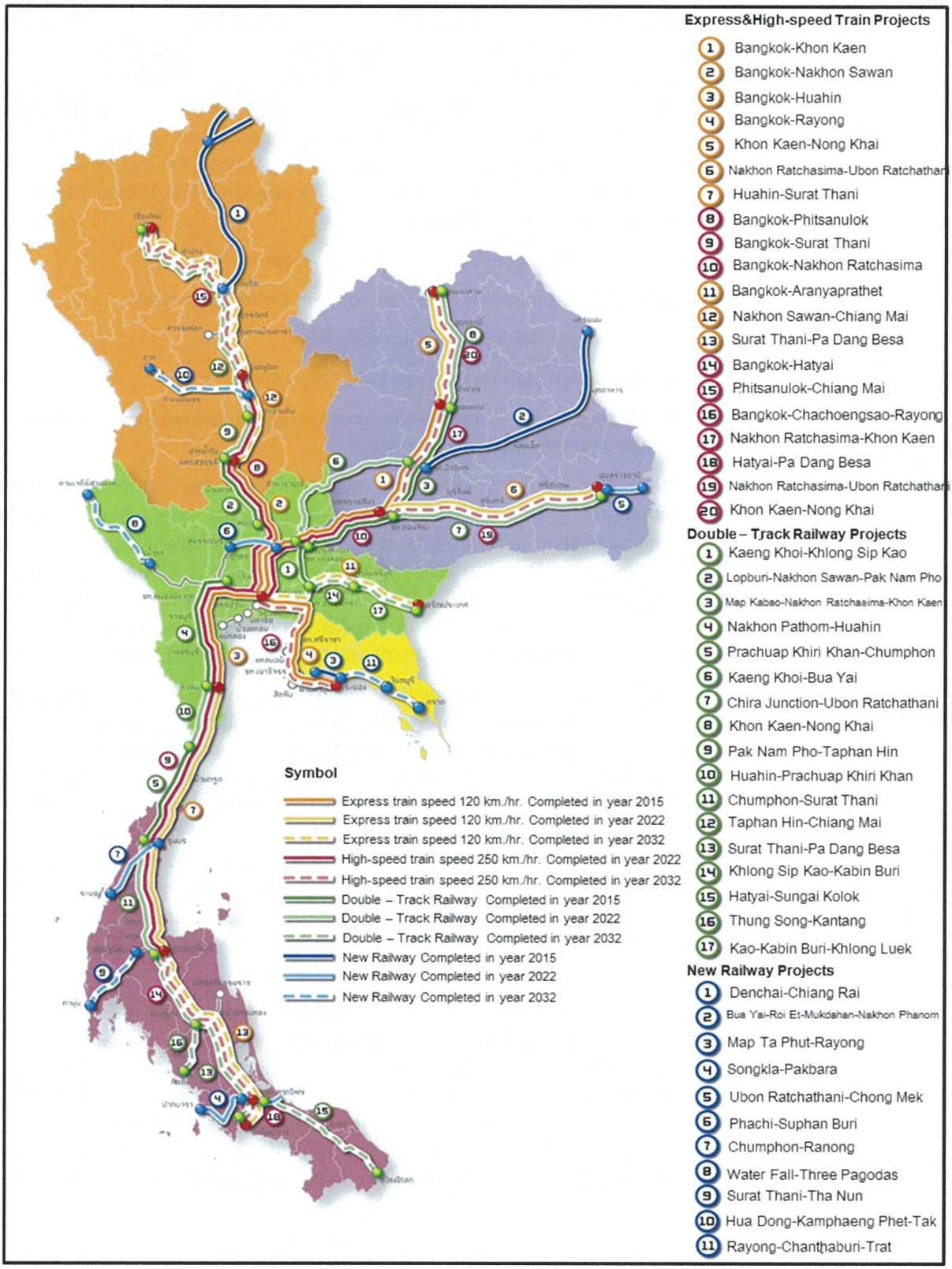
The master plan for the development of the rail system and high-speed rail (OTP 2010) has proposed a master plan for the development of the railway system. The investment is to develop the railway infrastructure between year 2011-2032 under a budget of 1.66 trillion baht, divided into 3 phases (short, medium and long term). The results of the study will be used as a guideline for the development of the railway system as well as the high-speed rail system. The Master Plan includes the following types of project plans:

- Nationwide Double Track Network Development Plan
- Infrastructure Improvement Plan to Meet Safety Standards
- New Railway Network Development Plan
- Development plan for express train / high speed train
- Other roadmaps, including infrastructure for multimodal transport, maintenance center and information technology.

At the beginning of a short-term plan or plan, this will improve the existing infrastructure more efficiently. The strength of the. Signal System and telecommunication to be able to operate quickly and safely. Supply of locomotives and lorries to increase the ability to handle more cargo. There will also be a further development of the network of more than 700 km, with a focus on radius distribution from Bangkok. This will increase the capacity of the bus. Fast, safe and reliable. Encouraged to change the mode of transport (Modal Shift) to use more rails.

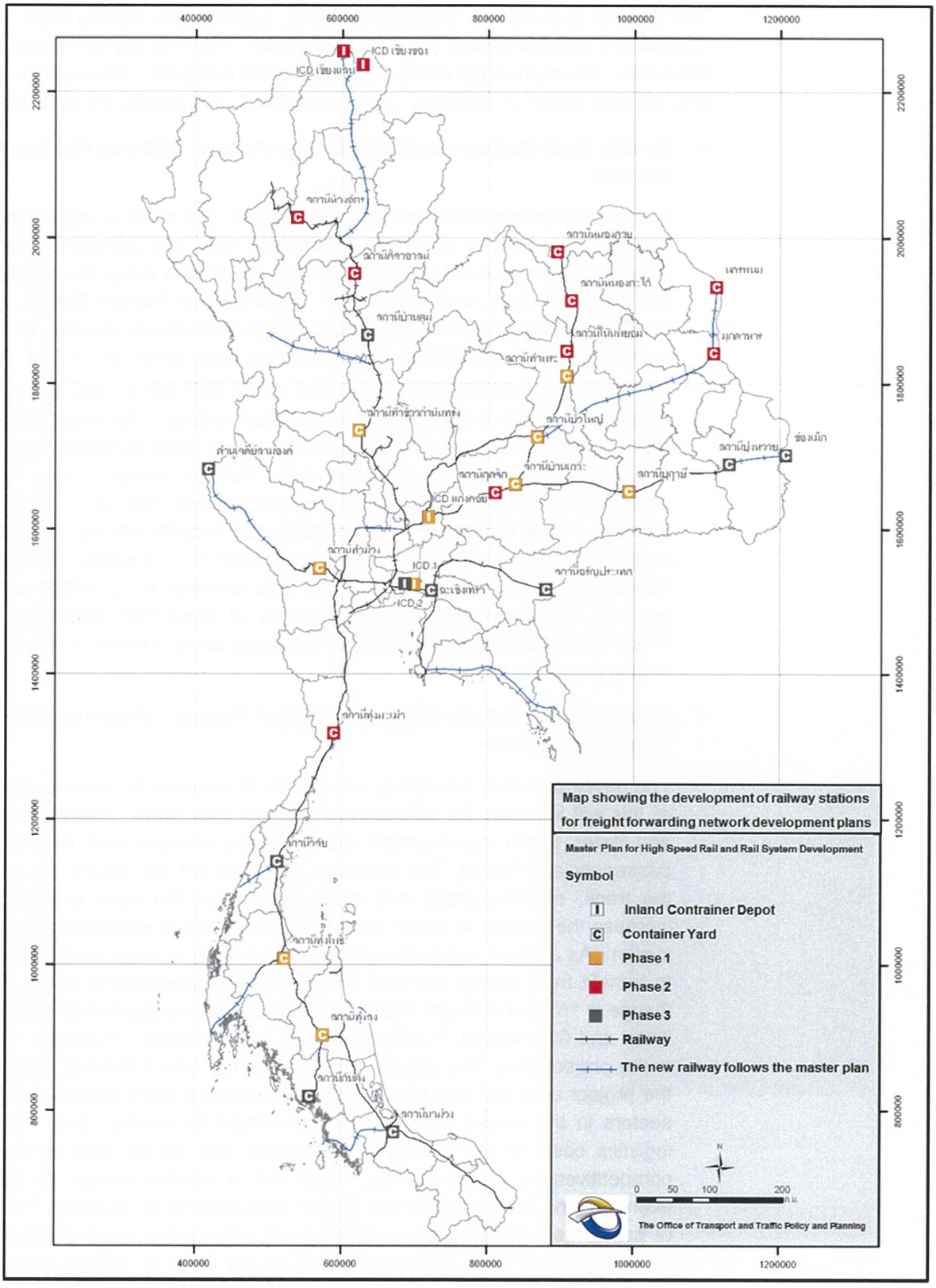
In addition, when the additional dual-network expansion is developed, it will develop a rapid train system that can run 120 km / h simultaneously, which is not a high investment cost and the use of the dual network is worth more. In the master plan, the development of express train 120 km / h, as appropriate, based on the results of economic analysis and consistent with the double development phase. In the medium term plan and long term plan. There are suggestions for twin development to cover the main railway network nationwide. Additional 120 km / hr rapid rail network and 250 km / h high speed rail system are proposed. This will be the infrastructure to support economic development, trade, investment and tourism. It is the image of the country as a transportation hub of the region. Overview of the master plan development displayed as **Figure 2.1.3-11** and **Figure 2.1.3-12**.

It is expected that when the plan is developed, there will be a passenger train (excluding suburban trains and trains in Bangkok), 70% increase from 77 million trips a year to 129 million trips per year and up to 140% to 186 million trips per year. If the project develops according to the master plan all of three phases, transportation volume will increase from an average of 26 million tons per year, about 160% to 68 million tons per year and if the three master plan projects are developed, the volume of transportation will increase by 370% to 124 million tons per year.



Source: Study on Master Plan for Ongoing Railway and High Speed Rail Systems (2010)

Figure 2.1.3-11 Overview of the Railway Network Development under the Master Plan for the Development of Rail and High Speed Rail Systems



Source: Study on Master Plan for Ongoing Railway and High Speed Rail Systems (2010)

Figure 2.1.3-12 Multi-Modal Transport Infrastructure Project in Line with the Master Plan for the Development of Rail and High-Speed Rail Systems

The project involves the Southern Railway, currently the double track has been studied and detailed design are Nakhon Pathom - Hua Hin (by SRT) and Prachuap Khirikhan - Chumphon (by OTP). High speed rail Bangkok - Padangbars is studied and detailed design in Bangkok - Hua Hin by OTP. The results are as follows.

- **Double Track Railway Study and Design Project : Nakhon Pathom - Hua Hin Section**

  It is a new double track development project. The route is approximately 170 km, the new railway construction is added one way parallel to the existing railway. The route is 60 meters wide. The route runs along the original railway line along the route, start at Km 47 + 700 at Nakhon Pathom Station. The route heading west to Nong Pla Duk Junction distance of about 16.5 km, then turn left to the south through Ratchaburi, Phetchaburi ends at Km 217 + 700. From Hua Hin station about 4 kilometers at Km 211 + 582.900 to Km 215 + 572.900 distance of about 4.290 km is the elevated runway. The track width is 1.00 meter, using ballast, uses UIC54 rails and mono block concrete, equipped with signaling and telecommunication systems Nakhon Pathom - Hua Hin. When double track on the southern railway line Nakhon Pathom - Nong Pla Duk Junction - Hua Hin are opened in 2015, the benefits will be: to increase rail freight capacity from 1 million tons per year to 1.5 million tons per year, increasing the number of passengers from 6 million to 12 million passengers per year, increasing the average capacity of more than 200 trains per day. Travel from Bangkok to Hua Hin The trip takes about 3 hours to reduce the time to less than 2 hours.

- **Double Track Railway Study and Design Project : Prachuap Khiri Khan - Chumphon Section**

  The development of the double rail network is intended to increase the capacity of this will increase the efficiency of the bus and safety, making travel easier and faster. It can accommodate the increasing transportation demand both by passenger and freight. The twin-track development will double the capacity of the track, enabling faster and safer bus routes. No need to wait. This will increase the chance to travel. More timely, resulting in confidence in the service system. As a result, transport operators are turning to more modal shift services to benefit from energy use and reduce overall transportation costs. The Meer Gauge is 167 km in length and is built with 21 stations (including Prachuap Khiri Khan and Chumphon), 5 additional stops and relocation. There are 14 stations in the project area. The project area is 2 districts and 6 districts. The people in the project area can use the transportation service more convenient. Industrial sectors in the project area can be use freight forwarding, thus reducing the logistics costs of the country systematically and will be able to develop the competitiveness of the country, which has a positive impact on the overall economy and society, worth the cost of resources to be invested. The forecast of passenger volume when a double-track railway has been development will increase to 2.7 times when compared to the case of without project in the launch year 2015, and the passenger volume will be more than almost four times in 2037. The freight volume on the Southern Railway will increase to 1.4-1.6 times of the case of without project as shown in **Table 2.1.3-4** and **Table 2.1.3-5**, respectively.

Table 2.1.3-4 Results of Forecasting Maximum Passengers Number in the Route (Maximum Line Load)

Year	Total number of passengers 2 directions (person per day)	
	Without project	With Project
2015	10,100	27,000
2017	10,400	34,900
2022	12,100	44,300
2027	14,200	51,000
2032	16,500	58,700
2037	16,500	64,900

Source: Study and Design of Double Track Railway, Prachuap Khiri Khan - Chumphon Section

Table 2.1.3-5 Forecast of freight volume (tonnes per year)

Year	Products volume passed through the project 2 directions (tons / day)	
	No project	Project Case
2015	637,800	1,021,900
2017	676,600	1,099,600
2022	784,400	1,318,200
2027	909,300	1,575,600
2032	1,054,200	1,883,200
2037	1,054,200	2,065,200

Source: Study and Design of Double Track Railway, Prachuap Khiri Khan - Chumphon Section

- **Double Track Railway Construction Project Chumphon - Surat Thani Section**

  Double Track Railway Project Chumphon - Surat Thani Section covers the area of Chumphon 5 districts including Mueang Chumphon District, Sawi District, Thung Tako District, Lang Suan District and Lamae District and covers 4 districts of Surat Thani including Tha Chana District, Chaiya District, Tha Chang District and Phunphin District. The project starts at the end of Chumphon Station, Mueang Chumphon District, Chumphon Province, at 469 + 300 km southwards along the Southern Railway Line and ends at Surat Thani Station, Phunphin District, Surat Thani Province at km 637 + 500 with the total distance of the project is 168.20 kilometers. The route will be the construction of a 1 meter rail or Meter Gauge parallel to the existing railroad, which will be on the left side of the current track, with some rail adjustments to allow the train speed of up to 160 km / hour. For some areas which are limited to speed of up to 120 km / hour, consists of 21 stations (excluding Chumphon station) and 6 stopping places

  The Chumphon - Surat Thani railway line has one container yard (CY), namely, Ban Thung Pho Junction railway station, Surat Thani and from the study of feasibility and design details of the project, did not set up container yard additional due to the large industrial plants in the area has a high concentration in Phunphin District and Mueang Surat Thani District, which is close to Thung Pho Railway Station. Designing and problem solving of railway crossing, which has a total of 108 railway crossing along the route, there are five types of modification are: 1) 12 elevated railway crossings; 2) 58underpasses 3)12 U-

shaped elevated road 4) 4 elevated trains and 5) recommended to use 23 nearby railway crossing, including the construction of fences along the railways for safety.

The station design concept is to use the existing station to improve and add to elements of use, fit, modern, and still retain the identity and culture of the locality, as well as facilities for the disabled and the elderly. There are 3 types of stations: 1) small stations (3rd class station) total 13 stations 2) medium station (2nd class station) total 5 stations and 3) large station (1st class station) total 3 stations.

- Investment limit : 23,285 Million Baht
- Economic Internal Rate of Return (EIRR) : 12.47%
- Financial Internal Rate of Return (FIRR) : 1.09%
- Forecast of passenger volume in 2037 : 24,871 Person / day
- Forecast of freight volume in 2037 : 1.33Million tons / year

- **High Speed Train Study and Design Project : Bangkok - Hua Hin Section**

  High Speed Train Study and Design Project Bangkok - Hua Hin section has conducted on Socio-economic, environmental and route issues, as well as, the layout and location of station, along with listen to opinions and useful suggestions from all sectors. There are representatives from the public, private and public sectors and people interested in Bangkok and other provinces in the project route. The route starts at Bangkok and ends at Hua Hin District, Prachuapkhirikhan Province, with a total distance of 209 kilometers, which will use the existing railroad area essentially. By starting the route from Central Bang Sue Station (Bangkok) and take the Southern Railway route through Nakorn Pathom Station, Ratchaburi Station to Pak Tho District, Ratchaburi Province then adjusted to Petchkasem Road before entering to Petchaburi station, then back to use the route of the Southern Railway to the end of Bo Fai Sub-district, Hua Hin District, Prachuap Khiri Khan Province. According to the studies, it has been found that there were 51 railway crossing throughout the route, which is railway crossing used in conjunction with the double track 30 locations, Department of Highways 3 locations, Department of Rural Roads 6 locations, and redesigned 12 locations which divided into the road, bridges over railway 4 locations and underpasses 8 locations. The design and location of the station will bring design ideas from the award-winning works of "Design Station Define Identity", which emphasizes aesthetically modern and architectural style consistent with the uniqueness of each province. It also designed to provide facilities for everyone (Universal Design) and take into account the management of routes connected to transportation system of each province. The location of Nakhon Pathom Station is in the vicinity of the present Nakhon Pathom Railway Station because it is a city center area that is well connected to other public transport systems and has sufficient space in the SRT land area. For economic results from the development of high-speed rail Bangkok - Hua Hin – Padang Besar has an Economic Internal Rate of Return (EIRR) from Bangkok to Hua Hin Section 8.11% and when the route is developed to Padang Besar, the EIRR will increase to 12.76%, with a total investment of 98,399 million Baht, a construction cost of 83,070 million Baht, with the

average fares of 2.5-3.0 baht per kilometer. The benefit of the project is that in 2029, the high speed train line Bangkok - Hua Hin will saves the cost of using the vehicle is 3,846.5 million Baht per year, saving travel time 924.5 million per year.

10) Master Plan for Development of Railway Network Supporting the Special Economic Zones Tourism and Area Development

The Ministry of Transport has assigned the Office of Transport and Traffic Policy and Planning (OTP) to study the master plan for the development of railway network supporting the special economic zone, tourism and area development by transmitting the policy of the 20-year National Strategy (2017-2036) and the Twelfth National Economic and Social Development Plan (2017-2021) to the implementation of a 20- year project (2017-2036) to be concrete, which the master plan aims to develop a rail network which has low transport cost and efficient use of energy to serve as the core network of the country to support the development of the city, economic area, tourism and international links to increase the competitiveness of the country and promote Thailand's role as the center of the ASEAN Economic Community.

The development roadmap for the Railway Network Master Plan includes seven roadmaps:

1. The Double Track Development Roadmap for Today's Railway Network
2. Infrastructure Improvement Roadmap to Meet Safety Standards
3. New Railway Development Roadmap
4. Roadmap for Standardized Rail Network Development
5. Roadmap for Electric Train System Development
6. Infrastructure Development Roadmap for Freight
7. Development Plan of Locomotive, Wheeled Vehicle

In addition, the master plan also provides guidelines to promote the development of rail systems to be more efficient, such as the development of rail industry, urban development to promote the rail system and the preparation of standardization of railway system, etc., and management development, such as the improvement of measures, laws and regulations related to rail transport, etc. The framework of the master plan for a period of 20 years (2017-2036), which the plan is divided into 3 phases: short or urgent (2017-2021), medium term (2022-2026) and long term (2027-2036). Once the project has been completed according to the all of 3 phase of the master plan, it will increase access to the system by the rail network going through 62 provinces from previously accessible 47 provinces, with the network extending over 2 times from 4,072 km to 8,901 km. The results of the study found that the economic benefits from the three phases of master plan in the 20 years with a total investment budget of 2.79 trillion baht, the economic return of 13.44%, the net present value of 129,882 million Baht.

The new railway line development project Chumphon - Ranong can be summarized as follows.

- The investment value of the project is Baht 18,748 million.
- Forecasted number of passengers in the period 2022-2037 is 4,600 - 8,700 people per day and the volume of goods is 640 - 1,420 thousand tons per year.
- Economic Internal Rate of Return (EIRR) is 12.71%

- New Railway Project Chumphon - Ranong is included in the long-term plan (2027-2036) of this Master Plan.

2.2 Compilation and Analysis of Basic Socio-Economic Data

2.2.1 Compilation of Basic Socio-Economic Data

The consultants have collected data on economic and social conditions in the area of the project and the area in both regional and national level, which is the fundamental factor that cause demand to travel. Economic and social studies of the project to analyze current economic and social conditions and anticipate future economic and social growth. This is very important because the results will be used to predict transport demand in future years.

Socio-economic studies have an important purpose to illustrate the information and direction of economic and social development in the past to the present as well as the potential and prospects of development of the area to be expected in the future, which will affect the construction of the new railway line Chumphon - Ranong deep sea port, as it is expected that the results of such development will lead to economic and social activities, as well as the impact on the demand quantity of travel both by people and goods.

Therefore, in the socio-economic study of the new railway line Chumphon - Ranong deep sea port will take into consideration the various development overview in the area of both national, regional and provincial, which will directly affect the implementation of the project. The study area to be used in economic and social studies will cover the key linkage networks that will need to be analyzed for traffic and transport, composed of Chumphon and Ranong as shown in **Figure 2.2.1-1**.

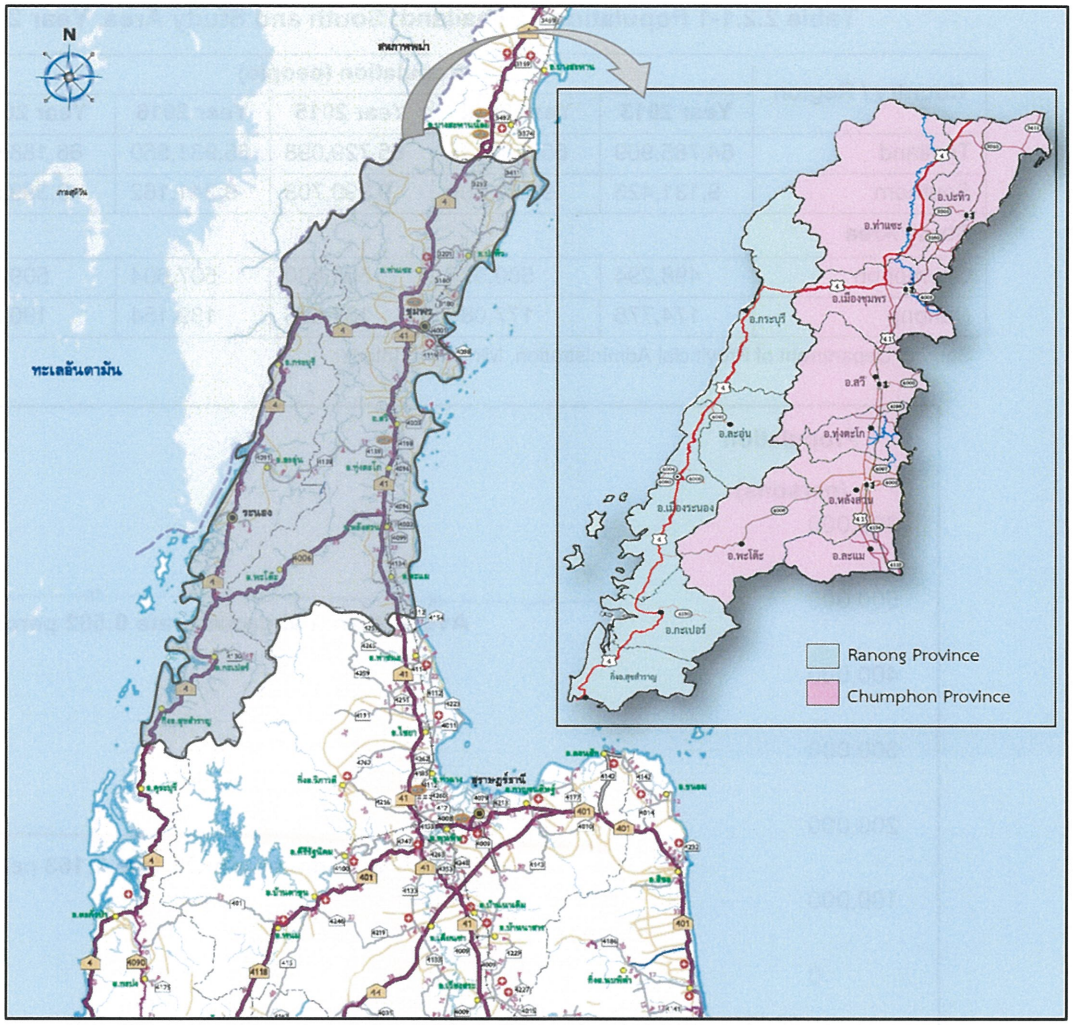


Figure 2.2.1-1 Project Area

The important economic and social data sources is available from the relevant agencies & study reports associated both nationally, regionally level and influence area of the project. The socio-economic data collected contains the following details.

1) Population

According to the population register of the Department of Provincial Administration, year 2013-2017, found that Thailand had a total population of 66,188,503 people in year 2017 with an average increase rate of 0.54% per year and the South has a population of 9,399,578 people accounted for 14.2% of the total population with an average increase rate of 0.73% per year. In the study area, Chumphon Province had a population of 509,590 people, accounted for 72.8% of the study area, with an average growth rate of 0.56% per year. Ranong had a total population of 190,399, accounted for 27.2%, with an average growth rate of 2.16% per year, as shown in **Table 2.2.1-1** and **Figure 2.2.1-2**. Population of Chumphon and Ranong in 2017 was ranked 54th and 77th in the country, respectively, and ranked 9th and 14th in the South, respectively.

Table 2.2.1-1 Population of Thailand, South and Study Area, Year 2013-2017

Country / Region	Population (people)					Increase rate (%)
	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	
Thailand	64,785,909	65,124,716	65,729,098	65,931,550	66,188,503	0.537
Southern	9,131,425	9,208,504	9,290,708	9,341,162	9,399,578	0.726
Study Area						
Chumphon	498,294	500,575	505,830	507,604	509,590	0.562
Ranong	174,776	177,089	187,536	189,154	190,399	2.163

Source: Department of Provincial Administration, Ministry of Interior

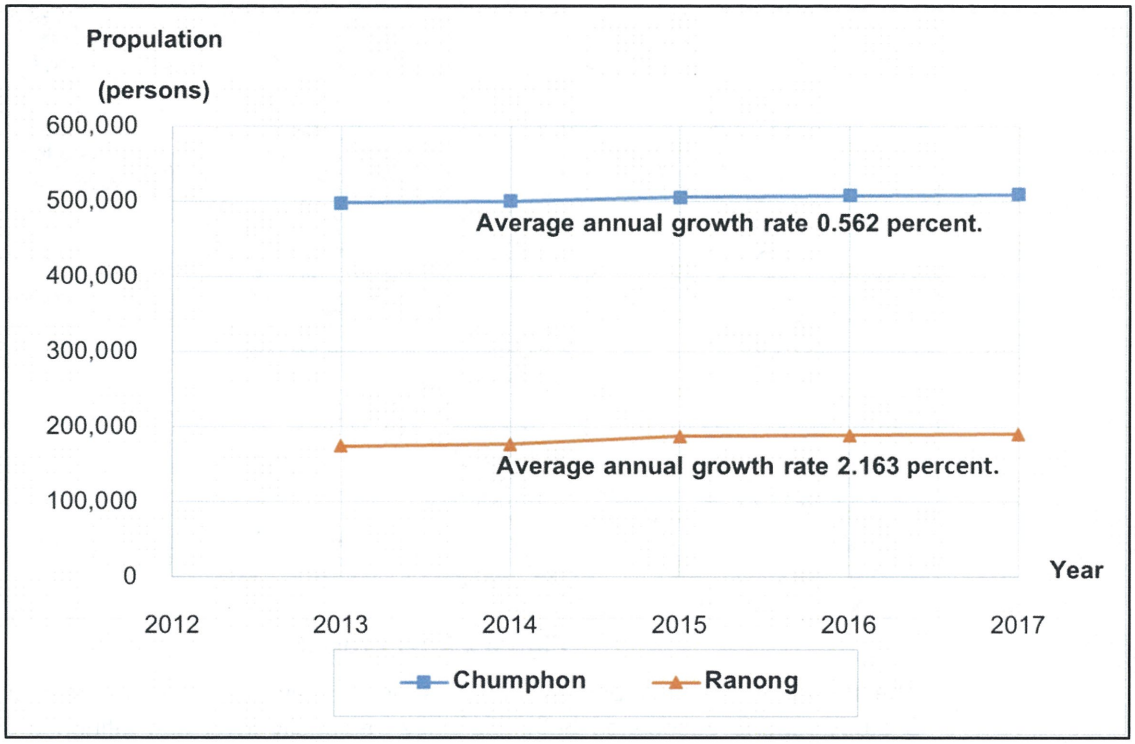


Figure 2.2.1-2 Population in Study Area, Year 2013-2017

When considering the population in study area of Chumphon and Ranong Province, classified by district during the past 5 years (2013-2017), it was found that:

In the year 2017, Mueang Chumphon District has the most population in Chumphon, with a population of 149,176 people, accounted for 29.3% of the total population of Chumphon, followed by Tha Sae District with a population of 86,002 people, accounted for 16.9%, and the district with the least population, 24,291 people, accounted for 4.8% is Phato District, as shown in **Table 2.2.1-2** and **Figure 2.2.1-3**.

Table 2.2.1-2 Population in Chumphon Province, Classified by District, Year 2013-2017

Province/ District	Population (people)					Increase rate (%)
	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	
Chumphon	**495,310**	**498,294**	**500,575**	**505,830**	**507,604**	**0.615**
Mueang Chumphon	145,671	146,609	147,797	148,687	149,176	0.596
Tha Sae	82,710	83,293	85,219	85,562	86,002	0.981
Pathio	47,392	47,301	48,070	48,131	48,346	0.499
Lang Suan	72,523	72,800	73,349	73,473	73,642	0.384
Lamae	29,307	29,326	29,483	29,471	29,576	0.229
Phato	23,658	23,866	24,010	24,120	24,291	0.662
Sawi	72,059	72,236	72,648	72,808	73,123	0.367
Thung Tako	24,974	25,144	25,254	25,352	25,434	0.457

Source: Department of Provincial Administration, Ministry of Interior

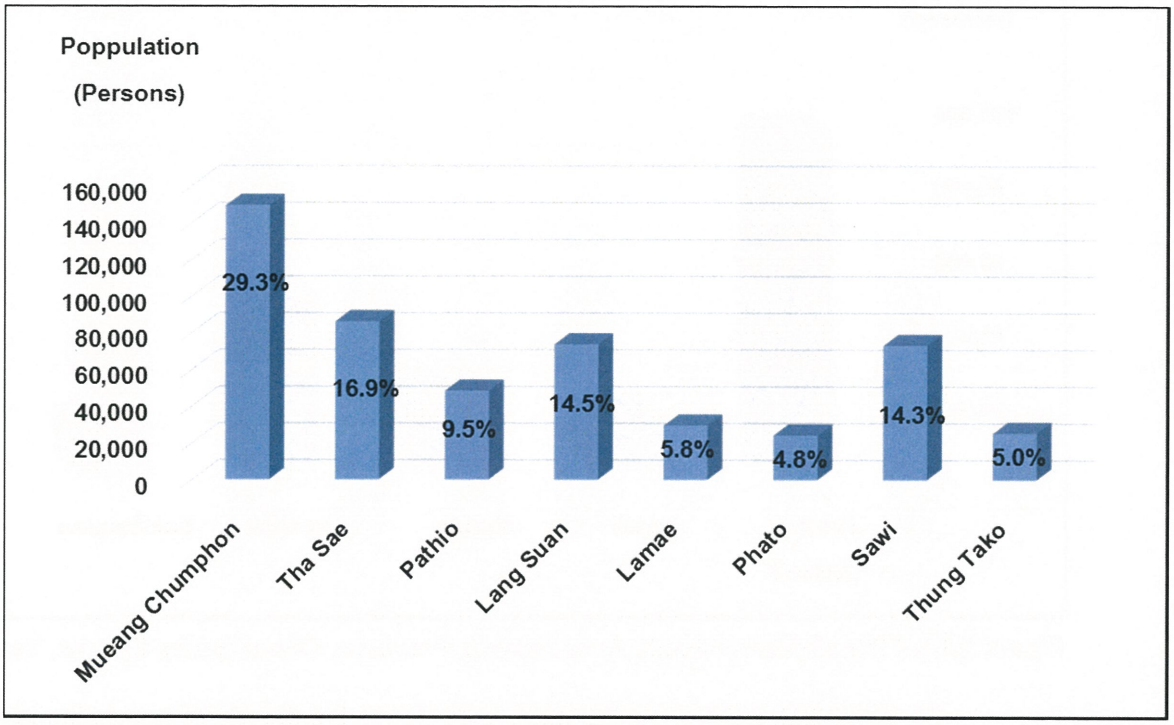


Figure 2.2.1-3 Population in Study Area Chumphon Province, Classified by District, Year 2017

For Ranong Province, Mueang Ranong District, Ranong Province has the most population of 91,808 people, accounted for 48.2% of the total population of Ranong, followed by Kraburi District with a population of 48,097 people, accounted for 25.3%, and the district with the least population, 14,004 people, accounted for 7.4% is Suk Samran District, as shown in **Table 2.2.1-3** and **Figure 2.2.1-4**.

Table 2.2.1-3 Population in Ranong Province, Classified by District, Year 2013-2017

Province/ District	Population (people)					Increase rate (%)
	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	
Ranong	**174,776**	**177,089**	**187,536**	**189,154**	**190,399**	**2.163**
Mueang Ranong	81,488	82,570	89,763	91,033	91,808	3.026
La-un	13,932	14,093	14,500	14,660	14,797	1.517
Kapoe	20,709	20,995	21,575	21,619	21,693	1.167
Kra Buri	46,368	46,867	47,964	47,999	48,097	0.919
Suk Samran	12,279	12,564	13,734	13,843	14,004	3.341

Source: Department of Provincial Administration, Ministry of Interior

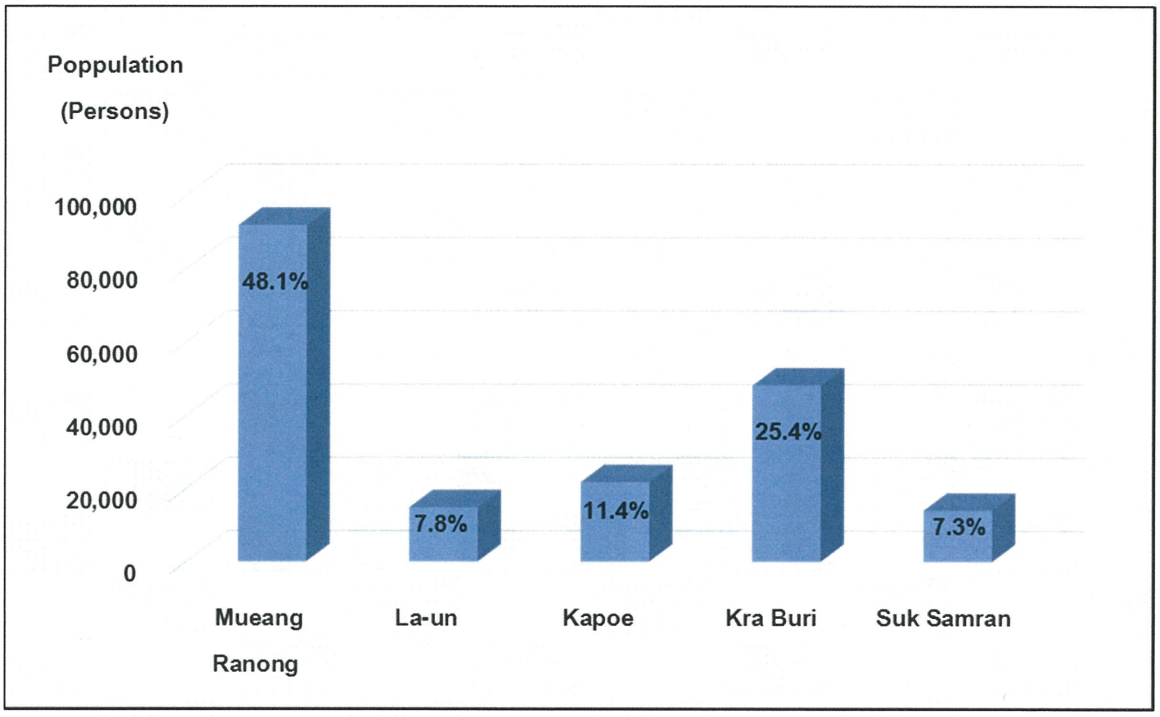


Figure 2.2.1-4 Population in Study Area Ranong Province, Classified by District, Year 2017

In addition to such population data, considering the density of population in the study area in the year 2017, it was found that Chumphon Province has a total of 228,773 households, with an average household size of 2.23 persons per household and a population density of 85 persons per sq.km. The district with the highest population density is Mueang Chumphon District, with a population density of 221 persons / sq.km, followed by Lang Suan District with a population density of 101 persons per sq.km. and Lamae District with a population density of 100 persons per sq.km. For the district with the least population density is Phato District, which has a population density of 24 persons per sq.km.

For Ranong Province has a total of 88,222 households, with an average household size of 2.16 persons per household and a population density was 58 persons per sq.km. The district with the highest population density is Mueang Ranong District, with a population density of 129 persons per sq.km, followed by Kra Buri District, with the population density of 61 persons / sq.km. and Suk Samran District, with the population density of 35 persons / sq.km. For the district with the least population density is La-un

District, which has a population density of 20 persons / sq.m. The details are shown in **Table 2.2.1-4**.

Table 2.2.1-4 Population, Household and Population Density in the Study Area, Year 2017

Province/ District	*Population	* Number of households	Average household size	** Area (sq.km.)	Population density (person / sq.km.)
Chumphon	**509,590**	**228,773**	**2.227**	**6,009.85**	**84.79**
Mueang Chumphon	149,176	73,185	2.038	675.1	220.97
Tha Sae	86,002	35,847	2.399	1,530.22	56.20
Pathio	48,346	20,807	2.324	672.41	71.90
Lang Suan	73,642	31,743	2.320	727.29	101.26
Lamae	29,576	12,929	2.288	296.14	99.87
Phato	24,291	10,883	2.232	1,017.33	23.88
Sawi	73,123	32,811	2.229	799.58	91.45
Thung Tako	25,434	10,568	2.407	291.79	87.17
Ranong	**190,399**	**88,222**	**2.158**	**3,298.05**	**57.73**
Mueang Ranong	91,808	46,501	1.974	713.723	128.63
La-un	14,797	6,352	2.330	748.546	19.77
Kapoe	21,693	8,216	2.640	657.688	32.98
Kra Buri	48,097	22,929	2.098	783.01	61.43
Suk Samran	14,004	4,224	3.315	395.087	35.45

Source: * Department of Provincial Administration, Ministry of Interior ** Chumphon Provincial Governor's Office and Ranong Provincial Governor's Office

2) Gross Product Value

The consultant collected the Gross Domestic Product (GDP) data from the Office of the National Economic and Social Development Board (NESDB). At present, NESDB has adjusted the gross value calculation method by using the Chain Volume Measure instead of the fixed base year method, the quantized chain method has been theoretically accepted and tested. It reflects the economic situation better than the traditional fixed-line method. Based on the constant base year model, the economic growth rate will be higher than the actual rate, since the base year is too old, the price of the product compared during the year is inconsistent with reality, because some economic structure has changed. The fixed base year calculation method is still used on a quarterly calculations, which in the future will adjust the calculation method from fixed base year to chain volume.

In Chain Volume Measures calculation, there will be add up-to-date price data to be used as a weight in the calculation every year, so the problem of discrepancies caused by the price of goods. The calculation of the chain can also add information about new activities / products throughout the series, it can reflect the change over time. Therefore, the quantitative chain calculation is more accurate in calculating the economic growth rate than the fixed base year calculation, which is a major reason for the countries consider switching to a chain-based calculation instead of a fixed year base.

In this analysis of GDP value will use the data of Gross Domestic Product-Chain Volume Measures, the details are as follows.

Based on the data of value of Gross Domestic Product-Chain Volume Measures in year 2011-2015, it is found that in 2015, Thailand has the gross product value of

9,501,222 million Baht, with an average growth rate of 3.43% per year and the South has a gross product value was 780,132 million Baht, accounted for 8.2% of total GDP, with the average growth rate of 2.87% per year. When considering the value of Gross Domestic Product-Chain Volume Measures in the area of study, it is found that in 2015, Chumphon Province has GDP value of 40,055 million Baht, accounted for 69.8% of the study area with an average increase rate of 2.86% per year. Ranong Province has GDP value of 17,297 million Baht, accounted for 30.2% with an average increase rate of 1.39% per year. The details are shown in **Table 2.2.1-5** and **Figure 2.2.1-5**. GDP value of Chumphon and Ranong in 2015 was ranked 35th and 64th of the country, respectively, and ranked 6th and 14th of the South, respectively.

Table 2.2-1-5 Gross Domestic Product-Chain Volume Measures at the National, Regional and Provincial Levels in the Study Area, Year 2011-2015

Country / Region	Gross Domestic Product Value (Million Baht)					Increase rate (%)
	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	
Thailand	8,301,560	8,902,825	9,146,100	9,229,755	9,501,222	3.432
South	696,601	725,839	752,011	749,632	780,132	2.872
Study Area						
Chumphon	35,777	36,939	40,973	40,945	40,055	2.864
Ranong	16,369	17,040	17,478	17,562	17,297	1.388

Source: Office of the National Economic and Social Development Board

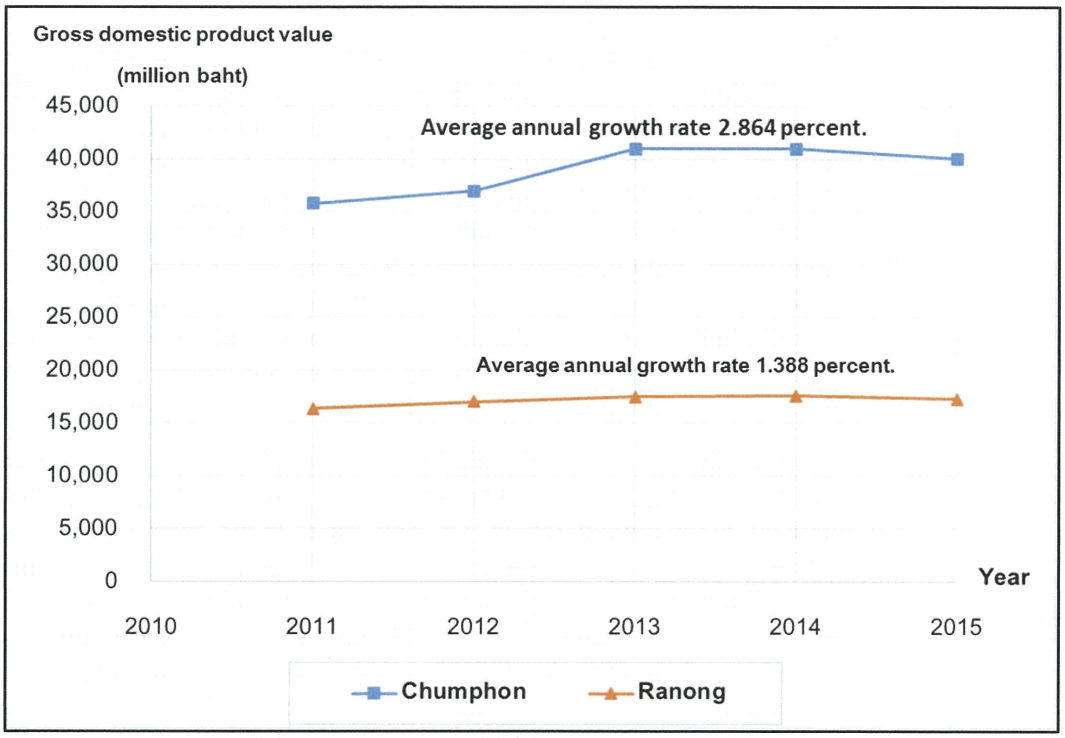


Figure 2.2.1-5 Gross Domestic Product-Chain Volume Measures at the Provincial Level in the Study Area, Year 2011-2015

3) Average income per capita per year

From the data of the average income per capita data of the Office of the National Economic and Social Development Board for Year 2011-2015, it was found that in 2015, Thailand had the average income per capita of 203,356 baht / year with an average increase rate of 4.46% per year. For the South, had the average income per capita of 130,978 baht / year with an average decrease rate of 0.35% per year. Considering the average income per capita in the study area, it was found that in 2015, Chumphon Province had an average income per capita of 151,835 baht / year with an average decrease rate of 1.62% per year. For Ranong Province, had an average income per capita of 91,452 baht / year with an average decrease rate of 0.6% per year, as shown in **Table 2.2.1-6** and **Figure 2.2.1-6**. The average income per capita of Chumphon and Ranong in 2015 was ranked 21st and 40th of the country, respectively, and ranked 6th and 10th of the South, respectively.

Table 2.2.1-6 Average Income per Capita of Thailand, South and Provinces in Study Area, Year 2011-2015

Country / Region	Average income per capita (Baht / year)					Increase rate (%)
	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	
Thailand	170,764	185,849	193,561	197,062	203,356	4.464
South	132,817	129,432	129,193	125,357	130,978	-0.348
Study Area						
Chumphon	142,377	140,400	146,928	146,633	151,835	1.621
Ranong	89,121	90,467	90,749	93,141	91,452	0.648

Source: Office of the National Economic and Social Development Board

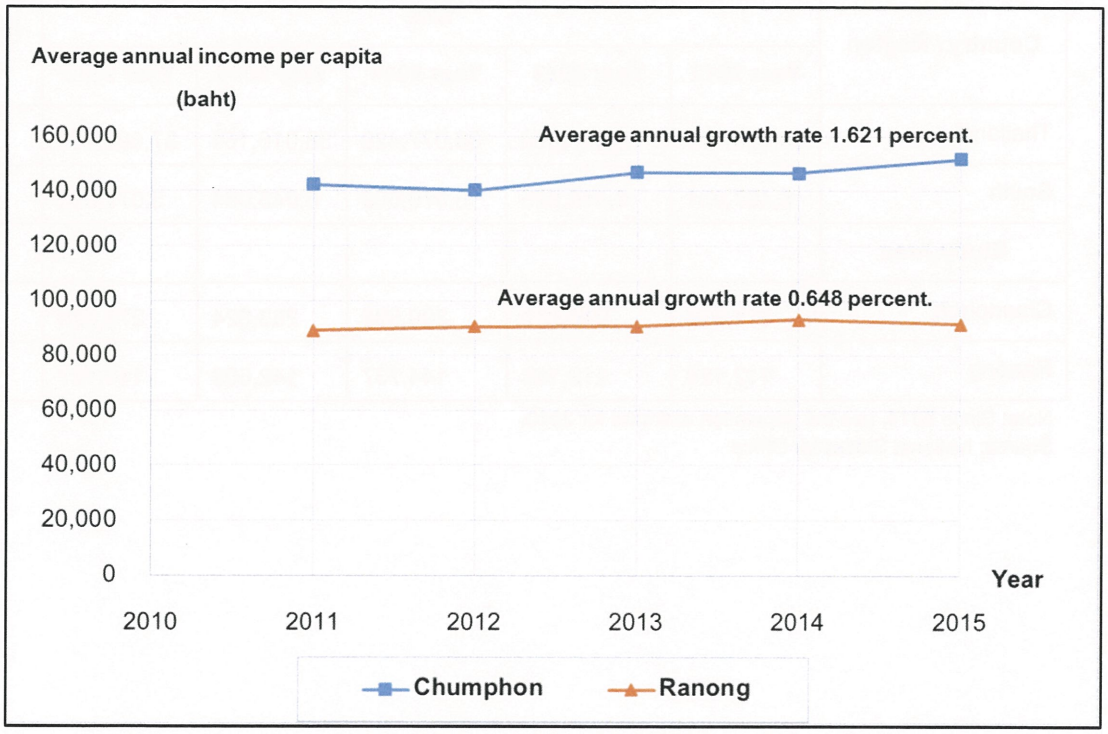


Figure 2.2.1-6 Average Income Per Capita in the Study Area, Year 2011-2015

4) Employment

Employment data will be collected from two agencies, the Ministry of Labor and the National Statistical Office. The information provided by the Ministry of Labor is the information gathered from the registration of the employer. The statistical office's data is based on surveys. When considered, the consultants selected data from the National Statistical for this study, as the information provided by the survey is more comprehensive than that of the Ministry of Labor, based on employer registration. There may be employment that the employer has not registered. The details of employment analysis are as follows.

According to the statistics of employed persons in Thailand in 2012-2016 from the National Statistical Office found that, in 2016, Thailand had the number of employed persons 37,692,651 people, with a downward trend in the average rate of 0.81% per year and the number of employed persons in the southern region was 5,077,565, accounted for 13.47% of nationwide employed persons with an average decrease rate of 1.65% per year. When considering the provinces in the study area, it was found that, in 2016, Chumphon Province had 279,529 employed persons, accounted for 66.6% of all employed persons in the study area with an average decrease rate of 2.63% per year. For Ranong Province, had 140,167 employed persons, accounted for 33.4% with an average increase of 5.74% per year, as shown in **Table 2.2.1-7** and **Figure 2.2.1-7**. The number of employed persons in Chumphon and Ranong in 2016 was ranked in the 52nd and 74th of the country, respectively, and ranked 9th and 14th of the South, respectively.

Table 2.2.1-7 Statistics of Employed Persons in Thailand, South and Provinces in Study Area, Year 2012-2016

(Unit: Person)

Country / Region	Year					Increase rate (%)
	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
Thailand	38,939,130	38,906,889	38,077,429	38,016,169	37,692,651	-0.810
South	5,427,031	5,446,525	5,079,609	5,043,084	5,077,565	-1.650
Study Area						
Chumphon	311,019	310,836	290,095	283,824	279,529	-2.633
Ranong	112,124	112,194	144,737	142,602	140,167	5.739

Note: Since 2014, use the population estimate for 2010.
Source: National Statistical Office

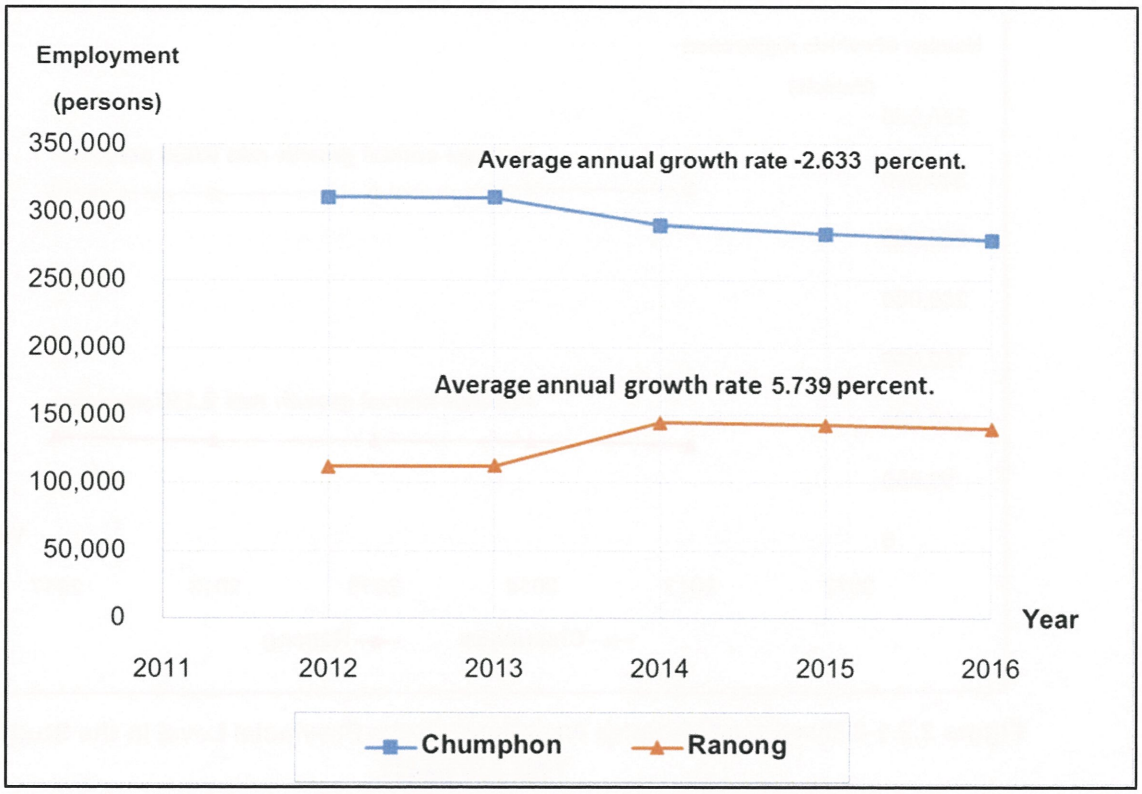


Figure 2.2.1-7 Number of Employed Persons in Provincial Area at the Provincial Level in Study Area, Year 2012-2016

5) Number of Vehicles

According to the car registrations accumulated in the year 2013-2017 of the Department of Land Transport found that Thailand has a total of 38,308,763 registered vehicles, with an average increase rate of 2.56% per year and the south has registered 4,711,358 vehicles, accounted for 12.3% of the total registered vehicles, with an average decrease rate of 0.10% per year. When considering the provinces in the study area, it was found that, Chumphon Province has 292,425 vehicles registered, accounted for 76.8% of the study area, with an average increase rate of 0.0% per year. For Ranong Province, the number of registered vehicles was 88,475, accounted for 23.2% per year, with an average increase rate of 2.26% per year. The details are shown in **Table 2.2.1-8** and **Figure 2.2.1-8**. The number of registered vehicles in Chumphon and Ranong in 2017 was ranked 39th and 75th of the country, respectively, and ranked 6th and 14th of the South, respectively.

Table 2.2.1-8 Number of Vehicles Registered in Thailand, South and Provinces in the Study Area, Year 2013-2017

Country / Region	Number of registered vehicles (cars)					Increase rate (%)
	Year 2013	Year 2014	Year 2015	Year 2016	Year 2017	
Thailand	34,624,406	35,835,180	36,731,023	37,338,139	38,308,763	2.560
South	4,730,932	4,756,029	4,710,362	4,651,270	4,711,358	-0.104
Study area						
Chumphon	292,021	293,535	290,426	288,838	292,425	0.035
Ranong	80,910	83,525	84,501	84,934	88,475	2.260

Note: Vehicle registration number (accumulated) as at 31 December of each year.
Source: Department of Land Transport

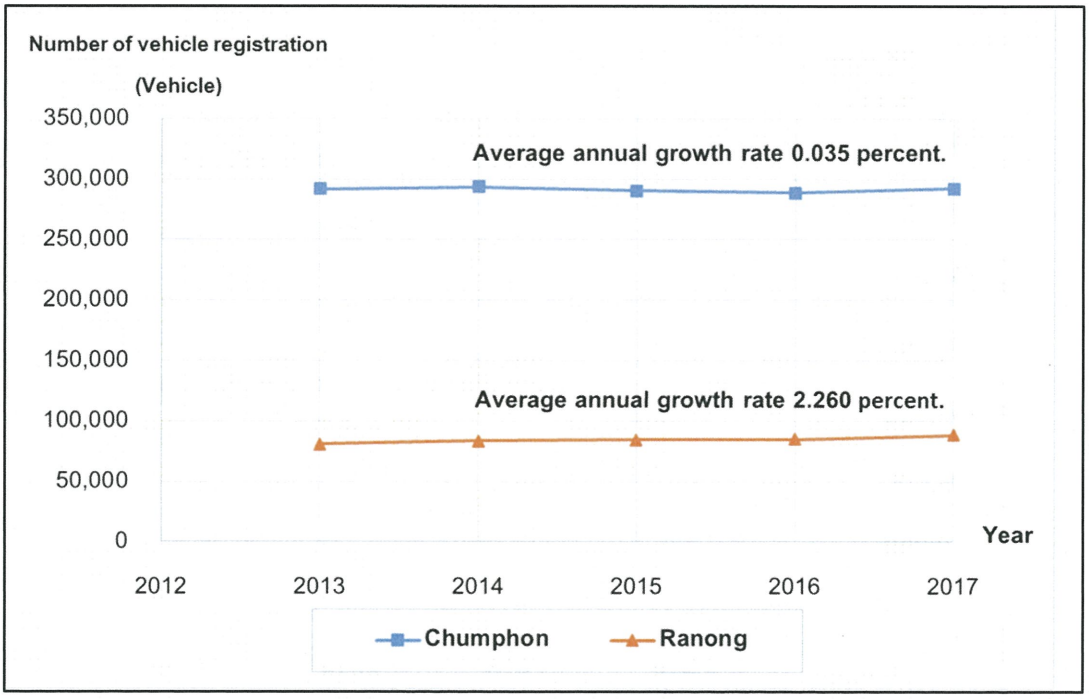


Figure 2.2.1-8 Number of Vehicles Registered at the Provincial Level in the Study Area, Year 2013-2017

6) Border Trade

Ranong has a border area with Myanmar. It consists of 3 districts with 5 border crossing points, including 4 permanent border crossings (passengers), namely: (1) Checkpoint at Pak Nam Pier, Pak Nam Sub-district, Mueang District (2) Checkpoint at Pak Nam Ranong, Pak Nam Sub-district, Mueang District (3) Checkpoint at Andaman Club Pier, Pak Nam Sub-district, Mueang District and (4) Checkpoint at Customs jetty, Ban Khao Nanghong, Pak Nam Sub-district, Mueang District, and the relief point (passenger and cargo), Moo 4 Ban Khao Fa Chi, Bang Kaew Sub-district, La-un District. The statistics of the Thai-Myanmar border trade in Ranong Province in 2016 had a total trade value of 25,578 million Baht, the import value is 8,285.21 million Baht and the export value of 17,292.72 million Baht. Considering the value of imports and exports, the products with the most import value were fish (chilled fish), followed by seamless pipe used in drilling and fish meal, and the products with the most export value were fuel, lubricant, followed by cement and seamless pipe used in drilling, as shown in **Table 2.2.1-9** to **Table 2.2.1-11** and **Figure 2.2.1-9**.

Table 2.2.1-9 Thai-Myanmar Border Trade Information, Ranong Province, Year 2013 - 2016

(Unit: Million Baht)

Item	Year				Increase rate (%)
	2013	2014	2015	2016	
Total value	**26,348.71**	**23,546.71**	**23,147.11**	**25,577.93**	**-0.985**
Export value	21,016.06	19,562.98	17,310.49	17,292.72	-6.293
Import value	5,332.65	3,983.59	5,836.62	8,285.21	15.821

Source: Ranong Commercial Office and Ranong Customs House

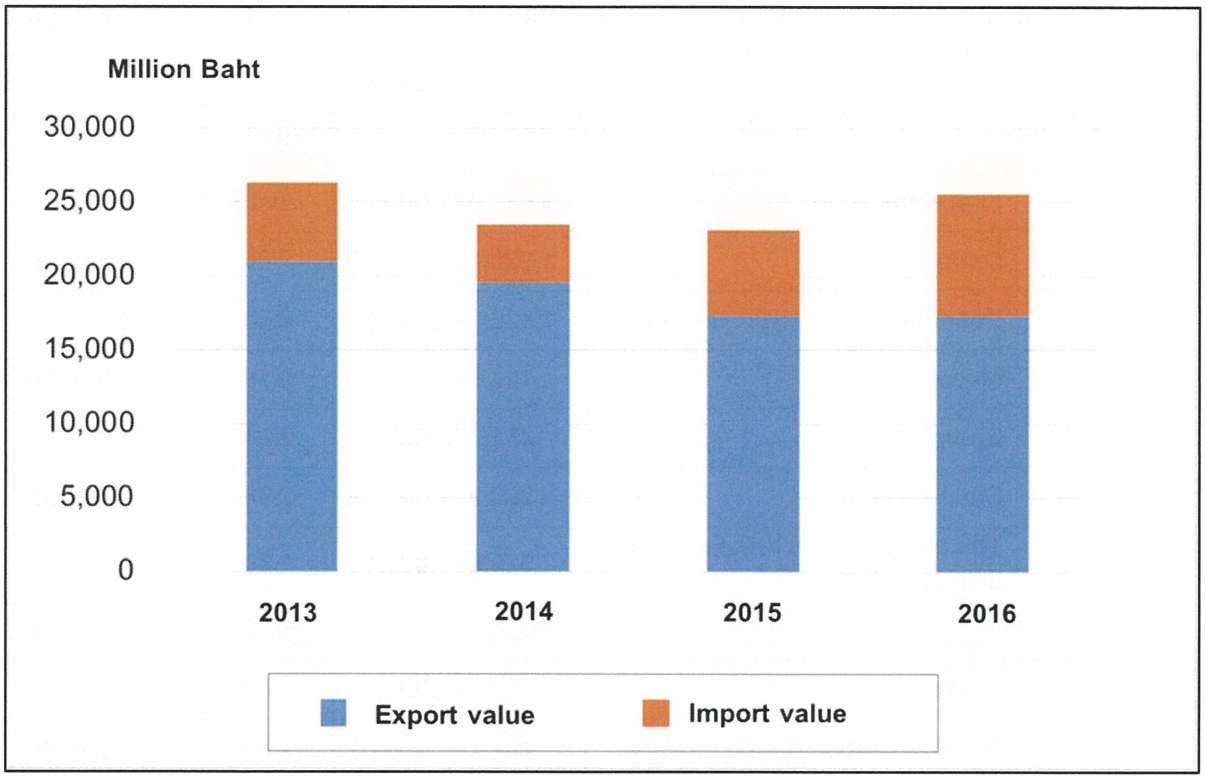


Figure 2.2.1-9 Thai-Myanmar Border Trade Information, Ranong Province, Year 2013 - 2016

Table 2.2.1-10 Thai-Myanmar Border Trade, Ranong Province (Top 10 Imports) in 2016

No.	Kind of product	Value		Weight	
		(Baht)	(%)	(Ton)	(%)
1	Aquatic fish (chilled fish)	1,271,432,713.00	15.35	104,304.14	34.93
2	Seamless pipe used in drilling	797,113,900.91	9.62	16,186.17	5.42
3	Fish meal	774,618,762.22	9.35	24,675.14	8.26
4	Made of iron	580,627,121.04	7.01	2,665.57	0.89
5	Drill Bits used in drilling projects	509,995,025.51	6.16	479.53	0.16
6	Valve - open with accessories	473,504,223.18	5.72	140.83	0.05
7	Drilling and Drilling Equipment	386,070,314.10	4.66	101.26	0.03
8	The pump used in the petroleum drilling project	356,778,014.16	4.31	525.33	0.18
9	Squid chilled, chilled Cockle	280,615,753.00	3.39	11,605.99	3.89
10	Wood charcoal	274,744,004.80	3.32	76,311.67	25.56
11	Other	2,579,737,077.92	31.14	61,580.57	20.62
Total		**8,285,214,909.84**	**100.00**	**298,576.2**	**100.00**

Source: Ranong Customs House

Table 2.2.1-11 Thai-Myanmar Border Trade, Ranong Province (Top 10 Exports) in 2016

No.	Kind of product	Value		Weight	
		(Baht)	(%)	(Ton)	(%)
1	Fuel, lubrication	3,537,011,099.74	20.45	204,459.17	18.13
2	cement	1,220,154,214.05	7.06	614,252.34	54.46
3	Seamless pipe used in drilling.	1,072,921,102.57	6.20	9,786.87	0.87
4	Made of iron	724,572,611.62	4.19	3,020.44	0.27
5	Energy drink	451,713,686.66	2.61	17,879.06	1.59
6	Steel joints	360,237,065.29	2.08	401.05	0.04
7	The pump is used in the offshore drilling project	326,861,821.16	1.89	512.43	0.05
8	Fishing net	321,213,171.29	1.86	2,130.14	0.19
9	Drinks	316,267,506.44	1.83	6,954.05	0.62
10	Drill Bits used in drilling projects	292,757,858.61	1.69	240.64	0.02
11	other	8,669,008,351.02	50.13	268,196.29	23.78
Grand Total		**17,292,718,488.45**	**100.00**	**1,127,832.48**	**100.00**

Source: Ranong Customs House

7) Tourism

In 2016, Thailand had a total of 265,387,106 visitors - times with an average increase rate of 7.46% per year, and the south had 47,534,371 visitors – times accounted for 17.91% of the total number of visitors with an average increase rate of 10.56% per year. The province in the south with the highest number of visitors in 2016 are Phuket, accounted for 28.2% of the visitors in the south, followed by Songkhla and Krabi, accounted for 14.0% and 12.2% of visitors in the south, respectively, as shown in **Table 2.2.1-12** and **Figure 2.2.1-10**.

Table 2.2.1-12 Number of Visitors in Thailand, South and Provinces in the Study Area

Country / Region	Number of visitors (person-time)					Increase rate (%)
	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
Thailand	199,533,210	217,112,440	227,226,499	249,074,211	265,387,106	7.46
Southern	32,355,052	37,631,961	40,641,026	45,923,464	47,534,371	10.56
1. Phuket	10,789,647	11,960,044	11,958,603	13,203,284	13,410,658	5.587
2. Songkhla	4,363,808	5,763,439	6,124,972	6,524,676	6,675,178	11.211
3. Krabi	3,160,738	3,761,234	4,735,217	5,575,541	5,803,836	16.408
4. Surat Thani	3,401,955	4,465,276	4,832,512	5,251,947	5,465,520	12.584
5. Phang Nga	1,612,978	2,158,682	3,730,398	4,176,738	4,475,223	29.061
6. Nakhon Si Thammarat	2,423,367	2,700,594	3,091,896	3,429,760	3,565,814	10.137
7. Phatthalung	1,089,992	1,178,007	1,236,012	1,326,468	1,487,188	8.078
8. Trang	1,137,961	1,281,663	1,308,968	1,414,663	1,465,811	6.534
9. Satun	1,000,424	1,093,479	1,224,234	1,328,813	1,376,430	8.304
10. Chumphon	997,406	1,123,722	1,203,977	1,301,218	1,357,428	8.009
11. Ranong	697,799	775,471	808,915	880,989	923,243	7.250
12. Narathiwat	489,944	570,973	589,690	635,910	646,020	7.158
13. Yala	429,044	563,771	589,653	622,376	624,879	9.856
14. Pattani	214,285	235,606	237,925	251,081	257,143	4.664

Source: Department of Tourism and the Ministry of Tourism and Sports

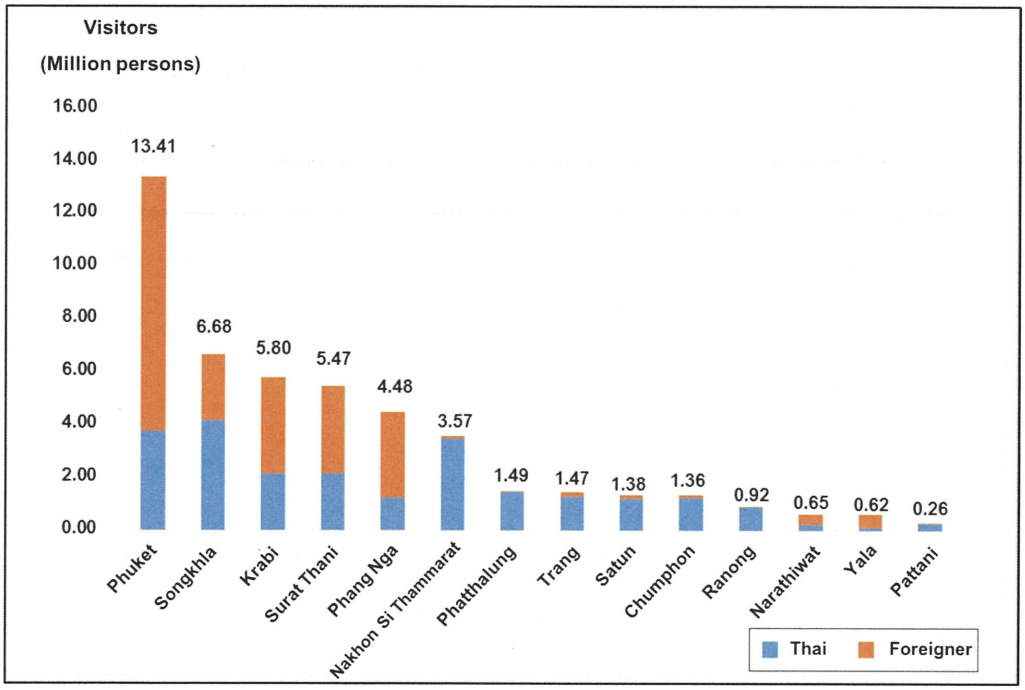


Figure 2.2.1-10 Number of Visitors in the Southern Provinces in 2016

Considered in the study area, in the year 2016 in Chumphon Province, there were 1,357,428 visitors – time, accounted for 2.9% of visitors in the south. For Ranong Province, the number of visitors was 923,243, accounted for 1.9% of visitors in the south, which more than 90% of the visitors in both provinces are Thai visitors, and in 2012-2016, the number of visitors in Chumphon has an average increased rate of 8.0% per year and Ranong has an average increased rate of 7.3% per year. The number of visitors in Chumphon and Ranong province in 2016 was ranked 48th and 54th of the country respectively, and ranked 10th and 11th of the south respectively, as shown in **Table 2.2.1-13** and **Figure 2.2.1-11**.

Table 2.2.1-13 Number of Visitors in the Study Area, Year 2012-2016

Province	Number of visitors (person-time)					Increase rate (%)
	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
Chumphon	**997,406**	**1,123,722**	**1,203,977**	**1,301,218**	**1,357,428**	**8.009**
- Thai	932,422	1,028,332	1,107,739	1,197,913	1,248,569	7.572
- Foreigner	64,984	95,390	96,238	103,305	108,859	13.767
Ranong	**697,799**	**775,471**	**808,915**	**880,989**	**923,243**	**7.250**
- Thai	657,598	729,986	763,058	830,706	870,793	7.273
- Foreigner	40,201	45,485	45,857	50,283	52,450	6.875

Source: Department of Tourism and the Ministry of Tourism and Sports

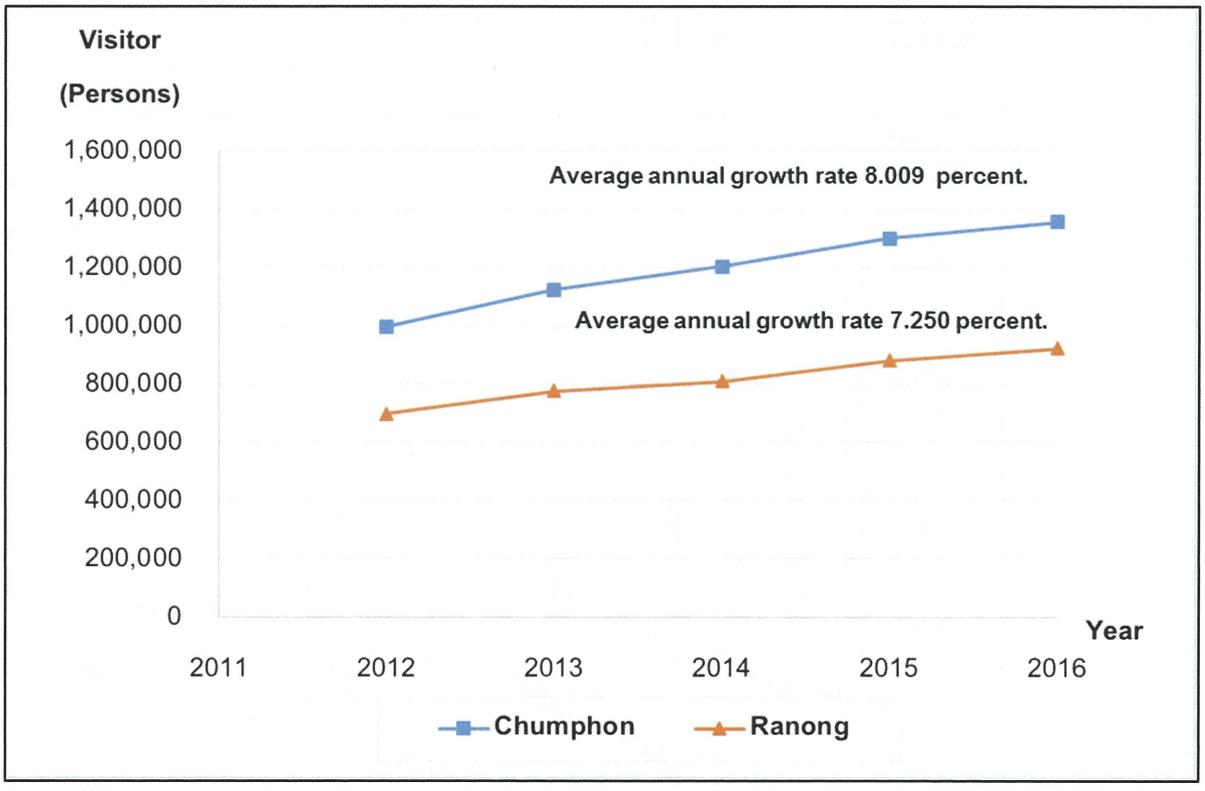


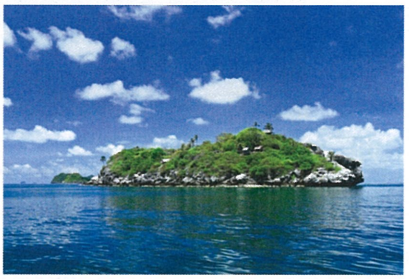
Figure 2.2.1-11 Number of Visitors in the Study Area, Year 2012-2016

Tourist Attractions in Chumphon and Ranong has both historical sites and natural attractions as well as man-made attractions. The details of the major tourist attractions of the two provinces from the tourist information of Thailand are as follows.

- **The major attraction of Chumphon Province**



Krom Luang Chumphon Khet Udomsak Court located on Sairee Beach. It is the site of the monument of Admiral Phra Borommawong Krom Luang Chumphon Khet Udomsak, who established a modern navy to Thailand. He is the goddess of all the ships and the worship of the people. The area of the Krom Luang Chumphon court consists of Chumphon court, located on the northern hills of Sairee Beach, front court facing the sea, nearby is the Museum Building and the frigate royal



National park Chumphon Islands consisting of a group of islands more than 40 islands, each with its own unique natural beauty, some islands have some fine white sandy beaches, some are Limestone Mountains with strangely shaped and beautiful view. The island is still full of coral reefs. The island is popular with tourists to snorkeling, such as Koh Matra, Koh Ngam, Koh Ma Phrao.



Wat Phrathat Sawi is located in Sawi District, a pristine temples of Chumphon Province. There is an important archaeological site contained the relics of the Lord Buddha. The sacred place of the people of Chumphon and people in neighboring provinces. The architecture of the relics of the relics are bell-shaped upside down. At present, the relics have been renovated to use the tiles close the pagoda but still the same pattern.



Kapo Waterfall National Forest Park is located in Hong Charoen Sub-district, Tha Sae District, Chumphon Province, located in the National Forest Kapo Jungle Waterfall with the area of 283 rai. The Forest Department has announced the establishment of a park on October 1, 1958. Inside, there is a small waterfall with water flowing throughout the year, namely; "Kapo Waterfall" is similar to a curved dam.



Wat Phra That Tham Khwan Mueang is located in Na Pho Sub-district, Sawi District, the temple is full of trees. Inside, there is a 20-meter high pagoda containing the relics, located on the top of the limestone with stairs up to approximately 200 steps, around the base is a large courtyard, which serves as a scenic spot of the surrounding district.

- **The major attraction of Ranong Province**



Raksa Warin Hot Spring Park is a naturally occurring well. There are 3 ponds, all 3 of which are about 65 degrees Celsius. The hot springs are analyzed by the Department of Science Service, which contains important minerals and the only source in Thailand is no sulfur additives. It makes no smell of sulfur and purity, can drink from the source without any moderation.



Rattanarangsan Palace (Simulation) is located in Khao Niwet, Mueang Ranong District, is a palace made of teak and iron wood. The palace was built as a memorial to the residence in Ranong Province of 3 kings is King Rama V, King Rama VI and King Rama VII.



Koh Phayam is a large island, second only to Koh Chang (Ranong). The middle of the island is a forest and wildlife species such as monkeys and wild boar. Koh Phayam has 5 beaches with large trees. Rubber plantation and hornbill. It is a place where nature is quite rich.



Wat Waribanpote (Wat Bangnon) is located in Bang Non district, Mueang District, a temple located on a hill, surrounded by mountains. The temple is enshrined the largest reclining Buddha image in the South, with a length of 22 meters. In the construction of a master craftsman of the Fine Arts Department to control the construction. The Buddha has a very beautiful shape. At the bottom of the temple is the site of the Maha Thutiya Chedi Sri Banpote, which is the pagoda shaped like a Myanmar.



Ngao Waterfall National Park Formerly known as Khlong Phrao National Park. The total area is about 417,500 rai or 668 square kilometers, covering the forest area of La-un and Rachakrud in La-un and Mueng Ranong districts. It was designated the 93rd National Park of Thailand on June 2, 1999.

2.2.2 Study and Analysis of Future Change Trends for Socio-Economic Conditions

The consultants have analyzed and forecasted the trend in socio-economic changes. The major variables of future change are gross domestic product, population, per capita income, employment, tourism at the national, regional and provincial levels. This affects the change in the number of trips and vehicles in the future, in which the consultant's forecast is divided into two parts.

- Estimates for base year since the latest year's data for each socio-economic variable will be in both 2015 and 2016, so the forecast for the next year will be updated to 2017, which is the base year used in the study to be consistent with the traffic survey data of the project, which was conducted in 2017.
- Target Year Forecast by forecasting the socio-economic variables in the future year, the target year of 2025, 2034, 2044, and 2054, respectively, to analyze the increase rate of the travel volume in the target year.

Further forecasts for the target year, there are the forecast approach and forecasting results of socio-economic factors affecting travel volumes can be summarized as follows.

1) Population Projections

The consultants have reviewed the population projections of Thailand from various agencies, including the Office of the National Economic and Social Development Board (NESDB), which has been updated since 2013, the previous one was made in 2007, using population data from the Department of Provincial Administration in 2017 (latest year data) as the base year for forecasting and forecasting the population from the year 2017. The population projections are summarized as follows:

- **National-level population forecasts**

  Forecasts continued from the year 2017 to 2039 by using population growth rate data according to the NESDB's population projection, the population projection is from year 2040 to 2054 will use the average growth rate of year 2017-2040 which is equal to -0.111 and use national demographic data as a base for regional and provincial population projections.

- **Regional-level population forecasts**

  Forecasts continued from the year 2017 to 2034 by using population growth rate data according to the NESDB's population projection, the population projection is from year 2035 to 2054 will use the average growth rate of year 2017 to 2035 of each region. Then make adjustments to the National-level totals as predicted.

- **Provincial-level population forecast**

  Forecasts continued from the year 2017 to 2029 by using population growth rate data according to the NESDB's population projection, the population projection is from year 2030 to 2054 will use the average growth rate of year 2017 to 2030 of each province. Then make adjustments to the expected regional totals.

2) Gross Product Value Forecasts

The consultants have reviewed the data from the various agency's forecasts, including:

- The Office of the National Economic and Social Development Board (NESDB)
- Bank of Thailand

Based on the forecasts of various agencies, it can be concluded that the gross national product growth rate is estimated at 4.0 percent and most of the forecasts are in the period of about 1-2 years. There is no agency that has a long-term forecast.

However, the analysis of economic growth rates cannot be considered solely because economic growth is constantly fluctuating. Therefore, it must be considered in the policy of the administration of the country as the government has set the average growth rate at 4.0-5.0 percent. If the economy is growing improperly, such as growing faster or slower than it should, the government will intervene in the policy to keep the growth of the economy at the policy level of about 4.0-5.0 percent per year.

Therefore, the consultant has a guideline for gross product forecasts as follows:

- Forecasts for the value of Gross Domestic Product (GDP) continued from year 2015 (latest data) to 2016 and 2017 with growth rate in 2016[6] and 2017[7] 3.20 and 3.55 percent, respectively, and forecasts continued from the year 2017 with an average annual growth rate of 4.60 percent in the target years.

- Forecasts for the value of Gross Regional Product (GRP) and Gross Provincial Product (GPP) by using the average growth rate of the data collected over the past 10 years in Gross Product Forecast and using GDP forecasts as a base for adjusting GRP. The sum of GRP every region is equal to GDP. Similarly, the sum of GPP every provinces in that region must be equal to GRP.

3) Forecasting on Average Income Per Capita

The consultants have a per capita income projection approach using the same criteria as the Gross Product Forecast and Population Projections, because the average income per capita is directly related to the proportion between GDP and population. Based on this rate of change, it can be analyzed for average per capita income, so the consultant forecasts using the forecasted gross product value divided by the population expected in the future.

4) Employment Forecasts

The consultants have reviewed the forecasting data of relevant agencies and the study of past projects. The proportion of employment for the whole population is relatively stable at 0.55-0.60 and at the regional and provincial levels, the proportion is quite stable as well. It can be said that employment will vary with the increasing population. Therefore, the consultant then predicts employment by using the average employment-to-population ratio.

---

[6] Growth rate in 2016 based on data from the National Economic and Social Development Board
[7] Growth rate in 2017 Based on data from the National Economic and Social Development Board

5) Travel Forecast

The consultants have reviewed the second national tourism development plan (2017-2021) from the Ministry of Tourism and Sports, which predicted and targeted the growth of the number of tourists, both foreign and domestic tourists as follows.

- Domestic travel of Thai tourists has a growth rate not less than 3 percent per year. The number of foreign tourists in 2015, about 30 million, will increase to 110 million in 2035 (the average increase rate of 6.7 percent per year)
- In estimating the number of visitors after year 2035, the consultants used the average increase rate of the number of visitors to half the average increase in the first period.

Details of population forecast, Gross Product Value, average income per capita, employment, number of tourists in the future, both nationally, the south and the study area are shown in **Table 2.2.2-1**.

Table 2.2.2-1 Forecasting of Socio-Economic Data in the Study Area

Region	Base Year 2017	Year				Average Annual Increase Rate (2017-2054)
		2025	2034	2044	2054	
Population Projections (person)						
Thailand	**66,188,503**	**66,989,313**	**66,178,832**	**64,172,277**	**63,461,140**	**-0.114**
South	9,399,578	9,780,031	9,947,458	10,085,859	10,322,699	0.254
Study area	699,989	733,231	748,699	760,652	781,104	0.297
Chumphon	509,590	536,746	550,087	559,974	576,889	0.336
Ranong	190,399	196,485	198,612	200,678	204,215	0.190
Gross Product Value Forecasts (million Baht)						
Thailand	**10,153,348**	**13,895,558**	**19,777,711**	**29,275,844**	**43,335,401**	**4.000**
South	817,551	1,034,633	1,351,191	1,821,296	2,458,527	3.020
Study area	58,237	64,762	71,422	77,420	81,449	**0.911**
Chumphon	40,739	45,812	51,044	55,821	59,098	**1.011**
Ranong	17,498	18,950	20,378	21,599	22,351	**0.664**
Forecasting on Average Income Per Capita (Baht)						
Thailand	**153,531**	**207,429**	**298,853**	**456,207**	**682,865**	**4.116**
South	86,938	105,790	135,833	180,579	238,167	2.761
Study area	171,616	181,796	195,395	207,315	211,891	**0.571**
Chumphon	79,626	85,351	92,793	99,685	102,443	**0.683**
Ranong	91,990	96,445	102,602	107,630	109,448	**0.471**
Employment Forecast (person)						
Thailand	**38,985,028**	**39,456,705**	**38,979,332**	**37,797,471**	**37,378,611**	**-0.114**
South	5,385,958	5,603,958	5,699,893	5,779,197	5,914,907	0.254
Study area	426,432	446,553	455,885	463,115	475,485	0.295
Chumphon	304,372	320,591	328,560	334,465	344,568	0.336
Ranong	122,060	125,962	127,325	128,650	130,917	0.190

Table 2.2.2-1 Forecasting of Socio-Economic Data in the Study Area

Region	Base Year 2017	Year				Average Annual Increase Rate (2017-2054)
		2025	2034	2044	2054	
Predict the Number of Visitors (person)						
Thailand	**275,812,901**	**378,758,011**	**552,430,856**	**705,734,895**	**889,607,342**	**3.216**
South	**49,842,526**	**73,651,585**	**116,946,398**	**157,466,325**	**208,009,771**	**3.937**
Study area	2,355,060	3,054,446	4,126,416	4,993,203	5,965,750	**2.544**
Chumphon	1,402,179	1,824,238	2,475,408	3,005,399	3,603,242	2.584
Ranong	952,881	1,230,208	1,651,008	1,987,804	2,362,508	2.484

Source: Analysis by consultants

2.3 Study on Trade Conditions Between Thailand and BIMSTEC

2.3.1 Overview of Thailand's Trade

In 2016, Thailand's trade with BIMSTEC countries had an export value (in terms of Thai Baht) is approximately 5% of total Thai exports. In the years 2012-2016, Thailand's trade with these countries has value of exports in baht term rises steadily, as shown in **Table 2.3.1-1**.

Table 2.3.1-1 Thailand's Export Market Structure

	Export Value (Million Baht)					Average Growth Rate (%)
	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
AFEC	4,845,631	4,789,032	4,977,588	4,929,136	5,158,870	**1.58**
BMSTEC	305,606	311,998	360,805	364,493	378,498	**5.49**
EU	599,890	607,291	675,811	668,340	701,911	**4.00**
Middle East	354,731	348,967	371,012	350,046	319,570	**-2.58**
Other	971,905	862,255	925,874	913,708	991,855	**0.51**
Total	**7,077,762**	**6,909,544**	**7,311,089**	**7,225,723**	**7,550,704**	**1.63**

Source: Information and Communication Technology Center, Office of the Permanent Secretary by the Cooperation of the Customs Department.

In 2016, Thailand's trade with BIMSTEC countries had an import value (in terms of Thai baht) is approximately 2.6% of total Thai imports. In the years 2012-2016, Thailand's trade with these countries has value of imports in baht term in a volatile manner, with the highest import value in 2013 then declined steadily, as shown in **Table 2.3.1-1**.

Table 2.3.1-2 Thailand's Import Market Structure

	Import Value (Million Baht)					Average Increase rate (%)
	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
AFEC	5,164,550	4,886,687	4,972,015	4,896,291	4,951,705	**-1.05**
BMSTEC	226,848	234,422	229,456	214,052	178,356	**-5.84**
EU	606,199	649,675	602,290	588,549	609,065	**0.12**
Middle East	1,016,250	1,099,240	953,309	629,434	524,231	**-15.25**
Other	772,276	787,609	646,835	577,751	624,830	**-5.16**
Total	**7,786,123**	**7,657,633**	**7,403,905**	**6,906,078**	**6,888,187**	**-3.02**

Source: Information and Communication Technology Center Office of the Permanent Secretary By the cooperation of the Customs Department.

Thailand Trade Market Structure Imports and exports to various countries during 2012 - 2016, as shown in **Figure 2.3.1-1**.

- Thailand's export value grew by 1.63 percent per year. BIMSTEC countries posted the highest increase in export value, at 5.49 percent per year. Followed by EU is growing at a rate of 4.00% per year and APEC growth rate increased by 1.58 percent per year, respectively. For BIMSTEC countries, Thailand's trade with these countries during 2012-2016 has value of exports in baht term rises steadily. In 2016, Thailand's trade with BIMSTEC was valued at 378,498 million Baht, representing about 5.01% of total Thai exports.

- Import value of Thailand has slowed down by 3.02 percent per year, with EU countries posting the highest growth rate of 0.12 percent per year. For BIMSTEC countries, Thailand's trade with these countries in the period 2012 - 2016 had a growth rate of 5.84%. In 2016, Thailand's trade with BIMSTEC was valued at 178,356 million Baht, accounted for about 2.59% of total Thai imports.

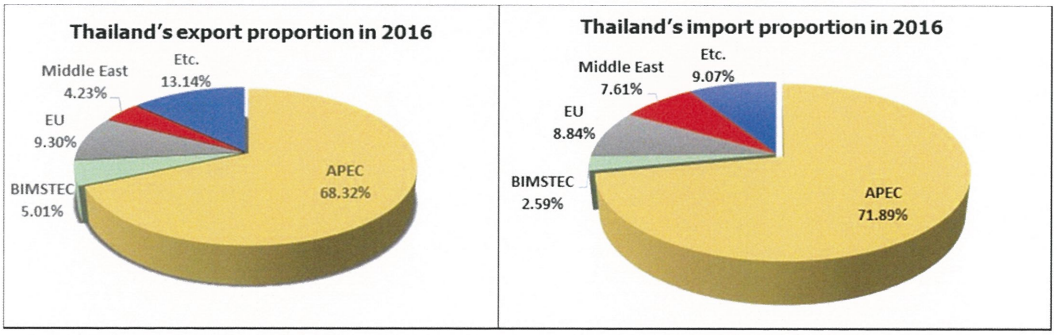


Figure 2.3.1-1 Structure of Export and Import Market of Thailand in 2016

2.3.2 Trade Overview Between Thailand and BIMSTEC

1) Export to BIMSTEC Countries

Exports of Thai to BIMSTEC countries during the years 2007-2016 showed an average growth rate increased by 13.3 percent per year. In 2016, export value BIMSTEC countries have export value of 10,795.8 million US dollars, accounted for 5.01% of total Thai exports.

Considering exports in the year 2016, this group found that exports to India were the most valued at $ 5,155.20 million US dollars. (47.75 per cent of exports to BIMSTEC), followed by Myanmar and Bangladesh (38.70 per cent and 8.71 per cent respectively to BIMSTEC). Thai export to Bhutan has the lowest value of exports in this group, only 0.22% of exports to BIMSTEC as shown in **Table 2.3.2-1** and **Figure 2.3.2-1**.

2) Import from BIMSTEC Countries

Imports of Thailand from BIMSTEC during the years 2007-2016 showed an average growth rate increased by 4.0% per year. In 2016, import value (in US dollars) from BIMSTEC countries with 5,023.7 million US dollars, accounted for 2.59% of total Thai imports.

Considering the importation in 2016 of these countries, it is found that the highest value of Thai imports from India is 2,572.7 million US dollars, accounted for 51.21% of imports from BIMSTEC), followed by Myanmar and Bangladesh, accounted for 46.87% and 1.11% of the import value from the BIMSTEC), respectively. Thailand's imports from Bhutan have the smallest import value in this category, valued at 0.10 million US dollars as shown in **Table 2.3.2-2** and **Figure 2.3.2-1**.

Table 2.3.2-1 Thai export market with BIMSTEC countries

Country	Export Value (Million USD)										Growth Rate (%)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
India	2,662.91	3,345.10	3,223.80	4,393.60	5,181.50	5,473.30	5,181.80	5,608.90	5,294.20	5,155.20	12.4
(%Δ)	(47.1)	(25.6)	(-3.6)	(36.3)	(17.9)	(5.6)	(-5.3)	(8.2)	(-5.6)	(-2.6)	
Myanmar	957.86	1,331.32	1,544.70	2,072.96	2,845.90	3,127.00	3,788.50	4,239.10	4,171.80	4,178.20	19.5
(%Δ)	(26.6)	(39.0)	(16.0)	(34.2)	(37.3)	(9.9)	(21.2)	(11.9)	(-1.6)	(0.2)	
Bangladesh	510.43	574.38	621.60	885.60	1,215.52	764.47	845.86	863.40	858.60	939.70	9.4
(%Δ)	(9.4)	(12.5)	(8.2)	(42.5)	(37.3)	(-37.1)	(10.7)	(2.1)	(-0.6)	(9.4)	
Sri Lanka	273.22	344.52	328.34	401.58	486.95	453.41	422.15	452.20	434.00	431.80	4.6
(%Δ)	(-7.3)	(26.1)	(-4.7)	(22.3)	(21.3)	(-6.9)	(-6.9)	(7.1)	(-4.0)	(-0.5)	
Nepal	38.08	52.60	78.24	69.93	64.45	63.29	55.75	58.00	54.60	66.70	13.1
(%Δ)	(55.9)	(38.1)	(48.7)	(-10.6)	(-7.8)	(-1.8)	(-11.9)	(4.0)	(-5.9)	(22.3)	
Bhutan	2.83	5.83	7.22	13.10	18.42	15.17	25.80	4.00	11.50	24.20	50.4
(%Δ)	(-13.2)	(106.0)	(23.9)	(81.4)	(40.6)	(-17.6)	(70.1)	(-84.4)	(187.1)	(110.4)	
THAI-BIMSTEC	**4,445.34**	**5,653.76**	**5,803.90**	**7,836.77**	**9,812.73**	**9,896.63**	**10,319.86**	**11,225.60**	**10,824.70**	**10,795.80**	**13.3**
(%Δ)	**(32.5)**	**(27.2)**	**(2.7)**	**(35.0)**	**(25.2)**	**(0.9)**	**(4.3)**	**(8.8)**	**(-3.6)**	**(-0.3)**	
THAI-WORLD	**153,865.00**	**177,775.20**	**152,426.50**	**193,298.10**	**222,579.20**	**229,084.30**	**228,498.50**	**227,462.00**	**214,309.60**	**215,387.50**	**5.9**
(%Δ)	**(18.6)**	**(15.5)**	**(-14.3)**	**(26.8)**	**(15.2)**	**(2.9)**	**(-0.3)**	**(-0.5)**	**(-5.8)**	**(0.5)**	

Source : Information and Communication Technology Center with Cooperation of the Customs Department

Note : Numbers in parentheses are the annual percentage rate

Table 2.3.2-2 Import market of Thailand with BIMSTEC countries

Country	Import Value (Million USD)										Growth Rate (%)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
India	2,066.13	2,629.70	1,727.70	2,252.70	3,020.10	3,400.40	3,504.30	3,039.50	2,628.40	2,572.70	14.0
(%Δ)	(27.7)	(27.3)	(34.3)	(30.4)	(34.1)	(12.6)	(3.1)	(-13.3)	(-13.5)	(-2.1)	
Myanmar	2,301.42	3,376.20	2,781.60	2,813.90	3,485.80	3,674.00	4,032.90	3,916.70	3,566.10	2,354.50	2.3
(%Δ)	(-0.9)	(46.7)	(-17.6)	(1.2)	(23.9)	(5.4)	(9.8)	(-2.9)	(-9.0)	(-34.0)	
Bangladesh	14.22	22.08	32.57	24.35	42.20	86.90	63.40	43.50	44.20	55.90	16.7
(%Δ)	(-59.7)	(55.2)	(47.5)	(-25.2)	(73.4)	(105.8)	(-27.0)	(-31.4)	(1.5)	(26.6)	
Sri Lanka	36.23	66.87	61.52	82.92	93.10	95.20	56.70	58.50	54.00	39.90	8.9
(%Δ)	(34.4)	(84.6)	(-8.0)	(34.8)	(12.3)	(2.3)	(-40.5)	(3.1)	(-7.6)	(-26.1)	
Nepal	0.72	0.35	0.62	0.34	1.29	0.61	0.52	0.90	0.80	0.60	27.7
(%Δ)	(46.2)	(-51.4)	(76.7)	(-44.8)	(279.4)	(-52.5)	(-15.1)	(77.4)	(-12.6)	(-26.4)	
Bhutan	24.06	0.08	0.11	0.13	0.09	0.36	0.04	0.10	-	0.10	139.1
(%Δ)	(1,060.7)	(-99.7)	(44.7)	(13.0)	(-26.5)	(285.3)	(-88.3)	(39.6)	(-26.6)	(188.8)	
THAI-BIMSTEC	**4,442.78**	**6,095.27**	**4,604.12**	**5,174.34**	**6,642.59**	**7,257.47**	**7,657.86**	**7,059.20**	**6,293.50**	**5,023.70**	**4.0**
(%Δ)	**(11.0)**	**(37.2)**	**(-24.5)**	**(12.4)**	**(28.4)**	**(9.3)**	**(5.5)**	**(-7.8)**	**(-10.8)**	**(-20.2)**	
THAI-WORLD	**139,958.90**	**179,223.30**	**133,703.70**	**182,927.10**	**228,779.70**	**249,114.70**	**250,416.10**	**227,748.60**	**202,653.00**	**194,198.00**	**5.8**
(%Δ)	**(8.7)**	**(28.1)**	**(-25.4)**	**(36.8)**	**(25.1)**	**(8.9)**	**(0.5)**	**(-9.1)**	**(-11.0)**	**(-4.2)**	

Source : Information and Communication Technology Center with Cooperation of the Customs Department

Note : Numbers in parentheses are the annual percentage rate

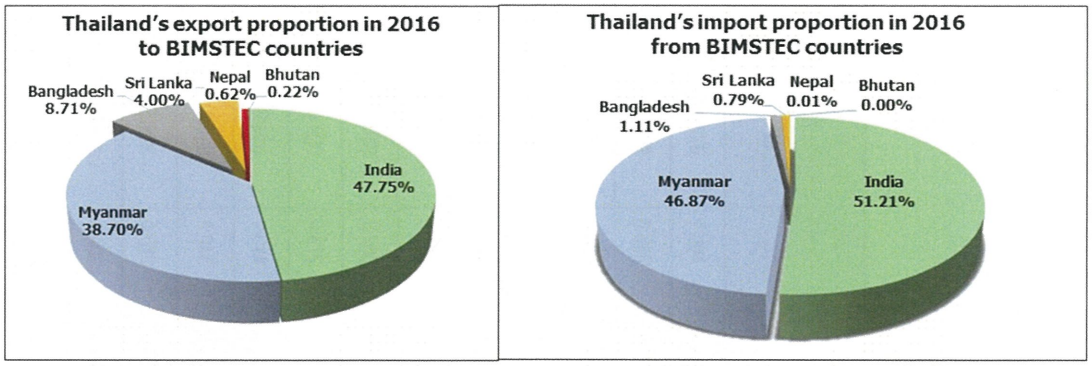


Figure 2.3.2-1 Imports and Exports of BIMSTEC Products in 2016

3) Major product categories for export and import in BIMSTEC

- **Export product**

  Considering the type of goods exported to BIMSTEC during the years 2007-2016. The highest growth rate was found in sugar, with an average growth rate of 139.25 percent per year, followed by beverages with an average growth rate of 28.94 percent per year and air conditioners and components with an average growth rate of 26.12 percent per year. In 2016, Thai exports to BIMSTEC at the highest value of three were chemicals (8.09 percent of exports to BIMSTEC), followed by plastic pellets (7.48% of export value to BIMSTEC) and machinery and mechanical components (5.25% of export value to BIMSTEC), respectively, as shown in **Table 2.3.2-3** and **Figure 2.3.2-2**

Table 2.3.2-3 Major export items to BIMSTEC countries in the years 2007-2016

Product	Export Value (Million USD)										Growth Rate (%)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
1.Chemical products	203.8	245.9	409.8	630.7	898.5	771.0	754.0	893.5	766.1	873.5	20.62
2.Polymers of ethylene, propylene, etc in primary	433.7	500.2	457.2	655.0	719.1	653.7	697.7	787.9	782.0	807.6	8.10
3.Machinery and parts thereof	154.5	188.5	223.2	462.0	581.8	509.5	589.1	646.2	520.9	567.0	19.52
4.Iron and steel and their products	461.0	434.5	195.9	317.1	371.4	828.3	585.8	501.6	516.6	503.9	10.91
5.Motor cars, parts and accessories	173.3	232.7	255.8	399.4	486.7	479.7	470.4	523.0	494.7	486.6	13.66
6.Beverages	45.6	77.3	102.8	161.1	250.1	317.6	322.0	402.6	395.1	373.1	28.94
7.Air conditioning machine and parts thereof	58.4	82.3	83.8	180.4	187.8	292.1	274.6	320.9	307.0	340.3	26.12
8.Sugar	32.9	17.2	222.3	245.3	123.4	94.9	106.7	118.8	273.0	320.4	139.25
9.Refine fuels	177.1	499.9	407.4	340.7	513.2	494.0	569.0	593.8	415.1	319.9	17.87
10.Woven fabrics	140.2	153.6	176.0	230.6	283.3	271.4	320.0	330.2	340.5	310.4	9.91
11.Precious stones and jewellery	100.0	160.6	147.0	246.8	460.1	395.2	391.0	370.0	280.6	309.7	19.12
12.Cement	146.0	167.3	209.8	281.1	234.1	286.3	258.1	298.6	309.2	295.5	9.39
13.Plastic products	77.0	87.6	103.5	130.7	161.7	178.3	241.9	242.2	226.6	251.6	14.73
14.Rubber products	68.0	91.8	101.6	153.5	196.7	222.2	210.2	213.5	219.7	245.3	16.51
15.Radio-broadcast receivers, television receiver	161.5	104.3	132.6	90.7	107.1	175.7	158.9	255.4	263.4	237.7	9.64
Sum 15 Item	**2,433.0**	**3,043.7**	**3,228.7**	**4,525.1**	**5,575.0**	**5,969.9**	**5,949.4**	**6,498.1**	**6,110.6**	**6,242.5**	**11.85**
Other	2,012.3	2,610.1	2,575.2	3,311.7	4,237.7	3,926.8	4,370.5	4,727.4	4,714.1	4,553.3	10.37

Source : Information and Communication Technology Center with Cooperation of the Customs Department

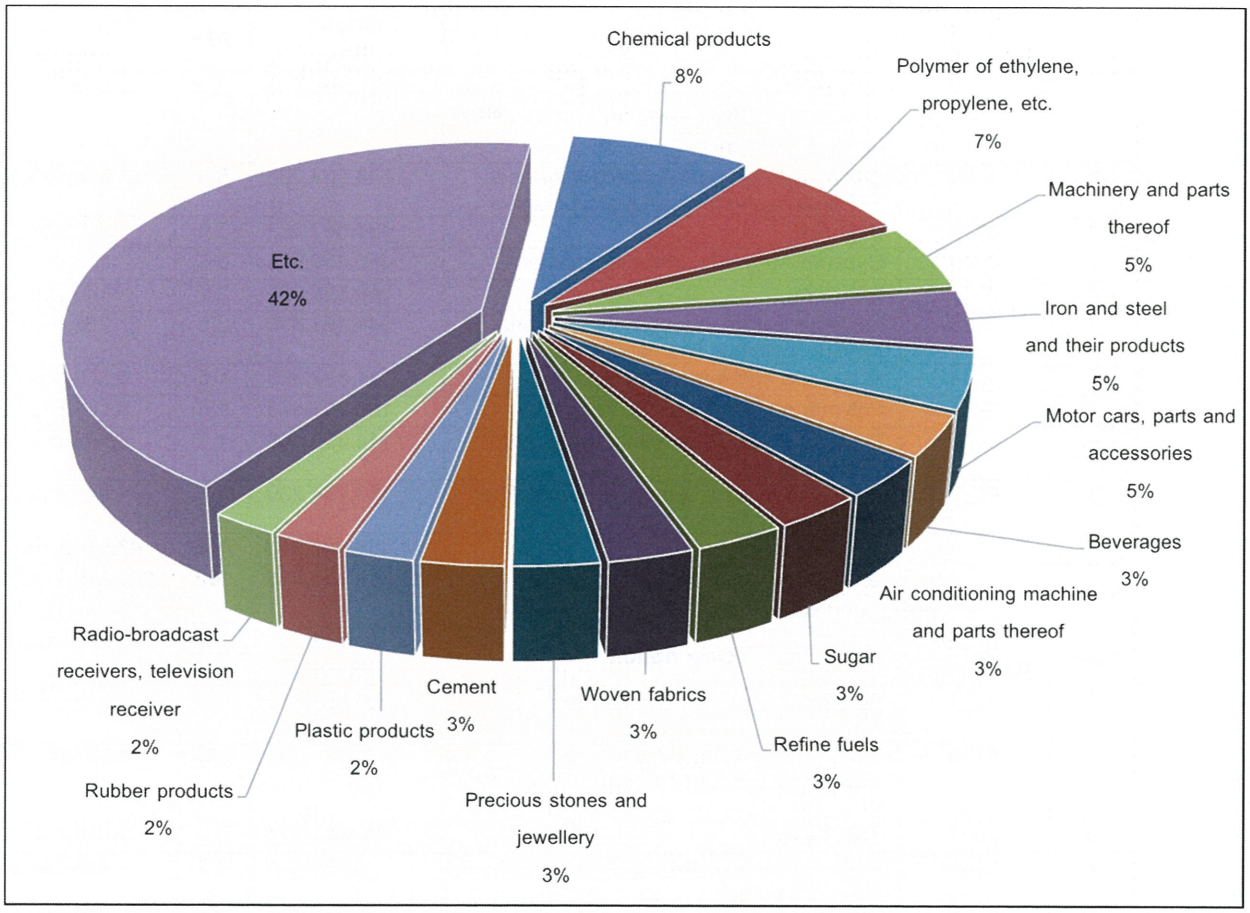


Figure 2.3.2-2 Key Export Categories for BIMSTEC Countries in 2016

In addition to considering the value of exports of the top 15 products, the consultants collected the top 10 products with the export volume in kilograms and liters as shown in **Table 2.3.2-4**, the export of goods to BIMSTEC countries (in kilograms) in 2016 of the top 10 products accounted for 75% of the export volume (in kilograms) to all BIMSTEC, found that the bulk of the exports were cement (51.8%), followed by dolomite and gypsum (5.5%, 3.6% and 3.4% respectively). Export Products (In liters), it was found that the bulk of export products were beverages, especially water drinks, minerals and soft drinks (55.2%), followed by finished oils and beer (37.5% and 6.8% respectively), were among the top 15 exporters.

Table 2.3.2-4 List of Goods Exported to BIMSTEC Countries by Volume (kg) and (liter) Top 10 in 2016

Rank	Code Harmonize	Description	weight (kg)	(%)	Export value (Baht)	(%)
1	2523	Cement Portland Cement Others (not including white cement) and other hydraulic cement.	6,953,546,726	51.8	10,376,761,449	2.7
2	1701	Sugar obtained from sugarcane or beet and pure in chemistry in a solid manner	734,553,206	5.5	11,265,893,180	3.0
3	2518	Dolomite	488,563,363	3.6	177,601,278	0.0
4	2520	Gypsum Anhydrite, including plaster	458,439,809	3.4	518,366,177	0.1
5	2521	limestone	358,522,683	2.7	146,850,984	0.0
6	2529	Feldspar, Lucite, nepheline and nepheline syenite, including fluorescent.	341,381,806	2.5	396,340,452	0.1
7	7204	Scrap and non-ferrous metals	211,893,259	1.6	3,368,238,355	0.9
8	3901	Polymer of ethylene in the first place	186,203,976	1.4	8,161,890,226	2.2
9	3907	Polycarbonate Other epoxy resins and epoxide resins.	144,818,185	1.1	8,508,058,345	2.2
10	6811	Made of asbestos cement Cellulose fiber cement	130,764,230	1.0	947,636,374	0.3
10 items			**10,008,687,243**	**74.6**	**43,867,636,820**	**11.6**
Total export volume (kg)			**13,418,729,095**	**100**	**235,240,795,208**	**62.2**
Total export value to BIMSTEC			-	-	**378,162,067,663**	**100**
Rank	**Code Harmonize**	**Description**	**weight (liter)**	**(%)**	**Export value (Baht)**	**(%)**
1	2202	Water includes mineral water and soft drinks	999,836,626	55.2	7,243,246,240	1.9
2	2710	Petroleum and mineral oils from bituminous minerals, in addition to crude oil	679,301,558	37.5	10,304,002,697	2.7
3	2203	Malt beers	122,553,351	6.8	2,888,710,798	0.8
4	2208	Ethyl alcohol Alcoholic strength by volume is less than 80%	4,954,055	0.3	2,240,894,957	0.6
5	2204	Wine is made from fresh grapes. Including wine with alcohol.	4,633,161	0.3	580,928,044	0.2
6	2209	vinegar	342,725	0.0	5,745,843	0.0
7	2207	Ethyl alcohol Alcoholic strength by volume of 80% or more.	159,270	0.0	32,517,890	0.0
8	2205	Vermont and other wines. Made from fresh grapes.	8,451	0.0	1,673,601	0.0
9	2206	Other fermented beverages	404	0.0	140,203	0.0
10	2709	Crude petroleum and crude oil from bituminous minerals.	50	0.0	1,737	0.0
Total Export Volume (L)			**1,811,789,651**	**100**	**23,297,862,010**	**6.2**
Total export value to BIMSTEC			-	-	**378,162,067,663**	**100**

Source: Information and Communication Technology Center Office of the Permanent Secretary By the cooperation of the Customs Department.

- **Import product**

  Considering the type of imported BIMSTEC products during the years 2007-2016, the most productive growth was coffee, tea, spices, with an average growth rate of 59.62 percent per year, followed by steel and products, with an average growth rate of 35.90 percent per year. With regard to 2016, the imported products from BIMSTEC group, the top three value is natural gas (38.83% of total imports from BIMSTEC), followed by chemicals (6.97% of imports from BIMSTEC) and gemstone, jewelry, bars and gold (5.80% of total imports from BIMSTEC), respectively as shown in **Table 2.3.2-5** and **Figure 2.3.2-3**.

Table 2.3.2-5 Major Imports from BIMSTEC 2007-2016

Product	Import Value (Million USD)										Growth Rate (%)
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
1.Natural gas	2,068.3	3,119.1	2,327.2	2,595.4	3,292.2	3,423.0	3,674.7	3,539.7	3,272.4	1,950.8	2.61
2.Chemicals	201.1	268.5	205.2	238.3	314.0	290.7	306.4	357.4	418.9	350.1	8.14
3.Jewellery including silver bars and gold	430.1	456.3	327.5	374.2	707.5	743.8	558.7	280.0	264.7	291.3	1.79
4.Machinery and parts	105.3	118.4	127.5	226.7	288.2	401.2	319.6	297.1	281.7	270.3	14.18
5.Parts and accessories of vehicles	40.1	48.6	79.4	124.0	137.8	225.0	228.3	281.7	240.0	235.5	24.81
6.Fresh aquatic animals, chilled, frozen, processe	38.3	62.3	66.6	104.4	119.1	114.8	140.4	110.4	138.5	200.7	23.12
7.Electrical machinery and parts	31.3	43.6	47.1	68.7	66.3	75.7	88.3	108.4	123.3	171.2	21.76
8.Medicinal and pharmaceutical products	76.1	91.2	97.1	108.6	140.1	139.0	141.6	173.9	181.5	152.0	8.80
9.Other metal ores, metal waste scrap	328.3	380.1	156.0	269.6	226.0	144.3	147.3	252.2	196.1	150.9	0.59
10.Vegetables and vegetable products	145.7	341.9	190.1	182.9	262.0	426.2	424.7	237.0	150.1	125.9	10.56
11.Coffee, tea and spices	3.5	8.0	7.4	6.1	16.9	31.3	31.7	38.3	49.8	108.9	59.62
12.Iron, steel and products	75.5	228.3	80.7	70.2	68.3	157.0	431.9	157.2	81.1	87.7	35.90
13.Edible meat	42.2	67.5	61.5	64.7	89.1	109.1	73.4	70.0	57.4	73.8	9.96
14.Yarn and fibers	77.9	94.9	61.2	81.0	112.3	176.7	143.4	100.0	71.8	70.5	3.95
15.Garments	5.4	8.4	12.2	14.7	20.0	29.5	41.3	46.6	52.2	64.6	32.60
Sum 15 Item	**3,669.1**	**5,337.1**	**3,846.7**	**4,529.5**	**5,859.8**	**6,487.3**	**6,751.7**	**6,049.9**	**5,579.6**	**4,304.2**	**4.27**
Other	773.7	758.2	757.4	644.8	782.8	770.2	505.8	1,009.3	713.9	719.5	4.39

Source : Information and Communication Technology Center with Cooperation of the Customs Department

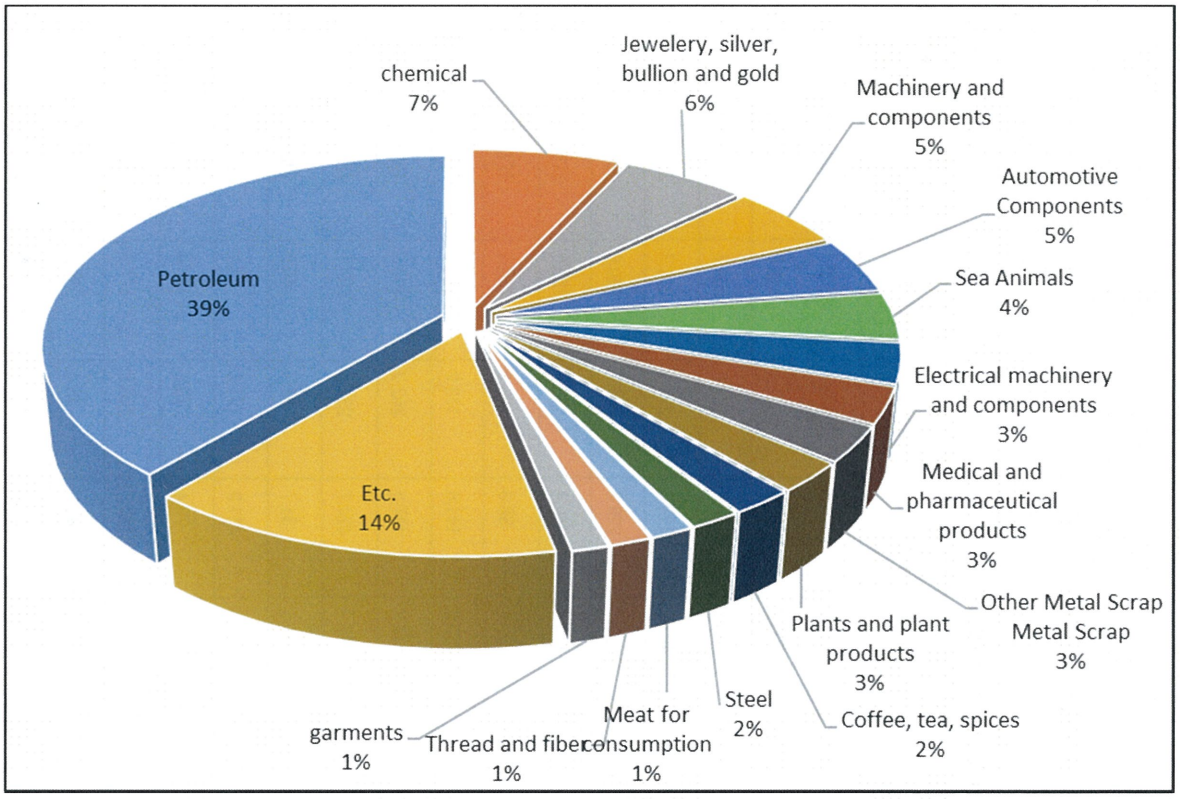


Figure 2.3.2-3 Imports of key products from BIMSTEC countries in 2016

In addition to considering the import value of the top 15 products. The consultants collected the top 10 products with the import volume in kilograms and liters as shown in **Table 2.3.2-6**, the import of goods from the BIMSTEC group (in kilograms) in 2016 of the top 10 products accounted for 91% of the volume of imports. From the BIMSTEC group, found that the bulk of imports were natural gas (84.8%), followed by chilled and frozen fish, salt, charcoal and steel (1.3% 1.0% 0.7% and 0.7% respectively). In terms of volume (in liters), the bulk of imported products were instant oil (99.2%), followed by beverages (0.8%),

Table 2.3.2-6 List of Products Imported from Countries in the BIMSTEC Group by Volume (kg and liter) Top 10 in 2016

Rank	Code Harmonize	Description	weight (kg)	(%)	Import value (Baht)	(%)
1	2711	Other petroleum and hydrocarbon gases	9,134,986,034	84.8	69,285,801,525	38.8
2	0302	Fresh or chilled fish	145,193,210	1.3	1,955,719,462	1.1
3	2501	Salt, including sea water	108,917,810	1.0	67,674,789	0.0
4	4402	Charcoal (including charcoal or nut)	78,114,156	0.7	322,790,982	0.2
5	7201	Smelting iron and spikelet steel are squalane or other essential elements	73,217,640	0.7	634,971,626	0.4
6	0303	Frozen fish	62,465,604	0.6	4,055,758,758	2.3
7	0511	Fish or fish products that are inanimate and unfit for human consumption.	55,442,180	0.5	168,516,438	0.1
8	0904	Chili in the clan. Including Capsicum chili or Piemonte. Dried or crushed	53,553,178	0.5	3,683,983,960	2.1
9	7202	Steel Ingot (Ferro Alloy)	41,273,771	0.4	1,108,373,854	0.6
10	2526	Natural titmouse and tart	38,819,990	0.4	276,852,010	0.2
10 items			**9,753,163,583**	**90.9**	**81,283,591,394**	**45.6**
Total import volume (kg)			**10,768,983,097**	**100**	**141,251,493,640**	**79.2**
Total import value from BIMSTEC			-	-	**178,355,510,856**	**100**
Rank	**Code Harmonize**	**Description**	**weight (liter)**	**(%)**	**Import value (Baht)**	**(%)**
1	2710	Petroleum and mineral oils from bituminous minerals. In addition to crude oil	107,923,129	99.2	1,457,297,849	0.82
2	2208	Ethyl alcohol Alcoholic strength by volume is less than 80%	409,319	0.4	35,377,356	0.02
3	2203	Malt beers	384,601	0.3	14,872,319	0.01
4	2207	Ethyl alcohol Alcoholic strength by volume of 80% or more	80,000	0.1	2,256,948	0.00
5	2204	Wine is made from fresh grapes. Including wine with alcohol	877	0.0	233,887	0.00
6	2202	Water includes mineral water and soft drinks	63	0.0	18,743	0.00
7	2709	Crude petroleum and crude oil from bituminous minerals	4	0.0	1,791	0.00
Total import volume (Liter)			**108,797,993**	**100**	**1,510,058,893**	**0.8**
Total import value from BIMSTEC			-	-	**178,355,510,856**	**100**

Source: Information and Communication Technology Center Office of the Permanent Secretary By the cooperation of the Customs Department.

2.3.3 Analysis of Potential Export and Import Goods in BIMSTEC Countries

- **Export product**

  Considering the export of goods to BIMSTEC countries in terms of export volume and export value, it was found that the potential export products to BIMSTEC countries are:

  - Cement (HS 2523)
  - sugar (HS 1701)
  - Alcoholic beverages and vinegar (HS 22)
  - finished oil (HS 2710)
  - Plastic pellets (HS 3901 3907)
  - Iron and steel (HS 7204)
  - gypsum (HS 2520)
  - Dolomite (HS 2518)
  - Rubber (HS 4001 4011)
  - Automotive Components and Equipment (HS 8708)

  In order to know the major export markets of each potential export category to BIMSTEC countries, the consultants have collected the export quantity of goods in the year 2016 of each type of goods, classified by BIMSTEC countries as shown in **Table 2.3.3-1**, the major export markets for BIMSTEC are India, Myanmar, Bangladesh and Sri Lanka. For Nepal and Bhutan, there is a very small amount of Thai exports. India is a major export market for Thai products in many products such as plastic products, iron and steel, dolomite, rubber and its components and accessories. Myanmar is a major export market for Thai products such as cement, sugar, beverages and finished products. Bangladesh is the export market for Thai products such as cement and gypsum of Thailand. For Sri Lanka, Thailand is a major exporter of gypsum.

Table 2.3.3-1 Exports of 10 major products to BIMSTEC countries in 2016

Product	India	Myanmar	Bangladesh	Sri Lanka	Nepal	Bhutan	Total
Cement (KG)	18,026,902	2,748,845,899	3,825,967,762	360,706,163	-	-	**6,953,546,726**
Proportion (%)	(0.26)	(39.53)	(55.02)	(5.19)	(0.00)	(0.00)	**(100.00)**
Beverages, spirits and vinegar (LT)	7,228,139	1,114,411,445	1,912,032	136,852	8,679,718	119,857	**1,132,488,043**
Proportion (%)	(0.64)	(98.40)	(0.17)	(0.01)	(0.77)	(0.01)	**(100.00)**
Sugar (KG)	1,865,017	679,770,373	2,525,750	50,391,066	1,000	-	**734,553,206**
Proportion (%)	(0.25)	(92.54)	(0.34)	(6.86)	(0.00)	(0.00)	**(100.00)**
Petroleum oils (LT)	31,947,303	630,508,271	8,969,182	7,876,802	-	-	**679,301,558**
Proportion (%)	(4.70)	(92.82)	(1.32)	(1.16)	(0.00)	(0.00)	**(100.00)**
Dolomite (KG)	488,507,150	-	56,213	-	-	-	**488,563,363**
Proportion (%)	(99.99)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	**(100.00)**
Gypsum (KG)	111,773,270	3,131,275	192,488,210	151,047,054	-	-	**458,439,809**
Proportion (%)	(24.38)	(0.68)	(41.99)	(32.95)	(0.00)	(0.00)	**(100.00)**
Polymers of ethylene, propylene, etc in primary (KG)	254,262,778	31,647,060	36,556,346	7,787,799	487,678	280,500	**331,022,161**
Proportion (%)	(76.81)	(9.56)	(11.04)	(2.35)	(0.15)	(0.08)	**(100.00)**
Iron and steel and their products (KG)	178,824,597	124,387	32,922,930	21,345	-	-	**211,893,259**
Proportion (%)	(84.39)	(0.06)	(15.54)	(0.01)	(0.00)	(0.00)	**(100.00)**
Rubber (New pneumatic tyres, of rubber.) (KG)	95,124,033	11,351,524	2,352,616	14,348,224	4,570	1,434	**123,182,401**
Proportion (%)	(77.22)	(9.22)	(1.91)	(11.65)	(0.00)	(0.00)	**(100.00)**
Motor cars, parts and accessories (KG)	33,327,476	6,449,289	1,793,072	821,186	32,222	14,026	**42,437,271**
Proportion (%)	(78.53)	(15.20)	(4.23)	(1.94)	(0.08)	(0.03)	**(100.00)**

Source : Information and Communication Technology Center with Cooperation of the Customs Department

- **Import product**

  Considering the import data from BIMSTEC countries in terms of import volume and import value, it is found that the potential imports from BIMSTEC countries are:

  - Fresh fish, chilled (HS 0302 0303)
  - Iron and steel (HS 7201 7202)
  - Charcoal (HS 4402)
  - Finished oil (HS 2710)
  - Automotive Components and Equipment (HS 8708)

  In order to know the major source of imports in each category of potential goods imported from BIMSTEC countries, the consultants have collected the import volume of goods in the year 2016 of each type of goods as shown in **Table 2.3.3-2** shows that major import sources of BIMSTEC countries are India and Myanmar. For other countries, imports of Thai products with very low import volumes. India is a major importer of Thai goods in many commodities, including iron and steel, car parts & accessories and finished oil. For Myanmar, is a major source of imports of Thai products in the category of fresh fish, chilled fish and charcoal.

Table 2.3.3-2 Imports of 5 key products from BIMSTEC countries in 2016

Product	India	Myanmar	Bangladesh	Sri Lanka	Nepal	Bhutan	Total
Fish, frozen (KG)	61,060,366	146,571,988	26,460	-	-	-	**207,658,814**
Proportion (%)	(29.40)	(70.58)	(0.01)	(0.00)	(0.00)	(0.00)	**(100.00)**
Iron and steel and their products (KG)	114,491,411	-	-	-	-	-	**114,491,411**
Proportion (%)	(100.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	**(100.00)**
Petroleum oils (LT)	107,923,129	-	-	-	-	-	**107,923,129**
Proportion (%)	(100.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	**(100.00)**
Wood charcoal (KG)	4,368,111	73,746,045	-	-	-	-	**78,114,156**
Proportion (%)	(5.59)	(94.41)	(0.00)	(0.00)	(0.00)	(0.00)	**(100.00)**
Motor cars, parts and accessories (KG)	26,578,137	4,142	-	4,270	-	-	**26,586,549**
Proportion (%)	(99.97)	(0.02)	(0.00)	(0.02)	(0.00)	(0.00)	**(100.00)**

Source : Information and Communication Technology Center with Cooperation of the Customs Department

2.4 Conclusion

2.4.1 Policy Compliance and the Development Strategy of the Transportation Infrastructure of the Country

From a review of the country's transport infrastructure development policy and strategy, it will focus on promoting the development of rail transport in both passenger and cargo transport. This is because rail transport is a form of transportation that uses energy efficiently and is environmentally friendly, thus contributing to air pollution and environmental problems that are lower than road transport, it also reduces traffic problems. The policy and strategy can be summarized as follows.

- The 20-Year National Strategy and 12th national economic and social development plan, plan to develop infrastructure and logistics systems by promoting rail transport and logistics centers in various forms linking the industrial production base to the country's trade gate. Specific strategies for the development of the region and the city have been proposed, which is an important strategy that has significant implications for the tourism industry and services, by promoting tourism links between southern Andaman and Gulf of Thailand, with the development of potential tourist destinations to add value to the region by raising Ranong Province as a health tourism and spa and Chumphon is an agricultural tourism.
- The 3rd Strategic Plan for Logistics Development in Thailand requires a strategy for the development of transport infrastructure and logistic networks along the strategic route to link the sub-region and to be a trading gate, by supporting the shift to a more efficient transportation model, promoting the modification of transport modes (Shift Mode) and multimodal transport. Develop and improve railway network as the main transport network in the country. Including the development of facilities and logistics activities.
- Development Strategies for Thailand's Transport System for 20 Years and Strategic Development of Transport Infrastructure of Thailand, 2015-2022, plan to develop transport network, focusing on rail infrastructure as the primary transport model by developing a rail network between cities to reduce transportation costs. Including the integration of existing infrastructure management to maximize utilization.
- The 2nd National Tourism Development Plan and the Southern Region Development Strategy, as well as the Chumphon and Ranong Development Strategies, have plans to develop infrastructure and facilities to support the expansion of tourism and development of quality of tourism, products and services for sustainable tourism, as well as support for Ranong Port as a gateway to the Andaman Sea.

Considering the consistency of the Chumphon - Ranong Railway Project with the development policy and strategy of the country, it can be concluded that ***the Chumphon - Ranong Railway Project will create a link between the two coasts (the Andaman and the Gulf of Thailand), which will promote tourism between the two coasts. It also connects freight transport between the production base to the Ranong port, which is the trading gateway to the Andaman side, linking with BIMSTEC countries in the form of travel and transport by train, which used energy efficient and environmentally friendly.***

2.4.2 Compilation and Analysis of Basic Socio-Economic Data

In studying and forecasting railway passenger volume, the project compiled and analyzed the trend of factors in economic and social conditions, which is the basic factor in the demand for travel, which consists of GDP, population, per capita income, employment, tourism at the national, regional and provincial levels from related sources, can be summarized as follows.

- In 2017, Chumphon Province had a population of 509,590 and Ranong Province had a population of 190,399, with the increase rate of population in Chumphon and Ranong by 0.336% and 0.190%, respectively.
- In 2015, Chumphon Province had a GDP value of 40,055 million Baht and Ranong Province had a GDP value of 17,297 million Baht with the increase rate of the GDP value of Chumphon and Ranong by 1.011% and 0.664%, respectively.
- In 2015, Chumphon Province has the average income per capita of 151,835 Baht / year and Ranong Province has the average income per capita of 91,452 baht / year, with the increase rate of the average per capita income of Chumphon and Ranong by 0.683% and 0.471%, respectively.
- In 2016, Chumphon Province had 279,529 employed persons and Ranong Province had 140,167 employed persons, with the increase rate of number of employed persons in Chumphon and Ranong by 0.336% and 0.190%, respectively.
- In 2013, Chumphon Province had 1,357,428 visitors - times and Ranong had 923,243 visits, with the increase rate of number of visitors in Chumphon and Ranong by 2.584% 2,484%, respectively.

2.4.3 Trade Between Thailand and BIMSTEC

In studying and forecasting the freight volume on the railway project, it will be transported through Ranong Deep Sea Port to neighboring Andaman coast. Currently, it is transported through many private ports in Ranong Province for export and import to Myanmar, which is a result of border trade. While the Ranong Deep Sea Port, which is a port that is supervised by the Port Authority of Thailand, has not yet been transported through the port to the Andaman Sea, especially BIMSTEC countries, which currently does not carry freight through Ranong Deep Sea Port.

The Thai-Myanmar border trade statistics in Ranong for the year 2016 had a total trade value of 25,578 million Baht, an import value of 8,285.21 million Baht, and export value of 17,292.72 million Baht. Considering the value of imports and exports, it is found that the most import products are aquatic animals. (chilled fish), followed by seamless pipes for drilling and fish meal, and products with the highest export value were fuels, lubricants, followed by cement and seamless pipes for drilling.

There is also a need to study trade conditions with BIMSTEC countries, which currently do not carry freight through Ranong Deep Sea Port. Most of the products are produced and consumed in the upper area and transported through Bangkok Port and Laem Chabang Port. Therefore, the trade study will give an insight into the types of goods and the volume of goods that will be important to analyze the potential cargoes that will be transported via Ranong Port in the case of the construction of the Chumphon-Ranong Deep Sea Port Railway project. In 2016, Thailand's trade with BIMSTEC countries had an export value (in Baht terms) accounted for 5.0% of total Thai exports and import value (in Baht terms) accounted for 2.6% of total Thai imports. Considering the export

and import of BIMSTEC products in terms of export volume and export value, it was found that:

- Major products with export potential are cement (HS 2523), sugar (HS 1701), liquor and vinegar (HS 22), finished oils (HS 2710), plastics pellets (HS 3901 3907), iron and steel (HS 7204) gypsum (HS 2520) dolomite (HS 2518), rubber (HS 4001 4011), car components and accessories (HS 8708)
- Major products with import potential are fresh fish chilled and frozen fish (HS 0302 0303), iron and steel (HS 7201 7202), wood charcoal (HS 4402), finished oils (HS 2710), car components and accessories (HS 8708)

Chapter 3

Analysis/Evaluation/Selection of Appropriate Route Alignment

Chapter 3
Analysis/Evaluation/Selection of Appropriate Route Alignment

3.1 Preparation of Basemap

The Consultant has used a set of L7018 maps of the Royal Thai Survey Department on the scale of 1:50,000 (as shown in **Figure 3.1-1**) covering the areas of the 4 alternative route alignments. The maps have been scanned into digital file format. The Consultant has also used satellite images in digital file format with the minimum resolution of 1 meter per pixel (as shown in **Figure 3.1-2**) covering the project area. Both maps and satellite images have been rectified into UTM (Universal Transverse Mercator) based on WGS84 for preparing a basemap.

3.2 Consideration of the Feasibility of Route Alignment

3.2.1 Origin-Destination

The Consultant has studied the southern railway from Chumphon-Ranong Provinces in order to develop the new railway from the Gulf of Thailand to the Andaman Sea for transportation and tourism purposes including linking to Ranong Deep Sea Port. The route shall be able to link the origin-destination of potential freights/passengers to use the rail system. The Consultant has surveyed the origin-destination linkages of freights/passengers which may influence the determination and design of alternative route alignments, e.g.

- Location of the station and use of the surrounding area.
- The existing location of container yard and inland container depot and as planned for the future.
- The current development projects or future projects concerning transportation demand.
- General environmental impacts.
- The survey enabled the Consultant to know the potential and feasibility of railway system development that shall be able to fulfill more transportation demands in the future.

The Consultant has the idea that the starting point of the project shall be on the existing southern railway in Chumphon Province and the ending point shall be at Ranong Deep Sea Port. The next section described the starting point and ending point of alternative route alignments.



Figure 3.1-1 L7018 Maps of the Royal Thai Survey Department on the Scale of 1:50,000

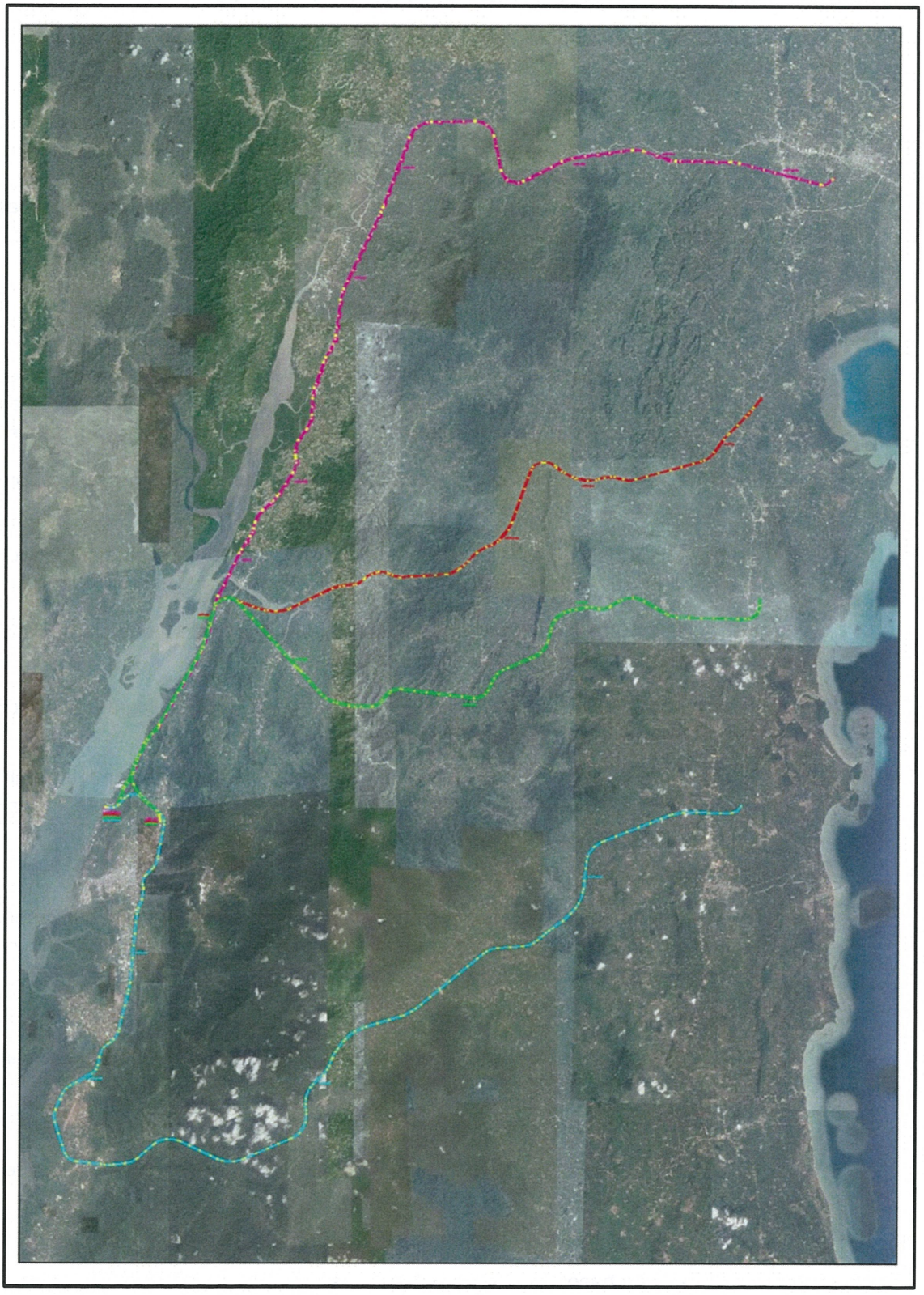


Figure 3.1-2 Satellite Images with the Minimum Resolution of 1 Meter Per Pixel

3.2.2 Criteria for Selection of Alternative Route Alignments

The Consultant has selected the alternative route alignments to analyze for the most appropriate route alignment of the project based on the following criteria:

1) Basemap

   Besides satellite images and aerial photographs, the Consultant has used other maps, e.g. watershed classification, national park, wildlife sanctuary, wetland, mangrove forest, national reserved forest and fault zone for preparing a basemap to analyze and design the appropriate route alignment by taking into account the engineering principles and environments.

2) Survey the origin-destination linkages of potential freights/passengers to use the rail system

   The Consultant has surveyed the origin-destination linkages of freights/passengers from satellite images and aerial photographs including field survey in the area which may influence the determination and design of alternative route alignments, e.g.

   (1) Location of the station and use of the surrounding area by communities including major tourist attractions.

   (2) The existing location of container yard and inland container depot and as planned for the future.

   (3) The current development projects or future projects concerning transportation demand at regional and national levels.

   (4) Topography along the selected alternative route alignments which affects directly to the train operation cost.

   The survey enabled the Consultant to know the potential and feasibility of the selected alternative route alignment to be developed as a new railway for the fulfillment of more transportation demands in the future.

3) Determination of alternative route alignments

   The determination has considered thoroughly the areas where the alignment has to pass both the areas to be avoided and the appropriate areas. The criteria for consideration were as follows:

   (1) Areas to be avoided

      Areas to be avoided according to promulgation as they are sensitive to environmental impacts. These areas include:

      - Main watershed classification area.
      - Conservative forest area according to promulgation and the cabinet resolution.
      - The area where natural resources should be preserved.
      - Archaeological sites and artifacts.

      These areas should be the first priority to be avoided. However, if it is unavoidable, the alternative route alignments should be designed to pass the areas with minimum impacts, shortest distance or furthermost from the areas.

Areas to be avoided due to environmental impacts at regional level

These areas include a dense village or community, land use area, area with complete natural, flooded area, mountainous area etc. However, if it is unavoidable, the alternative route alignments should be designed to pass the areas with minimum impacts.

Areas to be avoided due to topography and community

These areas include a dense village or community, land use area, area with complete natural, flooded area, mountainous area etc. However, if it is unavoidable, the alternative route alignments should be designed to pass the areas with minimum impacts.

(2) Appropriate areas

These areas include plain, wasteland, public area without structures, blank land, area without dense perennial plant and forbidden plant, plateau etc.

(3) Areas of other agencies which coordination with the responsible agency is needed

These areas include areas of other agencies, e.g. the Royal Irrigation Department, the State Railway of Thailand, the Rural Roads Department and other public areas etc. The route alignment can pass these areas but coordination with the responsible agency is needed and the scope of work should suit the utilization of that agency and not obstruct the land use of other agencies.

However, in consideration the determination of alternative route alignments, besides area issues, other following significant issues have to be considered as well:

- Route length. The shorter route has more advantage than the longer route.
- Geometric properties, e.g. horizontal alignment and vertical alignment. The horizontal curves alignment to avoid obstacles is inferior to the straight alignment and it is likewise the alignment that has to often change the elevation due to the topography.
- Specific construction which needs to avoid restricted areas along the alignment, e.g. overpass and tunnel differs from the typical at-grade railway which is the most economical and feasible. The specific construction affects directly the construction cost and difficulty and ease in construction etc.
- Safety in train operation, e.g. the alignment that has many level crossings is inferior to the alignment that has fewer level crossings as this is a factor that affects directly the accident rate. It is likewise the alignment that has tunnel along the alignment is inferior to the alignment that has not because of the risk of crime or difficulty in evacuation upon accident occurs within the tunnel.
- Geological conditions, e.g. the active fault line shall affect the special structure which passes that fault line.

4) Geometric design principles of the route alignment

Following the above criteria, the Consultant has determined the route alignment to extend from the existing southern railway to Ranong Deep Sea Port and Muang Ranong. Due to the complex topography, the railway structures have to be at-grade railway, railway bridge and tunnel alternately to avoid obstacles. The design criteria

and standards are based on the SRT's standards and the standards which are compliance with the international organizations, e.g. European Norm, British and American Standards, International Standards Organization (ISO), The Union Internationale des Chemins de fers (UIC) and AREMA (American Railway Engineers and Maintenance of Way Association) etc.

3.2.3 Alternative Route Alignments

The project area covers 2 provinces, i.e. 6 districts of Chumphon Province consisting of Muang Chumphon District, Sawi District, Lang Suan District, Tha Sae District, Thung Tako District and Phato District and 3 districts of Ranong Provinces consisting of Muang Ranong District, La-un District and Kra Buri District. The Consultant has determined the alternative route alignments which can extend from the existing southern railway to Ranong Deep Sea Port and Muang Ranong. The Consultant has divided the project area into 3 corridors and determined 2-4 alternative route alignments for each corridor that have the same end point at Ranong Deep Sea Port. However, the alternative route alignments on the upper and the central corridor have been designated as the junction into the city of Muang Ranong (Spur line) to support people in the area. For the alternative route alignments on the lower corridor is already pass though the city of Muang Ranong. There don't need to make a spur line into the city of Muang Ranong like the other routes alignments on the upper and the central corridor. Details are as follows:

3.2.3.1 Alternative Route Alignments on each Corridor

1) Alternative route alignment on the upper corridor

There were 2 alternative route alignments parallel to Highway Route No. 4

1.1) Alternative Route Alignment 1

This alternative route alignment shall start at Na Cha-ang Station which is 1 station prior to Chumphon Station and the distance between stations is about 6 km. Then, the alignment shall run to the west, pass Rural Road Nos. Chor Por 1007 and 1001, Highway Route Nos. 360 and 4, head to the northwest to make a detour of the mountain terrain, parallel to Rural Road No. Chor Por 4004 (Ban Khao Pang-Ban Suan), head to the southwest to pass Highway Route No. 4 in Pak Chan Sub-district, head to the south parallel to the east of Highway Route No. 4 with a distance of about 1-2 km from the highway. The alignment shall pass Highway Route No. 4 again near the start of Rural Road No. Ror Nor. 1008, Nam Chuet Sub-district, Kra Buri District, head to the south parallel to Highway Route No. 4 (Phetkasem Road) but switch to the west, pass Lam Liang Sub-district and Bang Yai Sub-district of Kra Buri District, Bang Kaeo Sub-district and Bang Phra Tai Sub-district of La-un District, Sai Daeng Sub-district and Pak Nam Sub-district of Muang District, Ranong Province. The area is mangrove forest alternating with rolling terrain. The alignment shall pass main canals, e.g. Lam Liang Canal and La-un Canal. Most of the communities are located along Highway Route No. 4 (Phetkasem Road) and the distributor road. With the said conditions, it is inevitable that the alignment shall need specific construction to avoid environmental impacts. The alignment shall end at Ranong Deep Sea Port, having a total length of 106.25 km.

1.2) Alternative Route Alignment 2

This alternative route alignment shall start at the south of Chumphon Station, about 3.20 km from Chumphon Station and about 0.80 km from the north of Saeng Dad Station. The alignment shall curve off the existing southern railway, head to the west to pass Highway Route Nos. 2009 and 41, run westerly to parallel Highway Route No. 4 (Phetkasem Road) with a distance of about 1.0 km from the highway, pass Khun Krating Sub-district, Ban Na Sub-district and Wang Mai Sub-district of Muang District, Chumphon Province, Choporo Sub-district and Pak Chan Sub-district of Kra Buri District, Ranong Province. The area is flat alternating with rolling terrain and at Chumphon and Ranong border is mountain terrain where the alignment shall need specific construction. The communities are located along Highway Route No. 4 (Phetkasem Road) and nearby. After that the alignment shall run southerly, parallel to the east of Highway Route No. 4 (Phetkasem Road) with a distance of about 1-2 km from the highway, pass Mamu Sub-district, Namchuet Noi Sub-district and Namchuet Sub-district of Kra Buri District, Ranong Province. Then, the alignment shall be elevated across Highway Route No. 4 (Phetkasem Road) near Namchuet and Lam Liang Border, head to the south parallel to Highway Route No. 4 (Phetkasem Road) but switch to the west, pass Lam Liang Sub-district and Bang Yai Sub-district of Kra Buri District, Bang Kaeo Sub-district and Bang Phra Tai Sub-district of La-un District, Sai Daeng Sub-district and Pak Nam Sub-district of Muang District, Ranong Province. The area is mangrove forest alternating with rolling terrain. The alignment shall pass main canals, e.g. Lam Liang Canal and La-un Canal. Most of the communities are located along Highway Route No. 4 (Phetkasem Road) and the distributor road. With the said conditions, it is inevitable that the alignment shall need specific construction to avoid environmental impacts. The alignment shall end at Ranong Deep Sea Port, having a total length of 102.50 km.

2) Alternative route alignment on the central corridor

There were 4 alternative route alignments parallel to Highway Route No. 4139

2.1) Alternative Route Alignment 1

This alternative route alignment shall start at the south of Wisai Station, about 1.50 km from the station. The alignment shall separate from the existing southern railway, head to the southwest to pass Highway Route No. 41, head to the west to pass Khron Sub-district and Thung Raya Sub-district of Sawi District, Chumphon Province. The alignment shall continue westerly to pass Chumphon and Ranong Border where locates Thung Raya-Na Sak Wildlife Sanctuary and Ngao Waterfall National Park and the area is mountain terrain where the alignment shall need specific construction. Most of the communities are located scattering lightly along the rural road and the local road. The alignment shall pass Lam Liang Sub-district, pass Lam Liang Canal, Highway Route No. 4 and Lam Liang Canal again. The alignment shall run southerly parallel to the west of Highway Route No. 4 with a distance of about 1.0 km from the highway, pass Bang Yai Sub-district, Bang Kaeo Sub-district, Sai Daeng Sub-district and Pak Nam Sub-district of Muang District, Ranong Province. The area is mangrove forest alternating with rolling terrain. Most of the communities are located along Highway Route No. 4 (Phetkasem Road) and the distributor road. With the said conditions, it is

inevitable that the alignment shall need specific construction to avoid environmental impacts. The alignment shall end at Ranong Deep Sea Port, having a total length of 80.28 km.

2.2) Alternative Route Alignment 2

This alternative route alignment shall start at the south of Wisai Station, about 1.50 km from the station. The alignment shall separate from the existing southern railway, head to the southwest to pass Highway Route No. 41, head to the west to pass Wisai Tai Sub-district, Khron Sub-district, Sawi Sub-district and Thung Raya Sub-district of Sawi District, Chumphon Province. Then, the alignment shall be curved to avoid the north of Kao Thalu Mountain Range, head to the south to pass Kao Thalu Sub-district of Sawi District, Chumphon Province. The alignment shall head to the west to pass Chumphon and Ranong Border where locates Thung Raya-Na Sak Wildlife Sanctuary and Ngao Waterfall National Park and the area is mountain terrain where the alignment shall need specific construction. Most of the communities are located scattering lightly along the rural road and the local road. Upon entering Ranong Province, the alignment shall head to the west and southwest to parallel and pass Rural Road No. Ror Nor. 5011 intermittently. The alignment shall pass La-un Canal, run along the canal, pass Highway Route Nos. 4139 and 4 (Phetkasem Road), pass Bang Kaeo Sub-district of La-un District and Sai Daeng Sub-district of Muang District, Ranong Province where most of the areas are mountain terrain and the areas at La-un canal are lowland alternating with rolling terrain with light community. After passing Highway Route No. 4 (Phetkasem Road), the alignment shall head to the south, parallel to the west of Highway Route No. 4 (Phetkasem Road), pass Sai Daeng Sub-district and Pak Nam Sub-district of Muang District, Ranong Province. The area is mangrove forest alternating with rolling terrain. Most of the communities are located along Highway Route No. 4 (Phetkasem Road) and the distributor road. With the said conditions, it is inevitable that the alignment shall need specific construction to avoid environmental impacts. The alignment shall end at Ranong Deep Sea Port, having a total length of 74.15 km.

2.3) Alternative Route Alignment 3

The starting point of this alternative route alignment is the same as Alternative Route Alignment 2, i.e. at the south of Wisai Station, about 1.50 km from the station. The alignment shall separate from the existing southern railway, head to the southwest to pass Highway Route No. 41, head to the west to pass Khron Sub-district, Sawi Sub-district, Thung Raya Sub-district and Na Sak Sub-district. After passing Kao Thalu, the alignment shall divert to the south to pass Kao Thalu Sub-district and Khao Khai Sub-district of Sawi District, Chumphon Province. The area is plain alternating with rolling terrain, e.g. Kao Thalu. The communities are located along Rural Road Nos. Chor Por. 4014, Ror Nor. 5011 and Highway Route No. 4139 and there is a medium dense community at Kao Thalu Intersection. Then, the alignment shall head to the west to pass Highway Route No. 4139 and pass Chumphon and Ranong Border where locates Ngao Waterfall National Park and the area is mountain terrain where the alignment shall need specific construction. Upon entering Ranong Province, the alignment shall head to the west and the northwest respectively. After passing Ngao Waterfall National Park, the alignment shall parallel the north of Highway Route No. 4139 again, pass La-

un Nua Sub-district, La-un Tai Sub-district and Bang Phra Tai Sub-district of La-un District, Ranong Province. The areas are lowland alternating with rolling terrain with community along Highway Route No. 4139. The alignment shall pass Highway Route No. 4139, pass through mountain terrain, pass Highway Route No. 4 (Phetkasem Road) and parallel to the west of Highway Route No. 4 with a distance of about 1.0 km from the highway, pass Sai Daeng Sub-district and Pak Nam Sub-district of Muang District, Ranong Province. The area is mangrove forest alternating with rolling terrain. Most of the communities are located along Highway Route No. 4 (Phetkasem Road) and the distributor road. With the said conditions, it is inevitable that the alignment shall need specific construction to avoid environmental impacts. The alignment shall end at Ranong Deep Sea Port, having a total length of 81.42 km.

2.4) Alternative Route Alignment 4

The alignment shall start at the south of Khao Suan Thurian Station, about 400 m from the station. The alignment shall separate from the existing southern railway, curve to the southwest to pass Highway Route No. 41, head to the west to parallel the north of Highway Route No. 4139 with a distance of about 1.50 km from the highway. The alignment shall pass the south of Highway Route No. 4139 for a distance of about 4 km, pass and parallel the north of Highway Route No. 4139 again with a distance of about 0.5 km from the highway, pass Na Sak Sub-district of Sawi District and Thung Takhrai Sub-district of Thung Tako District, Chumphon Province. The alignment shall curve to the south to pass Highway Route No. 4139 again, divert to the southwest to pass Khao Khai Sub-district of Sawi District, Chumphon Province. The alignment shall head to the west to pass Highway Route No. 4139 and pass Chumphon and Ranong Border where locates Ngao Waterfall National Park and the area is mountain terrain where the alignment shall need specific construction. Most of the communities are located scattering lightly along the rural road and the local road. Upon entering Ranong Province, the alignment shall overlie Alternative Route Alignment 3 until the ending point of the project at Ranong Deep Sea Port, having a total length of 74.70 km.

3) Alternative route alignment on the lower corridor

There were 2 alternative route alignments parallel to Highway Route No. 4006

3.1) Alternative Route Alignment 1

This alternative route alignment shall start from Khuan Hin Mui Station, curve to the west to pass Highway Route Nos. 4097 and 41, head to the north of Highway Route No. 4006 with a distance of about 1-3 km from the highway. Then, the alignment shall run parallel to the south of Highway Route No. 4006 for a distance of about 26 km, pass and parallel the north of Highway Route No. 4006 again with a distance of about 1.0 km from the highway. The alignment shall head to the south to pass Highway Route No. 4006, divert to the west and parallel Highway Route No. 4006 with a distance of about 2-3 km from the highway. The alignment shall be near and parallel to the south of Highway Route No. 4006 again prior to arriving at Chumphon and Ranong Border, pass Na Kha Sub-district, Wang Tako Sub-district, Had Yai Sub-district of Lang Suan District and Pang Wan Sub-district, Phra Rak Sub-district, Phato Sub-district, Phra Song Sub-district of Phato District, Chumpon

Province. Most of the areas are plain alternating with mountain terrain intermittently where the alignment shall need specific construction. The communities are located scattering along Highway Route No. 4006. After that, the alignment shall head to the west to overlie Highway Route No. 4006 for a distance of about 1.0 km, parallel to the south and pass Chumphon and Ranong Border where locates Ngao Waterfall National Park and the area is mountain terrain where the alignment shall need specific construction. Upon entering Ranong Province, the alignment shall head to the northwest to pass Highway Route No. 4 (Phetkasem Road), make a detour to the north to avoid Ranong Airport. The alignment shall head to the east to pass and parallel the east of Highway Route No. 4 (Phetkasem Road) with a distance of about 1.0 km from the highway. At this section, the alignment shall run between Phetkasem Road (left side) and mountain terrain (right side) with a dense community and main government offices along Phetkasem Road. After passing the community areas, the alignment shall be elevated across Highway Route No. 4 (Phetkasem Road) in Bang Non Sub-district, head to the northwest to pass through the mountain terrain in Kra Buri National Park. The alignment shall pass Ratchakrud Sub-district, Ngao Sub-district, Bang Rin Sub-district, Khao Niwet Sub-district, Bang Non Sub-district and Pak Nam Sub-district of Muang District, Ranong Province. With the said conditions, it is inevitable that the alignment shall need specific construction in many locations to avoid environmental impacts. The alignment shall end at Ranong Deep Sea Port, having a total length of 108.20 km.

3.2) Alternative Route Alignment 2

This alternative route alignment shall start from Lang Suan Station, run southwesterly to pass Highway Route No. 41, head to the south to pass Tha Mapla Sub-district, Had Yai Sub-district and Ban Kuan Sub-district, head to the west to parallel and pass Highway Route No. 4006, pass Pang Wan Sub-district, Phra Rak Sub-district, Phato Sub-district, Phra Song Sub-district of Phato District, Chumpon Province. Most of the areas are plain alternating with mountain terrain intermittently where the alignment shall need specific construction. The communities are located scattering along Highway Route No. 4006. The alignment after this section shall be the same alignment as Alternative Route Alignment 1 until the ending point of the project, having a total length of 104.51 km.

Figure 3.2.3.-1 shows the alternative route alignments on each corridor.

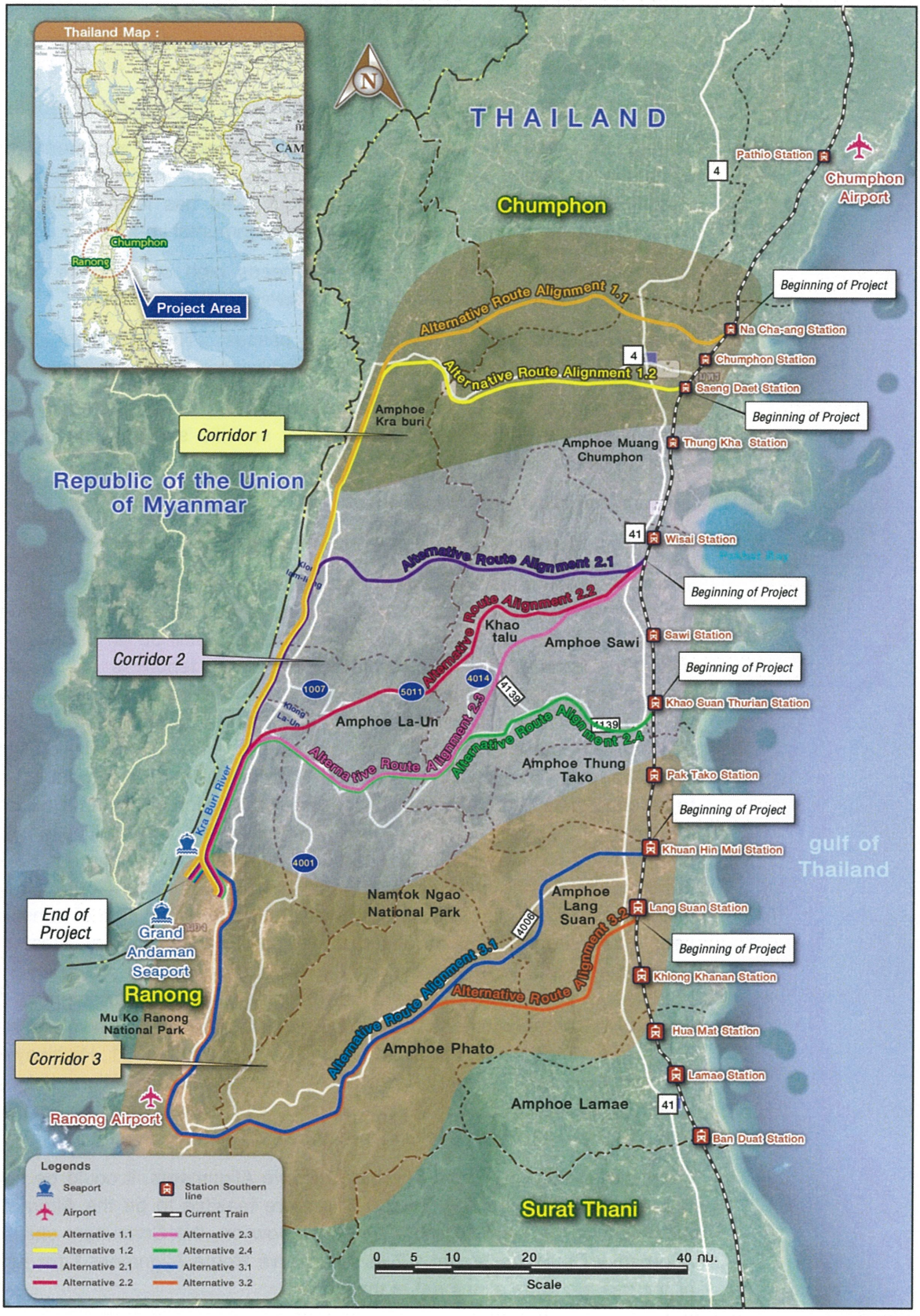


Figure 3.2.3.-1 Alternative Route Alignments on Each Corridor

3.2.3.2 Preliminary Screening of Alternative Route Alignments

The Consultant has initially screened the alternative route alignments on each corridor based on the following criteria:

- Route length. The longer route has less advantage than the shorter route.
- Topography of the area where the alignment passes. The alignment which has to pass the sensitive areas on environments, e.g. national park, watershed classification, mangrove forest, mountainous area has less advantage than the alignment which passes plain and has no environmental impact.
- Construction cost. The alignment that needs high construction cost has less advantage than the alignment that needs lower construction cost.
- Community density where the alignment passes. The alignment that passes a dense community shall affect the lifestyle and living of the local people.
- The alignment that has many level crossings shall affect the traffic conditions in the areas inevitably and it needs to construct specific structures to solve the level crossing problems.

The screening details are as follows:

1) Screening of alternative route alignments on upper corridor

There are 2 alternative route alignments as mentioned above. Both alternative route alignments are different from the beginning point to about STA. 44+000 (Alternative Route Alignment 1.1). The remaining shall be on the same alignment until the ending point of the project. The route length is slightly different as Alternative Route Alignment 1.1 is longer than Alternative Route Alignment 1.2 about 4.0 km. The topography is plain alternating with rolling terrain intermittently. Alternative Route Alignment 1.1 shall pass through the rolling terrain slightly longer than Alternative Route Alignment 1.2 so Alternative Route Alignment 1.1 shall need to be constructed as tunnel causing higher construction cost than Alternative Route Alignment 1.2. For community density, most of the communities are located on both sides of Highway Route No. 4 and Alternative Route Alignment 1.2 shall have more advantage as the alignment shall parallel Highway Route No. 4 with a distance of only 1.0 km from the highway and upon completion of construction, the people living nearby shall be able to travel more conveniently and faster. Another considering issue is level crossing, the alignment that has many level crossings shall result in the construction to solve the level crossing problem at that area. Alternative Route Alignment 1.1 is at the upper of Chumphon Town and has to pass 5 highway routes, i.e. Rural Road Nos. Chor Por. 1007, 1001, Highway Route No. 360 and 2 points of Highway Route No. 4. Alternative Route Alignment 1.2 is at the lower of Chumphon Town and has to pass 2 highway routes, i.e. Highway Route Nos. 2009 and 41 which is less than Alternative Route Alignment 1.1.

From the screening of both Alternative Route Alignments, it could be summarized that Alternative Route Alignment 1.2 is more feasible to be the Alternative Route Alignment of the upper corridor and from now on, the Consultant shall determine Alternative Route Alignment 1.2 as Alternative Route Alignment 1 for further study of appropriate route alignment of the project.

2) Screening of alternative route alignments on central corridor

There are 4 alternative route alignments; Alternative Route Alignments 2.1, 2.2 and 2.3 shall start from Wisai Station and Alternative Route Alignment 2.4 shall start from Khao Suan Thurian Station. The route length of Alternative Route Alignment 2.3 is the longest, i.e. 81.22 km, the second is Alternative Route Alignment 2.1, i.e. 80.28 km which is 7 km longer than Alternative Route Alignments 2.2 and 2.4. The topography where all alternative route alignments pass is similar as the alignments shall pass plain alternating with mountain terrain at Chumphon and Ranong Border where the alignments shall need specific construction, e.g. tunnel. The tunnel of Alternative Route Alignment 2.3 shall be slightly longer than other alternative route alignments. In considering of mangrove forest, Alternative Route Alignment 2.1 shall pass mangrove forest from Lam Liang Canal to La-un Canal which Alternative Route Alignment 2.1 shall be elevated longer than other alternative route alignments resulting in the construction cost of Alternative Route Alignments 2.1 and 2.3 higher than other alternative route alignments. In considering of community density scattering along Highway Route No. 4139, Rural Road Nos. Chor Por 4014, Ror Nor. 5011 and the local road which is relatively light to moderate density, Alternative Route Alignments 2.2 and 2.4 have more advantage than other alternative route alignments as Alternative Route Alignment 2.2 shall parallel Rural Road Nos. Chor Por. 2016 (Ban Kao Thalu-Ban Nam Cha) and Rural Ror Nor. 5011 intermittently and Alternative Route Alignment 2.4 shall parallel Highway Route No. 4139 almost the whole route. This is good for station location as people can access the station more conveniently than other alternative route alignments. In considering of level crossing problem, Alternative Route Alignments 2.1, 2.2 and 2.3 shall pass Highway Route No. 41, Rural Road Nos. 4014 and Ror Nor. 5011 intermittently with few level crossings. Alternative Route Alignment 2.4 shall pass Highway Route Nos. 41 and 4139 for 5 level crossings and the alignment parallel to the highways shall have to make many switches to avoid communities.

From the screening of 4 Alternative Route Alignments, it could be summarized that Alternative Route Alignments 2.2 and 2.4 are more feasible to be the Alternative Route Alignment of the central corridor and from now on, the Consultant shall determine Alternative Route Alignment 2.2 as Alternative Route Alignment 2 and Alternative Route Alignment 2.4 as Alternative Route Alignment 3 for further study of appropriate route alignment of the project.

3) Screening of alternative route alignments on lower corridor

There are 2 alternative route alignments; Alternative Route Alignment 3.1 shall start from Khuan Hin Mui Station and Alternative Route Alignment 3.2 shall start from Lang Suan Station. These 2 alternative alignments shall merge at Sta. 36+000 (Alternative Route Alignment 3.1). These 2 alignments are different as follows:

Alternative Route Alignment 3.1 is 3.4 km longer than Alternative Route Alignment 3.2. The topography where both alternative route alignments pass is similar as the alignments shall pass plain alternating with rolling terrain and mountain terrain. Alternative Route Alignment 3.1 shall parallel Highway Route No. 4006 and pass through rolling terrain at Sta. 18+000-Sta. 22+000. Alternative Route Alignment 3.2 shall pass through rolling terrain in many sections so the construction cost shall be higher than Alternative Route Alignment 3.1. In considering of community density, Alternative Route Alignment 3.1 shall parallel Highway Route No. 4006 where communities are located scattering on both sides which is different from Alternative Route Alignment 3.2 which shall pass vacant area. In considering of level crossing

problem, Alternative Route Alignment 3.1 shall have to pass Highway Route No. 4006 many times but not considered different significantly.

From the screening of both Alternative Route Alignments, it could be summarized that Alternative Route Alignment 3.1 is more feasible to be the Alternative Route Alignment of the lower corridor and from now on, the Consultant shall determine Alternative Route Alignment 3.1 as Alternative Route Alignment 4 for further study of appropriate route alignment of the project.

Figure 3.2.3-2 shows the screened alternative route alignments on each corridor.

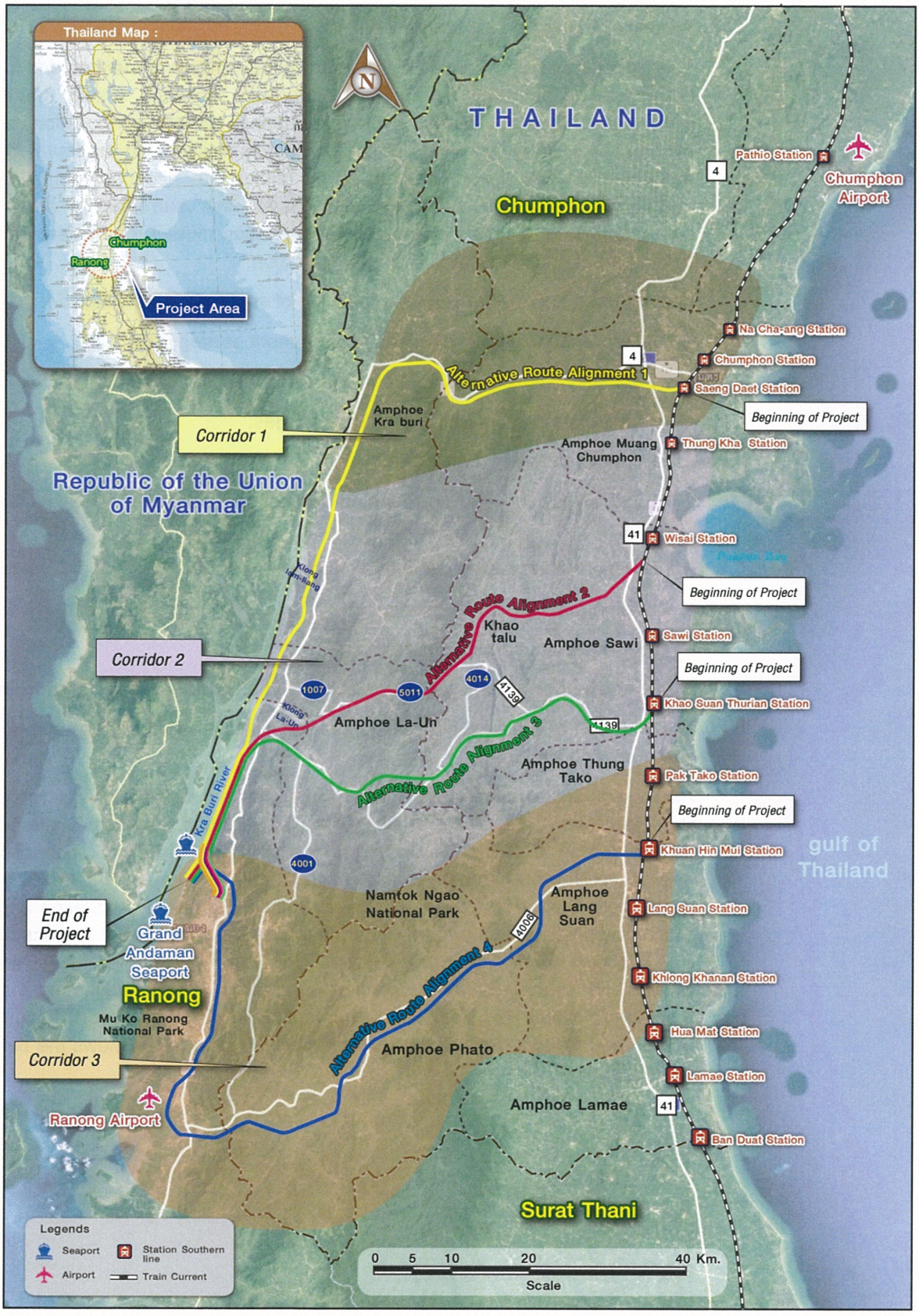


Figure 3.2.3-2 Screened Alternative Route Alignment

3.3 Station Location and Model

1) Appropriate station location

The Consultant has determined the appropriate number of stations and locations in corresponding with the needs and topography including linking the travel and transportation nearby. Determining the number of stations and locations shall affect the travel system which is one of the key factors in choosing the travel mode. The determination has to be appropriate by taking into account population density, attracting travel, corresponding with travel and surrounding area including appropriateness in linking with other transportation modes for efficient traffic, urban development and consistent with train operation.

Factors used to consider the determination of station locations include:

- Comprehensive town plan and development strategy plan.
- Population density and community area which affects passenger volumes.
- Trend of socio-economic condition changes.
- Distance between stations.
- Land acquisition and surrounding utilities contributing to the expansion of the station.
- Transportation network and interchange station.
- Station accessibility of people
- Potential for local tourism promotion.

2) Number of stations and locations along the alternative route alignments

The number of stations and locations of 4 alternative route alignments could be summarized as follows:

Alternative Route Alignment 1 shall have 9 stations namely Khun Krating Station, Ban Na Station, Wang Mai Station, Pak Chan Station, Kra Buri Station, Bang Yai Station, La-un Station, Ranong Port Station and Ranong Station respectively. Alternative Route Alignment 2 shall have 6 stations namely Khron Station, Thung Raya Station, Kao Thalu Station, La-un Station, Ranong Port Station and Ranong Station respectively. Alternative Route Alignment 3 shall have 6 stations namely Na Sak Station, Khao Khai Station, La-un Tai Station, La-un Station, Ranong Port Station and Ranong Station respectively. Alternative Route Alignment 4 shall have 5 stations namely Had Yai Station, Phato Station, Ranong Airport Station, Ranong Station and Ranong Port Station respectively. **Figure 3.3-1** shows the current area of each station.

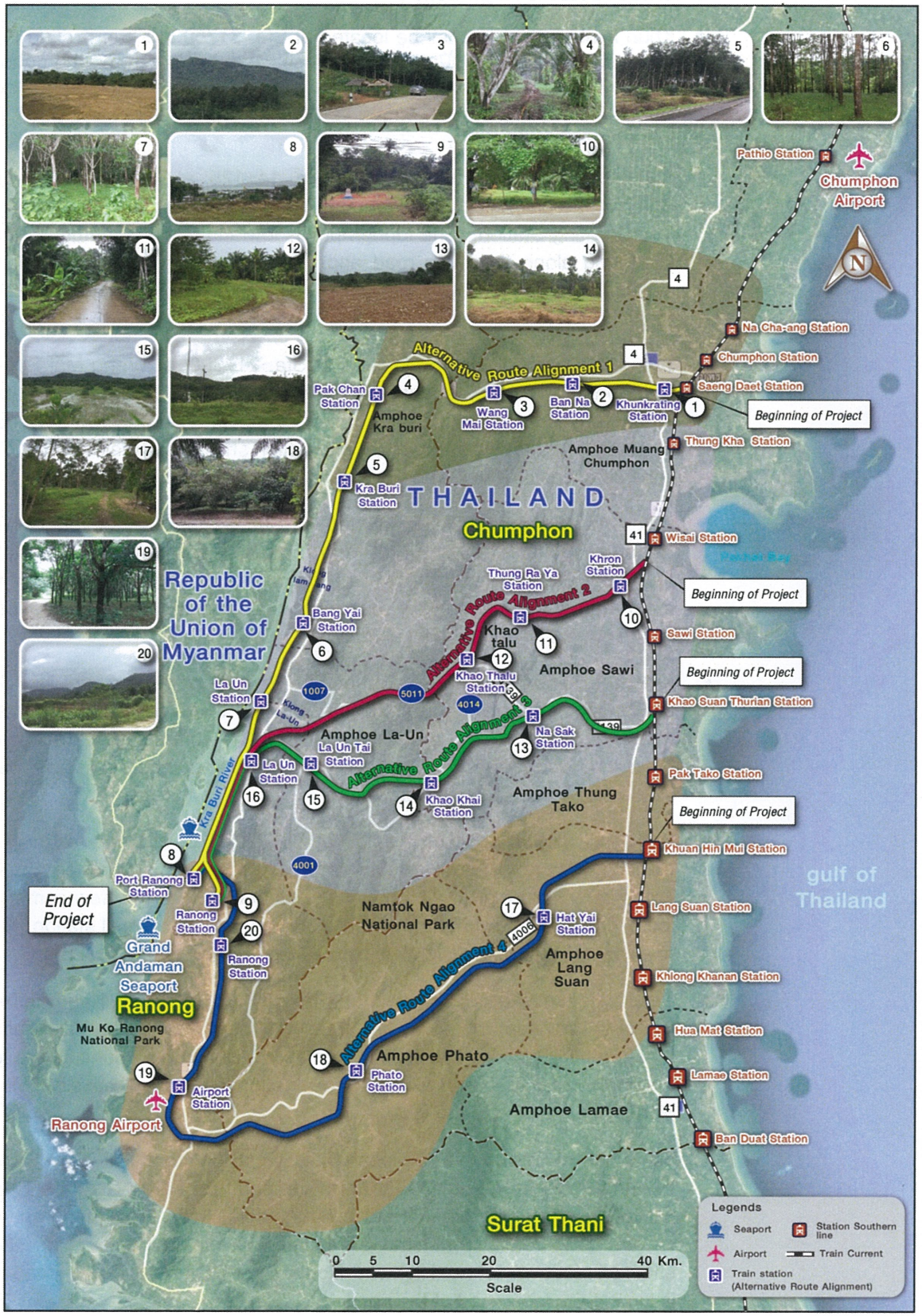


Figure 3.3-1 The Current Area of Each Station

Alternative Route Alignment 1

- Khun Krating Station shall be located at Sta. 3+750 in Khun Krating Sub-district, at the southwest of Chumphon Province, about 7 km from Chumphon Station. The topography is the agricultural area and plain. The station shall be accessible via Highway Route No. 41. The communities are located along the main road and the distributor road.
- Ban Na Station shall be located at Sta. 14+125, at Wang Mai Sub-district and Ban Na Sub-district Border of Chumphon Province, about 10 km from the west of Khun Krating Station. The topography is lowland. The communities are located scattering along the main road and the distributor road. The station shall be accessible via Highway Route No. 4 linking to the Rural Road No. Chor Por. 1005.
- Wang Mai Station shall be located at Sta. 21+700, at Wang Mai Sub-district of Chumphon Province, about 9 km from the west of Ban Na Station. The topography is rolling terrain and rubber plantation. As only few communities are located along the distributor road, the station shall be a small station. The station shall be accessible via Highway Route No. 4 linking to the local road.
- Pak Chan Station shall be located at Sta. 42+650, at Mamu Sub-district of Ranong Province, about 19 km from the southwest of Wang Mai Station. The topography is plain and palm plantation. The communities are located on the main road and the distributor road. The station shall be accessible via Highway Route No. 4 linking to the local road.
- Kra Buri Station shall be located at Sta. 52+600, at Nam Chuet Noi Sub-district of Ranong Province, about 10.5 km from the south of Pak Chan Station. The topography is plain and rubber plantation. The communities are located on the main road and the distributor road. The station shall be accessible via Highway Route No. 4 linking to the local road.
- Bang Yai Station shall be located at Sta. 70+570, at Bang Yai Sub-district of Ranong Province, about 18 km from the south of Pak Chan Station. The topography is rolling terrain and rubber plantation. As only few communities are located along the distributor road, the station shall be a small station. The station shall be accessible via Highway Route No. 4 linking to the local road.
- La-un Station shall be located at Sta. 78+600, at Bang Kaeo Sub-district of Ranong Province, about 9 km from the south of Bang Yai Station. The topography is plateau and rubber plantation. Dense communities are located on the main road at La-un Canal. The station shall be accessible via Highway Route No. 4 linking to the local road.
- Ranong Port Station shall be located at Sta. 102+200, at Pak Nam Sub-district of Ranong Province, about 23 km from the south of La-un Station. Ranong Port Station shall be the terminal station at Ranong Port. The topography is rolling terrain. Only few communities are located on the distributor road. The station shall be accessible via Highway Route No. 4004 and Rural Road No. 4010 linking to the local road of the port.

- Ranong Station shall be located on the spur line at Sta. 4+732, at Bang Non Sub-district of Ranong Province, about 3 km from the east of Ranong Port. The topography is plateau with dense communities especially at Ranong Town. The station shall be accessible via Highway Route Nos. 4 and 4004.

Alternative Route Alignment 2

- Khron Station shall be located at Sta. 5+170, at Khron Sub-district on the southwest of Chumphon Province, about 6.5 km from Wisai Station. The topography is plain and rubber plantation. The communities are located along the main road and the distributor road. The station shall be accessible via Highway Route No. 41 and the local road.

- Thung Raya Station shall be located at Sta. 17+350, at Thung Raya Sub-district of Chumphon Province, about 12.5 km from the southwest of Khron Station. The topography is lowland adjacent hill and rubber plantation. As only few communities are located along the distributor road, the station shall be a small station. The station shall be accessible via the local road.

- Kao Thalu Station shall be located at Sta. 28+250, at Kao Thalu Sub-district of Chumphon Province, about 10.7 km from the southwest of Thung Raya Station. The topography is lowland. As only few communities are located along the distributor road, the station shall be a small station. The station shall be accessible via the local road.

- La-un Station shall be located at Sta. 55+550, at Sai Daeng Sub-district of Ranong Province, about 27 km from the southwest of Kao Thalu Station. The topography is lowland adjacent hill. The communities are located along the main road. The station shall be accessible via Highway Route No. 4.

- Ranong Port Station shall be located on the same position as Alternative Route Alignment 1. The communities, accessibility to the station and topography are the same as Alternative Route Alignment 1 as well.

Alternative Route Alignment 3

- Na Sak Station shall be located at Sta. 16+550, at Na Sak Sub-district of Chumphon Province, about 16.5 km from the west of Khao Suan Thurian Station. The topography is lowland. The communities are located along the main road and the distributor road. The station shall be accessible via Highway Route No. 4139.

- Khao Khai Station shall be located at Sta. 29+500, at Khao Khai Sub-district of Chumphon Province, about 13 km from the southwest of Na Sak Station. The topography is plain. As only few communities are located along the distributor road, the station shall be a small station. The station shall be accessible via Highway Route No. 4139 linking to the local road.

- La-un Tai Station shall be located at Sta. 45+820, at La-un Tai Sub-district of Ranong Province, about 17 km from the west of Khao Khai Station. The topography is lowland. As only few communities are located along the distributor road, the station shall be a small station. The station shall be accessible via Highway Route No. 4139.

- La-un Station shall be located at Sta. 56+103, at Sai Daeng Sub-district of Ranong Province, about 9 km from the west of La-un Tai Station. The

topography is lowland adjacent hill. The communities are located along the main road at La-un Canal. The station shall be accessible via Highway Route No. 4.

- Ranong Port Station shall be located on the same position as Alternative Route Alignments 1 and 2. The communities, accessibility to the station and topography are the same as Alternative Route Alignments 1 and 2 as well.

Alternative Route Alignment 4

- Had Yai Station shall be located on the agricultural area at Sta. 15+650, at Had Yai Sub-district of Chumphon Province, about 16.5 km from the southwest of Khuan Hin Mui Station. The topography is plain. The communities are located on the main road and the distributor road. The station shall be accessible via Highway Route No. 4006.

- Phato Station shall be located on the agricultural area at Sta. 45+250, at Phato Sub-district of Chumphon Province, about 28.8 km from the southwest of Had Yai Station. The topography is lowland surrounded by rolling terrain. As only few communities are located along the main road and the distributor road, the station shall be a small station. The station shall be accessible via Highway Route No. 4006 linking to the local road.

- Ranong Airport Station shall be located at Sta. 79+150, at Ratchakrud Sub-district of Ranong Province, about 32.2 km from the west of Phato Station. The topography is plain. The communities are located on the main road. The station shall be accessible via Highway Route No. 4.

- Ranong Station shall be located at Sta. 90+500, at Bang Rin Sub-district of Ranong Province, about 16.5 km from the north of Ranong Airport Station towards Ranong Town. The topography is plateau. The communities are located on the main road and Ranong Town. The station shall be accessible via Highway Route No. 4 linking to the local road.

- Ranong Port Station shall be located at Sta. 107+901, at Pak Nam Sub-district of Ranong Province, on the same position of Alternative Route alignments 1, 2 and 3, about 12 km from the west of Ranong Station. The topography is rugged terrain. Few communities are located on the distributor road. The station shall be accessible via Highway Route No. 4004 and Rural Road No. Ror Nor. 4010 linking to the local road of the port.

3) Station size

According to the State Railways of Thailand, the station can be classified into 5 levels according to revenues, number of local people and the importance of train operation (e.g. the location of district train operation etc.). The classification details are as follows:

- Special Class Station namely Bangkok Station (Hua Lamphong), Lat Krabang Inland Container Depot and Laem Chabang Port Station.
- First Class Station namely Phetchaburi Station, Bang Sue Junction Station, Ayutthaya Station, Ban Phachi Junction Station, Nakhon Sawan Station, Pak Nam Pho Station, Hua Hin Station, Phitsanulok Station, Pichai Station, Uttaradit Station, Sila At Station, Chiang Mai Station, Mae Nam Station, Prachin Buri Station, Kaeng Khoi Junction Station, Nakhon Ratchasima Station, Thanon Chira Junction Station, Bua Yai Junction Station, Khon Kaen Station, Ubon

Ratchathani Station, Salaya Station, Ban Pong Station, Ratchaburi Station, Hua Hin Station, Prachuap Khiri Khan Station, Bang Saphan Yai Station, Chumphon Station, Lang Suan Station, Chaiya Station, Surat Thani Station, Khlong Chan Di Station, Thung Song Junction Station, Nakhon Si Thammarat Station, Phatthalung Station, Hat Yai Junction Station, Yala Station and Su-ngai Kolok Station.

- Second Class Station namely Talat Phlu Station, Khlong Tan Station, Lat Krabang Station, Mae Klong Station, Kabin Buri Station, Pattaya Station, Lam Chi Station, Sawankhalok Station, Ban Dara Junction Station, Khun Tan Station, Nong Pla Duk Junction Station, Nam Tok Station, Ban Krut Station, Map Ammarit Station, Pathio Station, Khao Chum Thong Junction Station, Cha-Uat Station, Kantang Station and Khiri Ratthanikhom Station.
- Third Class Station namely Kadon Kho Station, Wang Pho Station, Tase Station, Mai Kaen Station, Ban Mai etc.
- Fourth Class Station cancelled as per the announcements on July 23 and August 11, 2010.

The existing stations in the project area such as Chumphon Station and Lang Suan Station are first class station, Sawi Station is second class station, Khuan Hin Mui Station, Pak Tako Station, Na Cha-ang Station, Saeng Dad Station, Wisai Station and Thung Kha Station are third class station. However, the station classes can be changed according to revenues, number of local people and the importance of train operation. Although the relationship between station sizes and station classes of the project is unclear, the Consultant, at this stage, has forecasted that there shall be 2 sizes, i.e. 1. at provincial class and 2. at district/sub-district class according to the forecast of number of local people and preliminary travel volumes. These shall be the basis for further study and design if a halt is needed.

4) Suggestion of Container Yard (CY) or Inland Container Depot (ICD)

- Position of Container Yard (CY) for all alternative route alignments set at Contaniner Yard in Ranong Deep Sea Port that have enough space for storage throughout the forecast period. However, the consultants have considered rail design and adjusted the area for the rail also expropriation area around Ranong Deep Sea Port. But container yard in the future, lifting equipment as well as harbor management building will be under the supervision and responsibility of the Port Authority of Thailand (PAT) to design and construction.
- Inland Container Depot (ICD) use at LATKRABANG Inland Container Depot.
- Roller maintenance and refueling stations use at Chumphon Station. In Ranong Deep Sea Port station is only use for light maintenance.

3.4 Selection of Appropriate Route Alignment

3.4.1 Criteria for Selection

The Consultant has determined the method and criteria for selection of appropriate route alignment based on the Multi-Attribute Utility Theory (MAUT). According to this method, 3 parameters have been considered, i.e. 1. engineering, 2. economic and 3. environment. Generally, the Multi-Attribute Utility Theory (MAUT) considers the feasibility of 3 parameters as follows:

- Engineering. The method considers the route length, geometric properties both horizontal and vertical, structural form, difficulty and ease in construction, capacity to accommodate traffic volumes, comfort and safety etc.
- Economic or cost. Many projects have considered only construction cost, property or land compensation cost. However, some projects have considered additionally on vehicle operating cost saving (VOC), Vehicle Operating Time Saving (VOT), maintenance cost or attracting development.
- Environment or Impact on the Public. Generally, the method considers 4 environmental parameters such as physical resources, biological resources, human use values and quality of life values by selecting only significant and distinguishable impacts.

From **Table 3.4.1-1** below, it could be noticed that the weighting for each parameter may be different though it is a comparison to select the route alignment as there are no definite rules. It depends on the opinions of the relevant personnel and the circumstances at that time. Therefore, it requires the opinions and experience of experts to determine the criteria for comparison to the Steering Committee for approval in order to get the most appropriate format.

The reason that the weighting for comparison is different may come from many factors, e.g. for the case of Ramindra-Outer Ring Road Expressway Project which determined the high weighting on economic or cost due to the economic downturn (1997 Economic Crisis), some projects may emphasize on the project location or environmental impacts or level of service without concentration on construction cost etc. However, for the current trend, all sectors emphasize more on the environmental impacts.

Table 3.4.1-1 Sample of Different Weighting of Each Project

Project	Parameters Considered		
	1. Engineering	2. Economic	3. Environment
1. Pak Kret Bridge and Connecting Road Project (December 1996)	40 Weighting	30 Weighting	30 Weighting
2. Ramindra-Outer Ring Road Expressway Project (October 1997)	30 Weighting	40 Weighting	30 Weighting
3. Chiang Mai - Chiang Rai Inter-city Motorway Project (November 1999)	30 Weighting	35 Weighting	35 Weighting
4. Eastern Nakhon Sawan Bypass Project (March 2008)	35 Weighting	30 Weighting	35 Weighting
5. Suvarnabhumi Airport - Chachoengsao Highway Project (May 2008)	33 Weighting	33 Weighting	34 Weighting
6. Songkhla-Satun Landbridge Project (February 2010)	35 Weighting	25 Weighting	40 Weighting

Due to the complex topography of the project area which is mountain terrain between Chumphon and Ranong Provinces and most of the areas are national park and national reserved forest including fertile mangrove forest of the country, the construction of new railway may impact on resettlement/land and property expropriation especially the land which has to be expropriated for the construction of railway and stations. As the alignment has to pass the sensitive areas where air, noise and vibration shall be impacted as well, the Consultant has designated the weighting for environmental parameters higher than other parameters. Due to the complex topography as already mentioned above which requires specific construction, e.g. overpass, tunnel etc., these also result in higher investment cost. Upon consideration of 3 parameters which are important nearly equally, the Consultant has designated 30 weighting for engineering, 30 weighting for economic and investment and 40 weighting for environment and social respectively. The designated weighting as already approved by the Steering Committee in the meeting on September 13, 2017 was shown on **Table 3.4.1-2**.

Table 3.4.1-2 Designated Weighting of Important Parameters

Important Parameters	Designated Weighting
• **Engineering Parameters**	**(30)**
1. Route Length	5
2. Horizontal Characteristic of Route Alignment	5
3. Vertical Characteristic of Route Alignment	5
4. Difficulty and Ease in Construction	6
5. Safety in Train Operation	5
6. Geological Conditions	4
• **Economic and Investment Parameters**	**(30)**
1. Investment	
1.1 Immovable Property Expropriation Cost	5
1.2 Construction Cost	15
2. Passenger Volumes along Alternative Route Alignments	
2.1 Potential Population for each Station along the Alternative Route Alignments	5
2.2 Distance to Access each Station along the Alternative Route Alignments	5
• **Environmental and Social Parameters**	**(40)**
1. Important reserved and conservation areas	10
2. Soil and soil erosion	7
3. Surface water hydrology	5
4. Resettlement and community separation	
4.1 Number of buildings/structures	6
4.2 Number of communities that the alternative alignments pass	5
5. Sensitive areas to environmental and social impacts	
5.1 Sensitive areas to air-noise-vibration within the radius of 500 m. from the center line	4
5.2 Main road and rural road intersections	3
Total	**100**

3.4.2 Engineering Comparison (30 Weighting)

3.4.2.1 Criteria for Weighting on Engineering

The total designated weighting on engineering is 30 out of 100. The engineering parameters include route length, horizontal characteristic of alignment, vertical characteristic of alignment, difficulty and ease in construction, safety in train operation and geological conditions. Each parameter was designated 5 weighting except difficulty and ease in construction which was designated 6 weighting and geological conditions which was designated 4 weighting. This is because difficulty and ease in construction affects directly to construction technique, construction period and construction cost which is the significant factor affecting the cost efficiency of the project.

3.4.2.2 Route Length

The criteria for route length is that the longer route is inferior to the shorter route as it takes more time to travel and consumes more fuel. The Consultant has determined the starting point of the alignment at Chumphon Station and the ending point at Ranong Deep Sea Port including the existing southern alignment and the new alignment. The alignment which has the spur line to Ranong Station, the route length includes the length of spur line.

In ranking the alternative route alignments, the shortest alignment gets the full score and its multiplying factor is 1.00. The longer alignment gets the multiplying factor (coefficient) in proportion of that route length comparing with the shortest alignment as per the following equation:

$$e_i = 1 - \frac{(L_i - L_{min})}{L_{min}}$$

Whereas e_i = Multiplying factor of route length, *i*

L_i = Route length, *i*

L_{min} = Length of shortest route

Calculation method of route length: 5 weighting

1) Measure all alternative route alignments by designating the starting point at Chumphon Station and the ending point at Ranong Deep Sea Port which includes the new alignment and the existing southern alignment. For the alignment that has the spur line, the length includes the length of spur line (Alternative Route Alignments 1, 2 and 3 have the spur line to Ranong Town).

2) Calculation sample: refer to Conceptual Design Drawings

   The shortest alignment is Alternative Route Alignment 2 which the length is 101.956 km consisting of the existing southern alignment from Chumphon Station to Wisai Staion which the length is 22.820 km, the new alignment which the length is 74.154 km and the spur line which the length is 4.982 km.

   So **the multiplying factor of Alternative Route Alignment 2 is 1.00**.

   Considering Alternative Route Alignment 1 which the length is **110.662 km.**

   Based on the equation:

$$e_i = 1 - \frac{(L_i - L_{min})}{L_{min}}$$

Whereas e_i = Multiplying factor of route length, i

L_i = Route length, i

L_{min} = Length of shortest route

So the calculation for Alternative Route Alignment 1 is as follows:

Multiplying factor for Alternative Route Alignment 1 = 1 - (110.662 – 101.956)/101.956

= 0.91

∴ Scores of Alternative Route Alignment 1 = 0.91 x 5 = 4.55

As shown in Table **3.4.2 -1**.

Table 3.4.2-1 Route Length Scores

Route Alignment	Distance from Chumphon Station to Ranong Deep Sea Port / Ranong Station (Km.)				Multiplying Factor	Scores
	Main Line	Spur Line	Existing Southern Line	Total		
1	102.500	4.982	3.180	110.662	0.91	4.55
2	74.154	4.982	22.820	101.956	1.00	5.00
3	74.706	4.982	39.980	119.668	0.83	4.15
4	108.201	-	57.550	165.751	0.37	1.85

3.4.2.3 Horizontal Characteristic of Route Alignment

The straight alignment is better than the curved alignment. The wide curved radius alignment is better than the narrow curved radius alignment as the narrow curved radius alignment shortens the sight distance resulting in train speed decreasing, easily happening accident and rail wearing. The coefficient of each curve radius is as follows:

- Curve radius 3,000 m.
  The coefficient, $e_{h,1}$ = 1.00
- Curve radius 2,000 m. but less than 3,000 m.
  The coefficient, $e_{h,2}$ = 0.75
- Curve radius 1,600 m. but less than 2,000 m.
  The coefficient, $e_{h,3}$ = 0.50
- Curve radius 900 m. but less than 1,600 m.
  The coefficient, $e_{h,4}$ = 0.25
- Curve radius less than 900 m.
  The coefficient, $e_{h,5}$ = 0.00

In scoring the horizontal characteristic of alternative route alignment, i, the Consultant has considered the starting point of the alignment at Chumphon Station and the ending point at Ranong Deep Sea Port including the existing southern alignment and the new alignment. The multiplying factor of any alignment comes from the sum of the coefficient $e_{h,r}$ multiply by the total curve length of each curve radius, plus the difference between the sum of the curve length of the alignment that has maximum total curve length and the sum of the curve length of that alignment, multiply by the coefficient $e_{h,1}$ =1.00, then divide by the sum of the curve length of the alignment that has the total longest curve length. The reason is because the total curve length of each alternative route alignment is different. To achieve equality in scoring, it has to consider under the same database, which is to adjust the curve length of each alignment to equal the longest alignment and the additional curve length of the alignment, i, shall be assumed that it is an additional curve with a radius of more than 3,000 m. as per the following equation:

$$e_i = \frac{\sum_{r=1}^{5}(e_{h,r} \times \sum_{x=1}^{y} l_{r,x}) + e_{h,1}(L_{cmax} - L_{ci})}{L_{cmax}}$$

Whereas e_i = Multiplying factor of alternative route alignment, i

$e_{h,r}$ = Coefficient of any curve radius

$l_{r,x}$ = Curve length of any curve which has curve radius within r

$L_{c\,max}$ = Total curve length of the longest alignment

L_{ci} = Total curve length of alternative route alignment, i

Calculation method of horizontal characteristic of route alignment: 5 weighting

1) The consideration of horizontal characteristic of route alignment will consider as follow:
   - Measure curve length of every horizontal curvature the whole alternative route alignments by designating the starting point at Chumphon Station and the ending point at Ranong Deep Sea Port which includes the new alignment and the existing southern alignment. For the alignment that has the spur line, the length includes the length of spur line.
   - For each horizontal curvature, measure from point of curvature (PC) to point of tangent (PT).
   - The straight alignment of the alternative route alignments shall not be considered.
   - Identify the horizontal alignment according to the designated curve radius for comparison of the alternative route alignments.
2) Calculation sample: refer to Conceptual Design Drawings

   Considering Alternative Route Alignment 1 **Table 3.4.2-2** shows the curve length of each curve radius prior and after multiplying the coefficient.

Table 3.4.2-2 Curve Radius Lengths after Multiplying the Coefficient

Curve Radius Lengths of Alternative Route Alignment 1	Distance (km) $\sum l_{r,x}$	Coefficient $e_{h,r}$	Distance x Coefficient
	(1)	(2)	(1) x (2)
- Curve Radius Lengths of 3,000 m. or more	6.05	1.00	6.05
- Curve Radius Lengths of 2,000 m. or more but less than 3,000 m.	8.68	0.75	6.51
- Curve Radius Lengths of 1,600 m. or more but less than 2,000 m.	4.82	0.50	2.41
- Curve Radius Lengths of 900 m. or more but less than 1,600 m.	6.92	0.25	1.73
- Curve Radius Lengths Less than 900 m.	0.83	0.00	0.00
Total	**27.30**		**16.70**

So the total curve length of Alternative Route Alignment 1 (L_{ci}) = 27.30 km

$\sum_{r=1}^{5}(e_{h,r} \times \sum_{x=1}^{y} l_{r,x})$ = 16.70 km

and Alternative Route Alignment 4 has the longest curve length ($L_{c\,max}$) = 50.16 km

Based on the equation:

$$e_i = \frac{\sum_{r=1}^{5}(e_{h,r} \times \sum_{x=1}^{y} l_{r,x}) + e_{h,1}(L_{cmax} - L_{ci})}{L_{cmax}}$$

So the multiplying factor of Alternative Route Alignment 1 =

$$e_i = \frac{16.70 + 1.00(50.16 - 27.30)}{50.16} = 0.79$$

∴ Scores of Alternative Route Alignment 2 = 0.79 x 5 = 3.95

As shown in **Table 3.4.2-3**.

Table 3.4.2-3 Scores of Horizontal Characteristic of Alternative Route Alignments

Route No.	L_{ci} (km)	Curve Radius (m)	$e_{h,r}$	Sum($l_{r,x}$) (km)	$e_{h,r}$ x Sum($l_{r,x}$)	Sum($e_{h,r}$ x Sum($l_{r,x}$))	L_{cmax}-L_{ci}	Multiplying factor	Scores
	(1)	(3)	(4)	(5)	(6)=(4)x(5)	(7)=sum(6)	(8)=(2)-(1)	(9)=((7)+(8))/ (2)	
1	27.30	r ≥3,000	1.00	6.05	6.05	16.70	22.85	0.79	3.95
		2,000 ≤r< 3,000	0.75	8.68	6.51				
		1,600 ≤r< 2,000	0.50	4.82	2.41				
		900 ≤r<1,600	0.25	6.92	1.73				
		r<900	0.00	0.83	0.00				
2	32.31	r ≥3,000	1.00	3.99	3.99	14.88	17.84	0.65	3.25
		2,000 ≤r< 3,000	0.75	9.46	7.09				
		1,600 ≤r<2,000	0.50	0.00	0.00				
		900 ≤r<1,600	0.25	15.16	3.79				
		r< 900	0.00	3.71	0.00				
3	34.19	r ≥3,000	1.00	3.15	3.15	14.61	15.97	0.61	3.05
		2,000 ≤r< 3,000	0.75	9.26	6.95				
		1,6008 r< 2,000	0.50	0.00	0.00				
		900 ≤r<1,600	0.25	18.08	4.52				
		r< 900	0.00	3.71	0.00				
4	50.16	r ≥3,000	1.00	10.34	10.34	28.56	0.00	0.57	2.85
		2,000 ≤r< 3,000	0.75	16.97	12.72				
		1,600 ≤r< 2,000	0.50	2.38	1.19				
		900 ≤r<1,600	0.25	17.25	4.31				
		r < 900	0.00	3.22	0.00				
L_{cma}	50.16	km (2)							

3.4.2.4 Vertical Characteristic of Alternative Route Alignments

Travel on horizontal alignment is more comfort and safer than on the alignment that has to often change the gradient. Likewise, the flat slope is better than the steep slope as the steep slope requires more energy in train operation and increases the wear rate of rail as well. Therefore, each slope range has the following coefficients.

- Slope more than 0% to 5% The coefficient $e_{v,1}$ = 1.00
- Slope more than 5% to 8% The coefficient $e_{v,2}$ = 0.75
- Slope more than 8% to 10% The coefficient $e_{v,3}$ = 0.50
- Slope more than 10% The coefficient $e_{v,4}$ = 0.25

In scoring the vertical characteristic of alternative route alignment, i, the Consultant has considered the starting point of the alignment at Chumphon Station and the ending point at Ranong Deep Sea Port including the existing southern alignment and the new alignment. The multiplying factor of any alignment comes from the sum of the coefficient $e_{v,m}$ multiply by the total slope of each slope range, plus the difference between the sum of the slope length of the alignment that has maximum total slope

length and the sum of the slope length of that alignment, multiply by the coefficient $e_{v,1}$ =1.00, then divide by the sum of the slope length of the alignment that has the total longest slope length. The reason is because the total slope length of each alternative route alignment is different. To achieve equality in scoring, it has to consider under the same database, which is to adjust the slope length of each alignment to equal the longest alignment and the additional slope length of the alignment, i, shall be assumed that it is an additional slope of more than 0% to 5% as per the following equation:

$$e_i = \frac{\sum_{m=1}^{4}(e_{v,m} \times \sum_{x=1}^{y} l_{m,x}) + e_{v,1}(L_{vmax} - L_{vi})}{L_{vmax}}$$

Whereas e_i = Multiplying factor of alternative route alignment, i

$e_{v,m}$ = Coefficient of any slope alignment

$l_{m,x}$ = Any alignment that has slope within m

$L_{v\,max}$ = Total slope length of the longest alignment

L_{vi} = Total slope length of alternative route alignment, i

Calculation method of vertical characteristic of route alignment: 5 weighting

1) The consideration of vertical characteristic of route alignment will consider as follow:
   - Measure slope length of every slope range the whole alternative route alignments by designating the starting point at Chumphon Station and the ending point at Ranong Deep Sea Port which includes the new alignment and the existing southern alignment. For the alignment that has the spur line, the length includes the length of spur line.
   - For each slope range, measure from the start of slope (PVI) to the end of that slope (PVI).
   - The straight alignment (slope = 0) shall not be considered.
   - Identify the vertical alignment according to the designated slope range for comparison of the alternative route alignments.

2) Calculation sample: refer to Conceptual Design Drawings

   Considering Alternative Route Alignment 2 **Table 3.4.2-4** shows the slope length of each slope range prior and after multiplying the coefficient.

Table 3.4.2-4 Slope Lengths after Multiplying the Coefficient

Slope of Alternative Route Alignment 2	Distance (km) $\sum l_{m,x}$ (km)	Coefficient $e_{v,m}$	Distance x Coefficient
	(1)	(2)	(1) x (2)
- Slope from 0% to 5%	0.46	1.00	0.46
- Slope more than 5% to 8%	1.81	0.75	1.35
- Slope more than 8% to 10%	21.13	0.50	10.57
- Slope more than 10%	0.00	0.25	0.00
Total	**23.40**		**12.38**

So the total slope length of Alternative Route Alignment 2 (L_{vi}) = 23.40 km

$\sum_{m=1}^{4}(e_{v,m} \times \sum_{x=1}^{y} l_{m,x})$ = 12.38 km

and Alternative Route Alignment 1 has the longest slope length ($L_{v\max}$) = 30.46 km

Based on the equation:

$$e_i = \frac{\sum_{m=1}^{4}(e_{v,m} \times \sum_{x=1}^{y} l_{m,x}) + e_{v,1}(L_{vmax} - L_{vi})}{L_{vmax}}$$

So the multiplying factor of Alternative Route Alignment 2 =

$$e_i = \frac{12.38 + 1.00(30.46 - 23.40)}{30.46} = 0.64$$

∴ Scores of Alternative Route Alignment 2 = 0.64 x 5 = 3.20

As per **Table 3.4.2-5**

Table 3.4.2-5 Scores of Vertical Characteristic of Alternative Route Alignments

Route No.	L_{vi} (km)	Slope	$e_{v,m}$	Sum($l_{m,x}$) (km)	$e_{v,m}$x Sum($l_{m,x}$)	Sum($e_{v,m}$xSum($l_{m,x}$	L_{vmax}-L_{vi}	Multiplying factor	Scores
	(1)	(3)	(4)	(5)	(6)=(4)x(5)	(7)=sum(6)	(8)=(2)-(1)	(9)=((7)+(8))/(2)	
1	30.46	0‰ ≤m ≤5‰	1.00	1.35	1.35	15.91	0.00	0.52	2.60
		5‰ < m ≤8‰	0.75	0.00	0.00				
		8‰ < m ≤10‰	0.50	29.11	14.56				
		m > 10‰	0.25	0.00	0.00				
2	23.40	0‰ ≤m ≤5‰	1.00	0.46	0.46	12.38	7.07	0.64	3.20
		5‰ < m ≤8‰	0.75	1.81	1.35				
		8‰ < m ≤10‰	0.50	21.13	10.57				
		m > 10‰	0.25	0.00	0.00				
3	28.99	0‰ ≤m ≤5‰	1.00	0.46	0.46	14.73	1.47	0.53	2.65
		5‰ < m ≤8‰	0.75	0.00	0.00				
		8‰ < m ≤10‰	0.50	28.53	14.27				
		m > 10‰	0.25	0.00	0.00				
4	28.82	0‰ ≤m ≤5‰	1.00	4.80	4.80	16.81	1.64	0.61	3.05
		5‰ < m ≤8‰	0.75	0.00	0.00				
		8‰ < m ≤10‰	0.50	24.02	12.01				
		m > 10‰	0.25	0.00	0.00				
L_{vmax}	30.46	km (2)							

3.4.2.5 Difficulty and Ease in Construction

The at-grade alignment is easier and more convenient in construction than the elevated alignment. However, the elevated alignment is easier in construction than the alignment that has to be constructed in the tunnel. Upon consideration of difficulty and ease in construction in terms of construction period per kilometer, the coefficient of each structure is as follows:

- At-grade alignment The coefficient $e_{met,1}$ = 0.90
- Elevated alignment The coefficient $e_{met,2}$ = 0.75
- Tunnel The coefficient $e_{met,3}$ = 0.15

In scoring the difficulty and ease in construction of alternative route alignment, i, the multiplying factor of any alignment comes from the sum of the coefficient $e_{met,n}$ multiply by the structure length of each structure, plus the difference between the structure length of the alignment that has maximum total structure length and the sum of the structure length of that alignment, multiply by the coefficient $e_{met,4}$ =1.00 (no construction), then divide by the sum of the structure length of the alignment that has the total longest structure length. The reason is because the total structure length of each alternative route alignment is different. To achieve equality in scoring, it has to consider under the same database, which is to adjust the structure length of each alignment to equal the longest alignment and the additional structure length of the alignment, i, shall be assumed that it is an additional distance without construction as per the following equation:

$$e_i = \frac{\sum_{n=1}^{3}(e_{met,n} \times \sum_{x=1}^{y} l_{n,x}) + e_{met,4}(L'_{\max} - L'_i)}{L'_{\max}}$$

Whereas e_i = Multiplying factor of alternative route alignment, i

$e_{met,n}$ = Coefficient of alignment that has any structure

$l_{n,x}$ = Any alignment that has any structure, n

$L'_{\max}$ = Structure length of the longest alignment

L'_i = Structure length of alternative route alignment, i

Calculation method of difficulty and ease in construction: 6 weighting

1) The consideration of difficulty and ease in construction will consider as follow:
   - Measure the structure length which includes at-grade alignment, elevated alignment and tunnel the whole alternative route alignment.
   - Elevated structure on land. It depends on the soil condition of that area. But in some areas like mountain terrain where the soil in the area can bear heavy load, it may be possible to have high embankment. In comparison, this project has considered the area where the alignment level is higher than the existing soil level more than 7 m.
   - In case that the alignment has to pass the mangrove forest which is sensitive to environment, the alignment has to be elevated when the alignment level is higher than the existing soil level more than 3 m.

- In case that the alignment has to pass mountain terrain and the slope of the rail exceeds the power of the locomotive to climb up, a tunnel has to be construction if the peak of the mountain is more than 40 m. high.

2) Calculation sample: refer to Conceptual Design Drawings

Considering Alternative Route Alignment 3 **Table 3.4.2-6** shows the length of each structure prior and after multiplying the coefficient.

Table 3.4.2-6 Structure Lengths after Multiplying the Coefficient

Structure of Alternative Route Alignment 2	**Distance (km)** $\sum l_{n,x}$	**Coefficient** $e_{met,n}$	**Distance x Coefficient** $\sum l_{n,x}$ x $e_{met,n}$
	(1)	(2)	(1) x (2)
- At-grade alignment	41.25	0.90	37.13
- Elevated alignment	23.27	0.75	17.45
- Tunnel	15.17	0.15	2.28
Total	**79.69**		**56.85**

So the total structure length of Alternative Route Alignment 2 (L_i') = 79.69 km

$\sum_{n=1}^{3}(e_{met,n} \times \sum_{x=1}^{y} l_{n,x})$ = 56.85 km

and Alternative Route Alignment 4 has the longest structure length (L'_{max}) = 108.20 km

Based on the equation:

$$e_i = \frac{\sum_{n=1}^{3}(e_{met,n} \times \sum_{x=1}^{y} l_{n,x}) + e_{met,4}(L'_{max} - L_i')}{L'_{max}}$$

So the multiplying factor of Alternative Route Alignment 2 =

$$e_i = \frac{56.85 + 1.00(108.20 - 79.69)}{108.20} = 0.79$$

∴ Scores of Alternative Route Alignment 2 = 0.79 x 6 = 4.74

As per **Table 3.4.2-7**.

Table 3.4.2-7 Scores of Difficulty and Ease in Construction

Route No.	L'_i (km)	Structure	$e_{met,n}$	Sum($l_{n,x}$) (km)	$e_{met,n}$x Sum($l_{n,x}$)	Sum($e_{met,n}$x Sum($l_{n,x}$))	L'_{max}-L_i	Multiplying factor	Scores
	(1)	(3)	(4)	(5)	(6)=(4)x(5)	(7)=sum(6)	(8)=(2)-(1)	(9)=((7)+(8))/(2)	
1	107.48	At Grade	0.90	69.53	62.58	87.36	0.72	0.81	4.86
		Elevated	0.75	31.81	23.86				
		Tunnel	0.15	6.14	0.92				
2	79.13	At Grade	0.90	44.31	39.88	60.47	29.07	0.83	4.98
		Elevated	0.75	25.61	19.21				
		Tunnel	0.15	9.21	1.38				
3	79.69	At Grade	0.90	41.25	37.13	56.85	28.51	0.79	4.74
		Elevated	0.75	23.27	17.45				
		Tunnel	0.15	15.17	2.28				
4	108.20	At Grade	0.90	56.30	50.67	77.81	0.00	0.72	4.32
		Elevated	0.75	32.26	24.20				
		Tunnel	0.15	19.64	2.95				
L'_{max}	108.20	km (2)							

3.4.2.6 Safety in Train Operation

In scoring the safety in train operation for freight and passenger transportation, the Consultant has considered the issue of train operation within the tunnel which there is risks from beyond control factors such as risk from sabotage, risk from collision of large wildlife in the tunnel, risk from evacuation due to a broken train, fire or accident. The more the tunnels have, the more the risks are. The Consultant has not considered the level crossing problem as the project can solve this problem as already described in the item "Conceptual Design to Solve Level Crossing Problems" and fences shall be provided for at-grade track the whole route for utmost safety.

Calculation method of Safety in Train Operation: 5 weighting

1) The consideration of safety in train operation, the consultant considers several functions beyond control as follow:

   - Consider number of tunnels as train operation within the tunnel has risks, e.g. risk from sabotage, risk from collision of large wildlife in the tunnel, risk from evacuation due to a broken train, fire or accident. The more the tunnel has, the more the risk is.
   - Consider the tunnel length due to difficulty in evacuation upon any incident, e.g. a broken train, fire or accident within the tunnel. The longer the tunnel is, the more the risk is.
   - Do not consider level crossing problems as the project can solve this problem as already described in the item "Conceptual Design to Solve Level Crossing Problems" and fences shall be provided for at-grade track the whole route for utmost safety.

2) Calculation sample: refer to Conceptual Design Drawings

   The Consultant has determined the coefficient for safety in train operation as shown in **Table 3.4.2-8**.

Table 3.4.2-8 Coefficient for Safety in Train Operation

Safety Level	Criteria for consideration	Multiplying factor
Very High Risk / Severe	The number and length of the tunnels are very high.	0.00
High Risk	The number and length of the tunnels are high.	0.25
Moderately safe	The number and length of the tunnels are moderate.	0.50
Safe	The number and length of the tunnels are less.	0.75
Very Safe	The number and length of the tunnel is very less or no tunnel.	1.00

So upon consideration about tunnel issues of all alternative alignments, the scores can be summarized as shown in **Table 3.4.2-9**.

Table 3.4.2-9 Scores of Safety in Train Operation

Alternative Route Alignment	Characteristics of Route Alignment	Multiplying factor	Scores
1	- Has 5 tunnels (including Spur Line) - Tunnels have average length of 1.23 km. - The longest tunnel is 1.88 km long.	0.75	3.75
2	- Has 6 tunnels (including Spur Line) - Tunnels have average length of 1.54 km. - The longest tunnel is 3.84 km long.	0.50	2.50
3	- Has 12 tunnels (including Spur Line) - Tunnels have average length of 1.26 km. - The longest tunnel is 3.20 km long.	0.25	1.25
4	- Has 9 tunnels (including Spur Line) - Tunnels have average length of 2.18 km. - The longest tunnel is 8.35 km long.	0.25	1.25

3.4.2.7 Geological Conditions

As the project area is located on the active fault line of "Ranong Fault Line" as appeared in the active fault line map of Thailand. The fault line is from the northeast-south west for about 300 km long from Ranong Province to Prachuap Khiri Khan Province and moves along the oblique. Therefore, it needs to consider the earthquake issue. The sensitive structure to be the most affected is tunnel. In scoring, the Consultant has considered the risk from active fault line and earthquake as follows:

- Whether the tunnel alignment shall pass and overlie the fault line appeared on the active fault line map.
- Whether the tunnel alignment shall pass an area that has a dense of active fault line.
- The tunnel length which may pass the active fault line.
- The direction of tunnel and fault line. If it is the cross-direction, there shall be a greater risk of damage to tunnel more than the parallel direction. The tunnel that

has a cross-direction with the fault line has a chance to pass the fault line as already discovered and appeared on the map or underground and not discovered yet.

If the tunnel passes the active fault line, upon an incident of earthquake, it can cause the tunnel to break or collapse which requires high costs and times in repairing.

Calculation method of geological conditions: 4 weighting

1) As the project area is located on the active fault line of "Ranong Fault Line" as appeared in the active fault line map of Thailand. The fault line is from the northeast-south west for about 300 km long from Ranong Province to Prachuap Khiri Khan Province and moves along the oblique. Therefore, it needs to consider the earthquake issue. The sensitive structure to be the most affected is tunnel. In scoring, the Consultant has considered the risk from active fault line and earthquake as follows:

   - Whether the tunnel alignment shall pass and overlie the fault line appeared on the active fault line map (Source: Active Fault Line Map of Thailand, Department of Mineral Resources, July 18, 2015).
   - Whether the tunnel alignment shall pass an area that has a dense of active fault line.
   - Number of tunnels and tunnel length, i.e. more number of tunnels and more length shall have a chance to pass the active fault line.
   - The direction of tunnel and fault line. If it is the cross-direction, there shall be a greater risk of damage to tunnel more than the parallel direction. The tunnel that has a cross-direction with the fault line has a chance to pass the fault line as already discovered and appeared on the map or underground and not discovered yet.

2) Calculation sample: refer to Conceptual Design Drawings

   The Consultant has determined the coefficient of geological conditions as per **Table 3.4.2-10**.

Table 3.4.2-10 Coefficient of Geological Conditions

Impact level on Tunnel	Criteria for Consideration	Multiplying Factor
Much impact / Severe	- A large number of tunnels pass and overlie the fault line appeared on the active fault line map. - Tunnel alignment passes an area with high density of active fault line in many points. - The number and length of the tunnels are very high - The direction of the tunnel is transverse with the direction of the fault line in many points.	0.00
Relatively much impact	- Tunnel pass and overlie the fault line appeared on the active fault line map not less than 2 points. - Tunnel alignment passes an area with high density of active fault line in many points. - The number and length of the tunnels are high - The direction of the tunnel is transverse with the direction of the fault line in many points.	0.25
Moderate impact	- Tunnel pass and overlie the fault line appeared on the active fault line map not less than 2 points. - Tunnel alignment passes an area with moderate density of active fault line. - The number and length of tunnels are moderate. - The direction of the tunnel is transverse with the direction of the fault line moderately.	0.50
Slightly impact	- Tunnel pass and overlie the fault line appeared on the active fault line map at 1 point. - Tunnel alignment passes an area with less density of active fault line. - The number and length of tunnels are less. - The direction of the tunnel is transverse with the direction of the fault line slightly.	0.75
No impact	- Tunnel does not pass and overlie the fault line appeared on the active fault line map. - Tunnel alignment passes an area with less density of active fault line. - The number and length of the tunnel is very less or no tunnel. - The direction of the tunnel is transverse with the direction of the fault line lightly.	1.00

So Upon consideration **Figure 3.4.2-1** which shows the tunnel location and Ranong Fault Line of each alternative route alignment, the scores of geological conditions can be summarized as in **Table 3.4.2-11**.

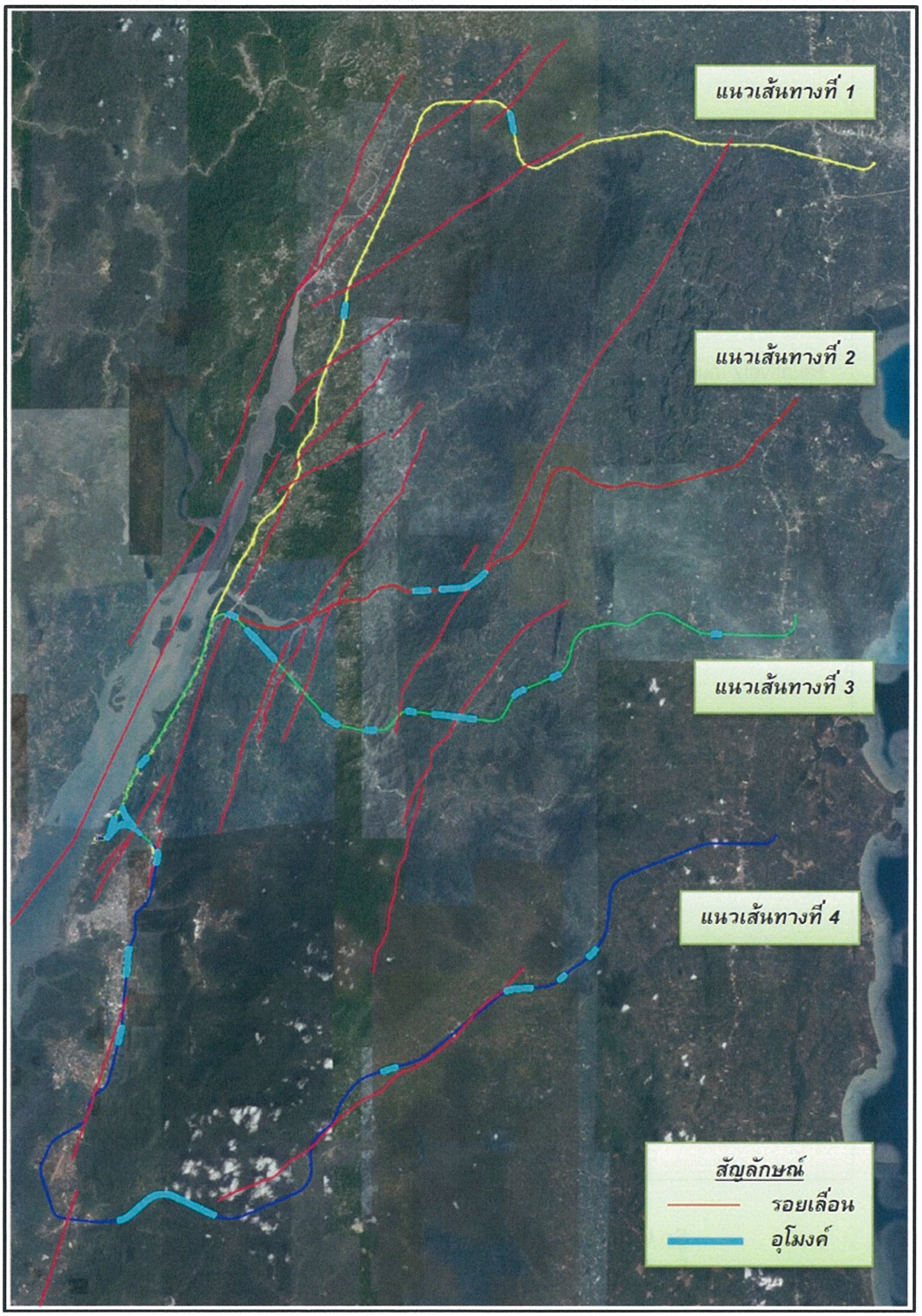


Figure 3.4.2-1 Tunnel Location and Ranong Fault Line

Table 3.4.2-11 Scores of Geological Conditions

No.	Tunnel of Alternative Railway Alignment 1						Tunnel of Alternative Railway Alignment 2						Tunnel of Alternative Railway Alignment 3						Tunnel of Alternative Railway Alignment 4					
	From Sta.	To Sta.	Length (Km)	Pass fault line as appeared in the map	Fault Line Density	Direction	From Sta.	To Sta.	Length (Km)	Pass fault line as appeared in the map	Fault Line Density	Direction	From Sta.	To Sta.	Length (Km)	Pass fault line as appeared in the map	Fault Line Density	Direction	From Sta.	To Sta.	Length (Km)	Pass fault line as appeared in the map	Fault Line Density	Direction
1	30+750	32+220	1.47	-	Moderate	x	31+740	35+580	3.84	Pass	Moderate	x	7+000	7+500	0.50	-	Light	x	18+780	19+580	0.80	-	Light	//
2	55+480	56+470	0.99	-	Moderate	x	36+550	37+650	1.10	-	Moderate	x	22+260	22+860	0.60	-	Moderate	//	21+950	22+500	0.55	-	Light	//
3	94+590	95+390	0.80	-	Dense	//	52+380	52+970	0.59	Pass	Dense	x	25+190	26+110	0.92	-	Moderate	//	24+800	26+800	2.00	-	Light	//
4	99+970	100+970	1.00	-	Dense	//	66+250	67+050	0.80	-	Dense	//	30+180	33+380	3.20	Pass	Moderate	x	37+270	38+370	1.10	-	Light	//
5							71+620	72+620	1.00	-	Dense	//	34+910	35+460	0.55	-	Moderate	x	57+490	65+840	8.35	Pass	Light	x
6													38+500	39+180	0.68	-	Moderate	x	86+660	87+960	1.30	-	Light	//
7													41+450	42+750	1.30	-	Moderate	x	91+980	94+060	2.08	-	Light	//
8													48+510	51+610	3.10	-	Dense	x	101+170	102+130	0.96	Pass	Dense	//
9													52+910	53+550	0.64	Pass	Dense	x	104+810	107+310	2.50	-	Dense	x
10													66+800	67+600	0.80	-	Dense	//						
11													72+170	73+170	1.00	-	Dense	//						
			4.26						7.33						13.29						19.64			
	Spur Line						Spur Line						Spur Line						Note:					
	From Sta.	To Sta.	Length (Km)				From Sta.	To Sta.	Length (Km)				From Sta.	To Sta.	Length (Km)				// Tunnel direction parallel to fault line					
	0+410	2+290	1.88	-	Dense	x	0+410	2+290	1.88	-	Dense	x	0+410	2+290	1.88	-	Dense	x	x Tunnel direction across fault line					
	Total length		6.14				Total length		9.21				Total length		15.17				Total length		19.64			
สรุป																								
	Impact level:		Slightly impact				Impact level:		Relatively much impact				Impact level:		Relatively much impact				Impact level:		Relatively much impact			
	Multiplying factor:		0.75				Multiplying factor:		0.25				Multiplying factor:		0.25				Multiplying factor:		0.25			
	Scores:		3.00				Scores:		1.00				Scores:		1.00				Scores:		1.00			

The criteria to consider the impact from the tunnel alignment passing the active fault line or a dense area of active fault line as appeared on the active fault line map of Thailand.

- Alternative Route Alignment 1 The tunnel alignment shall not pass the fault line appeared on the active fault line map of Thailand, the risk is Rank No. 4 (the least risk).
- Alternative Route Alignment 2 The tunnel alignment shall be about 32-33 km long, pass and overlie the fault line quite long and at Sta. 52+800, it shall pass a dense fault line as appeared on the active fault line map of Thailand, the risk is Rank No. 1 (very high risk).
- Alternative Route Alignment 3 At Sta. 31+500 and Sta. 53+400, the tunnel alignment shall pass a dense fault line as appeared on the active fault line map of Thailand, the risk is Rank No. 2 (high risk).
- Alternative Route Alignment 4 At Sta. 59+000 and at the end of the tunnel about Sta. 102+000, the tunnel alignment shall pass the fault line as appeared on the active fault line map of Thailand, the risk is Rank No. 3 (high risk).

Upon consideration with the number of tunnels/tunnel length and tunnel direction, the scores can be summarized as in **Table 3.4.2-11**.

3.4.2.8 Summary of Engineering Comparison

Based on engineering scores of various parameters of each alternative route alignment according to the above principles and methods, it can be summarized as in **Table 3.4.2-12**.

Table 3.4.2-12 Summary of Engineering Comparison

No.	Important Parameters	Designated Weighting	Route Alignment 1		Route Alignment 2		Route Alignment 3		Route Alignment 4	
			e_i	Scores	e_i	Scores	e_i	Scores	e_i	Scores
1	Route Length	5	0.91	4.55	1.00	5.00	0.83	4.15	0.37	1.85
2	Horizontal Characteristic	5	0.79	3.95	0.65	3.25	0.61	3.05	0.57	2.85
3	Vertical Characteristic	5	0.52	2.60	0.64	3.20	0.53	2.65	0.61	3.05
4	Difficulty and Ease in Construction	6	0.81	4.86	0.83	4.98	0.79	4.74	0.72	4.32
5	Safety in Train Operation	5	0.75	3.75	0.50	2.50	0.25	1.25	0.25	1.25
6	Geological Conditions	4	0.75	3.00	0.25	1.00	0.25	1.00	0.25	1.00
	Total	**30**		**22.71**		**19.93**		**16.84**		**14.32**

Due to the complex topography which needs to design the route alignment that is feasible for engineering and passes different area conditions either in topography, natural resources or conservation areas, each route alternative alignment has distinct engineering differences. From **Figures 3.4.2-2** and **3.4.2-3**, in consideration of the route length, Alternative Route Alignment 2 gets the highest scores whilst for other engineering parameters, Alternative Route Alignment 2 is not outstanding as it has to pass mountain terrain and it is likewise Alternative Route Alignments 3 and 4. Although Alternative Route Alignment 1 is ranked No. 2 for the route length and difficulty and ease in construction, after totaling all engineering parameters, Alternative Route Alignment 1 is outstanding whilst Alternative Route Alignments 2, 3 and 4 are ranked second respectively.

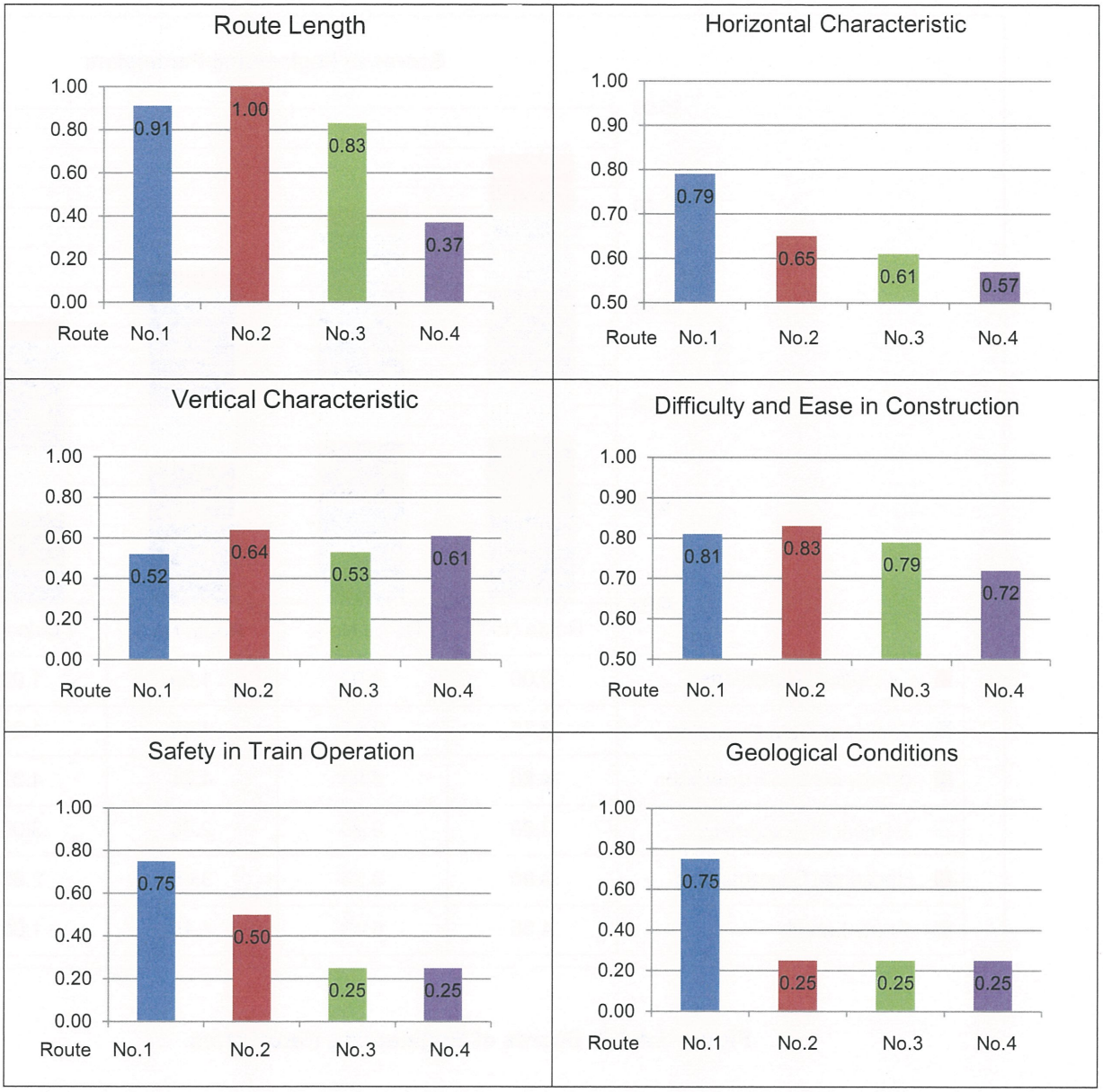
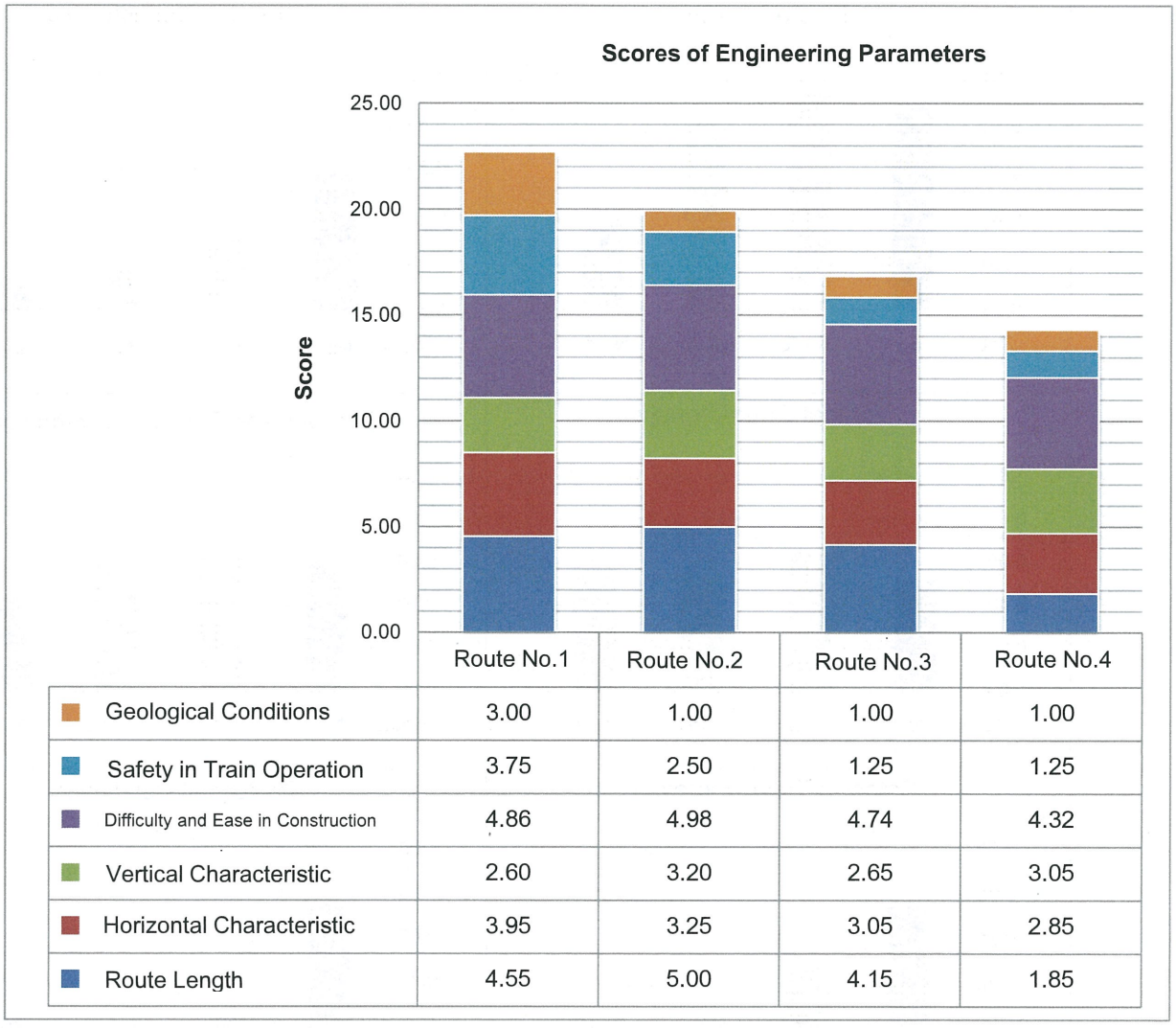


Figure 3.4.2-2 Multiplying Factor of Engineering Parameters



	Route No.1	Route No.2	Route No.3	Route No.4
Geological Conditions	3.00	1.00	1.00	1.00
Safety in Train Operation	3.75	2.50	1.25	1.25
Difficulty and Ease in Construction	4.86	4.98	4.74	4.32
Vertical Characteristic	2.60	3.20	2.65	3.05
Horizontal Characteristic	3.95	3.25	3.05	2.85
Route Length	4.55	5.00	4.15	1.85

Figure 3.4.2-3 Scores of Engineering Parameters

3.4.3 Economic and Investment Comparison (30 Weighting)

3.4.3.1 Criteria for Weighting on Economic and Investment

Thirty weighting was designated to economic and investment comparison. The criteria for weighting each parameter is shown in **Table 3.4.3-1**.

Table 3.4.3-1 Criteria for Weighting Economic and Investment Parameters

Parameters Considered	Weighting	Explanations / Reasons for Consideration
Investment	**(20)**	The investment cost is an important factor that reflects the economic worthiness of the project. Upon comparison of passenger volumes of each alternative route alignment, the investment parameter is more significant than other parameters. Therefore, high weighting was designated to the investment.
• Immovable property expropriation cost ▪ Land acquisition cost ▪ Compensation cost for demolition of buildings and structures	5	Immovable property expropriation cost is a separate budget and a different period with the construction budget. As the immovable property expropriation cost is less than the construction cost, the weighting is less as well.
• Construction cost	15	As construction cost is the main investment budget that reflects the value of investment, high weighting was designated to construction cost.
Passenger volumes along Alternative Route Alignments	**(10)**	Passenger volumes along the alignment are important to economic growth of communities around the station. However, upon comparison with investment, passenger volumes are less important than investment, therefore, the weighting is less as well.
• Potential population for each station along the alternative route alignments	5	The potential population for each station along the alternative route alignments and the distance to access each station is equally important. Therefore, the designated weighting for both parameters are equal.
• Distance to access each station along the alternative route alignments	5	

3.4.3.2 Investment

Twenty weighting was designated to the investment which consisted of immovable property expropriation cost 5 weighting and construction cost 15 weighting. The details are as follows:

3.4.3.2.1 Immovable property Expropriation Cost

Immovable property expropriation cost consisted of 2 parts, i.e. land acquisition cost and compensation cost for demolition of buildings and structures. Alternative route alignment with lower immovable property expropriation cost has more advantage than alternative route alignment with higher immovable property expropriation cost as it saves an investment budget. Alternative route alignment with the lowest immovable property expropriation cost gets the multiplying factor 1.00 and other alternative route alignments get the following multiplying factor from the following equation:

$$e_i = 1 - \frac{(1 - C_{exp,min}/C_{exp,max})(C_{exp,i} - C_{exp,min})}{(C_{exp,max} - C_{exp,min})}$$

Whereas e_i = Multiplying factor of alternative route alignment, i

$C_{exp,min}$ = Immovable property expropriation cost of alternative route alignment with the lowest compensation cost (Baht)

$C_{exp,max}$ = Immovable property expropriation cost of alternative route alignment with the highest compensation cost (Baht)

$C_{exp,i}$ = Immovable property expropriation cost of alternative route alignment, *i* (Baht)

Calculation method of immovable property expropriation cost: 5 weighting

1) Immovable property expropriation cost consisted of 2 main parameters:
   - Land acquisition cost.
   - Compensation cost for demolition of buildings and structures.
2) Calculation sample

   As per **Table 3.4.3-2**.
   - Alternative Route Alignment 3 has the lowest immovable property expropriation cost of 1,138.22 million Baht ($C_{exp,min}$).
   - Alternative Route Alignment 4 has the highest immovable property expropriation cost of 3,044.71 million Baht ($C_{exp,max}$).

Upon consideration Alternative Route Alignment 1, the immovable property expropriation cost = 1,908.42 million Baht ($C_{exp,1}$)

From the equation:

$$e_i = 1 - \frac{(1 - C_{exp,min}/C_{exp,max})(C_{exp,i} - C_{exp,min})}{(C_{exp,max} - C_{exp,min})}$$

So, the multiplying factor of Alternative Route Alignment 1 =

$$e_1 = 1 - \frac{(1 - 1{,}138.22/3{,}044.71)(1{,}908.42 - 1{,}138.22)}{(3{,}044.71 - 1{,}138.22)} = 0.75$$

∴ Score of Alternative Route Alignment 1 = 0.75 x 5 = 3.75

As per **Table 3.4.3-2.**

Table 3.4.3-2 Scores of Immovable Property Expropriation Cost

Route No.	Immovable Property Expropriation Cost (Million baht)			Immovable Property Expropriation Cost (Million baht)			Total (Million baht)	e_i	Scores
	Main Line			Spur Line					
	Land Acquisition Cost	Compensation Cost	Total	Land Acquisition Cost	Compensation Cost	Total			
1	1,324.94	474.26	1,799.20	51.97	57.26	109.22	1,908.42	0.75	3.75
2	627.52	429.01	1,056.52	51.97	57.26	109.22	1,165.74	0.99	4.95
3	667.01	361.99	1,029.00	51.97	57.26	109.22	1,138.22	1.00	5.00
4	2,384.21	644.83	3,044.71	-	-	-	3,044.71	0.37	1.85

3) **Tables 3.4.3-3** to **3.4.3-7** show the summary of immovable property expropriation cost of each alternative route alignment for further comparison

Table 3.4.3-3 Immovable Property Expropriation Cost of Alternative Route Alignment 1

No.	Item	Unit	Expropriation Cost
1	Land compensation cost (according to appraisal cost) (3315-2-50 Rai)	Baht	501,871,875.00
2	Adjusted to market price (200%)	Baht	1,003,743,750.00
3	Provisional sum for devaluation of the expropriated land (10% of 2)	Baht	100,374,375.00
4	Provisional sum for appeal and litigation (20% of 2+3)	Baht	220,823,625.00
	Total land compensation cost (2+3+4)	Baht	**1,324,941,750.00**
5	Buildings and structures compensation cost (192 nos.)	Baht	353,394,500.00
6	Provisional sum for appeal and litigation (20% of 5)	Baht	70,678,900.00
7	Crop and perennial plant	Baht	50,187,187.50
	Total buildings and structures compensation cost (5+6+7)	Baht	**474,260,587.50**
	Total Expropriation Cost	Baht	**1,799,202,337.50**

Note: Land appraisal is based on the appraisal of the accounting years, A.D. 2016-2019

Buildings and structures appraisal is based on the appraisal of Thai Appraisal Foundation, March 2017

Table 3.4.3-4 Immovable Property Expropriation Cost of Alternative Route Alignment 2

No.	Item	Unit	Expropriation Cost
1	Land compensation cost (according to appraisal cost) (2305-2-38 Rai)	Baht	237,696,562.50
2	Adjusted to market price (200%)	Baht	475,393,125.00
3	Provisional sum for devaluation of the expropriated land (10% of 2)	Baht	47,539,312.50
4	Provisional sum for appeal and litigation (20% of 2+3)	Baht	104,586,487.50
	Total land compensation cost (2+3+4)	Baht	**627,518,925.00**
5	Buildings and structures compensation cost (163 nos.)	Baht	337,696,500.00
6	Provisional sum for appeal and litigation (20% of 5)	Baht	67,539,300.00
7	Crop and perennial plant	Baht	23,769,656.25
	Total buildings and structures compensation cost (5+6+7)	Baht	**429,005,456.25**
	Total Expropriation Cost	Baht	**1,056,524,381.25**

Note: Land appraisal is based on the appraisal of the accounting years, A.D. 2016-2019

Buildings and structures appraisal is based on the appraisal of Thai Appraisal Foundation, March 2017

Table 3.4.3-5 Immovable Property Expropriation Cost of Alternative Route Alignment 3

No.	Item	Unit	Expropriation Cost
1	Land compensation cost (according to appraisal cost) (2366-1-75 Rai)	Baht	252,655,000.00
2	Adjusted to market price (200%)	Baht	505,310,000.00
3	Provisional sum for devaluation of the expropriated land (10% of 2)	Baht	50,531,000.00
4	Provisional sum for appeal and litigation (20% of 2+3)	Baht	111,168,200.00
	Total land compensation cost (2+3+4)	Baht	**667,009,200.00**
5	Buildings and structures compensation cost (137 nos.)	Baht	280,601,200.00
6	Provisional sum for appeal and litigation (20% of 5)	Baht	56,120,240.00
7	Crop and perennial plant	Baht	25,265,500.00
	Total buildings and structures compensation cost (5+6+7)	Baht	**361,986,940.00**
	Total Expropriation Cost	Baht	**1,028,996,140.00**

Note: Land appraisal is based on the appraisal of the accounting years, A.D. 2016-2019

Buildings and structures appraisal is based on the appraisal of Thai Appraisal Foundation, March 2017

Table 3.4.3-6 Immovable Property Expropriation Cost of Alternative Route Alignment 4

No.	Item	Unit	Expropriation Cost
1	Land compensation cost (according to appraisal cost) (3256-2-69 Rai)	Baht	903,108,906.25
2	Adjusted to market price (200%)	Baht	1,806,217,812.50
3	Provisional sum for devaluation of the expropriated land (10% of 2)	Baht	180,621,781.25
4	Provisional sum for appeal and litigation (20% of 2+3)	Baht	397,367,918.75
	Total land compensation cost (2+3+4)	Baht	**2,384,207,512.50**
5	Buildings and structures compensation cost (210 nos.)	Baht	475,163,600.00
7	Provisional sum for appeal and litigation (20% of 5)	Baht	95,032,720.00
8	Crop and perennial plant	Baht	90,310,890.63
	Total buildings and structures compensation cost (5+6+7)	Baht	**660,507,210.63**
	Total Expropriation Cost	Baht	**3,044,714,723.13**

Note: Land appraisal is based on the appraisal of the accounting years, A.D. 2016-2019

Buildings and structures appraisal is based on the appraisal of Thai Appraisal Foundation, March 2017

Table 3.4.3-7 Immovable Property Expropriation Cost of Spur Line of Alternative Route Alignments 1, 2 and 3

No.	Item	Unit	Expropriation Cost
1	Land compensation cost (according to appraisal cost) (171-1-25 Rai)	Baht	19,685,000.00
2	Adjusted to market price (200%)	Baht	39,370,000.00
3	Provisional sum for devaluation of the expropriated land (10% of 2)	Baht	3,937,000.00
4	Provisional sum for appeal and litigation (20% of 2+3)	Baht	8,661,400.00
	Total land compensation cost (2+3+4)	Baht	**51,968,400.00**
5	Buildings and structures compensation cost (23 nos.)	Baht	46,073,200.00
7	Provisional sum for appeal and litigation (20% of 5)	Baht	9,214,640.00
8	Crop and perennial plant	Baht	1,968,500.00
	Total buildings and structures compensation cost (5+6+7)	Baht	**57,256,340.00**
	Total Expropriation Cost	Baht	**109,224,740.00**

Note: Land appraisal is based on the appraisal of the accounting years, A.D. 2016-2019

Buildings and structures appraisal is based on the appraisal of Thai Appraisal Foundation, March 2017

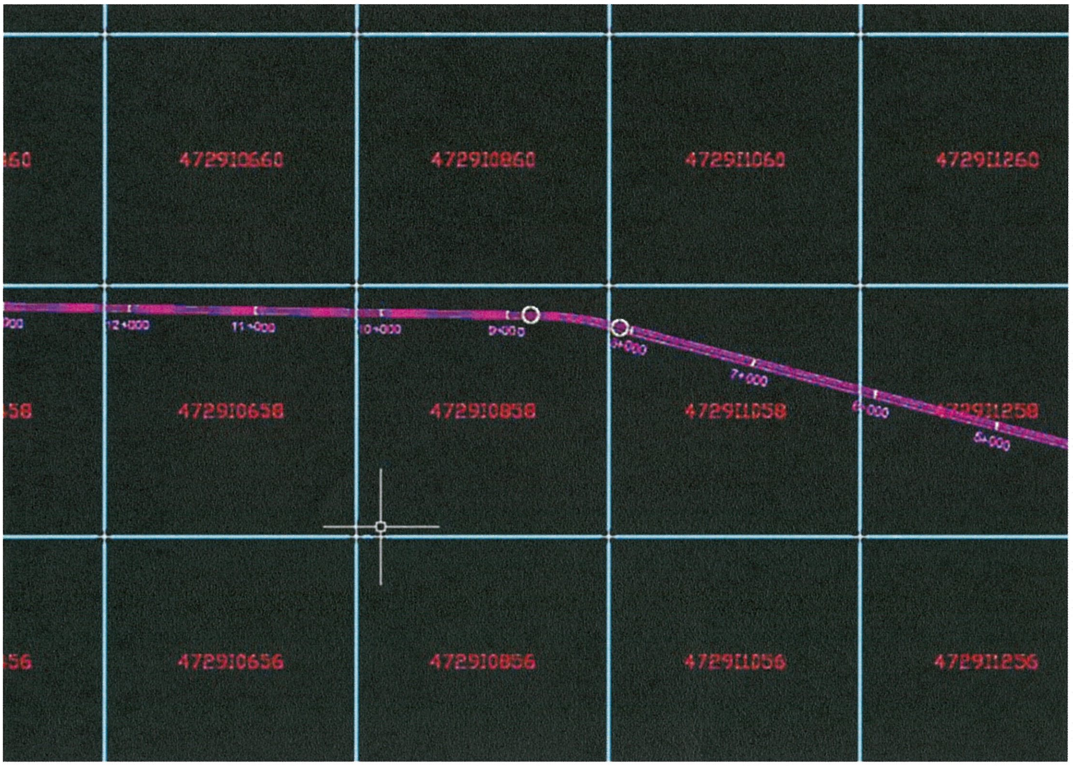


Figure 3.4.3-1 Sample of Alternative Route Alignment 1 (from Sta. 5+000 to Sta. 12+000) Placement on UTM Grids of the Department of Lands

2. Search for title deed No., mapsheet no., parcel no. and province from the Treasury Department's website as shown in **Figure 3.4.3-2** and **3.4.3-3**.

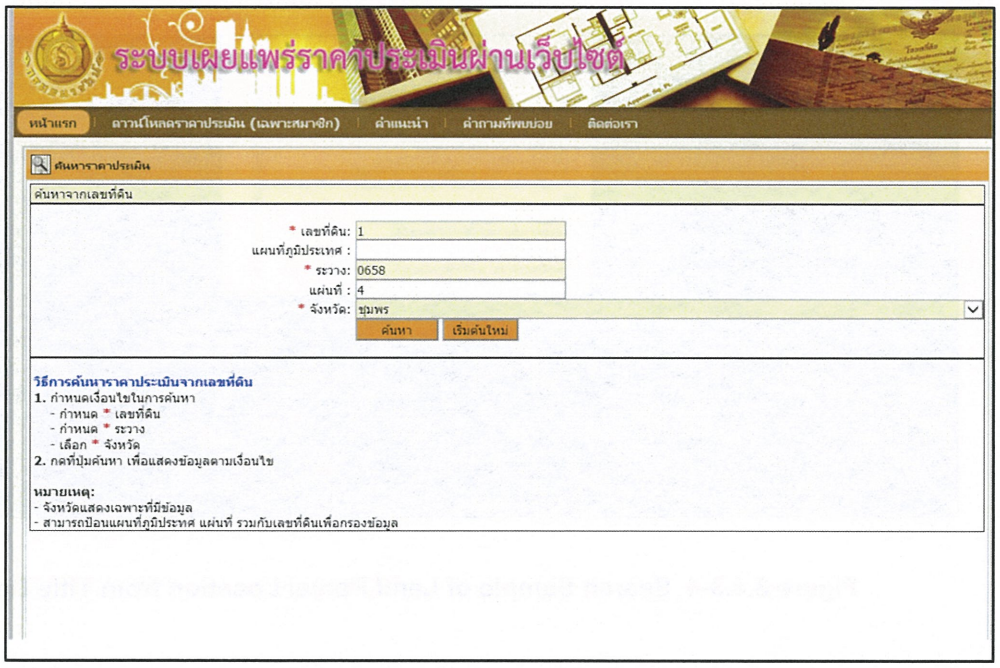


Figure 3.4.3-2 Search Sample of Title Deed No., Mapsheet No., Parcel No. and Province (1)

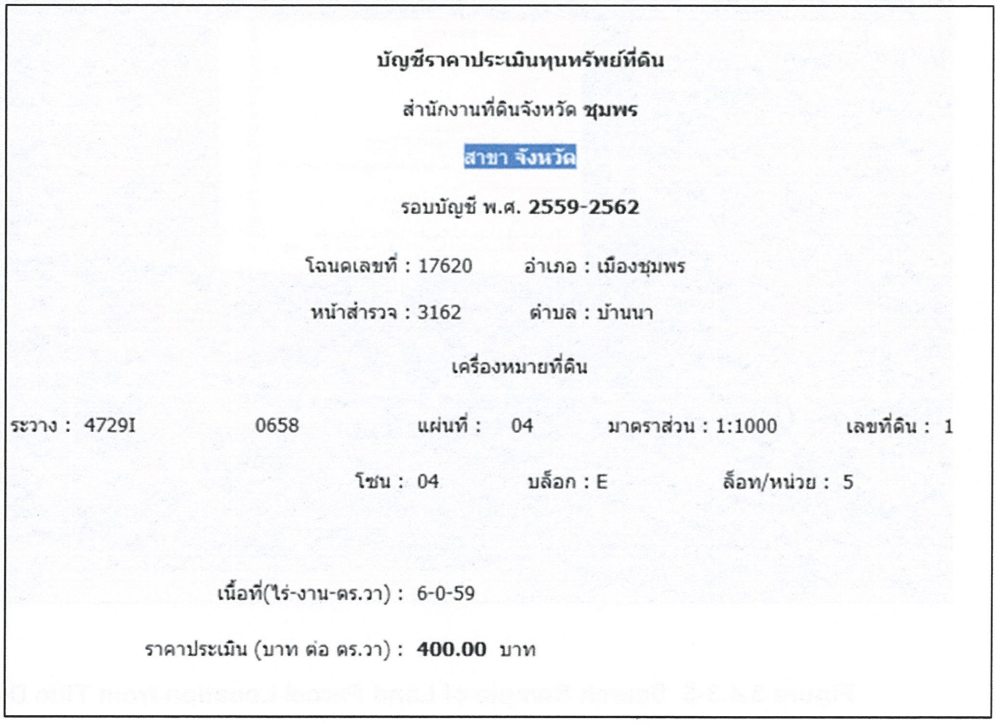


Figure 3.4.3-3 Search Sample of Title Deed No., Mapsheet No., Parcel No. and Province (2)

3. Search for land parcel location from title deed no. as shown in **Figure 3.4.3-4** and **3.4.3-5**

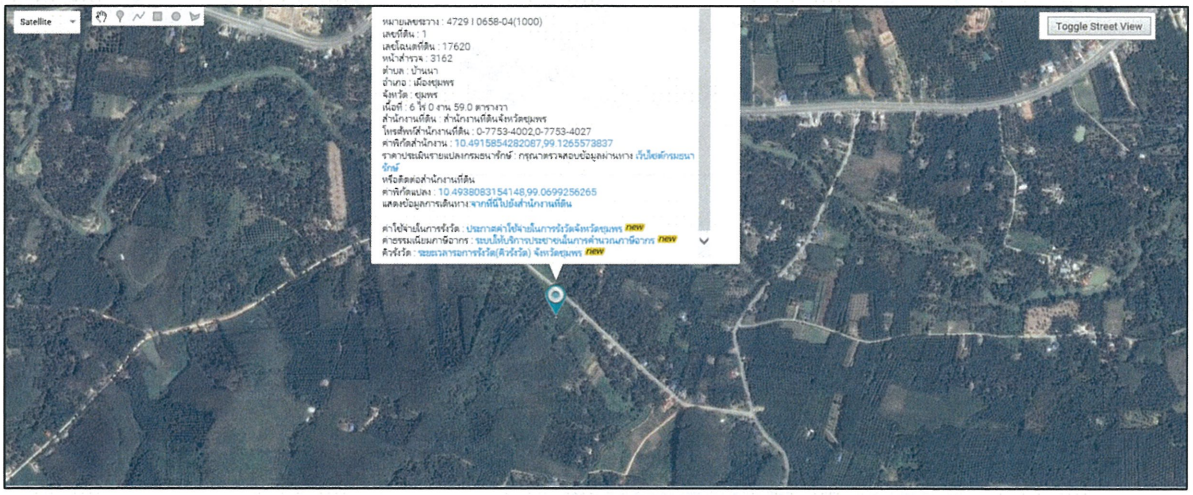


Figure 3.4.3-4 Search Sample of Land Parcel Location from Title Deed No. (1)

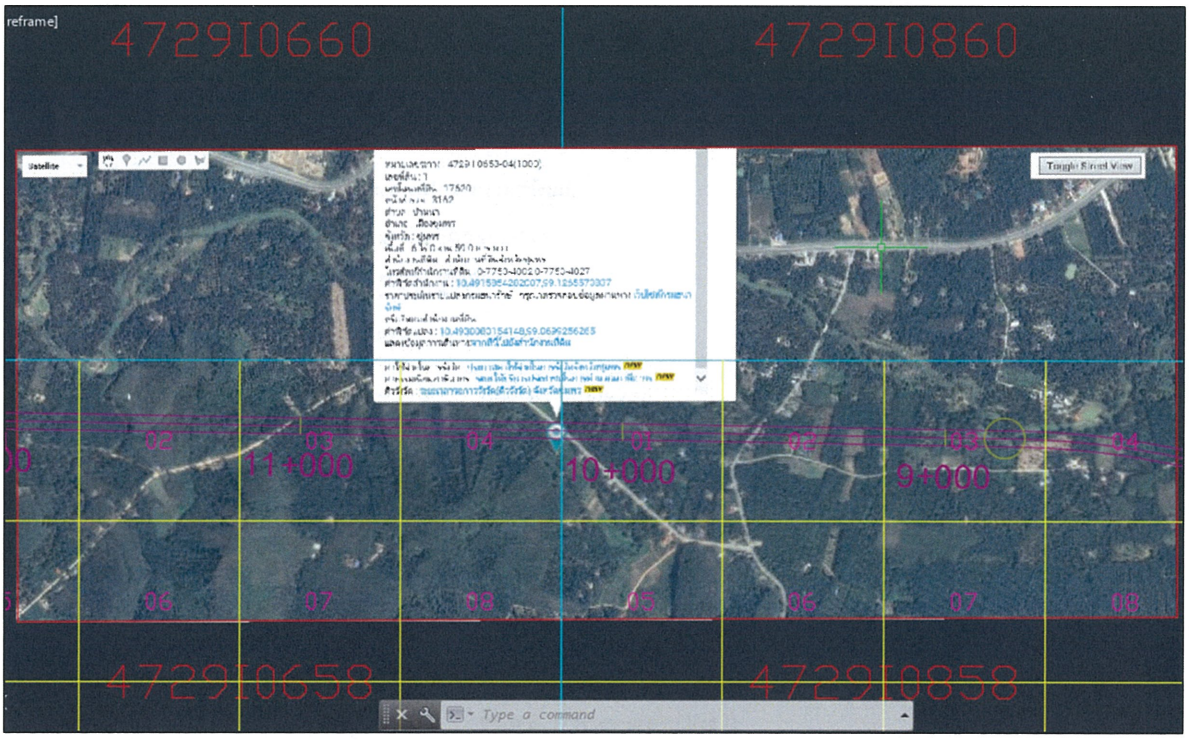


Figure 3.4.3-5 Search Sample of Land Parcel Location from Title Deed No. (2)

(2) Calculation of Land Acquisition Cost

Tables 3.4.3-8 to **3.4.3-12** show the land acquisition cost of Alternative Route Alignments.

Table 3.4.3-8 Land Acquisition Cost of Alternative Route Alignment 1

ALT# 1 (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
0+000 - 2+250	**Tak Dad Sub-district, Muang District, Chumphon Province**					
	- Land adjacent to Road No. 2009 for 40 m. (Tha Tapao Sub-district - Tak Dad Sub-district	80	1,000	2,400	2,400,000	
	- Land adjacent to road, lane, way for 40 m.	160	2,000	2,000	4,000,000	
	- Land without public roadway	2,010	25,125	1,300	32,662,500	
2+250 - 4+280	**Khun Krating Sub-district, Muang District, Chumphon Province**					
	- Land adjacent to Highway No. 41 for 40 m.	80	1,000	10,000	10,000,000	
	- Deduct Highway No. 41's right-of-way	60	750			
	- Land adjacent to road, lane, way for 40 m.	160	2,000	5,000	10,000,000	
	- Land without public roadway	1,730	21,625	3,250	70,281,250	
3+500 - 4+000	**- Land without public roadway**		**6,250**	**3,250**	**20,312,500**	**Khun Krating Station**
4+280 - 27+000	**Ban Na Sub-district, Muang District, Chumphon Province**					
	- Land adjacent to Rural Road No. Chor Por. 2005 for 40 m.	80	1,000	425	425,000	
	- Deduct Rural Road No. Chor Por. 2005's right-of-way	15	188			
	- Land adjacent to road, lane, way for 40 m.	1,040	13,000	400	5,200,000	
	- Land without public roadway	21,585	269,813	150	40,471,875	
13+875 - 14+375	**- Land without public roadway**		**6,250**	**150**	**937,500**	**Ban Na Station**
21+450 - 21+950	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**400**	**2,500,000**	**Wang Mai Station**
27+000 - 28+800	**Wang Mai Sub-district, Muang District, Chumphon Province**					
	- Land adjacent to road, lane, way for 40 m.	160	2,000	400	800,000	
	- Land without public roadway	1,640	20,500	150	3,075,000	
28+800 - 34+680	**Choporo Sub-district, Kra Buri District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	160	2,000	400	800,000	
	- Land without public roadway	5,720	71,500	100	7,150,000	
34+680 - 41+700	**Pak Chan Sub-district, Kra Buri District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	400	5,000	300	1,500,000	
	- Land without public roadway	6,620	82,750	100	8,275,000	
41+700 - 49+000	**Mamu Sub-district, Kra Buri District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	640	8,000	300	2,400,000	
	- Land without public roadway	6,660	83,250	100	8,325,000	
42+400 - 42+900	**- Land without public roadway**		**6,250**	**100**	**625,000**	**Pak Chan Station**
49+000 - 52+800	**Nam Chuet Noi Sub-district, Kra Buri District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	240	3,000	1,950	5,850,000	
	- Land without public roadway	3,560	44,500	375	16,687,500	
52+350 - 52+850	- Land without public roadway		**6,250**	**375**	**2,343,750**	**Kra Buri Station**
52+800 - 59+600	**Nam Chuet Sub-district, Kra Buri District, Ranong Province**					
56+400	- Land adjacent to Highway No. 4 for 40 m.	80	1,000	4,200	4,200,000	
	- Deduct Highway No. 4's right-of-way	60	750			
	- Land adjacent to Rural Road No. Ranong 1014 for 40 m.	1,000	12,500	2,600	32,500,000	
	- Land adjacent to road, lane, way for 40 m.	320	4,000	1,950	7,800,000	
	- Land without public roadway	5,340	66,750	375	25,031,250	
59+600 - 63+230	**Lamliang Sub-district, Kra Buri District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	400	5,000	300	1,500,000	
	- Deduct Lamliang Canal	100				
	- Land without public roadway	3,130	39,125	100	3,912,500	
63+230 - 75+000	**Bang Yai Sub-district, Kra Buri District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	480	6,000	750	4,500,000	
	- Land without public roadway	11,290	141,125	100	14,112,500	

Table 3.4.3-8 Land Acquisition Cost of Alternative Route Alignment 1 (Cont'd)

ALT# 1 (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
10+320 - 70+820	**- Land without public roadway**		**6,250**	**100**	**625,000**	**Bang Yai Station**
75+000 - 80+320	**Bang Kaew Sub-district, La-un District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	240	3,000	475	1,425,000	
	- Deduct La-un Canal	400				
	- Land without public roadway	4,680	58,500	100	5,850,000	
78+350 - 78+850	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**475**	**2,968,750**	**La-un Station**
80+320 - 91+350	**Sai Daeng Sub-district, Muang District, Ranong Province**					
80+320 - 86+000	- Land without public roadway	5,680	71,000	300	21,300,000	
86+000 - 91+350	- Kra Buri National Park	5,350	66,875		-	
91+350 - 102+500	**Pak Nam Sub-district, Muang District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	1,500	18,750	2,700	50,625,000	
	- Land without public roadway	9,650	120,625	400	48,250,000	
101+900 - 102+500	**- Land adjacent to road, lane, way for 40 m.**		**7,500**	**2,700**	**20,250,000**	**Ranong Port Station**
	Grand Total	**102,500**	**1,326,250**		**501,871,875**	

Note : Land acquisition cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-9 Land Acquisition Cost of Alternative Route Alignment 2

ALT# 2 (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
0+000 - 1+750	**Sawi Sub-district, Sawi District, Chumphon Province**					
0+000 - 1+000	- Existing railway	1,000	12,500		-	
	- Land adjacent to road, lane, way for 40 m.	80	1,000	400	400,000	
	- Land without public roadway	670	8,375	125	1,046,875	
1+750 - 8+320	**Khron Sub-district, Sawi District, Chumphon Province**					
	- Land adjacent to Highway No. 41 for 40 m.	80	1,000	875	875,000	
	- Deduct Highway No. 41's right-of-way	60	750			
	- Land adjacent to road, lane, way for 40 m.	480	6,000	400	2,400,000	
	- Land without public roadway	5,950	37,188	125	4,648,438	
4+920 - 5+420	**- Land adjacent to Highway No. 41 for 40 m.**		**6,250**	**400**	**2,500,000**	**Khron Station**
8+320 - 11+750	**Sawi Sub-district, Sawi District, Chumphon Province**					
	- Land adjacent to road, lane, way for 40 m.	160	2,000	400	800,000	
	- Land without public roadway	3,270	40,875	150	6,131,250	
11+750 - 24+260	**Thung Raya Sub-district, Sawi District, Chumphon Province**					
	- Land adjacent to road, lane, way for 40 m.	320	4,000	250	1,000,000	
	- Land without public roadway	12,190	152,375	100	15,237,500	
17+100 - 17+600	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**250**	**1,562,500**	
24+260 - 33+480	**Khao Thalu Sub-district, Sawi District, Chumphon Province**					
28+800	- Land adjacent to Rural Road No. Chor Por. 4139 for 40 m.	80	1,000	1,250	1,250,000	
	- Land adjacent to road, lane, way for 40 m.	320	4,000	325	1,300,000	
	- Land without public roadway	6,340	79,250	100	7,925,000	
31+000 - 33+480	- Ngao Waterfall National Park	2,480	31,000			
28+000 - 28+500	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**325**	**2,031,250**	**Khao Thalu Station**
33+480 - 47+360	**Bang Kaew Sub-district, La-un District, Ranong Province**					
	- Land adjacent to road, lane, way for 40 m.	740	9,250	250	2,312,500	
	- Land without public roadway	12,890	161,125	100	16,112,500	
	- Deduct La-un Canal	250	3,125		-	
47+360 - 49+580	**Bang Phra Tai Sub-district, La-un District, Ranong Province**					
	- Land without public roadway	2,220	27,750	100	2,775,000	
49+580 - 63+000	**Sai Daeng Sub-district, Muang District, Ranong Province**					
56+400	- Land adjacent to Highway No. 4 for 40 m.	80	1,000	12,000	12,000,000	
	- Deduct Highway No. 4's right-of-way	60	750			
	- Land adjacent to Rural Road No. Ranong 4001 for 40 m.	80	1,000	2,475	2,475,000	
	- Land adjacent to road, lane, way for 40 m.	640	8,000	475	3,800,000	
	- Land without public roadway	7,200	90,000	300	27,000,000	
	- Kra Buri Canal National Park	5,360	67,000		-	
55+300 - 55+800	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**475**	**2,968,750**	
63+000 - 74+154	**Pak Nam Sub-district, Muang District, Ranong Province**				-	
	- Land adjacent to road, lane, way for 40 m.	1,500	18,750	2,700	50,625,000	
	- Land without public roadway	9,654	120,675	400	48,270,000	
73+554 - 74+154	**- Land adjacent to road, lane, way for 40 m.**		**7,500**	**2,700**	**20,250,000**	**Ranong Port Station**
Grand Total		**74,154**	**922,238**		**237,696,563**	

Note : Land acquisition cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-10 Land Acquisition Cost of Alternative Route Alignment 3

ALT# 3 (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
0+000 - 1+460	**Na Sak Sub-district, Sawi District, Chumphon Province**					
0+000 - 0+800	- Existing railway	800	10,000		-	
	- Land adjacent to road, lane, way for 40 m.	80	1,000	600	600,000	
	- Land adjacent to local road	580	7,250	300	2,175,000	
1+460 - 5+000	**Thung Takhrai Sub-district, Thung Tako District, Chumphon Province**					
	- Land adjacent to Highway No. 41 for 40 m.	80	1,000	2,500	2,500,000	
	- Deduct Highway No. 41's right-of-way	60	750			
	- Land adjacent to road, lane, way for 40 m.	240	3,000	600	1,800,000	
	- Land without public roadway	3,160	19,750	125	2,468,750	
5+000 - 22+600	**Na Sak Sub-district, Sawi District, Chumphon Province**					
	- Land adjacent to Highway No. 4139 for 40 m.	240	3,000	2,050	6,150,000	
	- Land adjacent to road, lane, way for 40 m.	400	5,000	600	3,000,000	
	- Land without public roadway	16,960	212,000	125	26,500,000	
16+300 - 16+800	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**600**	**3,750,000**	**Na Sak Station**
22+600 - 31+600	**Khao Khai Sub-district, Sawi District, Chumphon Province**					
	- Land adjacent to Highway No. 4139 for 40 m.	80	1,000	2,050	2,050,000	
	- Land adjacent to road, lane, way for 40 m.	400	5,000	600	3,000,000	
	- Land without public roadway	8,520	106,500	125	13,312,500	
29+250 - 29+750	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**600**	**3,750,000**	**Khao Khai Station**
31+600 - 43+230	**La-un Nua Sub-district, La-un District, Ranong Province**		-			
	- Land adjacent to Highway No. 4139 for 40 m.	300	3,750	250	937,500	
	- Land adjacent to Rural Road No. Ror Nor. 1007 for 40 m.	160	2,000	200	400,000	
	- Land adjacent to road, lane, way for 40 m.	800	10,000	200	2,000,000	
	- Land without public roadway	10,370	129,625	100	12,962,500	
43+230 - 47+000	**La-un Tai Sub-district, La-un District, Ranong Province**		-			
	- Land adjacent to Highway No. 4091 for 40 m.	80	1,000	400	400,000	
	- Land adjacent to road, lane, way for 40 m.	360	4,500	300	1,350,000	
	- Land without public roadway	3,300	41,250	100	4,125,000	
	- Deduct La-un Canal	30	375		-	
45+570 - 46+070	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**300**	**1,875,000**	**La-un Tai Station**
47+000 - 49+600	**Bang Phra Tai Sub-district, La-un District, Ranong Province**		-		-	
	- Land without public roadway	2,600	32,500	100	3,250,000	
49+600 - 63+440	**Sai Daeng Sub-district, Muang District, Ranong Province**					
56+400	- Land adjacent to Highway No. 4 for 40 m.	80	1,000	12,000	12,000,000	
	- Deduct Highway No. 4's right-of-way	60	750			
	- Land adjacent to Rural Road No. Ranong 4001 for 40 m.	320	4,000	2,475	9,900,000	
	- Land adjacent to road, lane, way for 40 m.	640	8,000	475	3,800,000	
	- Land without public roadway	6,980	87,250	300	26,175,000	
	- Kra Buri Canal National Park	5,760	72,000		-	
55+853 - 56+353	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**475**	**2,968,750**	**La-un Station**
63+440 - 74+706	**Pak Nam Sub-district, Muang District, Ranong Province**		-		-	
	- Land adjacent to road, lane, way for 40 m.	1,500	18,750	2,700	50,625,000	
	- Land without public roadway	9,766	122,075	400	48,830,000	
74+106 - 74+706	**- Land adjacent to road, lane, way for 40 m.**		**7,500**	**2,700**	**20,250,000**	**Ranong Port Station**
Grand Total		**74,706**	**946,575**		**252,655,000**	

Note : Land acquisition cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-11 Land Acquisition Cost of Alternative Route Alignment 4

ALT# 4 (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
0+000 - 3+680	**Na Kha Sub-district, Lang Suan District, Chumphon Province**					
0+000 - 0+225	- Existing railway	225	2,813		-	
	- Land adjacent to Highway No. 41 for 40 m.	80	1,000	8,000	8,000,000	
	- Deduct Highway No. 41's right-of-way	60	750			
	- Land adjacent to Highway No. 4097 for 40 m.	80	1,000	3,500	3,500,000	
	- Land adjacent to road, lane, way for 40 m.	160	2,000	1,000	2,000,000	
	- Land adjacent to local road	200	2,500	2,500	6,250,000	
	- Land without public roadway	2,875	17,969	175	3,144,531	
3+680 - 14+620	**Wang Takor Sub-district, Lang Suan District, Chumphon Province**					
	- Land adjacent to road, lane, way for 40 m.	640	8,000	2,700	21,600,000	
	- Land without public roadway	10,300	64,375	175	11,265,625	
14+620 - 18+350	**Had Yai Sub-district, Lang Suan District, Chumphon Province**					
	- Land adjacent to Highway No. 4006 for 40 m.	80	1,000	3,775	3,775,000	
	- Land adjacent to road, lane, way for 40 m.	80	1,000	2,700	2,700,000	
	- Deduct canal	50	625		-	
	- Land without public roadway	3,520	44,000	125	5,500,000	
15+400 - 15+900	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**2,700**	**16,875,000**	**Had Yai Station**
18+350 - 28+330	**Pang Wan Sub-district, Phato District, Chumphon Province**					
	- Land adjacent to road, lane, way for 40 m.	1,040	13,000	500	6,500,000	
	- Deduct canal	210	2,625		-	
	- Land without public roadway	8,730	109,125	100	10,912,500	
28+330 -33+240	**Phra Rak Sub-district, Phato District, Chumphon Province**					
	- Land adjacent to road, lane, way for 40 m.	160	2,000	250	500,000	
	- Deduct canal	100	1,250		-	
	- Land without public roadway	4,650	58,125	100	5,812,500	
33+240 - 51+120	**Phato Sub-district, Phato District, Chumphon Province**					
	- Land adjacent to Highway No. 4006 for 40 m.	160	2,000	3,200	6,400,000	
	- Land adjacent to road, lane, way for 40 m.	400	5,000	250	1,250,000	
	- Deduct canal	100	1,250		-	
	- Land without public roadway	17,220	215,250	100	21,525,000	
45+000 - 45+500	**- Land without public roadway**		**6,250**	**100**	**625,000**	**Phato Station**
51+120 - 65+070	**Pak Song Sub-district, Phato District, Chumphon Province**				-	
	- Land adjacent to Highway No. 4006 for 40 m.	1,530	19,125	3,200	61,200,000	
	- Land adjacent to road, lane, way for 40 m.	2,120	26,500	200	5,300,000	
	- Deduct canal	100	1,250		-	
	- Land without public roadway	10,200	127,500	100	12,750,000	
65+070 - 98+100	**Ratchakrud ub-district, Muang District, Ranong Province**					
	- Land adjacent to Highway No. 4 for 40 m.	660	8,250	40,500	334,125,000	
	- Deduct Highway No. 4's right-of-way	60	750			
	- Land adjacent to road, lane, way for 40 m.	320	4,000	2,250	9,000,000	
	- Land without public roadway	31,990	399,875	450	179,943,750	
78+900 - 79+400	**- Land adjacent to road, lane, way for 40 m.**		**6,250**	**2,250**	**14,062,500**	**Airport Station**
90+500 - 90+750	**- Land without public roadway**		**6,250**	**450**	**2,812,500**	**Ranong Station**
98+100 - 105+000	**Bang Non Sub-district, Muang District, Ranong Province**					
	- Land adjacent to Highway No. 4 for 40 m.	80	1,000	40,500	40,500,000	
	- Deduct Highway No. 4's right-of-way	60	750			
	- Land adjacent to Rural Road No. Ranong 1002 for 40 m.	160	2,000	3,500	7,000,000	

Table 3.4.3-11 Land Acquisition Cost of Alternative Route Alignment 4 (Cont'd)

ALT# 4 (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
	- Land adjacent to road, lane, way for 40 m.	800	10,000	3,500	35,000,000	
	- Land without public roadway	5,800	72,500	450	32,625,000	
105+000 - 108+201	**Pak Nam Sub-district, Muang District, Ranong Province**				-	
	- Land adjacent to Rural Road No. Ranong 4010 for 40 m.	500	6,250	2,700	16,875,000	
	- Land adjacent to road, lane, way for 40 m.	560	7,000	725	5,075,000	
105+000 - 106+000	- Kra Buri Canal National Park	1,000	12,500		-	
	- Land without public roadway	1,141	14,263	400	5,705,000	
107+601 - 108+601	**- Land without public roadway**		**7,500**	**400**	**3,000,000**	
Grand Total		**108,201**	**1,302,669**		**903,108,906**	

Note : Land acquisition cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-12 Land Acquisition Cost of Spur Line of Alternative Route Alignments 1, 2 and 3

Spur Line (ROW. =50 M.)						
Sta.	Description	Distance (m.)	Area (Sq. Wah)	Appraisal Cost (Baht/Sq.Wah)	Total Land Acquisition Cost (Baht)	Note
1+000 - 4+982	**Pak Nam Sub-district, Muang District, Ranong Province**				-	
	- Land adjacent to road, lane, way for 40 m.	560	7,000	725	5,075,000	
	- Kra Buri Canal National Park	1,000	12,500		-	
	- Land without public roadway	2,922	36,525	400	14,610,000	
4+482 - 4+982	**- Land adjacent to road, lane, way for 40 m.**	**500**	**12,500**	**725**	**9,062,500**	**Ranong Station**
		4,982	**68,525**		**19,685,000**	

Note : Land acquisition cost shown in this table is used for comparison of the alternative route alignments only.

5) Calculation of Demolition Cost of Buildings and Structures

(1) Information about Building and Structure Cost

Building appraisal cost is based on Thai Appraisal Foundation of March, 2017 as shown in **Table 3.4.3-13**.

Table 3.4.3-13 Building Appraisal Cost

Structural Type	Legend	Appraisal Cost (Baht/Sq.m.)
1-storey single concrete house	1-SC	14,600
2-storey single concrete house	2-SC	14,600
3-storey single concrete house	3-SC	14,600
4-storey single concrete house	4-SC	14,900
1-storey wooden building	1-SW	13,000
2-storey wooden building	2-SW	12,600
1-storey half wooden half concrete house	1-SCW	11,400
2-storey half wooden half concrete house	2-SCW	11,400
1-storey building, zinc wall	1-SZ	7,600
Stall	Stall	1,500
1-storey factory	1-SCF	7,600
2-storey factory	2-SCF	7,600
3-storey commercial building	3-SCC	9,000
4-storey commercial building	4-SCC	8,500
Old 1-storey single concrete house	1-SCP	11,100

Note : Appraisal cost shown in this table is used for comparison of the alternative route alignments only.

(2) Calculation of Compensation Cost for Demolition as shown in **Tables 3.4.3-14** to **3.4.3-18**.

Table 3.4.3-14 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 1

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
1	0+320	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
2	0+320	2-SCW	1	7	12	84	11,400	957,600	191,520	1,149,120
3	0+360	2-SCW	1	7	16	112	11,400	1,276,800	255,360	1,532,160
4	0+465	1-SC	1	16	16	256	14,600	3,737,600	747,520	4,485,120
5	0+480	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
6	0+500	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
7	0+710	1-SC	1	16	18	288	14,600	4,204,800	840,960	5,045,760
8	1+065	1-SC	1	16	6	96	14,600	1,401,600	280,320	1,681,920
9	1+575	1-SC	1	12	5	60	14,600	876,000	175,200	1,051,200
10	1+585	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
11	1+650	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
12	1+655	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
13	1+810	Stall	1	6	9	54	1,500	81,000	16,200	97,200
14	1+810	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
15	4+000	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
16	4+000	1-SCF	1	25	30	750	7,600	5,700,000	1,140,000	6,840,000
17	4+000	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
18	4+000	Stall	1	5	9	45	1,500	67,500	13,500	81,000
19	4+000	1-SCF	1	20	50	1000	7,600	7,600,000	1,520,000	9,120,000
20	4+100	1-SC	1	12	30	360	14,600	5,256,000	1,051,200	6,307,200
21	5+400	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
22	5+450	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
23	5+455	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
24	5+500	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
25	5+700	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
26	7+912	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
27	7+972	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
28	8+462	1-SC	1	8	20	160	14,600	2,336,000	467,200	2,803,200
29	7+950	1-SC	1	21	20	420	14,600	6,132,000	1,226,400	7,358,400
30	9+445	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
31	9+530	Stall	1	4	5	20	1,500	30,000	6,000	36,000
32	9+535	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
33	9+880	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
34	13+780	1-SC	1	7	15	105	14,600	1,533,000	306,600	1,839,600
35	14+080	1-SC	1	7	15	105	14,600	1,533,000	306,600	1,839,600
36	14+170	1-SC	1	10	12	120	14,600	1,752,000	350,400	2,102,400
37	14+180	1-SC	1	14	20	280	14,600	4,088,000	817,600	4,905,600
38	16+080	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
39	16+200	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
40	16+420	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760

Table 3.4.3-14 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 1 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
41	16+630	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
42	16+645	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
43	17+000	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
44	17+180	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
45	17+275	1-SC	1	5	7	35	14,600	511,000	102,200	613,200
46	17+380	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
47	20+840	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
48	20+950	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
49	23+440	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
50	23+450	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
51	23+460	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
52	23+550	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
53	23+550	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
54	23+550	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
55	23+550	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
56	23+980	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
57	24+100.	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
58	25+000	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
59	26+870	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
60	27+400	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
61	28+130	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
62	27+850	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
63	28+140	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
64	28+140	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
65	28+140	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
66	28+220	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
67	28+220	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
68	28+250	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
69	28+250	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
70	28+250	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
71	28+260	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
72	28+260	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
73	28+260	Stall	1	4	5	20	1,500	30,000	6,000	36,000
74	28+270	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
75	28+270	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
76	28+300	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
77	28+270	2-SC	2	8	12	192	14,600	2,803,200	560,640	3,363,840
78	28+320	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
79	28+340	1-SC	1	12	25	300	14,600	4,380,000	876,000	5,256,000
80	28+360	1-SC	1	6	7	42	14,600	613,200	122,640	735,840

Table 3.4.3-14 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 1 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
81	33+060	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
82	33+100	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
83	33+130	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
84	33+800	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
85	33+870	1-SC	1	8	26	208	14,600	3,036,800	607,360	3,644,160
86	33+900	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
87	33+930	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
88	33+960	2-SC	2	8	9	144	14,600	2,102,400	420,480	2,522,880
89	35+430	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
90	35+430	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
91	38+530	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
92	38+980	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
93	38+990	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
94	39+010	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
95	39+200	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
96	39+600	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
97	39+850	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
98	40+400	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
99	41+230	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
100	41+300	1-SC	1	12	25	300	14,600	4,380,000	876,000	5,256,000
101	42+120	1-SC	1	8	8	64	14,600	934,400	186,880	1,121,280
102	42+150	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
103	42+160	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
104	44+140	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
105	44+860	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
106	45+020	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
107	45+020	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
108	45+300	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
109	46+440	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
110	46+435	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
111	47+545	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
112	50+09*0	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
113	50+340	2-SCW	2	7	12	168	11,400	1,915,200	383,040	2,298,240
114	50+575	2-SCW	2	7	8	112	11,400	1,276,800	255,360	1,532,160
115	50+575	2-SCW	2	16	15	480	11,400	5,472,000	1,094,400	6,566,400
116	50+625	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
117	50+950	1-SC	1	7	15	105	14,600	1,533,000	306,600	1,839,600
118	51+170	1-SC	1	7	6	42	14,600	613,200	122,640	735,840
119	51+170	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
120	51+570	1-SC	1	9	16	144	14,600	2,102,400	420,480	2,522,880

Table 3.4.3-14 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 1 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
121	51+660	1-SC	1	16	21	336	14,600	4,905,600	981,120	5,886,720
122	53+000	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
123	53+700	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
124	56+880	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
125	58+940	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
126	59+000	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
127	59+250	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
128	59+930	1-SC	1	12	21	252	14,600	3,679,200	735,840	4,415,040
129	59+950	Stall	1	9	85	765	1,500	1,147,500	229,500	1,377,000
130	65+840	Stall	1	9	85	765	1,500	1,147,500	229,500	1,377,000
131	65+850	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
132	65+850	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
133	68+510	1-SC	1	16	16	256	14,600	3,737,600	747,520	4,485,120
134	68+515	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
135	69+090	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
136	69+200	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
137	69+210	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
138	70+125	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
139	70+125	1-SW	1	6	12	72	13,000	936,000	187,200	1,123,200
140	74+185	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
141	74+185	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
142	75+530	1-SW	1	5	6	30	13,000	390,000	78,000	468,000
143	75+725	Stall	1	9	30	270	1,500	405,000	81,000	486,000
144	78+070	1-SC	1	18	18	324	14,600	4,730,400	946,080	5,676,480
145	78+320	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
146	79+182	Stall	1	6	8	48	1,500	72,000	14,400	86,400
147	84+130	1-SW	1	5	15	75	13,000	975,000	195,000	1,170,000
148	84+170	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
149	84+170	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
150	85+440	1-SC	1	16	22	352	14,600	5,139,200	1,027,840	6,167,040
151	86+000	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
152	86+000	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
153	86+000	2-SC	2	3	3	18	14,600	262,800	52,560	315,360
154	86+000	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
155	86+000	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
156	86+000	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
157	86+000	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
158	87+110	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
159	87+200	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
160	90+280	1-SC	1	6	8	48	14,600	700,800	140,160	840,960

Table 3.4.3-14 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 1 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
161	92+750	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
162	93+340	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
163	93+420	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
164	93+420	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
165	93+480	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
166	95+950	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
167	95+950	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
168	95+950	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
169	95+950	1-SC	1	16	16	256	14,600	3,737,600	747,520	4,485,120
170	95+950	1-SC	1	12	50	600	14,600	8,760,000	1,752,000	10,512,000
171	95+950	1-SC	1	12	50	600	14,600	8,760,000	1,752,000	10,512,000
172	95+950	1-SC	1	15	25	375	14,600	5,475,000	1,095,000	6,570,000
173	95+950	1-SC	1	7	7	49	14,600	715,400	143,080	858,480
174	95+950	1-SC	1	12	36	432	14,600	6,307,200	1,261,440	7,568,640
175	95+950	1-SC	1	6	6	36	14,600	525,600	105,120	630,720
176	95+950	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
177	96+325	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
178	96+325	1-SC	1	5	12	60	14,600	876,000	175,200	1,051,200
179	98+000	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
180	98+825	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
181	99+320	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
182	99+350	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
183	99+440	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
184	99+440	1-SC	1	5	9	45	14,600	657,000	131,400	788,400
185	99+445	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
186	99+465	1-SC	1	8	18	144	14,600	2,102,400	420,480	2,522,880
187	99+490	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
188	99+520	1-SC	1	12	22	264	14,600	3,854,400	770,880	4,625,280
189	99+750	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
190	99+760	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
191	99+820	Stall	1	4	6	24	1,500	36,000	7,200	43,200
192	99+820	Stall	1	4	6	24	1,500	36,000	7,200	43,200
Grand Total								**353,394,500**	**70,678,900**	**424,073,400**

Note : Compensation cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-15 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 2

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
1	4+000	1-SC	1	12	32	384	14,600	5,606,400	1,121,280	6,727,680
2	4+000	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
3	4+030	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
4	4+930	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
5	4+930	1-SC	1	6	14	84	14,600	1,226,400	245,280	1,471,680
6	4+930	1-SC	1	5	8	40	14,600	584,000	116,800	700,800
7	4+930	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
8	5+400	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
9	6+400	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
10	6+400	1-SC	1	7	14	98	14,600	1,430,800	286,160	1,716,960
11	6+600	2-SCW	2	12	15	360	11,400	4,104,000	820,800	4,924,800
12	8+020	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
13	8+200	1-SCF	1	20	50	1000	7,600	7,600,000	1,520,000	9,120,000
14	8+360	1-SC	1	7	15	105	14,600	1,533,000	306,600	1,839,600
15	8+360	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
16	8+440	2-SCW	2	8	18	288	11,400	3,283,200	656,640	3,939,840
17	8+500	2-SCW	2	15	18	540	11,400	6,156,000	1,231,200	7,387,200
18	10+430	1-SC	1	16	16	256	14,600	3,737,600	747,520	4,485,120
19	10+430	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
20	12+450	2-SCW	2	12	18	432	11,400	4,924,800	984,960	5,909,760
21	14+000	1-SC	1	12	35	420	14,600	6,132,000	1,226,400	7,358,400
22	14+000	1-SC	1	12	55	660	14,600	9,636,000	1,927,200	11,563,200
23	14+000	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
24	15+000	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
25	15+350	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
26	15+500	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
27	16+700	2-SCW	2	8	12	192	11,400	2,188,800	437,760	2,626,560
28	16+700	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
29	16+800	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
30	18+130	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
31	18+475	Stall	1	6	6	36	1,500	54,000	10,800	64,800
32	18+490	Stall	1	6	9	54	1,500	81,000	16,200	97,200
33	18+500	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
34	18+520	1-SC	1	8	8	64	14,600	934,400	186,880	1,121,280
35	18+530	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
36	18+490	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
37	18+500	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
38	18+580	1-SC	1	8	18	144	14,600	2,102,400	420,480	2,522,880
39	18+950	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
40	18+950	1-SC	1	6	8	48	14,600	700,800	140,160	840,960

Table 3.4.3-15 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 2 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
41	19+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
42	19+090	1-SC	1	16	25	400	14,600	5,840,000	1,168,000	7,008,000
43	19+100	Stall	1	6	9	54	1,500	81,000	16,200	97,200
44	19+700	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
45	19+700	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
46	19+700	Stall	1	5	5	25	1,500	37,500	7,500	45,000
47	19+720	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
48	19+720	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
49	19+750	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
50	19+750	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
51	19+750	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
52	20+460	1-SC	1	15	21	315	14,600	4,599,000	919,800	5,518,800
53	21+320	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
54	22+195	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
55	23+275	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
56	22+780	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
57	24+275	1-SC	1	12	14	168	14,600	2,452,800	490,560	2,943,360
58	24+275	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
59	24+275	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
60	24+275	Stall	1	5	6	30	1,500	45,000	9,000	54,000
61	24+275	2-SCW	2	12	18	432	11,400	4,924,800	984,960	5,909,760
62	24+275	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
63	24+285	2-SCW	2	15	15	450	11,400	5,130,000	1,026,000	6,156,000
64	24+720	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
65	25+250	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
66	25+250	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
67	25+250	Stall	1	5	6	30	1,500	45,000	9,000	54,000
68	25+250	1-SC	1	7	15	105	14,600	1,533,000	306,600	1,839,600
69	25+760	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
70	25+800	1-SC	1	7	18	126	14,600	1,839,600	367,920	2,207,520
71	26+970	2-SCW	2	7	12	168	11,400	1,915,200	383,040	2,298,240
72	27+000	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
73	27+800	Stall	1	4	5	20	1,500	30,000	6,000	36,000
74	27+800	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
75	27+800	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
76	29+450	Stall	1	5	6	30	1,500	45,000	9,000	54,000
77	30+320	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
78	30+360	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
79	30+320	1-SW	1	5	6	30	13,000	390,000	78,000	468,000
80	30+440	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680

Table 3.4.3-15 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 2 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
81	30+530	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
82	30+540	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
83	30+660	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
84	30+700	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
85	30+820	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
86	30+870	2-SCW	2	12	7	168	11,400	1,915,200	383,040	2,298,240
87	30+900	1-SW	1	8	8	64	13,000	832,000	166,400	998,400
88	31+390	1-SC	1	15	12	180	14,600	2,628,000	525,600	3,153,600
89	32+480	2-SCW	2	8	8	128	11,400	1,459,200	291,840	1,751,040
90	37+720	Stall	1	8	9	72	1,500	108,000	21,600	129,600
91	37+890	2-SCW	2	8	26	416	11,400	4,742,400	948,480	5,690,880
92	38+550	1-SC	1	12	9	108	14,600	1,576,800	315,360	1,892,160
93	39+160	1-SC	1	9	5	45	14,600	657,000	131,400	788,400
94	39+240	2-SC	2	6	9	108	14,600	1,576,800	315,360	1,892,160
95	39+240	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
96	39+240	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
97	39+420	1-SC	1	6	15	90	14,600	1,314,000	262,800	1,576,800
98	40+675	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
99	40+675	1-SC	1	9	18	162	14,600	2,365,200	473,040	2,838,240
100	40+675	1-SC	1	9	8	72	14,600	1,051,200	210,240	1,261,440
101	42+250	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
102	42+250	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
103	42+250	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
104	42+760	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
105	42+780	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
106	42+790	1-SC	1	8	25	200	14,600	2,920,000	584,000	3,504,000
107	44+615	2-SC	2	15	8	240	14,600	3,504,000	700,800	4,204,800
108	44+615	2-SC	2	12	9	216	14,600	3,153,600	630,720	3,784,320
109	44+615	Stall	1	10	15	150	1,500	225,000	45,000	270,000
110	53+190	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
111	55+230	Stall	1	6	8	48	1,500	72,000	14,400	86,400
112	55+270	1-SW	1	5	15	75	13,000	975,000	195,000	1,170,000
113	55+270	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
114	56+540	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
115	57+100	1-SC	1	16	22	352	14,600	5,139,200	1,027,840	6,167,040
116	57+100	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
117	57+100	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
118	57+100	2-SC	2	3	3	18	14,600	262,800	52,560	315,360
119	57+100	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
120	57+100	1-SC	1	4	5	20	14,600	292,000	58,400	350,400

Table 3.4.3-15 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 2 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
121	57+100	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
122	58+210	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
123	58+300	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
124	61+380	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
125	63+850	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
126	64+440	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
127	64+520	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
128	64+520	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
129	64+580	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
130	67+050	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
131	67+050	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
132	67+050	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
133	67+050	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
134	67+050	1-SC	1	16	16	256	14,600	3,737,600	747,520	4,485,120
135	67+050	1-SC	1	12	50	600	14,600	8,760,000	1,752,000	10,512,000
136	67+050	1-SC	1	12	50	600	14,600	8,760,000	1,752,000	10,512,000
137	67+050	1-SC	1	15	25	375	14,600	5,475,000	1,095,000	6,570,000
138	67+050	1-SC	1	7	7	49	14,600	715,400	143,080	858,480
139	67+050	1-SC	1	12	36	432	14,600	6,307,200	1,261,440	7,568,640
140	67+050	1-SC	1	6	6	36	14,600	525,600	105,120	630,720
141	67+380	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
142	67+400	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
143	67+420	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
144	67+420	1-SC	1	15	25	375	14,600	5,475,000	1,095,000	6,570,000
145	67+420	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
146	67+420	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
147	67+430	1-SC	1	7	18	126	14,600	1,839,600	367,920	2,207,520
148	67+480	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
149	69+100	1-SC	1	7	16	112	14,600	1,635,200	327,040	1,962,240
150	69+925	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
151	70+420	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
152	70+450	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
153	70+540	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
154	70+540	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
155	70+545	1-SC	1	5	9	45	14,600	657,000	131,400	788,400
156	70+565	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
157	70+590	1-SC	1	8	18	144	14,600	2,102,400	420,480	2,522,880
158	70+620	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
159	70+850	1-SC	1	12	22	264	14,600	3,854,400	770,880	4,625,280
160	70+860	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
161	70+920	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
162	70+920	Stall	1	4	6	24	1,500	36,000	7,200	43,200
163	70+920	Stall	1	4	6	24	1,500	36,000	7,200	43,200
Grand Total								**337,696,500**	**67,539,300**	**405,235,800**

Note : Compensation cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-16 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 3

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
1	1+535	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
2	1+535	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
3	3+610	2-SCW	2	7	15	210	11,400	2,394,000	478,800	2,872,800
4	4+650	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
5	5+465	1-SC	1	7	6	42	14,600	613,200	122,640	735,840
6	5+470	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
7	5+590	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
8	8+300	2-SCW	2	7	21	294	11,400	3,351,600	670,320	4,021,920
9	8+410	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
10	8+700	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
11	8+700	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
12	8+700	1-SC	1	7	16	112	14,600	1,635,200	327,040	1,962,240
13	9+700	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
14	9+700	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
15	11+800	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
16	11+980	2-SCW	2	8	15	240	11,400	2,736,000	547,200	3,283,200
17	11+980	2-SCW	2	6	8	96	11,400	1,094,400	218,880	1,313,280
18	11+980	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
19	13+000	2-SCW	2	8	21	336	11,400	3,830,400	766,080	4,596,480
20	13+000	2-SCW	2	8	21	336	11,400	3,830,400	766,080	4,596,480
21	13+000	2-SCW	2	8	12	192	11,400	2,188,800	437,760	2,626,560
22	13+680	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
23	13+720	1-SC	1	9	16	144	14,600	2,102,400	420,480	2,522,880
24	14+450	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
25	15+000	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
26	15+620	2-SCW	2	7	15	210	11,400	2,394,000	478,800	2,872,800
27	16+800	2-SCW	2	7	9	126	11,400	1,436,400	287,280	1,723,680
28	17+000	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
29	17+000	1-SC	1	6	5	30	14,600	438,000	87,600	525,600
30	17+030	1-SC	1	16	21	336	14,600	4,905,600	981,120	5,886,720
31	18+000	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
32	18+000	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
33	19+260	2-SCW	2	10	15	300	11,400	3,420,000	684,000	4,104,000
34	19+390	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
35	20+370	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
36	21+950	2-SCW	2	8	16	256	11,400	2,918,400	583,680	3,502,080
37	23+246	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
38	23+246	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
39	23+690	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
40	23+820	1-SC	1	6	8	48	14,600	700,800	140,160	840,960

Table 3.4.3-16 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 3 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
41	23+820	2-SCW	2	6	8	96	11,400	1,094,400	218,880	1,313,280
42	23+820	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
43	25+825	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
44	25+825	2-SCW	2	15	15	450	11,400	5,130,000	1,026,000	6,156,000
45	25+825	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
46	26+565	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
47	27+265	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
48	27+920	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
49	27+920	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
50	28+500	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
51	28+500	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
52	28+560	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
53	28+800	1-SC	1	15	16	240	14,600	3,504,000	700,800	4,204,800
54	28+800	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
55	29+910	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
56	29+970	2-SCW	2	15	15	450	11,400	5,130,000	1,026,000	6,156,000
57	31+365	2-SCW	2	8	15	240	11,400	2,736,000	547,200	3,283,200
58	31+285	2-SCW	2	8	10	160	11,400	1,824,000	364,800	2,188,800
59	43+290	2-SCW	2	9	15	270	11,400	3,078,000	615,600	3,693,600
60	43+370	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
61	43+400	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
62	44+825	1-SC	1	20	30	600	14,600	8,760,000	1,752,000	10,512,000
63	44+825	1-SC	1	6	10	60	14,600	876,000	175,200	1,051,200
64	44+825	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
65	44+825	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
66	45+000	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
67	45+000	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
68	45+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
69	45+000	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
70	45+300	1-SC	1	11	9	99	14,600	1,445,400	289,080	1,734,480
71	45+300	1-SC	1	11	12	132	14,600	1,927,200	385,440	2,312,640
72	45+300	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
73	45+300	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
74	45+300	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
75	45+300	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
76	45+300	1-SC	1	9	11	99	14,600	1,445,400	289,080	1,734,480
77	45+300	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
78	45+300	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
79	45+300	1-SC	1	12	30	360	14,600	5,256,000	1,051,200	6,307,200
80	45+300	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160

Table 3.4.3-16 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 3 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
81	45+300	1-SC	1	15	30	450	14,600	6,570,000	1,314,000	7,884,000
82	45+300	1-SC	1	12	30	360	14,600	5,256,000	1,051,200	6,307,200
83	45+300	1-SC	1	12	40	480	14,600	7,008,000	1,401,600	8,409,600
84	45+850	1-SC	1	25	25	625	14,600	9,125,000	1,825,000	10,950,000
85	45+850	1-SC	1	12	40	480	14,600	7,008,000	1,401,600	8,409,600
86	45+850	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
87	45+850	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
88	53+000	1-SC	1	12	25	300	14,600	4,380,000	876,000	5,256,000
89	53+050	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
90	53+050	1-SC	1	5	7	35	14,600	511,000	102,200	613,200
91	55+630	Stall	1	6	8	48	1,500	72,000	14,400	86,400
92	55+670	1-SW	1	5	15	75	13,000	975,000	195,000	1,170,000
93	55+670	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
94	56+940	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
95	57+500	1-SC	1	16	22	352	14,600	5,139,200	1,027,840	6,167,040
96	57+500	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
97	57+500	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
98	57+500	2-SC	2	3	3	18	14,600	262,800	52,560	315,360
99	57+500	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
100	57+500	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
101	57+500	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
102	58+610	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
103	58+700	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
104	61+780	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
105	64+250	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
106	64+840	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
107	64+920	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
108	64+920	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
109	64+980	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
110	67+320	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
111	67+320	1-SC	1	5	12	60	14,600	876,000	175,200	1,051,200
112	68+300	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
113	68+300	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
114	68+300	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
115	68+570	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
116	68+600	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
117	68+620	1-SC	1	8	20	160	14,600	2,336,000	467,200	2,803,200
118	68+620	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
119	68+700	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
120	69+170	1-SC	1	6	8	48	14,600	700,800	140,160	840,960

Table 3.4.3-16 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 3 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
121	69+170	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
122	69+170	1-SC	1	6	6	36	14,600	525,600	105,120	630,720
123	69+500	1-SC	1	7	16	112	14,600	1,635,200	327,040	1,962,240
124	70+325	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
125	70+820	1-SC	1	15	18	270	14,600	3,942,000	788,400	4,730,400
126	70+850	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
127	70+940	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
128	70+940	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
129	70+945	1-SC	1	5	9	45	14,600	657,000	131,400	788,400
130	70+965	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
131	70+990	1-SC	1	8	18	144	14,600	2,102,400	420,480	2,522,880
132	71+020	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
133	71+250	1-SC	1	12	22	264	14,600	3,854,400	770,880	4,625,280
134	71+260	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
135	71+320	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
136	71+320	Stall	1	4	6	24	1,500	36,000	7,200	43,200
137	71+320	Stall	1	4	6	24	1,500	36,000	7,200	43,200
Grand Total								**280,601,200**	**56,120,240**	**336,721,440**

Note : Compensation cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-17 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 4

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
1	6+380	1-SC	1	4	6	24	14,600	350,400	70,080	420,480
2	7+525	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
3	8+950	2-SCW	2	8	16	256	11,400	2,918,400	583,680	3,502,080
4	11+780	2-SCW	2	8	15	240	11,400	2,736,000	547,200	3,283,200
5	12+095	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
6	13+040	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
7	13+295	2-SCW	2	8	15	240	11,400	2,736,000	547,200	3,283,200
8	13+590	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
9	14+310	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
10	14+740	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
11	14+050	1-SC	1	6	6	36	14,600	525,600	105,120	630,720
12	16+045	1-SC	1	6	9	54	14,600	788,400	157,680	946,080
13	16+100	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
14	16+670	1-SC	1	9	26	234	14,600	3,416,400	683,280	4,099,680
15	16+670	1-SC	1	9	22	198	14,600	2,890,800	578,160	3,468,960
16	16+670	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
17	16+740	1-SC	1	9	16	144	14,600	2,102,400	420,480	2,522,880
18	20+620	2-SCW	2	9	18	324	11,400	3,693,600	738,720	4,432,320
19	21+770	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
20	21+770	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
21	22+810	2-SCW	2	12	18	432	11,400	4,924,800	984,960	5,909,760
22	22+810	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
23	23+200	2-SCW	2	7	14	196	11,400	2,234,400	446,880	2,681,280
24	23+270	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
25	23+860	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
26	24+075	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
27	24+090	1-SC	1	14	18	252	14,600	3,679,200	735,840	4,415,040
28	24+540	1-SC	1	18	19	342	14,600	4,993,200	998,640	5,991,840
29	27+640	1-SW	1	8	16	128	13,000	1,664,000	332,800	1,996,800
30	27+640	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
31	27+790	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
32	27+790	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
33	28+130	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
34	28+240	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
35	28+240	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
36	28+130	2-SCW	2	7	12	168	11,400	1,915,200	383,040	2,298,240
37	28+155	2-SCW	2	7	9	126	11,400	1,436,400	287,280	1,723,680
38	28+205	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
39	28+205	2-SCW	2	9	16	288	11,400	3,283,200	656,640	3,939,840
40	28+295	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680

Table 3.4.3-17 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 4 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
41	28+295	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
42	28+550	2-SCW	2	9	12	216	11,400	2,462,400	492,480	2,954,880
43	28+550	2-SCW	2	7	12	168	11,400	1,915,200	383,040	2,298,240
44	30+020	1-SC	1	12	18	216	14,600	3,153,600	630,720	3,784,320
45	30+020	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
46	30+020	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
47	30+020	2-SCW	2	8	15	240	11,400	2,736,000	547,200	3,283,200
48	30+020	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
49	30+020	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
50	30+030	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
51	30+030	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
52	30+030	2-SCW	2	9	12	216	11,400	2,462,400	492,480	2,954,880
53	30+050	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
54	30+050	1-SC	1	9	9	81	14,600	1,182,600	236,520	1,419,120
55	30+050	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
56	30+050	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
57	30+050	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
58	30+050	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
59	31+510	1-SC	1	9	30	270	14,600	3,942,000	788,400	4,730,400
60	31+510	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
61	31+510	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
62	32+170	1-SC	1	15	16	240	14,600	3,504,000	700,800	4,204,800
63	32+470	1-SC	1	14	14	196	14,600	2,861,600	572,320	3,433,920
64	34+000	1-SC	1	8	7	56	14,600	817,600	163,520	981,120
65	34+080	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
66	35+655	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
67	36+740	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
68	36+740	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
69	38+835	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
70	40+040	1-SC	1	6	18	108	14,600	1,576,800	315,360	1,892,160
71	40+145	1-SC	1	12	21	252	14,600	3,679,200	735,840	4,415,040
72	40+540	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
73	41+660	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
74	41+660	1-SC	1	7	16	112	14,600	1,635,200	327,040	1,962,240
75	42+485	1-SC	1	8	9	72	14,600	1,051,200	210,240	1,261,440
76	43+865	1-SC	1	7	16	112	14,600	1,635,200	327,040	1,962,240
77	46+060	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
78	46+060	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
79	46+110	Stall	1	5	9	45	1,500	67,500	13,500	81,000
80	46+655	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760

Table 3.4.3-17 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 4 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
81	47+175	1-SC	1	7	14	98	14,600	1,430,800	286,160	1,716,960
82	47+200	Stall	1	6	8	48	1,500	72,000	14,400	86,400
83	47+300	1-SC	1	14	18	252	14,600	3,679,200	735,840	4,415,040
84	49+230	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
85	49+350	1-SC	1	7	9	63	14,600	919,800	183,960	1,103,760
86	49+445	1-SC	1	7	8	56	14,600	817,600	163,520	981,120
87	49+465	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
88	50+400	1-SC	1	18	18	324	14,600	4,730,400	946,080	5,676,480
89	50+400	Stall	1	9	25	225	1,500	337,500	67,500	405,000
90	51+350	1-SC	1	7	18	126	14,600	1,839,600	367,920	2,207,520
91	51+350	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
92	51+500	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
93	51+500	1-SC	1	18	18	324	14,600	4,730,400	946,080	5,676,480
94	51+500	1-SC	1	12	15	180	14,600	2,628,000	525,600	3,153,600
95	51+580	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
96	51+640	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
97	51+640	1-SC	1	8	8	64	14,600	934,400	186,880	1,121,280
98	51+640	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
99	51+640	2-SC	2	12	12	288	14,600	4,204,800	840,960	5,045,760
100	52+200	1-SC	1	10	15	150	14,600	2,190,000	438,000	2,628,000
101	52+200	2-SC	2	12	20	480	14,600	7,008,000	1,401,600	8,409,600
102	52+200	2-SC	2	12	30	720	14,600	10,512,000	2,102,400	12,614,400
103	52+950	1-SC	1	5	6	30	14,600	438,000	87,600	525,600
104	53+800	2-SCW	2	12	18	432	11,400	4,924,800	984,960	5,909,760
105	53+850	2-SCW	2	15	15	450	11,400	5,130,000	1,026,000	6,156,000
106	53+900	2-SCW	2	8	9	144	11,400	1,641,600	328,320	1,969,920
107	53+970	2-SCW	2	12	12	288	11,400	3,283,200	656,640	3,939,840
108	54+330	1-SC	1	8	7	56	14,600	817,600	163,520	981,120
109	54+380	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
110	54+400	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
111	61+255	1-SC	1	15	20	300	14,600	4,380,000	876,000	5,256,000
112	62+060	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
113	62+230	1-SC	1	8	18	144	14,600	2,102,400	420,480	2,522,880
114	62+230	Stall	1	4	14	56	1,500	84,000	16,800	100,800
115	62+230	1-SC	1	9	20	180	14,600	2,628,000	525,600	3,153,600
116	62+230	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
117	63+650	1-SC	1	9	16	144	14,600	2,102,400	420,480	2,522,880
118	63+650	1-SC	1	9	16	144	14,600	2,102,400	420,480	2,522,880
119	63+700	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
120	63+900	1-SC	1	6	9	54	14,600	788,400	157,680	946,080

Table 3.4.3-17 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 4 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
121	64+180	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
122	64+460	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
123	69+285	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
124	69+285	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
125	69+285	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
126	69+285	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
127	69+285	1-SC	1	6	20	120	14,600	1,752,000	350,400	2,102,400
128	69+285	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
129	69+285	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
130	69+285	1-SC	1	6	16	96	14,600	1,401,600	280,320	1,681,920
131	69+285	1-SC	1	6	16	96	14,600	1,401,600	280,320	1,681,920
132	69+380	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
133	69+380	1-SC	1	6	14	84	14,600	1,226,400	245,280	1,471,680
134	69+380	1-SC	1	6	14	84	14,600	1,226,400	245,280	1,471,680
135	83+130	1-SC	1	7	15	105	14,600	1,533,000	306,600	1,839,600
136	86+260	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
137	89+040	1-SC	1	12	14	168	14,600	2,452,800	490,560	2,943,360
138	89+130	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
139	89+130	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
140	89+280	1-SC	1	6	12	72	14,600	1,051,200	210,240	1,261,440
141	89+340	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
142	89+370	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
143	89+370	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
144	89+460	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
145	89+560	1-SCF	1	25	50	1250	7,600	9,500,000	1,900,000	11,400,000
146	89+580	1-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
147	89+720	1-SC	1	6	8	48	14,600	700,800	140,160	840,960
148	91+945	1-SC	1	9	15	135	14,600	1,971,000	394,200	2,365,200
149	91+945	1-SC	1	15	20	300	14,600	4,380,000	876,000	5,256,000
150	91+945	1-SC	1	4	5	20	14,600	292,000	58,400	350,400
151	91+945	1-SC	1	8	19	152	14,600	2,219,200	443,840	2,663,040
152	95+150	1-SC	1	12	19	228	14,600	3,328,800	665,760	3,994,560
153	95+195	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
154	95+570	1-SC	1	4	9	36	14,600	525,600	105,120	630,720
155	95+570	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
156	95+675	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
157	95+720	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
158	95+720	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
159	95+720	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
160	95+720	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240

Table 3.4.3-17 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 4 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
161	95+720	1-SC	1	8	14	112	14,600	1,635,200	327,040	1,962,240
162	95+720	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
163	95+720	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
164	95+720	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
165	95+885	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
166	95+885	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
167	95+885	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
168	95+885	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
169	97+580	2-SC	1	12	20	240	14,600	3,504,000	700,800	4,204,800
170	97+580	3-SC	1	20	20	400	14,600	5,840,000	1,168,000	7,008,000
171	97+580	5-SCC	5	18	20	1800	8,500	15,300,000	3,060,000	18,360,000
172	97+580	1-SC	1	9	20	180	14,600	2,628,000	525,600	3,153,600
173	97+580	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
174	97+580	1-SC	1	5	20	100	14,600	1,460,000	292,000	1,752,000
175	97+580	1-SC	1	9	20	180	14,600	2,628,000	525,600	3,153,600
176	97+580	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
177	97+580	1-SC	1	8	25	200	14,600	2,920,000	584,000	3,504,000
178	97+580	1-SC	1	6	14	84	14,600	1,226,400	245,280	1,471,680
179	97+580	1-SC	1	9	14	126	14,600	1,839,600	367,920	2,207,520
180	97+580	1-SC	1	15	15	225	14,600	3,285,000	657,000	3,942,000
181	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
182	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
183	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
184	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
185	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
186	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
187	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
188	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
189	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
190	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
191	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
192	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
193	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
194	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
195	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
196	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
197	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
198	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
199	98+590	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
200	103+820	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920

Table 3.4.3-17 Compensation Cost for Demolition of Buildings and Structures of Alternative Route Alignment 4 (Cont'd)

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
201	103+820	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
202	103+870	1-SC	1	16	16	256	14,600	3,737,600	747,520	4,485,120
203	104+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
204	104+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
205	104+040	1-SC	1	9	18	162	14,600	2,365,200	473,040	2,838,240
206	104+100	1-SC	1	12	14	168	14,600	2,452,800	490,560	2,943,360
207	104+160	1-SCF	1	20	40	800	7,600	6,080,000	1,216,000	7,296,000
208	104+410	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
209	104+470	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
210	104+470	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
Grand Total								**475,163,600**	**95,032,720**	**570,196,320**

Note : Compensation cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-18 Compensation Cost for Demolition of Buildings and Structures of Spur Line

No.	Sta.	Structural Characteristics	No. of Storeys	Width (m.)	Length (m.)	Total Area (sq.m.)	Compensation Cost (Baht/sq.m.)	Compensation Cost (Baht)	Provisional Sum for Appeal (Baht)	Total Compensation Cost (Baht)
1	2+510	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
2	2+510	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
3	2+610	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
4	2+790	1-SCF	1	20	40	800	7,600	6,080,000	1,216,000	7,296,000
5	2+906	1-SC	1	12	14	168	14,600	2,452,800	490,560	2,943,360
6	2+906	1-SC	1	9	18	162	14,600	2,365,200	473,040	2,838,240
7	3+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
8	3+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
9	3+000	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
10	3+066	1-SCF	1	16	16	256	7,600	1,945,600	389,120	2,334,720
11	3+086	1-SC	1	9	12	108	14,600	1,576,800	315,360	1,892,160
12	3+086	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
13	3+200	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
14	3+270	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
15	3+410	1-SC	1	8	16	128	14,600	1,868,800	373,760	2,242,560
16	4+000	1-SC	1	8	12	96	14,600	1,401,600	280,320	1,681,920
17	4+020	1-SC	1	7	18	126	14,600	1,839,600	367,920	2,207,520
18	4+020	1-SC	1	6	22	132	14,600	1,927,200	385,440	2,312,640
19	4+020	1-SC	1	8	15	120	14,600	1,752,000	350,400	2,102,400
20	4+030	1-SC	1	6	7	42	14,600	613,200	122,640	735,840
21	4+030	1-SC	1	7	12	84	14,600	1,226,400	245,280	1,471,680
22	4+080	1-SC	1	12	16	192	14,600	2,803,200	560,640	3,363,840
23	4+900	1-SC	1	12	12	144	14,600	2,102,400	420,480	2,522,880
Grand Total								**46,073,200**	**9,214,640**	**55,287,840**

Note : Compensation cost shown in this table is used for comparison of the alternative route alignments only.

3.4.3.2.2 Construction Cost

Construction cost is a part of an investment cost of that route alignment. The alignment with the lowest construction cost has more advantage than the alignment with the highest construction cost as it saves an investment cost. The multiplying factor of the alignment with the lowest construction cost is 1.00. The multiplying factor of other alternative route alignments is as the following equation:

$$e_i = 1 - \frac{(1 - C_{cons,\min}/C_{cons,\max})(C_{cons,i} - C_{cons,\min})}{(C_{cons,\max} - C_{cons,\min})}$$

Whereas e_i = Multiplying factor of the alternative route alignment, i

$C_{cons,\min}$ = Construction cost of the alternative route alignment with the lowest construction cost (Baht)

$C_{cons,\max}$ = Construction cost of the alternative route alignment with the lowest construction cost (Baht)

$C_{cons,i}$ = Construction cost of the alternative route alignment, i (Baht)

Calculation method of construction cost: 15 weighting

1) - Alternative Route Alignment 2 has the lowest construction cost of 29,176.20 Baht ($C_{cons,\min}$)

   - Alternative Route Alignment 4 has the highest construction cost of 50,785.10 Baht ($C_{cons,\max}$)

   The construction cost of Alternative Route Alignment 3 = 38,048.26 Baht ($C_{cons,3}$)

   From the equation:

$$e_i = 1 - \frac{(1 - C_{cons,\min}/C_{cons,\max})(C_{cons,i} - C_{cons,\min})}{(C_{cons,\min} - C_{cons,\min})}$$

   So the multiplying factor of Alternative Route Alignment 3 =

$$e_3 = 1 - \frac{(1 - 29{,}176.20 / 50{,}785.10)(38{,}048.26 - 29{,}176.20)}{(50{,}785.10 - 29{,}176.20)} = 0.83$$

   ∴ Score of Alternative Route Alignment 1 = 0.83 x 5 = 12.45

   As per **Table 3.4.3-19**.

Table 3.4.3-19 Scores of Construction Cost

Route No.	Construction Cost (Million Baht)			Multiplying Factor	Scores
	Main Line	Spur Line	Total		
1	26,442.68	4,061.08	30,503.76	0.97	14.55
2	25,115.12	4,061.08	29,176.20	1.00	15.00
3	33,987.18	4,061.08	38,048.26	0.83	12.45
4	50,785.10	-	50,785.10	0.57	8.55

2) **Tables 3.4.3-20** to **Table 3.4.3-23** show the construction cost of each alternative route alignment.

Table 3.4.3-20 Construction Cost of Alternative Route Alignment 1

Type of Construction	Unit	Unit Price (Million Baht)	Alternative Route Alignment 1		Spur line	
			Quantity	Cost (Million Baht)	Quantity	Cost (Million Baht)
Dual tunnel (1 track per tunnel)						
• Dual tunnel, 500-3,000 m. long	Km	1,760	4.26	7,497.60	1.88	3,308.80
• Dual tunnel, more than 3,000 m. long	Km	1,440	-	-	-	-
• Slab track (2 tunnels)	Km	45	4.26	191.70	1.88	84.60
Total			**4.26**	**7,689.30**	**1.88**	**3,393.40**
Elevated track (Double track)						
• Elevated track, 7 - 15 m. high	Km	285	6.29	1,792.65	1.03	293.55
• Elevated track, more than 15 m. high	Km	345	9.95	3,432.75	-	-
• Elevated track at mangrove forest	Km	315	14.54	4,580.10	-	-
• Slab track (Double track)	Km	45	30.78	1,385.10	1.03	46.35
Total			**30.78**	**11,190.60**	**1.03**	**339.90**
At-grade track (Double track)						
• At-grade track, embankment fill 0 - 4 m. high	Km	15	14.04	210.60	0.65	9.75
• At-grade track, embankment fill 4 - 7 m. high	Km	85	10.77	915.45	1.05	89.25
• At-grade track, embankment cut 0 - 10 m. deep	Km	15	23.73	355.95	0.37	5.55
• At-grade track, embankment cut 10 - 20 m. deep	Km	70	9.38	656.60	-	-
• At-grade track, embankment cut more than 20 m. deep	Km	200	9.54	1,908.00	-	-
• Ballasted track (double track)	Km	30	67.46	2,023.80	2.07	62.10
• Fence	Km	3	67.46	202.38	2.07	6.21
Total			**67.46**	**6,272.78**	**2.07**	**172.86**
Station						
• Small	Station	40	8.00	320.00	-	-
• Medium	Station	50	-	-	1.00	50.00
Total			**8.00**	**320.00**	**1.00**	**50.00**
Signaling System						
• Signaling system for small station	Station	70	8.00	560.00	-	-
• Signaling system for medium station	Station	85	-	-	1.00	85.00
• Telecommunication	Km	4	102.50	410.00	4.98	19.92
Total	Station			**970.00**		**104.92**
Grand Total				**26,442.68**		**4,061.08**

Note : Construction cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-21 Construction Cost of Alternative Route Alignment 2

Type of Construction	Unit	Unit Price (Million Baht)	Alternative Route Alignment 2		Spur line	
			Quantity	Cost (Million Baht)	Quantity	Cost (Million Baht)
Dual tunnel (1 track per tunnel)						
• Dual tunnel, 500-3,000 m. long	Km	1,760	3.49	6,142.40	1.88	3,308.80
• Dual tunnel, more than 3,000 m. long	Km	1,440	3.84	5,529.60	-	-
• Slab track (2 tunnels)	Km	45	7.33	329.85	1.88	84.60
Total			**7.33**	**12,001.85**	**1.88**	**3,393.40**
Elevated track (Double track)						
• Elevated track, 7 - 15 m. high	Km	285	11.00	3,135.00	1.03	293.55
• Elevated track, more than 15 m. high	Km	345	4.85	1,673.25	-	-
• Elevated track at mangrove forest	Km	315	8.73	2,749.95	-	-
• Slab track (Double track)	Km	45	24.58	1,106.10	1.03	46.35
Total			**24.58**	**8,664.30**	**1.03**	**339.90**
At-grade track (Double track)						
• At-grade track, embankment fill 0 - 4 m. high	Km	15	9.57	143.55	0.65	9.75
• At-grade track, embankment fill 4 - 7 m. high	Km	85	3.75	318.75	1.05	89.25
• At-grade track, embankment cut 0 - 10 m. deep	Km	15	17.35	260.25	0.37	5.55
• At-grade track, embankment cut 10 - 20 m. deep	Km	70	6.37	445.90	-	-
• At-grade track, embankment cut more than 20 m. deep	Km	200	5.20	1,040.00	-	-
• Ballasted track (double track)	Km	30	42.24	1,267.20	2.07	62.10
• Fence	Km	3	42.24	126.72	2.07	6.21
Total			**42.24**	**3,602.37**	**2.07**	**172.86**
Station						
• Small	Station	40	5.00	200.00	-	-
• Medium	Station	50	-	-	1.00	50.00
Total			**5.00**	**200.00**	**1.00**	**50.00**
Signaling System						
• Signaling system for small station	Station	70	5.00	350.00	-	-
• Signaling system for medium station	Station	85	-	-	1.00	85.00
• Telecommunication	Km	4	74.15	296.60	4.98	19.92
Total				**646.60**		**104.92**
Grand Total				**25,115.12**		**4,061.08**

Note : Construction cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-22 Construction Cost of Alternative Route Alignment 3

Type of Construction	Unit	Unit Price (Million Baht)	Alternative Route Alignment 3		Spur line	
			Quantity	Cost (Million Baht)	Quantity	Cost (Million Baht)
Dual tunnel (1 track per tunnel)						
• Dual tunnel, 500-3,000 m. long	Km	1,760	6.99	12,302.40	1.88	3,308.80
• Dual tunnel, more than 3,000 m. long	Km	1,440	6.30	9,072.00	-	-
• Slab track (2 tunnels)	Km	45	13.29	598.05	1.88	84.60
Total			**13.29**	**21,972.45**	**1.88**	**3,393.40**
Elevated track (Double track)						
• Elevated track, 7 - 15 m. high	Km	285	10.33	2,944.05	1.03	293.55
• Elevated track, more than 15 m. high	Km	345	5.35	1,845.75	-	-
• Elevated track at mangrove forest	Km	315	6.56	2,066.40	-	-
• Slab track (Double track)	Km	45	22.24	1,000.80	1.03	46.35
Total			**22.24**	**7,857.00**	**1.03**	**339.90**
At-grade track (Double track)						
• At-grade track, embankment fill 0 - 4 m. high	Km	15	10.22	153.30	0.65	9.75
• At-grade track, embankment fill 4 - 7 m. high	Km	85	3.80	323.00	1.05	89.25
• At-grade track, embankment cut 0 - 10 m. deep	Km	15	15.35	230.25	0.37	5.55
• At-grade track, embankment cut 10 - 20 m. deep	Km	70	5.02	351.40	-	-
• At-grade track, embankment cut more than 20 m. deep	Km	200	4.79	958.00	-	-
• Ballasted track (double track)	Km	30	39.18	1,175.40	2.07	62.10
• Fence	Km	3	39.18	117.54	2.07	6.21
Total			**39.18**	**3,308.89**	**2.07**	**172.86**
Station						
• Small	Station	40	5.00	200.00	-	-
• Medium	Station	50	-	-	1.00	50.00
Total			**5.00**	**200.00**	**1.00**	**50.00**
Signaling System						
• Signaling system for small station	Station	70	5.00	350.00	-	-
• Signaling system for medium station	Station	85	-	-	1.00	85.00
• Telecommunication	Km	4	74.71	298.84	4.98	19.92
Total				**648.84**		**104.92**
Grand Total				**33,987.18**		**4,061.08**

Note : Construction cost shown in this table is used for comparison of the alternative route alignments only.

Table 3.4.3-23 Construction Cost of Alternative Route Alignment 4

Type of Construction	Unit	Unit Price (Million Baht)	Alternative Route Alignment 4	
			Quantity	Cost (Million Baht)
Dual tunnel (1 track per tunnel)				
• Dual tunnel, 500-3,000 m. long	Km	1,760	11.29	19,870.40
• Dual tunnel, more than 3,000 m. long	Km	1,440	8.35	12,024.00
• Slab track (2 tunnels)	Km	45	19.64	883.80
Total			**19.64**	**32,778.20**
Elevated track (Double track)				
• Elevated track, 7 - 15 m. high	Km	285	10.53	3,001.05
• Elevated track, more than 15 m. high	Km	345	18.20	6,279.00
• Elevated track at mangrove forest	Km	315	3.53	1,111.95
• Slab track (Double track)	Km	45	32.26	1,451.70
Total			**32.26**	**11,843.70**
At-grade track (Double track)				
• At-grade track, embankment fill 0 - 4 m. high	Km	15	10.07	151.05
• At-grade track, embankment fill 4 - 7 m. high	Km	85	6.96	591.60
• At-grade track, embankment cut 0 - 10 m. deep	Km	15	20.83	312.45
• At-grade track, embankment cut 10 - 20 m. deep	Km	70	11.12	778.40
• At-grade track, embankment cut more than 20 m. deep	Km	200	7.32	1,464.00
• Ballasted track (double track)	Km	30	56.30	1,689.00
• Fence	Km	3	56.30	168.90
Total			**56.30**	**5,155.40**
Station				
• Small	Station	40	4.00	160.00
• Medium	Station	50	1.00	50.00
Total			**5.00**	**210.00**
Signaling System				
• Signaling system for small station	Station	70	4.00	280.00
• Signaling system for medium station	Station	85	1.00	85.00
• Telecommunication	Km	4	108.20	432.80
Total				**797.80**
Grand Total				**50,785.10**

Note : Construction cost shown in this table is used for comparison of the alternative route alignments only.

3.4.3.3 Passenger Volumes along Alternative Route Alignments

In designating the weighting, the following 2 parameters were considered:

1) Potential population for each station along the alternative route alignments.
2) Distance to access each station along the alternative route alignments.

3.4.3.3.1 Potential Population for each Station along the Alternative Route Alignments

The potential population for each station along the alternative route alignments is determined by the number of the local people that can use the service. The multiplying factor for weighting is divided into 5 levels as shown in **Table 3.4.3-24**.

Table 3.4.3-24 Multiplying Factor of Potential Population for each Station along the Alternative Route Alignments

Number of Potential Population	Criteria	Multiplying Factor
Very good	More than 200,000 people	1.00
Good	150,001-200,000	0.75
Medium	100,001-150,000	0.50
Fair	50,001-100,000	0.25
Bad	Less than 50,000 people	0.00

Scoring of potential population for each station along the alternative route alignments: 5 weighting

Table 3.4.3-25 shows the multiplying factor and scores of potential population for each station along the alternative route alignments.

Table 3.4.3-25 Scores of Potential Population for each Station along the Alternative Route Alignments

Route No.	Number of Potential Population	Level	Multiplying Factor	Scores
1	206,968	Very good	1.00	5.00
2	106,376	Moderate	0.50	2.50
3	103,109	Moderate	0.50	2.50
4	111,075	Moderate	0.50	2.50

3.4.3.3.2 Distance to Access each Station along the Alternative Route Alignments

Distance to access each station along the alternative route alignments reflects difficulty and ease in accessing the station by taking into account the distance from station to community center. The multiplying factor for weighting is divided into 5 levels as shown in **Table 3.4.3-26**.

Table 3.4.3-26 Multiplying Factor of Distance to Access each Station along the Alternative Route Alignments

Distance to Access each Station	Criteria	Multiplying Factor
Very good	0-3 km	1.00
Good	3-6 km	0.75
Moderate	6-9 km	0.50
Fair	9-12 km	0.25
Bad	more than 12 km	0.00

Scoring of distance to access each station along the alternative route alignments: 5 weighting

Table 3.4.3-27 shows the multiplying factor and scores of distance to access each station along the alternative route alignments.

Table 3.4.3-27 Scores of Distance to Access each Station along the Alternative Route Alignments

Route No.	Distance (km)	Level of access to each Station	Multiplying Factor	Scores
1	2.997	Very good	1.00	5.00
2	6.731	Moderate	0.50	2.50
3	5.391	Good	0.75	3.75
4	4.070	Good	0.75	3.75

3.4.3.4 Summary of Economic and Investment Comparison

Based on economic and investment scores of various parameters of each alternative route alignment according to the above principles and methods, it can be summarized as in **Table 3.4.2-28**.

Table 3.4.3-28 Summary of Economic and Investment Comparison

No.	Important Parameters Considered	Designated Weighting	Route Alignment 1		Route Alignment 2		Route Alignment 3		Route Alignment 4	
			e_i	Scores	e_i	Scores	e_i	Scores	e_i	Scores
1	Investment									
1.1	Expropriation Cost	5	0.75	3.75	0.99	4.95	1.00	5.00	0.37	1.85
1.2	Construction Cost	15	0.97	14.55	1.00	15.00	0.83	12.45	0.57	8.55
2	Passenger Volumes along Alternative Route Alignments									
2.1	Potential Population for each Station	5	1.00	5.00	0.50	2.50	0.50	2.50	0.50	2.50
2.2	Distance to Access each Station	5	1.00	5.00	0.50	2.50	0.75	3.75	0.75	3.75
	Total	**30**		**28.30**		**24.95**		**23.70**		**16.65**

As Alternative Route Alignment 1 parallels Highway Route No. 4 (Phetkasem Road) which is the main road linking to Chumphon and Ranong, the compensation cost shall be very high. It is similar to Alternative Route Alignment 4 which parallels Highway Route No. 4009. Both alternative route alignments are longer than Alternative Route Alignments 2 and 3 and require more land and property expropriation so the scores on immovable property expropriation cost are less than Alternative Route Alignments 2 and 3 as shown in **Figure 3.4.3-6**. However, both alternative route alignments can have more passenger volumes than Alternative Route Alignment 2 and 3, especially Alternative Route Alignment 1 which parallels Highway Route No. 4 where communities are located along both sides. Upon consideration of construction cost, due to the complex topography which has mountain terrain between Chumphon and Ranong Border especially at the central and lower area, though Alternative Route Alignments 2 and 3 have the shortest route of 79.13 km and 79.69 km respectively (including spur line), the construction cost of both alignments are not different significantly from Alternative Route Alignment 1 which is 107.48 km. Therefore, Alternative Route Alignment 1 gets the highest scores on economic and investment as shown in **Figure 3.4.3-7.**

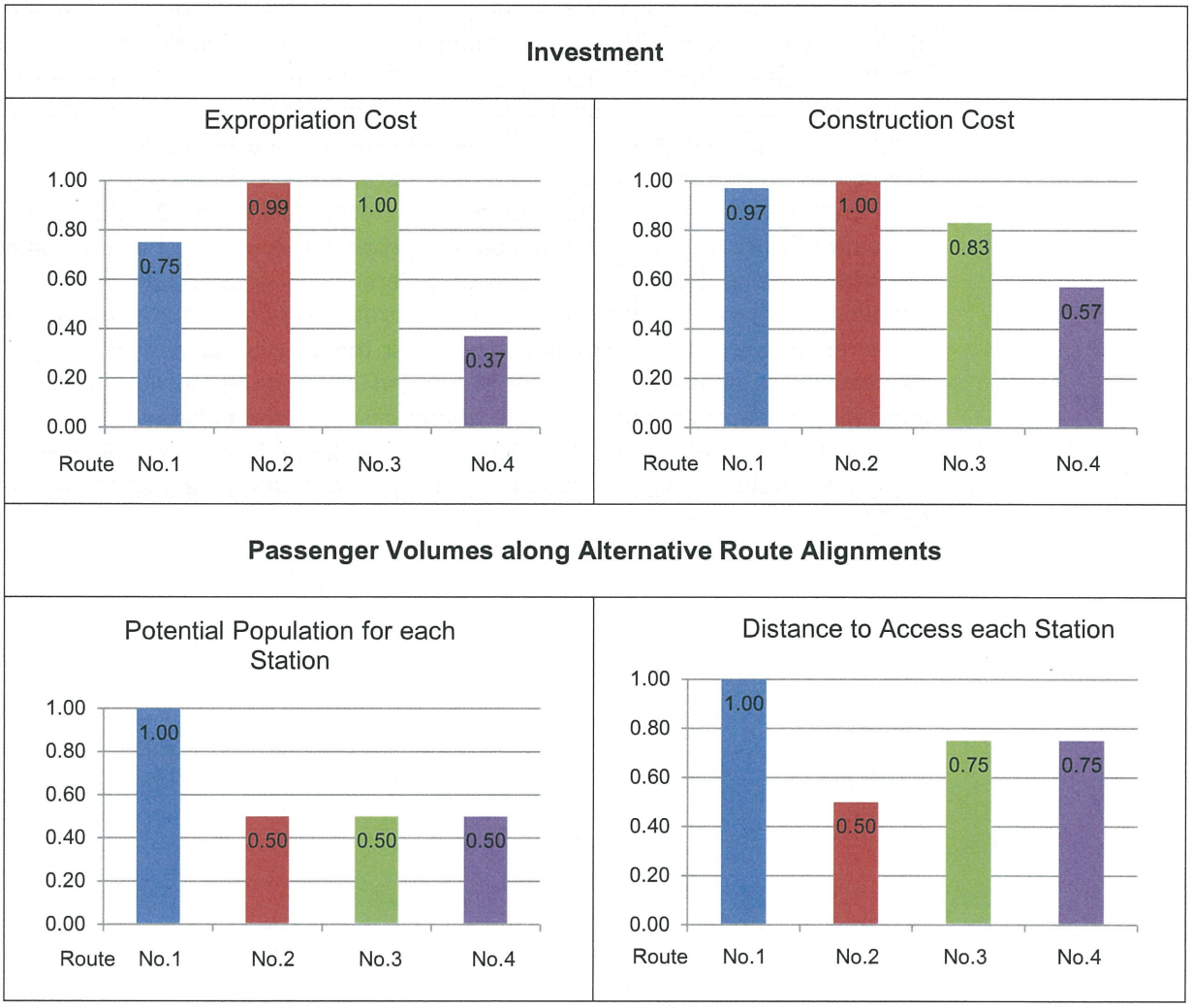
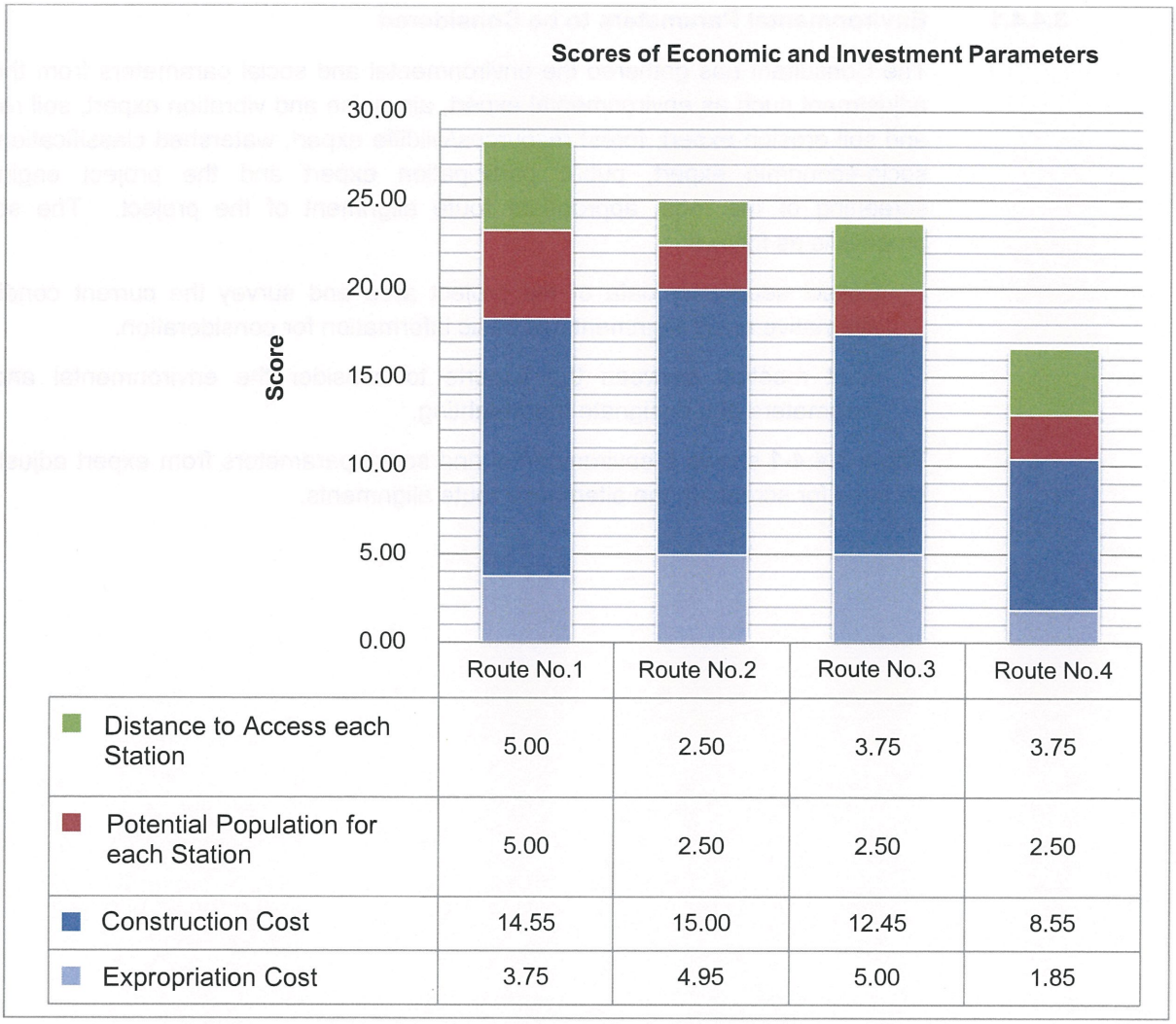


Figure 3.4.3-6 Multiplying Factor of Economic and Investment Parameters



	Route No.1	Route No.2	Route No.3	Route No.4
Distance to Access each Station	5.00	2.50	3.75	3.75
Potential Population for each Station	5.00	2.50	2.50	2.50
Construction Cost	14.55	15.00	12.45	8.55
Expropriation Cost	3.75	4.95	5.00	1.85

Figure 3.4.3-7 Scores of Economic and Investment Parameters

3.4.4 Environmental and Social Parameters (40 Weighting)

Forty weighting was designated to environmental parameters. Since the project area covers some areas of Chumphon and Ranong Provinces; the topography of the alternative route alignments is mountain terrain, fertile forested watershed, important reserved areas, e.g. Watershed Classification 1, Sadejnaikrom Kromlaung Chumphon Wildlife Sanctuary, Thung Raya-Na Sak Wildlife Sanctuary, Ngao Waterfall National Park, Kra Buri National Park and mangrove forest (mangrove forest according to the cabinet's resolution) etc., the construction of new railway may impact on the lifestyle and living of the local people. Therefore, 40 weighting out of 100 weighting was given to environmental and social impacts in comparison the alternative route alignments due to its importance.

3.4.4.1 Environmental Parameters to be Considered

The Consultant has gathered the environmental and social parameters from the expert adjustment such as environmental expert, air, noise and vibration expert, soil resources and soil erosion expert, forest resources/wildlife expert, watershed classification expert, socio-economic expert, public participation expert and the project engineer for screening of the most appropriate route alignment of the project. The screening process is as follows:

- Collect secondary data of the project area and survey the current conditions of alternative route alignments as basic information for consideration.
- Joint meeting between the experts to consider the environmental and social parameters and designate the weighting.

Table 3.4.4-1 shows 5 environmental and social parameters from expert adjustment to be used for screening the alternative route alignments.

Table 3.4.4-1 Environmental and Social Parameters from Expert Adjustment

Environmental Parameters	Key Issues Considered	Alternative Route Alignments			
		1	2	3	4
1. Physical Environmental Resources					
1.1 Geography	- Impact on changes of the terrain	✓	✓	✓	✓
1.2 Soil and soil erosion	- Impact on soil settlement and soil erosion	✓✓	✓✓	✓✓	✓✓
	- Impact on soil erosion due to rainwater	✓✓	✓✓	✓✓	✓✓
1.3 Geology and earthquake	- Impact on geological conditions	✓	✓	✓	✓
	- Impact on the increase of landslide / collapse in the area	✓	✓	✓	✓
	- Impact of earthquakes	✓	✓	✓	✓
1.4 Surface water hydrology	- Impact on surface water flow	✓✓	✓✓	✓✓	✓✓
	- Impact on surface water quality	✓✓	✓✓	✓✓	✓✓
1.5 Air and atmosphere	- Impact of dust diffusion on people near the route	✓✓	✓✓	✓✓	✓✓
	- Impact of increased air pollution from vehicles and machines on people near the route	✓✓	✓✓	✓✓	✓✓
1.6 Noise	- Impact of noise from the project on people near the route	✓✓	✓✓	✓✓	✓✓
1.7 Vibration	- Impact of vibration from the project on people and buildings near the route	✓✓	✓✓	✓✓	✓✓

Remark : ✓ Low environmental and social impact.
× Environmental parameters have no impact
✓✓ Environmental and social parameters have more than moderate impact and are different significantly.

Table 3.4.4-1 Environmental and Social Parameters from Expert Adjustment (Cont'd)

Environmental Parameters	Key Issues Considered	Alternative Route Alignments			
		1	2	3	4
2. Biological Environmental Resources					
2.1 Watershed classification	- Impact on Watershed Classification 1A	✓✓	✓✓	✓✓	✓✓
2.2 Forest resources	- Impact on loss of forest area in the conservation area	✓✓	✓✓	✓✓	✓✓
2.3 Wildlife resources	- Impact on habitat destruction and the amount of wildlife	✓✓	✓✓	✓✓	✓✓
2.4 Aquatic ecology / mangrove forest	- Impact on Aquatic ecology/mangrove forest	✓✓	✓✓	✓✓	✓✓
3. Value of Human Use					
3.1 Transportation	- Impact on traffic as well as local transport network.	✓	✓	✓	✓
3.2 Public utilities	- Impact on utilities relocation etc.	×	×	×	×
3.3 Drainage and flood control	- Impact on the flow of water and natural drainage.	✓	✓	✓	✓
3.4 Land use	- Impact on changes of land use from the current conditions	✓	✓	✓	✓
3.5 Recreation	- Impact on access to tourist sites or loss of recreational areas.	×	×	×	×
4. Value of Quality of Life					
4.1 Economic and social	- Impact on economic, social and lifestyle.	✓	✓	✓	✓
4.2 Resettlement and expropriation	- Impact on loss of land, structures and agricultural crops of people.	✓✓	✓✓	✓✓	✓✓

Remark : ✓ Low environmental and social impact.
× Environmental parameters have no impact
✓✓ Environmental and social parameters have more than moderate impact and are different significantly.

Table 3.4.4-1 Environmental and Social Parameters from Expert Adjustment (Cont'd)

Environmental Parameters	Key Issues Considered	Alternative Route Alignments			
		1	2	3	4
4. Value of Quality of Life (continued)					
4.3 Education	- Impact on educational development / educational opportunities	×	×	×	×
4.4 Public health	- Impact on community health services	×	×	×	×
	- Impact on people's health at community level	✓	✓	✓	✓
4.5 Occupational health / sanitation	- Impact on health and hygiene/injury because of accident from working	✓	✓	✓	✓
	- Impact on community sanitation such as waste/wastewater management	×	×	×	×
4.6 Community separation	- Impact on ease of travel, communication of the community and access to desired areas	✓	✓	✓	✓
4.7 Accidents and safety	- Impact on various activities of the project which tend to cause accidents to road users and pedestrians/risk for accidents.	✓	✓	✓	✓
4.8 Social security	- Impact of project activities on risk to social security	✓	✓	✓	✓
4.9 Specific important to the community	- Impact on structures that are specific important to the community.	×	×	×	×

Remark : ✓ Low environmental and social impact.
× Environmental parameters have no impact
✓✓ Environmental and social parameters have more than moderate impact and are different significantly.

Table 3.4.4-1 Environmental and Social Parameters from Expert Adjustment (Cont'd)

Environmental Parameters	Key Issues Considered	Alternative Route Alignments			
		1	2	3	4
4. Value of Quality of Life (continued)					
4.10 History and archeology	- Impact on the destruction or damage to archaeological site and antiquities	×	×	×	×
4.11 Aesthetics	- Impact on changes of landscape or reduction of landscape value	✓	✓	✓	✓

Remark : ✓ Low environmental and social impact.
× Environmental parameters have no impact
✓✓ Environmental and social parameters have more than moderate impact and are different significantly.

1) Important reserved and conservation areas

Most of the areas are natural forest where they are fertile natural resources and environments and are designated as reserved and conservation areas, e.g. Watershed Classification 1, national park, wildlife sanctuary, mangrove forest and national reserved forest. If the alignment passes these conservation areas, the natural conditions will be changed, e.g. clearing, tree cutting, disturbance of food sources and habitat of wildlife etc. It is, therefore, necessary to select the alignment that avoids passing the conservation forest or passes the conservation forest only for the shortest distance to prevent and mitigate the impacts on the fertility of natural resources in the conservation forest to minimum.

2) Risk areas to soil erosion

As the topography of Chumphon and Ranong Provinces are mountain terrain with heavy rains on a regular basis, many areas are vulnerable to soil erosion. When the land is used for various activities of the project, especially at the steep slope area, without proper measures to conserve soil and water, there will be an impact on ecosystems and natural resources, such as soil erosion, loss of soil with nutrients and organic matter, sedimentation and obstruction of natural streams etc. Therefore, the new railway from Chumphon-Ranong Deep Sea Port must avoid passing the areas that are vulnerable to severe soil erosion by considering the distance of each alternative route alignment passing the risk areas at severe or very severe levels according to the Southern Soil Erosion Map of the Department of Lands (2002).

3) Surface water hydrology

Construction of the new railway may have to pass many main canals, e.g. Lang Suan Canal, Sawi Canal, La-un Canal and Kaper Canal etc. As the current condition is the forested watershed especially at Tenasserim Hills and Phuket Hills at Chumphon and Ranong Border where it is the forested watershed of the said canals, the construction of railway bridge and railway either during mobilization or construction may cause sedimentation in the canal and the position of pier may obstruct or change the water flow. These may cause an impact on surface water hydrology. The selection of alternative route alignments shall consider the number of crossing between the alignment and the canal appeared on the topographic map

of the Royal Thai Survey Department (2003) by superimposing all alternative route alignment to selecte the most appropriate alignment.

4) Resettlement and Community Separation

The construction of new railway may affect communities along the alignment especially the land and structures that need to be expropriated, lifestyle and living of the local people. It is therefore necessary to select the alignment that creates the least impact on communities by applying the GIS and satellite image to inspect the number of buildings/structures and communities expected to be impacted on each alternative route alignment.

5) Sensitive areas to environmental and social impacts

Construction activities and during train operation may cause dust, vibration and noise to sensitive areas to environmental impacts. Moreover, level crossing may be at risk for accidents during project construction. Therefore, the appropriate alignment shall avoid passing sensitive areas to environment and social such as hospital, institution, religious places, communities and shall have the least level crossings.

3.4.4.2 Designated Weighting of each Environmental and Social Parameters

Five environmental parameters have been considered to compare the alternative route alignments consisting of important reserved and conservation areas, risk areas to soil erosion, surface water hydrology, resettlement and community separation and sensitive areas to environmental and social impacts as already mentioned above. The Consultant has designated the weighting for each parameter by the Weighted-Sum Model of Multiple-criteria Analysis which is a weighted score. Each of the key factors will be compared in pairs, with the following criteria:

- When the horizontal parameter (R_i) is much more important than the vertical parameter (C_j), the designated weighting is 5.
- When the horizontal parameter (R_i) is more important than the vertical parameter (C_j), the designated weighting is 4.
- When the horizontal parameter (R_i) is equal important to the vertical parameter (C_j), the designated weighting is 3.
- When the horizontal parameter (R_i) is less important than the vertical parameter (C_j), the designated weighting is 2.
- When the horizontal parameter (R_i) is much less important than the vertical parameter (C_j), the designated weighting is 1.

Table 3.4.4-2 shows the designated weighting of environmental parameters.

Table 3.4.4-2 Designated Weighting of Environmental and Social Parameters

Environmental and Social Parameters	1. Important reserved and conservation areas	2. Soil and soil erosion	3. Surface water hydrology	4. Resettlement and community separation	5. Sensitive areas to environmental and social impacts	Total scores	Weighting	Adjusted scores
1. Important reserved and conservation areas		4	4	2	4	14.00	0.24	10.00
2. Soil and soil erosion	2		4	2	3	11.00	0.18	7.00
3. Surface water hydrology	2	2		1	2	7.00	0.12	5.00
4. Resettlement and community separation	4	4	5		4	17.00	0.28	11.00
5. Sensitive areas to environmental and social impacts	2	3	4	2		11.00	0.18	7.00
Total						**60.00**	**1.00**	**40.00**

However, the Consultant has determined the sub-environmental parameters and weighting for consideration of the appropriate route alignment as follows:

1) Important reserved and conservation areas 10 weighting
2) Soil and soil erosion 7 weighting
3) Surface water hydrology 5 weighting
4) Resettlement and community separation
   - Number of buildings/structures 6 weighting
   - Number of communities that the alternative alignment passes 5 weighting
5) Sensitive areas to environmental and social impacts
   - Sensitive areas to air-noise-vibration within the radius of 500 m. from the center line 4 weighting
   - Main road and rural road intersections 3 weighting

For the multiplying factor which depends on the level of impact, the basic rule is that if there is much impact, the multiplying factor will be low. If there is less impact, the multiplying factor will be high by comparing and/or considering the impact period, area to be impacted and continuous impacts which may happen as shown in **Table 3.4.4-3**.

Table 3.4.4-3 Criteria for Considering Impact Levels and the Multiplying Factor according to the Impact Levels

Impact level	Criteria for Considering Impact Levels	Multiplying Factor
Very much impact / severe	- It is a long-term direct impact and has a wide range of impact and/or becomes continuous impact. - Has the most impact upon comparing with other alternatives.	0.00
Much impact	- It is a long-term impact and has a relatively wide range of impact or becomes continuous impact. - Has relatively much impact upon comparing with other alternatives.	0.25
Moderate impact	- It is a temporary impact but the amount of loss or extent of damage is quite wide or becomes continuous impact. - It is a long-term impact but the damage is quite limited. - Has moderate impact or between the most impact and the least impact.	0.50
Little impact / low	- It is a temporary impact and the amount of loss or extent of damage is not much. - It is a long-term/permanent impact but the amount of loss or extent of damage is very little. - Has relatively little impact upon comparing with other alternatives.	0.75
Very little impact	- No change in environmental resources due to the project or change very little. - Has the least impact upon comparing with other alternatives.	1.00

3.4.4.3 Determination of Multiplying Factor, MF

The criteria for determination of multiplying factor (MF) from 0.00 to 1.00 is shown in **Table 3.4.4-4** and the result of determination is shown **Table 3.4.4-5**.

Table 3.4.4-4 Criteria for Determination of Multiplying Factor (MF) for Environmental and Social Parameters

Environmental Parameters Considered	Criteria for Determination of Multiplying Factor (MF)
1. Important reserved and conservation areas	Consider the distance of the route that passes important reserved and conservation areas, such as Watershed Area Class 1, National Park, Wildlife Sanctuary and Mangrove Forests that expected to cause loss of forest/mangrove forest and destroy the habitat of wildlife. The distance was divided into ranges equally with the following multiplying factor: MF = 1.00 when the distance is from 0 to 9,000 meters. MF = 0.75 when the distance is from 9,001 to 18,000 meters. MF = 0.50 when the distance is from 18,001 to 27,000 meters. MF = 0.25 when the distance is from 27,001 to 36,000 meters. MF = 0.0 when the distance is more than 36,001 meters.
2. Soil and Soil erosion	Consider the distance of the route that passes the risk areas to soil erosion severely or very severely. The distance was divided into ranges equally with the following multiplying factor: MF = 1.00 when the distance is from 0 to 7,000 meters. MF = 0.75 when the distance is from 7,001 to 14,000 meters. MF = 0.50 when the distance is from 14,001 to 21,000 meters. MF = 0.25 when the distance is from 21,001 to 28,000 meters. MF = 0.0 when the distance is more than 28,001 meters.
3. Surface water hydrology	Consider the impact on canals that are expected to be affected by changes of surface water flow and surface water quality. The crossing points and the multiplying factor are as follows: MF = 1.00 when the crossing points are from 0 to 60 points MF = 0.75 when the crossing points are from 61 to 120 points MF = 0.50 when the crossing points are from 121 to 180 points MF = 0.25 when the crossing points are from 181 to 240 points MF = 0.00 when the crossing points are more than 241 points
4. Resettlement and community separation 4.1 Number of buildings/structures demolished	Consider number of buildings and structures to be demolished. The demolished buildings/structures and multiplying factor are as follows: MF = 1.00 when the number of demolished buildings/structures are from 0 to 60 nos. MF = 0.75 when the number of demolished buildings/structures are from 61 to 120 nos. MF = 0.50 when the number of demolished buildings/structures are from 121 to 180 nos. MF = 0.25 when the number of demolished buildings/structures are from 181 to 240 nos. MF = 0.00 when the number of demolished buildings/structures are more than 240 nos.
4.2 Number of communities that the alternative alignment passes	Consider number of communities/villages that are expected to be affected from travel inconvenience and inaccessibility to the desired area. The number of communities/villages and the multiplying factor are as follows: MF = 1.00 when the number of communities/villages are from 0 to 20 nos. MF = 0.75 when the number of communities/villages are from 21 to 40 nos. MF = 0.50 when the number of communities/villages are from 41 to 60 nos. MF = 0.25 when the number of communities/villages are from 61 to 80 nos.

Table 3.4.4-4 Criteria for Determination of Multiplying Factor (MF) for Environmental and Social Parameters (Cont'd)

Environmental Parameters	Criteria for Determination of Multiplying Factor (MF)
	MF = 0.00 when the number of communities/villages are more than 81 nos.
5. Sensitive areas to environmental and social impacts 5.1 Sensitive areas to air-noise-vibration within the radius of 500 m. from the center line	Consider sensitive areas to dust-air-noise-vibration within the radius of 500 m. from the center line such as hospitals, schools and religious places. MF = 1.00 when the number of sensitive areas are from 0 to 20 nos. MF = 0.75 when the number of sensitive areas are from 21 to 40 nos. MF = 0.50 when the number of sensitive areas are from 41 to 60 nos. MF = 0.25 when the number of sensitive areas are from 61 to 80 nos. MF = 0.00 when the number of sensitive areas are more than 81 nos.
5.2 Main road and rural road intersections	Consider number of level crossings on main road and rural road intersections. MF = 1.00 when the number of level crossings are from 0 to 10 nos. MF = 0.75 when the number of level crossings are from 11 to 20 nos. MF = 0.50 when the number of level crossings are from 21 to 30 nos. MF = 0.25 when the number of level crossings are from 31 to 40 nos. MF = 0.00 when the number of level crossings are more than 41 nos.

Table 3.4.4-5 Result of Determination of Multiplying Factor, MF, for Environmental and Social Parameters

No.	Environmental and Social Parameters	Route Alignment 1		Route Alignment 2		Route Alignment 3		Route Alignment 4	
		Impact	MF	Impact	MF	Impact	MF	Impact	MF
1	Important reserved and conservation areas (Distance of the route that cross through the reserved areas)	16,602 m	0.75	18,138 m	0.50	18,003 m	0.50	27,655 m	0.25
2	Soil and Soil erosion (distance of the route that cross through the high risk areas to soil erosion)	21,681 m	0.25	15,456 m	0.50	14,862 m	0.50	22,463 m	0.25
3	Surface water hydrology (Number of the route that cross canals)	192 areas	0.25	117 areas	0.75	126 areas	0.50	121 areas	0.50
4	Resettlement and community separation								
4.1	Number of buildings/structures	120 buildings	0.75	108 buildings	0.75	104 buildings	0.75	138 buildings	0.50
4.2	Number of communities that the alternative alignment passes	39 places	0.75	28 places	0.75	31 places	0.75	41 places	0.50
5	Sensitive areas to environmental and social impacts								
5.1	Sensitive areas to air-noise-vibration within the radius of 500 m. from the center line	31 places	0.75	17 places	1.00	18 places	1.00	21 places	0.75
5.2	Main road and rural road intersections (number of the intersections)	16 places	0.75	14 places	0.75	16 places	0.75	21 places	0.50

3.4.4.4 Summary of Environmental and Social Comparison

In scoring the environmental and social parameters of each alternative route alignment according to the above mentioned principles and methods, the result can be summarized in **Table 3.4.4-6, Figures 3.4.4-1** and **3.4.4-2**.

Upon consideration of environmental and social parameters of all alternative route alignments, it could be summarized that as all alternative route alignments have to pass mountain terrain where it is vulnerable to soil erosion, forested watershed, mangrove forest and communities along the main road and the distributor road, Alternative Route Alignment 1 has the shortest distance in passing conservation forest. Though Alternative Route Alignment 2 passes the least number of sensitive areas to environmental and social impacts such as temple, school, hospital, village and road intersection, it passes conservation forest likewise Alternative Route Alignments 3 and 4 but Alternative Route Alignment 4 has the longest route resulting in the most environmental and social impacts. So, Alternative Route Alignment 2 is the most feasible for environmental and social comparison and the result is as follows:

- Rank No. 1 Alternative Route Alignment 2 Scores 26.75
- Rank No. 2 Alternative Route Alignment 3 Scores 25.50
- Rank No. 3 Alternative Route Alignment 1 Scores 24.00
- Rank No. 4 Alternative Route Alignment 4 Scores 16.75

Table 3.4.4-6 Scores of Environmental and Social Parameters

No.	Important Parameters Considered	Designated Weighting	Route Alignment 1		Route Alignment 2		Route Alignment 3		Route Alignment 4	
			e_i	Scores	e_i	Scores	e_i	Scores	e_i	Scores
1	Important reserved and conservation areas	10	0.75	7.50	0.50	5.00	0.50	5.00	0.25	2.50
2	Soil and soil erosion	7	0.25	1.75	0.50	3.50	0.50	3.50	0.25	1.75
3	Surface water hydrology	5	0.25	1.25	0.75	3.75	0.50	2.50	0.50	2.50
4	Resettlement and community separation									
4.1	Number of buildings/structures	6	0.75	4.50	0.75	4.50	0.75	4.50	0.50	3.00
4.2	Number of communities that the alternative alignment passes	5	0.75	3.75	0.75	3.75	0.75	3.75	0.50	2.50
5	Sensitive areas to environmental and social impacts									
5.1	Sensitive areas to air-noise-vibration within the radius of 500 m. from the center line	4	0.75	3.00	1.00	4.00	1.00	4.00	0.75	3.00
5.2	Main road and rural road intersections	3	0.75	2.25	0.75	2.25	0.75	2.25	0.50	1.50
	Total	**40**		**24.00**		**26.75**		**25.50**		**16.75**

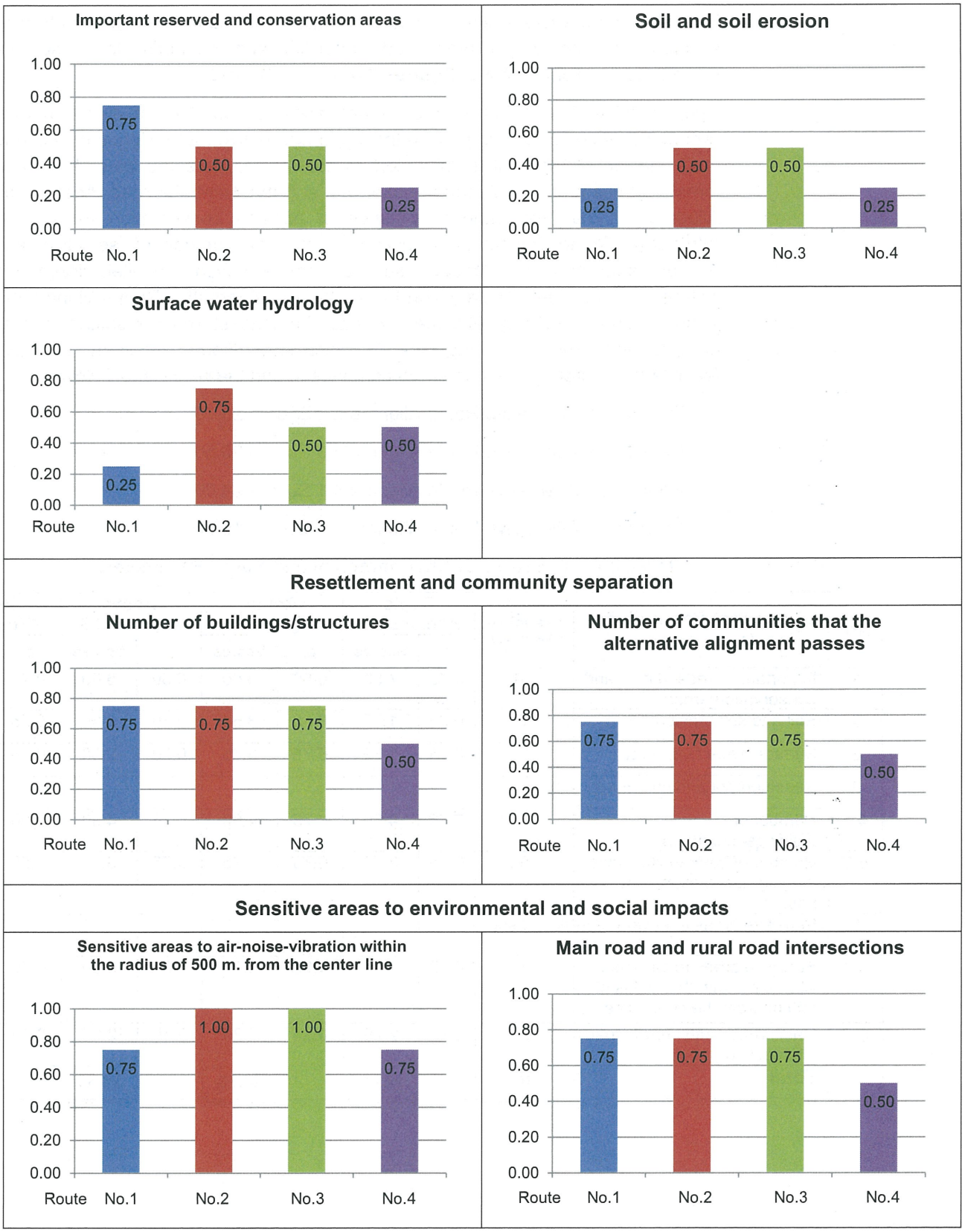
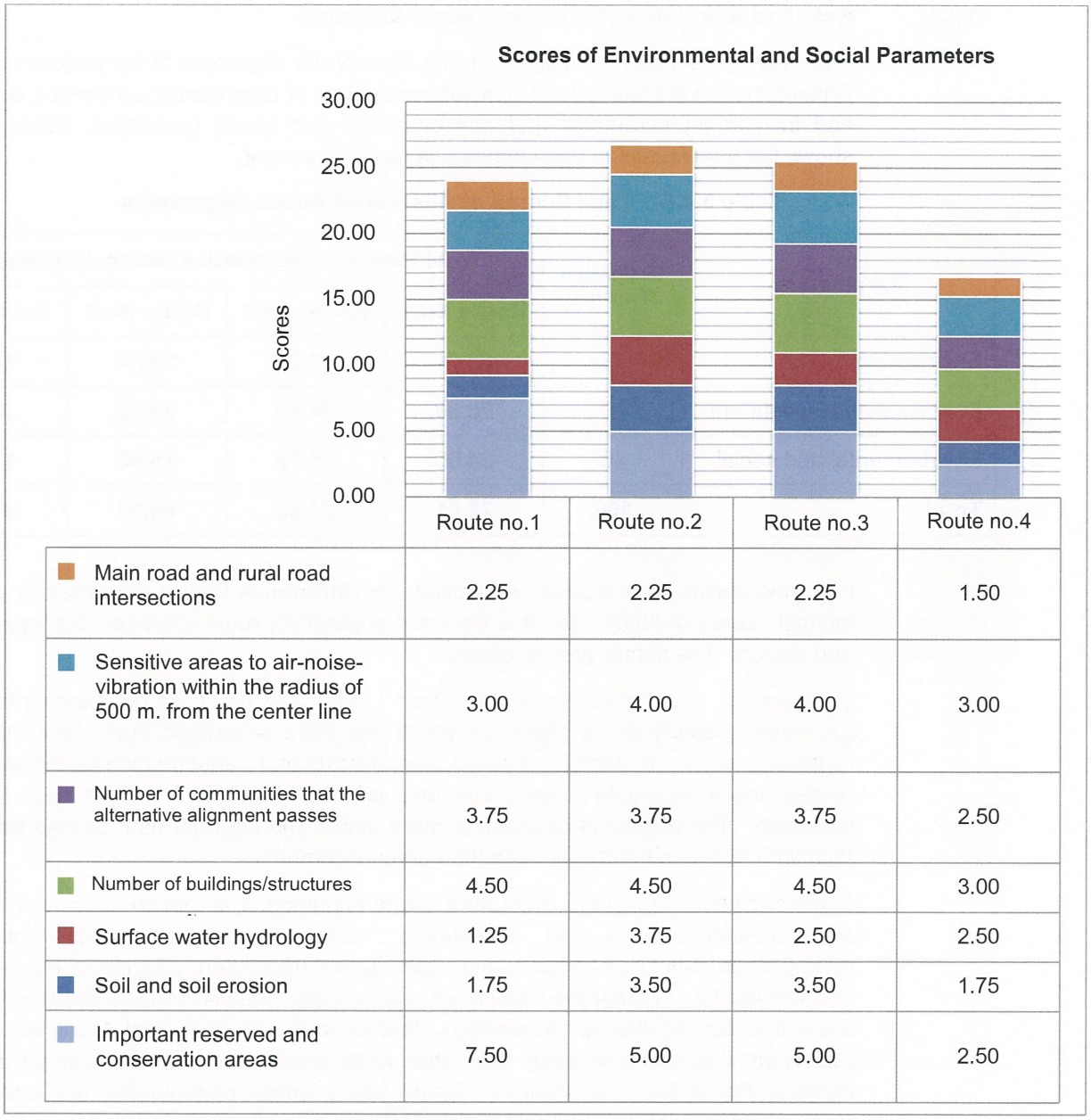


Figure 3.4.4-1 Multiplying Factor of Environmental and Social Parameters



	Route no.1	Route no.2	Route no.3	Route no.4
Main road and rural road intersections	2.25	2.25	2.25	1.50
Sensitive areas to air-noise-vibration within the radius of 500 m. from the center line	3.00	4.00	4.00	3.00
Number of communities that the alternative alignment passes	3.75	3.75	3.75	2.50
Number of buildings/structures	4.50	4.50	4.50	3.00
Surface water hydrology	1.25	3.75	2.50	2.50
Soil and soil erosion	1.75	3.50	3.50	1.75
Important reserved and conservation areas	7.50	5.00	5.00	2.50

Figure 3.4.4-2 Scores of Environmental and Social Parameters

3.4.5 Result of Alternative Route Alignments Selection

From the comparison to select the most appropriate alignment of the project which the Consultant has considered the 3 major parameters of engineering parameter, economic and investment parameter and environmental and social parameter, **Table 3.4.5-1** shows the total scores of each alternative route alignment.

Table 3.4.5-1 Total Scores of Alternative Route Alignments

Parameters	Designated Weighting	Total Scores of Alternative Route Alignments			
		Route No.1	Route No.2	Route No.3	Route No.4
Engineering	30	22.71	19.93	16.84	14.32
Economic and investment	30	28.30	24.95	23.70	16.65
Environmental and social	40	24.00	26.75	25.50	16.75
Total	**100**	**75.01**	**71.63**	**66.04**	**47.72**

From the above table, it could be noticed that **Alternative Route Alignment 1** gets the highest scores of 75.01. So, it is the most appropriate route alignment for future study and design. The details are as follows:

Engineering. Alternative Route Alignment 1 is ranked no. 1 for engineering from the geometric property of the alignment which has more advantage than other alternative route alignments. In addition, it saves time in travel and transportation as the alignment passes lower mountain terrain, has less curvature and is the most safe for train operation. The alignment structure is more stable and stronger as it passes the active fault time "Ranong Fault Line" less than other alignments.

Economic and investment. Alternative Route Alignment 1 is ranked no. 1 for economic and investment as an investment cost (construction cost and land expropriation/structures compensation cost) is less than Alternative Route Alignments 3 and 4 distinctly. Though the investment cost is higher than Alternative Route Alignment 2 but it is not significant. In addition, Alternative Route Alignment 1 can have more passenger volumes than other alternative route alignments as the alignment parallels Highway Route No. 4 (Phetkasem Road) where dense communities are located. It responds to the need of the local people better.

Environment and Social. Alternative Route Alignment 1 is ranked no. 2 whilst Alternative Route Alignment 2 is ranked no. 1 for this comparison but all alternative route alignments of the project have to pass mountain terrain where it is vulnerable to soil erosion. Some areas are forested watershed and mangrove forest and scattered communities are located on the existing road. Alternative Route Alignment 1 passes conservation area for the shortest distance and Alternative Route Alignment 2 passes the least sensitive areas to environment and social impacts.

Chapter 4

Study and Forecast of Traffic and Transportation

Chapter 4
Study and Forecast of Traffic and Transportation

4.1 Study and Forecast of Traffic and Transportation

The survey consultants collected information on the network of roads, railways and ports in the project area including physical characteristics, terrain problems and obstacles to be used as information in the study.

1) Road network

National Highway 4 Bangkok - The permanent nebula (Thailand / Malaysia border) is the national highway of Thailand with the route to southern Thailand is 1,277.512 kilometers, it will be separated into Highway 4 through Ranong and Highway 41, heading to Phatthalung. At the intersection Pathomporn. The route between Chumphon and Ranong from the intersection of Pathomporn along Highway 4 to 2-4 lanes of road and the road is sloping and winding because it is a mountainous area. Traveling between each other is not very convenient. Especially for cargo trucks. Physical characteristics of major highways in Ranong and Chumphon area, as shown in **Figure 4.1-1**.

(1) Highway 4 (Petchakasem Road) is the main highway of Thailand. The main route to travel to the south. Currently, Highway4, Chumphon - Ranong is under construction to expand traffic lanes from 2 lanes to 4 lanes.

- Start construction at the intersection of Pathumporn Chumphon and Ranong, section 3, km 500 + 480, to km 513 + 300, the distance of 12.820 kilometers has been completed.
- Chumphon - Ranong Episode 4 (Chumphon - Kra Buri Monument) km 513 + 300 km to km 545 + 750 km, the distance of 32.450 kilometer, currently under construction from 2 lanes to 4 lanes.
- Chumphon - Ranong Period 2 km 545 + 750 km to km 569 + 250 km, the distance of 23.500 km has been completed construction is currently 4 traffic lanes.
- Chumphon - Ranong Period 1 km 569 + 250 to km 585 + 250 km distance 16.000 kilometers has been completed construction is currently 4-lanes.
- Chumphon – Ranong Period 5 (Klong Laen - Ranong), km 585 + 250 until km 603 + 000 17.750 km, currently under construction from 2 lanes to 4 lanes.
- The area of Ranong Province to the Ngao District is two lanes.
- Tambon Ngao district, Muang District, Ranong - Ratchadaphisek, Takua Pa, Phang Nga.2 lanes

(2) Highway 4091 is a highway with an access point to Highway 41 at the intersection of Khao Peep. Thung Tako District, Chumphon Province, connecting to Highway 4, Bang Si Kim, Amphoe Mueang, Ranong.

(3) Highway 4006 is a highway with an access point to Highway 41 in the district of Lang Suan, Chumphon through Phato District. It connects to Highway 4 at Rachkrud, Amphoe Mueang, Ranong.

(4) Highway 41 is a major highway to travel to the southern provinces. From the beginning Amphoe Mueang Chumphon, Amphoe Sawi, Amphoe Thung Tako, Amphoe Lang Suan, and Amphoe Lamae. Currently, the road is 4 lanes, totaling distance is 95.163 kilometers. Highway 41 connects to other roads to connect to Highway 4.

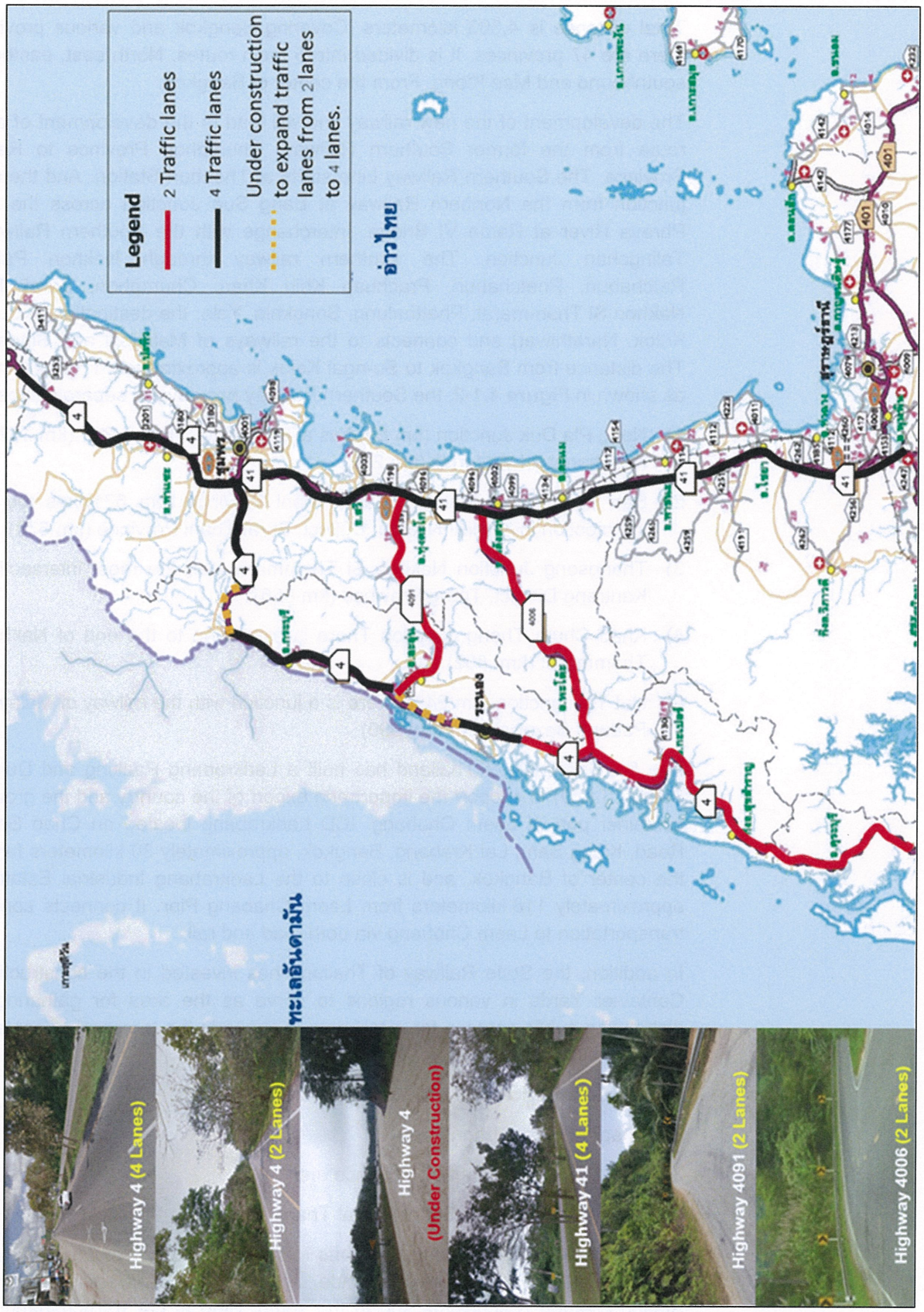


Figure 4.1-1 Road network in the study area

2) Railway Network

Total distance is 4,363 kilometers. Covering Bangkok and various provinces, there are 47 provinces. It is divided into 5 main routes. North east, eastbound, southbound and Mae Klong. From the center of Bangkok.

The development of the new railway line will lead to the development of a new route from the former Southern Railway. Chumphon Province to Ranong Province. The Southern Railway Line starts at Thonburi Station. And there is a junction from the Northern Railway at Bang Sue Junction across the Chao Phraya River at Rama VI Bridge. Interchange with the Southern Railway at Talingchan Junction. The southern railway through Nakhon Pathom, Ratchaburi, Phetchaburi, Prachuap Khiri Khan, Chumphon, Surat Thani, Nakhon Si Thammarat, Phatthalung, Songkhla, Yala, the destination at Su-ngai Kolok. Narathiwat) and connects to the railways of Malaysia and Singapore. The distance from Bangkok to Su-ngai Kolok is approximately 1,159 kilometers as shown in **Figure 4.1-2**, the Southern Railway has several separate lines.

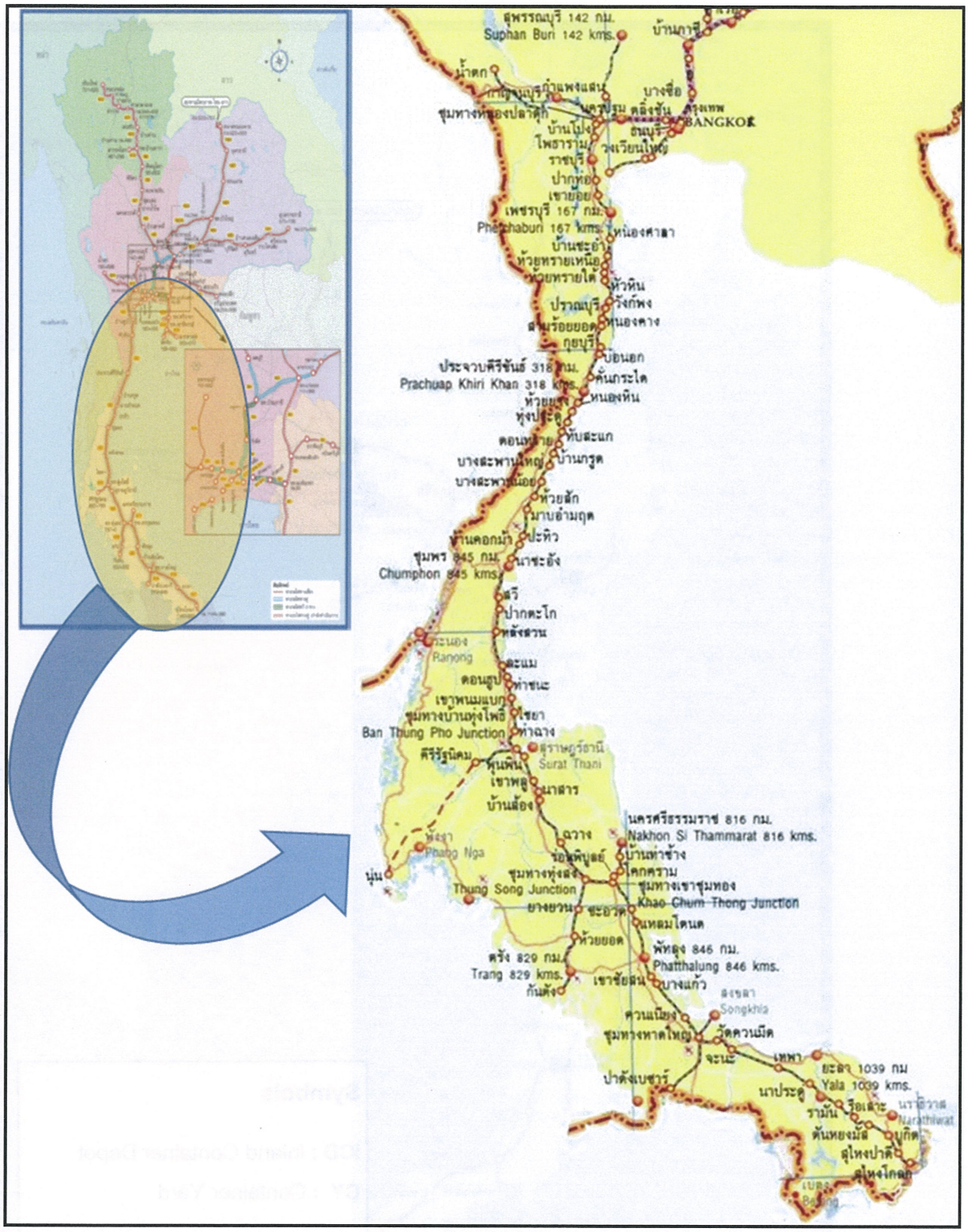
1) Nong Pla Duk Junction (km 80) has a junction to Suphan Buri (km 157) and Kanchanaburi Waterfall (km 210).
2) Ban Thung Pho Junction, Surat Thani Province (km 631) has the most intersection in Khirirat Nikhom District, Surat Thani Province (km 678).
3) Thungsong Junction Nakhon Si Thammarat has the most intersection at Kantrang District, Trang Province (km 866).
4) Khao Chum Thong Junction There is a junction to the end of Nakhon Si Thammarat (km. 832) and
5) Hat Yai Junction (km 945), there is a junction with the railway of Malaysia at Padang Bezar station (km 990).

The State Railway of Thailand has built a Ladkrabang Packing and Dumping Station (LICD) to support the import and export of the country and the growth of container port at Laem Chabang. ICD Ladkrabang located on Chao Samran Road, Klong Sam, Lat Krabang, Bangkok, approximately 30 kilometers far from the center of Bangkok, and is close to the Ladkrabang Industrial Estate and approximately 118 kilometers from Laem Chabang Pier. It connects container transportation to Laem Chabang via both road and rail.

In addition, the State Railway of Thailand has invested in the construction of Container Yards in various regions to serve as the area for gathering and distributing public cargoes for merchants. It supports the transport of containers using 4 train stations.

1) Kut Chik Station, Nakhon Ratchasima
2) Thapra Station, Khon Kaen
3) Sila Art Station Uttaradit Province and
4) Thung Pho Junction Station Surat Thani

There are also private storage stations in the northeastern route, namely Non Phrayom Station, Khon Kaen Province. Jira Road Junction and Island House Station Nakhon Ratchasima snd in the south. Stop at car Karnchanaburi and the Thungsong Junction. Nakhon Sri Thammarat as shown in **Figure 4.1-3**.



Source: The State Railway of Thailand

Figure 4.1-2 Southern Railway Network



Figure 4.1-3 The container terminal (CY) and the container and cargo terminal (ICD)

3) Bus Station Area

- **Chumphon Province for travel from Chumphon Province - Ranong has 3 main points of service**

  - **Chumphon Bus Terminal**

    Chumphon Passenger Terminal is located along Highway 4 (Petchakasem Road). From Chumphon to Ranong Passengers can board at this station. The bus will serve as an air-conditioned bus. All air-conditioned buses run from Bangkok - Chumphon - Ranong - Phang Nga - Phuket. This bus stop is also available, as shown in **Figure 4.1-4.**



Figure 4.1-4 Chumphon Bus Terminal

  - **Choke Anan and Rungkit Tour Bus**

    Choke Anan and Rungkit Bus Station is located at Pracha Uthit 1, Tambon Tha Tapao, Amphoe Mueang Chumphon. The bus service will be available. Rungkit Tour, which will serve the route Chumphon - Ranong - Phang Nga - Phuket Take Highway 4 (Petchkasem Road) and end at Phuket, as shown in **Figure 4.1-5**.



Figure 4.1-5 Choke Anan and Rungkit Tour Bus

    For Rungkit's air-conditioned bus tour. The bus will run from the bus station of Choke Anan in the city. Chumphon bus station will take you to the outside.

  - **Chumphon – Ranong Bus Terminal**

    Chumphon Bus Terminal - Ranong It will serve the Chumphon - Ranong route running along Highway4 (Petchakasem Road) and ending at Ranong Bus Station. The car will be available from 7am to 5pm. The car will leave every 15 minutes. The fare is about 120 baht / person, as shown in **Figure 4.1-6.**



Figure 4.1-6 Chumphon – Ranong Bus Terminal

- **Ranong Province** For travel from Ranong – Chumphon Province, there are 1 main point

  - **Ranong Bus Terminal**

    Ranong Bus Terminal Located along Highway4 (Petchakasem Road) Tambon Bang Rin, Muang Ranong. There are air-conditioned buses on the 1st and 2nd floors. All air-conditioned buses run from Bangkok to Ranong and Phang Nga to Phuket. This bus stop is also available. If you travel between Ranong - Chumphon. I can travel as shown in **Figure 4.1-7**.



Figure 4.1-7 Ranong Bus Terminal

For the route between Chumphon - Ranong province can travel by bus. Category 2 and 3 are detailed in **Table 4.1-1**.

Table 4.1-1 Service route between Chumphon - Ranong Province of Bus 2 and 3

Car category	Route	Standard car / service company	Number of trips (Holidays / Day)	Passenger volume (Person / day)
Bus 2	Ranong – Bangkok	Air conditioner, 1st class (Transport Company Limited)	2	48
	Ranong – Bangkok	Air conditioner, 1st class (New Mitr Tour Co., Ltd.)	6	192
	Ranong – Bangkok	Air conditioner, 1st class (Chuan AnanTour Co., Ltd.)	5	160
	Ranong – Bangkok	Air conditioner, 1st class (Sombat Tour Co., Ltd.)	3	96
	Ranong – Bangkok	Air conditioner, 2nd class (Alex Tour Co., Ltd.)	5	160
Total Bus 2			**21**	**656**
Bus 3 (Bus between provinces)	Ranong – Chumphon	ม.2 (จ) Van	20	200
	Chumphon – Kraburi	ม.3 mini bus	6	60
	Ranong – Prachuab khiri Khan	ม.2 (จ) Van	10	100
	Chumphon – Phuket	ม.1 (Air conditioner, 1st class)	10	200
Total Bus 3			**46**	**590**

Source: Ranong Transport Office

4) Ports in project area

The project area will be located in the Gulf of Thailand, Chumphon and Andaman coast in Ranong province, which will serve both passenger and cargo transportation.

- **Passenger Port**

  Most of the docks are tourist ports. Located on the river. Before leaving the Gulf of Thailand Chumphon. There will be a tourist port of the Provincial Administration Organization (OPP), Chumphon and many private ports. The tourist port of Chumphon province can accommodate large tourist boats such as ferries and passenger boats. Thai and foreign tourists are interested in visiting the sea at Chumphon each year. The trip to Koh Tao even in Surat Thani Province, but more than 80 percent of tourists prefer to use Chumphon more than 75 kilometers, as shown in **Figure 4.1-8**.



Port of Chumphon Provincial Administrative Organization



Sea Ferry Terminal



Port of Chumphon Municipality



Lom Phraya Pier

Figure 4.1-8 Port in Chumphon

Boat Port in Ranong It is a pier that crosses to Koh Phayam, Koh Chang. The bat island can be reached at Tonson Pier and a boat landing. They can also cross the border to Myanmar for tourism and Ranong border trade. The island can be crossed to Koh Song, Koh Son and Koh Khu at the Ranong Customs Pier, Port Authority Andaman Club Pier.

At present, the Harbor Department has constructed a wharf at Thanyon Canal, Ngon District, Muang District, Ranong province and has delivered it to the Ngao Subdistrict Administrative Organization. To manage In March 2017, the Pine Pier It can also be used as a link between tourist arrivals in the Upper South. And the land of Myanmar. The current situation of tourism in Ranong is likely to increase every year. It also corresponds to Ranong Development Strategy. The provinces that focus on tourism development are the main strategies of the country, as shown in **Figure 4.1-9**.



Jetty



Andaman Club Pier



Ranong Customs House



Ton Son Berth

Figure 4.1-9 Port in Ranong

- **Shipping Port**

  Ranong Port is located at the mouth of the Kra Buri River, Pak Nam District, Muang Ranong is the largest deep sea port on the Andaman coast of Thailand. Approximately 315 rai of waterway. From the west of Koh Chang to the wharf, the total distance of 28 kilometers, with a depth of 8 meters from the lowest water level. The width of the rails is 120 meters.

  The Harbor Terminal was completed on 23 July 2000, a multi-purpose dock capable of handling two 500 tons of gypsum cargo ships, but the port was not utilized properly. For this reason, the Cabinet has resolved on 25 March 2003 to the Port Authority of Thailand. Management of Ranong Port The second stage of the vessel has been built to accommodate 12,000 DWT vessels. The second Ranong Port was officially opened in July 2006 as the main port. In the Andaman Sea Shipping of Thailand linking the route between Ranong Pier and Myanmar Port. The BIMSTEC is a framework for economic cooperation in Thailand with six other countries: Bangladesh, Bhutan, India, Myanmar, Nepal and Sri Lanka, as shown in **Figure 4.1-10**. Moreover, there are problems connected to the network linking Ranong Port. Accessible by road only. Current road conditions link to the harbor. There are no traffic lanes. Transportation is not as convenient as it should be.



Figure 4.1-10 Ranong Port

Entrance to Ranong Pier Accessible by road only. Take Highway 4, Petchkasem, Bangkok - Chumphon - Ranong, 568 kilometers. Turn right onto Highway No 4010, which has been upgraded to a standard road. The distance is 13 kilometers and the road 3008 (Khao Nanghong - Sam Khla Road), which is the way to the Ranong port, Ranong Railway has no railway network. Therefore, rail transport from all regions to Ranong Port. It will be transported to the container yard of the railway station in Muang District, Chumphon, which will be used as a turning point from the train to the truck and then to Ranong Port. The distance is approximately 110 kilometers, as shown in **Figure 4.1-11**.



Figure 4.1-11 Ranong Port Link Network

There are also several small private berths located on the banks of Kra Buri River, Pak Nam Sub-district, Mueang District, Ranong Province, can accommodate up to 500 gross tons, as shown in **Figure 4.1-12**, most of which are transported to Myanmar. Construction materials Cement and consumer goods



Figure 4.1-12 Private port located on the banks of the Kraburi River Ranong

5) Airports in the project area

Ranong Airport or Ranong Airport is located in Tambon Rachukud, Amphoe Mueang Ranong, Ranong, on Highway 4 (Petchakasem), at km 634 - 636, covering an area of approximately 2,386 rai, approximately 25 kilometers far from Ranong Town. The Airport is under the jurisdiction of the Department of Airports Ministry of Transport, there are 4,000 sq.m. of passenger terminal building with 45 x 2,000 m. In the past, Phuket Air has been operating. However, the service was stopped in 2005 and Thai Air Asia was opened. The flight has been canceled since April 2009. Currently, Nok Air flies from Ranong to Bangkok (Don Mueang) 3 times a day, and AirAsia 1 time a day, as shown in **Figure 4.1-13**.



Figure 4.1-13 Ranong Airport

Chumphon Airport is the airport under the jurisdiction of the Airport Department. Ministry of Transport is located in Chum Kho Sub-district, Pathio District, Chumphon Province, constructed by resolution of Cabinet on May 15, 1990 to stimulate and revive Chumphon economy after a Typhoon Gay accident on November 4, 1989, the first airport was opened on March 14, 1998, with a budget of 530 million baht and was declared a customs airport on March 2 2000, Pathio District Chumphon Province has a total area of 2,485 rai, far from Chumphon Town to the north about 38 km. PB Air operated on March 14, 1998 and ceased operations in 2000. Then, Air Andaman was re-launched on October 30, 2002 but was discontinued on March 29, 2003, because of the problem of loss like PB Air. Currently, Nok Air is available and Air Asia will launch in the near future, as shown in **Figure 4.1-14.**



Figure 4.1-14 Chumphon Airport

4.2 Traffic and Transportation Survey and Collection

4.2.1 Traffic and Transportation Data Collection

The consultants will collect data on the demand for transportation and transportation in the study area. From the relevant agencies.

1) Traffic volume (AADT) on the road network in the study area

The consultants have collected relevant and historical transportation data for use as a basis for predicting future traffic volumes. Initially, the consultants collected traffic data on the highway surveyed by the Bureau of Highway Safety, Department of Highways, which surveys the traffic volume on the National Highway every year and made a report on Average Annual Daily Traffic (AADT) by classifying the types of vehicles into 12 categories.

(1) Passenger Car, less than 7 persons
(2) Passenger Car, more than 7 persons
(3) Light Bus
(4) Medium Bus
(5) Heavy Bus
(6) Light Truck (4 wheels)
(7) Medium Truck 2 axles (6 wheels)
(8) Heavy Truck 3 axles (10 wheels)
(9) Full Trailer (more than 3 wheels)
(10) Semi-Trailer (more than 3 wheels)
(11) Bicycle 2 wheels and 3 wheels
(12) Motorcycle and Tricycle

The data will be displayed on each control section composed of Highway number and control section by one highway consisting of several control sections. Each of the control sessions will be stored. Traffic data collected by the Department of Highways at various survey stations. Project area and nearby area during the year 2011-2015 as shown in **Table 4.2.1-1** and **Figure 4.2.1-1**

Table 4.2.1-1 Average Daily traffic Volume throughout the year (AADT) the project area period 2011-2016

Highway number	Control range	KM.	Route	Traffic volume (cars per day)						Growth rate (Percentage per year)
				Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
4	701	428+490	Num Rod – Porta Hinchang	13,276	19,671	16,214	17,788	17,110	18,696	7.09
				(41.73)	(31.10)	(33.13)	(37.00)	(32.96)	(31.54)	
4	702	451+513	Porta Hinchang – Wang Krok	20,881	24,906	30,026	29,528	20,405	18,812	-2.07
				(28.66)	(29.58)	(29.56)	(31.18)	(27.62)	(31.53)	
4	801	490+753	Seab Yuan – Kra Buri	14,901	9,198	10,581	10,961	11,378	11,678	-4.76
				(51.31)	(21.91)	(21.64)	(13.37)	(12.00)	(12.81)	
4	801	528+103	Seab Yuan – Kra Buri	14,651	10,142	6,738	5,986	7,162	6,703	-14.48
				(43.92)	(25.69)	(17.20)	(13.60)	(14.24)	(15.49)	
4	802	565+823	Kra Buri – Ngao	3,768	4,407	4,879	5,182	4,768	5,365	7.32
				(20.36)	(20.92)	(24.98)	(22.73)	(16.13)	(16.48)	
4	802	590+103	Kra Buri – Ngao	4,769	4,545	4,827	5,155	5,431	6,005	4.72
				(15.56)	(14.65)	(14.19)	(15.91)	(14.91)	(15.65)	
4	802	608+465	Kra Buri – Ngao	7,083	11,303	8,569	8,413	8,686	10,881	8.97
				(13.95)	(12.23)	(11.05)	(12.69)	(9.37)	(7.72)	
4	803	644+321	Ngao – Aao Koey	3,609	3,984	2,536	3,956	4,214	4,740	5.60
				(14.80)	(139.91)	(17.07)	(11.93)	(11.01)	(9.62)	
4	803	675+021	Ngao – Aao Koey	4,469	2,711	4,260	4,177	2,561	2,730	-9.39
				(38.02)	(29.92)	(24.62)	(36.17)	(33.31)	(23.85)	
4	803	691+821	Ngao – Aao Koey	2,999	3,378	3,556	4,465	2,883	3,078	0.52
				(26.54)	(20.87)	(34.28)	(30.62)	(8.78)	(13.97)	
41	102	52+500	Kho Bor – Ta Thong	21,003	25,359	25,718	27,826	28,036	28,184	6.06
				(24.29)	(22.51)	(25.00)	(23.38)	(24.84)	(25.44)	
41	103	65+450	Ta Thong – Suan Somboon	30,282	26,081	24,335	20,563	30,018	24,309	-4.30
				(33.94)	(33.94)	(24.15)	(22.85)	(22.86)	(21.27)	

Source: Bureau of Highway Safety, Department of Highways
Note: Traffic volume does not include motorcycles. The numbers in brackets are the percentage of large cars.

Table 4.2.1-1 Average Daily traffic Volume throughout the year (AADT) the project area period 2011-2016 (Cont'd)

Highway number	Control range	KM.	Route	Traffic volume (cars per day)						Growth rate (Percentage per year)
				Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
41	103	78+200	Ta Thong – Suan Somboon	22,459	24,310	21,417	13,808	17,118	18,526	-3.78
				(44.37)	(26.84)	(23.46)	(25.53)	(31.22)	(25.79)	
412	100	0+140	Entrance to Ranong	9,903	5,188	9,092	12,516	12,764	15,634	9.56
				(9.04)	(3.60)	(3.26)	(2.85)	(2.73)	(2.41)	
4001	100	5+500	Po Tarod Intersection – Ta Yang	11,064	10,108	10,849	11,262	10,439	10,301	-1.42
				(8.75)	(9.05)	(7.71)	(6.99)	(7.44)	(6.63)	
4002	100	0+533	Lung Suan – Paknum Lung Suan	3,881	4,183	4,881	4,104	4,030	5,001	5.20
				(4.92)	(4.30)	(10.20)	(6.21)	(5.81)	(9.66)	
4003	100	3+850	Sawee – Bor Ka	2,800	3,160	3,838	4,253	4,839	5,285	13.55
				(8.93)	(7.85)	(5.78)	(3.95)	(5.95)	(2.54)	
4006	100	2+500	Rachakrud – Wang Takor	3,401	3,371	3,385	2,608	2,443	3,124	-1.68
				(30.26)	(18.93)	(22.30)	(15.34)	(15.39)	(19.33)	
4006	100	29+000	Rachakrud – Wang Takor	2,579	3,091	3,340	3,900	3,507	3,733	7.68
				(13.11)	(15.82)	(9.70)	(8.54)	(8.58)	(9.22)	
4091	101	2+500	Bang Si Kim – Kho Kai	1,954	2,384	1,407	893	1,161	799	-16.38
				(24.77)	(10.11)	(11.87)	(10.08)	(11.63)	(6.51)	
4091	101	19+088	Bang Si Kim – Kho Kai	2,411	1,049	862	572	944	356	-31.79
				(4.89)	(11.06)	(2.44)	(0.00)	(3.50)	(4.49)	
4091	101	43+173	Bang Si Kim – Kho Kai	1,775	997	1,100	1,177	1,556	1,683	-1.06
				(9.97)	(5.62)	(3.82)	(1.53)	(2.70)	(6.24)	
4091	101	59+373	Kho Kai – Kho Peeb	3,075	3,436	4,126	5,445	4,583	5,329	11.62
				(6.96)	(8.50)	(4.65)	(10.98)	(9.38)	(8.44)	
4098	100	2+600	Kho Mat Si – Sai Ree Beach	1,688	1,588	1,784	2,393	2,212	2,225	5.68
				(13.68)	(13.29)	(11.32)	(10.28)	(11.93)	(10.43)	

Source: Bureau of Highway Safety, Department of Highways
Note: Traffic volume does not include motorcycles. The numbers in brackets are the percentage of large cars

Table 4.2.1-1 Average Daily traffic Volume throughout the year (AADT) the project area period 2011-2016 (Cont'd)

Highway number	Control range	KM.	Route	Traffic volume (cars per day)						Growth rate (Percentage per year)
				Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	
4099	100	5+500	Kho Muang – Laem Sai Temple	554	525	671	906	1,143	1,331	19.16
				(11.73)	(10.67)	(9.69)	(5.52)	(6.30)	(5.11)	
4112	100	0+222	La Mae Intersection – Suan Tang	4,297	4,160	7,735	7,124	7,704	6,082	7.20
				(6.49)	(9.38)	(3.56)	(2.85)	(4.18)	(9.19)	
4119	100	0+565	Pak Khlong – Chumphon Estuary	6,561	7,441	7,332	6,579	7,115	8,141	4.41
				(9.31)	(8.51)	(8.54)	(6.29)	(8.85)	(5.93)	
4134	100	7+500	Lung Suan – La Mae	2,893	2,802	3,937	2,629	3,801	3,708	5.09
				(11.13)	(17.81)	(19.41)	(9.17)	(15.92)	(12.03)	
4198	100	0+500	Kho Suan Turean – Aoh Ma Muang	832	1,279	1,438	1,593	1,806	1,899	17.95
				(12.02)	(24.16)	(7.37)	(1.95)	(1.11)	(1.00)	

Source: Bureau of Highway Safety, Department of Highways
Note: Traffic volume does not include motorcycles. The numbers in brackets are the percentage of large cars

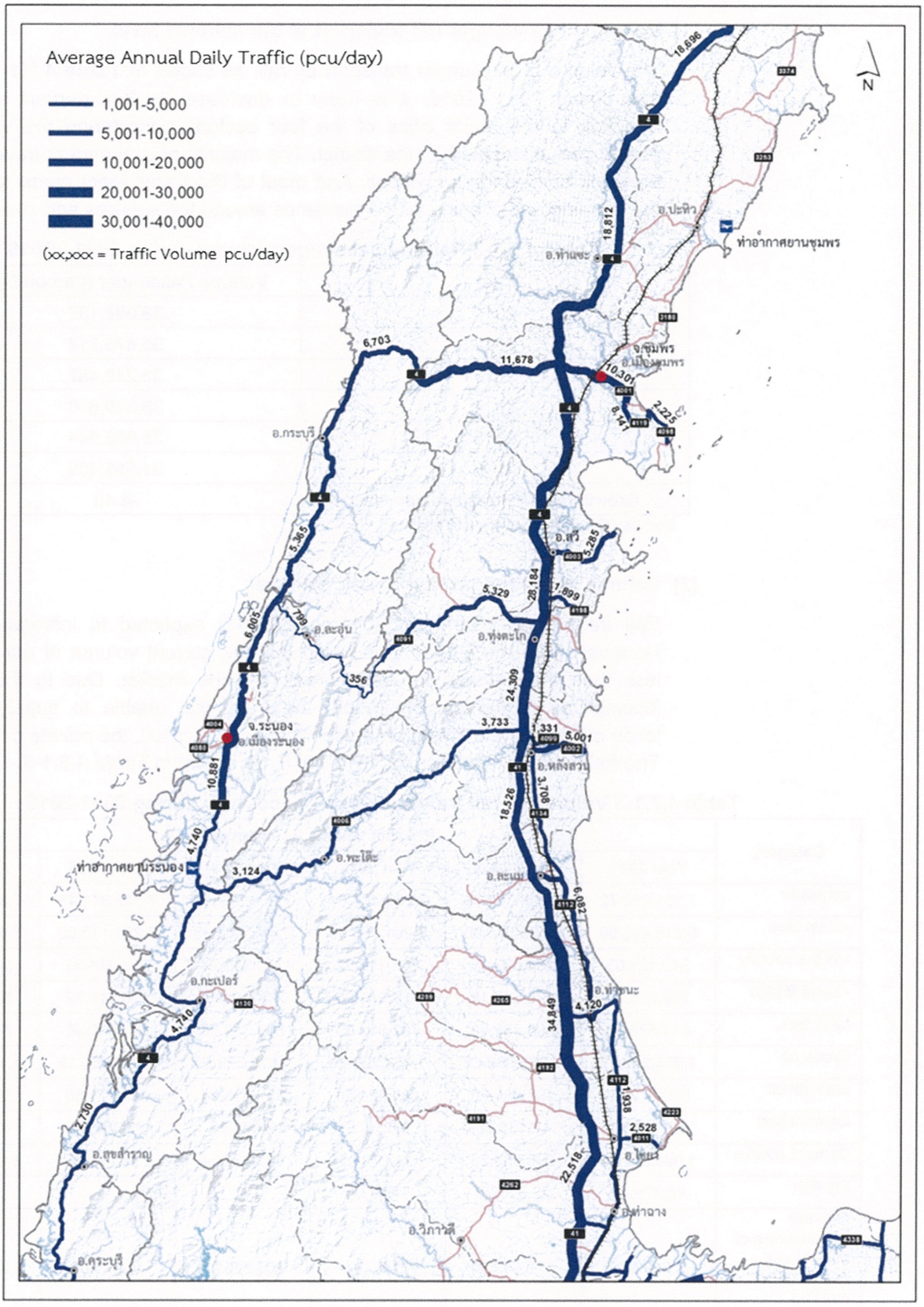


Figure 4.2.1-1 Average daily traffic volume throughout the year (AADT) in the project area in 2016

2) Passenger and freight traffic statistics

(1) Volume of passenger rail transport at the national level.

The volume of passenger transport by rail, as shown in **Table 4.2.1-2**, shows that during 2011 - 2016, it is likely to decrease by 3.45 percent per year. Bangkok to the major cities of the four sectors, considering the volume of passengers distributed by the district. The majority of passengers travel around Bangkok and nearby provinces. And most of the passengers come to work in the morning and evening with a residence around the suburbs and suburbs.

Table 4.2.1-2 Railway passenger volume during 2011 - 2016

Year	Volume Passenger (person / year)
2011	38,088,136
2012	35,475,714
2013	33,210,487
2014	38,389,840
2015	35,065,944
2016	31,955,459
Growth rate (Percentage per year)	-3.45

Source: The State Railway of Thailand

(2) Volume of rail freight at the national level

Rail freight traffic between 2011 and 2016 is expected to increase slightly. However, from the survey. It is found that the current volume of rail freight is less than the demand for transportation in the market. Due to the lack of locomotives in the demonstration, the train was unable to supply enough locomotives and the timing of transportation. As a result, the private confidence. The freight traffic statistics for 2011-2016 are shown in **Table 4.2.1-3.**

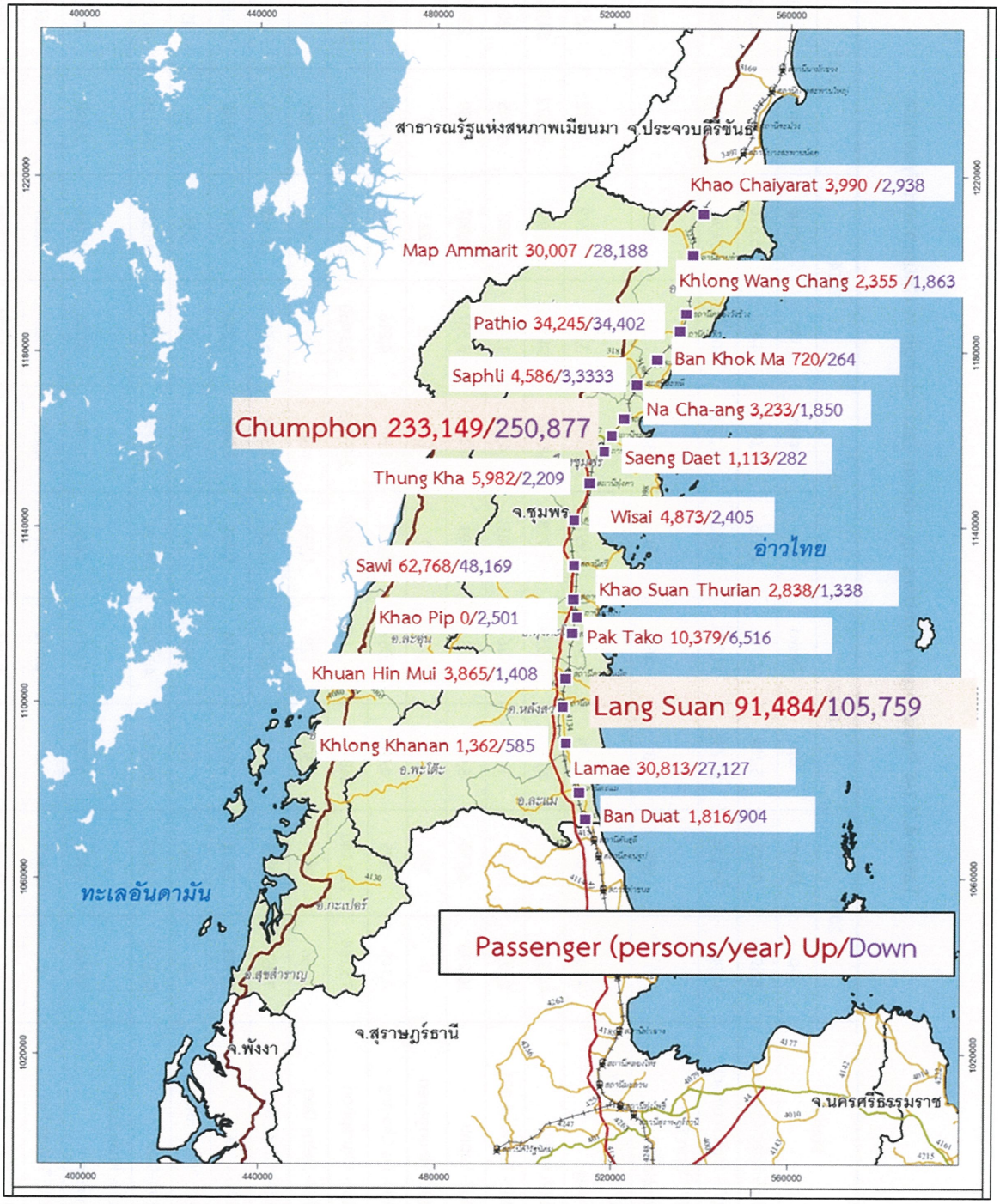
Table 4.2.1-3 Volume of rail freight across the country during 2011-2016

Category	Product volume (tons per year)					
	Year 2011	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016
container	7,121,212.72	7,008,731.36	7,654,484.67	7,853,929.17	7,715,311.13	7,859,557.22
- East Line	6,615,465.90	6,595,606.00	7,281,788.50	7,487,207.00	7,285,125.00	7,350,239.00
- in the country	349,171.03	284,609.18	268,112.52	274,330.27	293,374.35	313,595.29
- Land Bridge	156,575.79	128,516.18	104,583.65	92,391.90	136,811.77	195,722.93
LPG Gas	817,536.00	806,256.00	782,352.00	800,352.00	829,920.00	776,448.00
Crude oil	1,276,289.13	1,266,938.69	1,452,233.00	1,025,233.50	1,212,655.18	1,192,481.13
General oil	560,912.55	468,081.60	484,624.40	382,898.24	493,721.80	544,007.90
Cement bag	33,914.80	17,136.00	8,652.80	2,674.00	20,064.00	100,060.01
Cement powder	1,096,582.33	898,653.28	1,113,724.14	663,380.74	738,791.20	1,206,366.30
Fly Ash	42,475.40	22,870.20	5,544.00	-	-	-
General merchandise of military use, police, drinks, building materials.	126,698.33	472,603.20	511,236.21	206,825.00	41,675.60	31,912.60
Total	**11,075,621.26**	**10,961,270.33**	**12,012,851.22**	**10,935,292.65**	**11,052,138.91**	**11,710,833.16**

Source: The State Railway of Thailand

(3) Passenger train volume in the study area

In 2016, the number of passengers was 1,054,545 passengers per year. In Chumphon, as shown in **Figure 4.2.1-2**. The number of passenger passengers decreased from 2011 with 1,205,268 passengers per year, at a rate of -2.63 percent per annum. Chumporn stations accounted for 45.89% of the total passenger traffic in Chumphon. Subsequently, Lang Suan Station, Suvarnabhumi Station and Pathway Station, respectively, are shown in **Table 4.2.1-4.**



Source: The State Railway of Thailand

Figure 4.2.1-2 Passenger up - down each station in Chumphon Province, 2016

Table 4.2.1-4 Passenger numbers up - down each station in Chumphon Province

Station	2011		2012		2013		2014		2015		2016	
	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down
4172- Khao Chaiyarat	5,595	4,419	5,384	4,511	4,806	4,091	4,478	3,616	4,057	3,305	3,990	2,938
4175- Map Ammarit	34,985	34,284	34,735	33,210	32,852	31,575	30,535	29,941	29,331	28,373	30,007	28,188
4177-*Ban Sub Sombool	0	689	0	466	0	362	1	305	0	296	0	302
4178- Khlong Wang Chang	4,559	2,620	5,114	2,414	3,991	2,188	3,176	2,279	3,312	2,512	2,355	1,863
4179- Pathio	44,682	39,043	40,977	39,957	38,768	38,849	34,776	32,995	35,072	34,846	34,245	34,402
4181- Ban Khok Ma	2,461	588	1,797	426	1,985	459	1,215	352	1,045	301	720	264
4182- Saphli	10,290	6,630	8,417	5,281	6,997	4,453	6,307	4,047	4,989	2,933	4,586	3,333
4183-*Nhongnaien	0	328	0	277	0	425	0	223	0	203	7	248
4184- Na Cha-ang	4,745	1,375	4,644	1,062	4,683	1,075	4,216	986	4,005	1,400	3,233	1,850
4186- Chumphon	273,164	262,140	268,118	263,162	252,066	265,963	223,450	249,099	233,274	249,363	233,149	250,877
4187- Saeng Daet	1,156	297	1,304	128	1,533	140	994	168	1,159	186	1,113	282
4189- Thung Kha	7,057	3,075	6,134	2,710	5,306	2,333	5,717	2,365	6,143	1,989	5,982	2,209
4191- Wisai	6,546	3,212	6,061	2,916	5,295	2,948	5,286	2,757	4,842	2,558	4,873	2,405
4192-*Baan Khon	6	560	11	401	3	475	0	355	0	457	0	450
4194-Sawi	66,659	50,883	65,065	48,038	65,126	49,440	64,029	46,524	62,170	46,198	62,768	48,169
4196- Khao Suan Thurian	4,066	1,406	3,922	1,041	3,649	1,144	3,086	1,186	2,898	1,093	2,838	1,338
4197-* Khao Pip	0	2,627	2	2,596	13	2,610	0	2,187	0	2,008	0	2,501
4199- Pak Tako	15,611	8,374	15,441	8,842	13,751	8,048	13,630	7,828	12,040	7,027	10,379	6,516
4200-*Tra Thong	0	832	0	786	0	653	0	690	60	672	90	724

Source: The State Railway of Thailand

3) Air Transport Statistics

The air travel statistics shown in **Table 4.2.1-5** show that in 2017, the total number of passengers in the study area was 209,173 per year, an increase from 8,551 in 2011, with growth rates increased 70% per year, due to the discontinuity of the service. In the year 2017, Chumphon has 87,689 passengers and Ranong has 121,484 passengers.

Table 4.2.1-5 Passenger and air cargo volume statistics in study area

Area	Data	2011	2012	2013	2014	2015	2016	2017
Chumphon	Number of flights (trips / year)	452	708	1,988	1,202	1,561	1,496	1,480
	Number of passengers (person / year)	5,366	11,059	45,447	48,766	93,325	93,567	87,689
	Product volume (tons / year)	0	0	0	0	0	0	0
Ranong	Number of flights (trips / year)	246	410	1,213	1,028	1,500	1,484	1,602
	Number of passengers (person / year)	3,185	7,406	30,004	59,706	90,206	102,228	121,484
	Product volume (tons / year)	0	0	0	0	3,413	14,806	0
Total	Number of flights (trips / year)	698	1,118	3,201	2,230	3,061	2,980	3,082
	Number of passengers (person / year)	8,551	18,465	75,451	108,472	183,531	195,795	209,173
	Product volume (tons / year)	0	0	0	0	3,413	14,806	0

Source: Department of Civil Aviation

4) Water Transportation Statistics

By the year 2016, Ranong had a total of 346 vessels, representing 167,864 tons of cargo and 3,071 TEUs, down from 2015. Throughput of 192,213 tons and the number of containers is 5,083 TEU. At present, most of the cargo through the offshore supply, including Umbilical Cable, Heavy Lift Sling and Shackle. There are some products that do not contain cabinets, such as Cable Drum, as shown in **Table 4.2.1-6**.

Table 4.2.1-6 Ranong Ports through 2009-2016

Year	Boat volume (trip)	Product volume (tons)		Total (tons)	Number of containers (TEU)
		Incoming	Outgoing		
2009	321	9,970	17,420	27,390	1,216
2010	321	17,879	31,094	48,973	584
2011	257	18,284	24,051	42,335	2,015
2012	219	36,440	43,767	80,207	703
2013	282	43,818	90,976	134,794	1,242
2014	356	82,982	160,910	243,892	1,433
2015	315	65,803	126,410	192,213	5,083
2016	346	63,286	104,579	167,864	3,071

Source: The Port Authority of Thailand

4.2.2 Survey and Analysis of Traffic and Transportation Data

In addition to collecting relevant traffic and transportation data both past and present. The consultants will conduct surveys in additional areas. To understand the current state of the problem and the nature of travel. To use as a database for future traffic forecasts.

4.2.2.1 Traffic Volume and Passenger Traffic Survey

The traffic survey was completed on Thursday, July 13, and Saturday, July 15, 2017, as shown in **Figure 4.2.2-1**, with the atmosphere on the survey day as shown in **Figure 4.2.2-2** and **Figure 4.2.2-3**. The details and results of the survey are as follows.

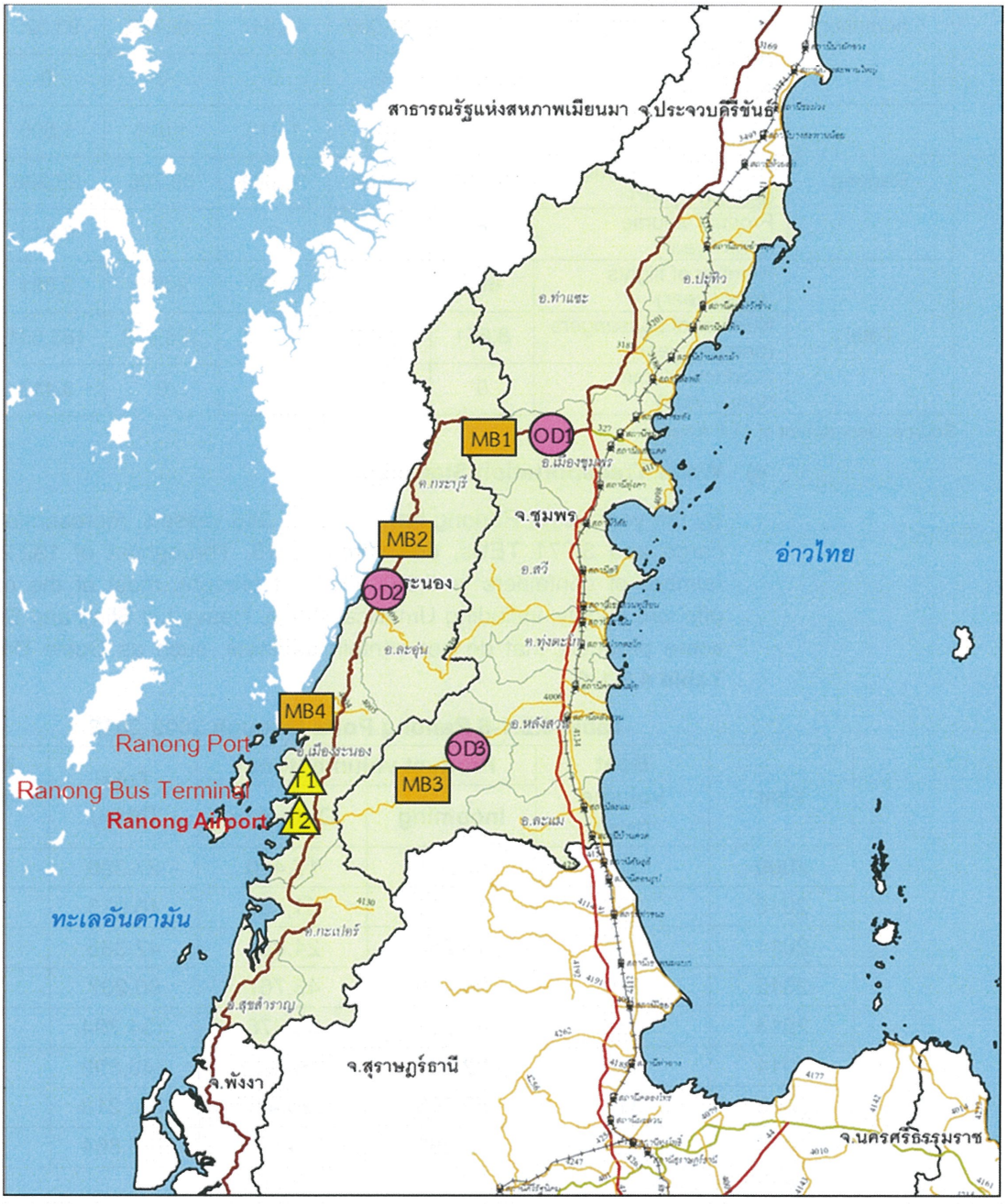


Figure 4.2.2-1 Traffic information survey points



Figure 4.2.2-2 Atmosphere in traffic volume survey



Figure 4.2.2-3 Origin - Destination and Travel Data Survey and Travel Behavior

1) Traffic survey on the segment road (Mid-Block Counts)

Survey on traffic volume on the main roads in the project area to analyze traffic conditions on the transport network at the project area and to calibrate the model. The consultant will survey the traffic volume on the road in the study area. The survey will be conducted for 2 days (weekdays and holidays). The survey will be conducted from 07:00 to 19:00. There are 11 types.

(1) Motorcycle
(2) Passenger car/Taxi
(3) Van
(4) Pick-Up
(5) Light Bus
(6) Medium Bus
(7) Heavy Bus
(8) Light Truck (4 Wheels)
(9) Medium Truck (6 Wheels)
(10) Heavy Truck (10 Wheels)
(11) Semi Trailer / Full Trailer

Traffic volume surveys are done by counting vehicles. Sort by type and direction on the road. Initially, 4 points were selected.

- MB1 : National Highway No.4 (Mueang Chumphon - Kra Buri)
- MB2 : National Highway No.4 (Kra Buri-Mueang Ranong)
- MB3 : National Highway No.4006
- MB4 : Rural Road No.4010

In analysis, each vehicle is converted into a Passenger Car Unit (PCU) using the PCU Factor as follows.

(1) Motorcycle = 0.33
(2) Passenger car/Taxi = 1
(3) Van = 1
(4) Pick-Up = 1
(5) Light Bus = 1.5
(6) Medium Bus = 1.5
(7) Heavy Bus = 2.5
(8) Light Truck (4 Wheels) = 1
(9) Medium Truck (6 Wheels) = 2.1
(10) Heavy Truck (10 Wheels) = 2.5
(11) Semi Trailer / Full Trailer = 2.5

The analysis of road traffic volume in unit vehicle per/day and pcu/day during weekdays and holidays is shown in **Table 4.2.2-1** and **Figure 4.2.2-4** to **Figure 4.2.2-8** as summarized below.

- **Highway 4, Chumphon - Kra Buri (MB1)** is the main highway that accommodates the traffic in and out of Ranong. There are 700 to 900 vehicles / hour or 700-1000 pcu / hour, which is 7-8% of traffic volume. Throughout the day, the proportion of vehicles used by the travelers in the area through the MB1 survey area is the highest proportion of pickup trucks, accounting for approximately 41-47%. 6-wheel-drive and 12 -15% trucks are available at Level E (2 lanes are currently being expanded to 4 lanes).
- **Highway 4, Kra Buri – Mueang Ranong (MB2)** is the main highway that accommodates traffic in and out of Ranong. There are 5,600-5,800 vehicles / day or 6,700-7,300 pcu / day, with peak traffic in the range of 400-500 cars / hour or 500-600 pcu / hr accounting for 7-8% of traffic throughout the day. The proportion of vehicles used by the travelers in the area through the MB2 survey area is the highest proportion of pickup trucks, accounting for approximately 21-31%. 13-16% passenger cars. 6-wheel and 18-80%. The service level is B (4-lane highway).

- **Highway 4006 (MB3)** is a secondary highway that accommodates traffic in and out of Ranong. There are 3,800-4,800 vehicles / day or 3,900-4,800 pcu / day with traffic volume. The rush hour is between 320-440 cars / hour or 300-400 pcu / hour, accounting for 7-8% of traffic throughout the day. The proportion of vehicles used by the travelers in the area through the survey area MB3 is the highest proportion of pickup trucks with the proportion of about 38-47 percent. Motorcycles from 6 to 7 percent are 8-9 percent. The service is at level A (4-lane highway).
- **Rural Road 4010 (MB4)** is a highway that accommodates inbound and outbound traffic. Ranong has an estimated traffic volume of 5,000 vehicles per day or 4,800 pcu / day. 360-480 cars / hour or 350-380 pcu / hour, accounting for 7-8% of traffic throughout the day. The proportion of vehicles used by the travelers in the area through the MB4 survey area was the highest for the pickup trucks, accounting for approximately 31-33%. 6-wheel and 6-8-wheel trucks are 6 -8 percent. The service level is D (two-lane highway).

Table 4.2.2-1 Traffic Volume Survey Results on the Segment Road

Survey points	Highway No.	Direction	Weekday				Holiday			
			Maximum hour traffic		All day traffic volume		Maximum hour traffic		Total traffic volume	
			Cars / hour	PCU / hour	Cars / day	PCU/day	Cars / hour	PCU / hour	Cars / day	PCU / day
MB 1	Highway No.4 (Mueang Chumphon-Kra Buri)	To Chumphon	338	412	5,168	6,273	444	483	5,568	6,601
		To Ranong	422	529	5,722	7,067	408	498	4,986	5,953
		Total	**760**	**941**	**10,890**	**13,340**	**852**	**981**	**10,554**	**12,553**
MB 2	Highway No.4 (Kra Buri-Mueang Ranong)	To Kra Buri	232	258	2,678	3,135	217	248	2,774	3,412
		To Ranong	207	240	2,935	3,642	248	309	3,010	3,898
		Total	**439**	**498**	**5,613**	**6,778**	**465**	**557**	**5,784**	**7,310**
MB 3	Highway No.4006	To Ranong	167	137	2,365	2,240	175	176	1,849	2,000
		To Lung Suan	273	261	2,467	2,607	145	130	1,975	1,957
		Total	**440**	**399**	**4,832**	**4,847**	**320**	**306**	**3,824**	**3,957**
MB 4	Rural Road No.4010	To Ranong	150	119	2,548	2,400	166	166	2,304	2,276
		To Kra Buri	289	263	2,578	2,488	200	193	2,656	2,541
		Total	**439**	**382**	**5,126**	**4,888**	**366**	**358**	**4,960**	**4,817**

Table 4.2.2-2 Proportion of Vehicles of the Road

	Weekday					Holiday				
	MB1	MB2	MB3	MB4	Average	MB1	MB2	MB3	MB4	เฉลี่ย
Motorcycle	9.09%	10.30%	23.42%	23.71%	15.86%	7.41%	12.79%	16.95%	28.15%	16.04%
Car / Taxi	14.44%	12.92%	9.75%	15.55%	13.20%	15.56%	16.32%	10.94%	14.29%	14.55%
Pick-Up	41.74%	35.76%	38.64%	33.32%	37.23%	46.17%	21.76%	47.18%	31.27%	35.70%
Personal car > 7 persons	7.08%	9.07%	4.42%	9.04%	7.60%	6.84%	11.24%	5.98%	6.29%	7.78%
Light Bus	3.37%	1.44%	1.94%	2.88%	2.33%	3.70%	3.26%	1.08%	3.12%	2.91%
Medium Bus	0.24%	1.10%	0.22%	0.00%	0.46%	0.91%	1.24%	0.61%	0.00%	0.72%
Heavy Bus	0.56%	0.64%	0.16%	0.00%	0.37%	0.32%	0.70%	0.30%	0.00%	0.34%
Light Truck (4 Wheels)	8.39%	10.64%	12.60%	9.80%	10.33%	6.89%	13.84%	8.92%	8.73%	9.72%
Medium Truck (6 Wheels)	3.78%	3.92%	3.47%	1.94%	3.34%	3.31%	4.75%	2.97%	2.07%	3.34%
Heavy Truck (10-12 Wheels)	4.97%	6.48%	1.83%	1.59%	4.02%	4.37%	6.14%	1.93%	2.60%	3.94%
Full Trailer / Semi Trailer	6.35%	7.73%	3.55%	2.17%	5.25%	4.52%	7.96%	3.14%	3.49%	4.96%
Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

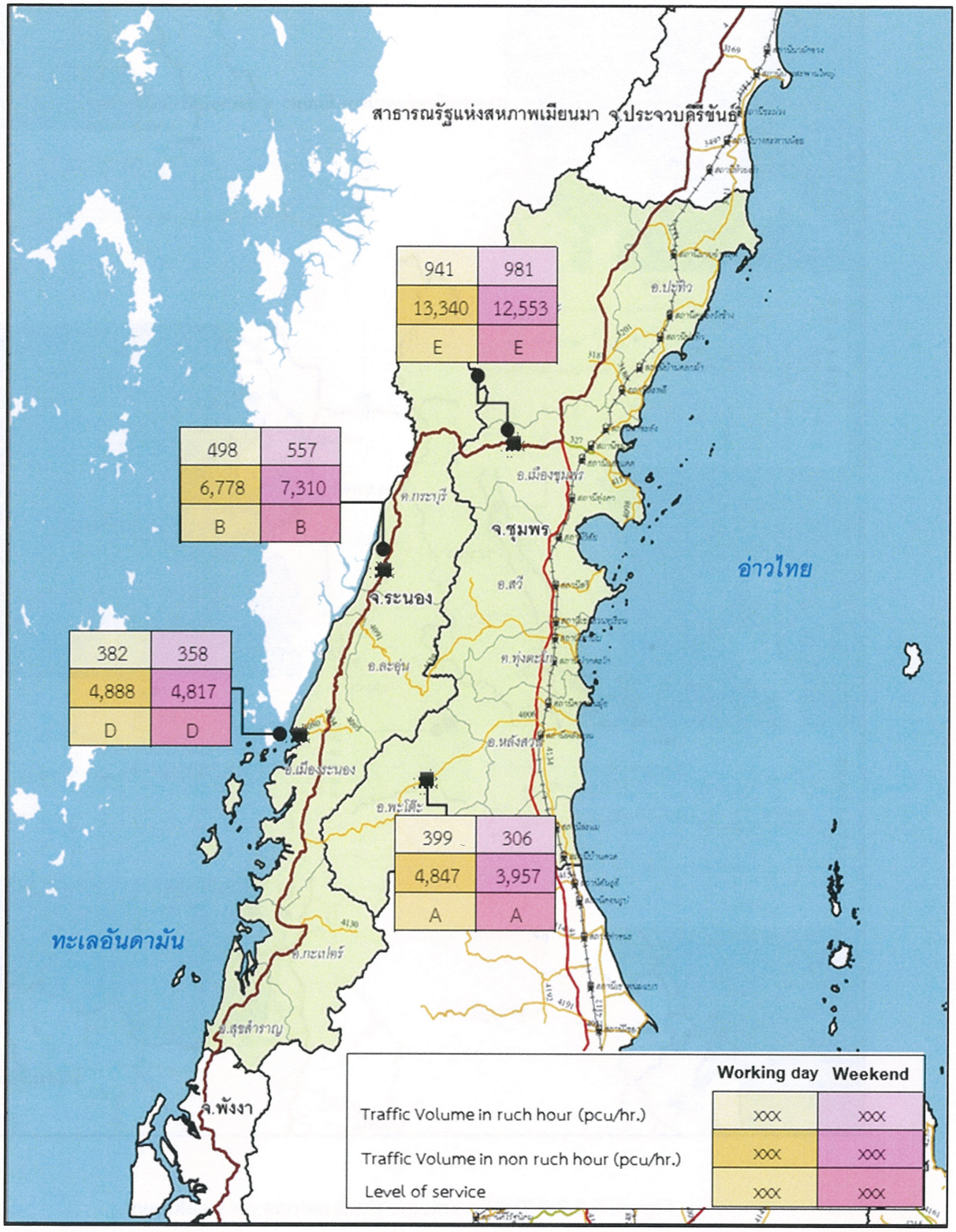


Figure 4.2.2-4 Road Traffic Volume Survey

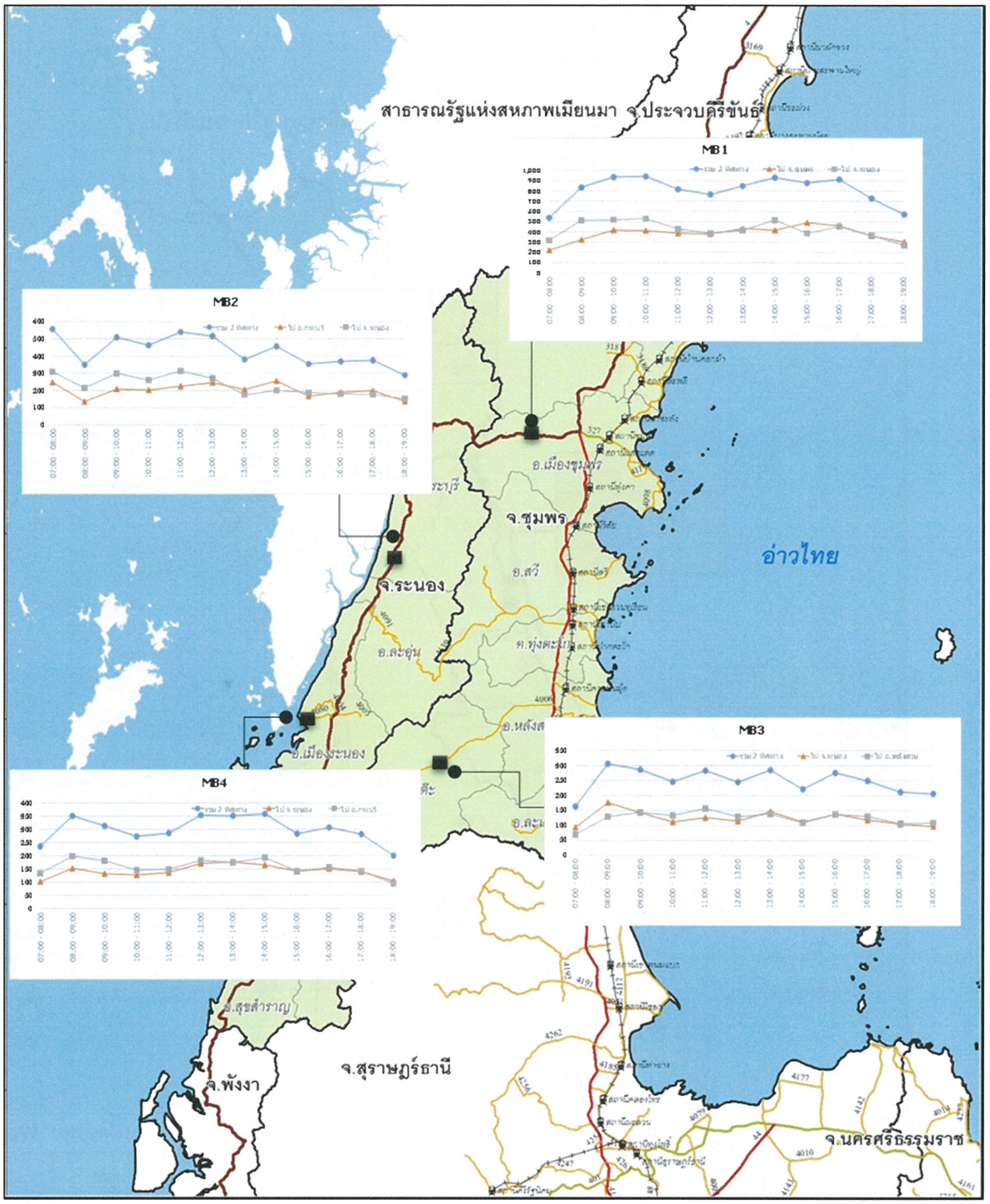


Figure 4.2.2-5 Traffic volume fluctuations on weekdays

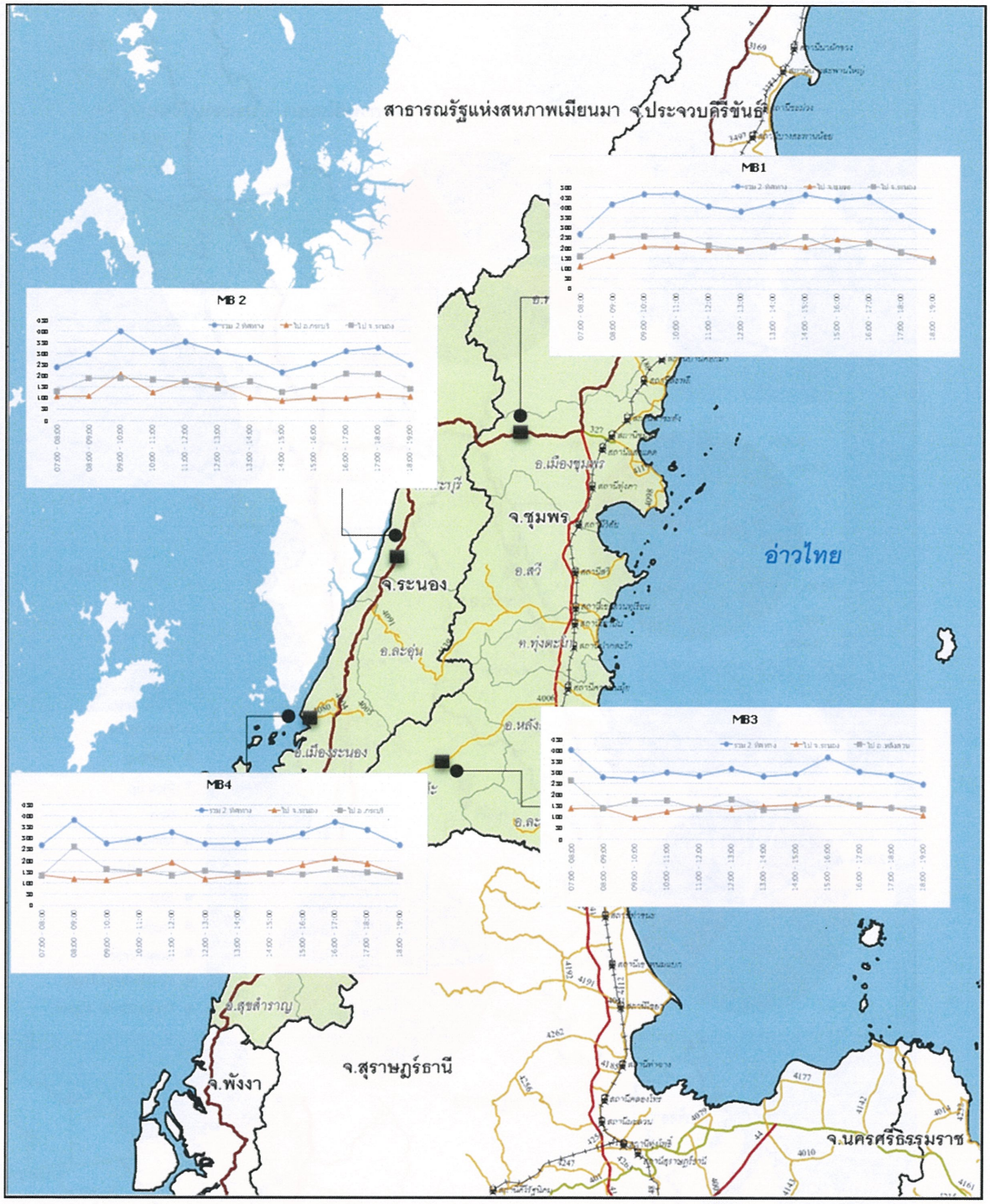


Figure 4.2.2-6 Variance of Road Traffic Volume on Holiday

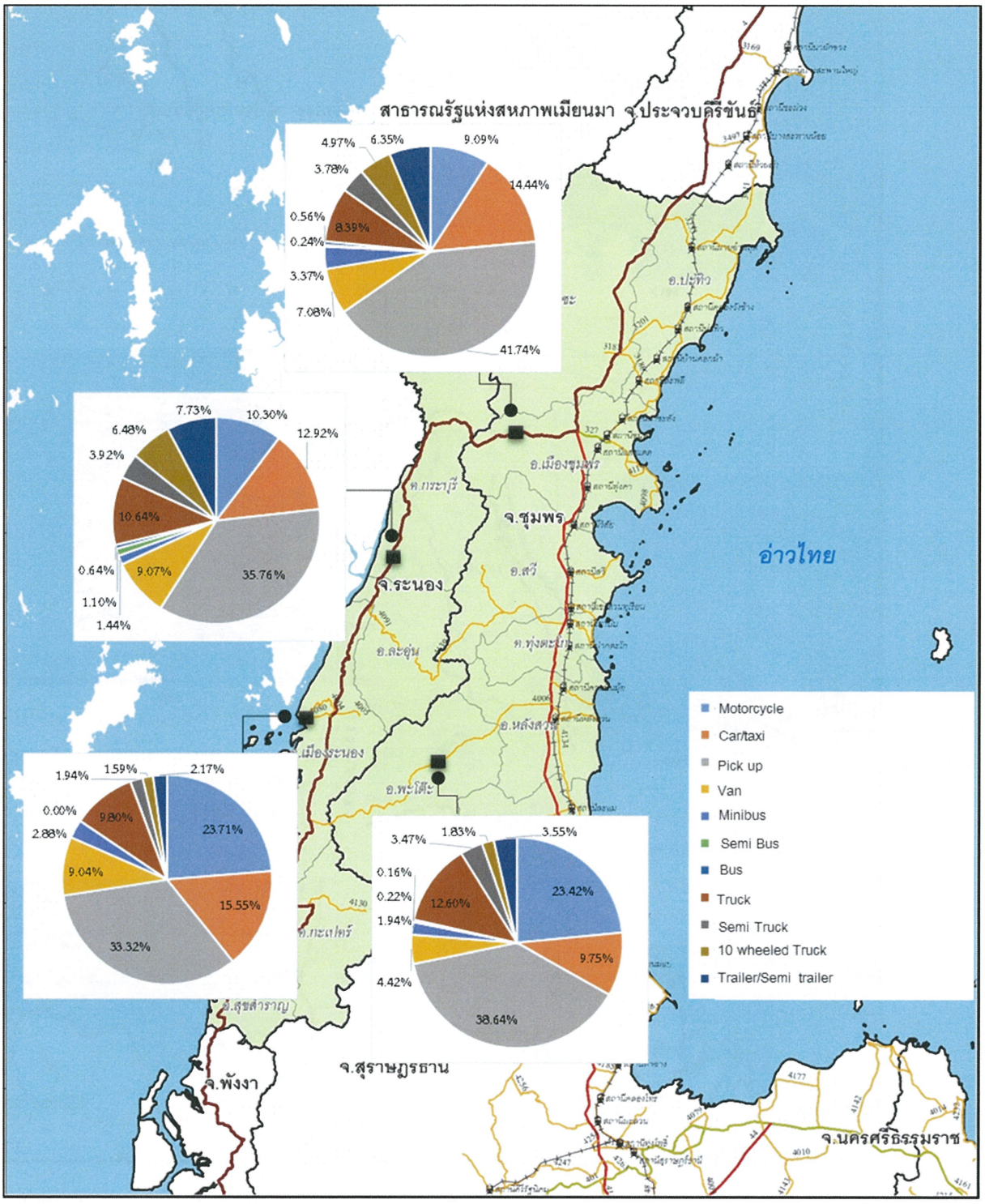


Figure 4.2.2-7 Proportion of vehicles on the road on weekdays.

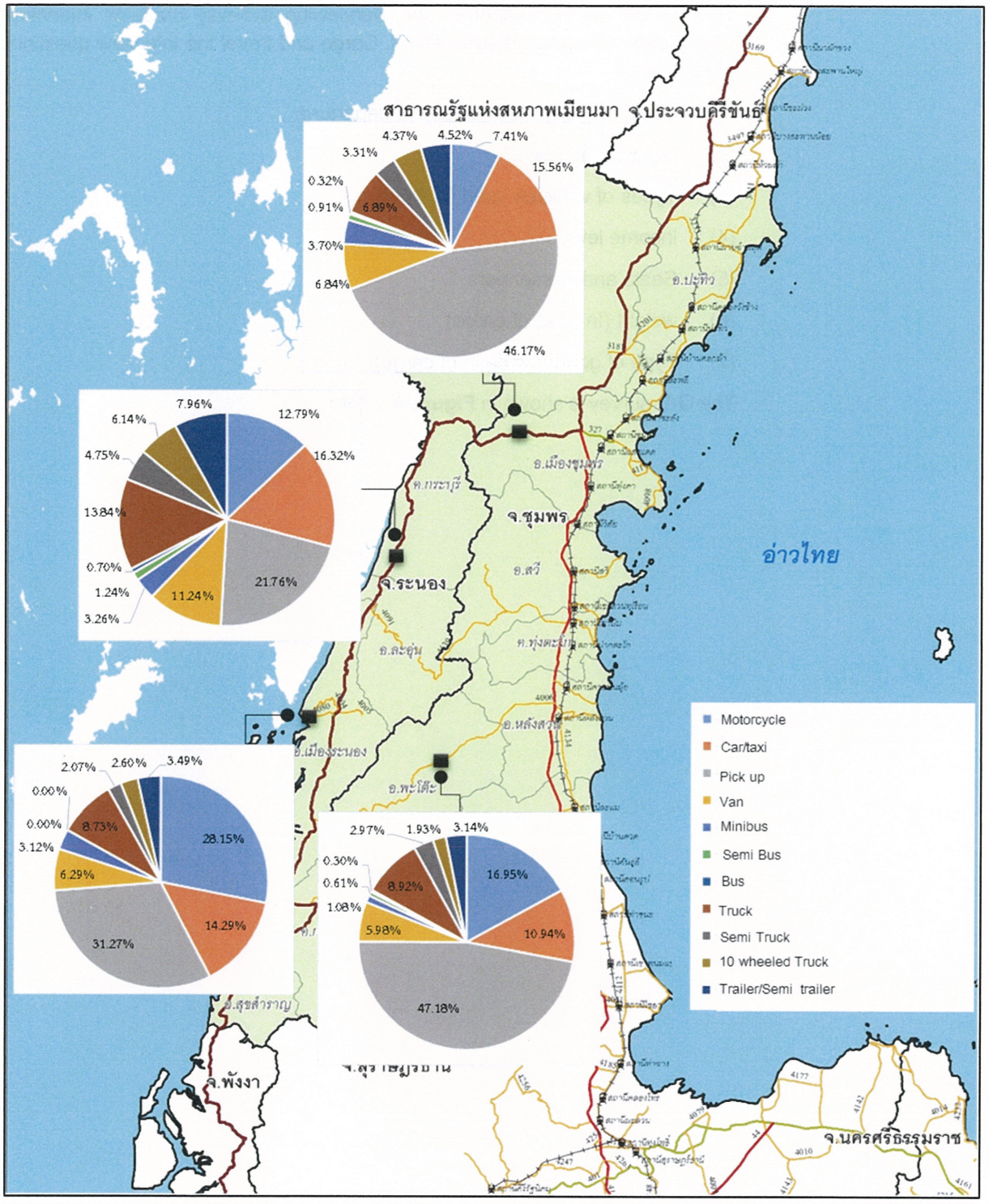


Figure 4.2.2-8 Proportion of vehicles on the road on Holiday

2) Origin-Destination Survey of Travelers

This survey will be conducted by interviewing two-way roadside interviewers. The survey data will cover personal travel. Cargo and travel the interview questions include the following:

(1) Origin and destination point of departure.

(2) Purpose of travel

(3) Types of vehicles used for travel.

(4) income level

(5) Seats and passengers

(6) weight (In case of cargo)

(7) Type of goods (in case of cargo)

The O-D survey is shown in **Figure 4.2.2-9**.

แผ่นที่ ☐☐☐

จุดสำรวจ ☐☐ ทิศทาง _____ ☐☐ ผู้ควบคุม ผู้สำรวจ วันที่ ☐☐ เดือน ☐☐

ประเภทรถ	จุดต้นทาง	จุดปลายทาง	วัตถุประสงค์	จำนวนคนในรถ (รวมคนขับ) สำหรับรถทุกประเภทยกเว้นรถประเภท 4,5	จำนวนคนในรถ (รวมคนขับ) สำหรับรถบัสขนาดกลางและขนาดใหญ่ (รถประเภท 4,5)	สำหรับรถบรรทุก 4, 6, 10 ล้อ (รถประเภท 6,7,8,9,10) ชนิดสินค้า	สำหรับรถบรรทุก 4, 6, 10 ล้อ (รถประเภท 6,7,8,9,10) น้ำหนัก	เวลาสัมภาษณ์
	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดต้นทางที่เดียวกับที่อยู่ปัจจุบัน	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดปลายทางที่เดียวกับที่อยู่ปัจจุบัน	1 2 3 4 5 6 _____		1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	1. ไม่มีสินค้า 2. เกษตร 3. ก่อสร้าง 4. อุตสาหกรรม 5. อื่นๆ ระบุ___ _____	1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	:
	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดต้นทางที่เดียวกับที่อยู่ปัจจุบัน	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดปลายทางที่เดียวกับที่อยู่ปัจจุบัน	1 2 3 4 5 6 _____		1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	1. ไม่มีสินค้า 2. เกษตร 3. ก่อสร้าง 4. อุตสาหกรรม 5. อื่นๆ ระบุ___ _____	1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	:
	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดต้นทางที่เดียวกับที่อยู่ปัจจุบัน	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดปลายทางที่เดียวกับที่อยู่ปัจจุบัน	1 2 3 4 5 6 _____		1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	1. ไม่มีสินค้า 2. เกษตร 3. ก่อสร้าง 4. อุตสาหกรรม 5. อื่นๆ ระบุ___ _____	1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	:
	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดต้นทางที่เดียวกับที่อยู่ปัจจุบัน	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดปลายทางที่เดียวกับที่อยู่ปัจจุบัน	1 2 3 4 5 6 _____		1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	1. ไม่มีสินค้า 2. เกษตร 3. ก่อสร้าง 4. อุตสาหกรรม 5. อื่นๆ ระบุ___ _____	1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	:
	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดต้นทางที่เดียวกับที่อยู่ปัจจุบัน	ชื่อสถานที่ : ตำบล : อำเภอ : จังหวัด : ◯ จุดปลายทางที่เดียวกับที่อยู่ปัจจุบัน	1 2 3 4 5 6 _____		1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	1. ไม่มีสินค้า 2. เกษตร 3. ก่อสร้าง 4. อุตสาหกรรม 5. อื่นๆ ระบุ___ _____	1. ว่าง 2. 1/4 3. 1/2 4. 3/4 5. เต็ม	:

วัตถุประสงค์การเดินทาง

1. ไป-กลับบ้าน
2. ไปทำงาน/เรียนหนังสือ
3. ติดต่อธุรกิจ/การค้า
4. ธุรกิจส่วนตัว
5. ท่องเที่ยว/พักผ่อน
6. อื่นๆ ระบุ

ชนิดของสินค้า

1. ไม่มีสินค้า
2. สินค้าการเกษตร ประมง เช่น
   - ข้าว
   - ข้าวโพด
   - ผัก
   - ผลไม้
   - ยางพารา
   - ของป่า
   - ไม้
   - ปลา
   - สัตว์ ฯลฯ
3. วัสดุและอุปกรณ์การก่อสร้าง เช่น
   - เหล็ก
   - หิน
   - ทราย
   - ปูนซีเมนต์ ฯลฯ
4. สินค้าอุตสาหกรรม และแปรรูป เช่น
   - น้ำมัน
   - ถ่านหิน
   - แร่
   - ปุ๋ย
   - อาหาร
   - น้ำตาล
   - เครื่องดื่ม
   - สิ่งประดิษฐ์จากโรงงาน
   - เครื่องหัตถกรรม
   - เครื่องใช้ในบ้าน ฯลฯ
5. อื่นๆ ระบุ

ประเภทรถ

1. รถยนต์นั่งไม่เกิน 7 คน
   รถกระบะส่วนบุคคล
2. รถยนต์นั่งเกิน 7 คน
   รถตู้ส่วนบุคคล
3. รถโดยสารขนาดเล็ก 4 ล้อ
   รถตู้โดยสาร
4. รถโดยสารขนาดกลาง 6 ล้อ
5. รถโดยสารขนาดใหญ่
6. รถบรรทุก 4 ล้อ
   รถกระบะบรรทุก
7. รถบรรทุก 6 ล้อ
8. รถบรรทุก 10 ล้อ
9. รถบรรทุกพ่วง
10. รถบรรทุกกึ่งพ่วง
11. รถจักรยาน ,รถจักรยานยนต์
    รถสามล้อเครื่อง

Figure 4.2.2-9 Survey of Origin – Destination of Travelers (O-D Survey)

The purpose of this survey is to understand the behavior of travel. The study area and the traffic volume within the study area. Traffic through the study area and traffic flow into or out of the study area for use as a basis for developing a travel demand model.

- **OD1 :** National Highway 4 (Mueang Chumphon - Kra Buri)
- **OD2** : National Highway 4 (Kra Buri-Mueang Ranong)
- **OD3** : National Highway 4006

From interview point of origin - destination, exit, study area on the survey point OD1 to OD3. Total number of samples is 3,070 samples. The survey results are as follows.

- **Vehicle type**

  The proportion of each vehicle surveyed was as shown in **Figure 4.2.2-10**. The most common types of vehicles were passenger pickup trucks and passenger cars of up to 7 persons, approximately 40%. And 37, respectively, followed by 4-wheel trucks and 7-passenger cars, 8% and 5%, respectively.

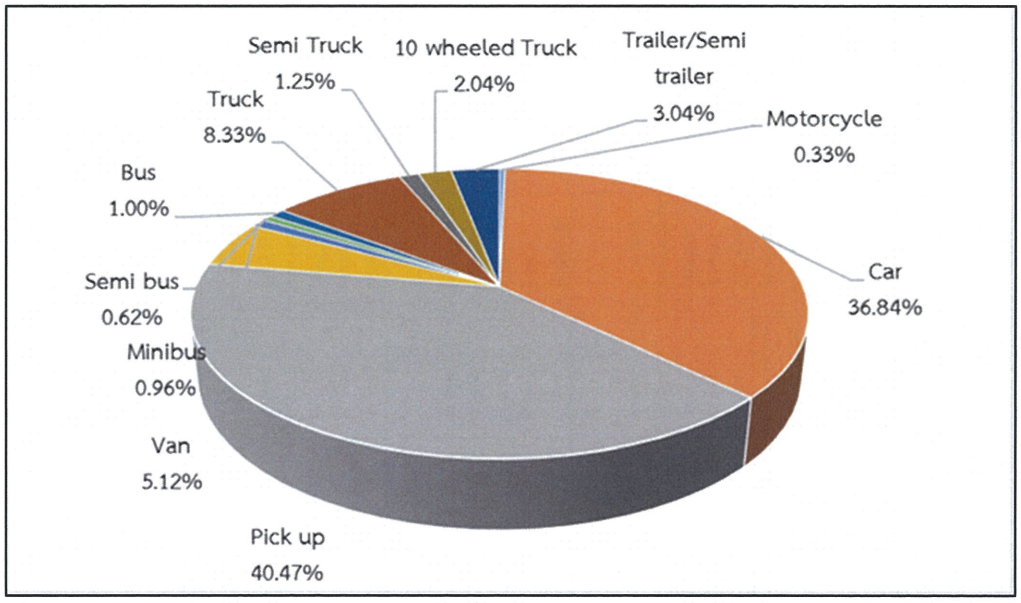


Figure 4.2.2-10 Proportion of Vehicles Survey

- **Point of origin - destination of travel**
  - **Personal Car**

    Most of the travelers travel by car to the provinces in the project area and neighboring provinces in the south. The province that is the most travel destination is Chumphon Province, 60.00%, followed by Ranong Province (16.83%) and Surat Thani Province 6.17%, as shown in **Figure 4.2.2-11**.

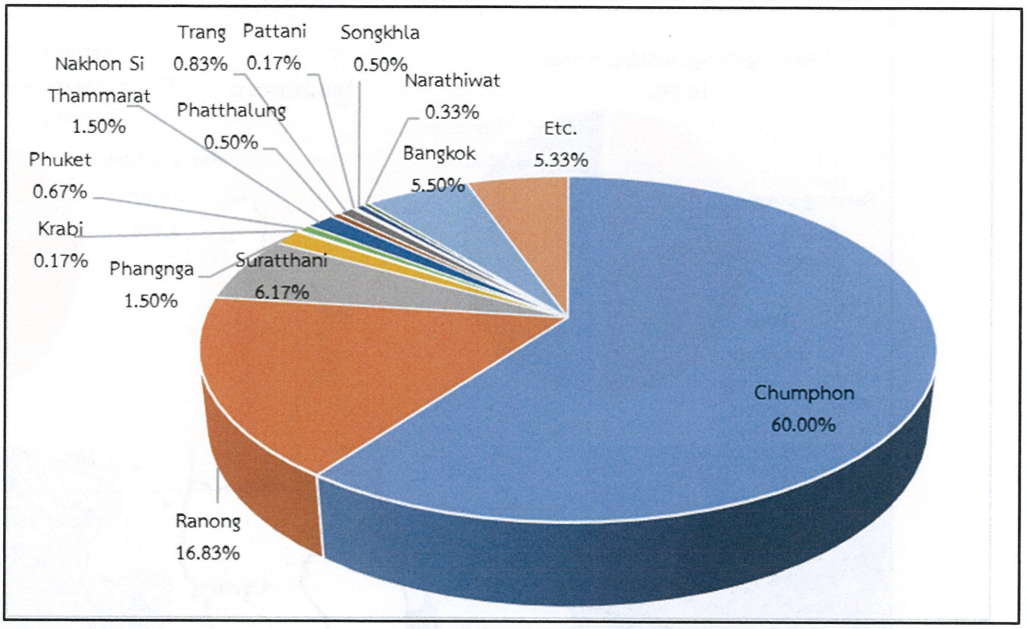


Figure 4.2.2-11 Origin point - destination, departure, exit, area by car

Considering the origin point - the destination is separated by the OD survey point as shown in **Figure 4.2.2-12**. The OD1 survey point on Highway 4, Chumphon - Most of the trip between Chumphon and Ranong. 72% followed by Ranong - Bangkok and the upper area. 15%. Travel on the survey point OD2 on Highway 4, A. Kraburi - Muang Ranong. Most of the trip in Ranong. 49%, followed by Ranong - Chumphon, 29% and Ranong - Bangkok and Upper Thailand. Traveling on Highway 4006 (OD3) is a journey between Chumphon - Ranong. 40% are traveling within Chumphon Province. It is 32% and it is traveling between Ranong and Lower South. Twenty-one percent

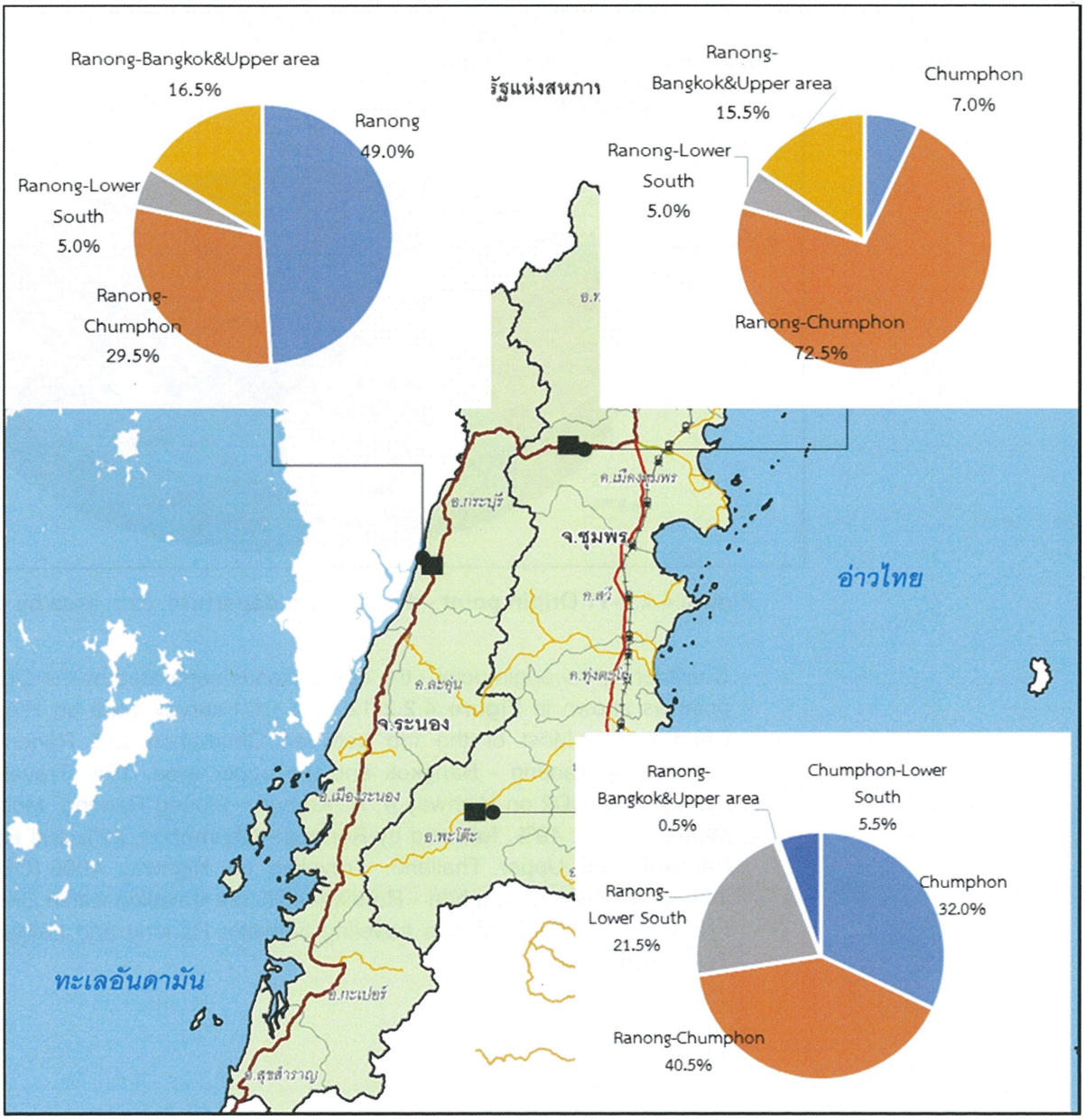


Figure 4.2.2-12 points of origin - Destination separated by survey point OD

- **Truck**

  Shipping destinations are trips to provinces in the project area and neighboring provinces in the south. The province that is the most travel destination is Chumphon province with 49.01%, followed by Ranong and Bangkok and its vicinity. Equivalent to 13.31%, as shown in **Figure 4.2.2-13**.

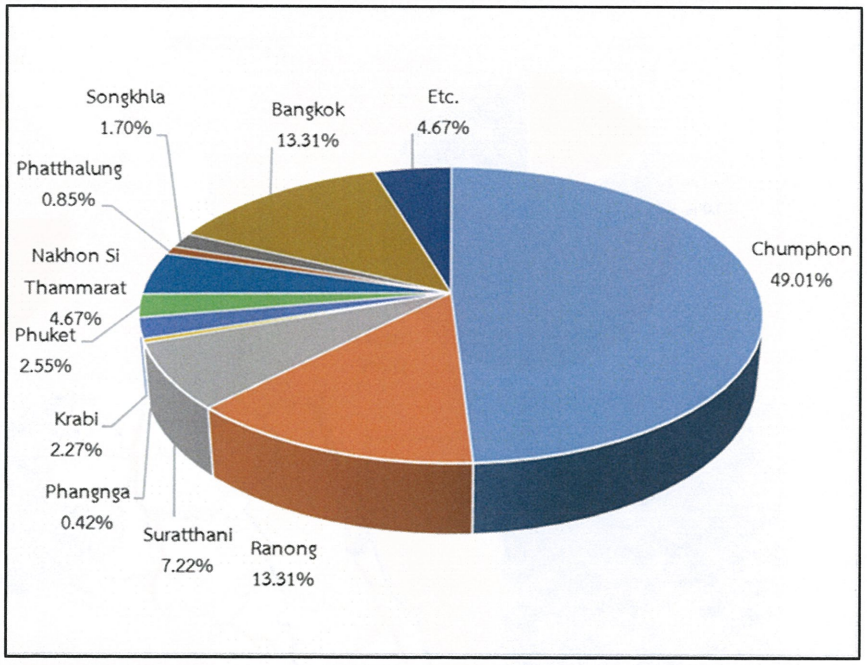


Figure 4.2.2-13 Point of origin - Destination of entry / exit of truck area

- **Purpose of travel**

  The survey was divided into two groups: general buses and trucks.

  - **General bus**

    The survey found that the purpose of travel to work was the highest proportion, about 56.64 percent, while personal travel accounted for 28.67 percent and traveling for travel accounted for 8.72 percent. The lowest percentage was 5.97%, as shown in **Table 4.2.2-3**.

Table 4.2.2-3 Purpose of travel classified by bus type

Vehicle type	Purpose of travel (%)				
	Work	Private	Tourism	Others	Total
Motorcycle	37.07	62.07	0.00	0.86	100
Personal Car	61.00	19.67	10.50	8.83	100
Pick-Up truck	62.03	27.83	6.67	3.48	100
Passenger car > 7 persons	57.50	25.00	15.00	2.50	100
Light Bus	58.97	30.77	5.13	5.13	100
Medium Bus	35.00	55.00	7.50	2.50	100
Heavy Bus	40.86	37.63	15.05	6.45	100
Average	**56.64**	**28.67**	**8.72**	**5.97**	**100**

Source: Survey Data

Considering the purpose of the OD survey, as shown in **Figure 4.2.2-14**, it was found that the survey sites on Highway 4 (OD1 and OD2) were mainly intended for work. 50-57 %, followed by Purpose to do personal business 17-27% and tourism accounted for 10-15 %. Travel on Highway 4006 (OD3) is a trip to work, accounting for 58%, private business accounted for 34%, and tourism accounted for 7%.

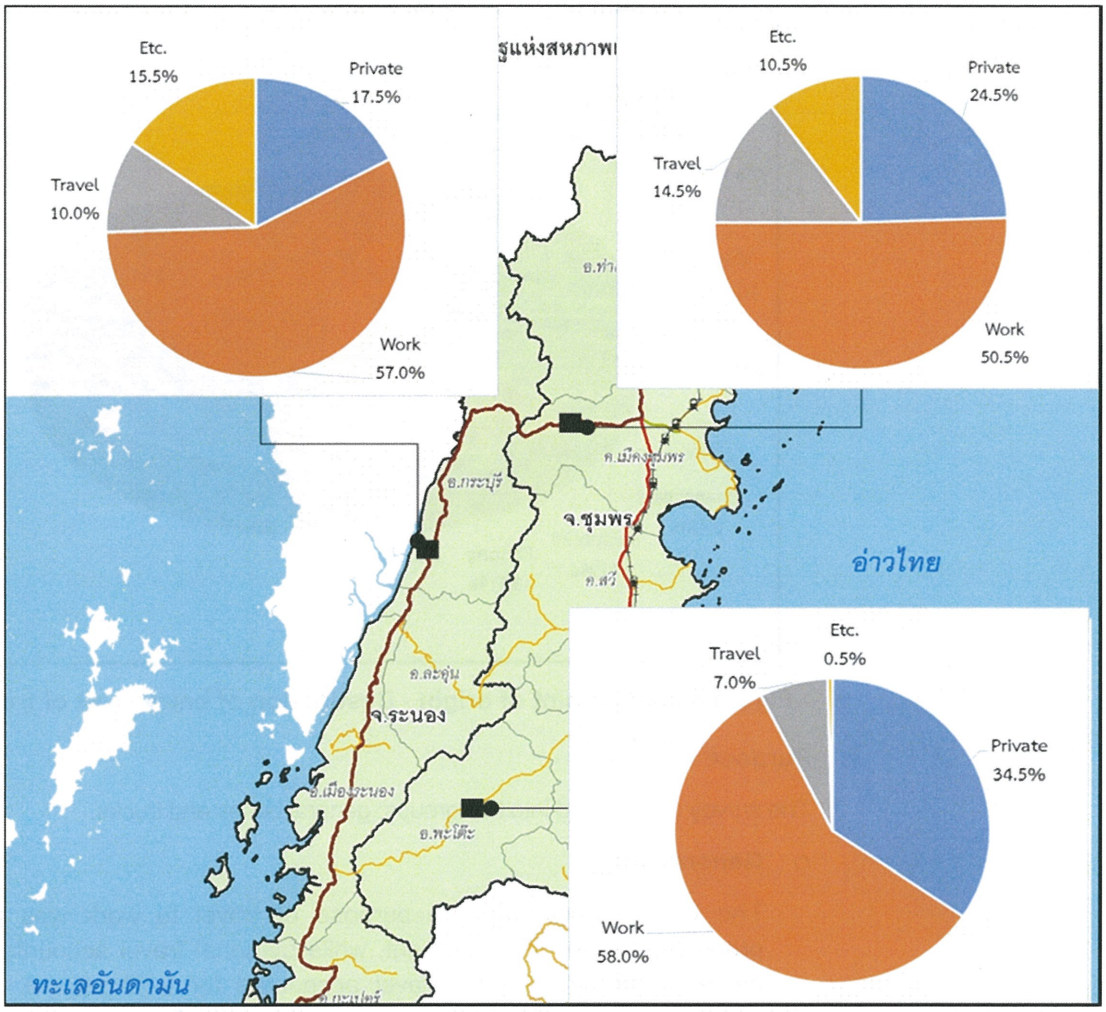


Figure 4.2.2-14 Purpose of the survey by OD survey point

- **Truck**

  The survey found that the purpose of travel to work is to have the greatest proportion. 97.80%, followed by private business trips. about 2.20%. The purpose of tourism and other. Not found in this survey. The details are shown in **Table 4.2.2-4**.

Table 4.2.2-4 Purpose of travel by truck type

Vehicle Type	Purpose of travel (%)				
	Work	Private	Tourism	Others	Total
Light Truck (4 Wheels)	98.20	1.80	0.00	0.00	100.00
Medium Truck (6 Wheels)	100.00	0.00	0.00	0.00	100.00
Heavy Truck (10 Wheels)	95.92	4.08	0.00	0.00	100.00
Full Trailer / Semi Trailer	97.22	2.78	0.00	0.00	100.00
Average	**97.80**	**2.20**	**0.00**	**0.00**	**100.00**

Source: Survey Data

- **Number of drivers and passengers**

  The survey found that no more than seven passenger cars and more than seven passenger cars had an average of 2.23 passengers and 5.21 passengers in the car, respectively, for the average number of riders and passengers for the bus. Small, medium and large were 5.87, 13.23 and 28.70 respectively, and for the average number of drivers and passengers for trucks were about 1.5-2.03. In **Table 4.2.2-5**

Table 4.2.2-5 Number of Riders and Passengers for Various Vehicles

Vehicle Type	Average number of people in the car
Motorcycle	1.73
Personal Car	2.23
Pick-Up Truck	1.97
Passenger Car > 7 Persons	5.21
Light Bus	5.87
Medium Bus	13.23
Heavy Bus	28.7
Light Truck (4 Wheels)	1.87
Medium Truck (6 Wheels)	2.03
Heavy Truck (10 Wheels)	1.53
Full Trailer / Semi Trailer	1.6
Average	**2.58**

Source: Survey Data

- **Product and load**

  The results of the survey on the type of goods transported in the study area show that the proportion of agricultural products is highest, accounting for 30.71%, followed by materials and construction materials. 29.59% and industrial products accounted for 27.34%, as shown in **Figure 4.2.2-15**.

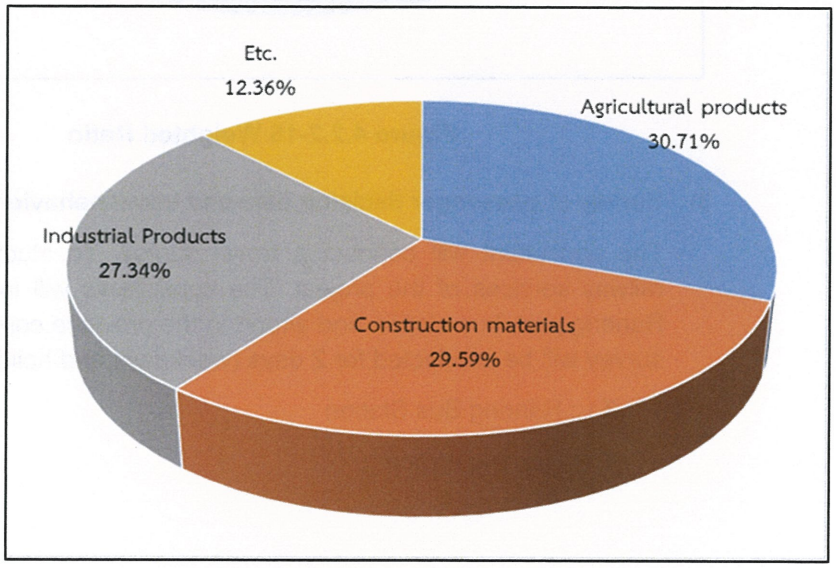


Figure 4.2.2-15 Proportion of Cargo Types

Considering the average overall weight, it was found that the proportion of fully loaded vehicles was the highest. The proportion was 59.27% of the total, followed by the empty car. The figure is 23.88%, while the rest is the proportion of cars with ¼ vehicles and ½ cars, respectively, as shown in **Table 4.2.2-6** and **Figure 4.2.2-16**.

Table 4.2.2-6 Truck Load Ratio of each type of truck

Vehicle Type	Weight ratio (percent)				
	Empty Car	Load 1/4 vehicles	Load 1/2 vehicles	Load 3/4 vehicles	Fully loaded vehicles
Light Truck (4 Wheels)	36.00	3.00	12.00	7.00	42.00
Medium Truck (6 Wheels)	3.13	3.13	6.25	6.25	81.25
Heavy Truck (10 Wheels)	14.00	2.00	4.00	8.00	72.00
Full Trailer / Semi Trailer	6.76	1.35	2.70	1.35	87.84
Average	23.88	2.53	8.43	5.90	59.27

Source: Survey Data

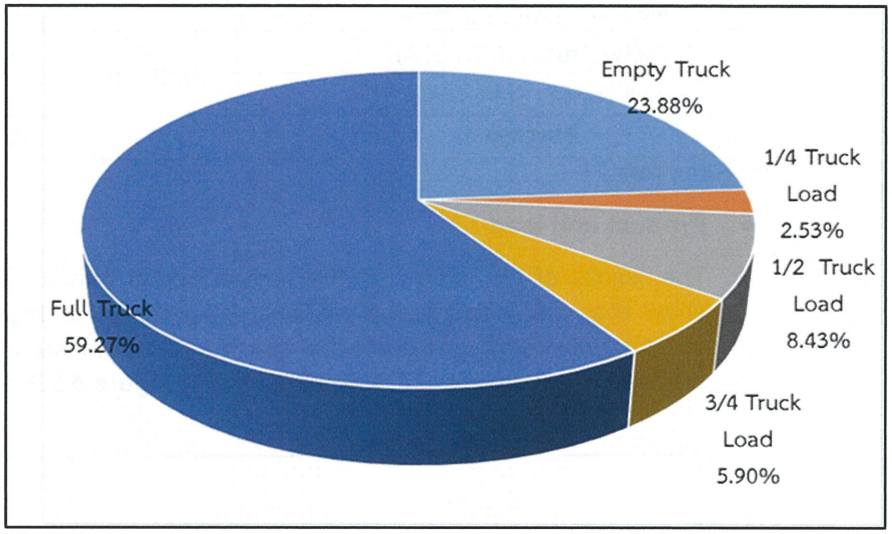


Figure 4.2.2-16 Weighted Ratio

3) Survey of passenger decision data and travel behavior

The consultant will conduct a travel survey. To study the trend of demand for railway services of the project. The consultants will interview the travelers at the Ranong port, bus station and airport in the province concerned with the project. The survey will be conducted for 2 days (weekdays and holidays).

- **T**1 : Ranong Bus Station
- **T**2 : Ranong Airport

From interviews with travelers at the bus stations and airports in Ranong province. Summarized as follows

- **Bus**

  The purpose of personal travel was the highest proportion of about 45.00%, while travel to work was 28.00% and travel to travel was 20.00%. The proportion of other purposes 7.00% Description as shown in **Figure 4.2.2-17**.

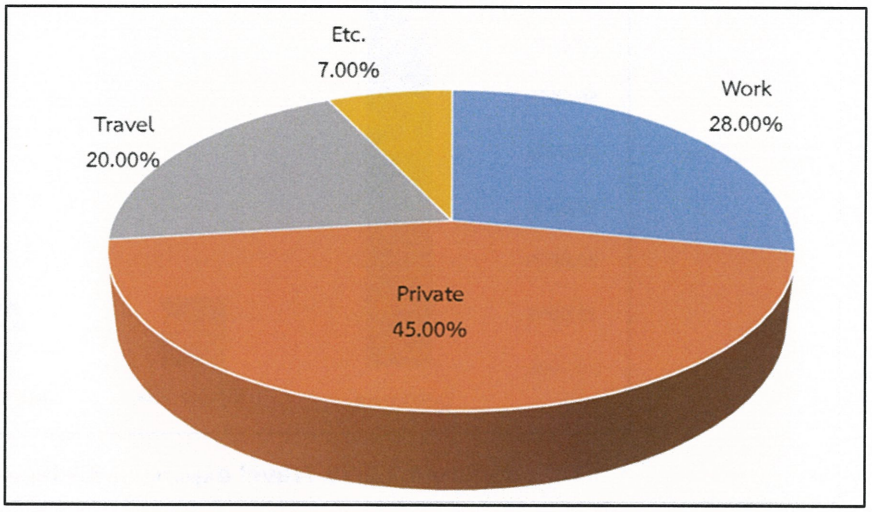


Figure 4.2.2-17 The purpose of the bus

Traveler's destination by bus, the province that is the most traveled destination is Chanthaburi province, accounting for 30.93%, followed by other areas (Prachuap Khiri Khan Phetchaburi and other provinces except in the south and Bangkok) accounted for 17.53 percent and Surat Thani. 13.40%, as shown in **Figure 4.2.2-18**.

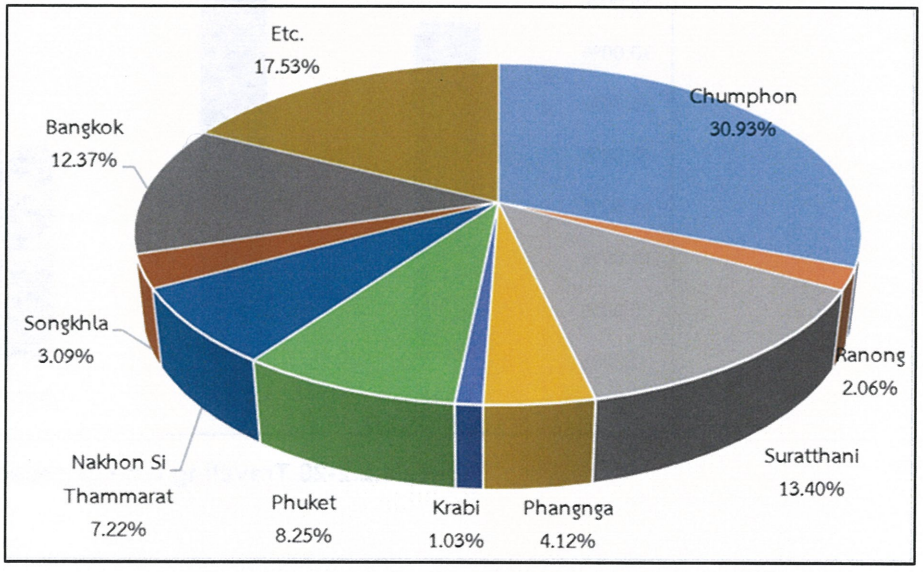


Figure 4.2.2-18 Destination of Bus Passenger

Survey Results of Bus Passenger Expenses to analyze the decision to choose travel patterns in various situations. The study found that most of the 73 percent had travel expenses ranging between 0-300 baht and between 301-500 baht and 501-800 baht. Baht is 13%, as shown in **Figure 4.2.2-19**.

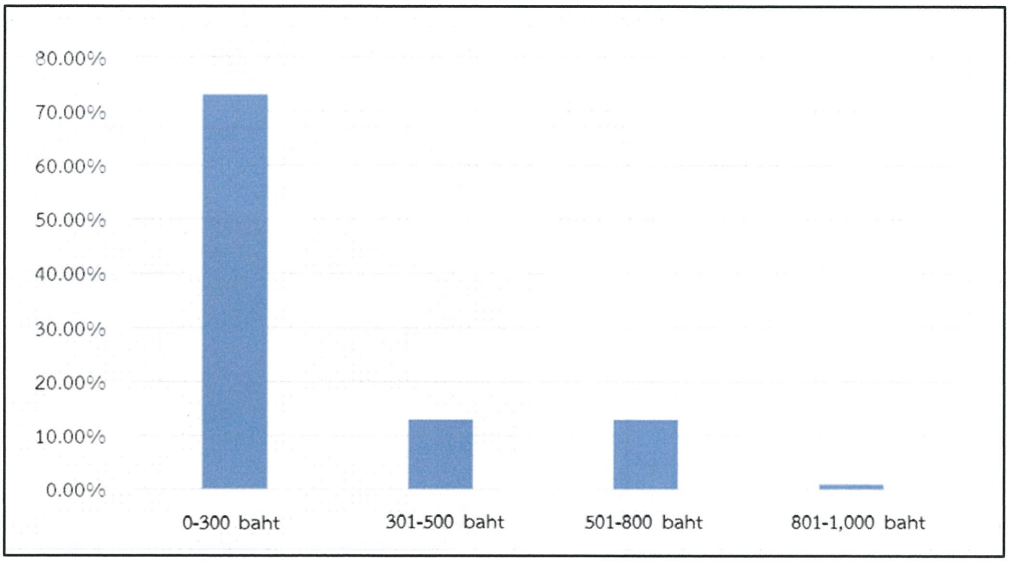


Figure 4.2.2-19 Travel expenses for those traveling by bus

In addition, when considering travel time, it was found that the majority of travel time was in the range of 3-5 hours or 42%, followed by 0-3 hours, 33% and 5-10 hours. Is 21% as shown in **Figure 4.2.2-20**.

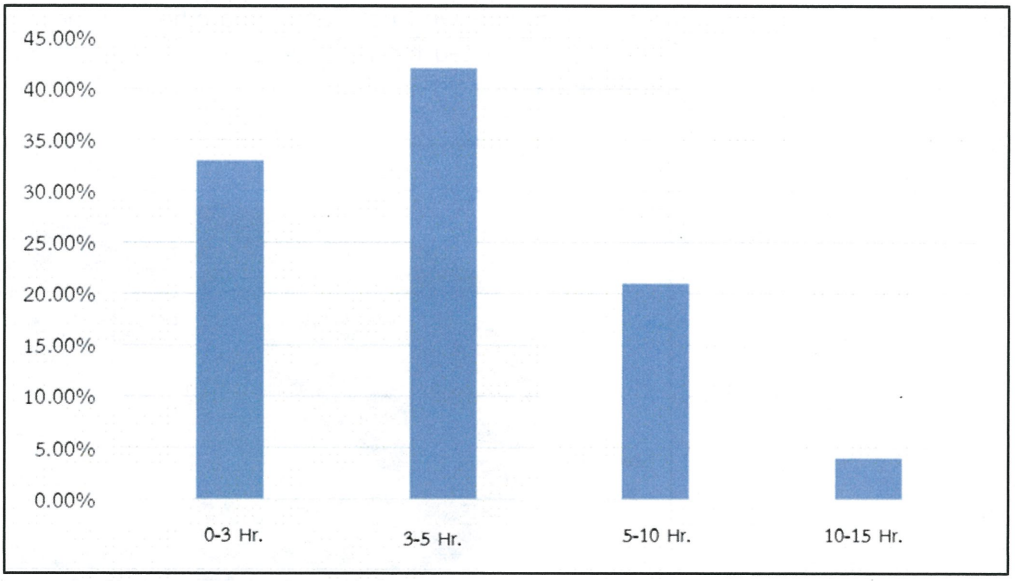


Figure 4.2.2-20 Traveling time of passengers by bus

- **Plane**

The purpose of travel to work was the highest proportion, about 34.48 percent, while travel for private business accounted for 27.59 percent and travel to travel accounted for 27.59 percent. 6.90% of the total, as shown in **Figure 4.2.2-21**.

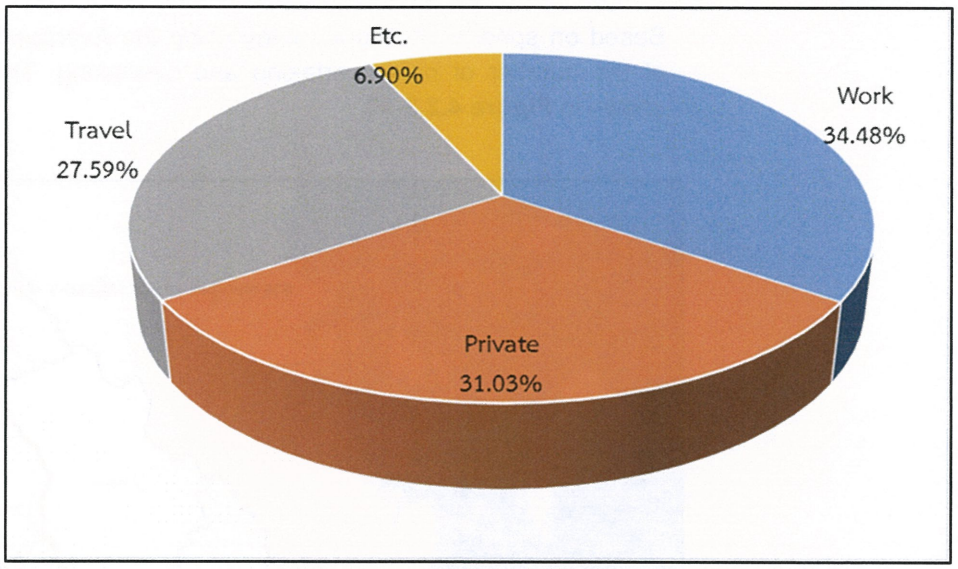


Figure 4.2.2-21 Objectives of Air Travel

Air travel destinations, the province is the most travel destination in Bangkok, accounting for 93.33%, followed by other provinces (6.50%), as shown in **Figure 4.2.2-22**

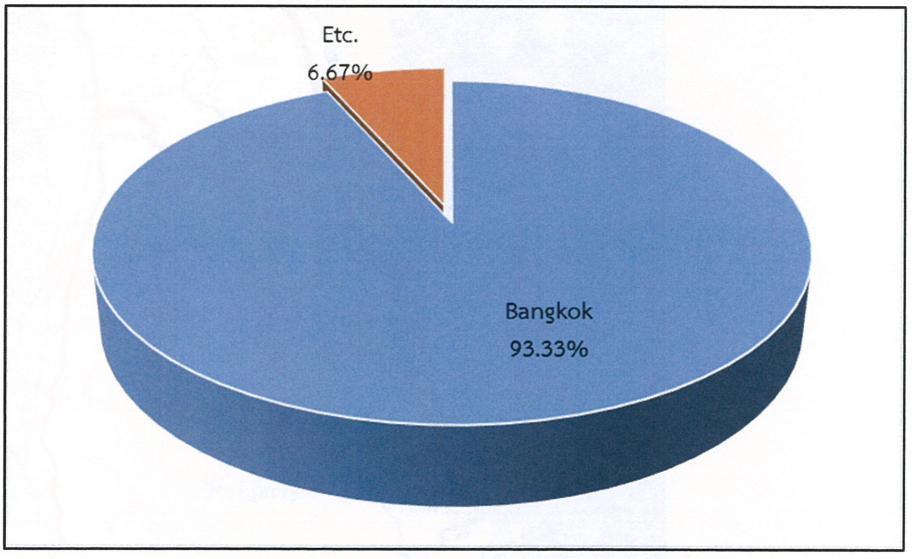


Figure 4.2.2-22 Destination of air travelers

The cost of travel by airplane is between 1,500-2,500 Baht and travel time is about 0-3 hours. The information will be used to analyze the choice of travel patterns. Method of Stated Preference

4) Travel Speed Survey

Travel time or the speed of vehicles on the road network. Information related to the use of the route used by road users. The consultant will conduct a survey of the travel time on the main highway in the area. The survey was conducted using personal cars running in designated routes. Then save the distance Time passes through the reference points.

Based on speed-of-network survey using the Average Car Technique, Regardless of the number of cars overtaking and overtaking. The results of the survey are shown in **Figure 4.2.2-23**.

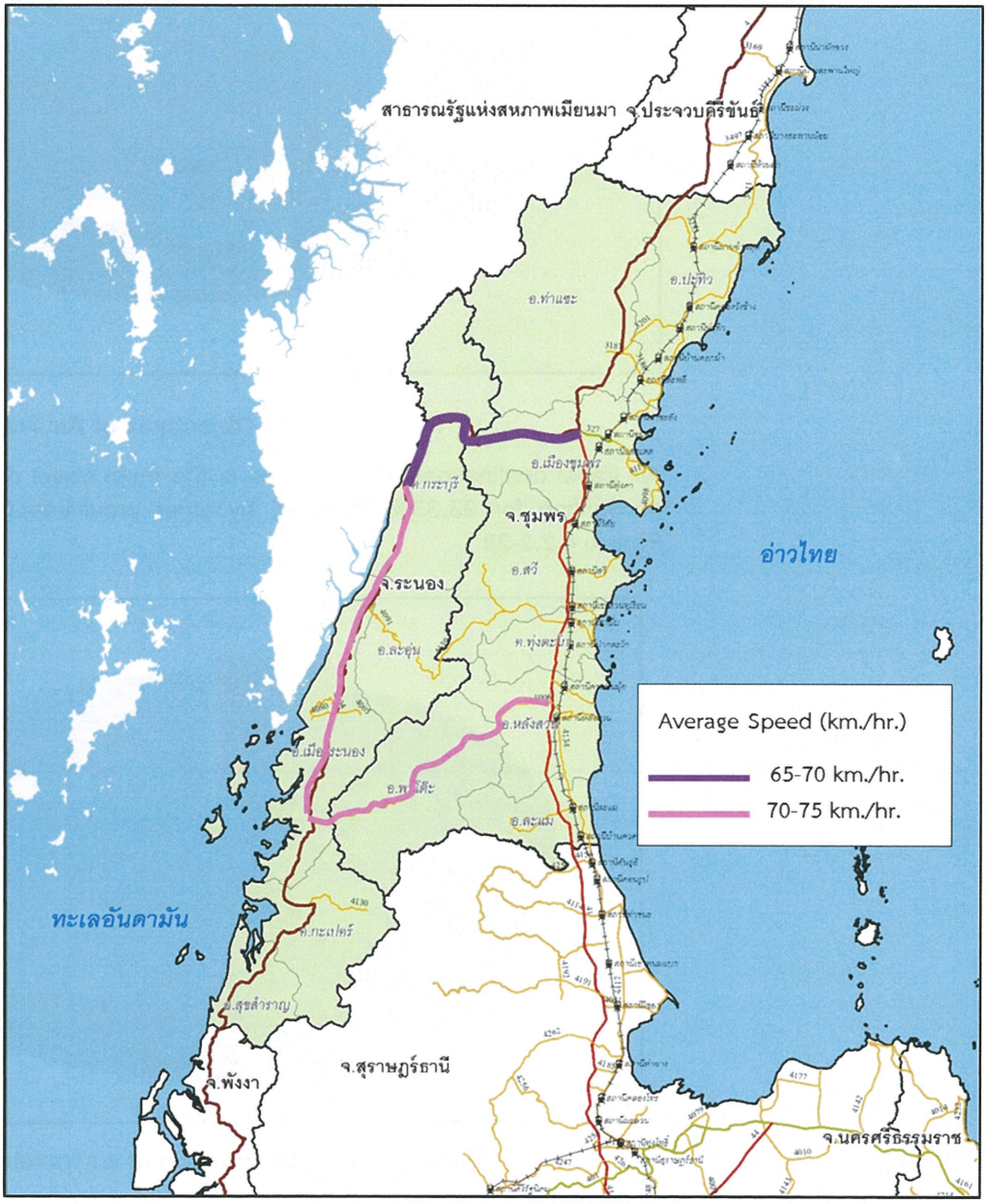


Figure 4.2.2-23 Average speed on main highways

4.2.2.2 Cargo Demand Survey

The consultants conducted a survey to collect cargo information through the ports in Ranong area. Currently, the number of port is 9, which is governed by one government port and 8 port of private sector, as shown in **Figure 4.2.2-24** by cargo shipped through the port. This area consists of cement products. Consumer goods, fishing equipment, other building materials Finished Fish Meal, Fertilizer and Off Shore Supply. The details of the port and cargo are as follows.



Figure 4.2.2-24 Port Location on the banks of the river Kra Buri, Ranong Province

1) Ranong Deep Sea Port

Ranong Port is a Jetty deep sea port with a pier structure extending from the coast. The 212-meter long bridge connects the two terminals, the first one is 26 meters wide and 134 meters long. It can accommodate up to 500 tons of cargo. 2 has a width of 30 meters and a length of 150 meters. It can accommodate up to 12,000 DWT ships at a time, as shown in **Figure 4.2.2-25**.

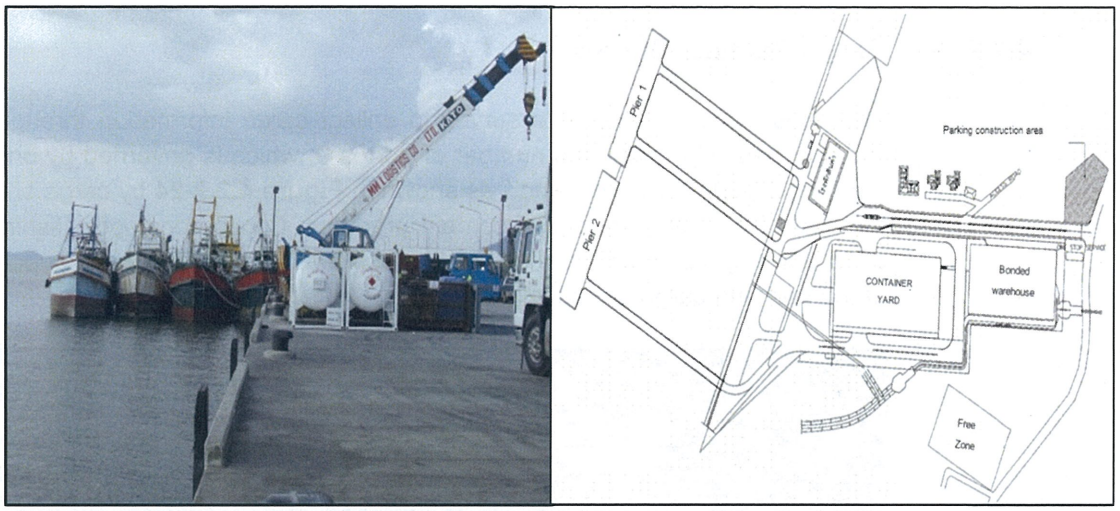


Figure 4.2.2-25 Description of berths and map of Ranong Port

Ranong Pier has the following facilities:

Shelter	1,500 sq.m.
General cargo area	7,200 square meters
Container space	11,000 square meters.
Outdoor warehouse	8,000 square meters.

Mobile Harbor Crane with a weight of not less than 63 metric tons at a radius of 20 meters, as shown in **Figure 4.2.2-26.**



Figure 4.2.2-26 Ranong Port Facilities

- Year 2008 - 2010 The GATI is shown in **Figure 4.2.2-27**, one of the leading companies in India. The business and logistics services have been integrated to the freight forwarding from Ranong. To the Chennai port India and Yangon Port, Myanmar, take 3-4 days and 1-2 days, respectively. Rubber gypsum board, which most products come from. Central Region And the upper South. Only one service can be used for one year. This is due to the high cost problem, such as the transportation of empty containers from foreign countries to Ranong Port. And the export of goods from the central and eastern parts of Ranong via Ranong Port also faced the problem of domestic transportation costs are relatively high. Along with the route behind the port of Ranong, he has a crooked nature. As a result, road costs are higher. In addition, the products from the South have not enough export products.



Figure 4.2.2-27 GATI Vessel

- In year 2011, SC Group has used the service of Sahaviriya Port to transport cement, gypsum board Container ship in the Gulf of Thailand. Come to the harbor, United Prachuap Khiri Khan Province to Yangon and lift the car up the truck. Transfer to Ranong Pier But there is a problem between the boat and the owner's agent. Cannot agree on the cost. Because of the high cost. No cargo from Ranong Pier on the boat. Including damage to the product. During the transfer, Ranong Pier was terminated.

- In 2015, the NCL line of N.C.L. International Logistics (Public) Co., Ltd., a fully integrated logistics company. It has been used to transport goods through Ranong Port to Ahlone International Port Terminal 1, Yangon. Myanmar The regular service is scheduled to be on a regular basis (a Munich Trader vessel is a chartered vessel from Singapore. It has the capacity to carry containers up to 12,000 DWT, 147 meters long, 7.5 meters deep). It is expected that the volume of containers passing through Ranong Port is not less than 6,000 TEU per year by loading cement products. Construction Materials, Ceramics and Consumer Goods By product Central Region through ICD Lat Krabang to Ranong Port. From Ranong Pier takes about 3 days after the service is experiencing problems. It was originally planned to have a service line once a week, once a month. In the end, only one service can be used. The problem cannot bear the high cost, such as transportation costs to transport empty cabinets from abroad to Ranong Port. And the export of goods from the central and eastern parts of Ranong via Ranong Port is also experiencing high domestic transportation costs. Along with the route behind the port of Ranong, he has a crooked nature.

As a result, road costs are higher. In addition, the products from the South have not enough export products.

- **S.A.K** used to serve Ranong Port It's a blanket. Arrive at Ranong Pier and head to drag to carry. Rubber And rubber wood plant in Ranong and Surat Thani. The towing vehicle was towed to the boat at S.A.K Pier in Krabi, using the port of Ranong for about 3 months, with a total of 224 TEUs.

2) Hem Rueng Ngern Berth

The location of Hem Rueng Ngern Berth is located on the banks of the Kra Buri River, Pak Nam Sub-district, Mueang District, Ranong Province. The pier is a 28-meter-wide reinforced concrete structure, 76 meters long, 6 meters deep, with a capacity of over 500 tons. The cargo through the pier is a cement product. The average volume of 114,000 tons per year is also transported to Myanmar, the city of Dawei, 90 percent of the source of cement from the cement plant in Thung Song and 10% of cement is from Saraburi. All cement products are loaded with 10-wheel trucks, 16-wheel and 18-wheel trucks. The size of the dock is 1,000-3,500 tons. For off Shore Supply products, which used to serve the port, but now there are no hairs, including palm oil. Tapioca and motorcycle Transport to the second island and the island of Madagascar, but no cargo of this type. The port is focused on providing cement transportation services. The port cannot accept the capacity of other products. In the future, the port plans to expand its capacity by expanding the port area by 80 meters, as shown in **Figure 4.2.2-28**.



Figure 4.2.2-28 Hem Rueng Ngern Berth

3) Manit Berth

The location of Manit Pier is located on the banks of the river, Pak Nam Sub-district, Muang District, Ranong. U-shaped reinforced concrete, 60 meters long, 60 meters long, 6 meters deep, 500 tons of gypsum is currently used as a cargo terminal. The export goods are fishing gear, nets, steel, shipbuilding, rope, oil for use in fishing boats, rubber pipes, about 20,000 tons / year, consumer goods, milk, snacks and drinks, about 12,000 tons / year. 3,000 tons / year and other products of cement and construction materials about 2,000 tons / year. Transport to Myanmar, the city

of Myeik Dawei and Yangon. To use the sling to lift the hair. If a boxed product is used to lift the hair down. The size of the ship is 500-1,000 tons. But now there is no hair. Imported from Myanmar. Palm oil is packed in gallons of rubber and minerals to transport to Malaysia, as shown in **Figure 4.2.2-29**.



Figure 4.2.2-29 Manit Berth

4) Yong Chao Berth 1

Located near Ranong Pier. Harbor Style Reinforced concrete, L-shaped, 40-meter wide, 60-meter long, 6.5-meter deep, 500-ton gulf. Nowadays, most of the Offshore Supply shipments by some offshore products are containerized. For special care products and some products are loaded by the basket. Use a sling to lift it up and down. The average volume of cargo through Yong Chao port is 10,078 tons / year, as shown in **Figure 4.2.2-30**.



Figure 4.2.2-30 Yong Chao Berth 1

5) Yong Chao Berth 2

Port style A 12-meter-wide reinforced concrete floor, 45-meter long, 6-meter deep, is less than 500 tons of gypsum. The cargo through the port is a consumer product of milk, lactose, canned coffee to Myanmar the average cargo volume is 12,182 tonnes / yr. The minimum size is 50 tons and the maximum size is 1,200 tons. The port is owned by the buyer, consumer products from the central factory. To keep at the warehouse of the port itself. And will ship goods ordered by the customer side of Myanmar. For lifting, people use lifting and conveyor belts, as shown in **Figure 4.2.2-31**.



Figure 4.2.2-31 Yong Chao Berth 2

6) Kijpaisan Berth

Harbor Style It is 112 meter wide with reinforced concrete pier, 32 meters wide, 108 meters long and 7.5 meters deep. It is suitable for ships of more than 500 tons. The average cement volume is 98,000 tons / year and the other type of steel pipe is 8,000 tons / year for transporting to Myanmar in the cities of Myeik and Dawei, 50% of cement is transported. The source of cement comes from the cement plant in Thung Song District (Thai cement) and 50% comes from the cement plant in Saraburi. (Siam City Cement). The origin of the plant in the central region. It is loaded with 10-wheel trucks, 16-wheel and 18-wheel trucks. Imported fish meal is about 8,000 tons / year from the city of Myeik. Then trucked to a truck. Mahachai Factory approximately 1,000-2,000 tons of glazed boats are shown in **Figure 4.2.2-32**.



Figure 4.2.2-32 Kijpaisan Berth

7) Go Guad Berth

Harbor Style 30-meter-wide reinforced concrete floor, 90-meter long, 6-m deep, supports over 500 tons of cargo. The export volume of cement is 55,000 tons / year, transported to Myanmar by the cement mills. The cement is transported from the cement factory, Thung Song (Thai cement). -2,000 tons of gaseous fuel. (Diesel and gasoline) is 80,000 tons / year for transporting to Myanmar. Kawthoung, Myeik, Dawei are originated from Chumphon, Phetchaburi and Chonburi is a tanker of 200-300 tons. But now there is no hair. Export goods for construction materials. Imported goods are processed from various kinds of wood. From Myanmar, as shown in **Figure 4.2.2-33**.



Figure 4.2.2-33 Go Guad Berth

8) Saeng Thong Berth

Location of the wharf. Saeng Thong Co., Ltd. is located at 90/54 Moo 1, Tambon Pak Nam, Amphur Muang, Ranong. U-shape reinforced concrete floor width of 70 meters, 150 meters long. Currently, the port is not available for shipping. But the port has divided the area. PTT rents the Free Trade Zone and is Off Shore Offshore as shown in **Figure 4.2.2-34**.



Figure 4.2.2-34 Saeng Thong Berth

9) Leng Seng Chan Berth

Harbor Style It is 12 meters wide, 140 meters long and 6.5 meters deep, supporting ships of less than 500 tons of gros. Most of them are cement products. The volume of transportation is about 80,000 tons per year, transported to Myanmar. The city of Myeik and Dawei as shown in **Figure 4.2.2-35**.



Figure 4.2.2-35 Leng Seng Chan Berth

Details of private jetty in Ranong area. This is summarized in **Table 4.2.2-7**.

Table 4.2.2-7 Private port on the banks of the river Kra Buri Ranong

Berth	Port Size (Ton gross)	Goods (Tons / year)	Origin	Destination
1.Hem Rueng Ngern	>500	**Total Outgoing Goods 114,000 tons / year**		
		Mortar (114,000 tons / month)	Thung Song District, Nakhon Si Thammarat Province	Dewei, Myeik
		* Nowadays, the space for warehousing is rented.Off shore supply		
Total volume of goods through the port. 114,000 tons / year				
2. Manit	500	**Total Outgoing Goods 37,000 tons / year**		
		Fishing equipment (20,000 tons / year)	Central Region	Myeik
		consumer products (12,000 tons / year)	Ranong Province	Myeik Dawei
		Cement (1,000 tons / year)	Thung Song District, Nakhon Si Thammarat Province	Myeik Dawei
		Tile (1,000 tons / year)	Ranong Province	Myeik
		Fertilizer (3,000 tons / year)	Ayutthaya	Myeik, Yangon
		Total Incoming Goods 1,500 tons / year		
		Fish meal (1,500 tons / year)	Myeik	Mahachai
Total volume of goods through the port. 38,500 tons / year				
3.Yong Chao 1	500	Off shore supply	Off shore supply	
Total volume of goods through the port. 10,078 tons / year				
4.Yong Chao 2	<500	**Total Outgoing Goods 12,182 tons / year**		
		Consumer goods (12,182 tons / year)	Central Region	Myeik Kawthoung Dawei
Total volume of goods through the port. 12,182 tons / year				
5.Kijpaisan	>500	**Total Outgoing Goods 106,000 tons / year**		
		Mortar (98,000 tons / year)	Thung Song, Nakhon Si Thammarat and Saraburi	Myeik Dawei
		Construction materials (8,000 tons / year)	Central Region	Myeik Dawei
		Total Incoming Goods 8,000 tons / year		
		Fish meal (8,000 tons / year)	Myeik	Mahachai
Total volume of goods through the port. 114,000 tons / year				
6. Go Guad	>500	**Total Outgoing Goods 135,000 tons / year**		
		Mortar (55,000 tons / year)	Thung Song District, Nakhon Si Thammarat Province	Myeik Dawei Mawlamyine
		Fuel (80,000 tons / year)	Chumphon Petchburi Chonburi	Kawthoung Myeik Dawei
Total volume of goods through the port. 135,000 tons / year				
7.Saeng Thong	500	* Currently, the area is used as an off shore supply storage facility. PTT rents Free Trade		-
-				
8.Leng Seng Chan	<500	**Total Outgoing Goods 80,000 tons / year**		
		Mortar (80,000 tons / year)	-	Myeik Dawei
Total volume of goods through the port. 80,000 tons / year				

Source: Compiled by consultants.

4.3 Analysis and Forecast of Passenger Volume

4.3.1 Guidelines and Procedures

1) Used Tools

The consultants will use the National Model (NAM) model of the Office of Transport and Traffic Policy and Planning (OTP) to improve and apply. The model is developed on the Cube application, which is widely used in modeling traffic and transportation projects of various agencies in Thailand, such as OTP Expressway Authority of Thailand (ETA). The model of transportation and traffic is in the form of Four-Step Model, which has the concept as shown in **Figure 4.3.1-1** and Structure Modeling shown in **Figure 4.3.1-2**.

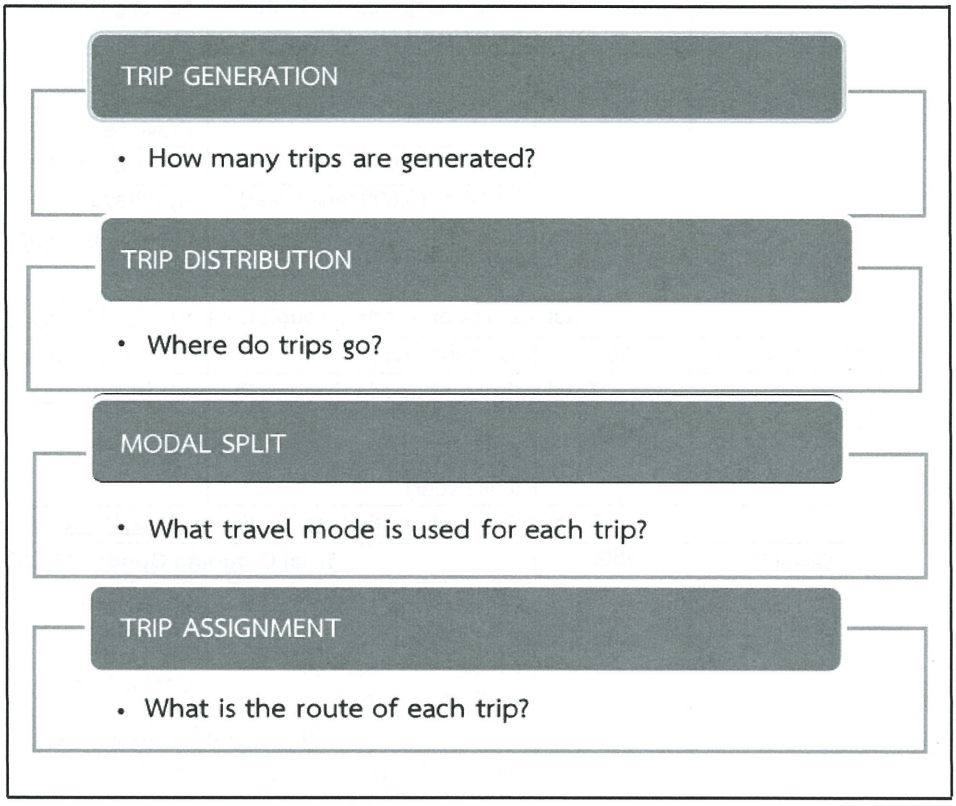


Figure 4.3.1-1 Four-Step Model

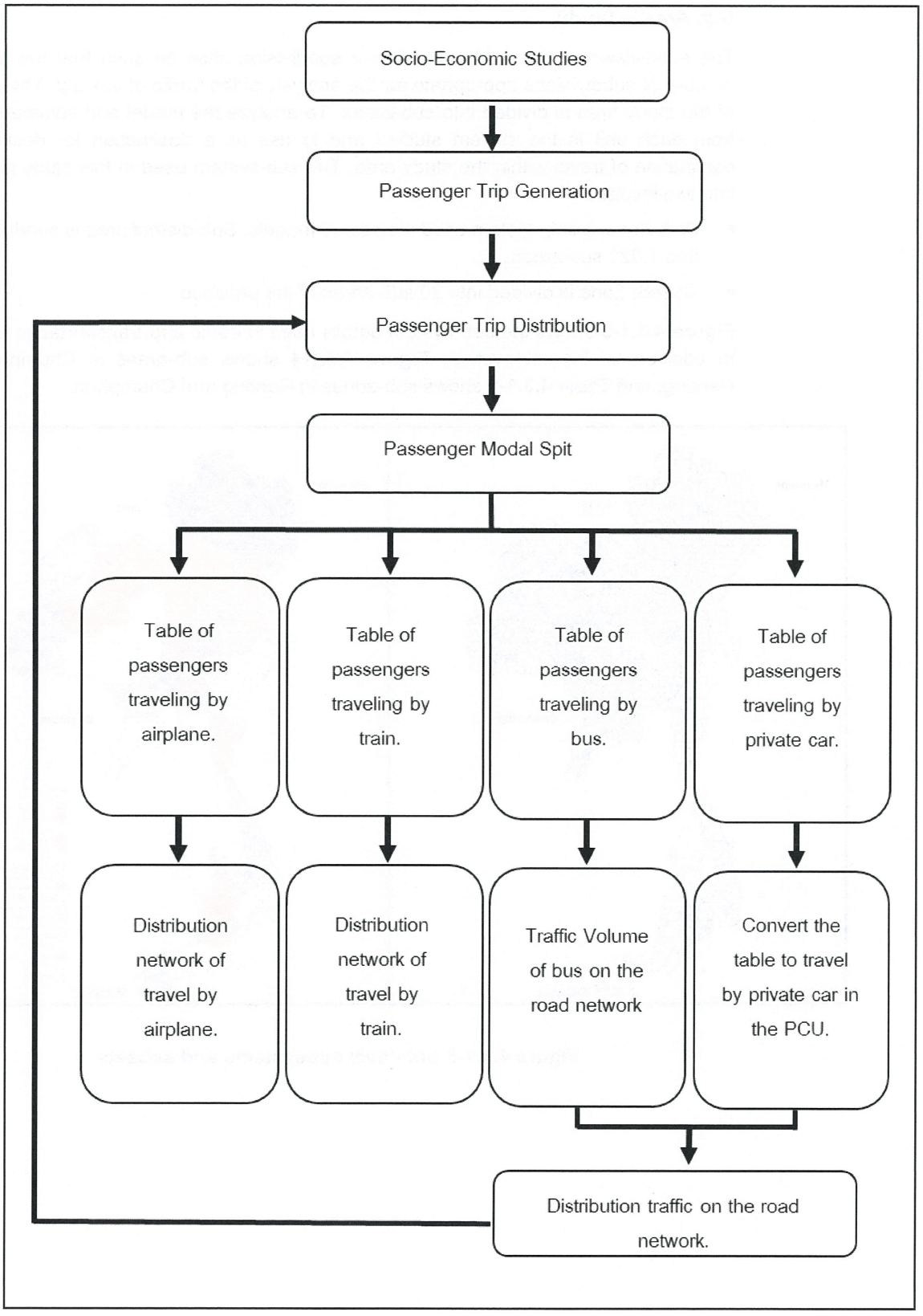


Figure 4.3.1-2 Transport and passenger traffic model structure

Sub Area in Study

The subdivision of the study area into a subdivision shall be such that the size and number of subdivisions appropriate for the analysis of the traffic of the city. The purpose of the study area is divided into sub-areas. To analyze the model and volume of travel from each unit in the system studied and to use as a destination for destination - destination of travel within the study area. The sub-system used in this study is divided into two levels.

- Fine Zone, a sub-system used in national models. Sub-district area is subdivided into 1,021 sub-areas.
- Coarse Zone is divided into 20 sub-areas of the province.

Figure 4.3.1-3 shows the sub-system details used in traffic and transportation analysis. In addition to the sub-system. **Figure 4.3.1-4** shows sub-areas in Chumphon and Ranong, and **Table 4.3.1-1** shows sub-zones in Ranong and Chumphon.

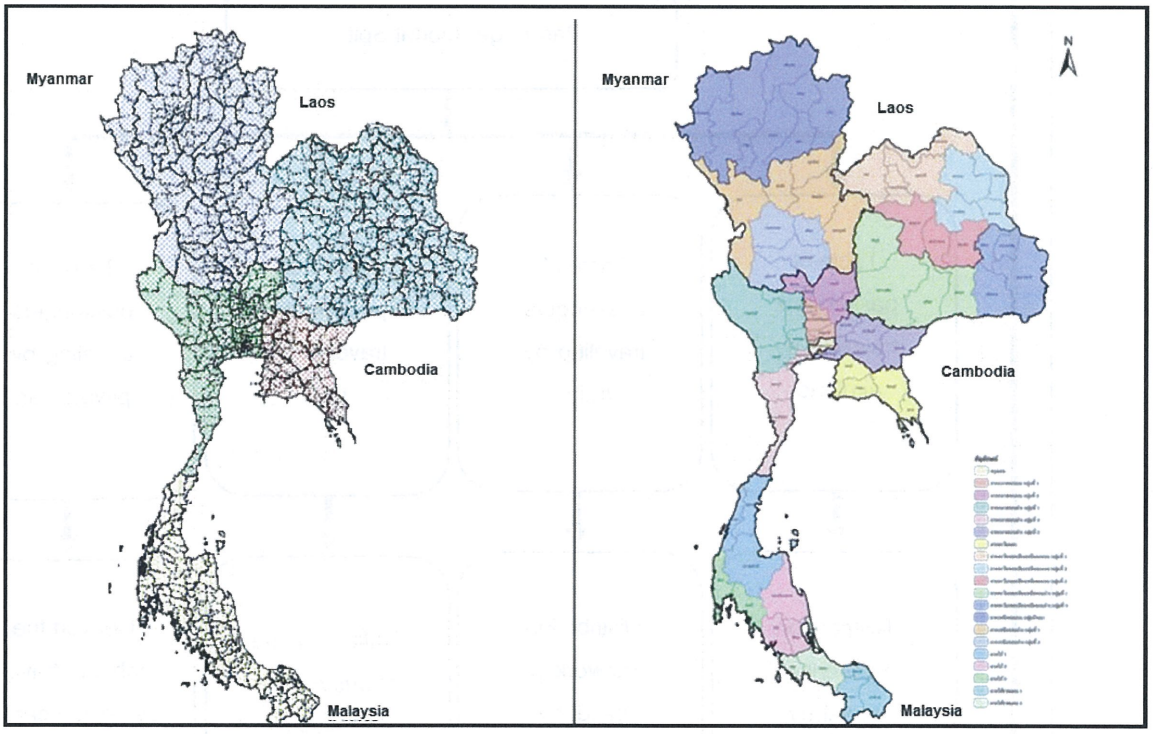


Figure 4.3.1-3 Sub-level subsystems and subsets



Figure 4.3.1-4 Sub-system at the sub-district level

Table 4.3.1-1. Sub-area details in Ranong and Chumphon

No.	Sub-district	District	Province
1	Tha Taphao	Mueang Chumphon	Chumphon
2	Pak Nam		
3	Tha Yang		
4	Bang Mak		
5	Na Thung		
6	Na Cha-ang		
7	Tak Daet		
8	Bang Luek		
9	Hat Phan Krai		
10	Wang Phai		
11	Wang Mai		
12	Ban Na		
13	Khun Krathing		
14	Thung Kha		
15	Wisai Nuea		
16	Hat Sai Ri		
17	Tham Sing		
18	Tha Sae	Tha Sae	
19	Khuring		
20	Salui		
21	Na Kratam		
22	Rap Ro		
23	Tha Kham		
24	Hong Charoen		
25	Hin Kaeo		
26	Sap Anan		
27	Song Phi Nong		
28	Lang Suan	Lang Suan	
29	Khan Ngoen		
30	Tha Maphla		
31	Na Kha		
32	Na Phaya		
33	Ban Khuan		
34	Bang Maphrao		
35	Bang Nam Chuet		
36	Pak Nam		
37	Pho Daeng	Lang Suan	Chumphon
38	Laem Sai		
39	Wang Tako		
40	Hat Yai		
41	Na Pho	Sawi	
42	Sawi		
43	Thung Raya		
44	Tha Hin		
45	Pak Phraek		
46	Dan Sawi		
47	Khron		
48	Wisai Tai		
49	Na Sak		
50	Khao Thalu		
51	Khao Khai		
52	Bang Son	Pathio	
53	Thale Sap		
54	Saphli		
55	Chum Kho		
56	Don Yang		
57	Pak Khlong		
58	Khao Chai Rat		
59	Lamae	Lamae	
60	Thung Luang		
61	Suan Taeng		
62	Thung Kha Wat		
63	Pak Tako	Thung Tako	
64	Thung Takhrai		
65	Tako		
66	Chong Mai Kaeo		
67	Phato	Phato	
68	Pak Song		
69	Pang Wan		
70	Phra Rak		
71	Khao Niwet	Mueang Ranong	Ranong
72	Ratchakrut		
73	Ngao		
74	Bang Rin		
75	Pak Nam		
76	Bang Non		
77	Hat Som Paen		
78	Sai Daeng		
79	Ko Phayam		
80	Nam Chuet	Kra Buri	
81	Nam Chuet Noi		
82	Mamu		
83	Pak Chan		
84	Lamliang		
85	Choporo		
86	Bang Yai		
87	Muang Kluang	Kapoe	
88	Kapoe		
89	Chiao Liang		
90	Ban Na		
91	Bang Hin		
92	La-un Tai	La-un	
93	La-un Nuea		
94	Bang Phra Tai		
95	Bang Phra Nuea		
96	Bang Kaeo		
97	Nai Wong Nuea		
98	Nai Wong Tai		
99	Nakha	Suk Samran	
100	Kamphuan		

2) Transport system model

Transportation network model will be developed from Geographic Information System and maps are widely available, along with information collected and collected from various agencies associated. The road network data that will be used in the traffic will be stored as a database on the computer. The "Node" and "Link" systems are considered by the Node to be the point of origin or destination of the trip, and Link is the path from one node to the other. The link details each of the networks. And the public transport network, these links will be used to choose the form and route to travel there. There is also a "centroid" of each subspace. It is used as the origin and destination of travel between the sub-areas. Details of the transportation network in the model include.

- Road network Information on the development of the network model includes the distance, capacity, road speed, type of road, etc.
- Public transport network Routes, water and coastal ships The information contained in the network model includes Route / Line, Mode, Company, Fare Table Location Station Capacity.

The details of the current transportation network will include transport, road, rail, air, water and coastal transport. Available now the transportation links, such as transportation stations, ports, airports, railway stations, etc., are shown in **Figure 4.3.1-5**. As shown in **Figure 4.3.1-6**.

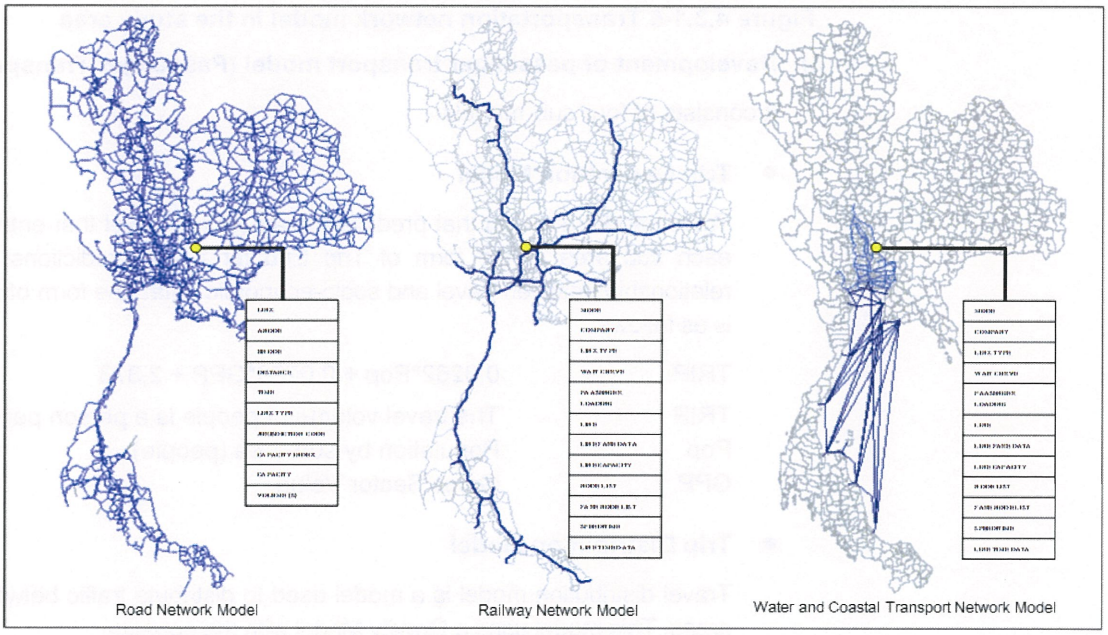


Figure 4.3.1-5 Various transport network models

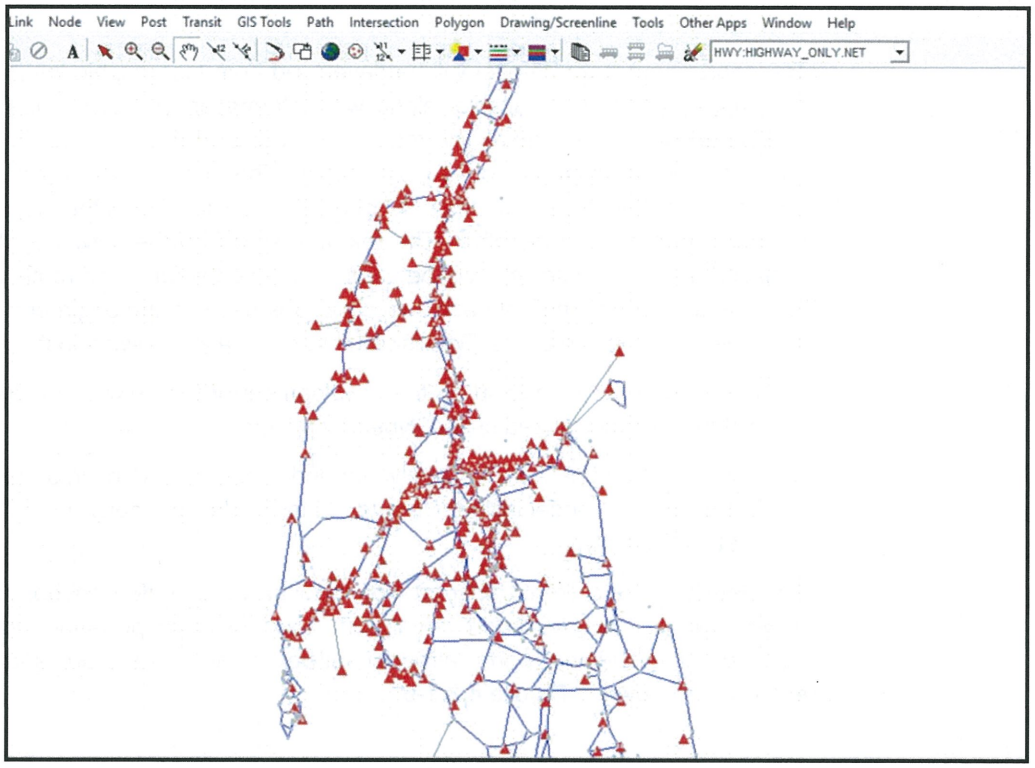


Figure 4.3.1-6 Transportation network model in the study area

3) Development of passenger transport model (Passenger Transportation)

It consists of four sub-models:

- **Trip Generation Model**

  Travel model a model that predicts the amount of travel that enters and exits each sub area in the form of Trip End for future predictions. There is a relationship between travel and socio-economic data. The form of the equation is as follows.

TRIP	0.0262*Pop + 0.0763*GPP + 2,373
TRIP	The travel volume of people is a person per day.
Pop	Population by sub-area (people)
GPP	Gross Sector Value

- **Trip Distribution Model**

  Travel distribution model is a model used to distribute traffic between different areas. This model uses a Gravity Model with the equation

$$T_{ij} = a_i * b_j * P_i * A * F(C_{ij}) * K_{ij}$$

By T_{ij}	Travel volume from sub area i go to j area
Pi	The volume of travel that takes place at sub-area i.
Aj	Travel volume to area j
aibj	Multiplier
F(Cij)	Function of travel expenses from sub areas i go to j area
Kij	Modifier of travel volume from sub area i go to j area

The function F (Cij) has the following form.

$F(C_{ij})$ = $C_{ij}^{1.556}\exp(-0.000635C_{ij})$

By C_{ij} Generalized cost of travel from subspace i to subspace j

The travel demand between the provinces and Trip Length distribution is shown in **Figure 4.3.1-7**.

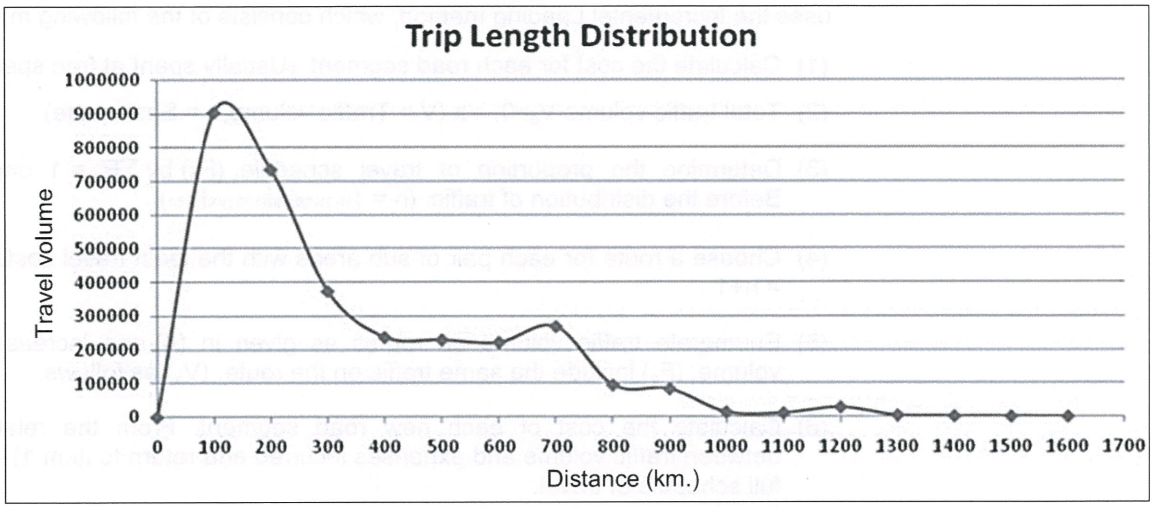


Figure 4.3.1-7 Trip Length distribution

Model of travel options a model used to describe the choice of travel patterns using utility theories. Travel is based on the behavior of each traveler. Travelers have many choices about how to travel and how and by what type of transportation. However, travelers will try to choose the option that provides the utmost utility or utility. This may be in the form of expenses or travel time.

Parameters of the Modal Split Model Ai Bi and Ci of the Utility Function of the equation are as follows. $U_i = (A_i + (B_i * GC_i))_k$

By Ui = Utility Function of Travel Form i
Ai = Specific Mode Constant) of Travel Form i
Bi = Coefficient of Variable Generalize Cost of Form i
k = Mode Province Specific
GCi = Generalized Cost of Travel by Form i

By GCi = Travel timei + *(Travel Costi) / (VOTi)
Travel Timei = Travel time (min) of Travel by Form i
Travel Costi = Travel Expenses (Baht) of Travel by Form i
VOTi = Time of Travel (Baht / hour) of Travel by Form i

Table 4.3.1-2 The coefficient of utility equations derived from the behavioral analysis of passenger travel patterns

Travel form	Time Value (Baht / hour)	Coefficient of variation	
		A	B
Passenger car	60	0	-0.0035
bus	36	-0.10	-0.0035
Train	27	-1.50	-0.0035
a plane	150	-2.00	-0.0035

- **Trip Assignment Model**

The results of the travel options will be in the form of travel schedules of the main types of travel. Daily travels will be enumerated on the public transport network and the public transport network. The volume of bus is calculated from the public transport network. The bus volume will be preloaded onto the network before the travel classification for other types of vehicles. The travel distribution uses the Incremental Loading method, which consists of the following methods.

(1) Calculate the cost for each road segment. (Usually spent at free speed)

(2) Total traffic volume V_a=0; ∀a (V = Traffic volume,a = Each route)

(3) Determine the proportion of travel schedule. (P_n) by $\sum P_n = 1$ and n = 0 Before the distribution of traffic. (n = จำนวนรอบของการแจกแจง)

(4) Choose a route for each pair of sub areas with the least travel costs. and n = n+1

(5) Enumerate traffic volume on routes as given in (4) and increase traffic volume. (F_a) include the same traffic on the route. (V_a) as follows.

(6) Calculate the cost of each new road segment. From the relationship between traffic volume and expenses incurred and return to item 1) until the full schedule of travel.

$$V_a^n = V_a^{n-1} + F_a$$

From the above methods. The decision to choose a travel route depends on the cost of traveling from the point of origin to the destination. This includes the distance and duration of travel. In terms of time spent traveling. It will change according to traffic conditions. This depends on the amount of traffic on the network and the capacity of the roads.

Summary of traffic and transportation model characteristics in the study is shown in **Table 4.3.1-3**.

Table 4.3.1-3 summarizes the features of traffic and transportation models in education

Modeling Features	Explanation
Study Area	The study area is 1,108 areas, divided into sub-districts in the study area and the district level in the outer space.
Network replication	• Road Transport Network • Railway Transport Network • Air Transport Network • Water Transport Network • Road network connected to the Asian Highway Project
Socio-Economic Information	Include all economic and social data of 77 provinces in 2017, 2025, 2034, 2044, and 2054. number of population • Gross product • Employment • Number of tourists
Travel model	objective TRIP = 0.0262*Pop + 0.0763*GPP + 2,373 By TRIP = Travel volume Unit = person-trip/day Pop = Population by sub-area (persons) GPP = Gross Product in constant value

Table 4.3.1-3 summarizes the features of traffic and transportation models in education (Cont'd)

Modeling Features	Explanation
(Trip Distribution)	$T_{ij} = a_i b_j P_i A_j F(C_{ij}) K_{ij}$ (Gravity Model) By T_{ij} Travel volume from i area Go to j area j C_{ij} Generalized Cost of Travel from area i to area j P_i The volume of travel that takes place at the sub area.i K_{ij} Travel Amplifier from area i to area j A_j Travel volume into j area j $a_i b_j$ Coefficients of travel variability and attraction of travel. $F(C_{ij})$ The cost of travel from sub-area i into sub-areas. $j = C_{ij}^{1.556} \exp(-0.000635\ C_{ij})$
Passenger Model	
Model of travel options (Model Split)	Model of travel options Development of a Multiclass Assignment Model Using Utility Theory to Develop a Model for Responsive Behavior Selecting Travel Patterns Under the assumption that travel is based on the decision-making behavior of each traveler. Travelers will choose the option that provides the utmost value or satisfaction. The utility functions or utility functions are as follows: Utility Function: $U_i = A_i + B_i$ * timei+Ci*costi By A_i Specific Mode Constant of travel form i B_i Coefficient of variation of travel time pattern i C_i Coefficient of cost variation of travel pattern i
Travel Distribution Model (Traffic Assignment)	The travel distribution model is a multi-class assignment. The classification of vehicles is divided into five categories. - motorcycles - Private car - Taxi - Buses (bus, school or bus) - truck The traffic distribution on the network is calculated using the Incremental Loading method. The traffic volume in the public transport system and the non-traffic bus type are added to the network as the initial traffic volume. Then the traffic volume for other vehicles will be calculated. The distribution is done by the same process (Iteration) until the network enters equilibrium or equilibrium. Passenger Modeling in the NAM model is the distribution of people traveling on three types of networks as follows: - Highway Network - Air Network - Rail Network

4) Model Calibration

The consultant has calibrated the traffic model (Model Validation) with the traffic data being surveyed. The traffic and transportation model is analyzed and tested. To forecast the volume of passenger and cargo transport. Current model calibration is done by comparing the model data. The data obtained from the survey, the tolerances obtained from the calibration must be acceptable. According to the criteria of the U.S. Department of Transportation as shown in **Table 4.3.1-4**, calibration results in **Table 4.3.1-5**.

Table 4.3.1-4 Tolerances Allowed for Model Calibration

Road type	% Acceptable tolerances
Expressway	+/- 10
Major Arterial	+/- 15
Minor Arterial	+/- 25
Traffic Volume (PCU/day)	**% Acceptable tolerances**
0 - 5,000	+/- 36
5,000 - 10,000	+/- 29
10,000 - 25,000	+/- 25
25,000 - 50,000	+/- 22
>50,000	+/- 21

Table 4.3.1-5 Model Calibration Results

Survey points	Highway No.	Direction	Traffic Volume (pcu/day)		Dislocation (%)
			Survey	Model	
MB 1	Highway 4 (Mueang Chumphon – Kra Buri)	To Chumphon	6,273	6,812	8.59%
		To Ranong	7,067	7,235	2.37%
		Total	**13,340**	**14,047**	**5.30%**
MB 2	Highway 4 (Kra Buri-Mueang Ranong)	To Kra Buri	3,135	3,314	5.70%
		To Ranong	3,642	3,409	-6.40%
		Total	**6,778**	**6,723**	**-0.81%**
MB 3	Highway 4006	To Ranong	2,240	2,382	6.32%
		To Lung Suan	2,607	2,876	10.32%
		Total	**4,847**	**5,258**	**8.47%**
MB 4	Rural Road 4010	To Ranong	2,400	2,715	13.11%
		To Kra Buri	2,488	2,740	10.15%
		Total	**4,888**	**5,455**	**11.60%**

4.3.2 Traffic Forecasts Emerging Due To Ease Of Travel

After the traffic and transportation model developed for the project. These traffic and transportation models will be used to forecast passenger and cargo volumes in the target year. In analyzing the model, the consultant determines the base year for the study to be in the year 2017 and will estimate the passenger and cargo volume in 2025, 2034, 2044 and 2044, as detailed in the assumptions in **Table 4.3.2-1**.

Table 4.3.2-1 Assumptions for Predicting Passenger Volume

1. Traffic and Transportation Modeling Database	
Traffic model	Traffic and Transportation Model : NAM (National Model)
2. Railway Project Information	
- Project implementation	Open in 2025
- Speed of service	- Double Tracks Train, Standard gauge, Average 160 km / h (Maximum 200 km / h) - Double Tracks Train with 1 meter guage- Average 100 km / h (Maximum 160 km / h) - Single Passenger Train, 1 m (ST / MG), Average 60 km / hour
- Number of stations of railway projects	Main station And sub-district.
- Basic fare	Trains (SRT) on the 3rd class average 0.40 baht / km. Train (SRT) 2nd class average 1.16 baht / km. Train (SRT) 1st class average 1.96 baht / km. Personal car average of 3.00 baht / km. Bus (bus) average 1.20 baht / km. Average airplane (standard) 5.60 Baht / km Aircraft (promotion) averaged 2.88 baht / km.
3. Development plan for double track rail network in the study area	- Prachuap Khiri Khan - Chumphon Open Year 2020 - Chumphon - Surat Thani Open Year 2021
4. Highway Intercity Development Plan	Interstate Highway Nakhon Pathom - Narathiwat Open Year 2036. The development phase is divided as follows. - Nakhon Pathom - Cha Am is scheduled to open in 2022. - Cha Am - Chumphon is scheduled to open in 2026. - Chumphon - Surat Thani is scheduled to open in 2034. - Surat Thani - Songkhla (Hat Yai) - Narathiwat (Sungai Kolok Custom) is scheduled to open in 2036.

Source: Consultant

In anticipation of the future volume of travel U.S. Bureau of Public Roads has divided the volume traveling in the future is divided into 4 sections.

1) Current traffic volume for new construction projects is the journey. Redirect traffic to use the new route for improved old projects. This is the journey. Travel volume used before the project. Including traffic from other routes. The change to the improved route instead.

2) Normal Growth Traffic is the amount of travel due to the expansion of economic and social conditions. The increase in the volume of travel in this section is added to the normal, whether the renovation or construction of the project or not.

3) The volume of new arrivals due to renovation or construction (Generated Traffic) The future volume of travel will not occur if there is no improvement or new construction. This is because the renovation or the new construction makes it much easier to travel. Travel volume in this section is divided into 2 types.

   - Induced Traffic is a recurring volume of travel. Due to improvements or construction, accessibility (Accessibility) improved.
   - Converted traffic is the result of a change in the mode of transportation when it is easier to travel with a new system.

4) Development Traffic is the amount of travel in the future caused by changes in land use.

In the study, the methodology for predicting travel volume is shown in **Figure 4.3.2-1.**

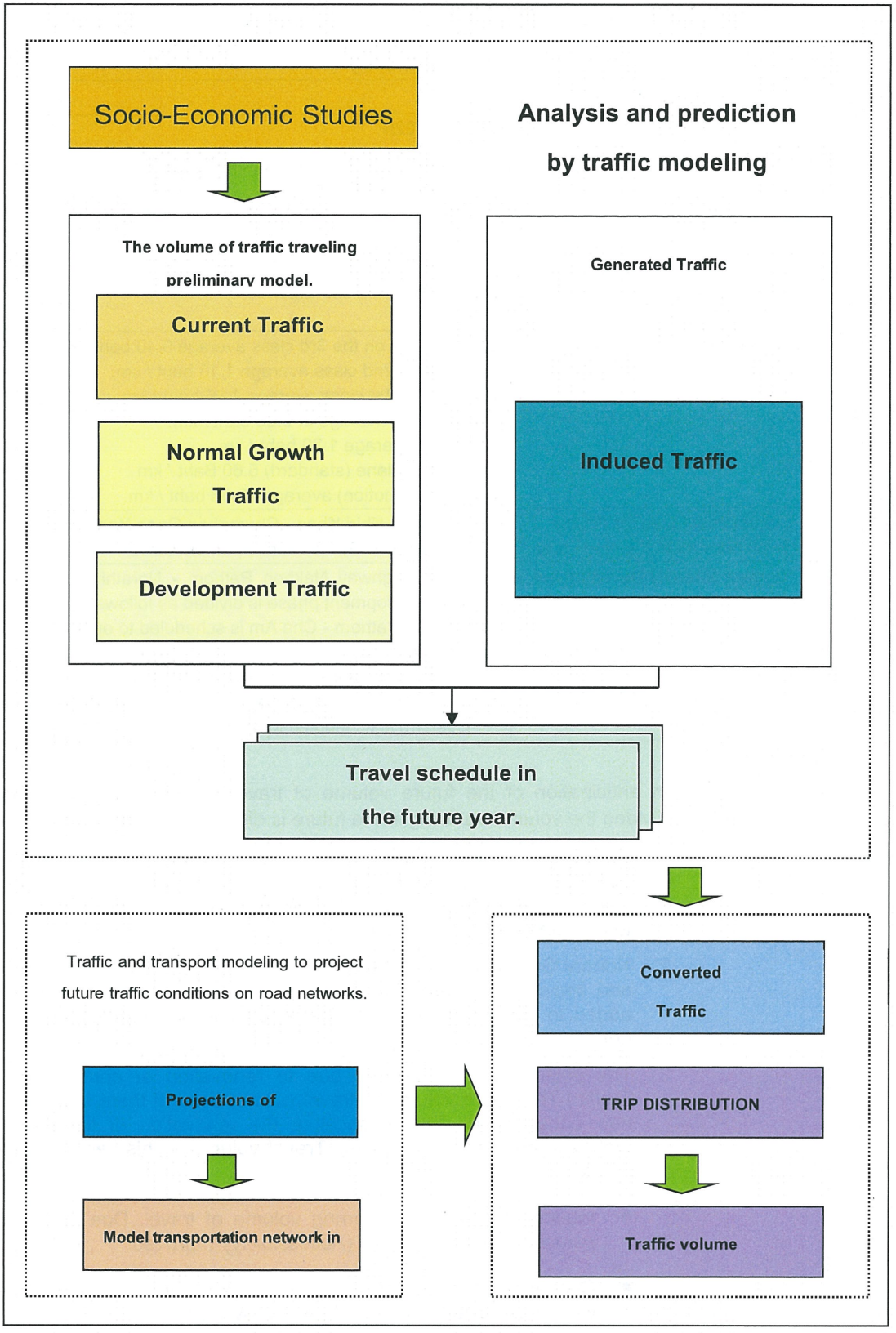


Figure 4.3.2-1 shows the predictions of traffic volume

- **New traffic volumes due to ease of travel**

  Traffic generated by Induced Traffic is the amount of traffic that is generated by the construction of a new route, resulting in travel due to existing travel requirements, but not traveling (Latent Demand). Come on, go up. The construction of the railway project Chumphon - Ranong. It is an economical and convenient alternative to travel. Then make a trip.

  This amount of travel is often compared with Elasticity as compared to travel expenses. (Including travel time), although there is no clear analysis of interviews or data collection. Douglass B. Lee, Jr., Has tested the increase in travel volume on the change in travel expenses, as shown in **Figure 4.3.2-2**, if any construction or improvement of the project that makes traveling cost less. This will result in a number of new travel. Can write the equation as follows.

$$e_{LR} = \frac{\%\Delta v}{\%\Delta p} = \frac{\Delta v}{\Delta p} \times \frac{p_1}{v_1} = \left(\frac{v_2 - v_1}{p_2 - p_1}\right) \times \frac{p_1}{v_1}$$

  By e = Elasticity
  P = Travel expenses (Including travel time)

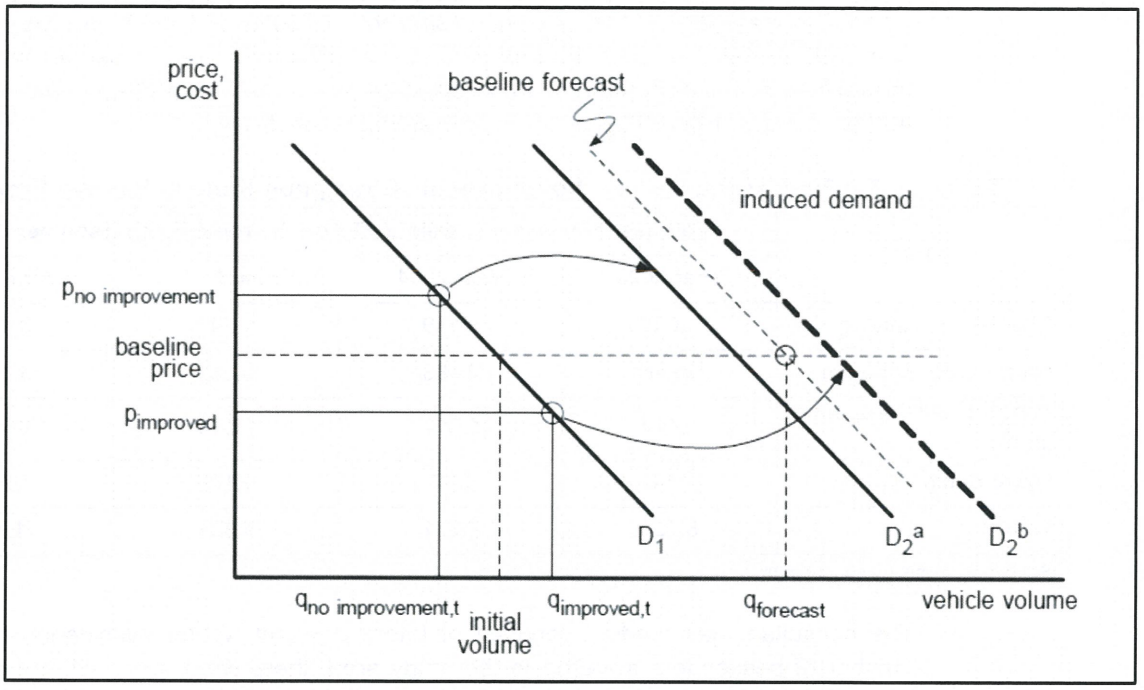


Figure 4.3.2-2 Induced Trips from the cost of travel changes

The test results show that e is between -1.00 and -2.00. In this study, e is equal to -1.50 for long distances and e is -0.75 for distance traveled. Induced Trips, which results in **Table 4.3.2-2** and **Table 4.3.2-3.**

Table 4.3.2-2 Elasticity of Induced Trips

Travel	Elasticity
long distance	-1.50
Near distance	-0.75

Source: Douglass B. Lee, Jr. and consultants.

Table 4.3.2-3 Percentage of Increased Train Volume (Induced Trips)

Area	%
Chumphon - Ranong	25.64
Local (along the route)	14.1
Bangkok Top area	7.91
Lower South	16.55

Source: Analysis by consultants.

4.3.3 Forecast of Passenger Volume

The consultants have estimated the number of passengers on the Chumphon - Ranong route. The forecast results are shown in **Table 4.3.3-1**. In 2025, total passenger traffic was 5,724 passengers per day, increasing to 11,710 passengers per day in 2597. Expected to use the train service project. Classified by area, most of them were passengers along the route (Local), followed by passengers from Chumphon - Ranong. And passengers from Bangkok and upper areas, respectively.

Table 4.3.3-1 Forecasting Railway Volume on the Chumphon-Ranong Railway Project

Area	Forecast of passenger train traffic on the route (per person per day)			
	Year 2025	Year 2034	Year 2044	Year 2054
Chumphon - Ranong	1,650	2,119	2,742	3,470
Local (along the route)	1,946	2,483	3,089	3,805
Bangkok and the upper area	1,414	1,812	2,314	2,932
Lower South	714	917	1,186	1,503
Total	**5,724**	**7,331**	**9,331**	**11,710**

Source: Analysis by consultants.

The consultant has made a forecast of future demand. When considering the total number of passengers traveling to the study area, there were about 41,769 people / day. Most of them were people traveling in the area of 24,194 people / day, accounting for 57.92%. Approximately 17,575 people / day, accounting for 42.08 percent of the total number of cars and buses, as shown in **Table 4.3.3-2**, this would be the case in the case of the construction of the new Chumphon-Ranong railway line.

Table 4.3.3-2. Travel volume separated by the form of travel to Ranong (in case there is no construction of Chumphon-Ranong Railway Line)

Travel style	Type	Year 2017	Year 2025	Year 2034	Year 2044	Year 2054
Travel volume (person per day)						
local	Car	19,362	22,549	26,502	30,788	35,442
	bus	4,832	5,577	6,523	7,539	8,602
	Total	**24,194**	**28,126**	**33,025**	**38,327**	**44,044**
Long distance & tourist	Car	8,262	10,309	13,144	16,864	21,046
	Bus	8,970	11,177	14,150	18,038	22,264
	Plane	343	434	566	761	1,023
	Total	**17,575**	**21,920**	**27,860**	**35,663**	**44,333**
Total Travel Volume		**41,769**	**50,046**	**60,885**	**73,990**	**88,377**
Travel proportion						
local	Car	80.03%	80.17%	80.25%	80.33%	80.47%
	bus	19.97%	19.83%	19.75%	19.67%	19.53%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Long distance & tourist	Car	47.01%	47.03%	47.18%	47.29%	47.47%
	Bus	51.04%	50.99%	50.79%	50.58%	50.22%
	Plane	1.95%	1.98%	2.03%	2.13%	2.31%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Source: Analysis by consultants

According to the analysis, the case of the new Chumphon - Ranong railway project will be transformed into a new train route. Local travel is approximately 6.86% to 8.55%. Long distance & tourist travel accounts for 16.82% to 17.39% of total travel in the project area. Last year of analysis as shown in **Table 4.3.3-3**.

Table 4.3.3-3 Travel Volume by Trip Model The entrance to the city of Ranong (In case of Chumphon - Ranong Railway Construction Project)

Travel style	Type	Year 2017	Year 2025	Year 2034	Year 2044	Year 2054
Travel volume (person per day)						
local	Car	19,362	22,181	26,097	30,350	34,959
	bus	4,832	4,242	4,751	5,270	5,751
	Train	-	1,946	2,483	3,089	3,805
	Total	**24,194**	**28,369**	**33,331**	**38,709**	**44,515**
Long distance & tourist	Car	8,262	9545	12,171	15,631	19,461
	bus	8,970	8,728	11,009	13,988	17,160
	Plane	343	412	529	701	943
	Train	-	3,778	4,848	6,242	7,905
	Total	**17,575**	**22,463**	**28,557**	**36,562**	**45,469**
Total Travel Volume		**41,769**	**50,832**	**61,888**	**75,271**	**89,984**
Travel proportion						
local	Car	80.03%	78.19%	78.30%	78.41%	78.53%
	bus	19.97%	14.95%	14.25%	13.61%	12.92%
	Train	-	6.86%	7.45%	7.98%	8.55%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**
Long distance & tourist	Car	47.01%	42.49%	42.62%	42.75%	42.80%
	bus	51.04%	38.86%	38.55%	38.26%	37.74%
	Plane	1.95%	1.83%	1.85%	1.92%	2.07%
	Train	-	16.82%	16.98%	17.07%	17.39%
	Total	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Source: Analysis by consultants.

When considering passenger trains by station. **Table 4.3.3-4** shows that the number of passengers in Ranong in 2025 was about 1,800 people per day and increased to 3,800 people per day in 2054, as shown in **Figure 4.3.3-1** and **4.3.3-2** and the Max Line Load in 2025 is 2,039 per day per direction, increased to 2,625 3,388 and 4,313 per day per direction in the analyzed year, respectively, as shown in **Figure 4.3.3-3** and **4.3.3-4**.

Table 4.3.3-4 Forecast of passenger volume by station on the Chumphon – Ranong Railway Project

Station	Passenger volume (person per day)											
	2025			2034			2044			2054		
	Get on	Get off	line load	Get on	Get off	line load	Get on	Get off	line load	Get on	Get off	line load
Chumphon - Ranong												
Bangkok and other region	663	0	663	849	0	849	1,086	0	1,086	1,377	0	1,377
Lower South	371	0	371	476	0	476	617	0	617	782	0	782
Chumphon	858	0	858	1,101	0	1,101	1,425	0	1,425	1,804	0	1,804
Khun Krating	163	68	1,987	217	95	2,548	283	129	3,282	358	149	4,172
Baan Na (1)	76	49	2,014	97	68	2,577	121	88	3,315	144	107	4,209
Baan Na (2)	95	108	2,001	122	138	2,561	153	179	3,289	187	226	4,170
Pak Jan	280	242	2,039	349	289	2,621	438	346	3,381	540	411	4,299
Kra Buri	200	330	1,909	242	436	2,427	296	523	3,154	355	663	3,991
Bang Yai	37	25	1,921	59	35	2,451	75	67	3,162	115	84	4,022
La-un	110	177	1,854	141	228	2,364	159	294	3,027	178	370	3,830
Ranong	0	1,854	0	0	2,364	0	0	3,027	0	0	3,830	0
Total	**2,853**	**2,853**		**3,653**	**3,653**		**4,653**	**4,653**		**5,840**	**5,840**	
Ranong - Chumphon												
Ranong	1,859	0	1,859	2,361	0	2,361	3,048	0	3,048	3,866	0	3,866
La-un	179	110	1,928	233	141	2,453	300	160	3,188	375	179	4,062
Bang Yai	25	40	1,913	52	63	2,442	67	81	3,174	84	122	4,024
Kra Buri	324	203	2,034	429	246	2,625	515	301	3,388	652	363	4,313
Pak Jan	241	288	1,987	288	361	2,552	345	452	3,281	408	556	4,165
Baan Na (2)	107	96	1,998	137	123	2,566	178	155	3,304	225	191	4,199
Baan Na (1)	56	78	1,976	74	97	2,543	90	121	3,273	104	145	4,158
Khun Krating	80	170	1,886	104	225	2,422	135	294	3,114	156	372	3,942
Chumphon	0	792	792	0	1,018	1,018	0	1,317	1,317	0	1,666	1,666
Lower South	0	343	343	0	441	441	0	569	569	0	721	721
Bangkok and other region	0	751	751	0	963	963	0	1,228	1,228	0	1,555	1,555
Total	**2,871**	**2,871**		**3,678**	**3,678**		**4,678**	**4,678**		**5,870**	**5,870**	
Total Boarding (passenger/day)	**5,724**	**5,724**	-	**7,331**	**7,331**	-	**9,331**	**9,331**	-	**11,710**	**11,710**	-
Max Line Load (passenger/day)			**2,039**			**2,625**			**3,388**			**4,313**

Source: Analysis by consultants

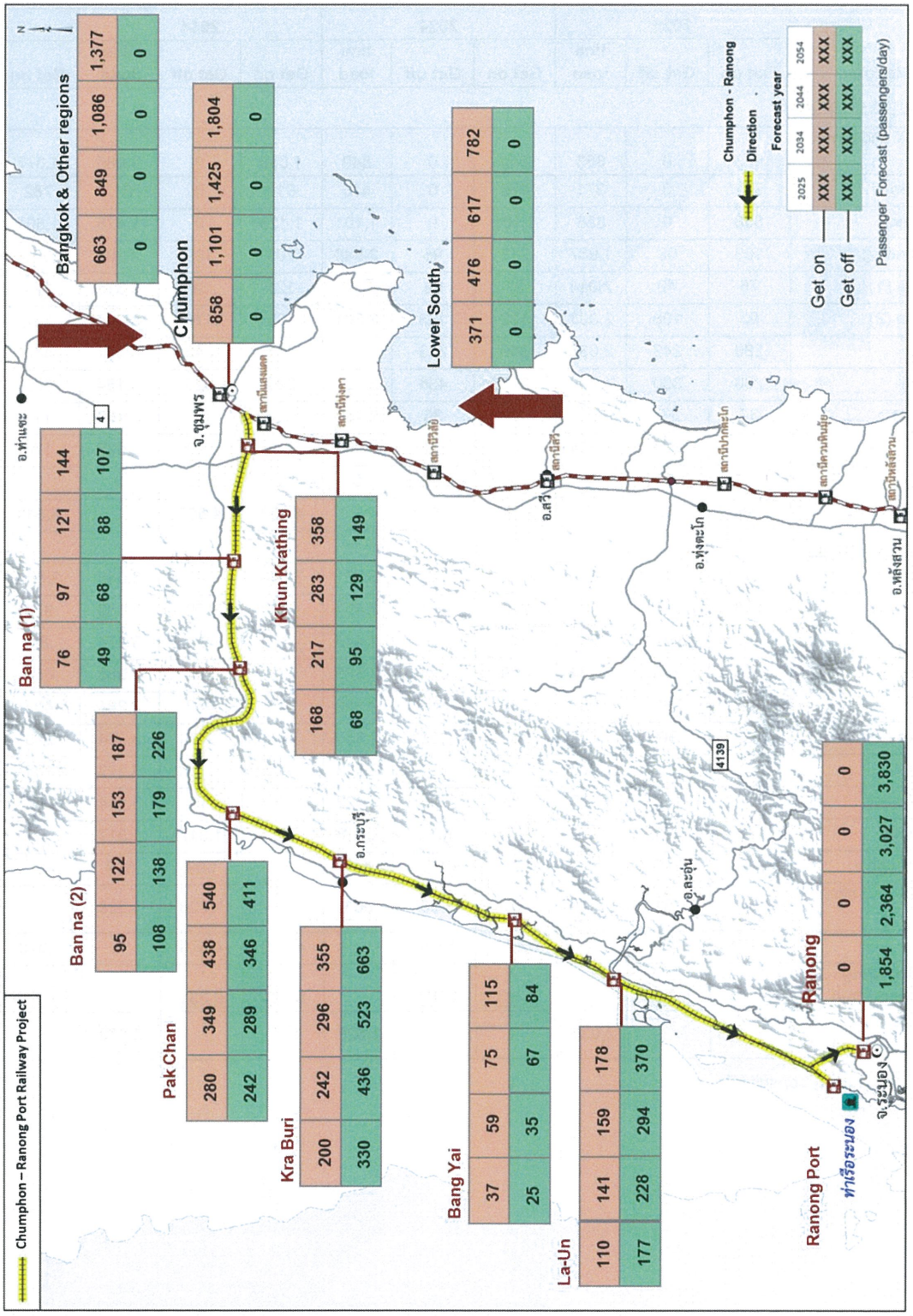


Figure 4.3.3-1 Forecast of passenger volume by station on the Chumphon – Ranong Railway Project (Direction: Chumphon - Ranong)

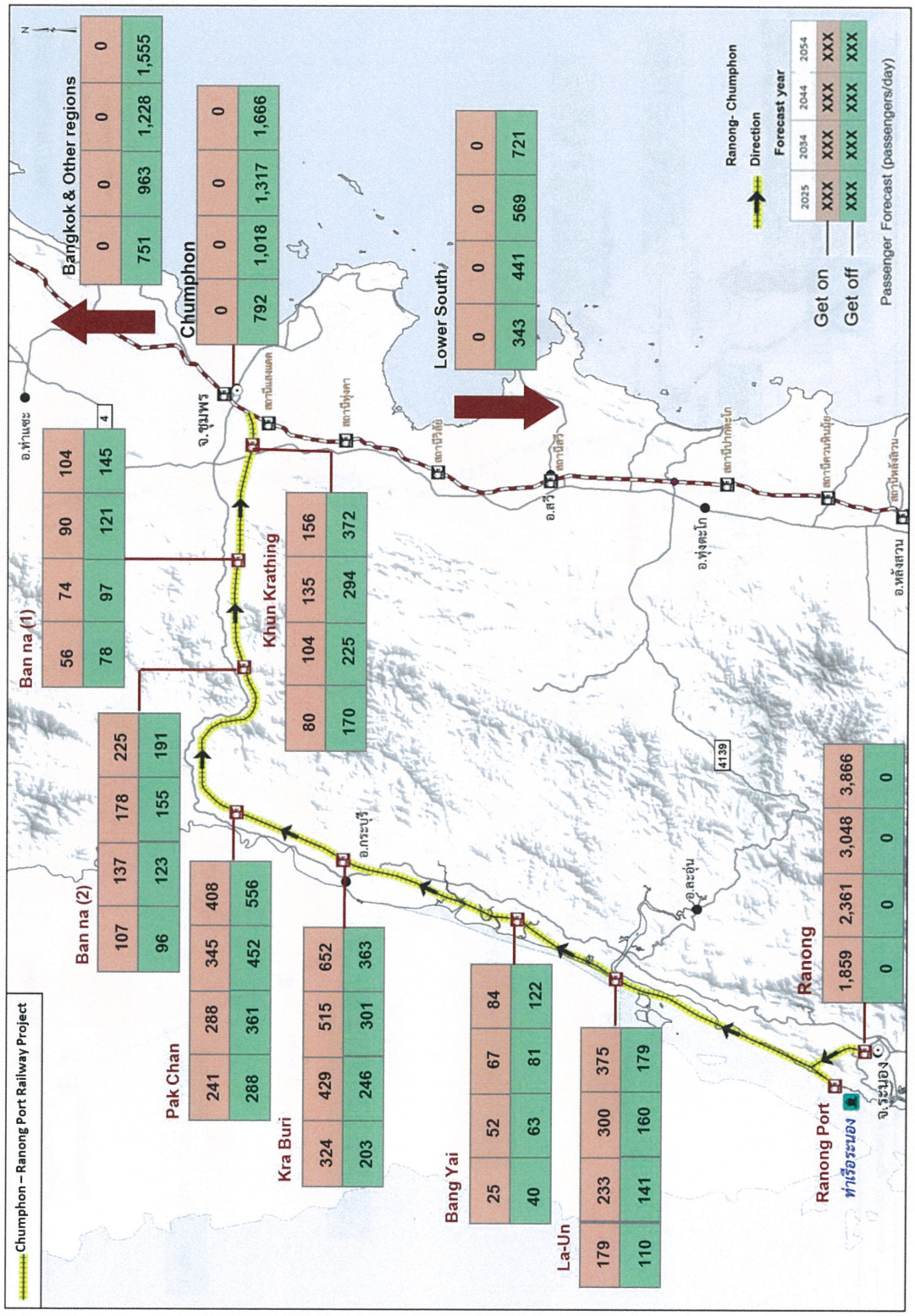


Figure 4.3.3-2 Forecast of passenger volume by station on the Chumphon – Ranong Railway Project
(Direction: Ranong - Chumphon)

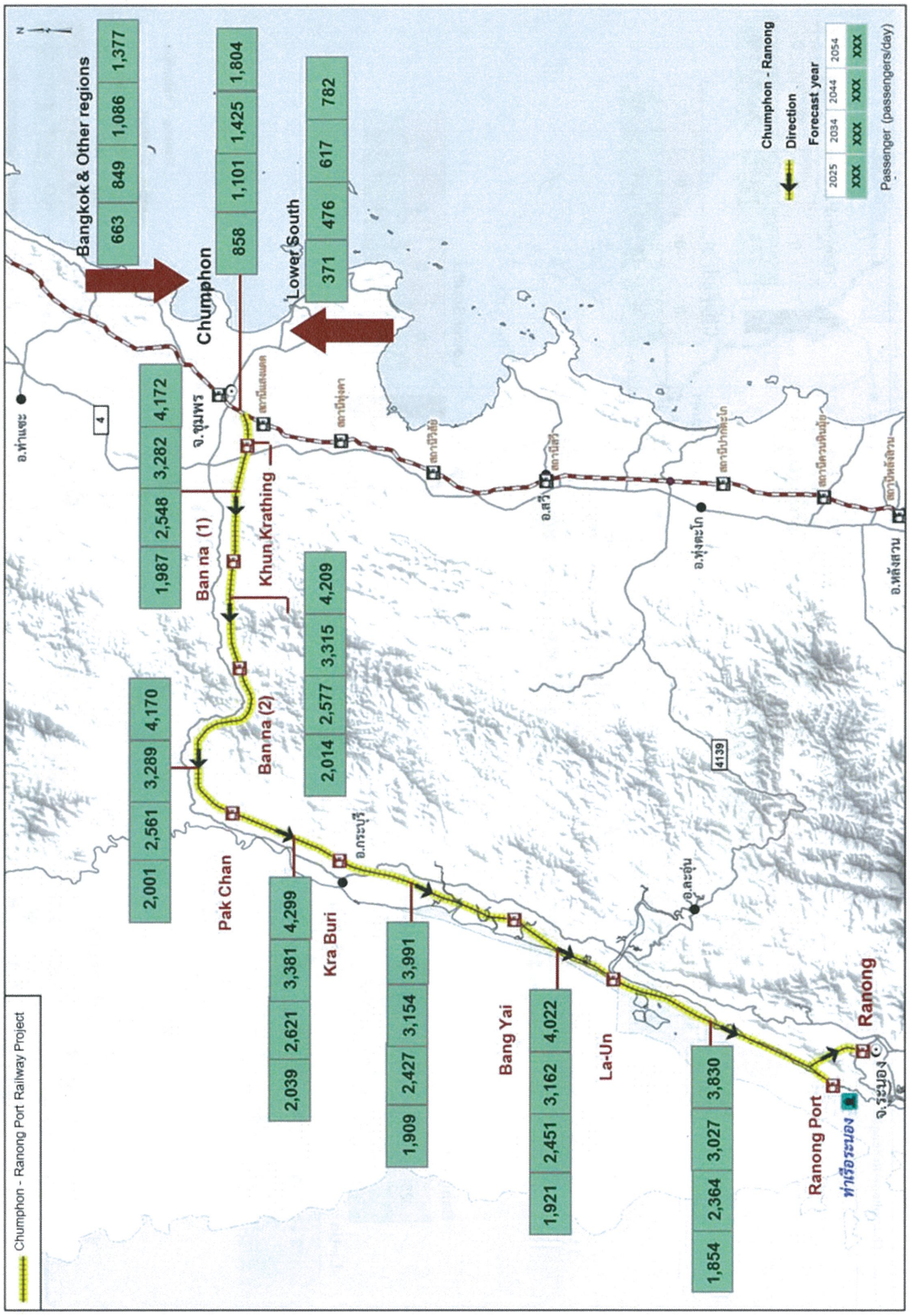


Figure 4.3.3-3 Forecast of passenger on the LINE LOAD on the Chumphon - Ranong Railway Project (Direction: Chumphon – Ranong)

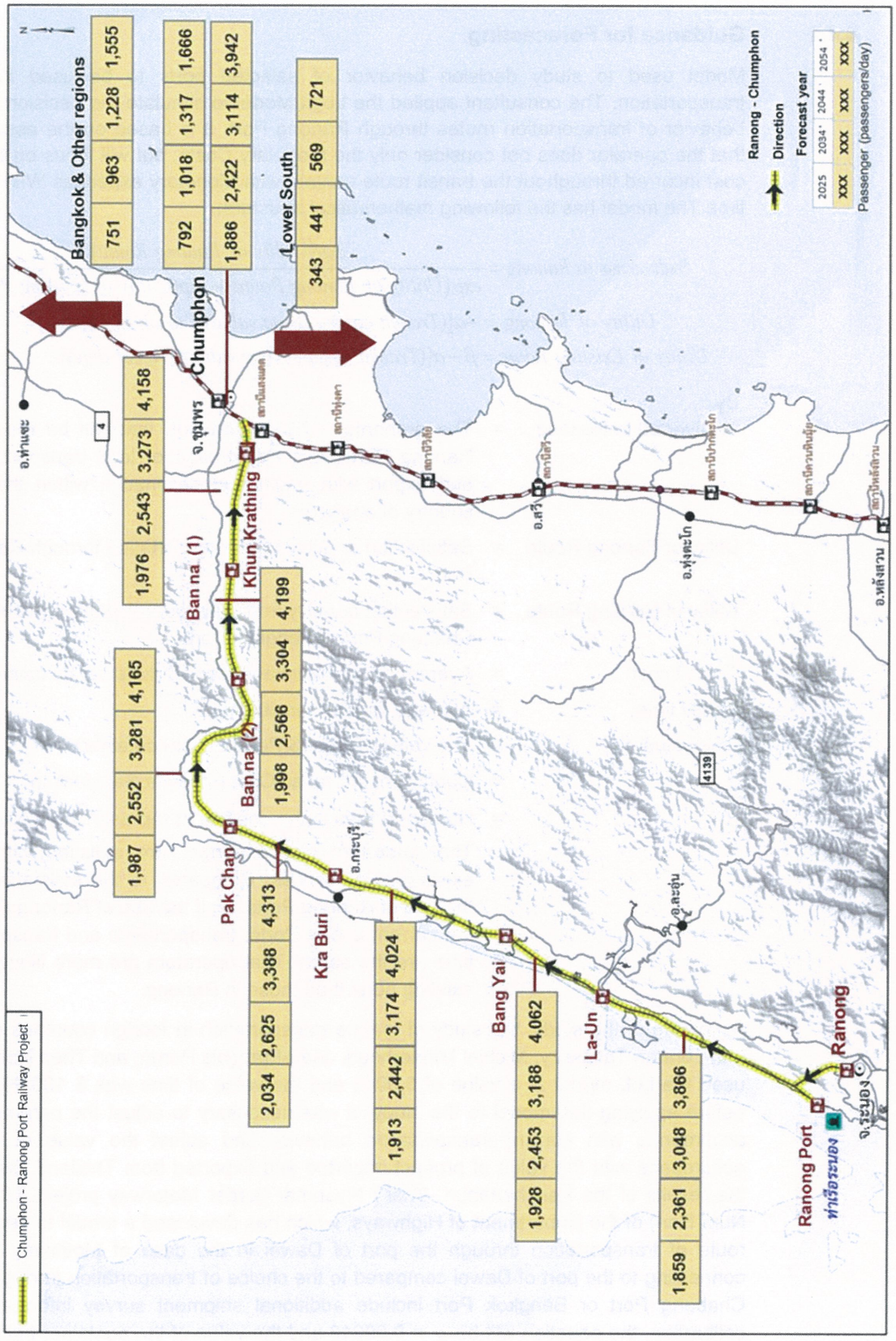


Figure 4.3.3-4 Forecast of passenger on the LINE LOAD on the Chumphon - Ranong Railway Project
(Direction: Ranong – Chumphon)

4.4 Analysis and Forecast of Product Volume

4.4.1 Guidance for Forecasting

Model used to study decision behavior of selected ports to be used in cargo transportation. The consultant applied the Logit Model to simulate the decision making behavior of transportation routes through Ranong Port. It is based on the assumption that the operator does not consider only the Monetary Costs, but will focus on the total cost incurred throughout the transit route contain with Monetary expenses With wasted time The model has the following mathematical structure:

$$\%diverted\ to\ Ranong = \frac{exp(Utility\ of\ Ranong\ Route)}{exp(Utility\ of\ Ranong\ Route) + exp(Utility\ of\ Existing\ Route)}$$

$$Utility\ of\ Ranong = -\alpha[(Transit\ cost) + (Time\ value)(Transit\ time)]$$

$$Utility\ of\ Existing\ Route = \beta - \alpha[(Transit\ cost) + (Time\ value)(Transit\ time)]$$

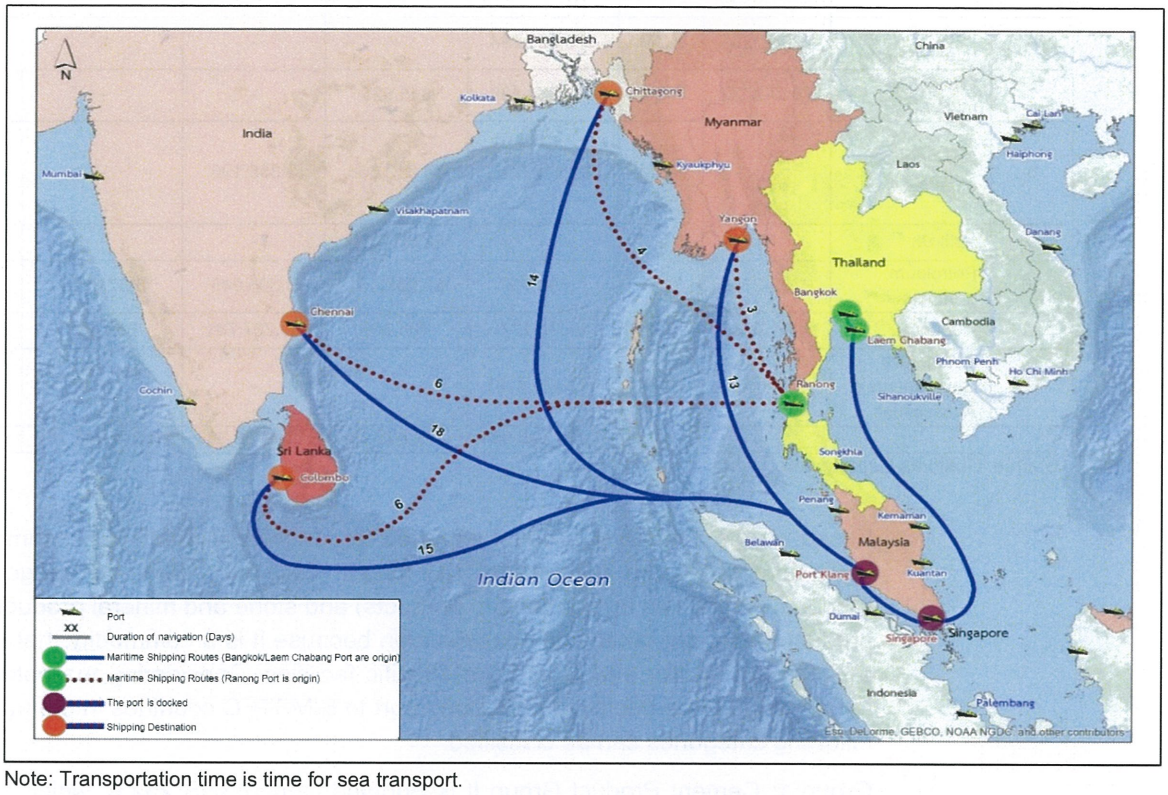
By

% Diverted to Ranong	=	The proportion of transportation that will be resorted to Ranong Port (Unit: Percentage of total transport, import and export with origin and destination within the target country of analysis)
Utility of Ranong Route	=	Satisfaction or utility from transportation through Ranong Port.
Utility of Existing Route	=	Satisfaction or utility from transportation through Laem Chabang Port or Bangkok Port.
Transit cost	=	Average cost of transportation (Dollars per container.
Transit time	=	Average time of transit (days)
Time value	=	The value of time ($ Per day per container)
α	=	Coefficient of Transit Cost Effect on Satisfaction
β	=	Homeport Bias is the coefficient representing the bias that Thai importers and exporters are satisfied with using existing port services. Compared to the satisfaction with the use of Ranong Ports, ie, if the use of Ranong Port and the current use of Ports, transportation and transportation time are the same. Thai operators are more likely to use existing ports than those in Ranong.

According to the study, the study of marine transportation in foreign countries showed that Loratan Tavasszy, Michiel Minderhoud, Jean-François Perrin, and Theo Notteboom used the LoL model at a value of 0.0045 and the value of time was $ 100. However, before applying this model to the study, it was necessary to adjust the parameters in accordance with current transportation behavior and adjust the value of time in accordance with the value of product imported and exported from Thailand. Based on the results of the Kanchanaburi -Thai / Myanmar border Motorway project. (Ban Phu Num Ron) of the Department of Highways, which has developed a model to decide the route of transportation through the port of Dawei in the case of Motorway project, connecting to the port of Dawei compared to the choice of transportation through Laem Chabang Port or Bangkok Port include additional shipment survey information. By calibration, the equation will be α = 0.00216 and the value of the container freight time is $ 65.23 per container per day, which is the value to be applied in this study.

Homeport Bias analysis is a comparison of the harbor selection behavior of operators located in the boundary or the harbor area of the port. The homeport bias value is 3.17. Operators will choose the current port. (Bangkok / Laem Chabang Port) Nearly 100% if transportation through Ranong Port has the same cost and time of transportation (Difference of Utility = 0)

Forecasting the volume of cargo transport opportunities through Ranong Port In addition to considering the cost of shipping. Figure 4.4.1-1 shows the comparison period for freight transport through Ranong Port to Laem Chabang Port / Bangkok. To BIMSTEC countries



Note: Transportation time is time for sea transport.

Figure 4.4.1-1 Comparison of shipment periods to BIMSTEC countries between Ranong Port and Laem Chabang Port / Bangkok

4.4.2 Export Volume Forecasts for Rail Freight through Ranong Port to BIMSTEC Countries

1) Export potential group of exports through Laem Chabang port / Bangkok border

By collecting cargo shipped via Laem Chabang Port / Bangkok Bld., 2559, most of the products exported to BIMSTEC countries are exported to India, Bangladesh, Myanmar and Sri Lanka. Bhutan and Nepal have very little exports. Based on the weight of exports to BIMSTEC countries, the top 12 exports Accounted for 85% of total weight. It is the most cement product. Second largest is the plastic, sugar and chemicals sectors, which show the highest volume of export product ranked by BIMSTEC countries as shown in **Table 4.4.2-1**.

Table 4.4.2-1 Export Volume to BIMSTEC Countries Classified by Product, 2016

Rank	Product	HS Code	Unit	India	Myanmar	Sri Lanka	Bangladesh	Total
1	cement	2523	KGM	79,399,208	232,996,010	372,976,445	3,828,748,896	4,514,120,559
2	plastic beads	3901-3907	KGM	407,688,214	41,355,324		9,540,408	458,583,946
3	the sugar	1701-1703	KGM	1,865,000	276,917,000	50,391,000	2,525,750	331,698,750
4	chemical	28 29 38	KGM	264,704,948	17,296,409	11,139,220	19,650,979	312,791,556
5	consumer products	2101-2106 3401 9619 4802-4805 5501-5508	KGM	93,731,400	57,564,939	29,262,744	71,503,600	252,062,683
6	Iron and steel (steel scrap)	7204-7205	KGM	179,821,294	-	-	-	179,821,294
7	Rocks and minerals	2520-2522	KGM	118,331,430	845,625	-	-	119,177,055
8	Construction materials	4410 4411 6905 6908	KGM	61,412,536	34,312,338	2,355,190	-	98,080,064
9	fertilizer	31	KGM	-	82,834,260	-	-	82,834,260
10	Petroleum products	2709-2710	LTR	1,796,757	28,265,651	6,395,946	8,571,761	45,030,115
11	Rubber	4001-4005	KGM	8,573,277	436,800	10,237,781	902,860	20,150,718
12	Automotive Components & Accessories	8708	KGM	17,071,000	-	-	-	17,071,000
			Total	**1,234,395,064**	**772,824,356**	**482,758,326**	**3,941,444,254**	**6,431,422,000**

Source: Customs Department

Based on the volume of product exported to countries in BIMSTEC countries, we have considered the potential of rail freight, especially container cargo. Liquid products (chemicals and petroleum products) and stone and mineral products It is a product that is not taken into consideration because it is a commodity that requires a specific container and must have specific facilities. Considering the potential for rail transport to be deployed in Ranong port to BIMSTEC countries in the future, the following categories can be classified.

Group 1: Cement Product Group It is Portland cement (HS 2523), which is a bulk product. Most Transported Most of the production is in the central region of Saraburi, most of which are transported to Bangladesh. Subsequent transport to Sri Lanka, Myanmar and India, respectively.

Group 2: Plastic Product Group (HS 3901-3907), which is the second largest volume of cement. Most of them are located in the eastern part of Rayong, where most of them are transported to India. Secondary transport to Myanmar and Bangladesh, respectively.

Group 3: Sugar product group (HS 1701-1703). Most of them are located in the Lower East. The most popular destination to Myanmar. Subsequently transported to Sri Lanka, Bangladesh and India, respectively.

Group 4: Construction Material Group HS 6908 (HS 7016), Gypsum Board (HS 6815) and Palmitic Board (HS 4410). Most of them are located in Bangkok and its vicinity. Most destinations are transported to India. Secondly, Sri Lanka is Myanmar.

Group 5: Fertilizer Product Group (HS 3105) is mainly located in the central region. Phranakhon Si Ayutthaya The destination for transportation to Myanmar.

Group 6: consumer products It consists of products. Coffee Beans (HS 2101) Coffee Beans (HS 2101) Coffee Beans (HS 2101) Coffee Beans (HS 2102) Coffee Beans (HS 2102)) and short fibers (HS 5501-5508). Most of them are located in Bangkok and its vicinity. Most destinations are transported to India. Followed by Bangladesh, Myanmar and Sri Lanka, respectively.

Group 7: Rubber Products Most of the production is located in eastern part of Rayong. Most of them are transported to Sri Lanka. Followed by India, Bangladesh and Myanmar, respectively.

Group 8: Components, components and components of motor vehicles (HS 8708). The destination is transported to India.

Group 9: Iron and steel (steel scrap) group (HS 7204-7205). The destination is transported to India.

Rail transport through Ranong Port to BIMSTEC countries is a containerized cargo. The conversion of such items into a cabinet. This is because the costs are in the unit. As shown in **Table 4.4.2-2**.

Table 4.4.2-2 Export Volume of key product to BIMSTEC countries in 2016

Product	India (cabinet)	Myanmar (cabinet)	Sri Lanka (cabinet)	Bangladesh (cabinet)	Total (cabinet)
1. Cement	3,176	9,320	14,919	153,150	180,565
2. plastic pellets	16,308	1,654	0	382	18,343
3. sugar	75	11,077	2,016	101	13,268
4. Building Materials	2,457	1,372	94	-	3,923
5. Fertilizer	0	3,313	0	0	3,313
6. Consumer Products	3,749	2,303	1,171	2,860	10,083
7. Rubber	343	17	410	36	806
8. Components and accessories of motor vehicles	683	0	0	0	683
9. Iron and steel (steel scrap)	7,193	0	0	0	7,193
Total	**33,982**	**29,057**	**18,609**	**156,529**	**238,177**

Source: Customs Department
Note: 1 container weight the size is 25 tons.

Considering the routes and ports for the transportation of all nine major export commodities, it is necessary to compare transport costs from the source (source) to the current port. (Laem Chabang Port / Bangkok Port) and alternative rail transport. Therefore, it is necessary to know the source or origin of the cargo, which is found in the upper area. And there is the opportunity to use the rail freight route through the Ranong Port. As shown in **Table 4.4.2-3** and **Figure 4.4.2-1**.

Table 4.4.2-3 Production area to export to BIMSTEC countries through Ranong multi-purpose port and area of the container storage

Target product	Production Area		CY / ICD for packing
	Region	Center province	
▪ cement	Central	Saraburi	▪ CY of the cement plant
▪ Construction materials	Bangkok and vicinity	Bangkok and vicinity	▪ Ladkrabang Packing and Dumping Station (LICD)
▪ consumer products	Bangkok and vicinity	Bangkok and vicinity	▪ Ladkrabang Packing and Dumping Station (LICD)
▪ the sugar	North East	Khon Kaen, Nakhon Ratchasima	▪ CY Tha Phra and Khon Kaen
▪ Car Parts & Accessories	Central	Samut Prakan, Pathum Thani and Phra Nakhon Si Ayutthaya.	▪ CY Kudjig, Nakhon Ratchasima
▪ plastic beads	East	Rayong	▪ Ladkrabang Packing and Dumping Station (LICD)
▪ fertilizer	Central	Ayutthaya	▪ CY of plastic factory And Ladkrabang Packing and Storing Station (LICD)
▪ Rubber	East	Rayong	▪ Ladkrabang Packing and Dumping Station (LICD)
▪ Iron and Steel (Steel Scrap)	East	Rayong	▪ Ladkrabang Packing and Dumping Station (LICD)

Source: The Consultants

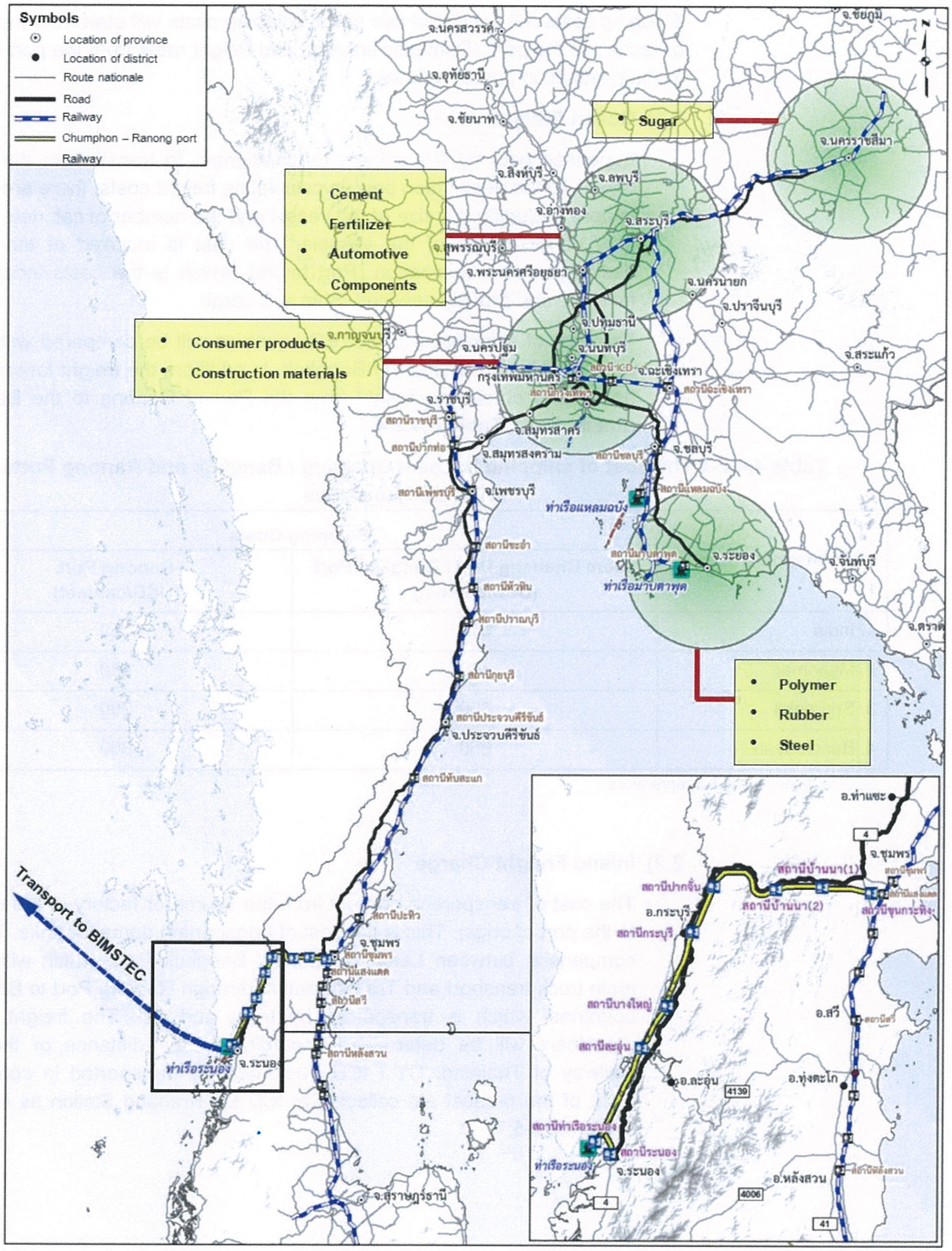


Figure 4.4.2-1 Source of potential product and transport opportunities to BIMSTEC countries through Ranong Port

2) Freight Charge

Shipping costs will consist of two parts: shipping costs will start from the factory or factory to the port. (Domestic linkage) and freight rates from the port of origin to the destination port as follows:

2.1) Ocean Freight

Expenses paid by the shipper or consignee. In transit from the port of origin. To the destination port. In calculating freight costs, there are various factors, including the size of the vessel and the number of cabinets and the time of navigation of the vessels. The cost is incurred at the port of destination and destination (Port tariffs), which is the costs incurred will facilitate and provide services. Ship and cargo

The cost of shipping to BIMSTEC countries will be compared with freight rates from Laem Chabang / Bangkok. In addition, the freight forwarder will be able to obtain the freight from the Port of Ranong to the BIMSTEC (Future Port). **Table 4.4.2-4**.

Table 4.4.2-4 The cost of shipping in Laem Chabang / Bangkok and Ranong Ports to BIMSTEC countries

Destination Country	Shipping Costs	
	Laem Chabang Port / Bangkok Port (USD/cabinet)	Ranong Port (USD/cabinet)
1. India	650	550
2. Myanmar	750	650
3. Sri Lanka	800	700
4. Bangladesh	850	800

Source: Interviewing Entrepreneurs

2.2) Inland Freight Charge

The cost of transporting product from the source or factory of the exporter to the port of origin. This is the cost of transporting domestic links. This is a comparison between Laem Chabang / Bangkok Port, which will be the main truck transport and Transportation through Ranong Port to BIMSTEC countries, which is transported by truck and rail. The freight rate of containers will be determined according to the distance of the State Railway of Thailand. CY / ICD trucks will be transported in containers. Most of the product are collected at ICD Lat Krabang Station as shown in **Table 4.4.2-5**.

Table 4.4.2-5 The Cost of transporting domestic links to transport product through Laem Chabang / Bangkok Port and Ranong Port to BIMSTEC countries

Category	Origin	Through Laem Chabang Port / Bangkok Port		Through Ranong Port by Train	
		Distance (km.)	Expenditure (Baht / cabinet / trip)	Distance (Km.)	Expenditure (Baht / cabinet / trip)
1. Cement	Central Region	200-250	4,000-5,000	700-750	10,500-11,500
2. plastic pellets	East	100-150	3,000-4,000	800-850	10,500-11,500
3. sugar	Lower East	300-400	9,000-10,000	900-950	12,500-13,500
4. Consumer Products	Bangkok and vicinity	150-200	3,500-4,500	700-750	10,000-11,000
5. Rubber	East	100-150	3,000-4,000	850-900	11,000-12,000
6. Building Materials	Bangkok	150-200	3,500-4,500	700-750	10,000-11,000
7. Fertilizer	Central Region	200-250	4,000-5,000	800-850	11,000-12,000
8. Products, components and components of automotive.	Central Region	200-250	4,000-5,000	800-850	11,000-12,000
9. Iron and steel (steel scrap)	East	100-150	3,000-4,000	850-900	11,000-12,000

Source: Compiled by consultants

The analysis and collection of data, costs and time of transportation from the production sites with BIMSTEC countries through Laem Chabang / Bangkok. And Ranong Port This includes the cost of domestic transportation both by road and by rail. Conclusions and comparison of costs and time of freight transport through Laem Chabang / Bangkok and Ranong Ports are shown in **Table 4.4.2-6**.

Table 4.4.2-6 Compare the cost and time of export cargo. Through Laem Chabang / Bangkok Port and Ranong Port Overall, domestic land transportation

Product/Origin	Destination	Freight costs to BIMSTEC countries			
		Through Laem Chabang Port / Bangkok Port		Through Ranong Port	
		By Road	Period	By Rail	Period
		(USD/cabinets)	(days)	(USD/cabinets)	(days)
1. Cement					
Central Region	India	786	19	884	10
	Myanmar	886	14	984	7
	Sri Lanka	936	16	1,034	10
	Bangladesh	986	15	1,134	8
2. plastic pellets					
East	India	741	19	884	10
	Myanmar	841	14	984	7
	Bangladesh	941	15	1,134	8

Table 4.4.2-6. Compare the cost and time of export cargo. Through Laem Chabang / Bangkok Port and Ranong Port Overall, domestic land transportation (Cont'd)

Product/Origin	Destination	Freight costs to BIMSTEC countries			
		Through Laem Chabang Port / Bangkok Port		Through Ranong Port	
		By Road	Period	By Rail	Period
		(USD/cabinets)	(days)	(USD/cabinets)	(days)
3. Building Materials					
Bangkok and vicinity	India	756	19	885	10
	Myanmar	856	14	985	7
	Sri Lanka	906	16	1,035	10
4. Consumer Products					
Bangkok and vicinity	India	756	19	885	10
	Myanmar	856	14	985	7
	Sri Lanka	906	16	1,035	10
	Bangladesh	956	15	1,135	8
5. Rubber					
East	India	741	19	915	10
	Myanmar	841	14	1,015	7
	Sri Lanka	891	16	1,065	10
	Bangladesh	941	15	1,165	8
6. Sugar					
Lower East	India	930	19	944	11
	Myanmar	1,030	14	1,044	8
	Sri Lanka	1,080	16	1,094	11
	Bangladesh	1,130	15	1,194	9
7. Fertilizer					
Central Region	Myanmar	886	14	1,015	7
8. Products, components and components of automotive.					
Central Region	India	786	19	915	10
9. Iron and steel (steel scrap)					
East	India	741	19	915	10

Source: compiled by consultants.

Note: Weighted average exchange rate between banks is 33.01 Baht per 1 USD (Reference is made by the Bank of Thailand on 16 November 2017).

3) Forecast of export volume to BIMSTEC countries

The forecast of export trends in the years 2025-2054 is due to the forecast of the export trend of 30 years, so the analysis of statistics and various factors. The forecasts are as follows.

3.1) Export volume statistics to BIMSTEC countries

The study collected statistical data on export volume to BIMSTEC countries during 2012-2016. And to analyze the forecasts of future products. The amount of export product from the Customs Department. The export volume is shown in **Table 4.4.2-7**.

Table 4.4.2-7 Export volume to BIMSTEC countries for Year 2012-2016 (Export data included from every checkpoint.)

Product	Year 2012	Year 2013	Year 2014	Year 2015	Year 2016	Growth rate per year (%)
cement	**5,622,391,199**	**4,458,819,718**	**5,245,530,955**	**5,556,024,526**	**6,953,546,726**	**5.5**
plastic beads	**421,640,041**	**429,925,268**	**463,821,241**	**510,449,223**	**550,620,869**	**6.9**
the sugar	**152,936,419**	**211,957,526**	**257,417,271**	**755,045,859**	**734,553,206**	**48.0**
Construction materials	**142,658,317**	**125,877,697**	**117,351,586**	**120,173,135**	**127,962,492**	**-2.7**
• Tile (kg)	48,204,509	61,525,045	60,446,203	68,161,639	64,097,391	7.4
• Brick (kg)	2,448,322	2,920,016	5,131,959	5,463,547	8,625,964	37.0
• Gypsum board (kg)	250,103	235,926	147,103	104,606	109,148	-18.7
• Particle Board	91,755,383	61,196,710	51,626,321	46,443,343	55,129,989	-12.0
fertilizer	**32,557,920**	**76,232,993**	**80,676,984**	**69,009,762**	**94,494,190**	**30.5**
consumer products	**326,362,314**	**331,560,434**	**552,914,183**	**932,019,019**	**1,265,720,449**	**40.3**
• Drinks (L)	146,644,973	138,243,046	337,698,277	680,627,432	999,836,626	61.6
• Creamer (kg)	41,671,868	46,169,913	53,864,481	51,739,725	51,529,821	5.5
• Shell Oil (kg)	14,810,082	17,476,196	19,334,410	21,286,018	23,754,541	12.5
• Coffee Mix (kg)	21,718,191	17,159,894	19,026,130	17,428,389	13,721,284	-10.8
• Soap (kg)	4,796,206	6,409,887	6,890,656	7,016,944	9,081,270	17.3
• Sanitary napkin (kg)	2,244,498	1,366,974	3,090,419	3,313,309	4,326,145	17.8
• Paper (kg)	33,661,119	34,794,937	49,187,573	79,423,584	88,061,173	27.2
• Artificial Fibers (kg)	60,815,377	69,939,587	63,822,237	71,183,618	75,409,589	5.5
• Excludes beverages (kg)	179,717,341	193,317,388	215,215,906	251,391,587	265,883,823	10.3
Rubber	**80,192,988**	**88,816,509**	**128,024,560**	**139,480,465**	**115,802,003**	**9.6**
Automotive Components & Accessories	**35,432,422**	**33,019,281**	**38,054,714**	**42,095,671**	**42,437,271**	**4.6**
Iron and steel (Steel Scrap)	**161,443,748**	**183,900,703**	**211,432,914**	**290,812,128**	**341,521,554**	**20.6**

Source: Customs Department

3.2) Guideline for export volume forecast (by product)

Forecasting the volume of exports to BIMSTEC countries is a long-term prediction, requiring analysis of statistical data and various factors. There are guidelines for forecasting export volume. 1) The pre-project period (2016-2025), which is based on the growth of export volume to BIMSTEC in 2012-2016, is expected to be in line with expectations. During the first 15 years of project life (2026-2040), the expected growth rate of this period was 75% of the expected growth rate in the first phase and 3) 15 years after Closed (years 2041-2054), which determines the growth rate in the forecast range of 50 percent growth rate predicted at the beginning. The forecasts are as follows.

- **Cement**

  This study expects that the volume of Thai cement exports to BIMSTEC countries before the launch of the project will increase at an average rate of 2.5 percent per annum (for all countries except Myanmar) and the rate of decline. The average annual export volume is 2.5% per annum (for Myanmar). In the subsequent years, 2026-2054, the

average annual export volume is equal to the export volume of cement in 2025.

- The volume of Thai cement exports to BIMTEC countries during 2012-2016 has increased at an average of 5% per year, with Bangladesh, Myanmar, Sri Lanka becoming the major market. In 2016, the export of Thai cement to Myanmar began to decline. It is estimated that the export volume of cement will be 2.5% per year. This represents half of the average annual rate of return.
- In the long term, the export of cement to BIMSTEC countries will tend to decrease. Currently, there are many multinational companies investing in the construction of cement mills in Myanmar. Starting in mid-2016, the prospects for Thai cement exports to Myanmar are likely to be lower, and Myanmar will have more cement capacity. And the cost of labor is lower than Thailand. Therefore, the competitiveness of cement exports is quite good. It can also be exported to Bangladesh, India and Sri Lanka.

○ **Plastic pellets**

It is expected that the export volume of plastic pellets to BIMSTEC countries before the launch of the project will increase at an average rate of 6.9 percent per year. Subsequently, during the first 15 and 15 years of the project. The average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

- In the years 2012-2016 The export volume of plastic pellets to BIMSTEC countries increased by an average of 6.9 percent per year.
- In the long run, due to limited capacity of the plant in Thailand. Raw materials such as natural gas and crude oil are limited. It is expected that the export of plastic pellets during the project opening period (30 years) will tend to increase at an average decrease rate from the pre-project period.

○ **Building Materials**

It is expected that the export volume of construction materials to BIMSTEC countries before the launch of the project will be reduced on average 2.7% per year, and later in the years 2026-2054 will be. The average annual export volume is equal to the volume of exports of building materials in 2025, with the following considerations.

- Between 2012 and 2016, the volume of exports of building materials to BIMSTEC countries fell by an average of 2.7 percent per annum. The major products in this category were Particle board, tiles and bricks.
- In the long term, due to the limited capacity of building materials in Thailand. And Myanmar will have more development of the building materials industry. It is expected that the export of construction materials during the project (30 years) will tend to increase at a fixed rate.

- **Consumer product**

  It is expected that the export volume of consumer product to BIMSTEC countries before the launch of the project will increase at an average rate of 10.0 percent per year. Subsequently, during the first 15 years and 15 years after the launch of the project. The average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

  - During 2012-2016, this product is likely to increase significantly. The major products in this group are soft drinks, paper and artificial fibers. Beverages are the main products in this group. This is likely to decline in 2012-2013, after which it is likely to increase significantly during the years 2013-2016, which is quite volatile. Since the beverage is an influential product of this group, the growth rate of this product is likely to increase significantly. Therefore, the trend of increase in this group. It is determined by the quantity of all products except drinks, which is quite volatile in the forecast. In the same year. consumer products Excluding beverages, the average rate is 10% per year.
  - Because BIMTEC countries are developing consumer product industries (Developing countries often start developing these industries first) and because of this low wage rate This will make the consumer product industry in this country more competitive in its domestic market. It is expected that the export of consumer product during the project (30 years) will tend to increase at an average rate decreased from the pre-project period.

- **Rubber**

  In this study, it is expected that the export volume of Thai rubber to BIMSTEC before the launch of the project will increase at an average rate of 10.0 percent per year, and then in the years 2026-2054, the average export volume per year is equal to the export volume of rubber in 2025, with the following considerations.

  - The export volume of rubber to BIMSTEC in 2012-2016 has an average increase of 10% per year, the major export markets are Sri Lanka and India.
  - In the world market, three major natural rubber producers and exporters in the world, namely Thailand, Indonesia and Malaysia, have a combined output of about 2/3 of world output and export of around 75% of global rubber trade. There are also other natural rubber producers in the ASEAN region, including Vietnam, the Philippines, Myanmar and Cambodia, which are major exporters (China, Japan, South Korea and the United States).
  - Thailand has limited access to rubber plantations. Due to the increase of rubber plantation area to almost every region. There is a shortage of labor in the rubber plantation. The price of natural rubber in the world market does not encourage the farmers in Thailand to increase the area of rubber.

- **Sugar**

  It is expected that the export volume of Thai sugar to BIMSTEC before the launch of the project will increase at an average rate of 10.0 percent per year. Subsequently, during the first 15 and 15 years of the project launch, the average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

  - During 2012-2016, export volume of sugar to BIMSTEC countries increased by 48.0% per year, which is likely to increase. When considering the export of sugar from the past 10 years (2007-2016), it is likely to increase with an average increase of 23.1 percent per year, which is expected to export sugar to the average. 10.0 percent per annum for the pre-projected forecast. That is half of the average annualized rate of 10 years.
  - Thailand Modifies Sugar Trade Policy By canceling export subsidies, sugar (Which was subsidized by domestic sugar sales at a higher price than the global market). Brazil is suing the World Trade Organization.) It is expected that the sugar industry will be able to reduce its export competitiveness.
  - Thailand has limited agricultural land. (Need to cultivate many economic crops) and there is a shortage of labor in the agricultural sector. Including the capacity constraints of sugar factories in Thailand that produce full capacity. It is expected that the export trend of sugar during the project will tend to increase at an average decline from the pre-project period.

- **Fertilizer**

  It is expected that the amount of fertilizer exported to BIMSTEC countries before the launch of the project will increase at an average rate of 9.2 percent per year. Subsequently, during the first 15 years and 15 years after the launch of the project. The average annual rate of decline is 75% and 50%, respectively.

  The following is considered.

  - Between 2012 and 2016, the amount of fertilizer exported to BIMSTEC countries increased by an average of 30.5 percent per year, which is likely to increase. And when considering fertilizer exports. Based on the past 10 years (2007 - 2016), the trend is still increasing with an average increase of 9.2 percent per year.
  - In the long term, Thailand has a high demand for fertilizers. Therefore, the ability to export is quite limited. It is expected that the trend of fertilizer export during the project (30 years) will tend to increase at an average rate decreased from the pre-project period.

- **Automotive components and components**

  In this study, it is expected that the export volume of components and automotive components of Thailand to BIMSTEC countries during the pre-launch period will increase at an average rate of 4.6 percent per year. Subsequently, during the first 15 years and 15 years Project launch, the average annual rate of decline is 75% and 50%, respectively. At first, respectively, the following considerations.

  - During 2012-2016, the export volume of automotive parts and components of Thailand to BIMSTEC countries increased by an average of 4.6 percent per year. The main export markets were India
  - Thailand's automotive parts industry is highly competitive. There are multinational companies from different countries. Especially Japan to invest a lot. Thailand can export cars. And components and accessories. A lot of the world. But in the long run, there will be full capacity constraints. It is expected that the export of components and components of automotive components during the project's opening (30 years) will tend to increase at an average decrease from the pre-launch period.

- **Iron and steel (steel scrap)**

  In this study, it is expected that the volume of steel and steel exports to BIMSTEC countries before the launch of the project will increase at an average rate of 10.0 percent per year. Subsequently, during the first 15 and 15 years of the project launch The average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

  - Over the past 5 years 2012-2016, the export volume of steel and steel products to BIMSTEC countries is expected to increase at an average annual rate of 20.6 percent. Steel and steel exports are expected to average 10.0 percent per year for the pre-projected period. This represents half of the average annual rate of return.
  - In the long term, the trend of steel and steel exports during the project launch period (30 years) is expected to increase at an average rate of decline from the pre-project period.

The average growth rate used to forecast export volume to BIMSTEC countries is summarized in **Table 4.4.2-8**.

Table 4.4.2-8 Average growth rate used to forecast export volume to BIMSTEC countries

Category	Average annual growth rate used in forecasting (%)		
	Pre-opening (Year 2016-2025)	The first 15 years (Year 2026-2040)	After the 15-year project (Year 2041-2054)
1. Cement	+2.5 (For all countries except Myanmar.) and -2.5 (For Myanmar)	stable (Volume equal to year 2025)	stable (Volume equal to year 2025)
2. plastic pellets	6.9	5.2	3.5
3. Building Materials	-2.7	stable (Volume equal to year 2025)	stable (Volume equal to year 2025)
4. Consumer Products	10.0	7.5	5.0
5. Rubber	10.0	stable (Volume equal to year 2025)	stable (Volume equal to year 2025)
6. Sugar	10.0	7.5	5.0
7. Fertilizer	9.2	6.9	4.6
8. Car Components	4.6	3.5	2.3
9. Iron and steel (Scrap)	10.0	7.5	5.0

Source: Analysis by consultants.

4) Forecasting of transport volume of exported product by railway project through Ranong Port

From the model Logit Model presented above. New rail service opened The Chumphon port linking with Ranong Port is likely to attract the volume of product exported to BIMSTEC countries through Laem Chabang Port / Bangkok Port. Transfer to Ranong Port, the figure shown in **Table 4.4.2-9**.

Table 4.4.2-9. Analysis of the proportion of containers to be used for Ranong Port. Classified by product group and destination country.

Category	Destination country	Proportion of the use of Ranong Port (%)
1. Cement	India	10.78
	Myanmar	8.35
	Sri Lanka	7.34
	Bangladesh	7.56
2. plastic pellets	India	9.87
	Myanmar	7.63
	Bangladesh	6.91
3. Building Materials	India	10.15
	Myanmar	7.85
	Sri Lanka	6.89
4. Consumer Products	India	10.15
	Myanmar	7.85
	Sri Lanka	6.89
	Bangladesh	7.11
5. Rubber	India	9.30
	Myanmar	7.18
	Sri Lanka	7.18
	Bangladesh	6.50
6. Sugar	India	11.17
	Myanmar	8.67
	Sri Lanka	7.61
	Bangladesh	7.85
7. Fertilizer	Myanmar	7.87
8. Car Components	India	10.17
9. Iron and steel (steel scrap)	India	9.30

Source: Analysis by consultants.

The proportion of the use of Ranong Port. Analyze the volume of containers expected to use the Ranong port service to export product to BIMSTEC countries when there are rail links from Chumphon to Ranong in the future. Based on current shipment volume data for 2016 and product forecasts for future years in 2025-2054, as shown in **Table 4.4.2-10**.

Table 4.4.2-10 Forecasts on the volume of containers exported to BIMSTEC countries to be used for Ranong port services in 2025-2054 (classification by product)

Category	Destination country	Export Volume (Cabinets)			
		2025	2034	2044	2054
1. Cement	India	428	428	428	428
	Myanmar	620	620	620	620
	Sri Lanka	1,367	1,367	1,367	1,367
	Bangladesh	14,467	14,467	14,467	14,467
	Total	**16,881**	**16,881**	**16,881**	**16,881**
2. plastic pellets	India	2,935	4,622	6,488	9,108
	Myanmar	230	362	509	714
	Total	**3,165**	**4,984**	**6,997**	**9,822**
3. Building Materials	India	195	195	195	195
	Myanmar	84	84	84	84
	Total	**279**	**279**	**279**	**279**
4. Consumer Products	India	898	1,721	2,803	4,566
	Myanmar	426	818	1,332	2,169
	Sri Lanka	190	365	594	968
	Bangladesh	479	919	1,497	2,439
	Total	**1,994**	**3,822**	**6,226**	**10,141**
5. Rubber	India	75	75	75	75
	Sri Lanka	69	69	69	69
	Total	**145**	**145**	**145**	**145**
6. Sugar	Myanmar	2,264	4,340	7,069	11,515
	Sri Lanka	362	694	1,130	1,841
	Total	**2,625**	**5,034**	**8,199**	**13,356**
7. Fertilizer	Myanmar	576	1,049	1,645	2,579
	Total	**576**	**1,049**	**1,645**	**2,579**
8. Automotive components and accessories	India	104	141	177	223
	Total	**104**	**141**	**177**	**223**
9. Iron and steel (steel scrap)	India	1,578	3,026	4,928	8,028
	Total	**1,578**	**3,026**	**4,928**	**8,028**
Grand Total		**27,347**	**35,361**	**45,478**	**61,454**

Source: Analysis by consultants.

As a result of the forecast of export volume from Table 4.4.2-10, it was found that in the year of launching the Chumphon-Ranong Railway Project, in 2025, the main items exported to BIMSTEC countries were exported through the port. Ranong was the most cement-like 16,881, accounting for 62% of exports to BIMSTEC, followed by plastic and sugar of 3,165 and 2,625, accounting for 12% and 10%, respectively. Exports by country are shown in **Table 4.4.2-11**.

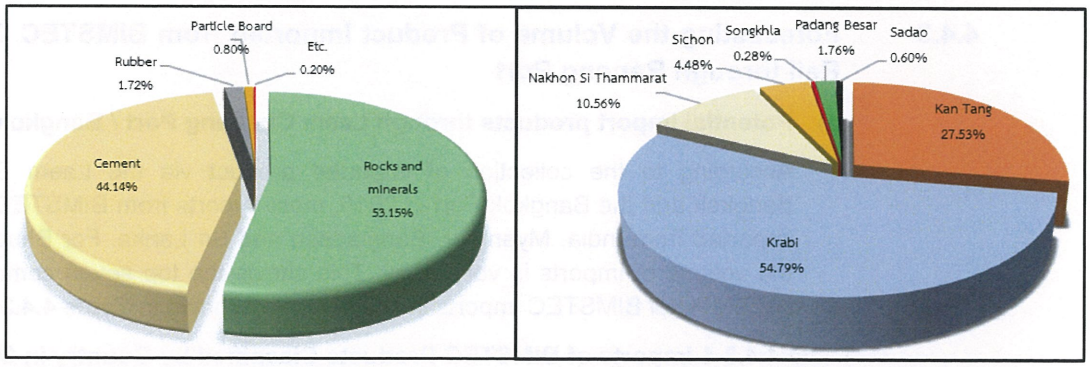
Table 4.4.2-11 Forecasts of export volume to BIMSTEC countries to be used for Ranong port services in 2025-2054 (classified by country)

Destination Country	Category	Export Volume (Cabinets)			
		2025	2034	2044	2054
Bangladesh	cement	14,467	14,467	14,467	14,467
	consumer products	479	919	1,497	2,439
	Total	**14,946**	**15,386**	**15,964**	**16,905**
India	plastic beads	2,935	4,622	6,488	9,108
	Iron and steel (steel scrap)	1,578	3,026	4,928	8,028
	cement	428	428	428	428
	Construction materials	195	195	195	195
	Automotive Components & Accessories	104	141	177	223
	consumer products	898	1,721	2,803	4,566
	Rubber	75	75	75	75
	Total	**6,212**	**10,207**	**15,094**	**22,622**
Myanmar	the sugar	2,264	4,340	7,069	11,515
	cement	620	620	620	620
	fertilizer	576	1,049	1,645	2,579
	consumer products	426	818	1,332	2,169
	plastic beads	230	362	509	714
	Construction materials	84	84	84	84
	Total	**4,200**	**7,273**	**11,259**	**17,682**
Sri Lanka	cement	1,367	1,367	1,367	1,367
	the sugar	362	694	1,130	1,841
	consumer products	190	365	594	968
	Rubber	69	69	69	69
	Total	**1,989**	**2,495**	**3,161**	**4,245**
Grand Total		**27,347**	**35,361**	**45,478**	**61,454**

Source: Analysis by consultants.

From Table 4.4.2-11, it is found that in the year of launching the Chumphon-Ranong Railway Project, in 2025, the main export countries were Ranong, Thailand, Export volume was 14,946, accounting for 55% of exports to BIMSTEC. Main products were cement, followed by India, Myanmar and Sri Lanka with export volume of 6,212 4,200 and 1,989 units. 23, 15 and 7 respectively. The main export products to India were steel, steel and steel (scrap) and consumer product. Major exports to Myanmar are sugar, cement and fertilizer. The main export to Sri Lanka is cement.

In addition, the export of product via the southern region with the opportunity to transport trams across Ranong to BIMSTEC countries has been considered. In 2016, it was found that the products with the highest export weight were: Minerals and minerals (53.15 percent of all products) transported to India. Followed by Bangladesh, Sri Lanka and Myanmar, respectively, followed by cement (44.14% of all exports), and followed by exports to Myanmar. Including stone and mineral products and cement (97.29% of all products). The rest are rubber, particleboard or fiberboard board made of wood, animal feed, seafood, chilled, frozen, etc., through the various transportation. In the south. As shown in **Figure 4.4.2-2**. Exports to each BIMSTEC country in the lower South are shown in **Table 4.4.2-12.**



Proportion of each type **Export ratio of each checkpoint**

Figure 4.4.2-2 Proportion of each type of product and proportion of transport through the southern border of Thailand to BIMSTEC countries in 2016

Table 4.4.2-12 Exports to BIMSTEC countries in 2016 from the southern border of Thailand

Rank	Category	Product volume (KGM)				Total
		Myanmar	India	Bangladesh	Sir Lanka	(KGM)
1	Rocks and minerals	480,000	713,092,000	709,629,000	148,200,000	1,571,401,000
2	cement	1,305,000,500	-	-	-	1,305,000,500
3	Rubber	-	44,849,015	82,000	6,043,210	50,974,225
4	Particleboard or fibreboard	214,032	22,437,125	859,387	-	23,510,544
5	Other nuts, fresh or dried	-	-	2,628,000	-	2,628,000
6	Plaster	-	1,411,820	-	-	1,411,820
7	The main plaster.	-	1,003,000	-	-	1,003,000
8	Animal feed	173,724.0	-	-	454,629	628,353
9	Chilled and frozen seafood	-	238,668	-	-	238,668
10	Materials made of rubber	59,181	-	-	-	59,181
11	Product used for conveying product or packaging.	-	112,842,215	700,000	156,799	113,699,014
	Total (kg)	**1,305,927,437**	**783,031,628**	**713,198,387**	**154,697,839**	**2,956,681,567**
	Total (tons)	**1,305,927.44**	**783,031.63**	**713,198.39**	**154,697.84**	**2,956,681.57**
	Total (pair)	**-**	**112,842,215**	**700,000**	**156,799**	**113,699,014**

Source: compiled by consultants.

Considering the type of products exported through the southern region, the opportunity to transport the rails through Ranong Port to BIMSTEC countries found that most of the products were mainly stone and mineral products. And cement (97.29% of all products). The transport is characterized by transport. Will ship from the port and to the mother ship on the island of Libong. It is about 20-30 nautical miles from the port and is transported to the BIMSTEC countries. The SCG cement is located in Thungsong District, Nakhon Si Thammarat Province. Bagged To export to Myanmar. The main cargo containers are rubber and wood particleboard or board. Including rubber glove products. The production base is located in the lower South. Export to Penang Port. Malaysia The distance is closer and the cost is cheaper. It is unlikely that there will be any chance of transporting cargo to Ranong Port in the future.

4.4.3 Forecasting the Volume of Product Imported from BIMSTEC Countries by Rail through Ranong Port

1) Potential import products through Laem Chabang Port / Bangkok Port

According to the collection of imported product via the Laem Chabang Port, Bangkok and the Bangkok Port in 2016, most imports from BIMSTEC countries are imported from India, Myanmar, Bangladesh and Sri Lanka. For Bhutan and Nepal, the volume of imports is very small. This shows the top seven commodity imports (72% of total BIMSTEC imports in kilograms) as shown in **Table 4.4.3-1.**

Table 4.4.3-1 Imports of BIMSTEC Products Classified by Country in 2016

Rank	Product	HS Code	Unit	India	Myanmar	Sri Lanka	Bangladesh	Total
1	Sulfur, clay, and soils.	25	KGM	226,448,267	0	0	0	**226,448,267**
2	Iron and steel	72	KGM	148,327,233	0	0	0	**148,327,233**
3	Consumer Products & Seeds	09, 11, 12, 15, 07	KGM	91,855,049	17,653,421	16,268,300	3,509,740	**129,286,510**
4	Fish and chilled water fish	03	KGM	63,230,535	189,649	0	0	**63,420,184**
5	Agricultural Product Group	23, 31	KGM	31,163,294	0	0	31,000,000	**62,163,294**
6	Industrial Products	28, 87, 39, 74	KGM	64,587,945	9,219,380	110,000	66,843	**73,984,168**
7	Wood and wooden charcoal	44	KGM	6,897,460	0	0	0	**6,897,460**
			MTQ	0	299,592	0	0	**299,592**
							Total (KGM)	**710,527,116 (72%)**
							Total (MTQ)	**299,592 (100%)**

Source: Customs Department

The volume of imported product. It will consider only the product that can be transported by container. It will not consider the product. And products that require specialized facilities. This is a cargo that can be transported back. To reduce the number of empty containers. Thailand is mainly export products. And the amount of imported product is very small, so transport empty containers in the back. And it reflects the cost of shipping. The container can be considered from the nature of the product. The products will be packaged in the form of bags, boxes, bottles, gallons, etc. that can be imported into the container. By considering that. Containers can be containerized. And it is likely to be imported through Ranong Port in the future. Products include:

Group 1: Wood and wood charcoal Products in this group. If imported from Myanmar, most of the wood products, such as teak, plywood and pruning for imported product from India, mostly charcoal from coconut. Most of them are transported to wood processing factories in Bangkok and its vicinity.

Group 2: Sulfur, Soil, and Plaster Most of the products in this group are salt and marble used in construction. Salt is an important raw material. Because it is used in the consumption. It can also be used in the manufacturing sector as well in the chemical industry. Chlorine compounds in salt are added to the tap water to help sterilize and deodorize, as well as being an important raw material for the production of PVC pipes. The main sources are from India. Most of them are transported to Bangkok and its vicinity.

Group 3: Iron and Steel Most of them are semi-finished products. And rolled products made of steel or stainless steel. India is the main import market. Most of them are transported to steel processing plants in Bangkok and its vicinity.

Group 4: Consumer Products and Seeds Products in this group include:

- Spices, teas, coffee, tea and tea, most of which are chilli (almost all), which are chilli, dried or crushed or ground.
- Products of the milling industry, milling and starch grains, starches, most of which are wheat flour. Second, grain products (corn)
- Grain, cereal and oil products. Most of the peanuts are edible. And seeds.
- Fat and oil products derived from animals and plants. (Consumable)
- Vegetable products, including some edible roots and heads Mostly green beans.

India is the main import market, followed by Myanmar and Sri Lanka, where most destinations are transported to Bangkok and its vicinity.

Group 5: Agricultural Products The products include animal feed, residues and residues from the food and fertilizer industries, with India and Bangladesh being the main import markets. Most of them are transported to the central area.

Group 6: Industrial Products Products in this group include inorganic chemicals. Automotive and components Plastic and plastic Copper and copper India is the main import market. Most of them are transported to factories in Bangkok and vicinity.

For special containers, such as the Reefer Container or Refrigerator, which is suitable for packaging fresh products that require refrigeration to maintain the quality of fresh produce required. Cooling to maintain product quality. Products used in this type of cabinet are fish and chilled water fish, which in this study is not taken into account. Because it is a commodity that requires the cabinets in a particular way to transport. The study of these imports has helped to reduce the number of empty containers exported from Thailand to BIMSTEC countries (in return product). Thailand is a major export country.

Considering the source or import of product. Most of them are located in Bangkok and its vicinity, and the central region can be summarized as the destination. (Source of consumption) of imported product is shown in **Table 4.4.3-2**.

Table 4.4.3-2. Consumption of imported product from BIMSTEC countries

Product	Bangkok and vicinity	Central Region
1. Wood and wood charcoal	√	
2. Salt, sulfur, soil and stone, plaster	√	
3. Iron and steel	√	
4. Consumer Products and Seeds	√	
5. Agricultural Products		√
6. Industrial Products	√	

Source: Consultant

Due to the potential transportation of product from BIMSTEC countries through Ranong Port. And rail transportation to domestic consumption. It is the container that is the main container. The conversion of such items into a cabinet. Because of the cost. Will be in the unit of the cabinet. The potential quantity of product in the unit is shown in **Table 4.4.3-3**.

Table 4.4.3-3 Imports volume of key products from BIMSTEC countries by country in 2016

Product	India (cabinets)	Myanmar (cabinets)	Sri Lanka (cabinets)	Bangladesh (cabinets)	Total (cabinets)
1. Wood and wood charcoal	276	9,986	0	0	10,262
2. Salt, sulfur, soil and stone, plaster	9,058	0	0	0	9,058
3. Iron and steel	5,933	0	0	0	5,933
4. Consumer Products and Seeds	3,666	706	651	140	5,171
5. Agricultural Products	1,247	0	0	1,240	2,487
6. Industrial Products	2,584	369	4	3	2,959
Total	**22,763**	**11,061**	**655**	**1,383**	**35,870**

Source: Customs Department

2) Freight Charge

The analysis and collection of data, costs and timeliness of BIMSTEC imports to Thailand destinations via Laem Chabang Port / Bangkok Port and Ranong Port. The cost of transporting imported goods is included in Ocean Freight, which represents the cost of shipping between BIMSTEC countries and the terminals in Thailand, as shown in the Table 4.4.2-4 above and Inland Freight Charge on both road and rail, as shown in **Table 4.4.3-4**.

Table 4.4.3-4 Domestic Transport Costs for BIMSTEC Imports through Laem Chabang / Bangkok Port and Ranong Port

Category	Destination	Through Laem Chabang Port / Bangkok Port		Through Ranong Port	
		Distance (Kilometer)	Expenditure (Baht / cabin / trip)	Distance (Kilometer)	Expenditure (Baht / cabin / trip)
1. Wood and wood charcoal	Bangkok	150-200	3,500-4,500	700-750	10,000-11,000
2. Salt, sulfur, soil and stone, plaster	Bangkok	150-200	3,500-4,500	700-750	10,000-11,000
3. Iron and steel	Bangkok	150-200	3,500-4,500	700-750	10,000-11,000
4. Consumer Products and Seeds	Bangkok	150-200	3,500-4,500	700-750	10,000-11,000
5. Agricultural Products	Central Region	200-250	4,000-5,000	800-850	11,000-12,000
6. Industrial Products	Bangkok	150-200	3,500-4,500	700-750	10,000-11,000

Remarks: * The distance and cost of transportation through Ranong port is inclusive of domestic and road transport.
Source: Business Sentiment Survey

Analysis and collection of data, costs and time of importing goods from BIMSTEC countries through Laem Chabang Port / Bangkok Port and Ranong Port to the destination or source of goods in Thailand, including the cost of domestic transportation both by road and by rail. It can summarize and compare the cost and time of transportation through Laem Chabang Port / Bangkok Port and Ranong Port, as shown in **Table 4.4.3-5**.

Table 4.4.3-5 Comparison of Cost and Time of Freight Import through Laem Chabang Port / Bangkok and Ranong Pier Overall, domestic land transportation

Product / Destination	Origin	The cost of importing goods from BIMSTEC countries			
		Through Laem Chabang Port / Bangkok Port		Through Ranong Port	
		By Road	Period	By Rail	Period
		(USD/cabinets)	(days)	(USD/cabinets)	(days)
1. Wood and wood charcoal					
Bangkok and vicinity	India	756	19	885	10
	Myanmar	856	14	985	7
2. Salt, sulfur, soil and stone, plaster					
Bangkok and vicinity	India	756	19	885	10
3. Iron and steel					
Bangkok and vicinity	India	756	19	885	10
4. Consumer Products and Seeds					
Bangkok and vicinity	India	756	19	885	10
	Myanmar	856	14	985	7
	Sri Lanka	906	16	1,035	10
	Bangladesh	956	15	1,135	8
5. Agricultural Products					
Central Region	India	786	19	915	10
	Bangladesh	986	15	1,165	8
6. Industrial Products					
Bangkok and vicinity	India	756	19	885	10
	Myanmar	856	14	985	7
	Sri Lanka	906	16	1,035	10
	Bangladesh	956	15	1,135	8

3) Forecast of export volume to BIMSTEC countries

The forecast of export trends in the years 2025-2054 is due to the forecast of the export trend of 30 years, so the analysis of statistics and various factors. The forecasts are as follows.

3.1) Export volume statistics to BIMSTEC countries

The study collected statistical data on export volume to BIMSTEC countries during 2012-2016. And to analyze the forecasts of future products. The amount of export product from the Customs Department. The export volume is shown in **Table 4.4.3-6**.

Table 4.4.3-6 Import volume from BIMSTEC countries for 2012-2016

Product volume (Cabinets)	Year 2012	Year 2016	Growth rate per year (%)
1. Wood and wood charcoal	4,205	10,262	25.0
2. Salt, sulfur, soil and stone, plaster	6,316	9,058	9.4
3. Iron and steel	8,520	5,933	-8.6
4. Consumer Products and Seeds	5,831	5,171	-3.0
• Dry chilies or grind or grind	1,268	1,794	9.1
• Products of the milling industry and color grains.	1,186	980	-4.7
• Grains, cereals and fruit oils.	1,303	874	-9.5
• fats and oils derived from animals and plants;	802	850	1.5
• Vegetables, including roots and certain edible species.	1,272	673	-14.7
5. Agricultural Products	19,439	2,487	-40.2
• Feed	19,359	1,247	-49.6
• fertilizer	80	1,240	98.5
6. Industrial Products	1,959	2,959	10.9
• Inorganic Chemicals	626	1,045	13.7
• Automotive and Components	726	793	2.2
• plastic and plastic	533	752	9.0
• Copper and copper.	73	369	49.9

Source: Customs Department

3.2) Guideline to forecast import volume (by product)

Forecasting the volume of imports from BIMSTEC countries is a long-term prediction, requiring analysis of statistics and environmental factors. The volume of imported product is forecasted. 1) The pre-project period (2016-2025), which is based on the growth rate of BIMSTEC's imports during 2012-2016, is used for forecasting. 2) During the first 15 years of the project (2026 - 2040), the expected growth rate of this period is 75% of the expected growth rate in the first phase and 3) 15 years after The project (year 2041-2054), in which the growth rate in the forecast range of 50 percent growth rate predicted at the beginning. The forecasts are as follows.

- **Wood and wood charcoal**

  It is expected that the volume of imports from BIMSTEC countries in the pre-project period will increase at an average rate of 10.0 percent per year. Subsequently, during the first 15 and 15 years of the project launch The average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

- During 2012-2016, the volume of imports of timber and timber Charcoal from BIMSTEC countries has averaged 25.0 percent per year, with Myanmar and India being the main importers. The import of wood and wood Charcoal is expected to be used at an average rate of 10.0 percent per year for projected pre-launch periods. This represents about half of the average annual increase in historical data.
- In the long term, the trend towards the import of wood and wood products is expected. At the beginning of the project (30 years), the logs will tend to increase at an average rate of decline from the pre-project period.

○ **Sulfuric salt, soil and stone products, plaster** (salt)

It is expected that the import volume of this product from BIMSTEC countries before the launch of the project will increase at an average rate of 9.4 percent per year. Subsequently, during the first 15 years and 15 years after the launch of the project. The average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

- During 2012-2016, the import volume of salt products from BIMSTEC countries increased by an average of 9.4 percent per year, with India as the main source of imports.
- At present, Thailand has relatively balanced production and use of salt in the country. It also imports more salt as well. In the future, Thailand will have a potash mining industry in the country for the first time. Potash is a mixture of fertilizer that is important for accelerating agricultural production. Meanwhile In the production of potash. In the long run, it is expected that the import of salt products during the project's opening period (30 years) will increase. The average rate decreased from the pre-project period.

○ **Iron and steel** (Semi-finished products and rolled products)

It is expected that the volume of imports of steel and steel from Thailand from BIMSTEC (imported from India) during the years 2025-2054 (long term) will have an average annual import volume equal to the lead volume. Steel and steel in 2016 with the following considerations.

- During 2012-2015, the import volume of steel and steel of Thailand from BIMSTEC countries decreased by 8.6%
- Import sources for steel and steel imports from Thailand include Japan, China, South Korea, Taiwan, Iran, USA, Malaysia, Vietnam and Russia. Major steel imports from India include HS7201, HS7202, HS7207, HS7225, and HS7209).
- Manufacturers in various industries in Thailand, such as the automotive industry. Electronics and the steel industry. It is a multinational company based in Japan, South Korea, China and the United States. It is likely to import steel raw materials from the countries where the parent company is located.

- In the long term, import volume of steel and steel from BIMSTEC countries is likely to remain stable.

- **Consumer groups and seeds** (chilli, wheat flour, peanuts, seeds and green beans)

  It is expected that the import volume of Thailand's consumer and grain products from BIMSTEC during the years 2025-2054 (long-term) will have an average annual import volume equal to the import volume of product. For consumption and seeds in 2016 with the following considerations.

  - During 2012-2016, the volume of imports of food and grain products from Thailand from BIMSTEC countries decreased by 3.0 percent per year.

  - When considering the products in this group, it was found that most of the products are chili. (Dry or crushed or crushed), which is likely to increase. Meanwhile, other products such as wheat flour, peanuts and seeds. Have a downward trend It is evident that these products tend to increase and decrease in the product. Therefore, in the long run, it is expected that this product will have a stable growth trend.

- **Agricultural Products** (Animal feed and fertilizer)

  It is expected that the volume of imports of agricultural products from Thailand from BIMSTEC countries during the years 2025-2054 (long term) will have an average annual import volume equal to the import volume of agricultural products in the year. 2016, with the following considerations:

  - During 2012-2016, the volume of imports of agricultural products in Thailand from BIMSTEC countries has decreased at an average of 40.2 percent per year.

  - In 2016, the proportion of feed and fertilizer is similar. However, considering the trend of commodities, it is found that in the years 2012 - 2016, animal feed is likely to decrease considerably. As fertilizer is likely to increase quite a lot, so in the long run, it is expected that this product will have a stable growth.

- **Industrial Products** (Inorganic chemicals Automotive and components Plastic and plastic Copper and copper)

  It is expected that the volume of imports from BIMSTEC countries in the pre-launch period will increase by 10.9 percent per year. Then, during the first 15 and 15 years of the project launch, the average annual rate of decline is 75% and 50%, respectively, based on the expected average growth rate in the first period, respectively.

  - During 2012-2016, the volume of imports of industrial products from BIMSTEC countries has increased at an average rate of 10.9 percent per year, with India as the main source of imports.

- When considering each product in 2012-2016, all products in this group tend to be in the same direction, with the trend of increasing imports as well.

The average growth rate used to forecast the volume of imports from BIMSTEC countries is summarized in **Table 4.4.3-7**.

Table 4.4.3-7 Average growth rate used to estimate the import volume from BIMSTEC countries

Category	Average annual growth rate used in forecasting. (%)		
	Pre-opening (2016-2025)	The first 15 years (2026-2040)	After the 15-year project (2041-2054)
1. Wood and wood charcoal	10.0	7.5	5.0
2. Salt, sulfur, soil and stone, plaster	9.4	7.1	4.7
3. Iron and steel	stable (product volume equal to year 2016)	stable (product volume equal to year 2016)	stable (product volume equal to year 2016)
4. Consumer Products and Seeds	stable (product volume equal to year 2016)	stable (product volume equal to year 2016)	stable (product volume equal to year 2016)
5. Agricultural Products	stable (product volume equal to year 2016)	stable (product volume equal to year 2016)	stable (product volume equal to year 2016)
6. Industrial Products	10.9	8.2	5.5

Source: Consultant

4) Forecasting of transport volume of imported product by railway project through Ranong Port

From the Logit Model equations and coefficients. The above presentation. New rail service opened The Chumphon port linking with Ranong Port is likely to attract the volume of product imported from BIMSTEC countries through Laem Chabang Port. Bangkok Port and the port in Bangkok, Ranong using Ranong Port. The figure shown in **Table 4.4.3-8**.

Table 4.4.3-8 Analysis of the proportion of containers to be used for Ranong Port. Classified by product group and country of origin

Category	Origin Country	Proportion of the use of Ranong Port (%)
1. Wood and wood charcoal	India	10.15
	Myanmar	7.85
2. Salt, sulfur, soil and stone, plaster	India	10.15
3. Iron and steel	India	10.15
4. Consumer Products and Seeds	India	10.15
	Myanmar	7.85
	Sri Lanka	7.85
	Bangladesh	7.11
5. Agricultural Products	India	10.17
	Bangladesh	7.12
6. Industrial Products	India	10.15
	Myanmar	7.85
	Sri Lanka	6.89
	Bangladesh	7.11

Source: Analysis by consultants.

The proportion of the use of Ranong Port. Analyze the volume of containers expected to use the Ranong port service to import product from BIMSTEC countries when the railway link from Chumphon to Ranong port in the future. Based on current shipment volume data for 2016 and forecasts for future products in the years 2025-2054, by source and destination of the commodity groups as shown in **Table 4.4.3-9**

Table 4.4.3-9 Forecasts of volume of imported containers from BIMSTEC countries to be used for Ranong Port Services in 2025-2054 (classification by products)

Category	Origin Country	Import volume (cabinets)			
		2025	2034	2044	2054
1. Salt, sulfur, soil and stone, plaster	India	2,064	3,811	6,032	9,549
2. Iron and steel	India	602	602	602	602
3. Wood and wood charcoal	Myanmar	1,849	3,546	5,776	9,408
4. Consumer Products and Seeds	India	372	372	372	372
5. Agricultural Products	India	127	127	127	127
	Bangladesh	88	88	88	88
	Total	**215**	**215**	**215**	**215**
6. Industrial Products	India	666	1,350	2,295	3,901
รวมทั้งหมด		**5,769**	**9,896**	**15,292**	**24,048**

Source: Analysis by consultants.

As a result of the forecast of import volume from Table 4.4.3-9, it was found that in the year of launching the Chumphon-Ranong Railway Project (2025), the main products imported from BIMSTEC countries through Ranong Port were the most items Sulfur, clay, soils, and plaster stones accounted for 36% of BIMSTEC's imports, followed by wood and charcoal, and bulk products. There are 1,849 and 666 units, representing 32 per cent and 12 per cent respectively. The volume of imported products is shown in **Table 4.4.3-10**.

Table 4.4.3-10 Forecast of the volume of imported containers from BIMSTEC countries to be used for Ranong port services in 2025-2054 (classified by country)

Origin Country	Category	Export Volume (Cabinets)			
		2025	2034	2044	2054
India	Sulfur, clay, and soils.	2,064	3,811	6,032	9,549
	Iron and steel	602	602	602	602
	Consumer Products & Seeds	372	372	372	372
	Agricultural Product Group	127	127	127	127
	Industrial Products	666	1,350	2,295	3,901
	Total	**3,831**	**6,262**	**9,428**	**14,552**
Myanmar	Wood and wooden charcoal	1,849	3,546	5,776	9,408
	Total	**1,849**	**3,546**	**5,776**	**9,408**
Bangladesh	Agricultural Product Group	88	88	88	88
	Total	**88**	**88**	**88**	**88**
Grand Total		**5,769**	**9,896**	**15,292**	**24,048**

Source: Analysis by consultants.

Table 4.4.3-10 shows that in the year of launching of the Chumphon-Ranong Railway Project (2025), the main importing country of Ranong is Ranong. Import volume was 3,831, accounting for 66% of the volume of imports from the BIMSTEC group. The main products were sulfur, clay and clays. Iron and steel products, followed by Myanmar and Bangladesh, had an import volume of 1,849 and 88, accounting for 32% and 2%, respectively. Main items imported from Myanmar were wood Coal and wood for Bangladesh. The main products are agricultural products.

Imports from the southern border of BIMSTEC countries in the year 2016 were very small. By importing through Songkhla the most about 8,745 tons, about 90 percent of all products. The most imported products are: Fresh seafood is chilled and frozen, which is approximately 7,087 tonnes (85%). Imports from India are 6,978 tonnes (85%) and Myanmar (110%). When considering consumption sources, it is found that most of them are located in Songkhla province. Therefore, it is expected that the import of product and rail transport through the port to the southern area is very low. Due to the limited nature of the container and its small volume. The consumption in the area of Songkhla.

4.5 Conclusions of The Study and Forecast of Traffic and Transportation

4.5.1 Collection and Survey of Traffic and Transportation Information

Collection of data on network and volume of passenger transport and transportation in the study area, can be summarized as follows.

- At present, the main route between Chumphon and Ranong is Phetkasem Road (Highway 4). From Chumphon (Pathomporn Intersection) - Ranong is a 2-4 lane road. About 5,000 - 11,500 vehicles per day. Most of them are bus about 80%. Most of the traffic is in the province and between Chumphon and Ranong. The main purpose is to work about 60%. Travel for Tourism will account for about 10% of travel. For air travel, the current airline is a small airline flying from Bangkok (Don Muang) 3-4 times a day. In the year 2016, the number of passengers traveling by air, including In Chumphon and Ranong, the number of passengers increased by 8,551 per year in 2011, an increase of 87% per year. Chumphon and Ranong have the same proportion of travel.
- At present, all cargo through the port of Ranong has a total cargo volume of 167,864 tons and a total of 3,071 TEUs in 2016. In addition, there is a private jetty. Many small Is located The Khao Nanghong, Kra Buri River, Ranong Province, can accommodate up to 500 tons of grosos, most of which are transported to Myanmar (island of two marshmallows). Construction materials Cement and consumer goods. The source of production or origin in the upper area is the Central, Eastern and Bangkok and its vicinity.

In addition, traffic and transportation problems have been accumulated in the project area.

- Currently traveling from Chumphon to Ranong, there are no rail links. There are only road network links. The road is 2-4 lanes and the road is steep and winding because it is a mountainous area. Traveling between each other is not very convenient. Especially for cargo trucks. Chumphon and Ranong Airports are also located away from the city. The journey into the city is quite remote and uncomfortable.

- Ranong Deep Sea Port, which is the main port used to transport Thai Andaman coast. Linking maritime routes with BIMSTEC countries, a framework for cooperation.
- Bangladesh, Bhutan, India, Myanmar, Nepal and Sri Lanka have no cargo through the port. In the past, there were lines that used to transport goods through Ranong Port to BIMSTEC countries, but were unable to bear high costs. And the goods are not enough. Therefore, we have canceled the use of Ranong port, such as the NCL boat line, because there is no cargo area behind the port. Moreover, there are problems connected to the network linking Ranong Port. Accessible by road only. Increased freight costs.

4.5.2 Projected Passenger Volume Forecast

Forecast of passenger volume of Chumphon - Ranong Railway Construction Project, the National Model (NAM) of the Office of Transport and Traffic Policy and Planning (OTP) has updated the traffic survey data and collected additional traffic and transportation data. Traffic and travel conditions in the study area, after that, the national model of transportation and traffic (National Model: NAM) was applied. It covers all types of trips and areas. Both provincial and nationwide. It also considers the emerging traffic volumes. The Induced Traffic, which is the amount of traffic generated by the construction of the railway project Chumphon - Ranong. It is an economical and convenient alternative to travel. Cause the journey The results are shown in **Table 4.5.2-1**.

Table 4.5.2-1 Forecast of total passenger volume using the Chumphon-Ranong Railway Project

Forecast	Passenger Volume (person / day)			
	Year 2025	Year 2034	Year 2044	Year 2054
Passenger Volume	5,724	7,331	9,331	11,710

4.5.3 Forecasting the Volume of Product Transported By Train Through Ranong Port

Forecast of freight traffic in Chumphon - Ranong Railway Construction Project Therefore, it is necessary to revise the model used to study the decision behavior of the selected route and port to be used in the transportation. The Logit Model was used to simulate the decision making behavior of transportation routes through Ranong Port. It is based on the assumption that the operator does not consider only the Monetary Costs, but will focus on the total cost incurred throughout the transit route contain with monetary expenses With wasted time

Considering the potential for future Ranong port, found that most products there are sources or sources in the upper area, the central, eastern, lower northeast and Bangkok and its vicinity. It consists of cement, plastic, sugar, construction materials, fertilizers and consumer goods. And components and components of automotive. The main destinations are in India, Myanmar, Bangladesh and Sri Lanka. Imports that are likely to be imported via Ranong Port in the future. It is found that most products have the same source or destination in the upper area. There are groups of commodities such as salt, sulfur, soil and stone. Wood and charcoal, iron, steel and steel. Products for consumption and grain. The main sources are in India, Myanmar, Bangladesh and Sri Lanka, as shown by the forecast of the volume of export and import containers from BIMSTEC countries to switch to rail transport through Ranong Port. **Table 4.5.3-1**.

Table 4.5.3-1 Forecasts of the volume of export and import containers from BIMSTEC countries to be converted to rail transport through Ranong Port in 2025-2054

Volume forecast	Product Volume (cabinets / year)			
	Year 2025	Year 2034	Year 2044	Year 2054
Volume of export containers	27,347	35,361	45,478	61,454
Volume of import containers	5,769	9,896	15,292	24,048
Total	33,116	45,257	60,770	85,502

Exports through the southern region, with the opportunity to transport trams across the Ranong port to BIMSTEC countries, found that most of the products were commodity types, rocks and minerals. And cement (97.29% of all products) and other products. The production base is located in the lower South. Export to Penang Port. Malaysia The distance is closer and the cost is cheaper. It is unlikely that there will be any chance of transporting cargo to Ranong Port in the future.

Chapter 5

Engineering Design

Chapter 5
Engineering Design

5.1 Engineering Design

5.1.1 Route Alignment Design

Route alignment design defines horizontal alignment and vertical alignment, taking into account the engineering suitability such as area conditions, major design criteria, locomotive performance and operation plan to respond effectively to the needs of passengers and goods including consideration of environmental impacts, such as avoiding the Watershed Classification 1, national park, wildlife sanctuaries, community and places of importance to the community such as religious places, schools, hospitals, government offices and historical landmarks.

5.1.1.1 Railway Geometric Design

Railway geometric design comply with the detailed design criteria and standards which are based on the standards of the State Railway of Thailand and the consistent universal standards, e.g. European Norm, British and American Standards, International Standards Organisation (ISO), The Union Internationale des Chemins de fers (UIC) and AREMA (American Railway Engineers and Maintenance of Way Association) etc.

Route alignment design must take into account the suitability for the terrain of the alignment and the design criteria. The factors and design criteria to consider include.

- Maximum speed.
- Safety distance of structural gauge.
- Track distance.
- Right of way.
- Ability to add tracks, develop or adapt to electrification train or high speed train in the future.
- Sensitive areas, e.g. communities, religious places, schools etc.
- Environmental conservation area e.g. national reserved forest, watershed area, wildlife sanctuary etc.
- Station location and layout.
- Drainage system
- Terrain or physical characteristics along the alignment.
- Existing public utilities including future plans.
- Other obstacles.

The railway geometric design is designed according to the criteria of the southern double track project of the State Railway of Thailand as shown in **Table 5.1.1-1.**

Table 5.1.1-1 Design Criteria of the Route Alignment

Item		Criteria / Standard
Typical Standards	Maximum design speed (Vmax) - Common area - Restricted area	 160 km./hr. 120 km./hr.
	Track gauge (G)	1,000 mm. (Minimum distance between rails) (1,060 mm. for geometric calculation)
	Structural profile	General : W 3,700 mm. x H 5,900 mm. For platform : W 3,060 mm.
	Loading profile	General : W 2,920 mm. x H 5,650 mm. For platform : W 2,920 mm. (V > 120 km./hr.) : W 2,860 mm. (V ≤ 120 km./hr.)
	Train length	Normally 20 m. long for commuter train 18-25 m. long for the SRT (use for calculation only)
	Maximum axle load	16 tf (passenger train and the SRT's locomotive) 20 tf (the SRT's freight train)
	Trainset and maximum length	The SRT's passenger train consisting of 20 cars (Maximum length 480 m.) The SRT's freight train consisting of 40 cars (Maximum length 620 m.)
Route Alignment	Minimum horizontal curve radius (R)	1. Main line (R ≥ 2,000 m. desirable) 1,600 m. for Vmax = 160 km./hr. 900 m. for Vmax = 120 km./hr. (400 m. for special case) 2. Depot and Siding track 200 m.
	Minimum horizontal curve radius at station	1. Straight is a fundamental rule for main track 2. General case for siding track and special case for main track 1,000 m.(600 m. if necessary) (Distance between track center and platform must be widened according to Vmax, curve radius and cant)
	Minimum vertical curve radius	Main line: 5,000 m. (Vmax ≤ 120 km./hr.) 10,000 m. (Vmax > 120 km./hr.)
	Maximum gradient for main line	1% (1.2% if necessary)
	Maximum gradient at station	0% (0.12% if necessary)
	Maximum cant (Cmax)	Cmax = Min. (90 mm., $G^2/(0.006H)$) (H = height of the center of rolling stock gravity, or 1.70 m.)
	Maximum cant deficiency	Cdmax = 50 mm.
	Maximum cant excess	Cexmax = 65 mm.

Table 5.1.1-1 Design Criteria of the Route Alignment (Cont'd)

Item		Criteria / Standard
	Applied cant (Co)	1. Ballasted track Co = (2/3) x 8.338 $(Vm+5)^2/R$ < 90 mm. Vm : Maximum actual operation speed at the curve. 2. Ballastless track Co = 8.338 Vo^2/R < 90 mm. Vo: Average speed at the curve 0.8Vmax Vmax : $((90+50) R/8.338)^{1/2}$< 120 km./hr.) However, possible maximum speed must be checked by Cd
	Transition curve form	Half sine curve (Vmax >120 km./hr. and TCL ≥ 50 m.) Half sine or cubic parabola (Vmax ≤ 120 km./hr. or TCL ≥50 m.) Cubic parabola (TCL < 50 m.)
	Minimum length of transition curve (TCL)	L = Max (L1, L2, L3) : L1 = 1.0C, L2 = 0.011CV, L3 = 0.0095CdV (If necessary, Vomax > 75 km./hr.): L1 = 0.6C, L2 = 0.0085CV, L3 = 0.0074CdV (If necessary, Vomax ≤ 75 km./hr.): L1 = 0.4C, L2 = 0.074CV, L3 = 0.0074CdV Where C = 8.338 Vo^2/R < 90 mm. V = Vmax at the curve Vo = 0.8Vmax or average speed Vmax : $((90+50) R/8.338)^{1/2}$ < 120 km./hr.) Cd = 8.338 $V^2/R - C$ < 50 mm. (Note : Vmax is not the actual operational speed except when necessary)
	Minimum length of tangent	1. Vmax > 120 km./hr. : 50 m. If impossible, two curves can be connected by one transition curve without tangent. 2. Vmax < 120 km./hr. : 20-25 m. (depends on the train length) If impossible, two curves can be connected by one transition curve without tangent.
	Minimum length of circular curve	1. Vmax > 120 km./hr. : 50 m. If impossible, two curves can be connected by one transition curve without tangent. 2. Vmax < 120 km./hr. : 20-25 m. (depends on the train length) If impossible, two curves can be connected by one transition curve without tangent.
	Minimum distance between track centers	4.0 m. outside station yard 5.0 m. between main line and siding track 4.5 m. between siding track
	Widening of structural profile	Structural profile, distance between track centers and formation width must be widened according to curve radius and applied cant
Track Structure	Rail profile	UIC 54
	Rail inclination	Main line 1:40, Depot 1:40
	Continuous welded rail (CWR)	1. Ballasted track R ≥ 500 m. 2. Ballastless track R ≥ 400 m.
	Bond (normal)	Ballastless track : 0.5 t/rail/m.

Table 5.1.1-1 Design Criteria of the Route Alignment (Cont'd)

Item		Criteria / Standard
	Minimum ballast thickness	1. Main track 300 mm. 2. Siding track 250 mm. 3. Depot 200 mm. 4. Good ballast at 150 mm. thick, the ballastless track shall be used for civil engineering design.
	Minimum concrete thickness	100 mm. (100-150 mm. beneath the track)
	Freight train length	Maximum 600 m.
	Turn out angle	1. Main line Vomax > 120 km./hr. : 1:16 Vomax < 120 km./hr. : 1:12 2. Siding track and depot : 1:8, 1:10
	Sleeper	1. Prestressed concrete 2. Plastic (as per the SRT's approval) 3. Wooden sleeper (for depot only)
Station	Platform height	4. The SRT standards
	Minimum platform width	More than 5 m. wide at the end of platform and 8 m. wide in the middle 4 m. wide for single track (2.0 m. wide if necessary) 5 m. wide for double track (3.0 m. wide if necessary) In case of wall installation, the platform width has to be widened.
	Distance between structure and the lowest edge of platform	- 2 m. (no wall installation) - If necessary, 1 m. for column and 1 m. for wall

5.1.1.2 Railway Cross Section Design

The railway cross section design is set to have the right-of-way width of 50 m. for double track construction with side ditch for longitudinal drainage. A single track shall be constructed in the beginning and when there are sufficient passenger and freight volumes, a double track shall be constructed without having to expropriate more land in the future. In some section of the alignment, it is necessary to have the right-of-way width more than 50 m., e.g. area to construct station and area to construct the local road along the alignment for solving community separation problem. Some section of the alignment also needs to have high embankment or deep cut as the terrain is hill alternating with mountain. The track formation of the project is as follows:

1) At-grade Railway

For double track design, the first thing to consider is the distance between the center of the structural gauge which the distance has to be sufficient for trains running in opposite directions. **Figure 5.1.1-1** shows the safety distance of structural gauge. If a double track is constructed simultaneously, the minimum distance between both centers is 4.00 m. If a double track is not constructed at the same time to avoid the disturbance of train operation, the minimum distance between both centers is 5.00 m. as shown in **Figure 5.1.1-2**.

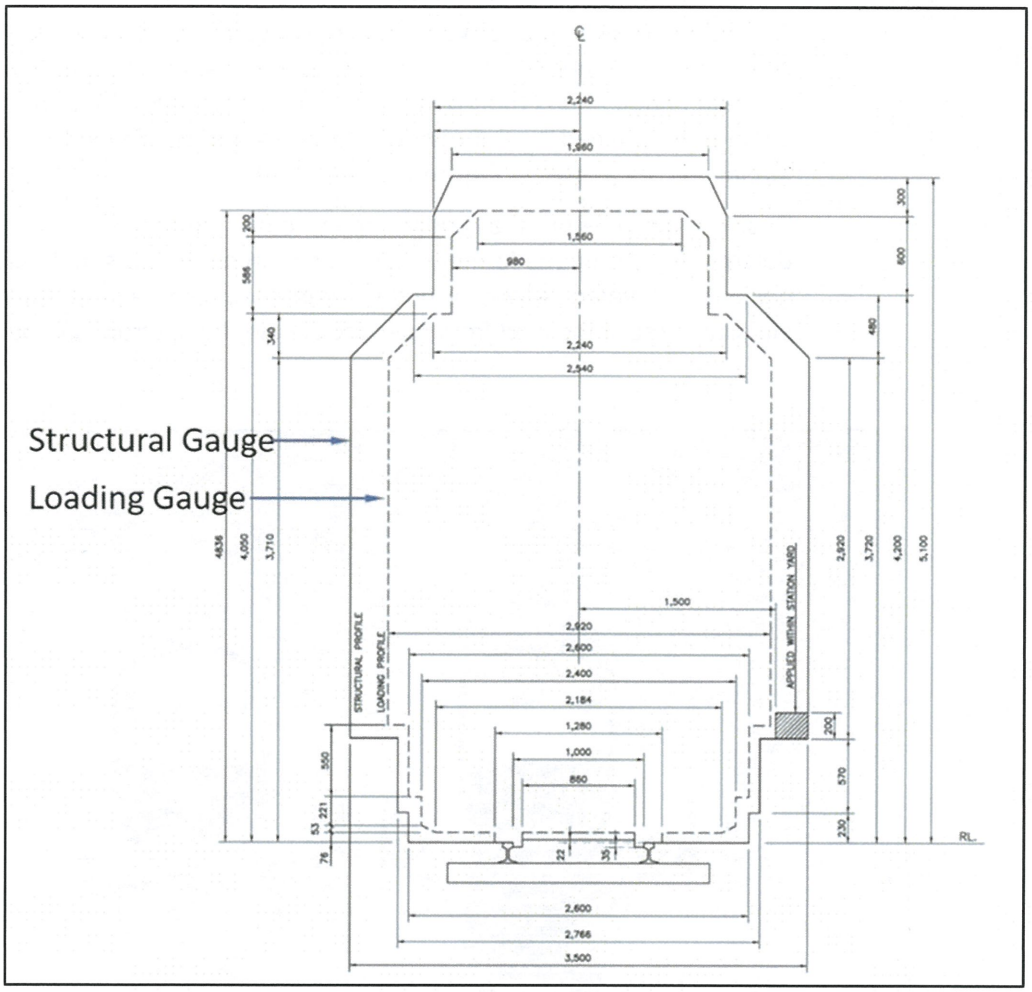


Figure 5.1.1-1 Safety Distance of Structural Gauge

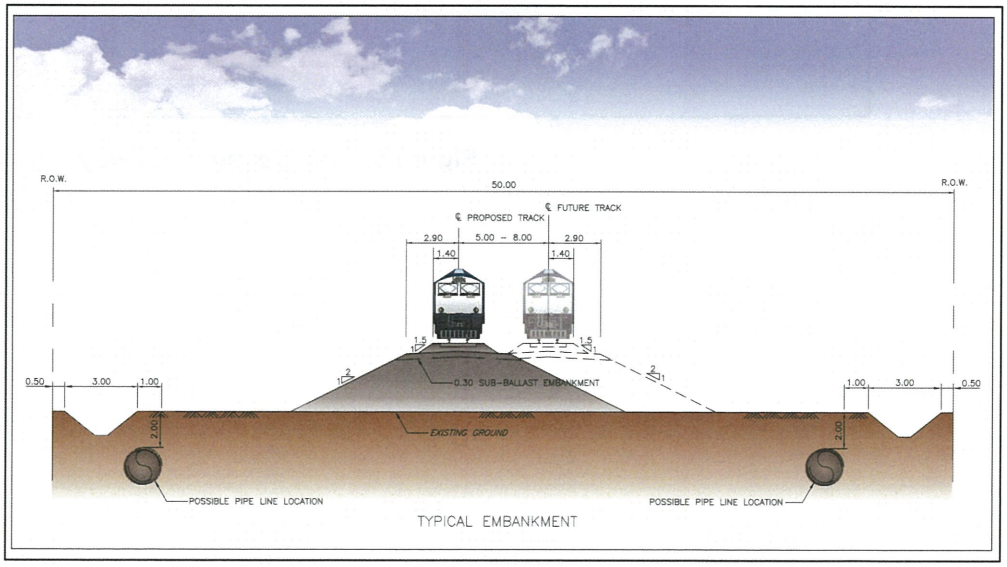


Figure 5.1.1-2 At-Grade Railway

2) Elevated Railway

The design of elevated railway takes into account the distance to cross or called the bridge span. Generally, there are 3 bridge spans, i.e. short bridge span (6 - 15 m.), medium bridge span (15 - 25 m.) and long bridge span (25 m. or more). The bridge span is determined by the obstacle to cross and as defined by the Department of Marine etc. as shown in **Figure 5.1.1-3**.

Besides considering the bridge span, other components to be considered in determining the bridge formation are superstructure and substructure. However the design of elevated railway or bridge span shall also have to consider the sufficient stability to resist the load from passenger train, freight train and other loads.

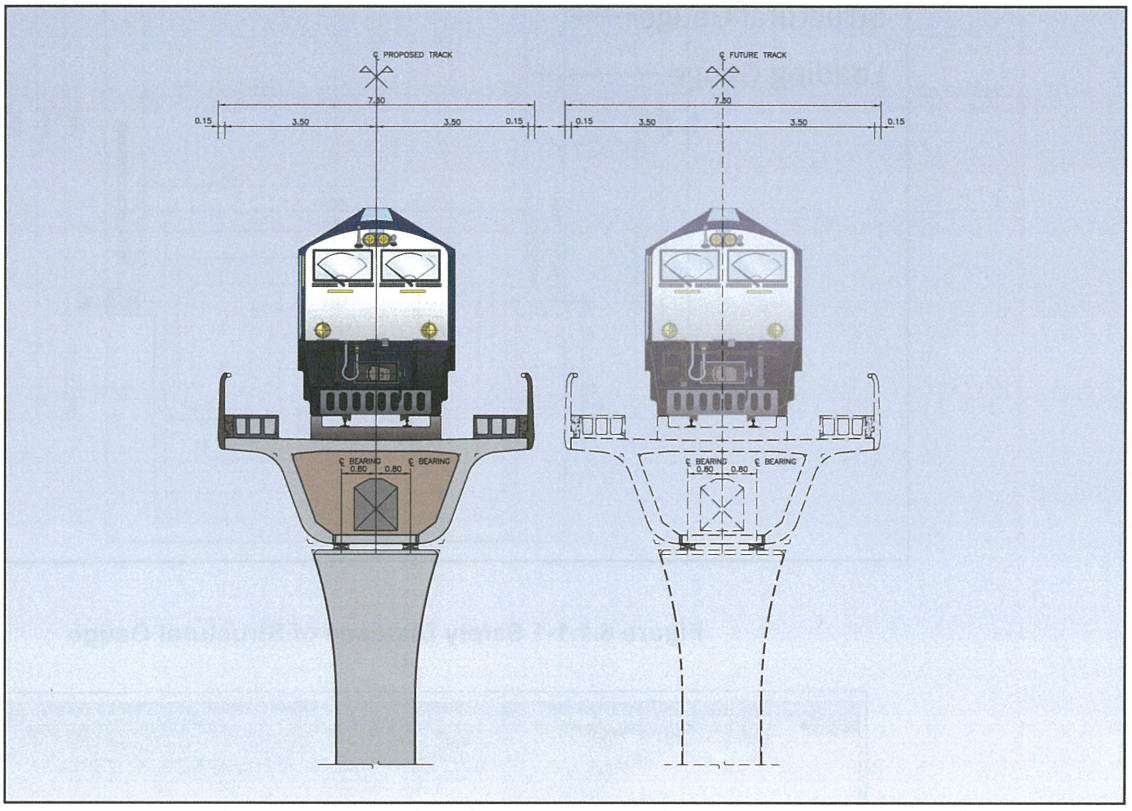


Figure 5.1.1-3 Elevated Railway

3) Railway tunnel

Generally, tunnel construction should be avoided as it requires high budget, complex maintenance and advanced technology to investigate. However, tunnel construction cannot be avoided for this project due to steep mountain terrain at Chumphon-Ranong Border and the design requirement for rail slope cannot be more than 1.20%. Therefore, some parts of the project have to be constructed as tunnels. There are two types of tunnels, i.e. single tunnel for double track as shown in **Figure 5.1.1-4** and double tunnel for single track as shown in **Figure 5.1.1- 5**.

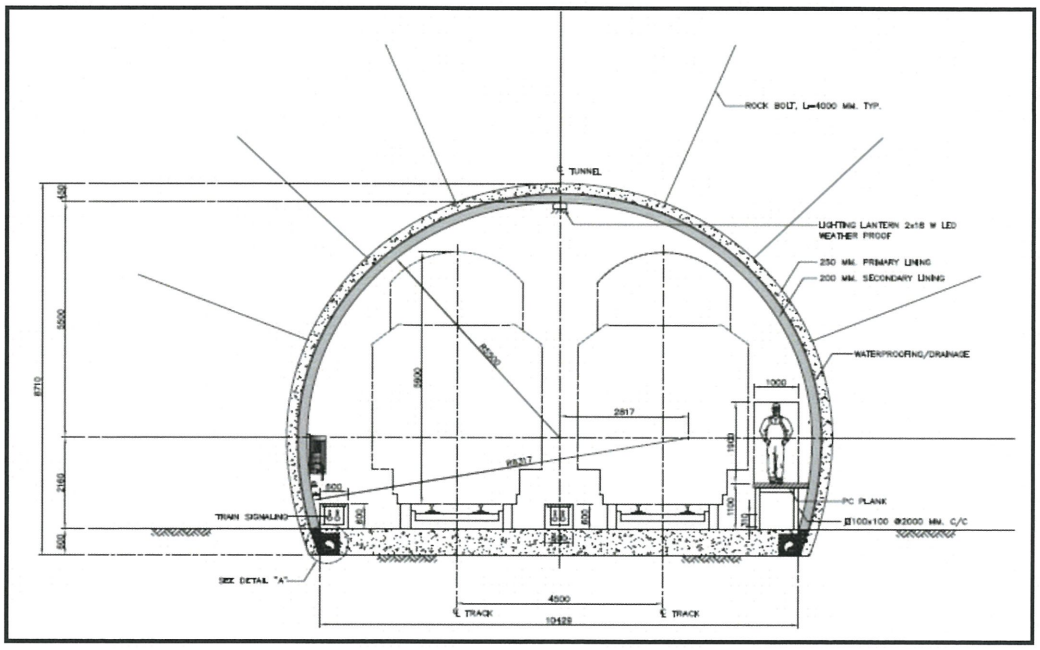


Figure 5.1.1-4 Single Tunnel for Double Track

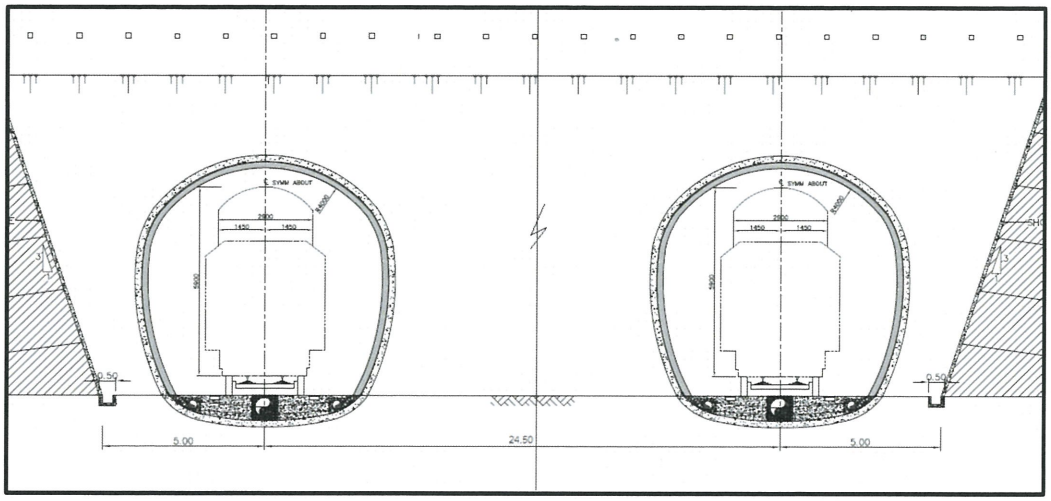


Figure 5.1.1-5 Double Tunnel for Single Track

5.1.1.3 Preliminary Alignment Design

For the preliminary alignment design, the Consultant has used the scale of 1:10,000 for the horizontal alignment and 1:500 for the vertical alignment. The plan and profile has aerial photograph as the background. The longitudinal section of the alignment is based on the DEM data in order to know the preliminary formation of the alignment and these data can be used to estimate the construction cost.

Sample of plan and profile and longitudinal section of the alignment is shown in **Figures 5.1.1-6** and **5.1.1-7**.

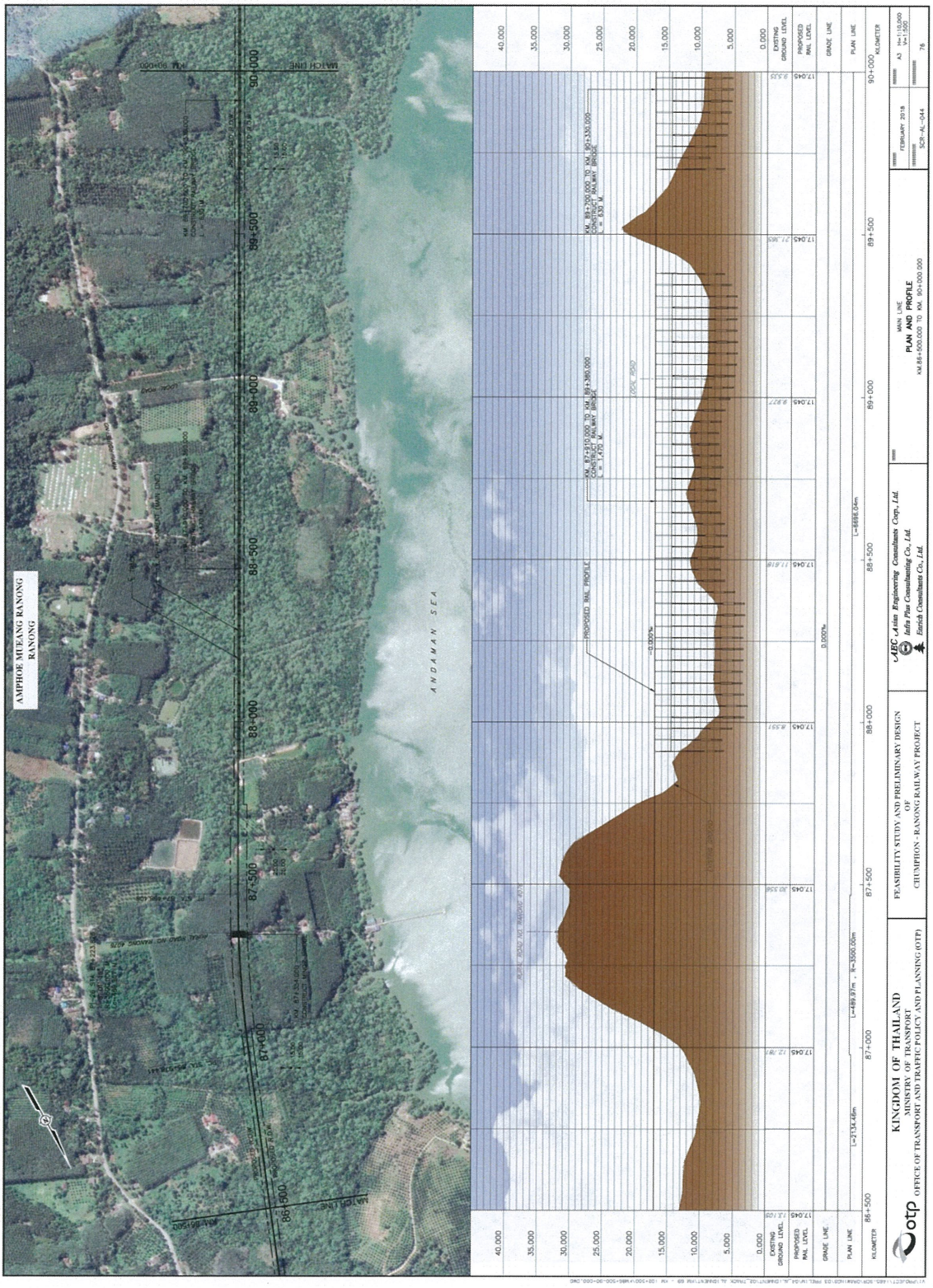


Figure 5.1.1-6 Sample of Plan and Profile and Longitudinal Section of the Alignment (1)

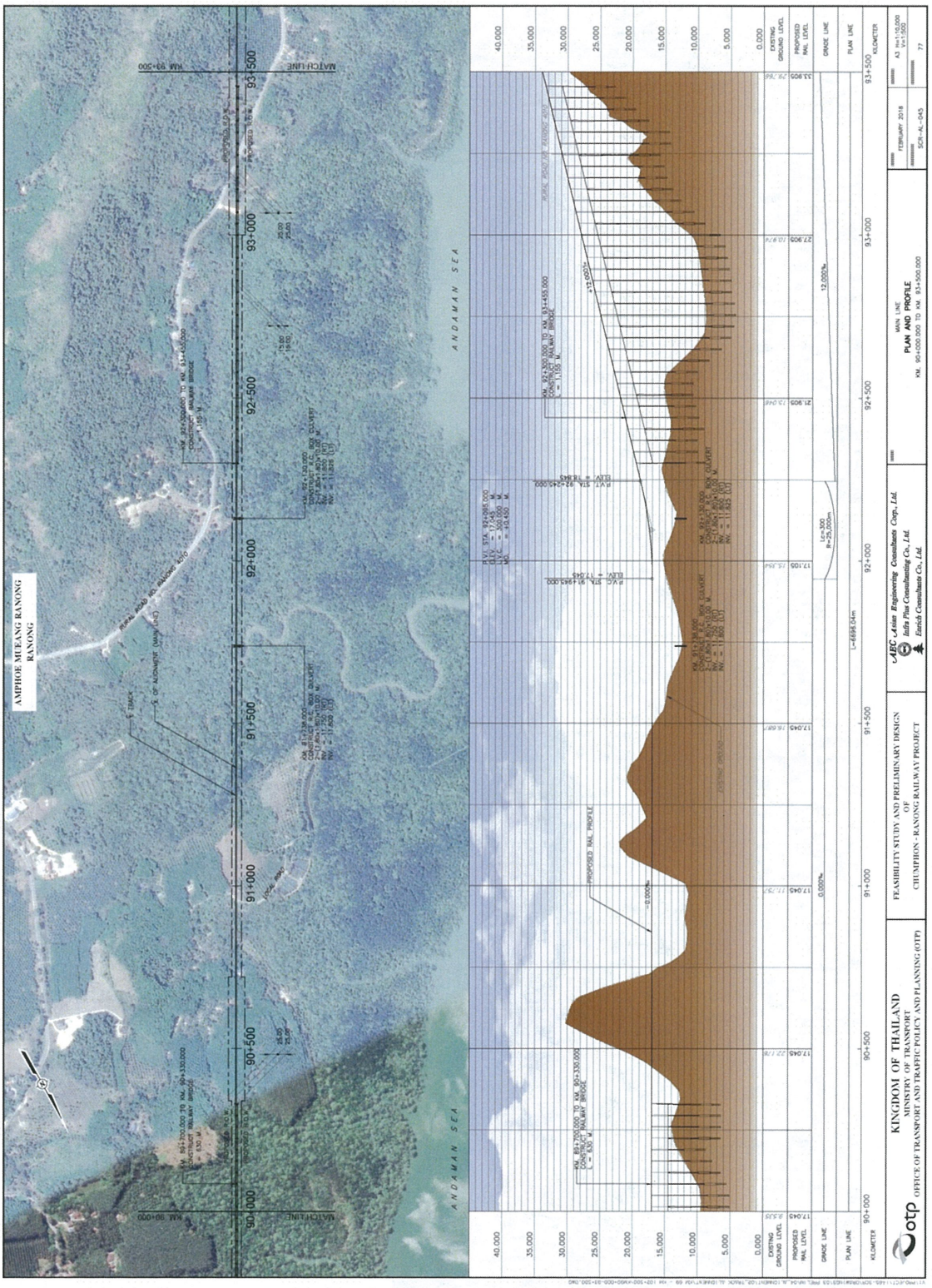


Figure 5.1.1-7 Sample of Plan and Profile and Longitudinal Section of the Alignment (2)

5.1.1.4 Alignment Design

The alignment consists of 3 routes, i.e. the main line from Chumphon to Ranong Deep Sea Port, 102.797 km long, the chord line from the existing southern railway (Surat Thani) to the main line, 1.129 km long and the spur line or separate line to Ranong town, 5.082 km long, totaling 109.008 km long. The alignment shall start at the south of Chumphon Railway Station, about 3.20 km from the station. Most of the alignment shall parallel Highway No. 4 (Petchkasem Road). The geography along the alignment is plain alternating with hill terrain. There are communities along Highway No. 4 and the alignment. The alignment shall locate 9 stations namely Khun Krating Station, Ban Na (1) Station, Ban Na (2) Station, Pak Chan Station, Kra Buri Station, Bang Yai Station, La-Un Station, Ranong Deep Sea Port Station and Ranong Station. The design speed shall be 160 km/h in common area and 120 km/h in restricted area. Ranong Deep Sea Port is a restricted area in terms of both horizontal and vertical alignment and this area shall be a container yard which requires a lot of space and the design speed shall be limited at 80 km/h. The alignment shall be in the new right-of-way. **Table 5.1.1-2** shows the horizontal curve radius and the design speed of the alignment and **Table 5.1.1-3** shows the slope and vertical curve radius of the alignment.

Table 5.1.1-2 Horizontal Curve Radius and Design Speed of the Alignment

No.	KM.	Horizontal Curve Radius (m.)	Design Speed (Km./Hr.)
Main line			
1	0+658.154	400	80
2	4+953.201	2,000	160
3	7+141.974	2,000	160
4	11+112.196	2,000	160
5	13+415.387	1,200	140
6	14+959.744	1,000	125
7	17+082.641	1,600	160
8	22+803.883	3,000	160
9	28+558.103	1,283	145
10	33+478.342	1,600	160
11	39+297.631	2,000	160
12	46+723.203	5,000	160
13	54+490.793	3,000	160
14	58+367.632	2,000	160
15	60+204.311	3,000	160
16	63+107.432	3,000	160
17	65+076.159	2,000	160
18	68+002.321	1,600	160
19	69+571.574	1,600	160
20	72+750.369	2,000	160
21	74+827.468	2,000	160

Table 5.1.1-2 Horizontal Curve Radius and Design Speed of the Alignment (Cont'd)

No.	KM.	Horizontal Curve Radius (m.)	Design Speed (Km./Hr.)
22	76+293.453	2,000	160
23	78+118.409	3,000	160
24	82+600.650	3,000	160
25	84+717.304	2,000	160
26	87+223.826	3,500	160
27	94+258.179	1,000	125
28	95+852.147	1,500	155
29	97+532.327	2,000	160
30	99+360.894	1,200	140
31	99+970.372	1,200	140
32	101+871.445	400	80
Chord line			
1	0+781.876	400	80
Spur line			
1	0+700.034	1,000	125
2	2+425.995	2,000	160
3	4+220.548	500	90

Table 5.1.1-3 Slope and Vertical Curve Radius of the Alignment

PVI.CH.	Crest / Sag	G1 (%)	G2 (%)	Rvc (used) (m)	Lvc (m)
Main line					
0+000.000	-	0	0	-	-
1+249.000	sag	0	+0.25	119,989	300
1+902.000	crest	+0.25	0	119,989	300
4+896.000	sag	0	+1.2	25,000	300
5+966.000	crest	+1.2	0	25,000	300
8+868.000	sag	0	+1.2	25,000	300
10+233.000	crest	+1.2	0	25,000	300
16+124.000	sag	0	+1.0	30,001	300
18+018.000	crest	+1.0	0	30,001	300
23+253.000	sag	0	+1.0	30,001	300
26+613.000	crest	+1.0	0	30,001	300
31+820.000	crest	0	-1.2	25,000	300
34+891.000	sag	-1.2	0	25,000	300
36+154.000	crest	0	-1.2	25,000	300
38+585.000	sag	-1.2	0	25,000	300

Table 5.1.1-3 Slope and Vertical Curve Radius of the Alignment (Cont'd)

PVI.CH.	Crest / Sag	G1 (%)	G2 (%)	Rvc (used) (m)	Lvc (m)
46+950.000	sag	0	+1.0	30,000	300
47+523.000	crest	+1.0	0	30,000	300
53+555.000	sag	0	+1.2	25,000	300
55+806.000	crest	+1.2	0	25,000	300
58+764.000	crest	0	-1.2	25,000	300
62+307.000	sag	-1.2	0	25,000	300
68+151.000	sag	0	+0.5	60,000	300
69+651.000	crest	+0.5	0	60,000	300
74+422.000	crest	0	-1.0	30,000	300
75+122.000	sag	-1.0	0	30,000	300
82+290.000	sag	0	+1.2	25,000	300
83+423.000	crest	+1.2	0	25,000	300
84+758.000	crest	0	-1.2	25,000	300
85+970.000	sag	-1.2	0	25,000	300
92+095.000	sag	0	+1.2	25,000	300
94+007.000	crest	+1.2	0	25,000	300
95+560.120	crest	0	-1.0	30,000	300
96+059.000	sag	-1.0	0	30,000	300
98+785.000	sag	0	+1.0	30,000	300
99+285.000	crest	+1.0	0	30,000	300
100+821.900	crest	0	-1.2	16,666	200
102+071.900	sag	-1.2	0	16,666	200
102+797.580	-	-	-		-
Chord line					
0+000.000	-	0	0	-	-
0+427.000	sag	0	+1.0	20,000	200
0+762.533	crest	+1.0	0	20,000	200
1+129.964	-	-	-		
Spur line					
0+000.000					
0+309.000	sag	0	+1.0	30,000	300
0+809.000	crest	+1.0	0	30,000	300
2+957.000	crest	0	-1.5	25,000	300
4+205.000	sag	-1.5	0	25,000	300
5+082.176					

5.1.2 Track Layout

Based on the train operation plan, it was found that the train service frequencies will not be much, therefore, this railway shall be a single track railway which is sufficient to accommodate the train traffic of the project. Ban Na (1) Station, Pak Chan Station, La-un Station and at the section separating from the southern railway will locate the siding tracks. From years 2025 to 2053 there will be only one siding track. By the year 2054, according to the forecast, travel demands by trains will be increased and the train service frequencies will be increased accordingly, so one siding track will be increased for the station that has the main track.

The trackwork design has taken into consideration the increment of siding tracks for both the station that already has and the station that has not including the extension to double track in the future.

The station layout should be on the zero inclination line or straight line with sufficient length for train to stop or wait for siding, i.e. 650 m. minimum and should have the main track and siding track as shown in **Figure 5.1.2-1**.

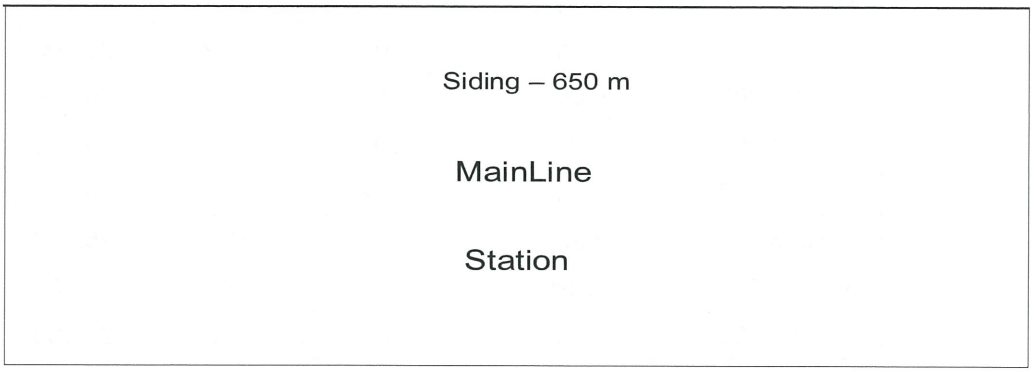


Figure 5.1.2-1 Station that has Main Track and Siding Track

1) Siding Track

For the station that has the main track and siding track, the main track shall be close to the platform for passengers' convenience in getting on and off the train. As the siding track shall be far from the station for train to stop or wait for siding or temporary parking, the platform at the siding track should be elevated to facilitate passengers in getting on and off the train as shown in **Figure 5.1.2-2**.

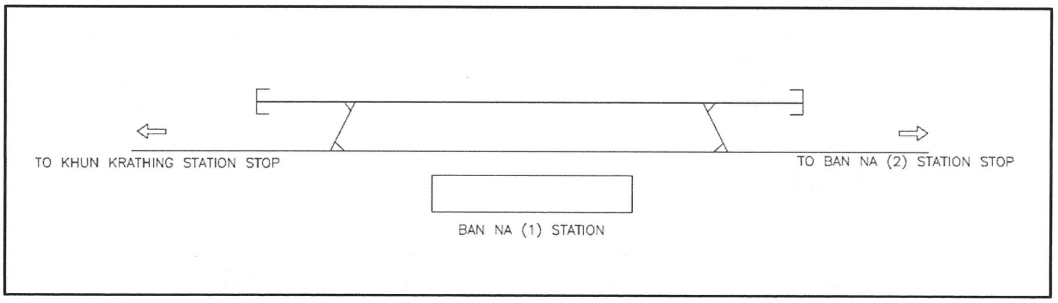


Figure 5.1.2-2 Siding Track

2) Connecting to the Southern Railway

The railway from Chumphon – Ranong Deep Sea Port will separate from the existing southern railway at Chumphon Station or Saeng Dad Station. It is expected that at the project implementation, the railway at Chumphon Station or Saeng Dad Station shall be upgraded to double track according to the national development plan of rail transport. There will be 2 connecting points at the north and south of the station to facilitate the arriving and departing trains from the project line for both inbound and outbound.

At the connecting point will locate the chord track to save time in waiting for siding of the arriving and departing trains from the project line. This chord track shall be at the north as most of the trains shall arrive and depart at this direction as shown in **Figure 5.1.2-3**.

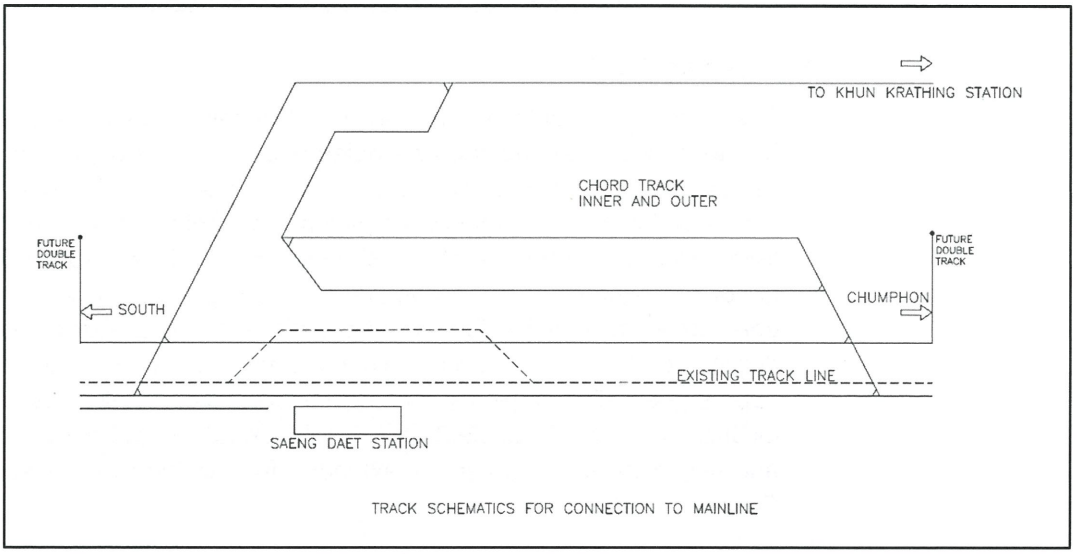


Figure 5.1.2-3 Connecting to the Southern Railway

3) Ranong Terminal Station

Ranong Terminal Station shall have 3 tracks which shall be sufficient for parking and shifting to express train and local train. The platform shall be between the tracks for express train and local train to facilitate passengers for getting on-off the train. Both tracks shall be connected at the end of the platform so that the locomotive can run to the other side. There shall be a track for temporary parking of broken train or maintenance as shown in **Figure 5.1.2-4**.

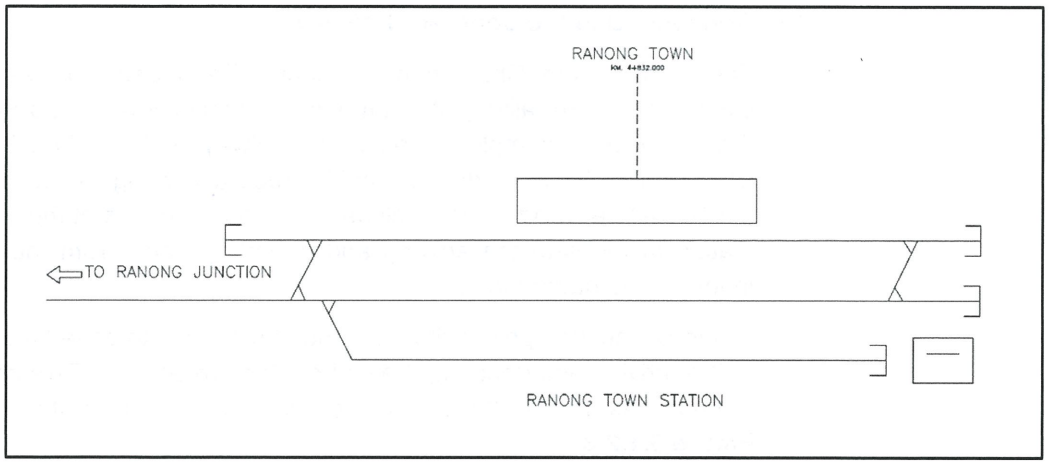


Figure 5.1.2-4 Ranong Terminal Station

4) Container Yard

The track at the container yard shall be the ballastless track and some of the track has to be grounded for the convenience of transiting goods and the movement of vehicles e.g. forklift or other equipment. There shall be 3 tracks, i.e. the main track, the track for transiting goods or parking the freight train and the siding track for locomotive to change direction. Within the container yard, there shall be a small depot for locomotive inspection prior to train procession and for maintenance as deemed necessary for further train procession or at least running to the SRT's depot e.g. Chumphon Depot, Thung Song Depot or other depots as deemed appropriate. The track for locomotive inspection shall have the fuel station for locomotive. There shall be 2 tracks at the depot, i.e. the entrance track to the depot and siding track which can be extended for parking the broken train as shown in **Figure 5.1.2-5**.

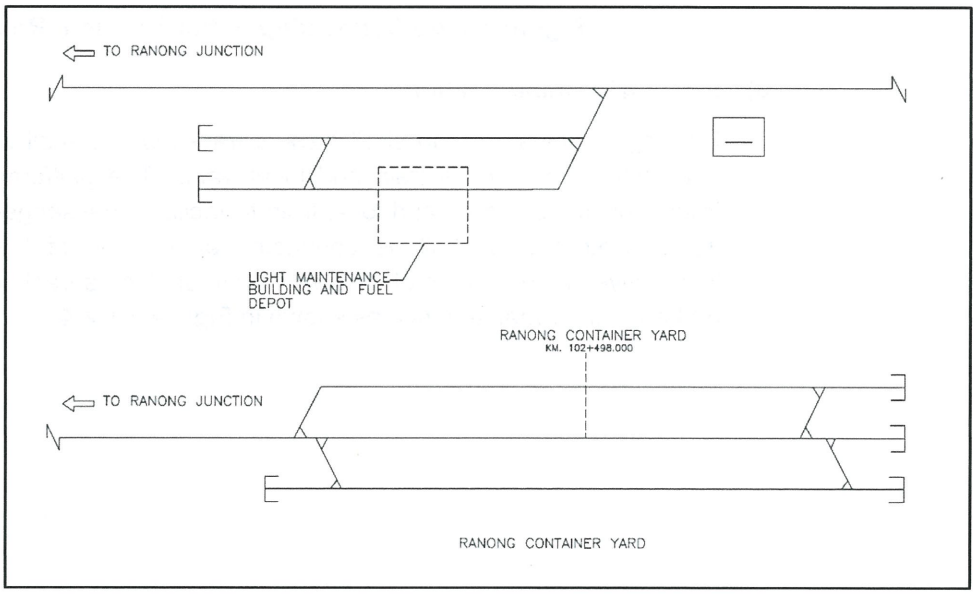


Figure 5.1.2-5 Container Yard Track Layout

The local train shall be refueled at Chumphon Station and maintained at Chumphon Depot or Thung Song Depot which has more capacity to maintain various types of trains in this area.

5.1.3 Trackwork Design

1) Design Principles

Trackwork shall be designed to the following principles:

- Easy to maintain both during train operation and maintenance or even unscheduled maintenance
- Low maintenance cost both tracks and rolling stock
- Use the long term availability of materials and equipment
- Use materials with the same standard of the SRT and are compatible for easy supply and storage
- The design has to be consistent and compatible with other systems e.g. signaling system and rolling stock
- Long term durability of tracks
- Appropriate with track structure and loading

The geometric design of track has followed the design criteria of the Construction of Southern Double Track Railway Project of the SRT

2) Trackwork Design

This project has 3 types of trackworks as follows:

- At-grade Ballasted Track
- Elevated Ballastless Track
- Tunnel Ballastless Track

Track components:

- Meter gauge
- Rail UIC 54E1 (inclined at 1:40) according to EN 13674-1 standard, long welded with hardness of not less than 260 HBW and a tensile strength of more than 880 N/mm^2
    - Load the train weight through wheels through track structure
    - Maximum axle load 20 tf
    - Elongation in loading and not deformed
    - Resistant to wear
- Turnout
    - 1:16
    - 1:12
    - 1:10
- Fastener for monoblock sleepers
    - Resist to longitudinal movement of rail
    - Resist to transverse movement of rail
    - Work well in high temperatures

- Low maintenance cost
- Few components
- Electrical resistance

- Monoblock sleepers bear axle load 20 tons
  - Bear the loads from the rails and distribute to the ballast
  - Limit the rail movement
  - Fasten the fastener for monoblock sleepers
- Insulation Rail Joint
  - Electrical insulator to use with track circuit to determine the position of the train
- Hogback sleeper with reinforcement
- Fastener for hogback sleeper with reinforcement
- 63 mm Rail ballast
  - Resist the force from the sleeper to hold the track in place
  - Elongation, absorb strengths
  - Well drainage of water
- Sub-ballasted
- Reinforced Concrete Track

Note: Rail installation on elevated track is the same and use the same equipment as rail installation in tunnel.

3) Project Track

This project has 2 types of tracks, i.e. the ballasted track and the ballastless track:

- The ballasted track, 67,010 m long, divided as follows:
  - At-grade track, 63,908 m on the main line.
  - At-grade track, 1,972 m on the spur line to Ranong Station.
  - At-grade track, 1,130 m on the chord line connecting to the southern railway.
- The ballastless track, 42,000 m long, divided as follows:
  - Elevated track, 32,270 m on the main line.
  - Elevated track, 1,330 m on for the spur line to Ranong Station.
  - Track in tunnel, 6,620 m. on the main line.
  - Track in tunnel, 1,780 m on the spur line to Ranong Station.
- The ballasted track for the minor lines, divided as follows:
  - Track at container yard, 2,000 m long.
  - Siding track, 3,000 m long.
  - Track at Ranong Station, 900 m long.

4) Ballasted Track

The at-grade track shall be ballasted track consisting of:

- Concrete sleepers, 600 mm. intervals
- Fastener of clamped or bolted type
- Ballast not smaller than 25 mm. placed below ballast of 30 mm.
- Turnout
  - 54E1 rail (inclined)
  - Switches 54E1A1 (shallow depth)
  - Prestressed concrete bearers
  - Monoblock cast manganese crossing with welded carbon steel legs, check rail shall be CEN 33C1
- 6-hole IRJ Insulated Joints (glued type)
- Slide buffer stop

Figure 5.1.3-1 illustrates the ballasted track.

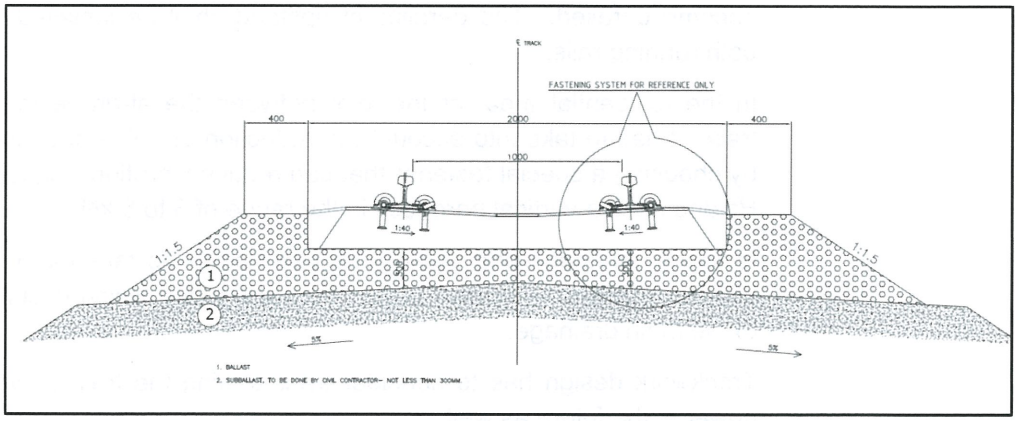


Figure 5.1.3-1 Ballasted Track

5) Ballastless Track

The elevated track, track in tunnel and at container yard shall be ballastless track. The rail is installed on the reinforced concrete sleepers which are embedded in the concrete again and reinforced by attaching to the starter bars of the viaduct deck or tunnel first pour concrete. In case of the container yard, the rail is embedded on the ground and the rail top is at ground level or called embedded track.

The fastener is of clamped or bolted type and could be adjusted by maintenance staff. **Figure 5.1.3-2** shows the ballastless track.

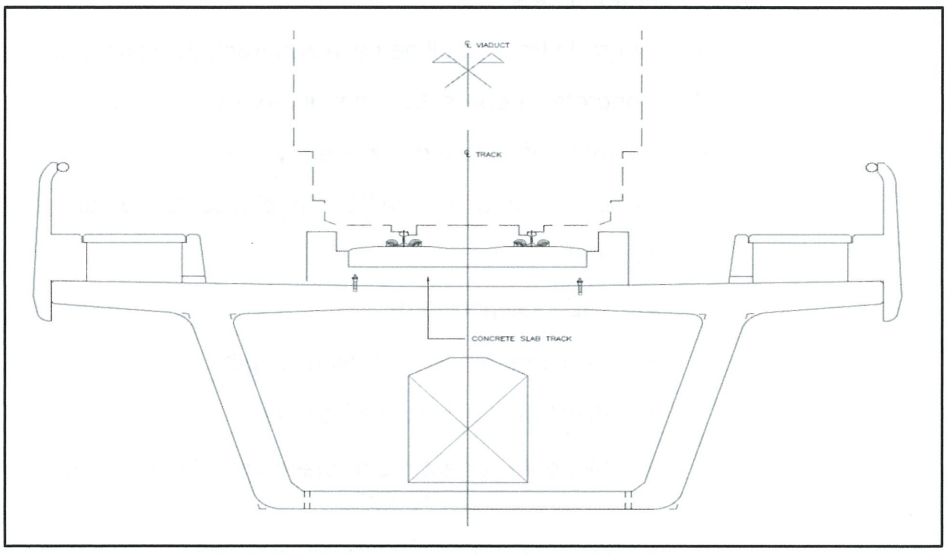


Figure 5.1.3-2 Non-Ballastless Track

Additionally, the elevated track shall be installed with derailment upstand with sufficient strength to restrain and hold a train in its upright position should the train become derailed. The derailment upstand shall be installed on the outer side of both running rails.

In the residential area, at the joint between the at-grade track and the elevated track, it has to take into account the reduction of noise and vibration that will occur by choosing a special fastener that can reduce vibration frequencies from 20 to 400 Hz and have a vertical hardness in the range of 3 to 5 kN.

In tunnel, drainage and flood protection has to be taken into consideration. The second drainage is located under the track scope which is sufficient to drain water to the main drainage.

Trackwork design has to consider transforming the train power system to electric power in the future as well.

6) Transition Track

Where the roadbed is changed e.g. changed from sub-grade to concrete bridge or tunnel, the stiffness of track on sub-grade is less than the stiffness of track on concrete bridge. Therefore, in order to harmonize the stiffness of track from changing roadbed, the transition track has to be provided at the joint to prevent differential settlement and damage to track structure e.g. rail or concrete sleeper due to the increased impact at that area as shown in **Figure 5.1.3-3**.

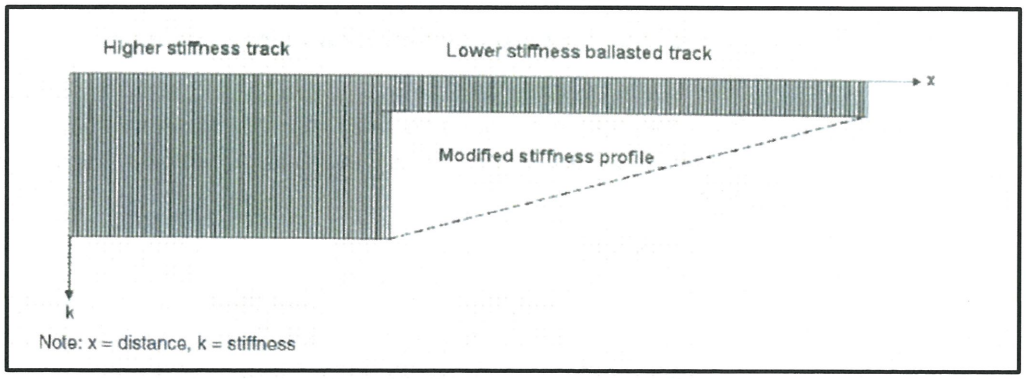


Figure 5.1.3-3 Transition Track

7) Component Design Life

The following minimum component design life shall be as follows:

- Clamped or bolted type rail fastenings - 15 years
- Rails on curve radius less than 400 m. - 10 years
- Rails on tangent track and on approaches - 25 years
- Resilient track fastening on viaducts and tunnels:
  - Resilient pads - 10 years
  - Anchor bolts - 15 years
  - Rail fastener system - 10 years
  - Electrical insulators - 10 years
- Reinforced concrete sleepers – 15 years
- Turnouts:
  - Switch blades and stock rails - 10 years
  - Resilient support pads - 10 years
  - Manganese steel crossing nose - 20 years
  - Anchor bolts - 20 years
  - Reinforced concrete bearers – 15 years
- IRJ (glued type) – 15 years

5.1.4 Drainage Design

1) Meteorology, Hydrology and Hydraulics Condition

The study, analysis and design of drainage system for this project were gathered from the relevant agencies such as the Meteorological Department, the Royal Irrigation Department and the Department of Water Resources. The details are as follows:

- Meteorological data

  The meteorological data was collected from the Weather and Rain Gauge Station near the project area, i.e. Chumphon Weather and Rain Gauge (during years 1980 – 2009) as shown in **Figure 5.1.4-1** and Ranong Weather and Rain Gauge Station (during years 1980 – 2009) as shown in **Figure 5.1.4-2**. The data included the average monthly climate statistics, temperature, humidity, dew point, atmospheric pressure, evaporation volume, cloudiness, sunshine hours, rainfall, number of rainy days. It provided detailed information that was helpful in designing as well as planning for construction to suit the weather.

CLIMATOLOGICAL DATA FOR PERIOD 1980 - 2009 index : 48532 (Station : 532201-CHUMPHON)

Station	CHUMPHON	Elevation of station above MSL	4.40	Meters
Index Statio	48517	Height of barometer above MSL	6.00	Meters
Latitude	10°29' N	Height of thermomerter above ground	1.20	Meters
logitude	99°11' E	Height of Anemometer above ground	11.7	Meters
		Height of Rain gauge	1.0	Meters

List	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pressure (Hectopascal)													
Mean	1,012.1	1,011.5	1,010.4	1,009.1	1,008.3	1,008.2	1,008.4	1,008.6	1,009.3	1,010.1	1,010.8	1,012.1	1,009.9
Mean max.	1,019.9	1,017.9	1,020.2	1,015.8	1,035.2	1,013.7	1,013.6	1,014.3	1,016.8	1,016.0	1,016.6	1,019.4	1,018.3
Mean min.	1,010.1	1,009.9	1,007.0	1,007.3	1,005.2	1,005.4	1,005.5	1,006.6	1,006.8	1,007.7	1,008.3	1,009.1	1,007.4
Change per day	3.6	3.8	4.0	3.9	3.5	3.2	3.1	3.3	3.7	4.0	3.7	3.5	3.6
Temteratur(Celsius)													
Mean	25.6	26.6	27.7	28.7	27.9	27.6	27.2	27.1	26.9	26.6	26.0	25.3	26.9
Mean max.	30.9	32.1	33.5	34.5	33.3	32.3	31.8	31.5	31.5	31.2	30.4	30.0	31.9
Mean min.	21.4	22.2	23.2	24.5	24.7	24.6	24.2	24.3	24.1	23.7	23.0	21.4	23.4
max	34.8	36.4	38.0	38.8	38.2	36.2	35.4	35.6	35.6	34.8	34.5	34.0	38.8
min	20.8	22.0	22.7	24.1	24.4	24.2	23.7	24.0	23.7	23.2	23.2	22.8	20.8
Relative Humidity(%)													
Mean	81	79	78	78	82	82	82	82	84	85	84	80	81
Mean max.	94	94	93	93	94	94	94	94	95	95	95	93	94
Mean min.	62	59	57	57	63	64	65	66	67	69	68	63	63
min	62	58	56	56	55	55	55	58	58	60	63	57	55
Dew Point (Celsius)													
Mean	21.7	22.4	23.1	24.1	24.2	23.9	23.6	23.6	23.6	23.8	22.8	21.3	23.2
Evaporation (mm.)													
Mean	107.0	109.0	137.0	140.0	120.0	109.0	110.0	107.0	103.0	94.0	89.0	101.0	1,326.00
Cloudiness (0-10)													
Mean	5.0	4.0	4.0	5.0	7.0	8.0	8.0	8.0	8.0	7.0	6.0	5.0	6.3
Sunshine Duration (hr.)													
(Monthly totals)	No measurement												
Visibility (km.)													
07.00LST	6.0	6.0	7.0	8.0	9.0	10.0	10.0	10.0	10.0	9.0	8.0	7.0	6.0
Mean	9.4	9.7	9.7	10.1	11.1	11	11	10.8	11.1	10.6	9.8	9.7	8.675
Wind (Knots)													
Mean wind speed	2.1	1.9	2.0	1.8	2.0	2.4	2.5	2.8	2.2	1.4	2.1	2.8	2.2
Prevailing wind	E	E	E	E	W	W	W	W	W	W	NE	NE	-
Max. wind speed	30.0	30.0	37.0	34.0	60.0	44.0	42.0	43.0	42.0	38.0	99.0	38.0	99.0
Rainfall (mm.)													
Monthly totals	56.6	46.2	92.5	89.4	189.7	171.9	182.4	207.6	178.2	247.2	297.9	125.7	1,885.3
Number of rainy days	7	5	6	8	18	19	20	21	20	19	14	8	165.0
Daily maximum	117.3	112.3	178.1	88.7	137.2	96.2	96.7	232.0	96.1	144.5	219.8	192.6	232.0
Number of days with													
Fog	12.0	11.0	12.0	10.0	2.0	1.0	1.0	1.0	0.0	2.0	6.0	12.0	70.0
Haze	3.0	3.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0	13.0
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorm	1.0	1.0	4.0	7.0	13.0	7.0	6.0	4.0	7.0	11.0	8.0	2.0	71.0
Squall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

source: statistic climate of Thailand Meteorologica Department,2011

Figure 5.1.4-1 Meteorological Data at Chumphon Weather and Rain Gauge Station

CLIMATOLOGICAL DATA FOR PERIOD 1980 - 2009 index : 48532 (Station : 532201-RANONG)

Station	Ranong	Elevation of station above MSL	7.00	Meters
Index Statio	48532	Height of barometer above MSL	8.00	Meters
Latitude	09°59' N	Height of thermomerter above ground	1.25	Meters
logitude	98°37' E	Height of Anemometer above ground	10.2	Meters
		Height of Rain gauge	0.8	Meters

List	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Pressure (Hectopascal)													
Mean	1,011.30	1,010.90	1,009.90	1,009.00	1,008.40	1,008.50	1,008.80	1,009.10	1,009.70	1,010.00	1,010.30	1,011.30	1,009.80
Mean max.	1,018.00	1,017.10	1,018.20	1,019.50	1,013.60	1,014.90	1,014.10	1,015.00	1,016.20	1,016.20	1,017.00	1,018.20	1,016.50
Mean min.	1,009.40	1,008.70	1,007.00	1,006.30	1,005.80	1,005.90	1,006.00	1,006.90	1,007.50	1,007.50	1,007.80	1,008.10	1,007.20
Change per day	4.1	4.3	4.3	4.1	3.5	3.1	3.0	3.2	3.7	4.0	4.0	4.0	3.8
Temteratur(Celsius)													
Mean	26.6	27.5	28.4	28.7	27.6	27.2	26.9	26.7	26.4	26.4	26.5	26.3	27.1
Mean max.	32.8	34.1	34.9	34.6	32.4	31.1	30.8	30.5	30.5	31.0	31.4	31.7	32.2
Mean min.	21.8	22.2	23.3	24.6	24.7	24.5	24.3	24.2	23.9	23.6	23.3	22.4	23.6
max	36.4	38.3	39.6	39.1	38.7	35.3	34.8	33.8	34.5	35.2	35.4	35.0	39.6
min	21.7	21.9	22.8	24.5	24.0	24.0	23.5	23.8	23.8	23.6	23.0	22.9	21.7
Relative Humidity(%)													
Mean	72	71	72	76	83	84	85	86	86	86	80	74	80
Mean max.	90	89	89	91	94	94	94	94	95	95	92	89	92
Mean min.	51	48	49	55	66	70	71	73	72	70	64	57	62
min	49	45	44	56	63	64	63	64	66	63	58	51	44
Dew Point (Celsius)													
Mean	20.9	21.2	22.2	23.7	24.3	24.2	24.0	24.0	23.9	23.6	22.7	21.1	23.0
Evaporation (mm.)													
Mean	121.0	129.0	157.0	135.0	105.0	96.0	99.0	94.0	88.0	86.0	88.0	110.0	1,308.0
Cloudiness (0-10)													
Mean	4.0	4.0	5.0	6.0	7.0	8.0	8.0	8.0	8.0	7.0	6.0	5.0	6.3
Sunshine Duration (hr.)													
(Monthly totals)	No measurement												
Visibility (km.)													
07.00LST	8.0	9.0	9.0	9.0	9.0	8.0	8.0	8.0	8.0	9.0	8.0	8.0	6.0
Mean	9.7	9.8	9.5	9.6	9.8	9.3	9.1	9.0	9.1	9.4	9.2	9.5	8.675
Wind (Knots)													
Mean wind speed	1.4	1.3	1.3	1.2	1.3	1.9	1.7	2.0	1.3	0.9	1.2	1.9	1.5
Prevailing wind	NE	NE	W	W	SW	S,SW	SW	SW	Sep	SW	NE	NE	-
Max. wind speed	25	33	26	27	32	158	32	36	270	28	25	26	270
Rainfall (mm.)													
Mean	9.0	15.7	64.4	152.9	500.5	663.7	622.9	794.6	655.7	420.7	149.1	41.8	4,091.0
Number of rainy days	3	3	6	12	24	24	25	27	25	24	14	6	193
Daily maximum	26.6	31.1	84.0	117.4	182.6	249.7	217.2	177.0	198.4	177.9	131.3	56.1	249.7
Number of days with													
Fog	14.0	14.0	14.0	9.0	2.0	1.0	1.0	0.0	0.0	2.0	6.0	12.0	75.00
Haze	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thunderstorm	0.0	1.0	3.0	8.0	13.0	7.0	5.0	5.0	4.0	6.0	3.0	1.0	56.0
Squall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

source: statistic climate of Thailand Meteorologica Department,2011

Figure 5.1.4-2 Meteorological Data at Ranong Weather and Rain Gauge Station

The Consultant has analyzed the relationship between rainfall intensity-duration-frequency from the rainfall data of the nearest weather and rain gauge stations, i.e. Muang District Station (Station Code 10013), Muang District, Chumphon Province from years 1954 - 1983 and 1986 - 1998 as shown in **Figure 5.1.4-3** and Muang District Station (Station Code 46013), Muang District, Ranong Province from years 1964 - 1998 as shown **Figure 5.1.4-4**.

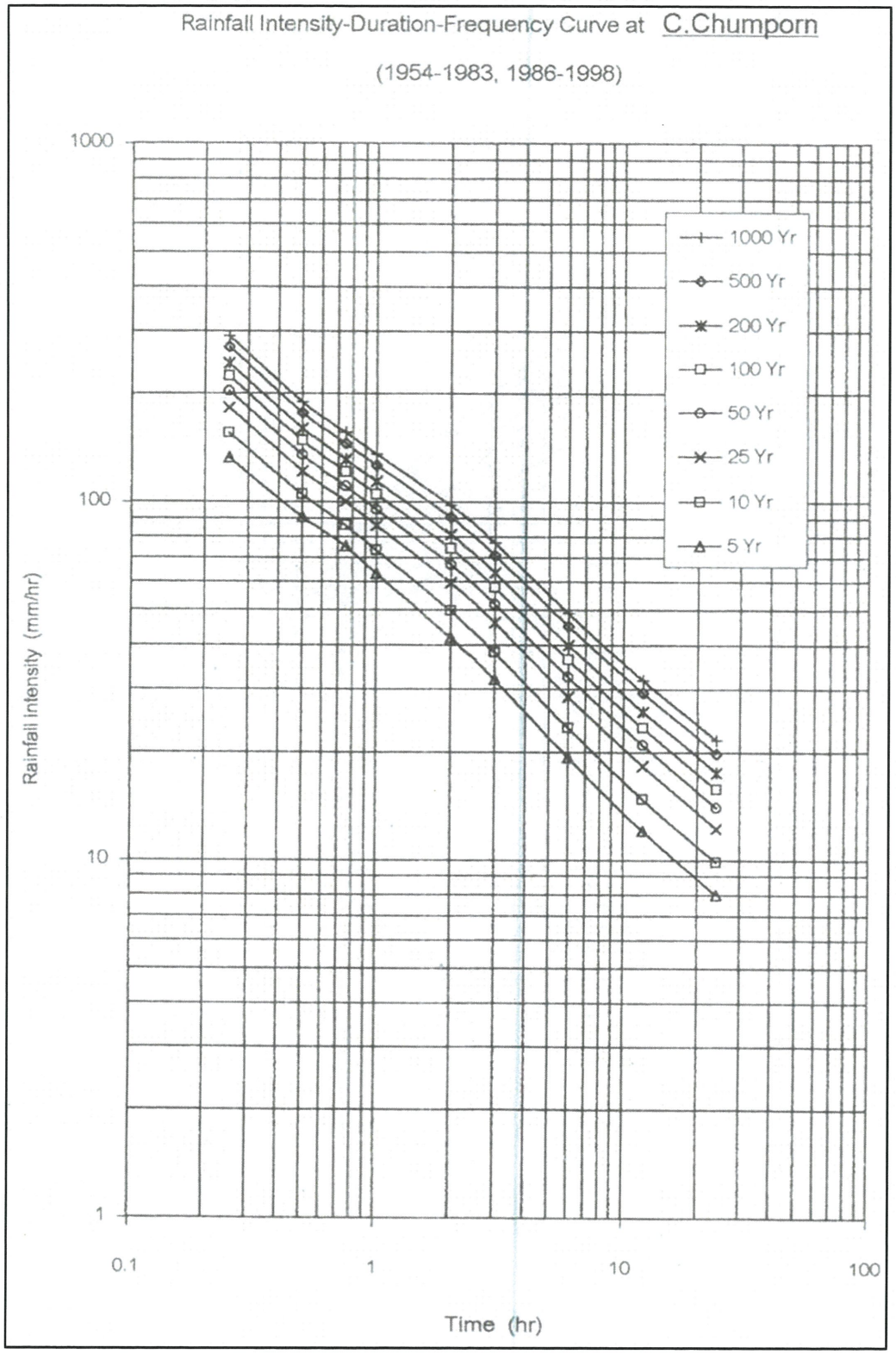


Figure 5.1.4-3 Rainfall Intensity–Duration–Frequency Curve at Station 10013, Chumphon Province

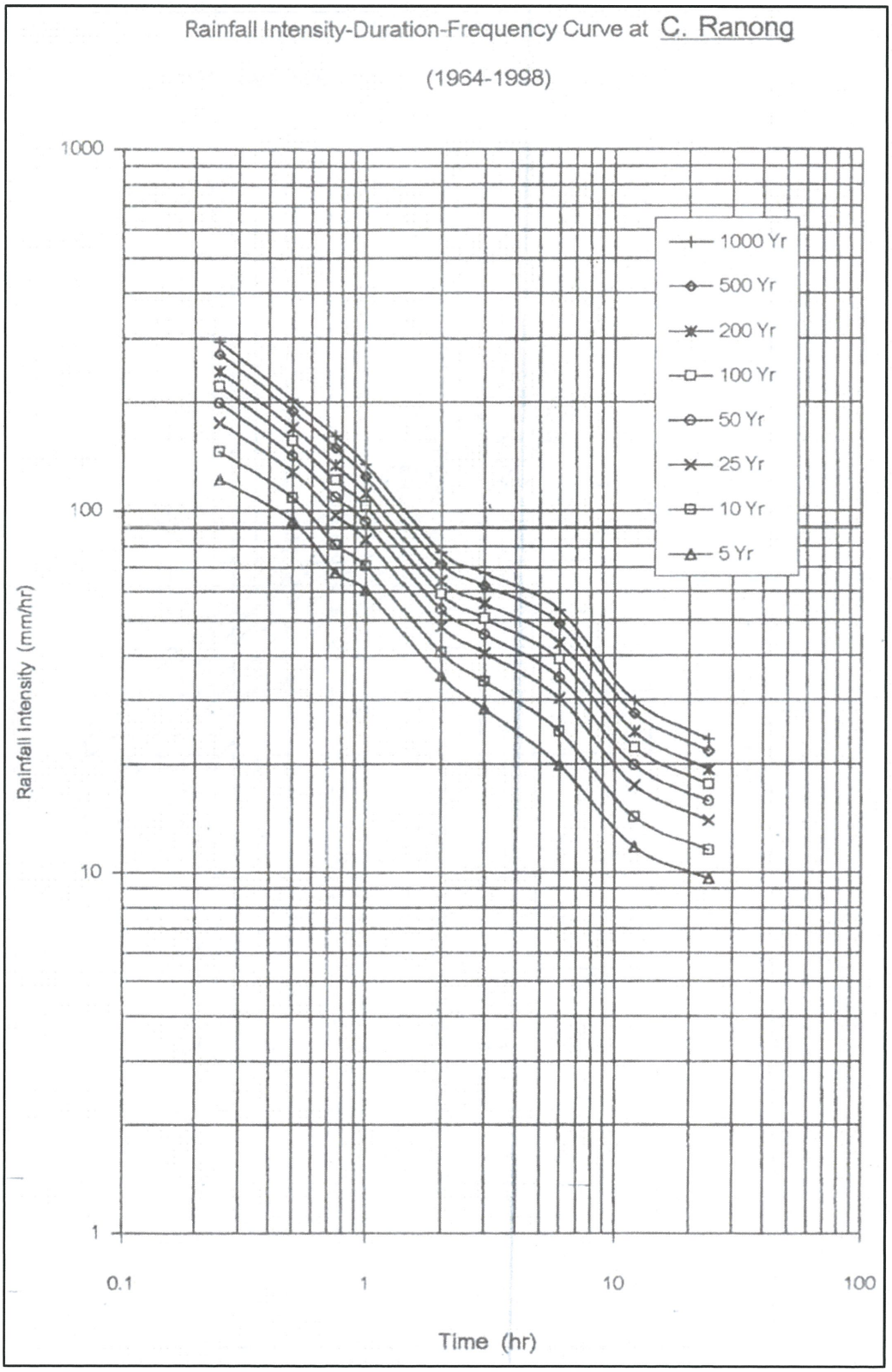


Figure 5.1.4-4 Rainfall Intensity–Duration–Frequency Curve at Station 46013, Ranong Province

- Hydrological data

  The project route shall be located from the east and west of Southern Watershed. **Figures 5.1.4-5** and **5.1.4-6** show the analysis of stream flow in the project area.

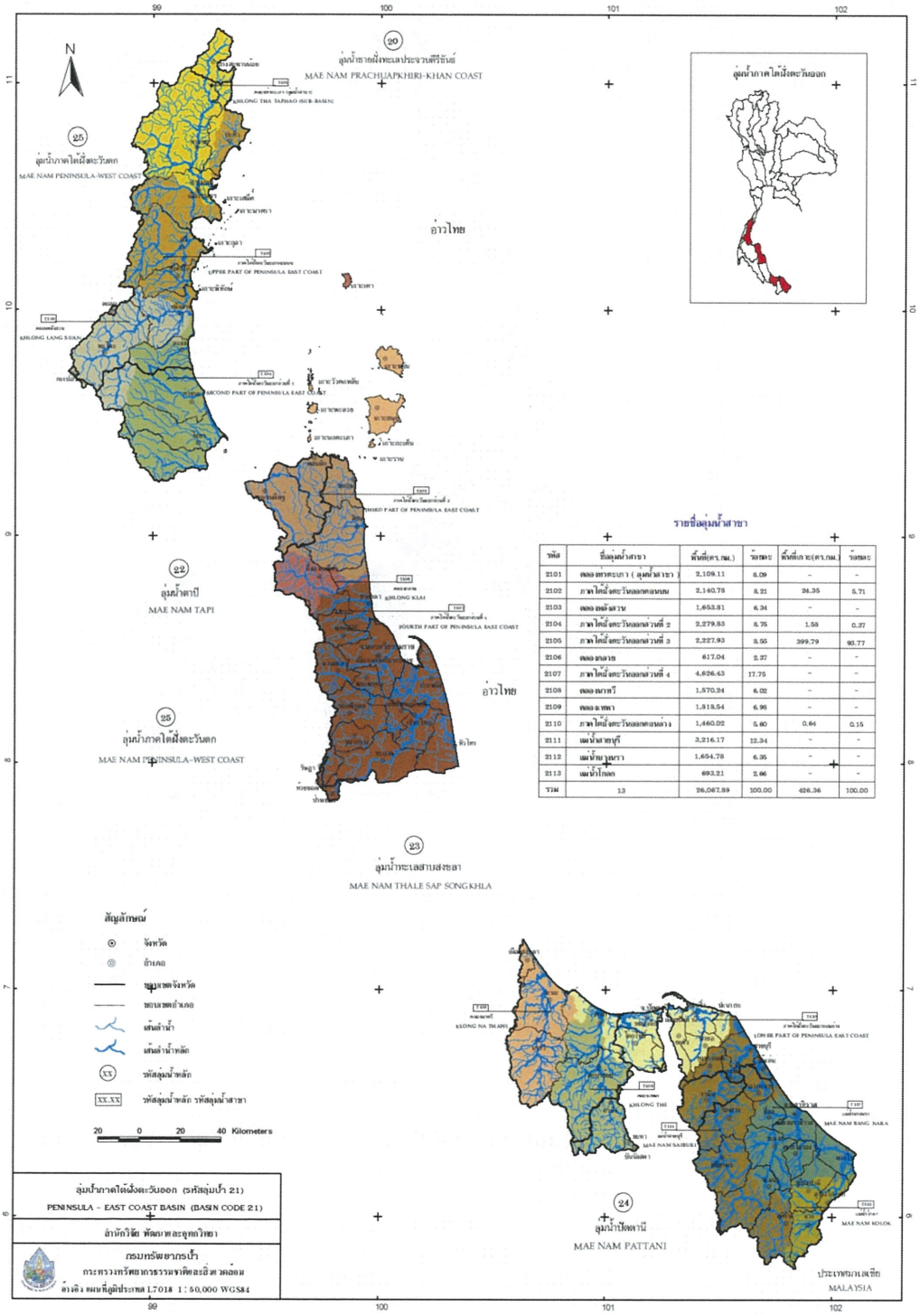
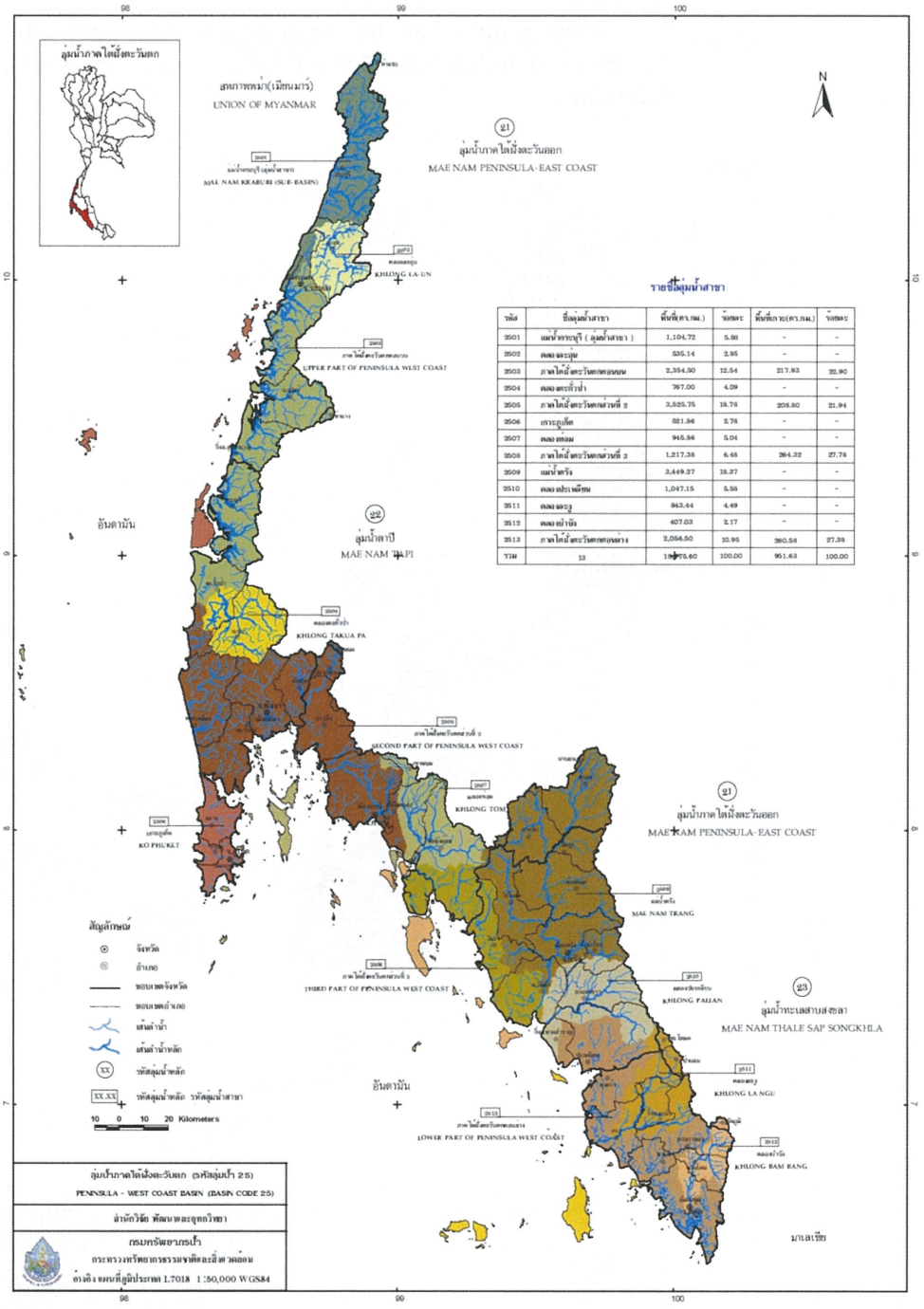


Figure 5.1.4-5 The East of Southern Watershed



รหัส	ชื่อลุ่มน้ำสาขา	พื้นที่(ตร.กม.)	ร้อยละ	พื้นที่เกาะ(ตร.กม.)	ร้อยละ
2501	แม่น้ำกระบุรี (ลุ่มน้ำสาขา)	1,104.72	5.88	-	-
2502	คลองละอุ่น	535.14	2.85	-	-
2503	ภาคใต้ฝั่งตะวันตกตอนบน	2,354.90	12.54	217.93	22.90
2504	คลองตะกั่วป่า	767.00	4.09	-	-
2505	ภาคใต้ฝั่งตะวันตกส่วนที่ 2	3,925.75	19.78	208.80	21.94
2506	เกาะภูเก็ต	521.86	2.78	-	-
2507	คลองท้อม	945.94	5.04	-	-
2508	ภาคใต้ฝั่งตะวันตกส่วนที่ 3	1,217.38	6.48	264.32	27.78
2509	แม่น้ำตรัง	3,449.27	18.37	-	-
2510	คลองปะเหลียน	1,047.15	5.58	-	-
2511	คลองละงู	863.44	4.69	-	-
2512	คลองบ้าบัง	407.03	2.17	-	-
2513	ภาคใต้ฝั่งตะวันตกตอนล่าง	2,056.50	10.95	260.58	27.38
รวม	13	18,775.60	100.00	951.63	100.00

Figure 5.1.4-6 The West of Southern Watershed

The project railway shall pass several major rivers, such as Saeng Dad Canal, Chumphon Canal, Nak Kharat Canal, Nguam Canal, Lang Suan Canal, Lak Canal, Wan Canal, Pak Sawa Canal, Nam Chuet Canal, Lam Liang Canal and La-un Canal etc.

2) Criteria and Standards for Design

The design criteria for drainage and flood protection is as follows:

(1) Design standards

The design of drainage and flood protection is based on the following design standards:

- American Railway Engineering and Maintenance of Way Association (AREMA)
- Design Standard of Department of Highways
- Design Standard of Department of Rural Road

(2) Hydrological design criteria is as follows:

(1) Calculation of the maximum water discharge

- For watershed areas less than 25 square kilometers, the Rational Equation Method is used for calculation of the maximum flood peak:

$$Q = 0.278\ CIA$$

Where: Q = Maximum flow rate design in cu.m. per second (m^3/sec)

C = Run off coefficient

I = Average rainfall intensity in mm/hour, the duration equals to the time of concentration

A = Watershed areas in square kilometers (km^2)

For value of C (run off coefficient) relates to the land use defined in **Table 5.1.4-1**.

Table 5.1.4-1 Value of C (Run Off Coefficient)

Land use	C
1. Business area and very dense residential area	0.75
2. Industrial area	0.70
3. Moderate dense residential area	0.50
4. Low dense residential area	0.40
5. Government Office area	0.40
6. SRT's area	0.35
7. Public area / agricultural area	0.15

To find the rainfall intensity, it is necessary to know the time needed for water to flow from the most remote point in a watershed to the watershed outlet (time of concentration, Tc) which could get from the California Division of Highways Formula:

$$Tc = \left\{0.87\frac{L^3}{H}\right\}^{0.385}$$

Where: T_c = Time of concentration, hour

L = Distance from the most remote point in a watershed to the watershed outlet, km.

H = Difference of the height of the most remote point in a watershed and the watershed outlet, m.

as shown in **Figure 5.1.4-7**.

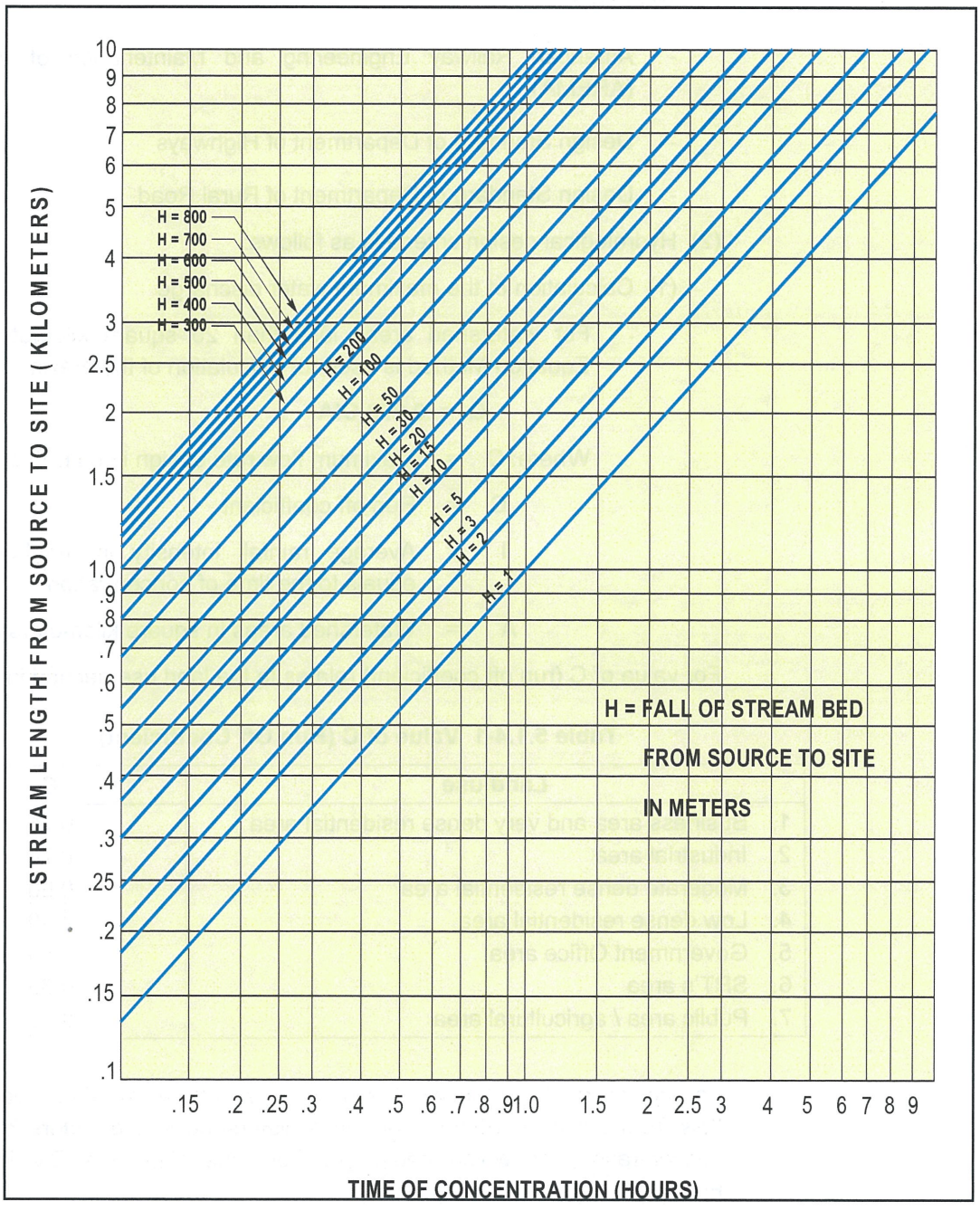


Figure 5.1.4-7 Time of Concentration Graph

- For watershed area more than 25 square kilometers, the Snyder's equation and Unit Hydrograph Peak is used for calculation of the maximum flood peak as follows:

$$Q = 0.001qp\ (\alpha i - \emptyset)\ tr\ A$$

where $t_r = (1.5/5.5) \times L^{0.6} \times L_1^{0.3}$

L = Distance from the most remote point in a watershed to the watershed outlet, km.

$L_1 = L_c / L$

L_c = Distance from a point on the stream nearest the centroid of the watershed area to the watershed outlet, km.

t_r = Critical rainfall duration, hour

$q_p = k_p / t_r$

q_p = Flood peak of the unit hydrograph, litre/sec/km^2

k_p = Flood peak coefficent varied according to the slope of watershed and grass covered, as defined in **Table 5.1.4-2**

Q = Maximum flow rate, m^3/sec

α = Rainfall reduction factor for large watershed, from **Figure 5.1.4-8**

i = Rainfall intensity, mm./hr.

$\emptyset$ = Infiltration capacity, mm./hr., as defined in **Table 5.1.4-3**

A = Watershed area, km^2

Table 5.1.4-2 Peak Discharge Coefficient

Catchment Topography	Peak Discharge Coefficent, K_p
Foothills and gently undulating slopes with forest or grass cover	28-30
Steep forested terrain in the headwaters, foothills and plain with a cover of forest or grass in the lower reaches	30-32
Steep forested slopes of high hills and low mountains	32-34

Table 5.1.4-3 Infiltration Capacity according to Types of Soil and Grass Covered

Cover Factor	Type	Ø (mm/hr)		
		Clays	Clay Loams	Sandy Loams
1.0 - 2.0	Poor	2 – 9	4 - 13	5 - 20
2.0 - 4.0	Medium	5 – 17	8 - 27	13 - 45
4.0 - 8.0	Good	10 – 35	15 - 55	25 - 90

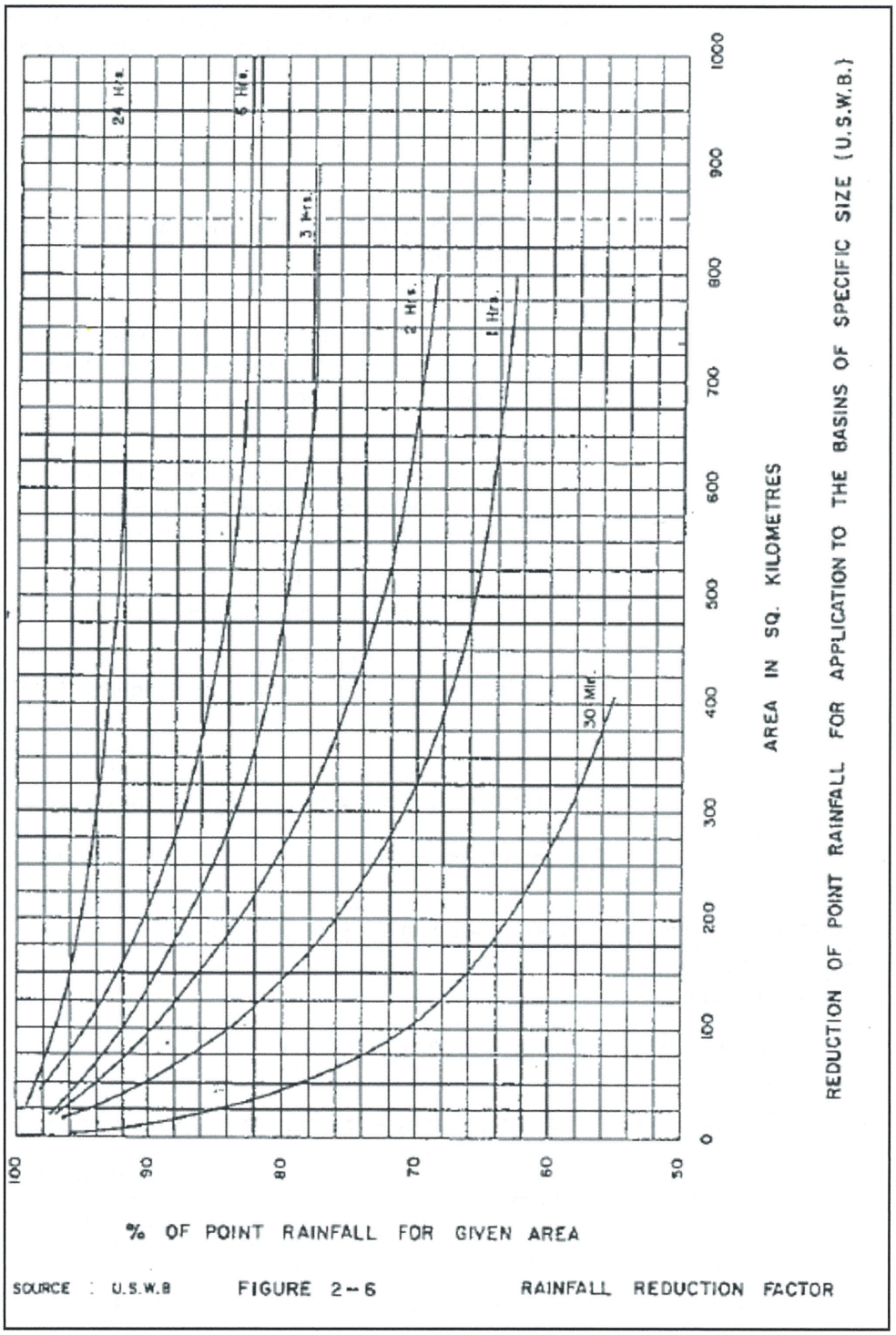


Figure 5.1.4-8 Rainfall Reduction Factor for Large Area

In checking the watershed area, the flood peak in each watershed area is calculated by the above formula. After that, the open channel of watershed outlet which passes the railway has to be checked whether there is enough open channel. Initially, the water velocity in the watershed outlet is defined at 2 meters per second. If the open channel safety is less than 1.5 times, the watershed outlet will be increased to increase the open channel safety. However, if the open channel is bridge, it will be equal to the existing bridge. If it is not enough, it will be designed as a culvert at a point where it can drain as much as required.

(2) Return period or frequency period (Tr)

In estimating the flood peak to design the watershed outlet, the calculated maximum flood peak or flood frequencies is considered. The return period takes into account the type of watershed outlet and the acceptable risk to that watershed outlet according to the following standards:

- Bridge design: Determine the maximum flood peak at a 50-100-year return period so the flood protection is not less than 100 years.
- Culvert design: Determine the maximum flood peak at a 25-year return period minimum.
- Track drainage design: Determine the maximum flood peak at a 20-year return period minimum.

(3) Hydraulic Design Criteria

a) Determine the type of watershed outlet.

For a watershed outlet which the water channel passes the alignment:

- Bridge is used for large water channel with the width more than 10.00 m. and/or the height of water more than 3.50 m. or a water channel with water transportation or floating logs.
- Box culvert is used for water channel with the width of water less than 10.00 m. and/or the height of water between 1.50-3.50 m. without water transportation and floating logs.

b) Calculate the flow properties in watershed outlet

Flow properties in watershed outlet are designed by open channel formula or Manning formula

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where R = Hydraulic Radius, m.

= A / P

A = Cross sectional area of flow, m2

P = Wetted perimeter, m.

S = Channel slope

n = Manning's roughness coefficient by

n = 0.014 for concrete surface

n = 0.030 for earth

Q = AV

c) Bridge design

- Flow velocity through the bridge not more than 2.5 m./sec.
- The upstream backwater must not overflow the bank.
- The clearance between the maximum water level and the substructure is determined by the supervisor of that waterway.

d) Culvert design

- Culvert should be designed to drain water for a 25-year flood without flooding in front of the pipe.
- In case of a 100-year flood, the head of the pipe shall be lower than the rail base not less than 0.60 m. or the head of the pipe is 1.5 times higher than the diameter of the pipe. However the lower value shall be used for design.
- The downstream velocity, in case of no protection, should not be more than 2.5 m./sec.
- Head Loss:
  - 0.5 for pipe culvert
  - 0.2 for box culvert
- Manning's Roughness Coefficient, n = 0.013

e) Design of drainage pipe or side drain

- Water flow in pipe and open channel shall be calculated by Manning Formula:

$$Q = \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where Q = Flow Rate, m^3/sec.

A = Cross-sectional area of flow, m^2

R = Hydraulic radius, m.

= A / P

P = Wetted perimeter, m.

S = Slope of the energy gradient (m./m.)

n = Manning's Roughness Coefficient

Value of n for pipe or concrete gutter is equal to 0.015 and it includes the energy loss (minor losses) in flowing, such as at the joint between pipe and the joint between pipe and manhole, etc.

The slope of the energy gradient (s) is not the slope of the channel except in uniform flow, the slope of the energy gradient is equal to the slope of the channel.

- Minimum flow velocity in pipe or open channel should not be less than 0.75 m./s. to prevent sedimentation in pipe.
- Water level in pipe means the flow of water to the full pipe at the maximum flow rate. Water level in open channel shall be lower than the bank not less than 15% of the designed water depth but not less than 0.10 m.
- Slope of pipe or open channel according to the length of pipe or open channel shall suit the terrain to save construction cost. However, the slope of the existing waterway to be improved shall be taken into consideration as well.

(4) Flood protection

Flood protection measures along both sides of railways and on railway tracks are as follows:

- Elevate the rail top to be higher than the maximum water level. The roadbed shall be at least 30 cm. higher than the maximum water level including the embankment settlement during operation. For bridge structure, the clearance between the maximum water level and the substructure is determined by the supervisor of that waterway and suitable for the terrain. However, the rail shall not be lowered than a 100-year flood.
- Provide drainage along the railway or transverse the railway adequate to accommodate water and drain to natural waterway and nearby area with suitable flow rate.

As the project alignment passes community areas, the drainage system has been designed in consistency with the drainage system of that community area, without causing problems to the existing drainage system of the community areas.

3) Preliminary Drainage Design

The main drainage system design along the railway consists of two parts:

(1) Drainage system along the railway

It is to drain rainwater in the right-of-way and floods from nearby area into the right-of-way to lowland areas outside the right-of-way or natural waterway to prevent flooding in the right-of-way.

- Components of drainage along the railway
  - Side ditch along both sides of the railway. This side ditch shall collect rainwater from the area within the right-of-way and/or rainwater or floods from area outer both sides of embankment to drain to natural waterway or culvert and further to lowland areas.
- Drainage Design Process
  - Estimate the watershed area and flow direction.
  - For each side of side drainage, the watershed area is the distance from the diameter of double track to the right-of-way or beyond the right-of-way to the area where water from that area can flow into the railway. However, it depends on whether it is an upstream area or a downstream area.
- Calculate the flood peak by Rational Formula
- The design rainfall for side ditch shall use a 25-year rainfall intensity and the time of concentration shall depend on the distance but not less than 15 minutes.
- Calculate the flow properties of side ditch as a uniform flow in open channel by using Manning Formula.

(2) Drainage system transverse the railway

It is to design the watershed outlet for natural waterway which passes the railway embankment or watershed outlet for drainage from an upstream area of

the railway to flow to a downstream area without damaging the railway embankment.

- Watershed out structure transverse the railway
  - Bridge is used for natural waterway which passes the railway; the width of the waterway should be approximately over 10 m.
  - Box culvert for waterway of not more than 10 m.
- Drainage Design Process
  - Estimate the watershed area and flow direction.
  - Calculate the flood peak based on the hydrology/hydraulics design criteria as mentioned above.
  - Calculate the flow properties through bridge and culvert as a uniform flow in open channel by using Manning Formula.

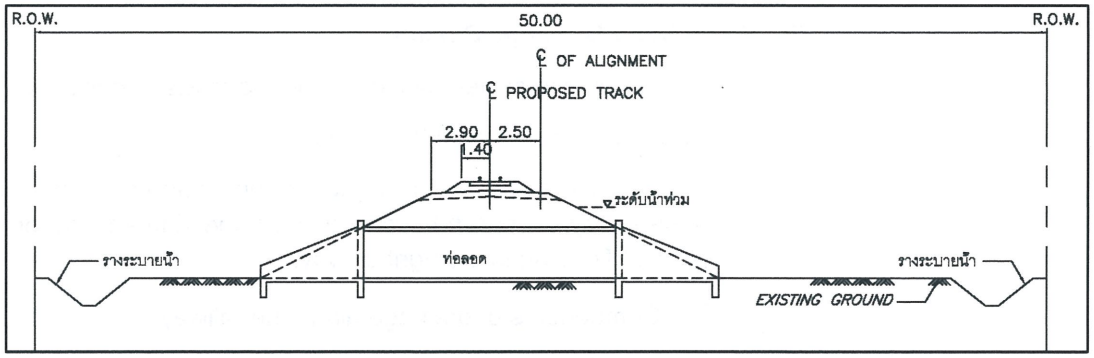


Figure 5.1.4-9 Typical Cross-section of the Preliminary Drainage System Design along the Railway

4) Drainage Design on Bridge or Elevated Track

- Calculate water discharge on the pavement

  Calculate the flow of water spread on the shoulder, parking lane or pavement which is a triangular conduit by applying the Manning Formula to calculate for the flow in triangular conduit as per below formula:

$$Q = \frac{K_u}{n} S_x^{1.67} S_L^{0.5} T^{2.67}$$

For velocity:

$$V = \frac{K_u}{n} S_L^{0.5} S_x^{0.67} T^{0.67}$$

In the term of T:

$$T = \left(\frac{Q_n}{K_n S_x^{1.67} S_L^{0.5}} \right)^{0.375}$$

then

$$T = \left(\frac{Q \times n}{0.376 \times \left(\frac{Sx}{100} \right)^{1.67} \times \left(\frac{Sl}{100} \right)^{0.5}} \right)^{0.375}$$

where K_u = 0.376 (= 0.56 in English units)

n = Manning's roughness coefficient

Q = Flow rate, m3/sec (ft3/sec)

T = Flow width (water spread), m. (ft.)

SX = Transverse slope, m./m. (ft./ft.)

SL = Longitudinal slope, m./m. (ft./ft.)

After deriving the flow width, inlet (scupper) intervals are calculated by using the formula:

$$S = \frac{\left(1.705 \times 10^6\right) \times \left(SxT\right)^{1.5} \times P}{0.278CIWp}$$

where S = The distance between each inlet

P = X+Y; X = the width of Inlet, Y = the length of Inlet

For calculating the depth of conduit of each span, the Manning Formula shall be applied by the trail and error as follows:

$$Q = \frac{1}{n}(b \times y)\left(\frac{by}{2y+b} \right)^{\frac{2}{3}} Sl^{\frac{1}{2}}$$

where b = Side drainage width, m.

y = Flow depth, m.

Sl = Longitudinal slope, m./m.

n = Manning's Roughness Coefficient

For drainage design on bridge, the vertical flow volumes depend on the entrance and the flow characteristic is similar to the flow in weir and varies according to the depth of water flowing into the entrance or drainage hole. The flow volumes of water flowing into the conduit or full drainage hole can be calculated from the following formula:

$$q_x = 0.6 A_x \sqrt{2gx}$$

where q_X = Flow rate, m^3/sec

0.6 = Coefficient of entrance

A_X = Area of conduit, m^2

g = 9.81 m./sec^2

x = Water depth in the conduit, m.

Drainage at the end of bridge or the lowest of elevated track; it is to drain or trap the remaining water from the upper part prior to flowing out of the elevated track. The open channel has to be large enough to accommodate water, e.g. grating, channel embankment and mixed open channel. The flow volumes can be calculated by applying the Rational Method. To find the size of intake grating, it has to know the open area which can accommodate water from the slope sufficiently.

$$P = \frac{0.278CIL_pW_p \times 50\%}{1.705(SxT_{LP})^{1.5} \times 10^6}$$

Where P = Length of the intake grating at the end of slope, m.

L_P = Distance from the highest slope to the lowest slope, m.

W_p = Slope width or distance from the rail top to the curb, m.

C = Runoff coefficient which depends on the hydrological characteristics of the watershed

I = Rainfall intensity, mm./hr.

5) Drainage Design in Station

Drainage design in station has to consider mainly the station layout and the terrain to be consistent with the surrounding area and to drain properly without flooding. The design principles of drainage system and other structures at station, such as box culvert, round pipe, U-ditch and drainage ditches are as follows:

- Consider the terrain and check the station layout including the existing drainage systems and drainage conditions.
- Consider the area, location of structures and levels which are relevant to railway, road and the existing drainage system as a guideline for designing the drainage system in consistency with the drainage works around the station and water supply and sanitary system.
- Estimate the peak discharge and various levels at the design point based on the drainage design criteria as described.
- Calculate the appropriate open channel of watershed outlet and compare the size of open channel of the existing watershed outlet and the new calculation. It should be larger than the existing ones.
- Conduct the detailed design in compliance with the SRT's principles and standards for preparation of complete construction drawings.

6) Hydrological Studies and Estimation of Watershed Outlet

The Consultant has studied the size of watershed area which could affect the drainage along the railway by using the topographic map on the scale of 1:50,000. **Figure 5.1.4-10** shows the watershed area and flow direction. Most of the areas along the alignment are mountain terrain, hill terrain and

trees. The agricultural land use is rubber plantation, palm plantation and other horticultural crops. There is waterway flowing from the mountain on the left side of the alignment. The waterway is deep and steep.

The project area has heavy rain in rainy season. The flood situation in the past is not severe, but nowadays, due to the changing conditions of land use from land reclamation on mountain for agriculture which causes quick flooding on road and community areas.

The preliminary estimation of the size of watershed outlet is considered from the flood peak calculated as shown in **Tables 5.1.4-4** and **5.1.4-5**. The water flow velocity in the watershed outlet is defined at 2 meters per second and calculates the open channel of the drainage. After that, the depth of the watershed outlet is defined from the peak discharge. If the flood peak is high, the depth of the waterway is high. The calculation details are shown in **Table 5.1.4-6**

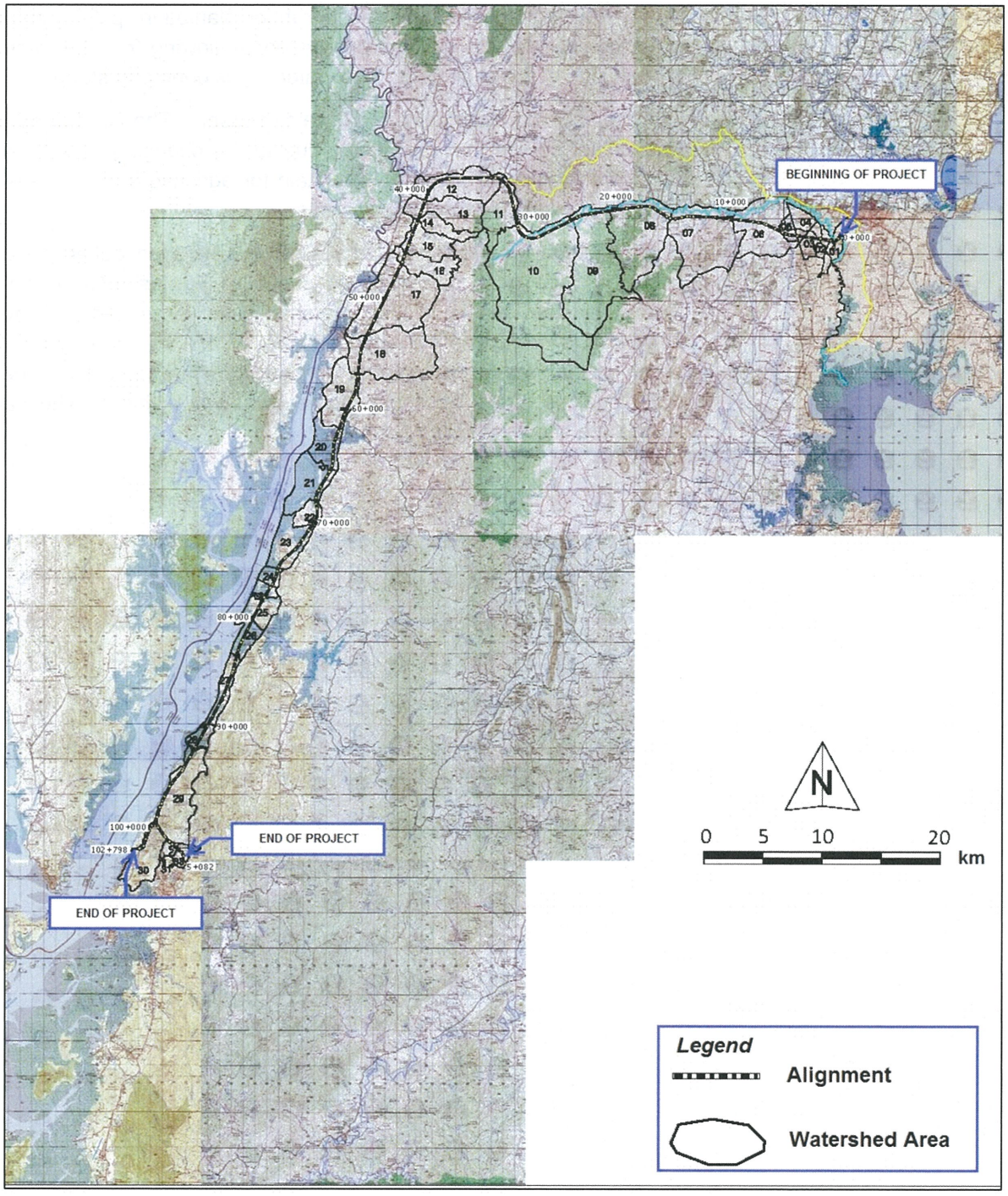


Fig. 5.1.4-10 Watershed Area and Flow Direction

Table 5.1.4-4 Calculation of the Flood Peak for Watershed Area less than 25 Km^2 (by Rational Method)

No.	Watershed Area		C	$Tc = (0.87\ L^3/H)^{0.385}$			I_{25}	Q	Stream
	Location	($km.^2$)		L (km.)	H (m.)	Tc (cm.)	(mm./hr.)	($m.^3/s.$)	
1	R-01	4.61	0.30	0.96	25	0.26	183	70.20	-
2	R-02	1.98	0.30	0.92	15	0.30	183	30.15	-
3	R-03	2.92	0.30	1.45	23	0.44	183	44.47	Nakarat Canal
4	R-04	3.97	0.30	0.91	51	0.19	183	60.46	-
5	R-05	2.28	0.30	1.46	34	0.38	183	34.72	-
6	R-06	21.73	0.30	2.11	36	0.57	122	221.10	-
7	R-07	19.67	0.30	3.51	20	1.27	86	141.41	Chumphon Canal, Huai Clone
8	R-11	12.13	0.30	2.31	98	0.43	122	123.42	Chumphon Canal, Hin Sai Canal, Chumphon Canal Branch
9	R-12	15.42	0.30	3.48	62	0.82	122	156.90	Hin Wua Canal
10	R-13	6.88	0.30	2.33	38	0.62	122	70.00	Leak Canal, Leak Canal, Chan Canal Branch, Wan Canal
11	R-14	0.02	0.30	1.10	21	0.33	183	0.30	-
12	R-15	6.45	0.30	2.39	68	0.51	122	65.63	No name canal
13	R-16	6.52	0.30	2.39	69	0.51	122	66.34	No name canal, Ta Prue Canal, Nam Chuet Canal
14	R-17	6.98	0.30	2.71	75	0.57	122	71.02	Pak Nam Canal, No name canal, Pak Nam Canal
15	R-18	3.85	0.30	4.10	140	0.72	101	32.30	La-un Canal
16	R-19	0.61	0.30	3.29	54	0.81	101	5.12	Bang Song Ra Canal, No name canal
17	R-20	9.28	0.30	2.42	41	0.63	101	77.86	Sib Tha Canal, No name canal
18	R-21	11.15	0.30	2.41	61	0.54	101	93.55	Bang Yai Nua Canal
19	R-22	8.55	0.30	1.33	77	0.25	122	86.99	Bang Yai Canal, Hin Kong Canal
20	R-23	0.02	0.30	2.66	89	0.52	122	0.20	-
21	R-24	0.01	0.30	0.73	31	0.18	183	0.15	Lud Canal, La-un Canal, No name canal
22	R-25	1.81	0.30	5.81	37	1.80	86	13.01	No name canal
23	R-26	2.49	0.30	0.50	2	0.33	183	37.92	No name canal
24	R-27	0.17	0.30	1.54	61	0.32	183	2.59	-
25	R-28	0.29	0.30	1.17	57	0.24	183	4.42	No name canal
26	R-29	0.31	0.30	2.71	35	0.76	101	2.60	-
27	R-30	4.21	0.30	2.37	38	0.63	122	42.84	-
28	R-31	0.52	0.30	1.80	20	0.59	122	5.29	Waterway
29	R-32	0.23	0.30	4.86	20	1.86	86	1.65	Bang Non Canal
30	R-33	2.12	0.30	1.60	22	0.50	183	32.29	Bang Non Canal

Table 5.1.4-5 Calculation of the Flood Peak for Watershed Area between 25-1,000 Km^2 (by Snyder's Equations)

No.	Watershed Area		L	L_C	L_1	t_r	K_p	q_p	Φ	α	I_{100}	$Q_{p\ Snyder's\ Eq.}$	Stream
	Location	($km.^2$)	(km.)	(km.)	(km.)	(hr.)		($l/s/km.^2$)			(mm./hr.)	(cu.m./sec.)	
1	R-08	28.55	6.49	0.35	0.05	0.20	30	150.72	40	90%	183	106.50	Huai Clone, Huai Pae, Huai Luek Canal, Chumphon Canal
2	R-09	37.44	11.21	0.89	0.08	0.26	30	113.91	40	90%	183	139.66	Chumphon Canal Branch, Khong Canal, Khong Canal
3	R-10	71.50	9.90	1.61	0.16	0.31	30	95.36	40	90%	183	266.71	Chumphon Canal, Hin Sai Canal, Chumphon Canal Branch

Table 5.1.4-6 Design of Watershed Outlet which passes the Railway

No.	Sta.	Watershed Area ($km.^2$)	Q ($m.^3/sec.$)	Open Channel Required ($km.^2$)	Depth Required (m.)	Open Channel Width (m.)	Stream	Appropriate Watershed Outlet
1	0+850	R-01	70.20	35.10	2	17.55		Box culvert
2	1+250	R-02	30.15	15.08	2	7.54		Box culvert
3	2+235	R-03	44.47	22.23	2	11.12	Nakarat Canal	Elevated structure
4	3+375	R-04	60.46	30.23	2	15.11		Box culvert
5	5+674	R-05	34.72	17.36	2	8.68		Box culvert
6	6+840	R-06	221.10	110.55	2	55.27		Elevated structure
	7+800							Box culvert
	8+375							Box culvert
7	9+573	R-07	141.41	70.70	2	35.35	Chumphon Canal, Huai Clone	Box culvert
	14+641							Box culvert
8	15+310	R-08	106.50	53.25	2	26.62	Huai Clone, Huai Pae, Huai Luek Canal, Chumphon Canal	Elevated structure
	16+209							Box culvert
	17+553							Elevated structure
	19+745							Elevated structure
9	21+050	R-09	139.66	69.83	2	34.91	Chumphon Canal Branch, Khong Canal	Elevated structure
	21+593							Elevated structure
	21+949							Box culvert
	22+328							Box culvert
10	24+556	R-10	266.71	133.35	2	66.68	Chumphon Canal, Hin Sai Canal, Chumphon Canal Branch	Box culvert
	25+110							Elevated structure
	25+773							Elevated structure
	27+198							Elevated structure
	27+878							Elevated structure
	28+840							Elevated structure
11	29+918	R-11	123.42	61.71	2	30.86	Chumphon Canal, Hin Sai Canal, Chumphon Canal	Box culvert
	33+173							Elevated structure
12	34+283	R-12	156.90	78.45	2	39.22	Hin Wua Canal	Elevated structure
	35+333							Elevated structure
	36+360							Elevated structure
	38+233							Elevated structure
	38+735							Box culvert
	39+810							Elevated structure
13	42+025	R-13	70.00	35.00	2	17.50	Leak Canal, Chan Canal Branch, Wan Canal	Elevated structure
14	42+585	R-14	0.30	0.15	2	0.08		Box culvert
15	44+808	R-15	65.63	32.81	2	16.41	No name canal	Box culvert

Table 5.1.4-6 Design of Watershed Outlet which passes the Railway (Cont'd)

No.	Sta.	Watershed Area ($km.^2$)	Q ($m.^3/sec.$)	Open Channel Required ($km.^2$)	Depth Required (m.)	Open Channel Width (m.)	Stream	Appropriate Watershed Outlet
16	45+805	R-16	66.34	33.17	2	16.58	No name canal, Ta Prue Canal, Nam Chuet Canal	Elevated structure
	46+765							Elevated structure
	48+098							Elevated structure
	49+190							Elevated structure
	50+590							Elevated structure
	50+970							Box culvert
	51+470							Elevated structure
	51+703							Box culvert
	52+500							Box culvert
	53+196							Box culvert
	54+070							Elevated structure
	55+663							Elevated structure
17	56+835	R-17	71.02	35.51	2	17.76	Pak Nam Canal, No name canal, Pak Nam Canal	Elevated structure
	57+135							Box culvert
	57+950							Box culvert
	57+868							Box culvert
	58+643							Elevated structure
	60+430							Elevated structure
18	63+381	R-18	32.30	16.15	2	8.08		Box culvert
19	63+728	R-19	5.12	2.56	2	1.28	Bang Song Ra Canal, No name canal	Elevated structure
20	66+425	R-20	77.86	38.93	2	19.46	Sib Tha Canal, No name canal	Elevated structure
	66+910							Box culvert
	67+440							Elevated structure
21	68+625	R-21	93.55	46.77	2	23.39	Bang Yai Nua Cana	Elevated structure
22	72+048	R-22	86.99	43.50	2	21.75	Bang Yai Canal, Hin Kong Canal	Box culvert
23	75+010	R-23	0.20	0.10	2	0.05		Elevated structure
	75+820							Elevated structure
	76+109							Box culvert
	76+651							Box culvert
24	77+000	R-24	0.15	0.08	2	0.04	Lud Canal, La-un Canal, No name canal	Box culvert
	77+438							Box culvert
	81+668							Elevated structure
	84+262							Box culvert

Table 5.1.4-6 Design of Watershed Outlet which passes the Railway (Cont'd)

No.	Sta.	Watershed Area ($km.^2$)	Q ($m.^3/sec.$)	Open Channel Required ($km.^2$)	Depth Required (m.)	Open Channel Width (m.)	Stream	Appropriate Watershed Outlet
25	84+500	R-25	13.01	6.51	2	3.25	No name canal	Box culvert
	85+500							Box culvert
	86+125							Elevated structure
	88+645							Elevated structure
26	90+015	R-26	37.92	18.96	2	9.48	No name canal	Elevated structure
	90+895							Box culvert
	91+738							Box culvert
27	92+130	R-27	2.59	1.29	2	0.65		Box culvert
	92+878							Elevated structure
	93+941							Box culvert
	96+103							Elevated structure
	96+583							Box culvert
	97+000							Box culvert
	97+598							Elevated structure
	98+538							Elevated structure
28	99+135	R-28	4.42	2.21	2	1.10	No name canal	Box culvert
	102+332							Box culvert
29	2+500	R-29	2.60	1.30	2	0.65		Box culvert
30	2+750	R-30	42.84	21.42	2	10.71		Box culvert
31	0+000	R-31	5.29	2.65	2	1.32	Waterway	Box culvert
32	3+436	R-32	1.65	0.83	2	0.41	Bang Non Canal	Box culvert
	3+955							Elevated structure
33	4+500	R-33	32.29	16.14	2	8.07	Bang Non Canal	Box culvert

5.1.5 Railway Station Design

5.1.5.1 Architectural Concept

The architecture of the project is based on the local architecture of the two provinces namely Ranong and Chumphon Provinces. These two provinces are located on different coasts. Ranong is located on the Andaman Sea and Chumphon is located on the Gulf of Thailand where they are different in geography, climate, and culture. Therefore, the architecture of the project will harmonize the architecture differences of the two provinces and create an identity for the project.

In designing the stations, the Consultant has applied the architecture of Kromluang Chumporn Shrine in Chumphon Province as shown in **Figure 5.1.5-1** and the architecture of Rattanarangsan Palace which is an ancient palace in Ranong Province as shown in **Figure 5.1.5-2**.



Figure 5.1.5-1 Kromluang Chumporn Shrine



Figure 5.1.5-2 Rattanarangsan Palace

The forecast of passenger volumes is analyzed to categorize the station sizes and types according to the number of passengers and there are 2 station types as follows:

1.) Station Type A: a provincial station; it is a medium station and there is 1 station. (Using the highest passenger volume forecasts, 2054)

2.) Station Type B: a district station; it is a small station and there are 7 stations. (Using the highest passenger volume forecasts, 2054)

Table 5.1.5-1 shows the size, type and location of each station.

Table 5.1.5-1 List of Stations, Type and Chainage

Code	Station Name	Type	Chainage
S-01	Khun Krating Station	Type B	KM. 003+688
S-02	Ban Na 1 Station	Type B	KM. 014+067
S-03	Ban Na 2 Station	Type B	KM. 022+000
S-04	Pak Chan Station	Type B	KM. 042+950
S-05	Kra Buri Station	Type B	KM. 052+900
S-06	Bang Yai Station	Type B	KM. 070+839
S-07	La-un Station	Type B	KM. 078+869
S-08	Ranong Port Station	-	KM. 102+498
S-09	Ranong Station	Type A	KM. 004+832

5.1.5.2 Architectural Design

The architectural design defines each functional area of the station and station yard according to the 2 types of stations which are a medium-sized station or TYPE A and a small-sized station or TYPE B as shown in **Table 5.1.5-2**.

Table 5.1.5-2 List of Station Area and other Details

No.	Descriptions	Type A (Area/Unit)	Type B (Area/Unit)
1. Station Building			
1.1	Lobby	30 sq.m	20 sq.m.
1.2	Waiting Area	21 sq.m.	12 sq.m.
1.3	Ticket Office	14 sq.m.	11 sq.m.
1.4	Queuing	30 sq.m.	20 sq.m.
1.5	Master Room	23 sq.m.	18 sq.m.
1.6	Communication and Signaling	22 sq.m.	16 sq.m.
1.7	Parcel Room	30 sq.m.	15 sq.m.
1.8	Staff Toilet		
1.9	Passenger Toilet		
1.10	Toilet for the Disabled	30 sq.m.	20 sq.m.
1.11	Storage	11 sq.m.	7 sq.m.
1.12	Electrical Room	11 sq.m.	6 sq.m.
1.13	Circulation	185 sq.m.	163 sq.m.
Total Area		**407 sq.m.**	**308 sq.m.**

Figure 5.1.5-2 List of Station Area and other Details (Cont.)

No.	Descriptions	Type A (Area/Unit)	Type B (Area/Unit)
2. Platform Area			
2.1	Platform	W 3.20 x L 400 m.	Width as in Drawings x L 400 m.
2.2	Canopy	80 m. long	50 m. long
3. Station Layout Area			
3.1	Parking for Public Vans	5 Units	3 Units
3.2	Parking for Private Cars	17 Units	15 Units
3.3	Parking for Motorcycles	18 Units	10 Units
3.4	Parking for Bicycles	10 Units	10 Units
3.5	Parking for the Disabled	2 Units	2 Units
3.6	Guardhouse	1 Unit	1 Unit
3.7	Gate and Fence	450 m.	460 m.
3.8	Access Road	As shown in drawing	As shown in drawing
3.9	Covered Walkway	50 m.	50 m.
3.10	Landscape Works	4,200 sq.m.	4,000 sq.m.
3.11	Staff Dormitories	400 sq.m.	400 sq.m.
3.12	Generator	20 sq.m.	20 sq.m.
3.13	Pump Room	16 sq.m.	16 sq.m.
4. Parking Area opposite the Railway (Only at Khun Krathig Station, Ban Na 1 Station, Pak Chan Station, Kra Buri Station and Bang Yai Station)			
4.1	Parking for Public Vans	-	3 Units
4.2	Parking for Private Cars	-	12 Units
4.3	Parking for Motorcycles	-	15 Units
4.4	Parking for Bicycles	-	10 Units
4.5	Parking for the Disabled	-	2 Units
4.6	Guardhouse	-	1 Unit
4.7	Gate and Fence	-	100 m.
4.8	Access Road	-	As shown in drawing

Figures 5.1.5-3 and **5.1.5-4** show the layout and perspective of a provincial station or medium-sized station or Type A station and **Figures 5.1.5-5** and **5.1.5-6** show a district station or small-sized station or Type B station.

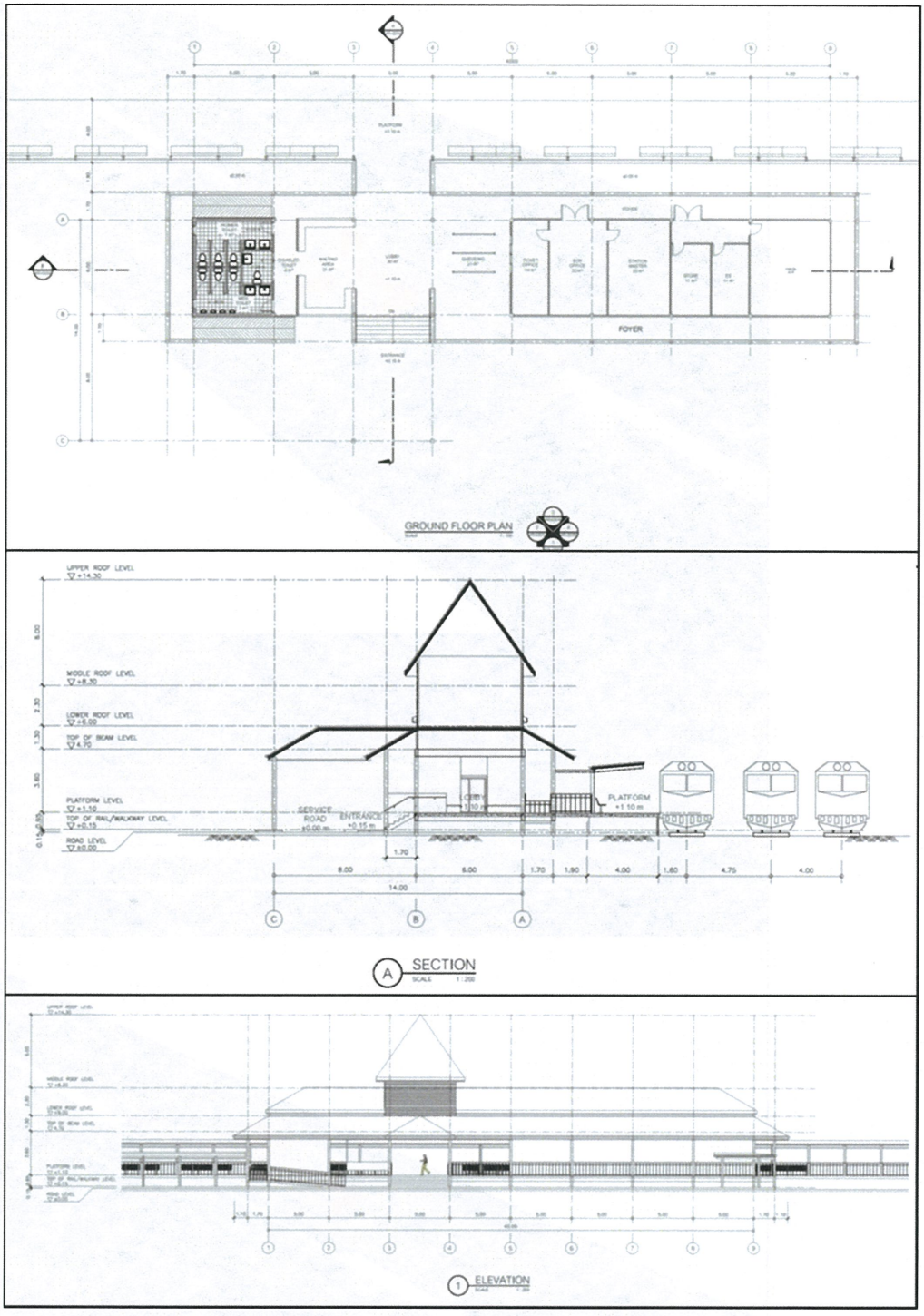


Figure 5.1.5.-3 Layout of Type A Station

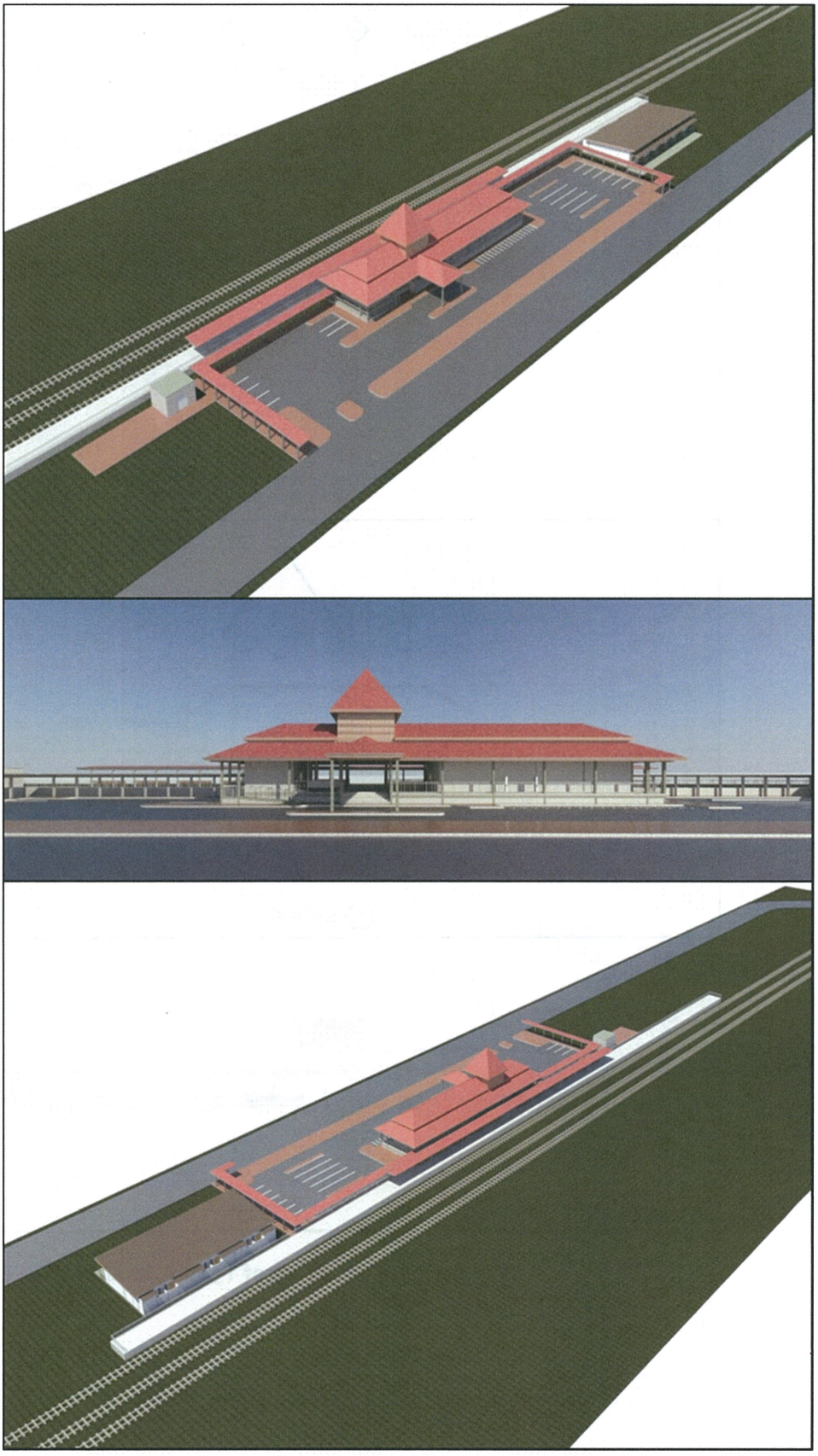


Figure 5.1.5.-4 Perspective of Type A Station

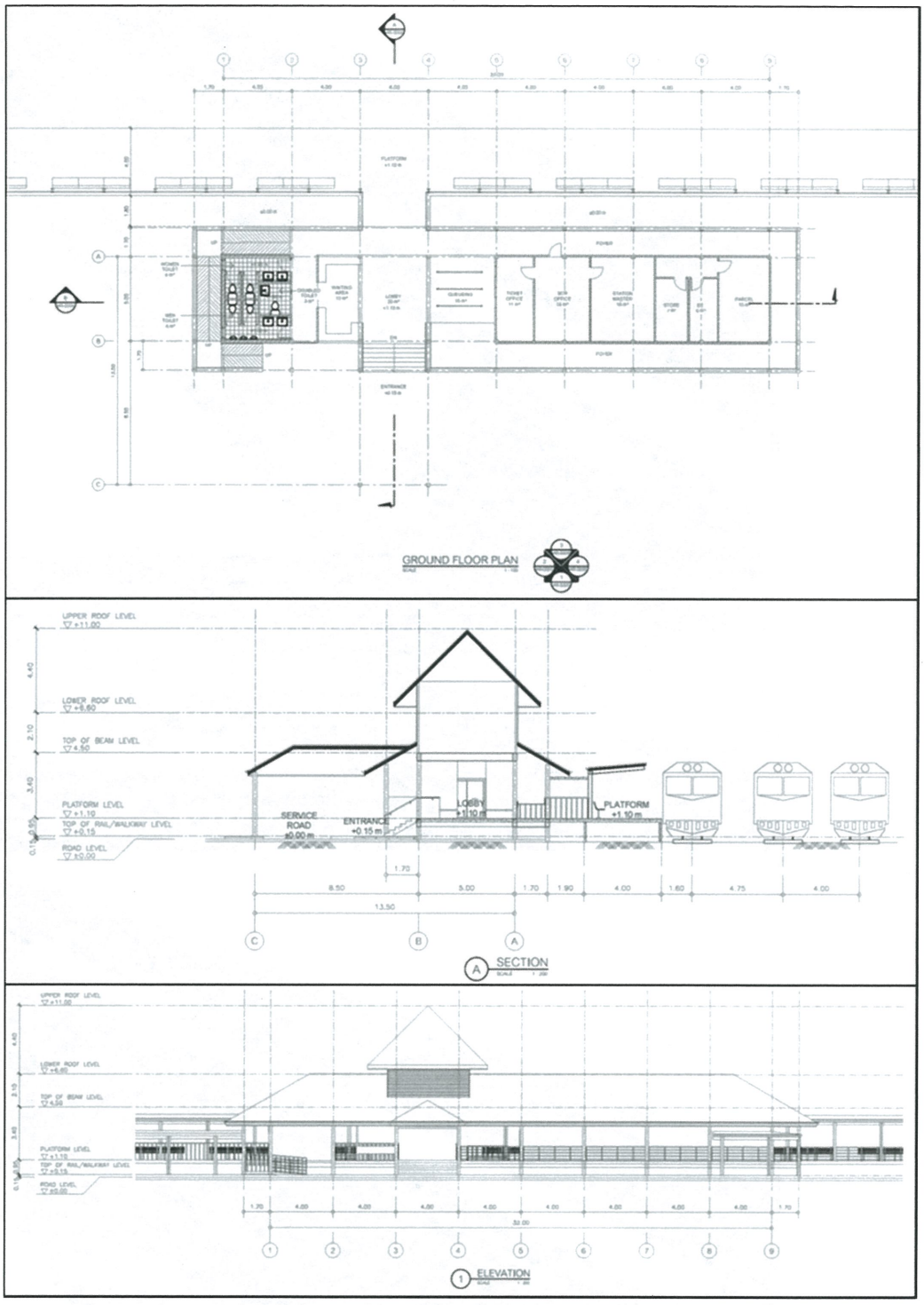


Figure 5.1.5-5 Layout of Type B Station

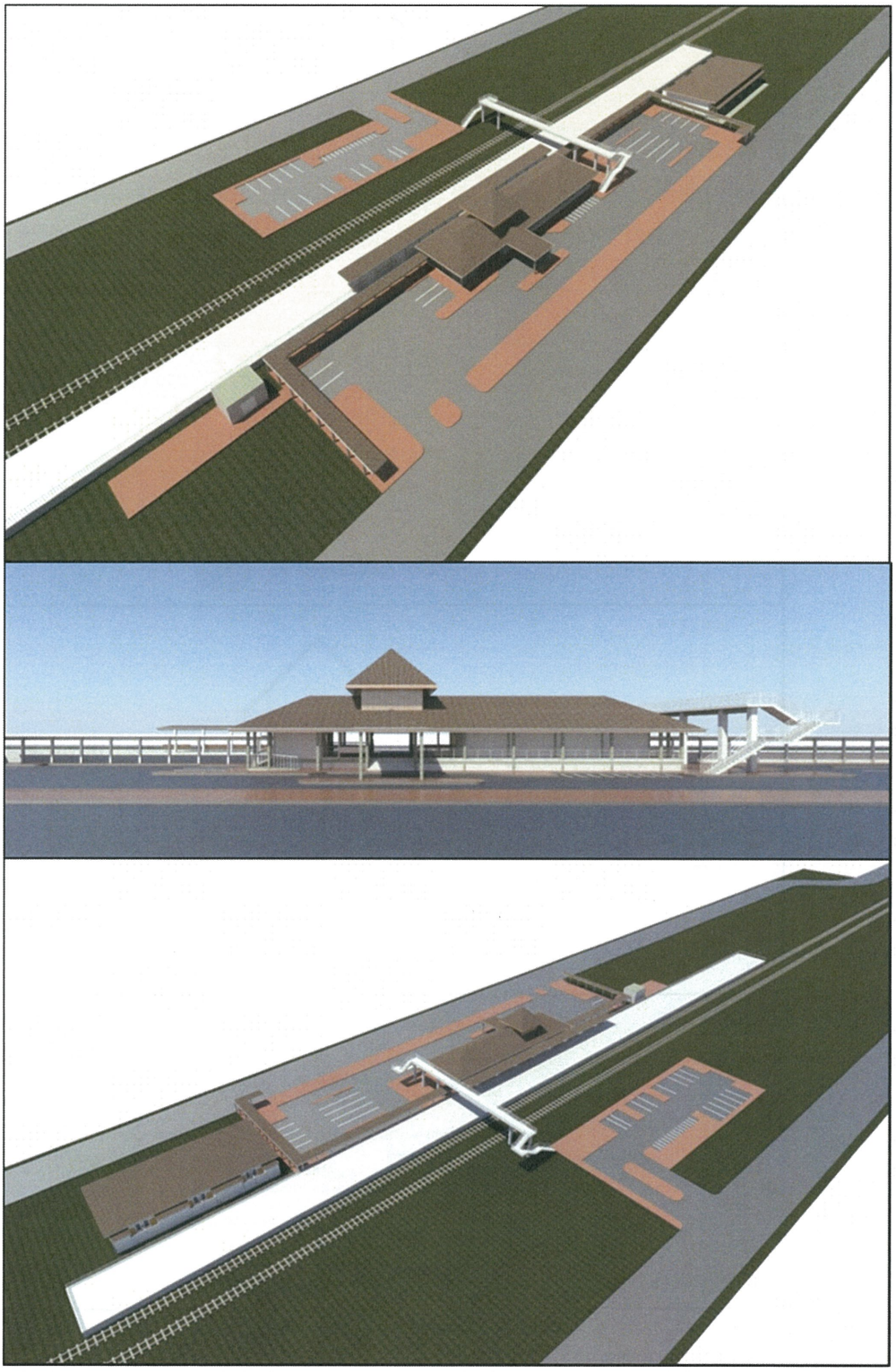


Figure 5.1.5-6 Perspective of Type B Station

5.1.6 Level Crossing Design

5.1.6.1 Solution of Level Crossing Problems

A level crossing is a major obstacle in train operation. In order to achieve the objective in train operation with a speed required and safety, the level crossing problems have to be solved completely. Therefore, the concept of grade separation to solve level crossing problems has been defined as a policy to be executed simultaneously with the development of the rail system. Followings are the procedures to solve level crossing problems:

1) Survey and gather necessary information, such as physical characteristics, terrain at the crossing, obstruction and traffic movement (TM) both at present and in the future.
2) Study and define the appropriate structure to correspond with the area and road, such as physical characteristics, traffic volumes, etc.
3) Based on the survey and gathered information, the Consultant has defined the design options for grade separation structure.

5.1.6.2 Design Criteria for Grade Separation Structure

The design of grade separation structure takes into account the traffic movement (TM) which derived from the number of trains multiplied by the number of vehicles crossing the railway within 24 hours and the unit is trains-vehicles per day as shown in **Figure 5.1.6-1**. However, other elements or factors have to be considered as well for the flexibility and appropriateness of each crossing, such as terrain, impact on the community, land expropriation, obstacles, difficulty and ease in construction and construction cost etc.

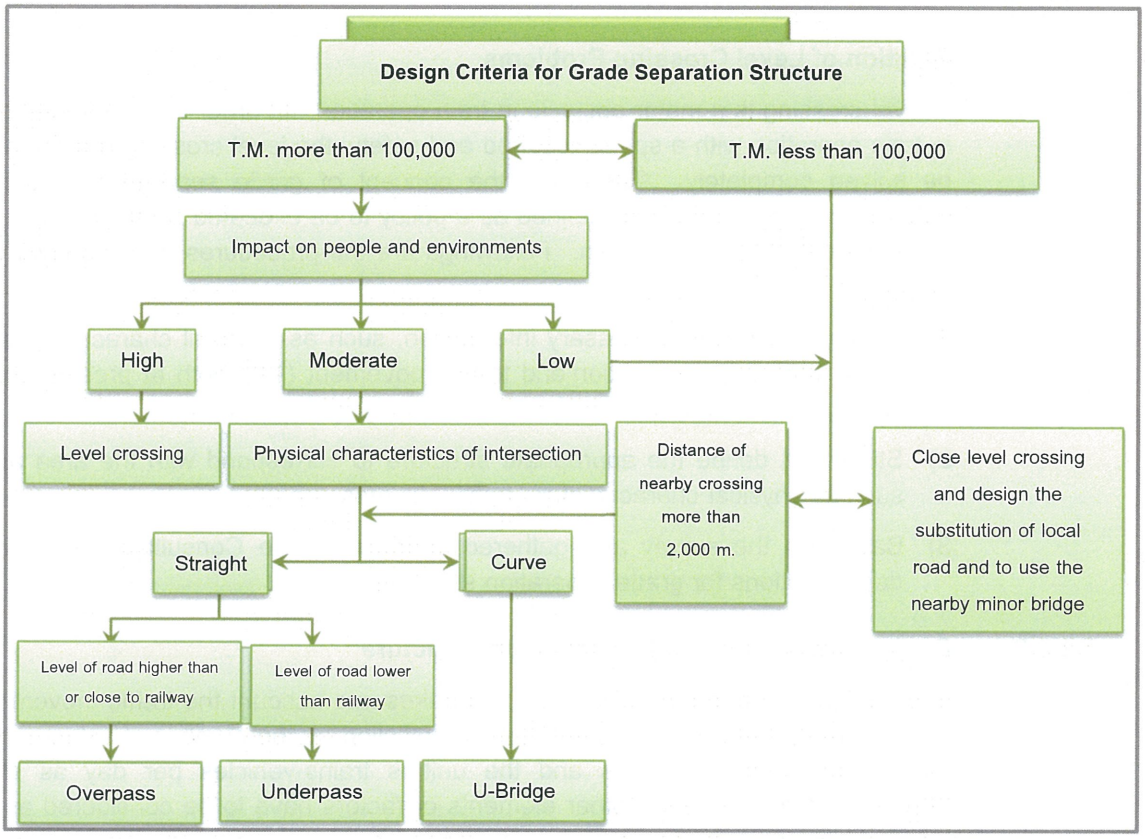


Figure 5.1.6-1 Guidelines for Design of Grade Separation Structure

Followings are the SRT's criteria which the Consultant has also taken into consideration for the design of grade separation:

- If the TM value of the first year operation exceeds 100,000 trains-vehicles per day, grade separation has to be constructed.
- If the TM value of the first year operation exceeds 80,000 trains-vehicles per day, grade separation has to be constructed within 2 years.
- If the TM value after a 5-year operation exceeds 100,000 trains-vehicles per day, grade separation has to be constructed.
- The road that has the embankment width more than 12 m. (Class 1) and high speed vehicles (over 80 km/hr.), grade separation has to be constructed.
- Grade separation has to be constructed at the following crossings.
  - Crossing the curved railway.
  - Crossing the slope railway.
  - Visibility of train drivers and car drivers; could not see each other within the distance of not less than 1,000 m.
  - Far from the end of curve, tunnel portal, bridge, mountain pass less than 2,000 m.
- Grade separation has to be constructed if the crossing is within the station yard.

5.1.6.3 Grade Separation Structure

As the Consultant realized the impact of community separation on both sides of railway and to mitigate this impact, the Consultant has taken the following 6 types of grade separation structures into consideration as detailed below and shown in **Figure 5.1.6-2**:

- Type 1: Elevated Railway

  This type depends mainly on the appropriateness of the geometry of the railway and terrain. If the railway is elevated or it is a railway bridge, the road at that point shall be designed as at-grade road under the railway by determining the columns in consistency with the highway development in the future. If the crossing is on the rural road, the clearance between the road and the substructure has to be appropriate.

- Type 2: Overpass

  This type the road is elevated across the at-grade railway. It is suitable for the existing road which is quite straight. The Consultant shall define the speed, lane width and road shoulder in accordance with the standard of level of service of each route. Where the road is elevated across a community area, the service road shall be constructed parallel to the overpass for the access of nearby people.

- Type 3: Minor Bridge

  With the terrain and geometry of the railway which cause the rail top to be much lower than the existing road, the minor bridge has to be provided so that people can use the existing road.

- Type 4: Service Road

  The service road is constructed parallel to the railway to connect the existing road, bridge or underpass nearby. This type is suitable for the crossings which are close to each other.

- Type 5: Box Underpass

  This type is used when the railway embankment is high. The local people can walk under the railway or even small vehicles, such as cars, vans can pass under the railway as well. Upon flooding, the box underpass shall assist draining.

- Type 6: Pedestrian Bridge

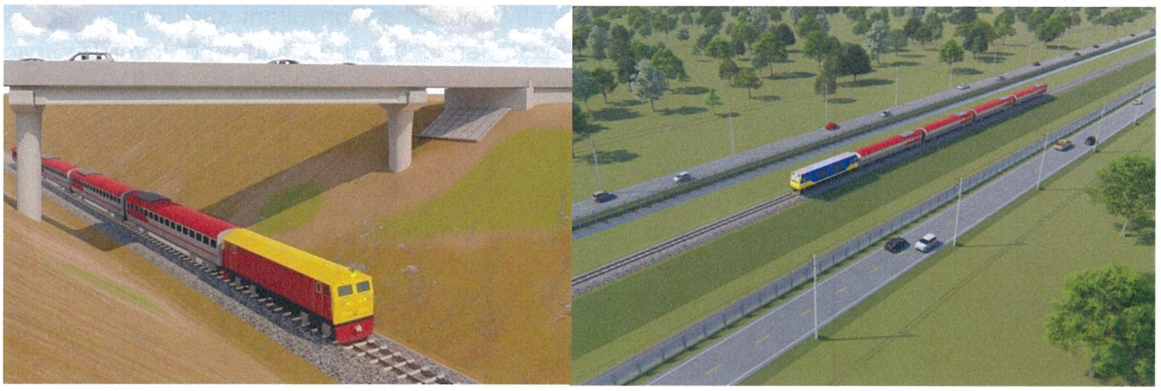
  Pedestrian bridge is a bridge for motorcycles, bicycles and local people.

The Consultant has designed the grade separation structure to suit the terrain, lifestyle and travel purposes of that area. However, the design of grade separation structure correlates specifically with the design of top rail level (geometric design of both horizontal and vertical alignments). The design of top rail level determines the type of grade separation structure whether it should be elevated railway or overpass. Therefore, it is necessary to design the top rail level and grade separation structure simultaneously.



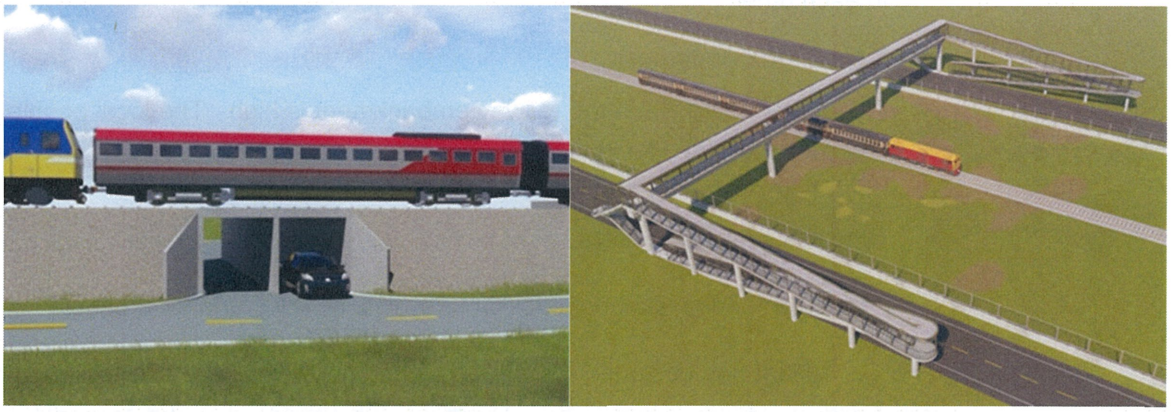
Type : 1 Elevated Railway

Type : 2 Overpass



Type : 3 Minor Bridge

Type : 4 Service Road



Type : 5 Box Underpass

Type : 6 Predestrian Bridge

Figure 5.1.6-2 Grade Separation Structures

5.1.6.4 Horizontal and Vertical Clearance Design Specifications

In designing an overpass or underpass, the Consultant has designed the horizontal and vertical clearances as specified in **Table 5.1.6-1** to mitigate the impact on the development of railway and road in the future.

Table 5.1.6-1 Clearance Design Specifications

Type	Horizontal Clearance	Vertical Clearance
Clearance for Train	** (Bridge span) to accommodate the future development plan	6.00 m.
Clearance for Vehicles	** (Bridge span) to accommodate the future development plan	5.50 m. (general) 5.00 m. (minimum)
Box Underpass	3.00 m. per direction	3.00 m.

Note: ** denotes the bridge span at that position. The Consultant shall consider the clearance of each position again.

5.1.6.5 Conclusion of Grade Separation Design

There are 84 nos. of grade separation as follows:

1) Type 1: Elevated railway consisting of 27 railway bridges crossing the existing road and 10 railway bridges crossing additionally constructed service road.
2) Type 2: 5 overpasses.
3) Type 3: 4 minor bridges.
4) Type 4: 32 service roads
5) Type 5: Box underpass consisting of 5 box underpasses on the existing road and 5 box underpasses on additionally constructed service road.
6) Type 6: 1 pedestrian bridge on the existing road and 1 pedestrian bridge on the service road.
7) Use the local road network to cross the nearby railway at 6 locations.
8) Close 4 nos. of the existing level crossings.

Table 5.1.6-2 shows the solution of level crossing problems at all stations

Table 5.1.6-2 Solution of Level Crossing Problems

Main Line							
No.	**Station (km)**	**Road Name**	**Type**	**No. of Lane**	**TM. (Year 2025)**	**Solution of Level Crossing Problems**	**Remark**
1	1+159	Chor Por 3009	AC	2	267,512	Overpass	
2	1+958	Local Road	Non-Asphalt	1	*	Local Road	Cross at Sta. 1+159
3	3+406	Local Road	Concrete	2	*	Serviced Road	Cross at Sta. 4+032
	3+688	-	-	-		-	**Khun Krating Station**
4	4+032	Highway 41	AC	4	524,538	Overpass	
5	4+830	Local Road	Non-Asphalt	1	*	Local Road	Cross at Sta. 4+032
6	6+000	Local Road	Concrete	2	*	Pedestrain Bridge	
7	7+303	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 7+635
8	7+635	Local Road	Concrete	2	6,202	Box Underpass	
	8+305	-	-	-		Box Underpass	
9	9+795	Chor Por 2121	AC	2	7,882	Elevated Railway	Remain existing condition
10	10+223	Chor Por 1045	AC	2	8,775	Serviced Road	Cross at Sta. 9+795
11	11+186	Local Road	AC	2	7,070	Serviced Road	Cross at Sta. 12+088
12	12+075	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 12+088
	12+088	-	-	-		Elevated Railway	Construct new road
13	13+297	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 12+088
	14+067	-	-	-		-	**Ban Na (1) Station**
14	14+374	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 12+088/Sta. 14+945
15	14+945	Chor Por 1005	AC	2	29,545	Overpass	
16	15+889	Local Road	Concrete	1	*	Serviced Road	Cross at Sta. 16+190
	16+190	-	-	-		Box Underpass	
17	16+487	Local Road	Non-Asphalt	1	*	Local Road	Cross at Sta. 16+190
18	17+656	Local Road	Non-Asphalt	1	*	Elevated Railway	Remain existing condition
19	18+648	Local Road	Non-Asphalt	1	*	Dismiss the road	
20	19+657	Local Road	Concrete	1	13,259	Elevated Railway	Remain existing condition
21	21+236	Local Road	Concrete	1	*	Serviced Road	Cross at Sta. 21+550
	21+550	-	-	-		Elevated Railway	Construct new road
22	21+680	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 21+550
	22+000	-	-	-		-	**Ban Na (2) Station**
23	22+289	Local Road	Non-Asphalt	1	*	Dismiss the road	
24	22+422	Local Road	Non-Asphalt	1	*	Dismiss the road	
25	23+340	Local Road	Non-Asphalt	1	*	Dismiss the road	
26	23+849	Local Road	Concrete	2	14,562	Minor Bridge	
27	25+364	Local Road	Concrete	2	*	Elevated Railway	Remain existing condition
28	25+595	Local Road	Concrete	2	*	Serviced Road	Cross at Sta. 25+364
29	25+721	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 25+364
30	27+769	Local Road	Non-Asphalt	1	*	Elevated Railway	Remain existing condition
31	28+032	Local Road	AC	2	*	Elevated Railway	Remain existing condition
32	28+161	Local Road	Concrete	1	*	Serviced Road	Cross at Sta. 28+032
33	28+619	Chor Por 2052	AC	2	12,492	Local Road	Cross at Sta. 28+032

Table 5.1.6-2 Solution of Level Crossing Problems (Cont'd)

No.	Station (km)	Road Name	Type	No. of Lane	TM. (Year 2025)	Solution of Level Crossing Problems	Remark
34	29+372	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 29+620
35	29+620	Local Road	Non-Asphalt	1	*	Minor Bridge	
	29+970	-	-	-		Box Underpass	
36	30+017	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 29+970
37	32+984	Local Road	Non-Asphalt	1	*	Elevated Railway	Remain existing condition
38	33+418	Ror Nor 3117	AC	2	13,489	Elevated Railway	Remain existing condition
39	34+299	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
40	35+878	Ror Nor 1017	AC	2	12,282	Elevated Railway	Remain existing condition
41	38+835	Local Road	Concrete	1	*	Box Underpass	
42	39+583	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 39+820
	39+820	-	-	-		Elevated Railway	Construct new road
	40+870	-	-	-		Pedestrain Bridge	
43	40+904	Local Road	Concrete	1	17,052	Serviced Road	Cross at Sta. 39+820
44	41+617	Ror Nor 1003	AC	2	22,963	Local Road	Cross at Sta. 42+587
45	42+587	Ror Nor 1003	AC	2	22,963	Overpass	
	42+950	-	-	-		-	**Pak Chan Station**
46	45+725	Ror Nor 1003	AC	2	22,963	Serviced Road	Cross at Sta. 45+780/Sta. 46+688
47	46+158	Local Road	AC	1	17,474	Serviced Road	Cross at Sta. 46+688
48	46+688	Local Road	AC	2	*	Elevated Railway	Remain existing condition
49	46+977	Local Road	AC	2	*	Serviced Road	Cross at Sta. 46+688
50	47+850	Ror Nor 1018	AC	2	15,731	Elevated Railway	Remain existing condition
	48+391	-	-	-		Elevated Railway	Construct new road
51	48+597	Local Road	AC	2	*	Serviced Road	Cross at Sta. 48+391
52	51+660	Local Road	Concrete	1	*	Box Underpass	
53	52+119	Local Road	AC	2	19,601	Elevated Railway	Remain existing condition
	52+900	-	-	-		-	**Kra Buri Station**
54	53+377	Ror Nor 1014	AC	2	720	Overpass	
55	54+110	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
56	56+771	Ror Nor 1008	AC	2	15,903	Elevated Railway	Remain existing condition
57	56+859	Highway 4	AC	4	154,717	Elevated Railway	Remain existing condition
58	61+661	Local Road	AC	2	15,903	Serviced Road	Cross at Sta. 61+865
	61+865	-	-	-		Elevated Railway	Construct new road
59	62+555	Local Road	Concrete	2	*	Elevated Railway	Remain existing condition
60	62+969	N/A	Non-Asphalt	1	*	Elevated Railway	Remain existing condition
61	69+162	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
62	70+559	Local Road	Concrete	1	*	Serviced Road	Cross at Sta. 71+170
	70+839	-	-	-		-	**Bang Yai Station**
	71+170	-	-	-		Elevated Railway	Construct new road
63	74+568	Local Road	AC	2	*	Serviced Road	Cross at Sta. 74+600
	74+600					Elevated Railway	Construct new road
	76+685	-	-	-		Box Underpass	
64	76+884	Ror Nor 3080	AC	2	*	Serviced Road	Cross at Sta. 76+685
	78+580	-	-	-		Elevated Railway	Construct new road

Table 5.1.6-2 Solution of Level Crossing Problems (Cont'd)

No.	Station (km)	Road Name	Type	No. of Lane	TM. (Year 2025)	Solution of Level Crossing Problems	Remark
65	78+669	Ror Nor 3028	Concrete	2	*	Serviced Road	Cross at Sta. 78+580
	78+869	-	-	-		-	**La-un Station**
66	79+149	Ror Nor 3028	Concrete	2	*	Serviced Road	Cross at Sta. 78+580
67	83+260	Local Road	AC	2	*	Elevated Railway	Remain existing condition
68	85+229	Local Road	Non-Asphalt	1	*	Local Road	Cross at Sta. 85+463
69	85+463	Local Road	Concrete	1	*	Box Underpass	
70	85+999	N/A	Non-Asphalt	1	*	Elevated Railway	Remain existing condition
71	87+354	Ror Nor 4076	AC	2	*	Minor Bridge	
72	89+055	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
73	93+248	Ror Nor 4010	AC	2	*	Elevated Railway	Remain existing condition
74	95+931	Local Road	Non-Asphalt	1	*	Elevated Railway	Remain existing condition
75	96+353	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
76	96+629	Local Road	Concrete	1	*	Box Underpass	
77	96+722	Local Road	Non-Asphalt	1	*	Serviced Road	Cross at Sta. 96+629
78	98+428	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
79	102+107	Ror Nor 4010	AC	2	33,912	Minor Bridge	
80	102+357	Ror Nor 4010	AC	2	*	Serviced Road	Cross at Sta. 102+107
	102+498	-	-	-		-	**Ranong Port Station**
Spur Line							
No.	**Station (km)**	**Road Name**	**Type**	**No. of Lane**	**TM. (Year 2025)**	**Solution of Level Crossing Problems**	**Remark**
81	2+552	Ror Nor 1002	AC	2	15,539	Serviced Road	Cross at Sta. 2+732
	2+732	-	-	-		Elevated Railway	Construct new road
82	2+942	Local Road	Concrete	1	*	Elevated Railway	Remain existing condition
83	3+540	Local Road	AC	2	*	Serviced Road	Cross at Sta. 3+760
	3+760	-	-	-		Elevated Railway	Construct new road
84	4+400	Local Road	Concrete	2	*	Serviced Road	Cross at Sta. 4+452
	4+452	-	-	-		Box Underpass	
	4+832	-	-	-		-	**Ranong Station**

Remark: * TM. Less than 10,000 trains-vehicles per day

5.1.7 Geotechnical Engineering Design

5.1.7.1 Geological Condition along the Project Route Alignment

The Consultant has studied the Geological Map of Thailand of Ranong and Chumphon Provinces, year 2007 as shown in **Figure 5.1.7-1**, prepared by the Bureau of Geology, Department of Mineral Resources, which shows that the geological condition of the project area and its vicinity can be divided into 4 main periods as follows:

1) Carboniferous - Permian Rock Group (CPk)

Carboniferous - Permian Rock Group (about 350-245 million years) or called Kaeng Krachan Rock Group was found as a mountain terrain lying from the northeast to the southwest. Kaeng Krachan Rock Group can be divided into 3 sub-groups as follows:

- Laem Mai Phai Formation (CPlp) consists of alternations of mudstone, sandstone and Feldspar sandstone. The mudstone is gray and thin. The sandstone is white opal, fine texture, semi-circular and little rounded shape. The Feldspar sandstone is white, medium texture and little round.
- Ko He Formation (CPkh) consists of diamictites, with pebbles generally smaller than 2 cm including quartz, quart-zite, sandstone, limestone, marble, granite and gneiss.
- Khao Phra Formation (CPkp) consists of mudstone, laminated mudstone, siltstone and sandstone.
- Kaeng Krachan Rock Group; besides having sedimentary rock, there is metamorphic unit (CPm) which consists of schist, quartz -schist, biotite- quartz, sericite schist, gray to grayish green. These rocks are exposed to granite. With the geological features of the Kaeng Krachan Rock Group which is mountain terrain, there are many waterfalls such as Chum Saeng Waterfall (Rainbow Waterfall), Bok Krai Waterfall, Punyaban Waterfall, Ngao Waterfall, Tone Phet Waterfall, Rark Roy Waterfall and Khao Phra Narai Waterfall etc.

2) Permian Rock Group (Pr)

Permian Rock Group (about 286-245 million years) or called Ratchaburi Rock Group is scattered from Sangkhlaburi District, Kanchanaburi Province to Yala Province. Most have a mountainous nature. It consists of limestone with Karst topography. Limestone has a chemical composition of calcium carbonate (CaCO3). It can be used as raw material in the cement industry and chemical industry. It can also be used as a construction material. Limestone has soluble properties in acidic water. Therefore, caves with limestone stalagmites are found in limestone mountains. The limestone near the granite is transformed into marble which can be used as ornamental stone. The soil that decays from limestone is often orange-red or called Terra Rosa which has essential minerals for plants. So the area near the limestone is a good source of cultivation. Although the limestone mountains are steep with cliff, there is no soil sediment on the hilltop. There is no risk to landslide. However, the phenomenon of pit collapse may occur in the plains near the limestone mountains.

The Ratchaburi Rock Group consists of limestone, dolomite limestone and alternations of dolomite stone, sandstone and shale. Limestone, dolomite limestone and dolomite stone are gray to dark gray. The Ratchaburi Rock Group is found

scattering as small hills from the west of Muang Ranong District to Chumphon Province.

3) Quaternary Sediments (Q)

Quaternary sediments refer to gravel, sand, soil and clay which have not yet solidified into rocks aging about 1.6 million years ago. Quaternary sediments are found in narrow plains along the west coast of Ranong Province and the east of Chumphon Province. Most of them locate the community. The quaternary sediments in each area can be classified by type and sedimentation environment which can be divided into 3 units as follows:

- Alluvial deposit (Qa) consists of gravel, sand, silt and clay. It happens from water flow gravel, rock, soil and sand to deposit unsystematically with the influence of slope and surface water. It could be found at the plain near the river bank. This plain area is always flooded.
- Colluvial deposit and residual deposit (Qc), sedimentary rock consists of quartzite, sandstone, siltstone, granite, sand, silt, laterite. It happens from the decay of original stone. It is usually found near the foothills or basin. This sediment can be used as a source of embankment fill for construction. This area has risk to landslides so it is not suitable for residential purposes.

4) Cretaceous Intrusive Granite (Kgr)

It consists of biotite-muscovite granite, white, fine to medium texture, aging about 140-65 million years. It was found scattering as high mountain terrain from the east of Ranong Province from La-un District to Kaper District and also at Kra Buri District, Chang Island, North Surin Island and South Surin Island etc. Mostly, the granite is inserted into the Kaeng Krachan Rock Group, resulting in tin mineral.

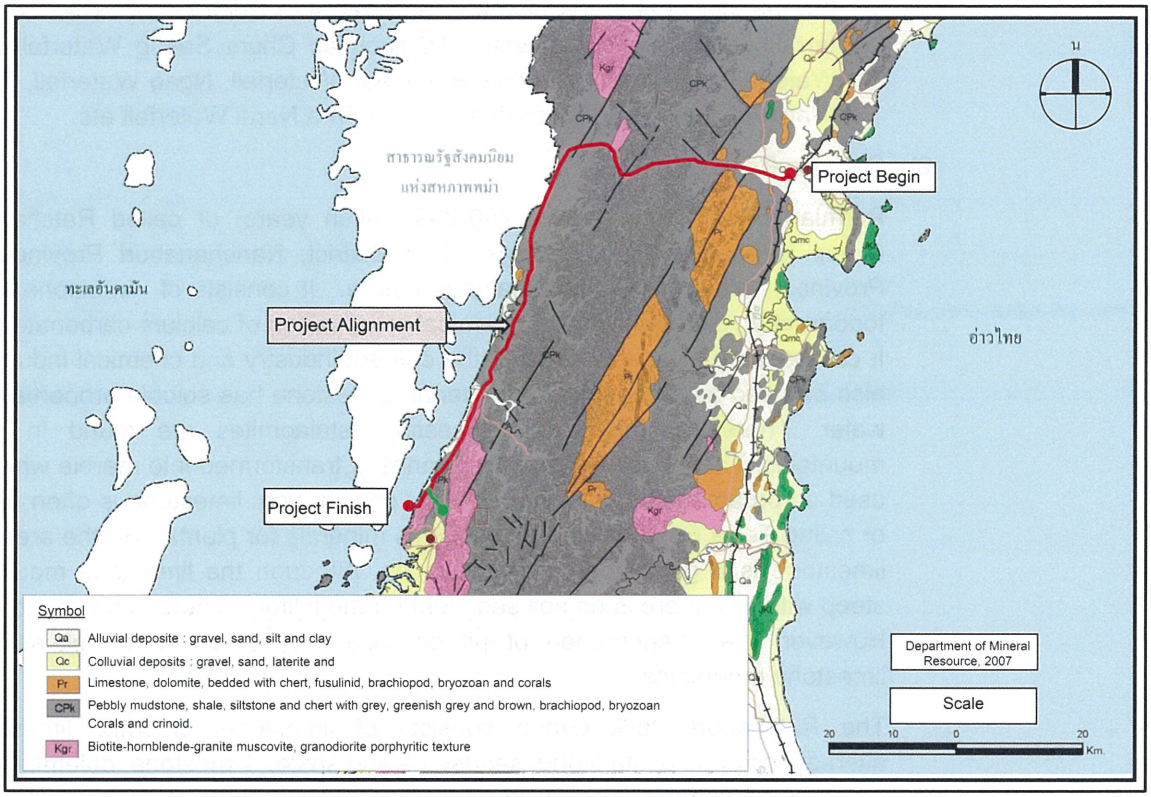


Figure 5.1.7-1 Geological Map of the Project Area and Its Vicinity

Geological Structure

A lot of fold line, fault line and fracture line is found in Kaeng Krachan Rock Group (Carboniferous – Permian Rock Group) near the project area. The major fault line found is Ranong Fault Line which is strike-slip fault line from the northeast to the southwest and from the Andaman Sea, Ranong Province to the Gulf of Thailand in the northeast until Prachuap Khiri Khan and Chumphon Provinces for 300 km long. Ranong Fault Line is an active fault line with right-lateral motion. Most of fracture line is from the northeast to the southwest and from the northwest to the southeast. The influence of Ranong Fault Line which passes Kaeng Krachan Rock Group causes many hot springs such as Ban Had Yai Hot Springs, Raksawarin Hot Sprints, Bang Rin Hot Springs and Porn Rang Hot Springs etc.

The fold line is commonly found in Kaeng Krachan Rock Group and is one-sided oblique. Most of the rock bed is oblique to the northwest and the fold axis is from the northeast to the southwest. Ranong Fault Line is active fault line (**Figure 5.1.7-2** Active Fault Line Map of Thailand). The influence of Ranong Fault Line which passes Kaeng Krachan Rock Group causes many hot springs such as Ban Khao Phlu, La Mae District. Additionally, Lang Suan Fault Line is found at the southeast of Ranong Province in the same direction of Ranong Fault Line. Most of fracture line is found from the northeast to the southwest parallel to the mountain range on the west of Ranong Province. The minor fracture line found is from the northwest to the southeast.

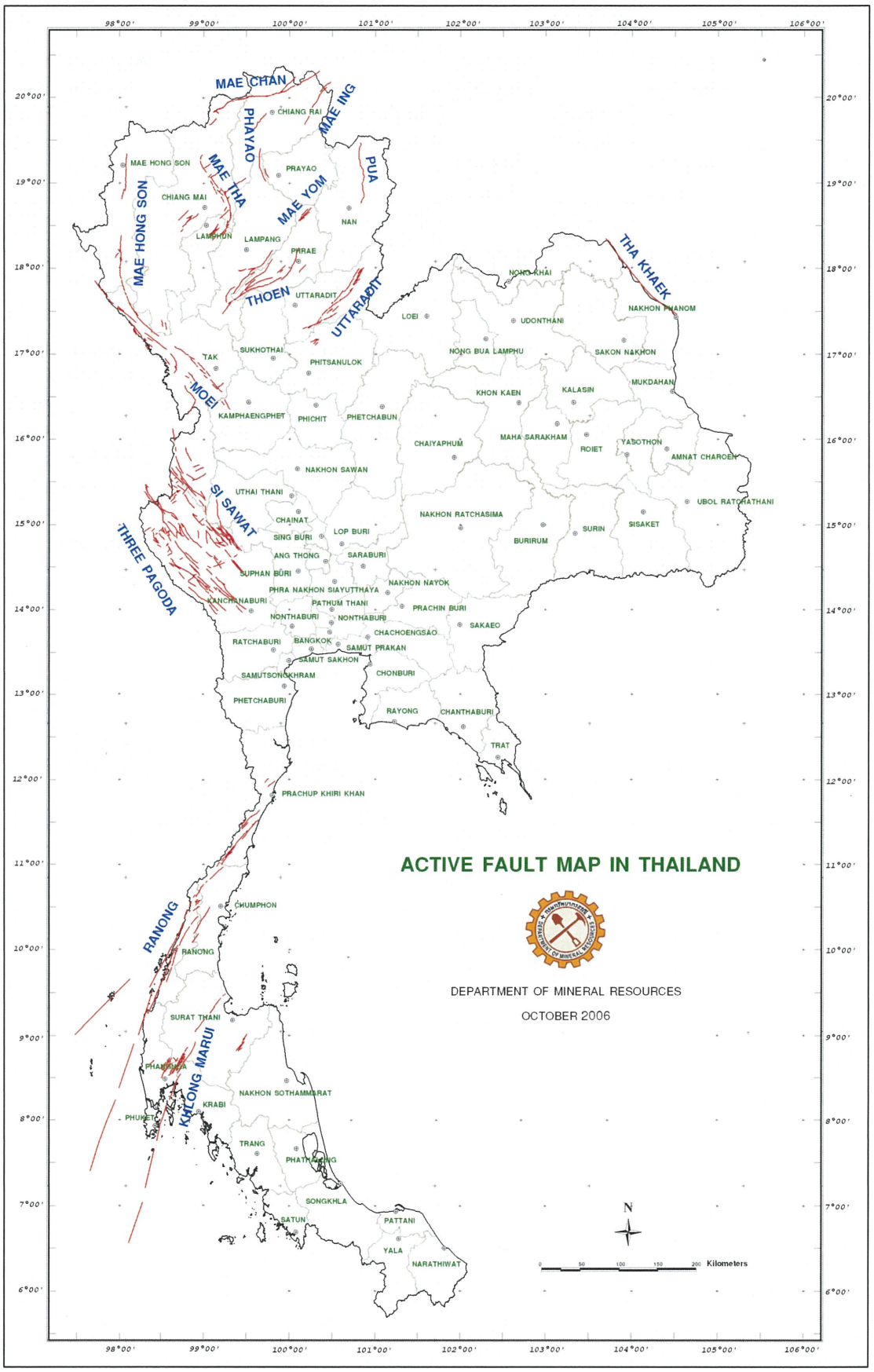


Figure 5.1.7-2 Active Fault Line Map of Thailand

5.1.7.2 Geological and Geotechnical Survey

1) Survey and Test Embankment Material for At-grade Railway Embankment

Soil samplings were collected from 10 test pits where at-grade railway embankment shall be constructed for the following tests:

- Sieve Analysis
- Atterberg Limits
- Standard Compaction
- California Bearing Ratio and Swell.

2) Soil Survey for Bridge Foundation and Other Structures

Total nine (9) boreholes where bridge and elevated structures shall be constructed were drilled to 7-22 m. until the rock bed was found and then the rock bed was drilled to 2-3 m. for investigation.

Rotary drilling and wash boring method to collect undisturbed samples were performed every 1.50 m. by using a thin tube.

Standard Penetration Test (SPT) was performed every 1.50 m. at stiff clay, hard clay and sand beds and soil samples were collected for laboratory test.

The diamond core bits were used to drill the rock bed and NMLC Triple Tube Core Barrel was used to collect rock samples.

The details of boreholes and test pits locations are shown in **Tables 5.1.7-1** and **5.1.7-2** and **Figure 5.1.7-3**.

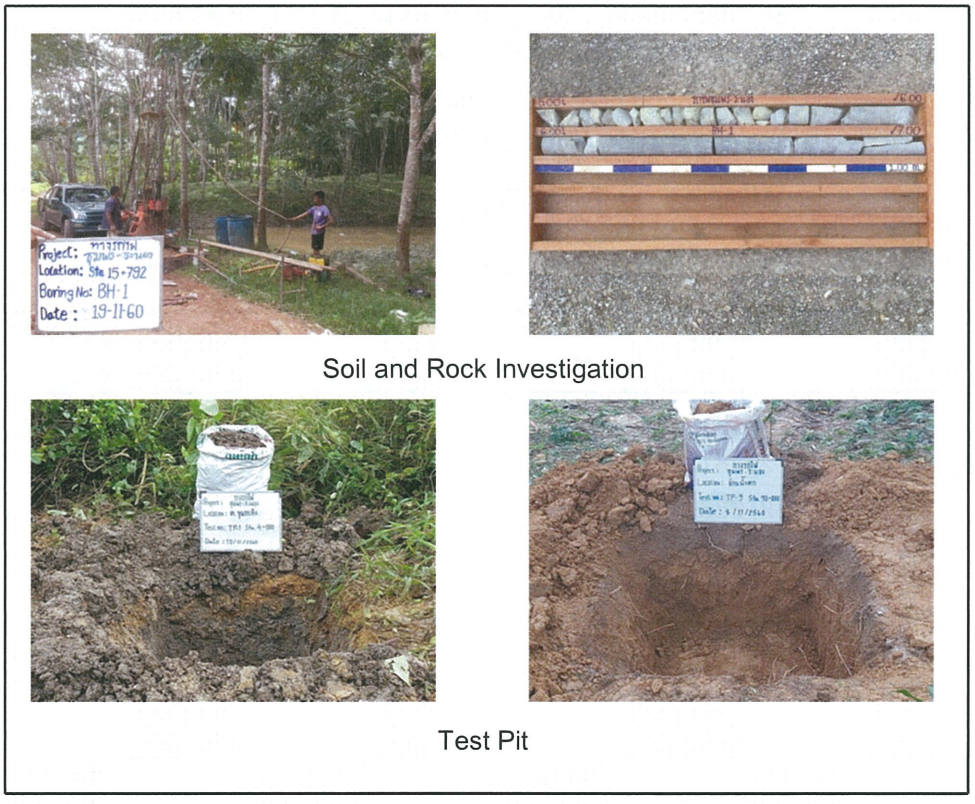
Table 5.1.7-1 Details of Boreholes Locations

No.	Chainage	Borehole No.	Elevation m.	Depth/Thickness, m		Ground Water Level*, m
				Soil	Rock	
1	15+792	BH-1	45.0	5.0	2.0	3.0
2	22+481	BH-2	71.0	7.0	2.0	3.5
3	32+226	BH-3	45.0	6.0	2.0	4.0
4	44+925	BH-4	20.0	12.0	2.0	3.5
5	59+751	BH-5	20.0	8.4	2.0	3.0
6	65+678	BH-6	15.0	8.0	3.0	4.0
7	79+873	BH-7	19.0	13.0	3.0	3.5
8	88+577	BH-8	12.5	10.0	3.0	2.5
9	101+709	BH-9	35.0	19.0	3.0	3.0

Note: * The ground water level is measured from the mouth of borehole at the time of drilling.

Table 5.1.7-2 Details of Test Pits Locations

No.	Chainage	Test Pit No.
1	4+000	TP-1
2	10+000	TP-2
3	20+000	TP-3
4	30+000	TP-4
5	41+000	TP-5
6	52+000	TP-6
7	58+000	TP-7
8	76+000	TP-8
9	90+000	TP-9
10	99+000	TP-10



Soil and Rock Investigation

Test Pit

Figure 5.1.7-3 Sample of Soil Investigation Works

3) Field and Laboratory Test

Based on the soil samples from soil boring, the field and laboratory tests were performed in accordance with ASTM and AASHTO as shown in **Table 5.1.7-3**.

Table 5.1.7-3 Laboratory Tests and Standards

Description	Test Standards
Standard Penetration Test (SPT)	ASTM D 1586
Natural Water Content	ASTM D 2216-90
Atterberg's Limits	ASTM D 4318-84
Unit Weight	Weight & Dimension Measurement
Sieve Analysis	ASTM D 422-63 (Re-approved 1991)
Unconfined Compression Test	ASTM D 2216-85
Uniaxial Compression Test	ASTM D 3148

The test results from soil boring and field and laboratory tests, such as soil types, basic soil properties, shear strength of soils, standard penetration test (SPT) and soil settlement properties, were used as a data for railway embankment design on stability and settlement evaluation.

Table 5.1.7-4 shows the soil profile along the alignment.

Table 5.1.7-4 Summary of Soil Profile along the Alignment

Km. (Approximately)	Soil and Rock Description
Km.0 to Km.45 At Mueang Chumphon District, Chumphon and Kra Buri District, Ranong	The top soil is stiff to very stiff silty /sandy clay of 0.5-5.5 m thick, then the layer of hard silty/sandy clay of 1.5-11.5 m thick. At Sta.32+226, BH-1, the topsoil is medium dense to dense sand of 6 m. thick. After that it is the claystone tuff and granite rock bed until the end of the hole.
Km.45 to Km.66 At Kra Buri District, Ranong	The top soil is stiff to very stiff silty/sandy clay of 3-4 m. thick, then it is the medium dense to very dense sand layer of 4-5 m. thick. After that it is the sandstone rock bed until the end of the hole.
Km.66 to Km.102 At Kra Buri District and La-Un District, Ranong	The top soil is stiff to very stiff silty/sandy clay of 7-10 m. thick except at Sta. 88+577, BH-8, the top soil is soft clay. After that it is hard silty/sandy clay layer of 2-9 m thick, then gneiss, granodiorite and hornfels rock bed until the end of the hole.

The test results from test pits and laboratory tests, such as soil types, basic properties of natural ground and California bearing ratio (CBR) which shows the load-bearing capacity of soil under the compacted soil, were used as a data for railway embankment design and as a data in case of using natural ground as construction material for embankment works.

Figure 5.1.7-4 shows the test results from soil boring and **Figure 5.1.7-5** shows the test results from test pit.

Summary of Test Results

BH-9 (Sta.101+709) โครงการงานศึกษาความเหมาะสม เส้นทางรถไฟชุมพร-ระนอง

Sample No.	Depth (m) From	Depth (m) To	W_n (%)	Atterberg Limits (%) LL	PL	PI	Sieve Analysis % Passing (US Standard Sieve) 1"	3/4"	1/2"	3/8"	#4	#10	#40	#100	#200	USCS Group[a]	Soil Strength (kN/m²) P_{uc}[b]	Torvane	S_{uc}[c]	Unit[d] Weight (kN/m³)	SPT-N[e] (Blows/ 300 mm)
SS- 1	0.00	0.45	13.2	Insufficient Sample					100	86	76	68	59	56	55	(CL)				-	11
SS- 2	0.50	0.95	14.1	Insufficient Sample						100	90	83	70	63	61	(CL)				-	13
SS- 3	1.00	1.45	13.5	Insufficient Sample					100	92	84	77	65	58	55	(CL)				-	21
SS- 4	1.50	1.95	18.7	Insufficient Sample						100	92	88	80	73	70	(CL)				-	10
SS- 5	2.00	2.45	15.3	Insufficient Sample					100	94	88	85	75	68	66	(CL)				-	12
SS- 6	2.50	2.95	19.5	Insufficient Sample					100	95	88	82	70	62	59	(CL)				-	11
SS- 7	3.00	3.45	12.5	Insufficient Sample						100	92	83	68	58	56	(CL)				-	12
SS- 8	4.50	4.95	20.6	Insufficient Sample						100	93	92	88	85	83	(CL)				-	11
SS- 9	6.00	6.45	29.3	51.8	28.8	23.0					100	99	96	92	89	CH				-	12
SS- 10	7.50	7.95	20.3	Insufficient Sample						100	92	83	75	69	68	(CL)				-	14
SS- 11	9.00	9.45	23.5	40.6	26.7	13.9				100	91	80	62	55	53	CL				-	23
SS- 12	10.50	10.95	24.7	Insufficient Sample					100	94	85	78	68	62	61	(CL)				-	31
SS- 13	12.00	12.45	25.5	43.0	32.2	10.8			100	85	75	67	58	55	54	CL				-	48
SS- 14	13.50	13.95	18.7	Insufficient Sample						100	99	95	90	84	82	(CL)				-	53
SS- 15	15.00	15.45	16.1	Insufficient Sample						100	93	88	80	73	70	(CL)				-	55
SS- 16	16.50	16.95	20.6	Insufficient Sample									100	95	93	(CL)				-	30,50/25,-
SS- 17	18.00	18.45	17.1	Insufficient Sample									100	93	90	(CL)				-	20/0,-,-
RC- 1	19.00	20.50														HORNFELS					
RC- 2	20.50	22.00														HORNFELS					

Notes:

[a] USCS groups provided in parenthesis are from visual classification

[b] P_{uc} = Pocket Penetrometer Resistance

[c] S_{uc} = $q_u/2$; where qu is Unconfined Compressive Strength from Unconfined Compression Test

[d] Unit Weight provided for split spoon samples (SS) are for disturbed samples from SPT tests.

[e] If the sampler is driven less than 450 mm, the number of blows per each complete and partial (less than or equal to 150 mm) increments were recorded.

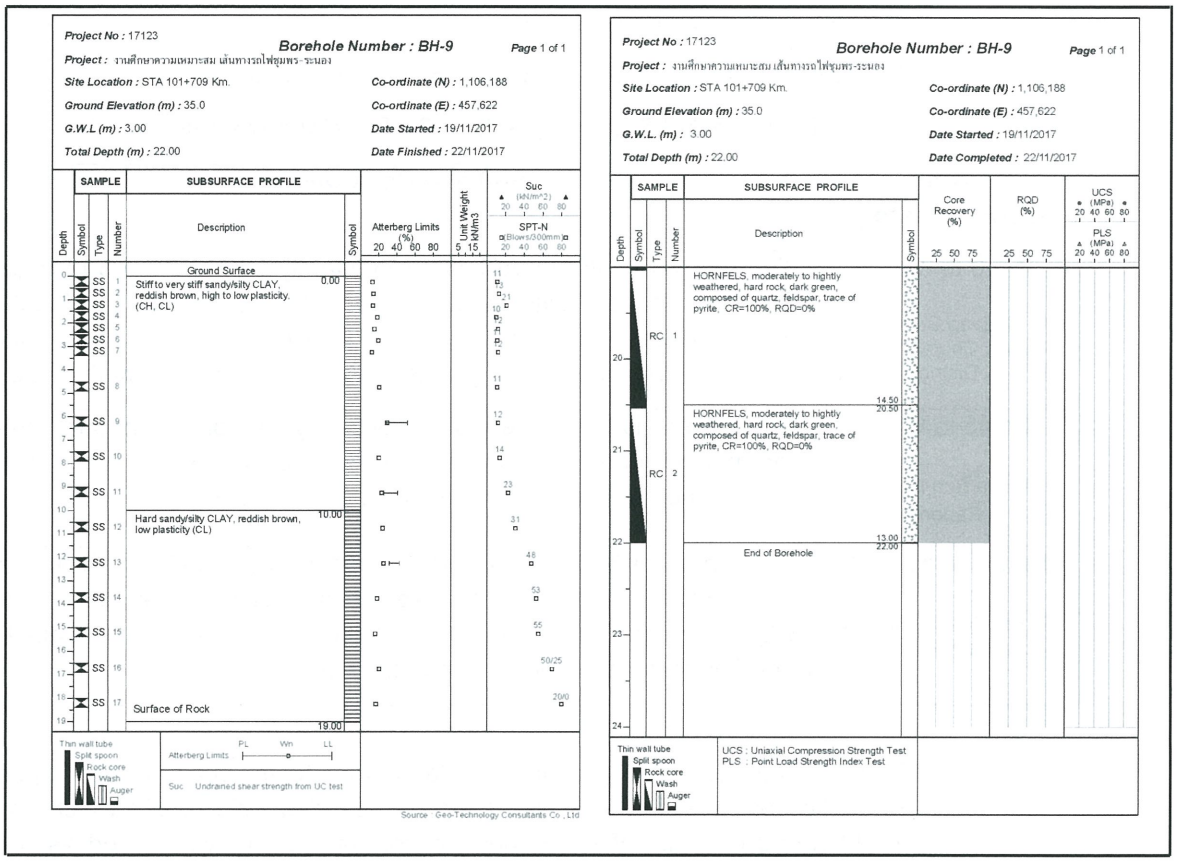


Figure 5.1.7-4 Sample of Test Results from Soil Boring

Summary of Test Pit Results

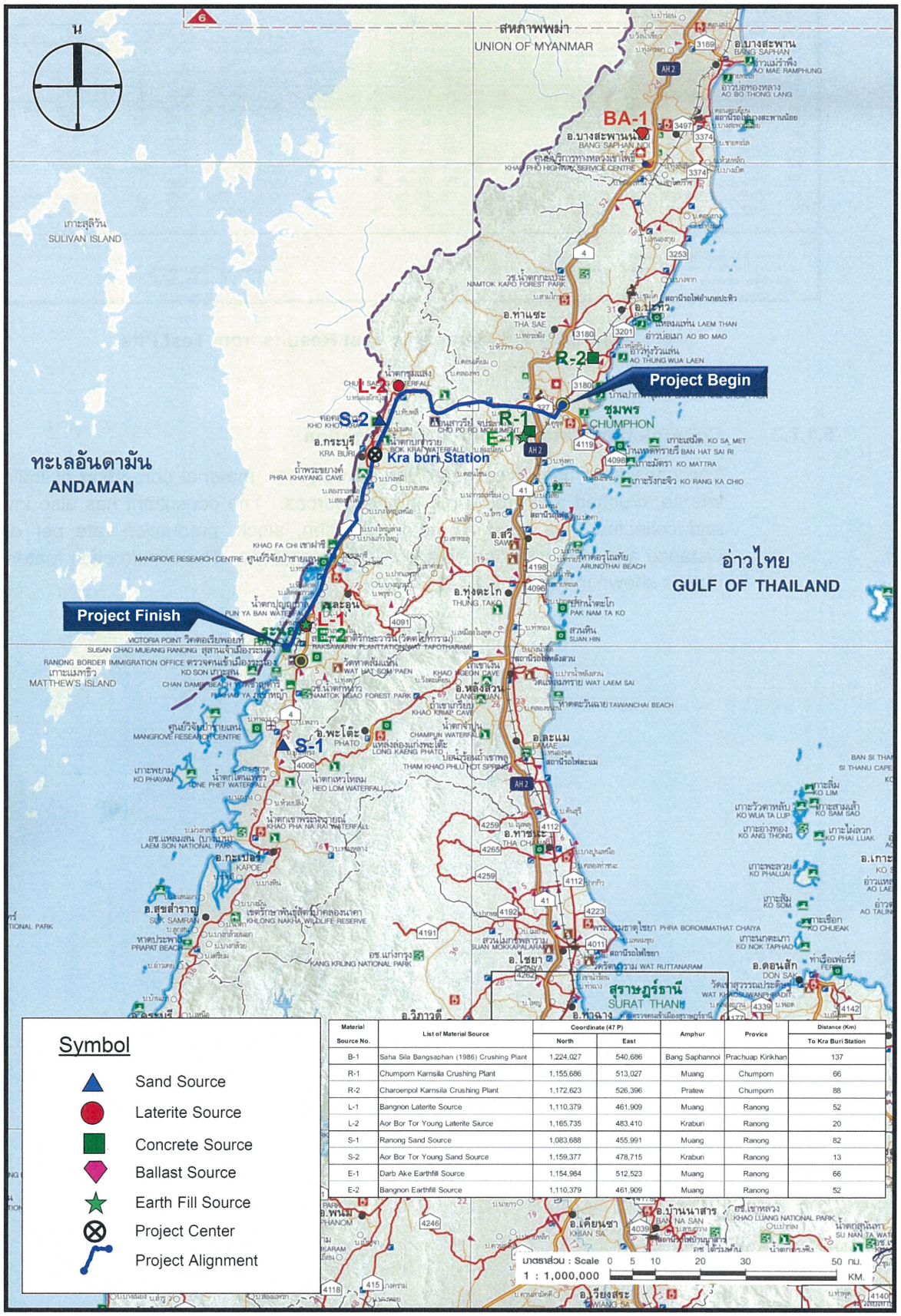
Test Pit No.	Sta.	Sample Discription	Atterberg Limits (%)			Sieve Analysis % Passing (US Standard Sieve)									Classification			Compaction Test[1]		CBR Test[1]		Direct Shear		
			LL	PL	PI	1"	3/4"	1/2"	3/8"	#4	#10	#40	#100	#200	USCS Group	AASHTO Group	UIC 719R Class	MDD[2] (t/m³)	OMC[3] (%)	CBR (%)	Swell (%)	c (t/m²)	c (kPa)	Φ (deg.)
TP-1	4+000	Silty CLAY	65.4	36.0	29.4					100	98	96	87	85	CH	A-7-5 (33)	QS1 [1.1]	1.415	28.2	2.5	2.298	3.95	38.7	10.0
TP-2	10+000	Sandy CLAY	37.5	20.0	17.5			100	90	88	81	74	69	65	CL	A-6 (9)	QS1 [1.1]	1.702	18.7	8.7	0.211			
TP-3	20+000	Silty SAND	54.4	32.8	21.6	100	92	87	84	63	42	31	25	23	SM	A-2-7 (1)	QS1 [1.3]	1.685	20.2	9.7	0.000	2.92	28.6	21.3
TP-4	30+000	Sandy CLAY	37.6	21.2	16.4					100	98	78	60	56	CL	A-6 (7)	QS1 [1.1]	1.711	18.0	7.1	0.145			
TP-5	41+000	Silty CLAY	54.0	31.0	23.0				100	99	98	96	84	81	CH	A-7-6 (22)	QS1 [1.1]	1.448	28.2	3.8	0.109	2.39	23.4	17.3
TP-6	52+000	Sandy CLAY	44.6	27.8	16.8					100	100	96	65	62	CL	A-7-6 (10)	QS1 [1.1]	1.565	22.9	6.6	0.138			
TP-7	58+000	Silty CLAY	36.5	21.2	15.3				100	100	100	97	83	79	CL	A-6 (11)	QS1 [1.1]	1.673	20.4	8.0	0.196	2.09	20.5	19.1
TP-8	76+000	Silty CLAY	60.2	36.8	23.4					100	100	99	96	95	CH	A-7-6 (35)	QS1 [1.1]	1.386	31.2	2.7	0.175			
TP-9	90+000	Sandy CLAY	56.4	29.3	27.1					100	100	76	65	63	CH	A-7-6 (16)	QS1 [1.1]	1.600	22.4	5.9	0.196	2.48	24.3	17.7
TP-10	99+000	Clayey SAND	34.5	22.7	11.8	100	94	90	88	84	78	60	48	46	SC	A-6 (2)	QS1 [1.1]	1.680	18.8	6.9	0.167			

Notes:
1 Compaction test followed AASHTO T 99 (Standard) and 4 days soaked CBR is reported at 95 % maximum dry density for each sample.
2 MDD : Maximum Dry Density
3 OMC : Optimum Moisture Content
4 Degree of dispersion
Non. = Non dispersive (% of dispersive < 30)
Int. = Intermediate (% of dispersive 30 - 50)
Disp. = Dispersive (% of dispersive > 50)

Figure 5.1.7-5 Sample of Test Results from Test Pits

5.1.7.3 Construction Material Source Investigation

The consultant has investigated the construction material consisting of ballast, sand, laterite, crushed rock from appropriate sources. The consultant has also investigated and collected data such as name, location, stock, production rate per day, price, distance and transportation cost from these sources. The construction material source map is shown in **Figure 5.1.7-5**



Material Source No.	List of Material Source	Coordinate (47 P) North	Coordinate (47 P) East	Amphur	Provice	Distance (Km) To Kra Buri Station
B-1	Saha Sila Bangsaphan (1986) Crushing Plant	1,224,027	540,686	Bang Saphannoi	Prachuap Kirikhan	137
R-1	Chumporn Karnsila Crushing Plant	1,155,686	513,027	Muang	Chumporn	66
R-2	Charoenpol Karnsila Crushing Plant	1,172,623	526,396	Pratew	Chumporn	88
L-1	Bangnon Laterite Source	1,110,379	461,909	Muang	Ranong	52
L-2	Aor Bor Tor Young Laterite Siurce	1,165,735	483,410	Kraburi	Ranong	20
S-1	Ranong Sand Source	1,083,688	455,991	Muang	Ranong	82
S-2	Aor Bor Tor Young Sand Source	1,159,377	478,715	Kraburi	Ranong	13
E-1	Darb Ake Earthfill Source	1,154,984	512,523	Muang	Ranong	66
E-2	Bangnon Earthfill Source	1,110,379	461,909	Muang	Ranong	52

Figure 5.1.7-6 Construction Material Source Map

5.1.7.4 Design Criteria, Standards and Specifications

The geological and geotechnical survey and results were used for the analysis and design of trackbed embankment and foundation so that the constructions are in compliance with engineering principles and safety.

The trackbed of railway, foundations of bridges, railway stations and other superstructures have to be designed to support the load and the structural weight without excessive settlement more than the allowable standard.

The selection of foundation types depend on the soil conditions encountered. If the hard soil stratum is not too deep from the ground surface, the spread footings should be designed. However, if the hard soil stratum is very deep, the pile foundations should be designed or ground improvement is also an alternative.

The Consultant has conducted the design based on the following international standards:

- UIC 719R : Earthworks and Trackbed Layers for Railway Lines
- AREMA 2014
- NAVFAC DM7.02 Foundations and Earth Structures
- EN1997 : Eurocode 7 – Geotechnical Design
- Other Standards

5.1.7.5 Trackbed Embankment Structure Design according to UIC 719R and AREMA

The train weight is distributed to the wheels to the soil strata as shown in **Figure 5.1.7-7.** A trackbed structure consists of a number of layers with qualified materials to withstand the train weight transmitting to railway metal wheels and rails that are moving through and transmitting to concrete sleepers placed at intervals causing the stress wave on the ballasts. The stress wave is transmitted to subgrade/ground. It is different from the stress from truck's wheels transmitting to the smooth road surface. The trackbed design has been researched for a long time in European countries, such as England, France, etc. Currently, the United States has continued researching including other countries such as Japan, China, etc.

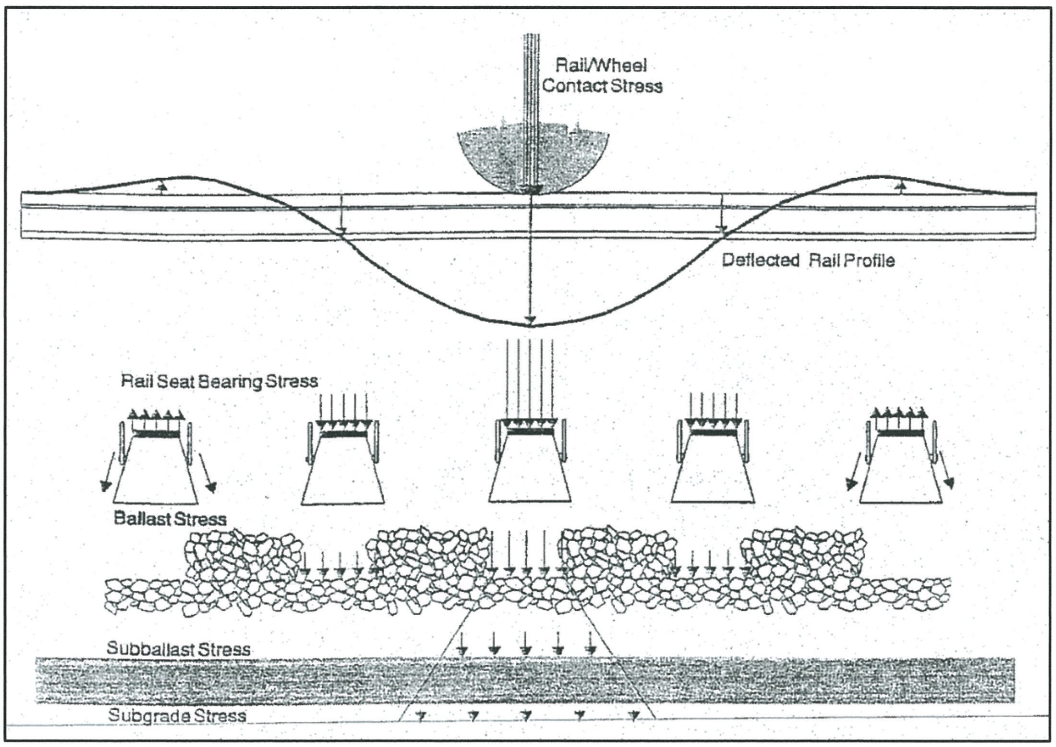


Figure 5.1.7-7 Distribution of Train Weight from Wheels to Subsoil

The trackbed structure design for Track Doubling Projects has applied the design criteria of UIC 719R and AREMA for the construction materials in Thailand as follows:

- Calculation of blanket layer thickness which consists of subballast layer and subbase layer according to the quality of soil layers derived from test pit on the subgrade alignment is based on UIC 719 R.
- As recommended by AREMA, the depth below subballast approximately 1.5 m is significantly affected by the stress waves. The upper part of subgrade which is approximately 0.6 m. thick should be made of quality embankment materials and drainage is important due to the affect from the stress waves.
- The construction materials for fill and compacted layers of trackbed embankment use the same standard of materials as for highways and roads of the Department of Highways (DOH) which the contractors are familiar with and can be used for road construction in the project.

Where the alignment passes the plain and rolling terrains, the trackbed of at-grade railway shall be situated on the subgrade and foundation with sufficient strength. The typical cross-section of the trackbed embankment structure which looks like trapezoidal is shown in **Figure 5.1.7-8**. The trackbed embankment layers from the bottom to the top consist of the following:

(1) Embankment fill layer

(2) Prepared subgrade layer

(3) Sand blanket with geotextile layer

(4) Subbase layer

(5) Subballast layer

(6) Ballast layer.

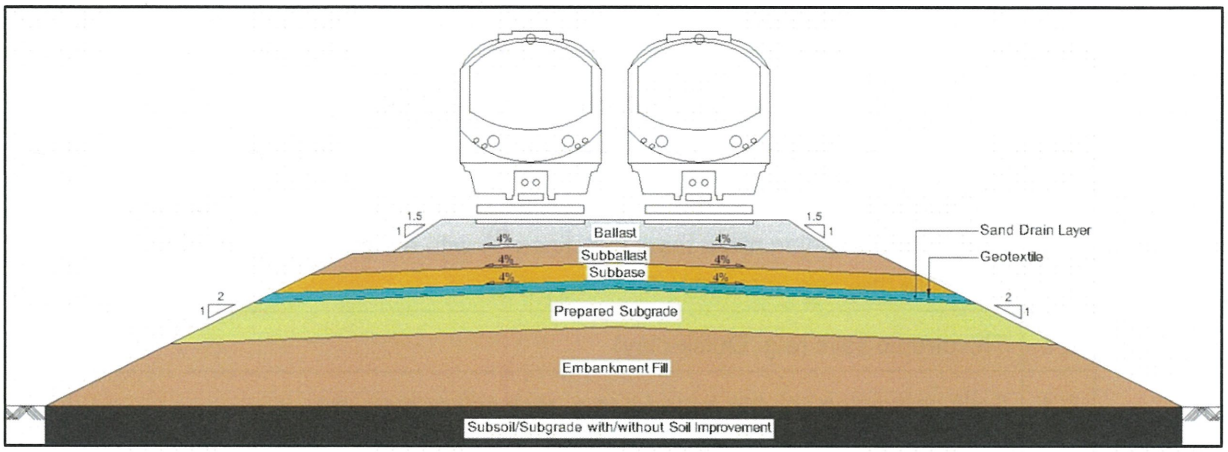


Figure 5.1.7-8 Typical Cross-Section of Trackbed Embankment Structure

The trackbed embankment structure must be designed to be durable enough to load the train weight from above. The fill materials have to be strong/stiff descending according to the depth and supported by sufficient strength foundations. In designing, the collapse or damage which may occur in many circumstances such as the collapse due to soil bearing stability or slope stability or settlement have to be investigated. The strength of natural ground foundation can be classified into 3 types as follows:

- First, the embankment on the natural ground foundation which the top soils have been scraped off.
- Second, the embankment on the natural ground foundation which needs shallow improvement.
- Third, the embankment on the natural ground foundation which needs deep improvement.

The suitable side slope of embankment takes into account the quality of fill materials for sufficient embankment stability, reduction of lateral movement of the embankment, and prevention or reduction of soil erosion which may cause discrepancies in quality and material compaction on the side of the embankment, and the lateral material with low value of Angle of Repose. Therefore, the recommended AREMA ratio of 2 (H) : 1 (V) shall be used for side slope of embankment. In case of the right-of-way restriction, the retaining wall or earth reinforcement shall be designed.

Design Criteria for Trackbed Embankment Structure according to UIC 719R

The subgrade may be taken from other sources (in case of embankment fill) or the existing soil/rock at construction site (in case of embankment cut) which can be categorized by the quality classes from QS0 to QS3 as follows:

1) QS0 : Unsuitable soils which must be dig out or improved.
2) QS1 : Poor soils which may be acceptable but have to be improved with good drainage system.
3) QS2 : Average soils.
4) QS3 : Good soils.

Table 5.1.7-5 shows the subgrade categories according to quality classes.

Table 5.1.7-5 Subgrade Categories according to Quality Classes (Ref: UIC 719R)

Soil Types (Geotechnical Classification)		Quality Classes
0.1	Organic soils	QS0
0.2	Soft soils containing more than 15% fines [(1)], with a high moisture content: therefore they are unsuitable for compaction.	
0.3	Thixotropic soils (e.g. Quick-clay)	
0.4	Soils containing soluble material (e.g. rock salt or gypsum)	
0.5	Contaminated ground (e.g. industrial waste)	
0.6	Mixed material / organic soils [(2)]	
1.1	Soils containing more than 40 % of fines [(1)] (except soils classified under 0.2)	QS1
1.2	Rocks which are very susceptible to weathering e.g. - Chalk with dry density < 1. 7 t/m^3 and high friability - Marl - Weathered shale	
1.3	Soils containing 15 to 40% fines [(1)] (except soils classified under 0.2)	QS1[(3)]
1.4	Rocks which are moderately susceptible to weathering e.g - Chalk with dry density < 1. 7 t/m^3 and low friability - Unweathered shale	
1.5	Soft rock e.g. microdeval wet (MDE) > 40 and Los Angeles (LAA) > 40	
2.1	Soils containing from 5 to 15 % fines [(1)]	QS2[(4)]
2.2	Uniform soil containing less than 5 % fines [(1)] (C_u ≤6)	
2.3	Moderately hard rock, e.g. if 25 < MDE ≤40 and 30 < LAA ≤40	
3.1	Well graded soils containing less than 5 % fines [(1)]	QS3
3.2	Hard rock, e.g. MDE ≤25 and LAA ≤30	

Notes:

(1) *These percentages are calculated from particle size distribution analysis undertaken on material passing a 60 mm sieve.*

(2) *Certain railways sometimes include these soils in quality class QS1.*

(3) *These soils can be categorized under class QS2 if the hydrogeological and hydrological conditions are good.*

(4) *These soils can be categorized under quality class QS3 if the hydrogeological and hydrological conditions are good.*

In addition, the subgrades can be categorized by the bearing capacity classes from P1 to P3 which depend on (1) class of fill soil or the in-situ soil, and (2) the quality and thickness of prepared subgrade layer (if used) which is prepared for support blanket layer (and divided to be subballast layer and subbase layer).

P1 : Poor subgrade

P2 : Average subgrade

P3 : Good subgrade

Table 5.1.7-6 shows the subgrade categories according to bearing capacity classes and soil compaction quality according to UIC 719 R is as follows:

(1) Embankment Fill

$\rho_d \geq$ 95 %ρ_d(max) (standard proctor test)

$E_{V2} \geq$ 45 MN/m^2 (for fine soils)

$E_{V2} \geq$ 60 MN/m^2 (for coarse grained soils, sandy soils and gravelly soils)

(2) Prepared Subgrade

$\rho_d \geq$ 100 % ρ_d (max) (standard proctor test)

$E_{V2} \geq$ 80 MN/m^2

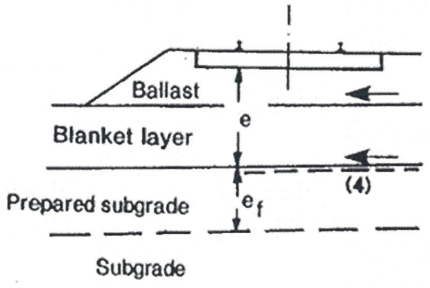
Where ρ_d is dry density, E_{V2} is modulus of deformation of the second loading of plate bearing test (according to DIN 18134 or NF P 94117.1 standards)

Table 5.1.7-6 Subgrade Categories according to Bearing Capacity Classes (Ref: UIC 719R)

Subgrade Categories according to Quality Classes	Subgrade Categories according to Bearing Capacity Classes	Prepared Subgrade Thickness	
		Quality Classes of Soils to be Prepared Subgrade	Minimum Thickness of Prepared Subgrade (e_f) Required
QS1	P1	QS1	-
	P2	QS2	0.50 m.
	P2	QS3	0.35 m.
	P3	QS3	0.50 m.
QS2	P2	QS2	-
	P3	QS3	0.35 m.
QS3	P3	QS3	-

(3) Calculation of Blanket layer Thickness

The calculation of blanket layer thickness follows UIC 719R. **Figure 5.1.7-9** shows the empirical formula and details of the various parameters for e = E+a+b+c+d+e+f+g. Therefore the thickness of the blanket layer is equal to the difference between the e and the thickness of the ballast layer.



$$e = E + a + b + c + d + f + g$$

(e in metres)

E	= 0.70 m	for soils of bearing capacity class P1 (1)
E	= 0.55 m	for soils of bearing capacity class P2 (1)
E	= 0.45 m	for soils of bearing capacity class P3 (1)
a	= 0	for UIC groups 1 and 2 (or lines where v (speed) > 160 km/h irrespective of the UIC group (2)
a	= - 0.05 m	for UIC group 3 and 4 (2)
a	= - 0.10 m	for UIC groups 5, 6 and "7, 8, 9 with passengers" (2)
a	= - 0.15 m	for UIC groups "7, 8, 9 without passengers" (2)
b	= 0	for wooden sleepers of length 2.60 m
b	$= \frac{2.50 - L}{2}$	for concrete sleepers of length L (b in m, L in m; b possibly negative if L > 2.50 m)
c	= 0	for usual dimensions
c	= - 0.10 m	special case for difficult working conditions on existing lines of "UIC groups other than "7, 8, 9 without passengers" (2)
c	= - 0.05 m	special case for difficult working conditions on existing lines of "UIC groups other than "7, 8, 9 without passengers" (2)
d	= 0	when the nominal maximum axleload of hauled vehicles does not exceed 200 kN
d	= + 0.05 m	when the nominal maximum axleload of hauled vehicles does not exceed 225 kN
d	= + 0.12 m	when the nominal maximum axleload of hauled vehicles does not exceed 250 kN
f	= 0	where the line speed does not exceed $V \leq 160$ km/h and for high speed lines where the subgrade is of bearing capacity class P3 (1)
f	= + 0.05 m	for high speed lines where the subgrade is of bearing capacity class P2 (1)
f	= + 0.10 m	for high speed lines where the subgrade is of bearing capacity class P1 (1)
g	= +	the trackbed must include a geotextile if the prepared subgrade is formed from soils of quality class QS1 or QS2 (2)
g	= 0	(no geotextile is required) if the prepared subgrade is formed from soils of quality class QS3 (2)

Figure 5.1.7-9 Calculation of the Minimum Thickness (e) of Trackbed

5.1.7.6 Trackbed Embankment Structure Design

5.1.7.6.1 Embankment Materials

1) Embankment Fill

The embankment fill is constructed of soil materials of low plasticity (LL ≤40) which pass sieve No. 200 not exceeding 40% with the following soil compaction:

$\rho_d \geq 95\%\rho_d$ (max) standard proctor test

CBR ≥ 5%

The 1 m. upper part of fill materials which are underneath the prepared subgrade have to be compacted at 100% ρ_d(max) standard proctor test and the lower fill materials have to be compacted at 95% ρ_d(max) standard proctor test.

2) Prepared Subgrade

The prepared subgrade is the layer between the embankment fill/subgrade and blanket layer (subballast layer and subbase layer). It reduces the settlement of the embankment and prevents water to seep into the subgrade soil below. The thickness of this layer depends on the required ability to load (bearing capacity class) and soil quality class to be used as an embankment fill/subgrade.

Soils containing more than 15% fines are often those with QS1 and QS2 quality class which can be used as prepared subgrade or subbase of road works according to the standard of selected material Type A of highway road works which is the Standard No. DOH-S 208/1989 of the Department of Highways with the thickness as indicated in the drawing and pass sieve No. 200 not exceeding 30% with the following soil compaction:

$\rho_d \geq 95\% \rho_d$ (max) (modified proctor test)

CBR ≥ 10%

3) Sand Drain (above Geotextile)

The sand drain is above the prepared subgrade. As the application of filter principle of subballast materials by subgrade gradation to find the gradation curve of subballast materials is difficulty and ineffective, the sand drain with non-woven geotextile with a weight of not less than 300 grams per square meter can solve this problem.

The sand drain or clean sand drains water from the subgrade and prepared subgrade upon high groundwater level, reduces water surface tension in the space between the soil particles as capillary water and also when high moisture soils are affected by the stress wave from running trains. This will prevent the loose of subgrade strength due to the excessive water pressure. The sand drain shall have the following properties.

The suitable gradation shall have the largest size of not more than 9.5 mm. (3/8 inch) or passing the sieve size 3/8 inch 100%. The fines passing sieve No. 200 shall not be more than 5% in order to avoid internal movement of fines in the sand drain layer. The geotextile shall be placed under sand drain to function as separator and filter the fines of subgrade or prepared subgrade.

4) Subbase

The subbase is the lower blanket layer. The soil materials have less strength than subballast which is the upper blanket layer. The subbase shall be compacted at the CBR not less than 25% so that the soil stiffness shall not jump much between layers with the thickness as indicated in the drawing. The properties shall be the same as soil aggregate material of highway road works which is the Standard No. DOH-S 205/1989 of the Department of Highways. The material passing sieve No. 200 does not exceed 20% with the following compaction:

ρ_d $\geq$ 95% ρ_d (max)(Modified Proctor Test)

CBR $\geq$ 25%

LAA $\leq$ 60%

5) Subballast

The subballast is an important layer between the ballast layer and subbase layer. The subballast is the upper blanket layer to distribute the stresses from the ballast to the subbase and prepared subgrade or subgrade. It also prevents erosion and permeability of the water to the layer below the material to be used as the subballast. The material to be used as subballast shall comply with the specifications for base course of the road works (AREMA Manual for Railway Engineering 2014 Article No. 2.11.2.5). Its gradation shall prevent insertion of ballast into subballast.

The material properties of subballast according to UIC 719R shall have the strength of rock tested for microdeval in the presence of water not less than 20%, and Los Angeles Abrasion (LAA) not more than 20-25% which are very high resistant to abrasion and are a rare stone material in Thailand. The properties of crushed rock used for the base course of highways in Thailand have the LAA not exceeding 40% and the CBR not less than 80% in order to compensate for the high resistance quality to abrasion by the crushed rock with CBR not less than 80%. So, the subballast shall have the same properties as crushed rock standard of highway road works No. DOH-S 201/2001 of the Department of Highways as follows:

The fine materials passing sieve No. 200 do not exceed 8%, 15% depending on the type specified.

Los Angeles abrasion (LAA) not more than 40%.

Liquid limit not more than 25%.

Plastic index not more than 6%.

ρ_d $\geq$ 95% ρ_d (max) (modified proctor test)

CBR $\geq$ 80%

6) Ballast

The ballast distributes stresses from sleepers to the materials below and prevents the movement of sleepers as well. AREMA recommends the ballast thickness of not less than 0.30 m. The rocks to be used as ballast should be igneous rocks such as granite, basalt, andesite, which are crushed to distribution sizes with appropriate flatness, sharpness, physical properties and thickness as specified by the track engineer.

The Consultant has summarized the types and quality of materials to be used for railway embankment as shown in **Table 5.1.7-7**.

Table 5.1.7-7 Types and Quality of Materials to be used for Railway Embankment

No.	Layer	Material Type	Fines, % Passing # 200	CBR	Compaction Type
0	Ballast				
1.1	Subballast	Crushed Rock	≤8 or ≤15	≥80	95% modified compaction
1.2	Subbase	Soil Aggregate	≤20	≥ 25	95% modified compaction
2.1	Sand Drain Layer	Clean Sand	≤5		
2.2	Geotextile	Non-woven			
3.1	Prepared Subgrade	Selected Material	≤30	≥10	95% modified compaction
3.2	Embankment Fill	Fill Material	≤35	≥5	100% standard compaction of 1 m. upper layers and 95% standard compaction of lower layers

5.1.7.6.2 Calculation of Thickness of Blanket Layer and Material Layers of Railway Embankment

The thickness of the blanket layer is calculated to design different types of materials appropriately with the materials used generally in Thailand. The material strength shall be lowered from top to bottom. The soil strength properties shall be considered by CBR. The thickness of the layers under the blanket layer shall follow the recommendations of AREMA in terms of stress wave influences from the running train.

The Consultant has calculated the material layers in case the subgrades are categorized by quality classes according to UIC 719R for 3 cases and calculated the blanket layer thickness as shown in **Table 5.1.7-8**. **Table 5.7.1-9** shows the thickness of each layer of the trackbed embankment. The calculation for the bearing capacity class of the subgrade of average subgrade, P2 is illustrated as follows.

- Soil bearing capacity class P2, E = 550 mm
- Train speed 160 km/hr, a = 0,
- Sleeper length 2.00 m., b = (2.50 - 2.00)/2 = 0.25 m.= 250 mm,
- For usual dimension, c = 0,
- Nominal maximum axle load does not exceed 20 ton, d = 0,
- Train speed does not exceed 160 km/hr, f = 0
- A layer of sand drain with geotextile, g = 0

Therefore, e (ballast and blanket layer thickness) = E + a +b + c + d + e + f + g

= 550 +0+ 250 + 0 + 0 + 0 + 0

= 800 mm.

Table 5.1.7-8 Calculation for Blanket Layer Thickness (Unit: millimeter, mm)

Description	Symbol	UIC 719R Soil Class of Subgrade
		QS1
Percent Fines of Subgrade Soils		> 40
Prepared Subgrade Type		QS2(2.1, 2.2) or QS1[3](1.3 to 1.5)
Bearing Type		P2
Prepared Subgrade Required Depth	Min e_f	500
Initial Thickness of Blanket Layer	E	550
Factor of Sleeper Length	b	250
Ballast and Blanket Layer Thickness	e	800
Ballast Thickness	T0	300
Blanket Layer Thickness Calculated		500

Table 5.1.7-9 Design Thickness of Each Layer of Trackbed Embankment

No.	Name	Material Type	Min CBR	Thick	Min Layer Thickness Based on Soil Class of Subgrade (mm)
					QS1
	Design of Track-Bed Layer (UIC 719R)				
0	Ballast (By Track Engineer)			**T0**	300
1.1	Subballast	Crushed Rock	80	T1	300
1.2	Subbase	Soil Aggregate	25	T2	200
2.1	Sand Drain	Clean Sand		T3	100
2.2	Geotextile	Non-woven			
3.1	Prepared Subgrade	Selected Material Type A	10	T4	500
3.2.1	Embankment Fill, 1 m. Upper	Fill Material 100% Standard Compaction	5	T5	1000
3.2.1	Embankment Fill, Lower	Fill Material 95% Standard Compaction	5	T6	
	Blanket Layer TT = T1+T2				500
	Blanket Layer Calculated (Minimum Required)				500
					OK
	Stress Wave Influences (AREMA Recommendations)				
TT1 = T4+T5					1500
TT1 shall be greater than 600 mm					OK
TT2 = T1+T2+T3+T4+T5					2100
TT2 shall be greater than 1500 mm					OK

5.1.7.6.3 Trackbed Embankment of the Project

From the CBR test result of the 10 samples from the test pits along the at-grade alignment, the percentile of CBR is plotted as shown in **Figure 5.1.7-10**. It reveals that the subgrade at 85 percentile has CBR 3.1% or 3% or QS1 Quality Class according to UIC 719R. Therefore, the suitable trackbed embankment of the Project should be composed of each layer of QS1 Quality Class and the prepared subgrade should be improved to 0.50 m. thick along the entire line.

The embankment can be in 2 cases as follows:

1) The embankment that is not elevated with fill material; the soil below the prepared subgrade has to be improved with soil that has CBR not less than 5%, thickness of 1500 - (200 + 100 + 500) = 700 mm but as it is below the subgrade and the fill material thickness is less than 0.60 m., the thickness of not less than 0.60 m. is allowable.

2) The embankment that needs to be elevated by fill material with thickness more than or equal to 0.60 mm., the soil below the subgrade has to be improved with soil that has CBR not less than 5% at the thickness of not less than 0.30 m. as well.

Whenever the earth is saturated with rain water during the rainy season, the bearing will be decreased as tested by the soil samples submerged for 4 days. So the improvement of soil with soil that has higher CBR shall function as shallow foundation for upper embankment to distribute the loads to the ground more uniformly.

The typical cross-sections of trackbed embankment fill and embankment cut are shown in **Figures 5.1.7-11** and **5.1.7-12**.

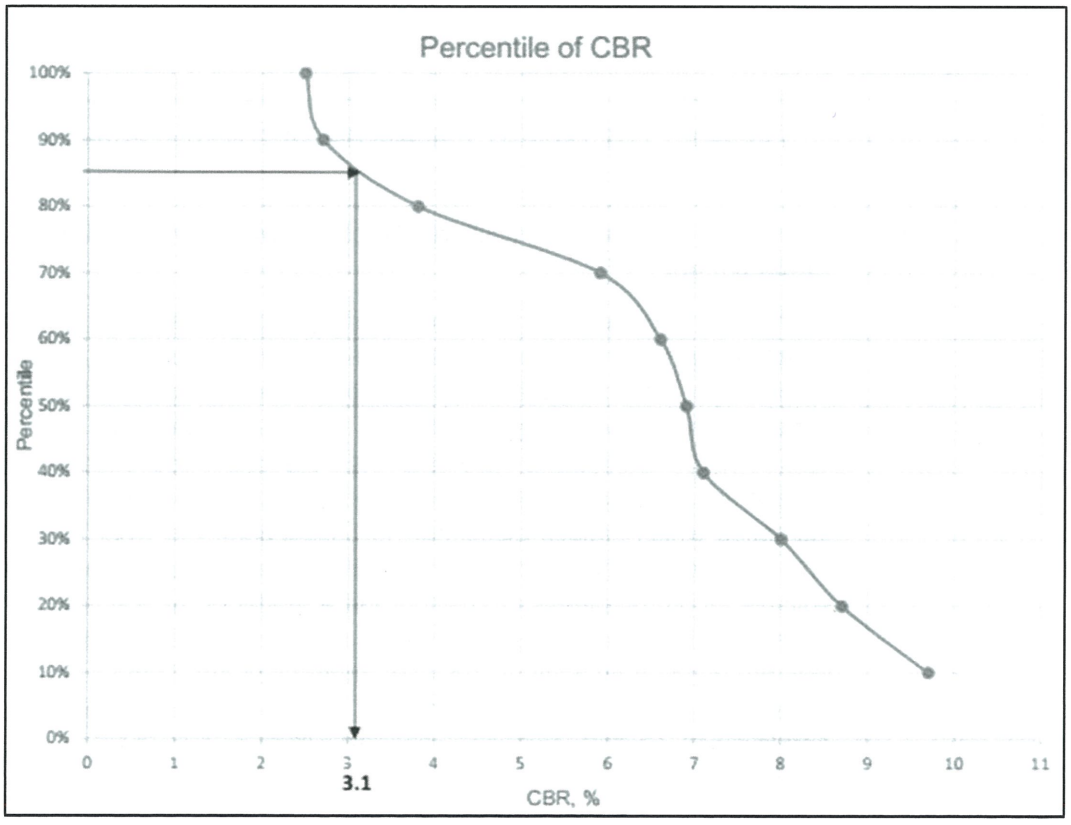


Figure 5.1.7-10 Percentile of CBR of Subgrade along the At-grade Track

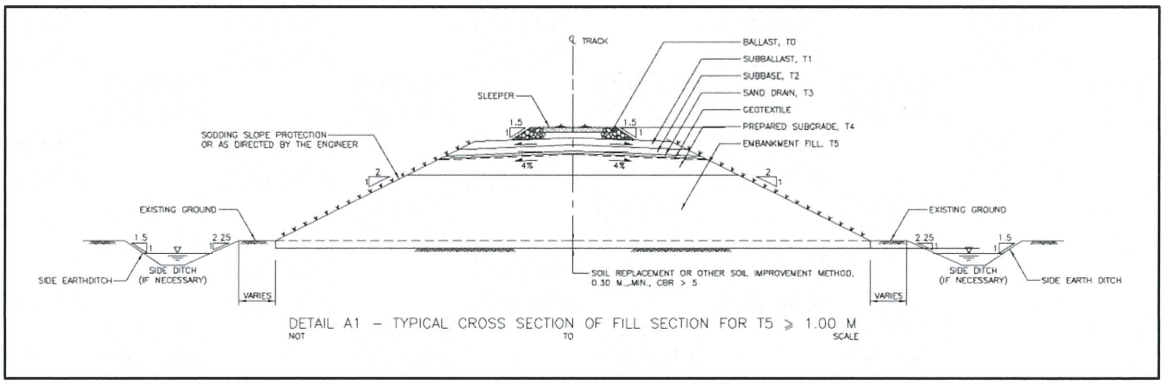


Figure 5.1.7-11 Typical Cross-section of Trackbed Embankment Fill

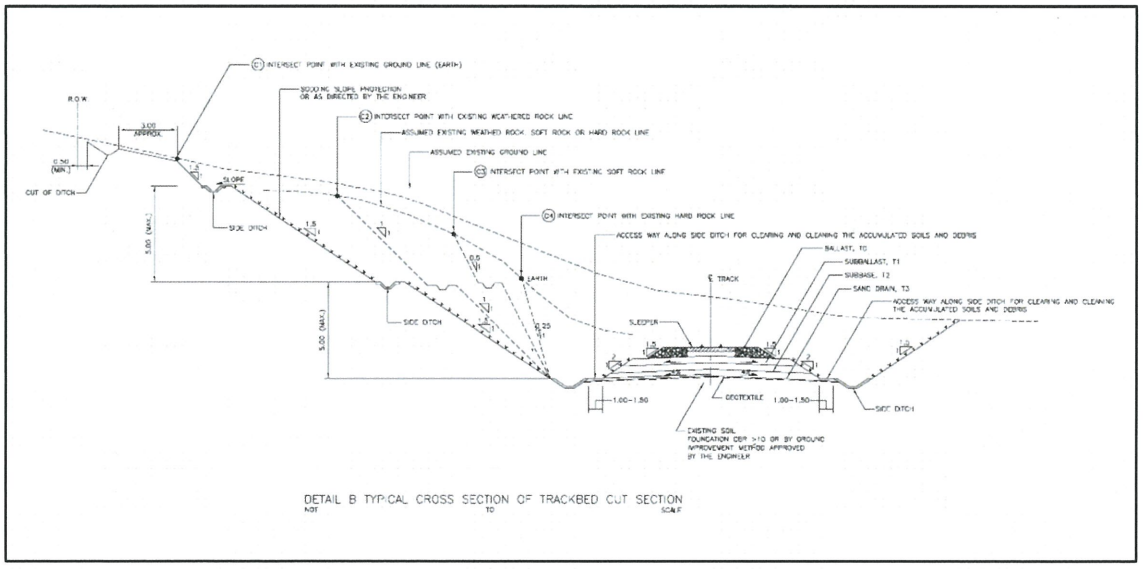


Figure 5.1.7-12 Typical Cross-section of Trackbed Embankment Cut

5.1.7.6.4 Transition Structure of Railway Track between Bridge Abutment and Trackbed Embankment

At the joint between the rails on the bridge abutment which is a reinforced concrete structure and trackbed embankment normally has unequal subsidence or different movement. The bridge abutment is considered no subsidence but the embankment materials moves vertically due to the train's live load. As the vertical stiffness of embankment materials is very less than the reinforced concrete bridge abutment, it causes the train to stumble, bump and vibrate at this area. The dynamic force is increased which causes discomfort to passengers, the wear and damage to the train and its system, safety system and additional maintenance cost. The research on the suitable length of stiffness transition and a model of the trains running on the very low stiffness soil which was represented by soft clay and on the higher stiffness soil which was represented by dense sand were undertaken and found a ratio of train running at a speed comparable to Rayleigh Wave. This ratio was represented by DAF (Dynamic Amplification Factor) and the length of stiffness transition (L) as shown in **Figure 5.1.7-13**.

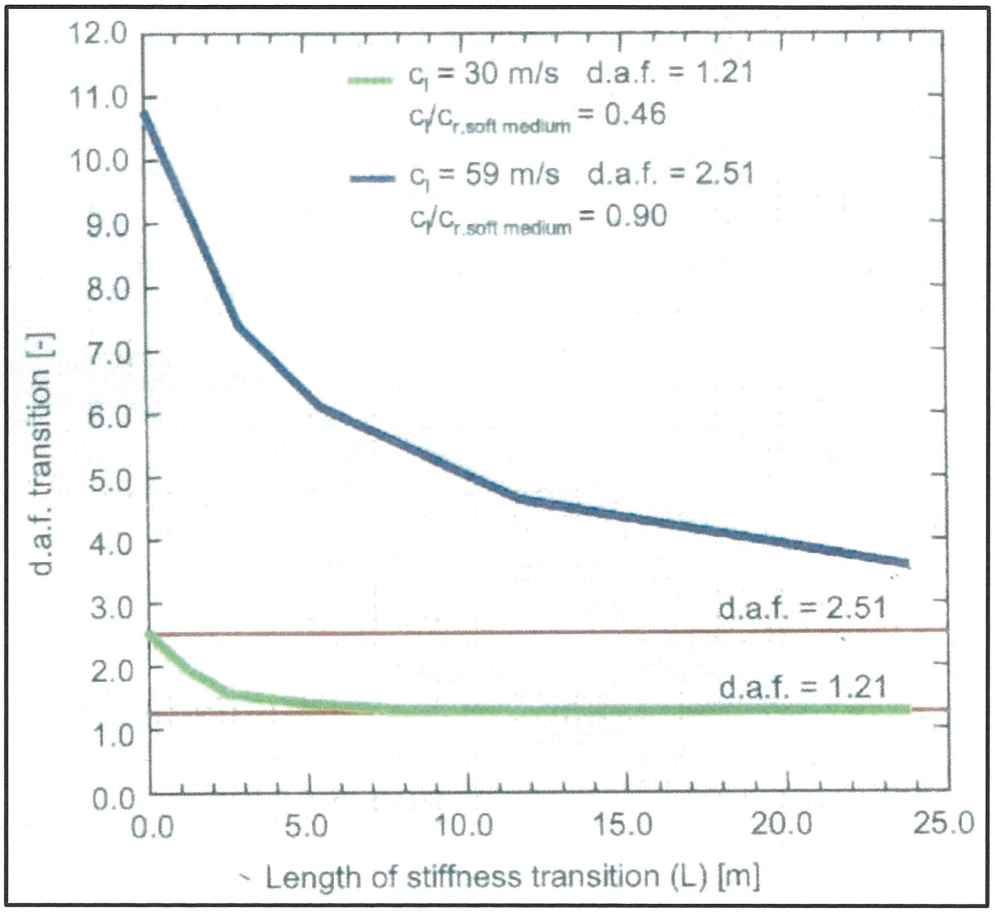


Figure 5.1.7-13 Dynamic Amplification within the Stiffness Transition

Delft University of Technology has research a correlation between the change in height of the bridge and the rail on the embankment (different deformation) and the railway length that is affected.

Figure 5.1.7-14 shows the differences in height and a transition length that are acceptable for high speed rolling stock on the basis of a maximum permissible dynamic wheel force 140 kN and a vertical car body acceleration at 1 m/s^2. The graph shows that the minimum transition length is 10 m.

For this Project, the height of imperfection is less than 30 mm., the minimum transition length is 10 m. However, the variance of 1x is provided, so the Transition Length is 20 m. which is equal to the California High-Speed Train as shown in **Figure 5.1.7-15**. This figure also shows the appropriate materials for the project. **Figure 5.1.7-16** shows the typical cross-section of transition structure between bridge abutment and trackbed embankment.

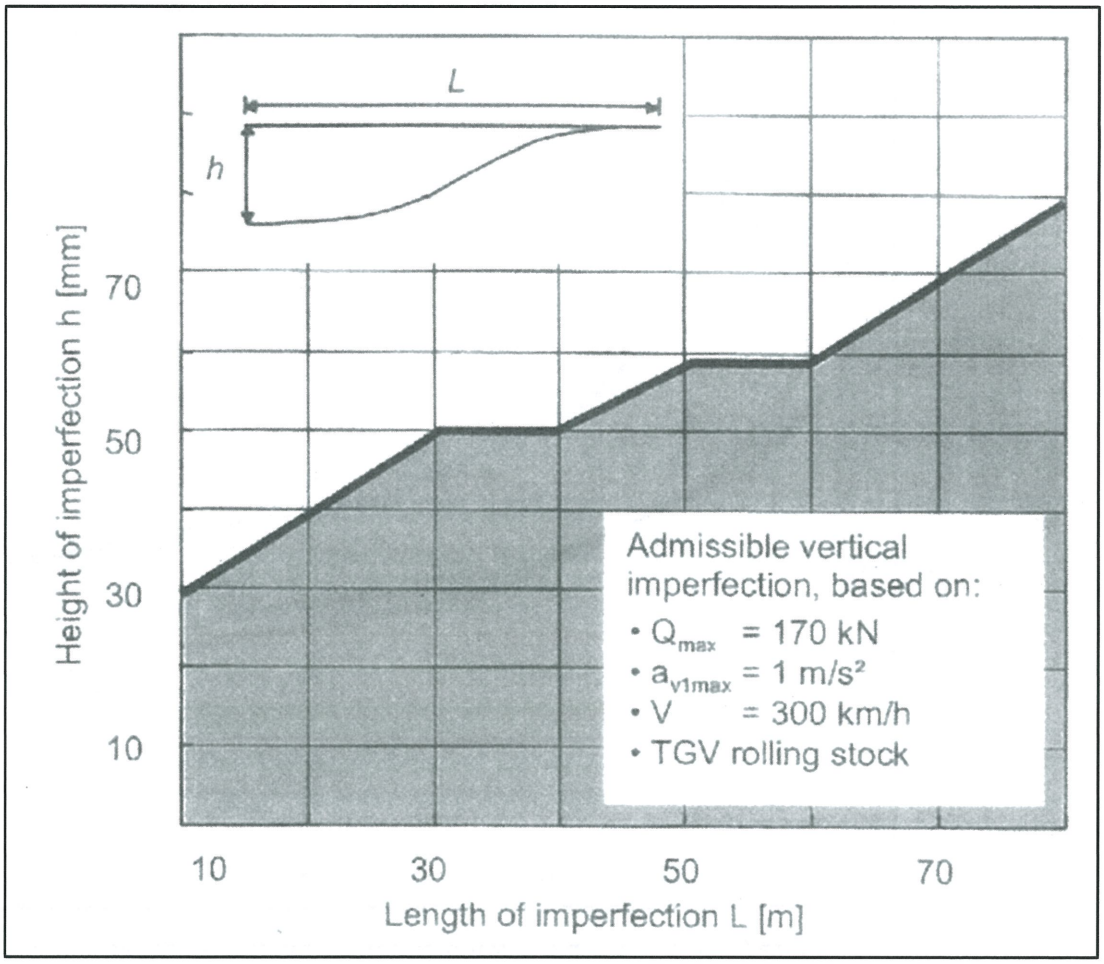


Figure 5.1.7-14 Design Graph for a Transition Structure

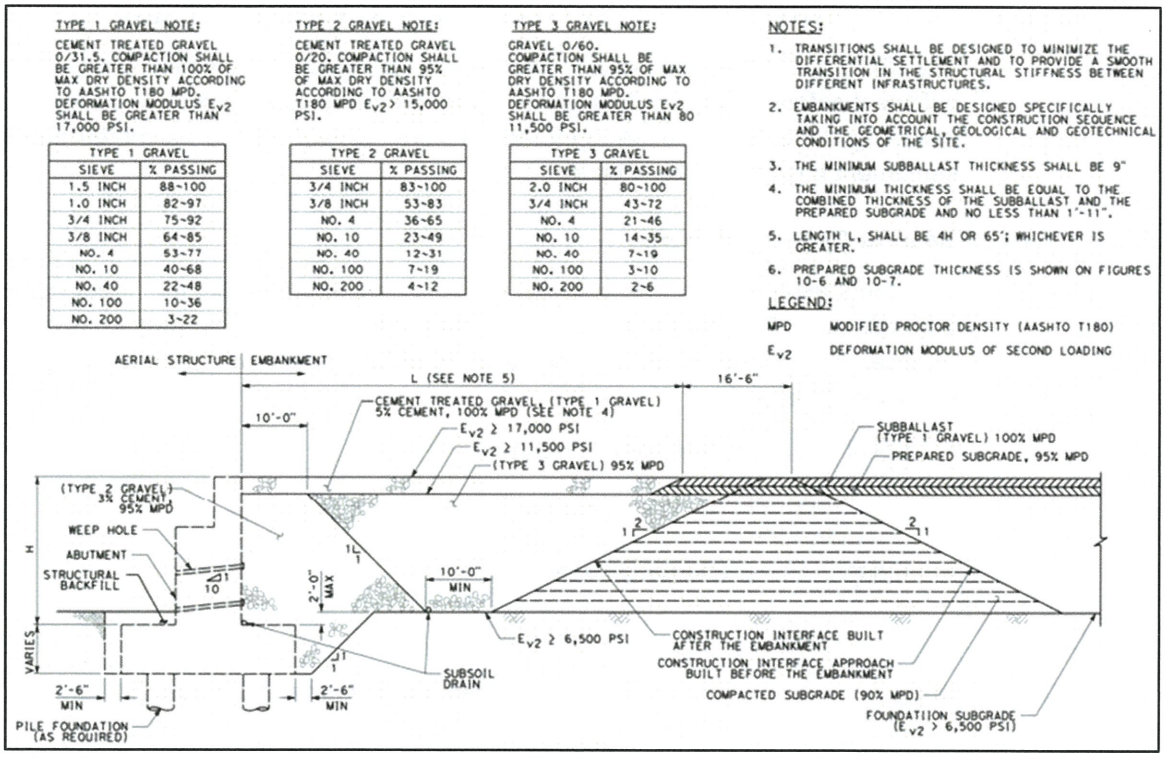


Figure 5.1.7-15 Sample of Transition Structure (Ref: Transition from Aerial Structure to Embankment Drawing of California High-Speed Train Project)

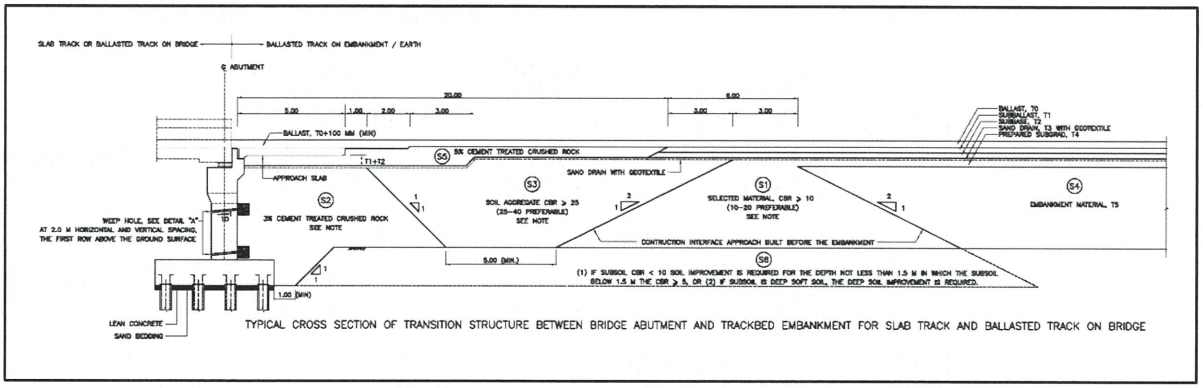


Figure 5.1.7-16 Typical Cross-section of Transition Structure between Bridge Abutment and Embankment of the Project

5.1.7.6.5 SLOPE PROTECTION AND SETTLEMENT ANALYSIS AND DESIGN

The fill embankment of railway has to be designed to function as purposes with sufficient safety. The stability against failure that may occur in forms of earth movement including slope failure, bearing capacity failure, as well as the estimated consolidation settlement has to be investigated.

5.1.7.6.6 Bearing Capacity Failure

The foundation soil of the railway embankment shall resist the loadings from the embankment. The analysis uses the same principle of strip footing resting on the surface. The ultimate load bearing capacity of foundation soil is calculated by following equation of Terzaghi.

- Local Shear Failure (SPT-N < 30)

$$q_u = 0.667\, cN'_c + q'N'_q + 0.5\, \gamma BN'_\gamma$$

- General Shear Failure (SPT-N > 30)

$$q_u = cN_c + q'N_q + 0.5\, \gamma BN_\gamma$$

when q_u = Maximum load per unit area of the foundation.

c = Cohesion

q' = Effective overburden stress at location of footing

γ = Soil density

B = Width of footing

N'_c , N'_q , N'_γ = Terzaghi's Modified Bearing Capacity Factors

N_c , N_q , N_γ = Terzaghi's Bearing Capacity Factors

The soil bearing capacity compared with embankment and service load, Factor of Safety (FS) shall be not less than 1.5. In case of embankment without service load, Factor of Safety (FS) shall be not less than 2.0.

The simplified design table was used to evaluate the soil bearing capacity under embankment and calculated according to Standard Penetration Test (SPT-N) which varied from 4 to 15 blows/ft at embankment height from 1 to 7 m.

The live load of track is 68 kN/m^2 which is included the impacted factor according to AREMA 2014 and BS 5400.

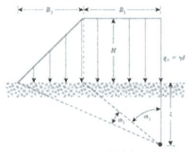
Tables 5.1.7-10 and **5.1.7-11** show the soil bearing capacity for clay and sand respectively.

Table 5.1.7-10 Soil Bearing Capacity under Embankment for Clay

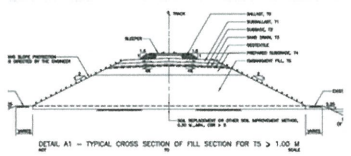
Stress Distribution on Ground at Center Line of Single Track Calculation

Live Load from Track 68 kN/m²

Case No.	H of Emb. Z, m	Track Width, B	α_1	α_2	$((B_1+B_2)/B_2)(\alpha_1+\alpha_2)-(B_1/B_2)(\alpha_2)$	I	Δσ kN/m²	2Δσ kN/m²
1	1.0	3	0.00	1.25	1.55	0.493	33.5	67.1
2	2.0	3	0.00	0.98	1.44	0.460	31.3	62.5
3	3.0	3	0.00	0.79	1.29	0.409	27.8	55.6
4	4.0	3	0.00	0.64	1.12	0.358	24.3	48.6
5	5.0	3	0.00	0.54	0.98	0.312	21.2	42.5



$$\Delta\sigma_z = \frac{q_s}{\pi}\left[\left(\frac{B_1+B_2}{B_2}\right)(\alpha_1+\alpha_2)-\frac{B_1}{B_2}(\alpha_2)\right]$$



Case No	Embankment Hight, H (m)	Embankment Width, B (m)	Depth[1] Df (m)	Soil Type	Density (γ) (t/m³)	Avg SPT (blows/ft)	Angle of Friction (∅)	Cohesion (c, t/m²)	Surcharge (q', t/m²)	Nc[2] or N'c	Nq[2] or N'q	Nγ[2] or N'γ	qa[2] (t/m²)	Load on Ground DL (t/m²)	Load on Ground LL (t/m²)	Load on Ground DL+LL (t/m²)	Factor of Safety DL+LL min.1.5	Factor of Safety DL min.2.0
1	1	11.50	0.0	CLAY	1.60	4	-	2.5	0.0	5.70	1.00	0.00	9.5	1.9	6.8	8.7	**1.1**	5.0
	2	12.50	0.0	CLAY	1.60	4	-	2.5	0.0	5.70	1.00	0.00	9.5	3.8	6.4	10.2	**0.9**	2.5
	3	13.50	0.0	CLAY	1.60	4	-	2.5	0.0	5.70	1.00	0.00	9.5	5.7	5.7	11.4	**0.8**	**1.7**
	4	14.50	0.0	CLAY	1.60	4	-	2.5	0.0	5.70	1.00	0.00	9.5	7.6	5.0	12.6	**0.8**	**1.3**
	5	15.50	0.0	CLAY	1.60	4	-	2.5	0.0	5.70	1.00	0.00	9.5	9.5	4.3	13.8	**0.7**	**1.0**
2	1	11.50	0.0	CLAY	1.70	5	-	3.1	0.0	5.70	1.00	0.00	11.9	1.9	6.8	8.7	**1.4**	6.3
	2	12.50	0.0	CLAY	1.70	5	-	3.1	0.0	5.70	1.00	0.00	11.9	3.8	6.4	10.2	**1.2**	3.1
	3	13.50	0.0	CLAY	1.70	5	-	3.1	0.0	5.70	1.00	0.00	11.9	5.7	5.7	11.4	**1.0**	2.1
	4	14.50	0.0	CLAY	1.70	5	-	3.1	0.0	5.70	1.00	0.00	11.9	7.6	5.0	12.6	**0.9**	**1.6**
	5	15.50	0.0	CLAY	1.70	5	-	3.1	0.0	5.70	1.00	0.00	11.9	9.5	4.3	13.8	**0.9**	**1.3**
3	1	11.50	0.0	CLAY	1.80	6	-	3.8	0.0	5.70	1.00	0.00	14.3	1.9	6.8	8.7	1.6	7.5
	2	12.50	0.0	CLAY	1.80	6	-	3.8	0.0	5.70	1.00	0.00	14.3	3.8	6.4	10.2	**1.4**	3.8
	3	13.50	0.0	CLAY	1.80	6	-	3.8	0.0	5.70	1.00	0.00	14.3	5.7	5.7	11.4	**1.3**	2.5
	4	14.50	0.0	CLAY	1.80	6	-	3.8	0.0	5.70	1.00	0.00	14.3	7.6	5.0	12.6	**1.1**	**1.9**
	5	15.50	0.0	CLAY	1.80	6	-	3.8	0.0	5.70	1.00	0.00	14.3	9.5	4.3	13.8	**1.0**	**1.5**
4	1	11.50	0.0	CLAY	1.90	7	-	4.4	0.0	5.70	1.00	0.00	16.6	1.9	6.8	8.7	1.9	8.8
	2	12.50	0.0	CLAY	1.90	7	-	4.4	0.0	5.70	1.00	0.00	16.6	3.8	6.4	10.2	1.6	4.4
	3	13.50	0.0	CLAY	1.90	7	-	4.4	0.0	5.70	1.00	0.00	16.6	5.7	5.7	11.4	1.5	2.9
	4	14.50	0.0	CLAY	1.90	7	-	4.4	0.0	5.70	1.00	0.00	16.6	7.6	5.0	12.6	**1.3**	2.2
	5	15.50	0.0	CLAY	1.90	7	-	4.4	0.0	5.70	1.00	0.00	16.6	9.5	4.3	13.8	**1.2**	**1.8**
5	1	11.50	0.0	CLAY	1.90	8	-	5.0	0.0	5.70	1.00	0.00	19.0	1.9	6.8	8.7	2.2	10.0
	2	12.50	0.0	CLAY	1.90	8	-	5.0	0.0	5.70	1.00	0.00	19.0	3.8	6.4	10.2	1.9	5.0
	3	13.50	0.0	CLAY	1.90	8	-	5.0	0.0	5.70	1.00	0.00	19.0	5.7	5.7	11.4	1.7	3.3
	4	14.50	0.0	CLAY	1.90	8	-	5.0	0.0	5.70	1.00	0.00	19.0	7.6	5.0	12.6	1.5	2.5
	5	15.50	0.0	CLAY	1.90	8	-	5.0	0.0	5.70	1.00	0.00	19.0	9.5	4.3	13.8	**1.4**	2.0
6	1	11.50	0.0	CLAY	1.90	9	-	5.7	0.0	5.70	1.00	0.00	21.7	1.9	6.8	8.7	2.5	11.4
	2	12.50	0.0	CLAY	1.90	9	-	5.7	0.0	5.70	1.00	0.00	21.7	3.8	6.4	10.2	2.1	5.7
	3	13.50	0.0	CLAY	1.90	9	-	5.7	0.0	5.70	1.00	0.00	21.7	5.7	5.7	11.4	1.9	3.8
	4	14.50	0.0	CLAY	1.90	9	-	5.7	0.0	5.70	1.00	0.00	21.7	7.6	5.0	12.6	1.7	2.9
	5	15.50	0.0	CLAY	1.90	9	-	5.7	0.0	5.70	1.00	0.00	21.7	9.5	4.3	13.8	1.6	2.3

Remarks;

(1) Depth from existing ground

(2) Terzaghi's Bearing Capacity Factors (Nc, Nq, Nγ)
or Terzaghi's Modified Bearing Capacity Factors (N'c, N'q, N'γ)

(3) For General Failure : $q_u = cN_c + q'N_q + 0.5\gamma'BN_\gamma$
For Local Shear Failure : $q_u = 0.667cN'_c + q'N'_q + 0.5\gamma'BN'_\gamma$

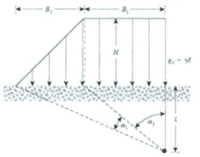
(4) $q_a = q_u / F.S.$, Factor of Safety

Table 5.1.7-10 Soil Bearing Capacity under Embankment for Clay (Cont'd)

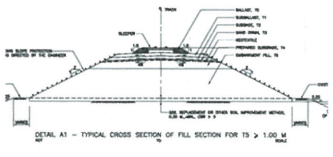
Stress Distribution on Ground at Center Line of Single Track Calculation

Live Load from Track 68 kN/m²

Case No.	H of Emb. Z, m	Track Width, B	α_1	α_2	$((B_1+B_2)/B_2)(\alpha_1+\alpha_2) - (B_1/B_2)(\alpha_2)$	I	Δσ kN/m²	2Δσ kN/m²
1	3.0	3	0.00	0.79	1.29	0.409	27.8	55.6
2	4.0	3	0.00	0.64	1.12	0.358	24.3	48.6
3	5.0	3	0.00	0.54	0.98	0.312	21.2	42.5
4	6.0	3	0.00	0.46	0.86	0.275	18.7	37.4
5	7.0	3	0.00	0.40	0.77	0.244	16.6	33.2



$$\Delta\sigma_z = \frac{q_s}{\pi}\left[\left(\frac{B_1+B_2}{B_2}\right)(\alpha_1+\alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right]$$



Case No	Embankment Hight, H (m)	Embankment Width, B (m)	Depth(1) Df (m)	Soil Type	Density (γ) (t / m³)	Avg SPT (blows/ft)	Angle of Friction (∅)	Cohesion (c, t/m²)	Surcharge (q', t/m²)	Nc(2) or N'c	Nq(2) or N'q	Nγ(2) or N'γ	qu(2) (t/m²)	Load on Ground DL (t/m²)	Load on Ground LL (t/m²)	Load on Ground DL+LL (t/m²)	Factor of Safety DL+LL min.1.5	Factor of Safety DL min.2.0
7	3	13.50	0.0	CLAY	1.60	10	-	6.4	0.0	5.70	1.00	0.00	24.4	5.7	5.7	11.4	2.1	4.3
	4	14.50	0.0	CLAY	1.60	10	-	6.4	0.0	5.70	1.00	0.00	24.4	7.6	5.0	12.6	1.9	3.2
	5	15.50	0.0	CLAY	1.60	10	-	6.4	0.0	5.70	1.00	0.00	24.4	9.5	4.3	13.8	1.8	2.6
	6	16.50	0.0	CLAY	1.60	10	-	6.4	0.0	5.70	1.00	0.00	24.4	11.4	3.8	15.2	1.6	2.1
	7	17.50	0.0	CLAY	1.60	10	-	6.4	0.0	5.70	1.00	0.00	24.4	13.3	3.4	16.7	1.5	**1.8**
8	3	13.50	0.0	CLAY	1.70	11	-	7.1	0.0	5.70	1.00	0.00	27.1	5.7	5.7	11.4	2.4	4.8
	4	14.50	0.0	CLAY	1.70	11	-	7.1	0.0	5.70	1.00	0.00	27.1	7.6	5.0	12.6	2.2	3.6
	5	15.50	0.0	CLAY	1.70	11	-	7.1	0.0	5.70	1.00	0.00	27.1	9.5	4.3	13.8	2.0	2.9
	6	16.50	0.0	CLAY	1.70	11	-	7.1	0.0	5.70	1.00	0.00	27.1	11.4	3.8	15.2	1.8	2.4
	7	17.50	0.0	CLAY	1.70	11	-	7.1	0.0	5.70	1.00	0.00	27.1	13.3	3.4	16.7	1.6	2.0
9	3	13.50	0.0	CLAY	1.80	12	-	7.9	0.0	5.70	1.00	0.00	29.9	5.7	5.7	11.4	2.6	5.2
	4	14.50	0.0	CLAY	1.80	12	-	7.9	0.0	5.70	1.00	0.00	29.9	7.6	5.0	12.6	2.4	3.9
	5	15.50	0.0	CLAY	1.80	12	-	7.9	0.0	5.70	1.00	0.00	29.9	9.5	4.3	13.8	2.2	3.1
	6	16.50	0.0	CLAY	1.80	12	-	7.9	0.0	5.70	1.00	0.00	29.9	11.4	3.8	15.2	2.0	2.6
	7	17.50	0.0	CLAY	1.80	12	-	7.9	0.0	5.70	1.00	0.00	29.9	13.3	3.4	16.7	1.8	2.2
10	3	13.50	0.0	CLAY	1.90	13	-	8.6	0.0	5.70	1.00	0.00	32.6	5.7	5.7	11.4	2.9	5.7
	4	14.50	0.0	CLAY	1.90	13	-	8.6	0.0	5.70	1.00	0.00	32.6	7.6	5.0	12.6	2.6	4.3
	5	15.50	0.0	CLAY	1.90	13	-	8.6	0.0	5.70	1.00	0.00	32.6	9.5	4.3	13.8	2.4	3.4
	6	16.50	0.0	CLAY	1.90	13	-	8.6	0.0	5.70	1.00	0.00	32.6	11.4	3.8	15.2	2.1	2.9
	7	17.50	0.0	CLAY	1.90	13	-	8.6	0.0	5.70	1.00	0.00	32.6	13.3	3.4	16.7	2.0	2.4
11	3	13.50	0.0	CLAY	1.90	14	-	9.3	0.0	5.70	1.00	0.00	35.3	5.7	5.7	11.4	3.1	6.2
	4	14.50	0.0	CLAY	1.90	14	-	9.3	0.0	5.70	1.00	0.00	35.3	7.6	5.0	12.6	2.8	4.6
	5	15.50	0.0	CLAY	1.90	14	-	9.3	0.0	5.70	1.00	0.00	35.3	9.5	4.3	13.8	2.6	3.7
	6	16.50	0.0	CLAY	1.90	14	-	9.3	0.0	5.70	1.00	0.00	35.3	11.4	3.8	15.2	2.3	3.1
	7	17.50	0.0	CLAY	1.90	14	-	9.3	0.0	5.70	1.00	0.00	35.3	13.3	3.4	16.7	2.1	**2.7**
12	3	13.50	0.0	CLAY	1.90	15	-	10.0	0.0	5.70	1.00	0.00	38.0	5.7	5.7	11.4	3.3	6.7
	4	14.50	0.0	CLAY	1.90	15	-	10.0	0.0	5.70	1.00	0.00	38.0	7.6	5.0	12.6	3.0	5.0
	5	15.50	0.0	CLAY	1.90	15	-	10.0	0.0	5.70	1.00	0.00	38.0	9.5	4.3	13.8	2.7	4.0
	6	16.50	0.0	CLAY	1.90	15	-	10.0	0.0	5.70	1.00	0.00	38.0	11.4	3.8	15.2	2.5	3.3
	7	17.50	0.0	CLAY	1.90	15	-	10.0	0.0	5.70	1.00	0.00	38.0	13.3	3.4	16.7	2.3	2.9

Remarks:

(1) Depth from existing ground

(2) Terzaghi's Bearing Capacity Factors (Nc, Nq, Nγ)
or Terzaghi's Modified Bearing Capacity Factors (N'c, N'q, N'γ)

(3) For General Failure : $q_u = cN_c + q'N_q + 0.5\gamma'BN_\gamma$
For Local Shear Failure : $q_u = 0.667cN'_c + q'N'_q + 0.5\gamma'BN'_\gamma$

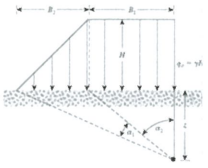
(4) $q_a = q_u$ / F.S. , Factor of Safety

Table 5.1.7-11 Soil Bearing Capacity under Embankment for Sand

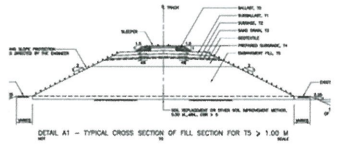
Stress Distribution on Ground at Center Line of Single Track Calculation

Live Load from Track 68 kN/m²

Case No.	H of Emb. Z, m	Track Width, B	α_1	α_2	$((P1-P2)/P1)((\alpha_1-\alpha_2))$ $-(P2/P1)*(\alpha_2)$	I	$\Delta\sigma$ kN/m²	$2\Delta\sigma$ kN/m²
1	1.0	3	0.00	1.25	1.55	0.493	33.5	67.1
2	2.0	3	0.00	0.98	1.44	0.460	31.3	62.5
3	3.0	3	0.00	0.79	1.29	0.409	27.8	55.6
4	4.0	3	0.00	0.64	1.12	0.358	24.3	48.6
5	5.0	3	0.00	0.54	0.98	0.312	21.2	42.5



$$\Delta\sigma_z = \frac{q_s}{\pi}\left[\left(\frac{B_1+B_2}{B_2}\right)(\alpha_1+\alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right]$$



Case No	Embankment Hight, H (m)	Embankment Width, B (m)	Depth[1] Df (m)	Soil Type	Density (γ) (t / m³)	Avg SPT (blows/ft)	Angle of Friction (∅)	Cohesion (c, t/m²)	Surcharge (q', t/m²)	Nc[2] or N'c	Nq[2] or N'q	Nγ[2] or N'γ	q_u[2] (t/m²)	Load on Ground DL (t/m²)	Load on Ground LL (t/m²)	Load on Ground DL+LL (t/m²)	Factor of Safety DL+LL min.1.5	Factor of Safety DL min.2.0
1	1	11.50	0.0	SAND	1.70	4	28.0	-	0.0	17.13	7.07	3.29	13.2	1.9	6.8	8.7	1.5	7.0
	2	12.50	0.0	SAND	1.70	4	28.0	-	0.0	17.13	7.07	3.29	14.4	3.8	6.4	10.2	**1.4**	3.8
	3	13.50	0.0	SAND	1.70	4	28.0	-	0.0	17.13	7.07	3.29	15.5	5.7	5.7	11.4	**1.4**	2.7
	4	14.50	0.0	SAND	1.70	4	28.0	-	0.0	17.13	7.07	3.29	16.7	7.6	5.0	12.6	**1.3**	2.2
	5	15.50	0.0	SAND	1.70	4	28.0	-	0.0	17.13	7.07	3.29	17.8	9.5	4.3	13.8	**1.3**	**1.9**
2	1	11.50	0.0	SAND	1.70	5	28.3	-	0.0	17.13	7.07	3.29	13.2	1.9	6.8	8.7	1.5	7.0
	2	12.50	0.0	SAND	1.70	5	28.3	-	0.0	17.13	7.07	3.29	14.4	3.8	6.4	10.2	**1.4**	3.8
	3	13.50	0.0	SAND	1.70	5	28.3	-	0.0	17.13	7.07	3.29	15.5	5.7	5.7	11.4	**1.4**	2.7
	4	14.50	0.0	SAND	1.70	5	28.3	-	0.0	17.13	7.07	3.29	16.7	7.6	5.0	12.6	**1.3**	2.2
	5	15.50	0.0	SAND	1.70	5	28.3	-	0.0	17.13	7.07	3.29	17.8	9.5	4.3	13.8	**1.3**	**1.9**
3	1	11.50	0.0	SAND	1.80	6	28.7	-	0.0	18.03	7.66	3.76	17.3	1.9	6.8	8.7	2.0	9.1
	2	12.50	0.0	SAND	1.80	6	28.7	-	0.0	18.03	7.66	3.76	18.8	3.8	6.4	10.2	1.8	4.9
	3	13.50	0.0	SAND	1.80	6	28.7	-	0.0	18.03	7.66	3.76	20.3	5.7	5.7	11.4	1.8	3.6
	4	14.50	0.0	SAND	1.80	6	28.7	-	0.0	18.03	7.66	3.76	21.8	7.6	5.0	12.6	1.7	2.9
	5	15.50	0.0	SAND	1.80	6	28.7	-	0.0	18.03	7.66	3.76	23.3	9.5	4.3	13.8	1.7	2.5
4	1	11.50	0.0	SAND	1.90	7	29.0	-	0.0	18.03	7.66	3.76	19.5	1.9	6.8	8.7	2.2	10.2
	2	12.50	0.0	SAND	1.90	7	29.0	-	0.0	18.03	7.66	3.76	21.2	3.8	6.4	10.2	2.1	5.6
	3	13.50	0.0	SAND	1.90	7	29.0	-	0.0	18.03	7.66	3.76	22.8	5.7	5.7	11.4	2.0	4.0
	4	14.50	0.0	SAND	1.90	7	29.0	-	0.0	18.03	7.66	3.76	24.5	7.6	5.0	12.6	2.0	3.2
	5	15.50	0.0	SAND	1.90	7	29.0	-	0.0	18.03	7.66	3.76	26.2	9.5	4.3	13.8	1.9	2.8
5	1	11.50	0.0	SAND	1.90	8	29.3	-	0.0	18.03	7.66	3.76	19.5	1.9	6.8	8.7	2.2	10.2
	2	12.50	0.0	SAND	1.90	8	29.3	-	0.0	18.03	7.66	3.76	21.2	3.8	6.4	10.2	2.1	5.6
	3	13.50	0.0	SAND	1.90	8	29.3	-	0.0	18.03	7.66	3.76	22.8	5.7	5.7	11.4	2.0	4.0
	4	14.50	0.0	SAND	1.90	8	29.3	-	0.0	18.03	7.66	3.76	24.5	7.6	5.0	12.6	2.0	3.2
	5	15.50	0.0	SAND	1.90	8	29.3	-	0.0	18.03	7.66	3.76	26.2	9.5	4.3	13.8	1.9	2.8
6	1	11.50	0.0	SAND	1.90	9	29.7	-	0.0	18.99	8.31	4.39	22.7	1.9	6.8	8.7	2.6	12.0
	2	12.50	0.0	SAND	1.90	9	29.7	-	0.0	18.99	8.31	4.39	24.7	3.8	6.4	10.2	2.4	6.5
	3	13.50	0.0	SAND	1.90	9	29.7	-	0.0	18.99	8.31	4.39	26.7	5.7	5.7	11.4	2.3	4.7
	4	14.50	0.0	SAND	1.90	9	29.7	-	0.0	18.99	8.31	4.39	28.6	7.6	5.0	12.6	2.3	3.8
	5	15.50	0.0	SAND	1.90	9	29.7	-	0.0	18.99	8.31	4.39	30.6	9.5	4.3	13.8	2.2	3.2

Remarks:

(1) Depth from existing ground

(2) Terzaghi's Bearing Capacity Factors (Nc, Nq, Nγ)
or Terzaghi's Modified Bearing Capacity Factors (N'c, N'q, N'γ)

(3) For General Failure : $q_u = cN_c + q'N_q + 0.5\gamma'BN_\gamma$
For Local Shear Failure : $q_u = 0.667cN'_c + q'N'_q + 0.5\gamma'BN'_\gamma$

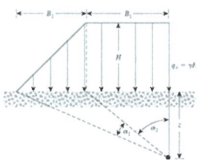
(4) $q_a = q_u$ / F.S. , Factor of Safety

Table 5.1.7-11 Soil Bearing Capacity under Embankment for Sand (Cont'd)

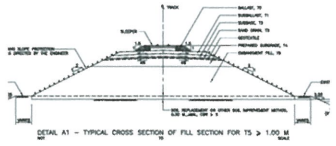
Stress Distribution on Ground at Center Line of Single Track Calculation

Live Load from Track 68 kN/m²

Case No.	H of Emb. Z, m	Track Width, B	α_1	α_2	$((F1\text{-}F1)/F1)\times(\alpha_1\text{-}\alpha_2)$	I	Δσ kN/m²	2Δσ kN/m²
1	3.0	3	0.00	0.79	1.29	0.409	27.8	55.6
2	4.0	3	0.00	0.64	1.12	0.358	24.3	48.6
3	5.0	3	0.00	0.54	0.98	0.312	21.2	42.5
4	6.0	3	0.00	0.46	0.86	0.275	18.7	37.4
5	7.0	3	0.00	0.40	0.77	0.244	16.6	33.2



$$\Delta\sigma_z = \frac{q_d}{\pi}\left[\left(\frac{B_1+B_2}{B_2}\right)(\alpha_1+\alpha_2) - \frac{B_1}{B_2}(\alpha_2)\right]$$



Case No	Embankment Hight, H (m)	Embankment Width, B (m)	Depth(1) Df (m)	Soil Type	Density (γ) (t/m³)	Avg SPT (blows/ft)	Angle of Friction (∅)	Cohesion (c, t/m²)	Surcharge (q', t/m²)	Nc(2) or N'c	Nq(2) or N'q	Nγ(2) or N'γ	q_a(3) (t/m²)	Load on Ground DL (t/m²)	Load on Ground LL (t/m²)	Load on Ground DL+LL (t/m²)	Factor of Safety DL+LL min.1.5	Factor of Safety DL min.2.0
7	3	13.50	0.0	SAND	1.70	10	30.0	-	0.0	18.99	8.31	4.39	20.7	5.7	5.7	11.4	1.8	3.6
	4	14.50	0.0	SAND	1.70	10	30.0	-	0.0	18.99	8.31	4.39	22.3	7.6	5.0	12.6	1.8	2.9
	5	15.50	0.0	SAND	1.70	10	30.0	-	0.0	18.99	8.31	4.39	23.8	9.5	4.3	13.8	1.7	2.5
	6	16.50	0.0	SAND	1.70	10	30.0	-	0.0	18.99	8.31	4.39	25.4	11.4	3.8	15.2	1.7	2.2
	7	17.50	0.0	SAND	1.70	10	30.0	-	0.0	18.99	8.31	4.39	26.9	13.3	3.4	16.7	1.6	2.0
8	3	13.50	0.0	SAND	1.70	11	30.3	-	0.0	18.99	8.31	4.39	20.7	5.7	5.7	11.4	1.8	3.6
	4	14.50	0.0	SAND	1.70	11	30.3	-	0.0	18.99	8.31	4.39	22.3	7.6	5.0	12.6	1.8	2.9
	5	15.50	0.0	SAND	1.70	11	30.3	-	0.0	18.99	8.31	4.39	23.8	9.5	4.3	13.8	1.7	2.5
	6	16.50	0.0	SAND	1.70	11	30.3	-	0.0	18.99	8.31	4.39	25.4	11.4	3.8	15.2	1.7	2.2
	7	17.50	0.0	SAND	1.70	11	30.3	-	0.0	18.99	8.31	4.39	26.9	13.3	3.4	16.7	1.6	2.0
9	3	13.50	0.0	SAND	1.80	12	30.6	-	0.0	20.03	9.03	4.83	26.1	5.7	5.7	11.4	2.3	4.6
	4	14.50	0.0	SAND	1.80	12	30.6	-	0.0	20.03	9.03	4.83	28.0	7.6	5.0	12.6	2.2	3.7
	5	15.50	0.0	SAND	1.80	12	30.6	-	0.0	20.03	9.03	4.83	29.9	9.5	4.3	13.8	2.2	3.2
	6	16.50	0.0	SAND	1.80	12	30.6	-	0.0	20.03	9.03	4.83	31.9	11.4	3.8	15.2	2.1	2.8
	7	17.50	0.0	SAND	1.80	12	30.6	-	0.0	20.03	9.03	4.83	33.8	13.3	3.4	16.7	2.0	2.5
10	3	13.50	0.0	SAND	1.90	13	30.9	-	0.0	20.03	9.03	4.83	29.3	5.7	5.7	11.4	2.6	5.1
	4	14.50	0.0	SAND	1.90	13	30.9	-	0.0	20.03	9.03	4.83	31.5	7.6	5.0	12.6	2.5	4.1
	5	15.50	0.0	SAND	1.90	13	30.9	-	0.0	20.03	9.03	4.83	33.7	9.5	4.3	13.8	2.4	3.5
	6	16.50	0.0	SAND	1.90	13	30.9	-	0.0	20.03	9.03	4.83	35.9	11.4	3.8	15.2	2.4	3.1
	7	17.50	0.0	SAND	1.90	13	30.9	-	0.0	20.03	9.03	4.83	38.0	13.3	3.4	16.7	2.3	2.9
11	3	13.50	0.0	SAND	1.90	14	31.2	-	0.0	20.03	9.03	4.83	29.3	5.7	5.7	11.4	2.6	5.1
	4	14.50	0.0	SAND	1.90	14	31.2	-	0.0	20.03	9.03	4.83	31.5	7.6	5.0	12.6	2.5	4.1
	5	15.50	0.0	SAND	1.90	14	31.2	-	0.0	20.03	9.03	4.83	33.7	9.5	4.3	13.8	2.4	3.5
	6	16.50	0.0	SAND	1.90	14	31.2	-	0.0	20.03	9.03	4.83	35.9	11.4	3.8	15.2	2.4	3.1
	7	17.50	0.0	SAND	1.90	14	31.2	-	0.0	20.03	9.03	4.83	38.0	13.3	3.4	16.7	2.3	2.9
12	3	13.50	0.0	SAND	1.90	15	31.5	-	0.0	21.16	9.82	5.51	33.5	5.7	5.7	11.4	2.9	5.9
	4	14.50	0.0	SAND	1.90	15	31.5	-	0.0	21.16	9.82	5.51	36.0	7.6	5.0	12.6	2.9	4.7
	5	15.50	0.0	SAND	1.90	15	31.5	-	0.0	21.16	9.82	5.51	38.4	9.5	4.3	13.8	2.8	4.0
	6	16.50	0.0	SAND	1.90	15	31.5	-	0.0	21.16	9.82	5.51	40.9	11.4	3.8	15.2	2.7	3.6
	7	17.50	0.0	SAND	1.90	15	31.5	-	0.0	21.16	9.82	5.51	43.4	13.3	3.4	16.7	2.6	3.3

Remarks:

(1) Depth from existing ground

(2) Terzaghi's Bearing Capacity Factors (Nc, Nq, Nγ)
or Terzaghi's Modified Bearing Capacity Factors (N'c, N'q, N'γ)

(3) For General Failure : $q_u = cN_c + q'N_q + 0.5\gamma'BN_\gamma$
For Local Shear Failure : $q_u = 0.667cN'_c + q'N'_q + 0.5\gamma'BN'_\gamma$

(4) $q_a = q_u$ / F.S. , Factor of Safety

5.1.7.6.7 Toe Slope Failure

The toe slope failure occurs from the insufficient strength of the foundation while the side slope is quite stable. The failure will be a break in movement of an arc of a circle. The FS of the design is determined not less than 1.5. The theory applied to analyze the stability of the side slope and back slope is Limit Equilibrium Analysis which is an analysis of soil conditions at the plastic balance of forces acting on the soil mass before moving down. The FS is calculated by comparing the sliding resistance from shear strength of soil according to Limit Equilibrium with the force to move of soil on the assumed sliding surface and assume that it is sliding (balanced state). For the analysis of embankment stability, it is assumed that the sliding surface is spherical. Then split the soil into pieces or bars. Calculate the forces on each soil bar as shown in **Figure 5.1.7-17**. Then calculate the momentum of the total soil mass at the point where the soil mass is disrupted. The effect is compared to the ratio of resistance and force as shown in the figure. The ratio is the factor of safety.

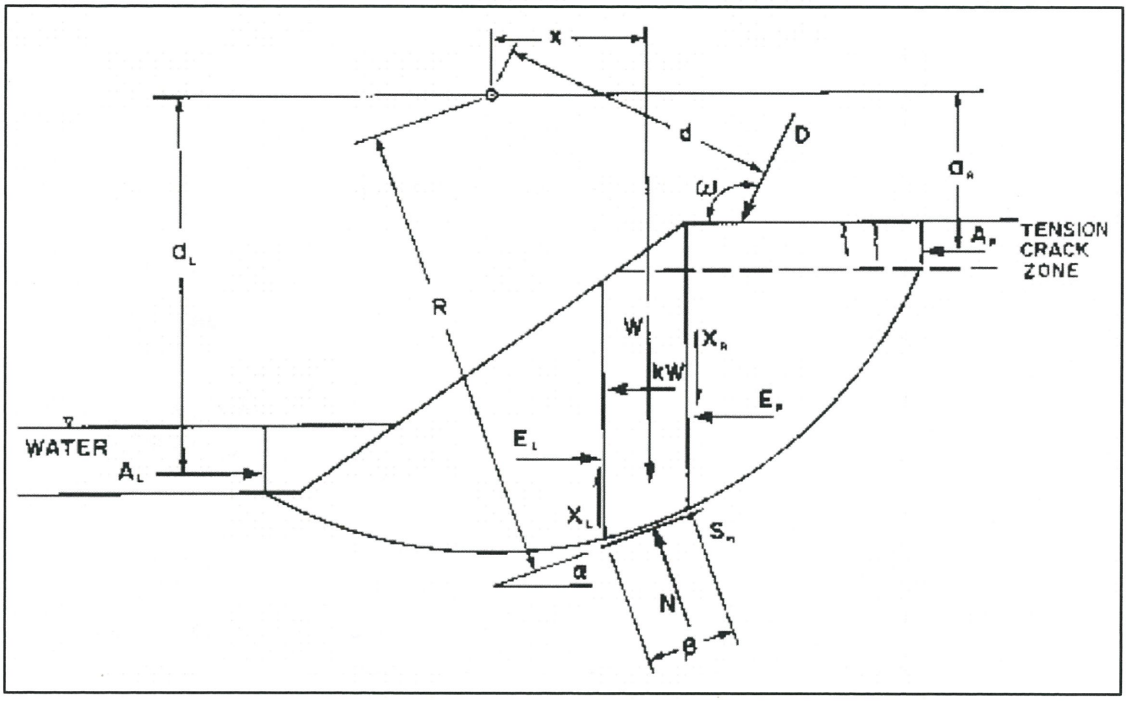


Figure 5.1.7-17 A Schematic of Various Forces on the Soil Mass

The Factor of Safety, FS, is derived from the following equation:

$$FS = \frac{\sum\left[\left(c\beta + W\tan\phi\right)\left\{\cos\alpha + \frac{\sin\alpha\tan\phi}{FS}\right\}\right]}{\sum W\sin\alpha}$$

where C = Cohesion (F/L^2)

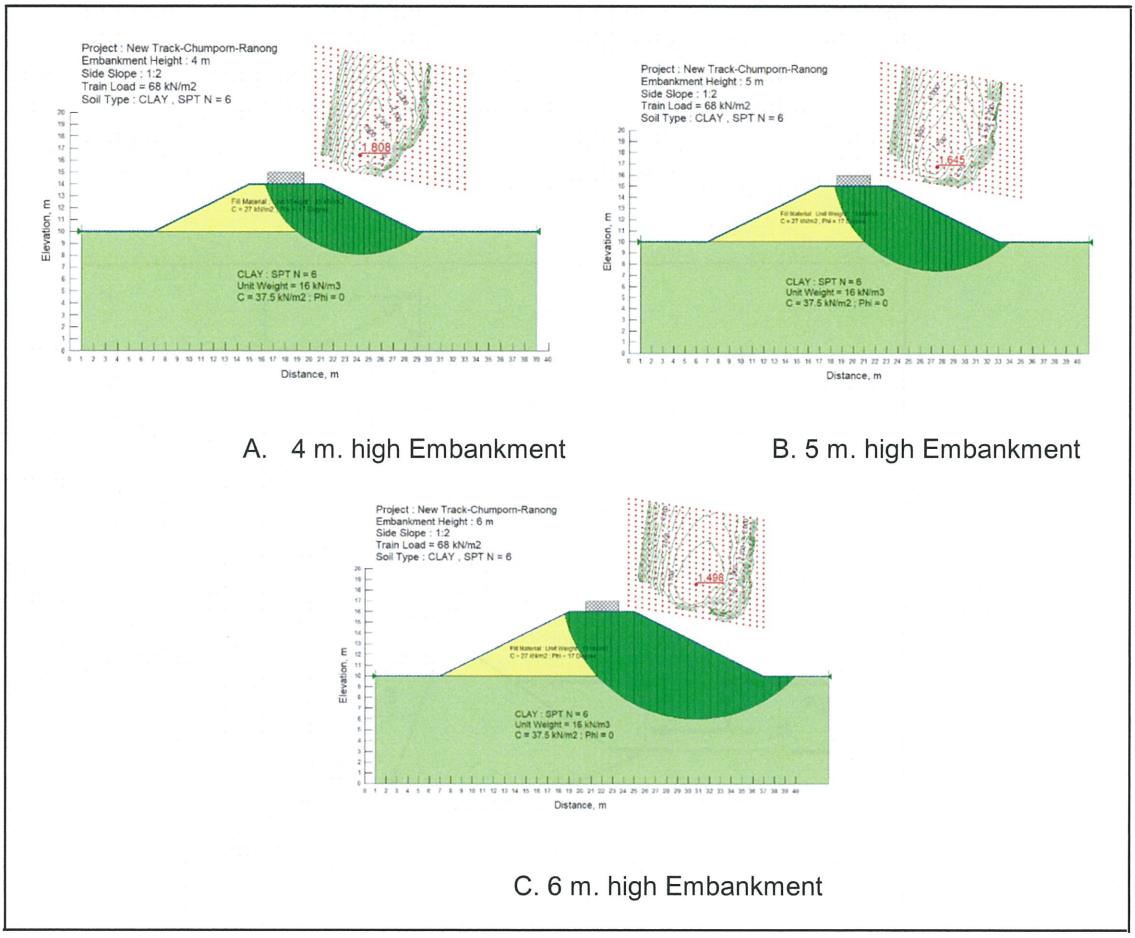
β = Slice base length (L)

ϕ = Friction angle (degree)

W = Slice weight (F)

α = Slice base inclination (degree)

In analyzing the embankment stability, the Consultant has followed the Standard Penetration Test (SPT-N) which varies from 6 to 8 blows/ft for clay and 16 blows/ft for sand at the embankment height from 4 to 8 m. for convenience in consideration of embankment stability along the alignment as per **Figures 5.1.7-18** to **5.1.7-21** for clay and sand respectively.



A. 4 m. high Embankment

B. 5 m. high Embankment

C. 6 m. high Embankment

Figure 5.1.7-18 Embankment Stability Analysis for Clay having SPT N = 6

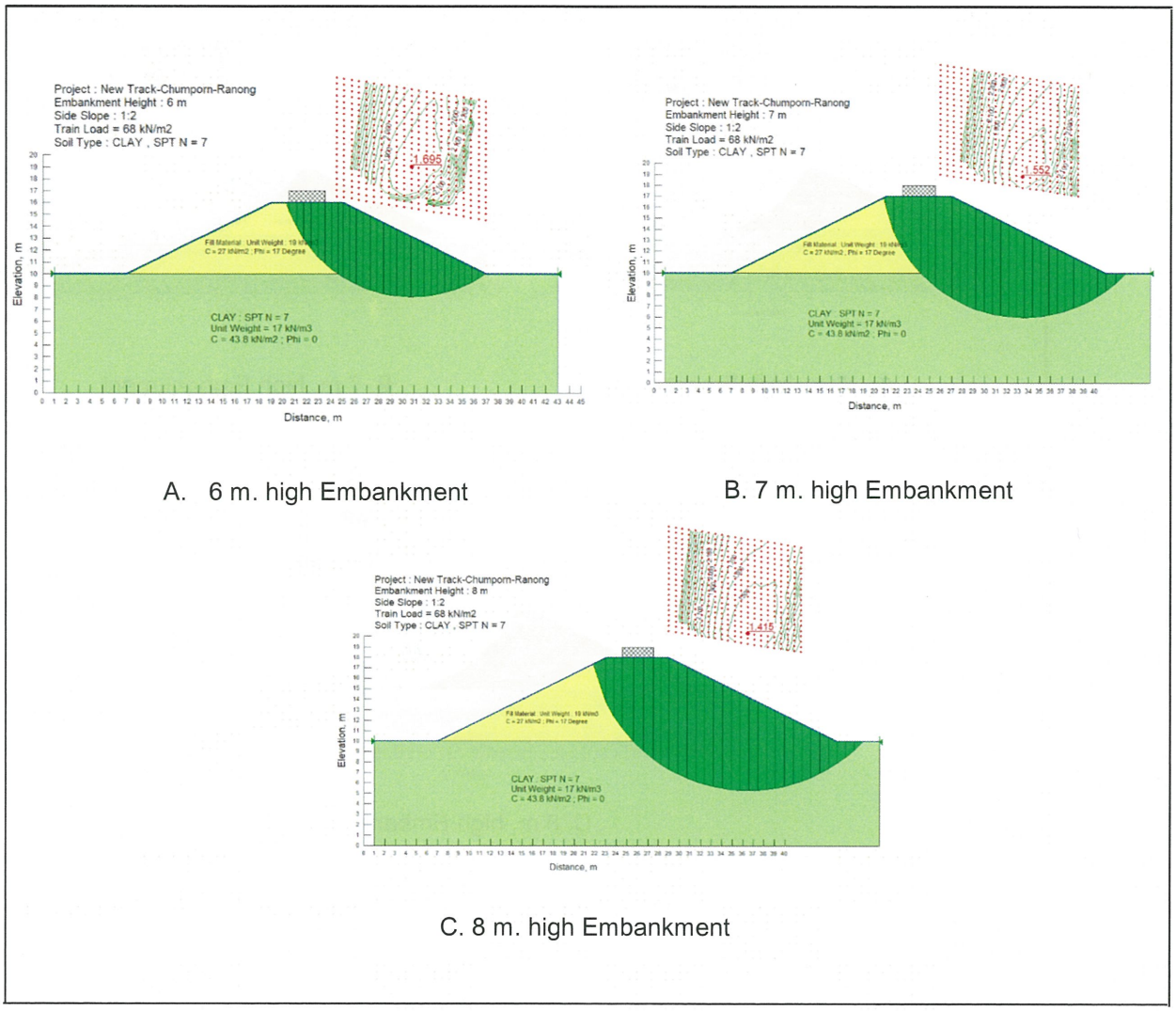


Figure 5.1.7-19 Embankment Stability Analysis for Clay having SPT N = 7

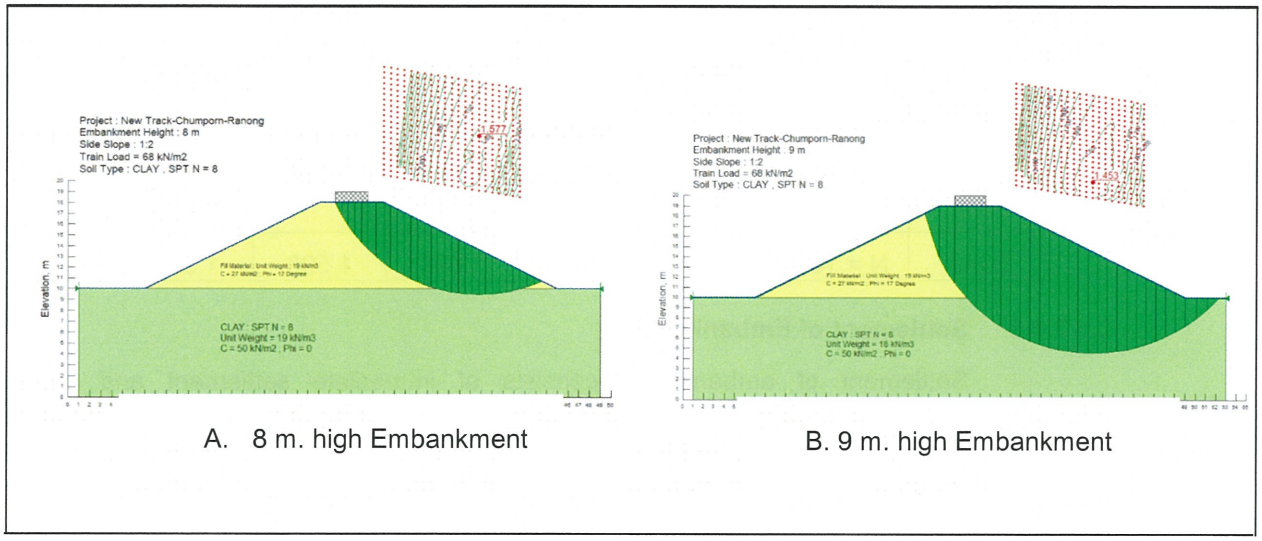
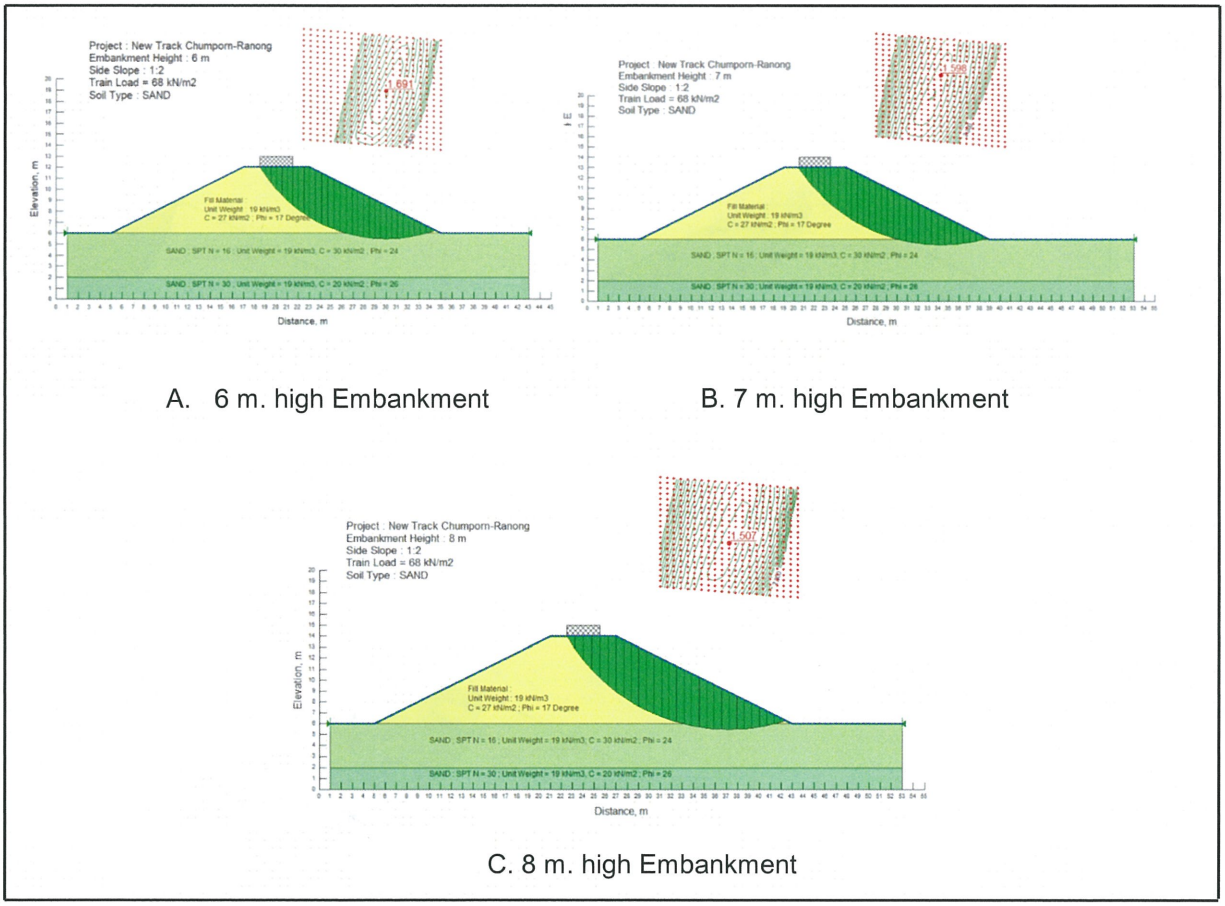


Figure 5.1.7-20 Embankment Stability Analysis for Clay having SPT N = 8



A. 6 m. high Embankment

B. 7 m. high Embankment

C. 8 m. high Embankment

Figure 5.1.7-21 Embankment Stability Analysis for Sand having SPT N = 16

From the embankment stability analysis shown above, it can be summarized as in **Table 5.1.7-12**.

Table 5.1.7-12 Summary of Simplified Slope Stability

Soil Type	SPT N	Factor of Safety for Embankment Height, m.					
		H = 4	H = 5	H = 6	H = 7	H = 8	H = 9
Clay	N = 6	1.808	1.645	1.498			
	N = 7			1.695	1.552	1.415	
	N = 8					1.577	1.453
Sand	N = 16			1.691	1.598	1.507	

5.1.7.6.8 Settlement of Embankment

Settlement of embankment consists of immediate settlement and consolidation settlement. Normally, immediate settlement is not large and stops after construction but consolidation settlement is large and takes time in settlement. If the subsoil is soft soil, the settlement will be unacceptable and the subsoil needs to be improved.

1) Immediate Settlement

The immediate settlement can be calculated by Elastic theory by the following equation:

$$Si = (1-v^2)(ql)\,\triangle H / Es$$

when Si = Immediate settlement

v = Poisson Ratio (0.3 for Sand, 0.4 for Clay)

q = Dead load and live load

I = Boussinesq Influence Factor at the middle of embankment

△H = Thickness of soil

Es = Elastic Modulus of soil

2) Consolidation Settlement

The consolidation settlement can be calculated by Terzaghi theory which is a calculation of one-dimensional consolidation by the following equation:

$$S_c = H\left[RR.\log\frac{P_c'}{P_o'} + CR.\log\frac{P_o' + \Delta P}{P_c'}\right]$$

when S_c = Primary Consolidation Settlement

H = Compressible Layer Thickness

RR = Recompression Ratio

CR = Compression Ratio

P'c = Effective Maximum Past Pressure

P'o = Present Overburden Pressure at the Mid Layer

△P = Applied Vertical Pressure

In case of weak soil foundation or large settlement, the quality of subsoil needs to be improved. The improvement of subsoil in terms of load capacity of the soil, slope stability and settlement of fill embankment can be achieved by many methods which have to be suitable for the geological conditions of each area.

From the results of settlement calculation after 2 years of embankment construction, the remaining settlements of each location are less than 20 cm., except at Sta. 44+925, Sta.79+873 and Sta.101+709 which are more than 40 cm. Ballast fill to adjust tracked level could be used for these sections. **Table 5.1.7-13** shows the calculation details.

For soil bearing capacities and slope stability, most meet the criteria that is the FS is more than 1.5. **Table 5.1.7-14** shows the calculation details.

Table 5.1.7-13 Settlement Calculation of Boreholes along the Alignment

Borehole No.	Sta.	Embankment Height m.	Immediate Settlement m.	Total Consolidation Settlement m.	Total Settlement m.	Consolidation Settlement		Remaining Settlement	
						At 1 year m.	At 2 years m.	After 1 year m.	After 2 years m.
BH-1	15+792	7	0.014	0.474	0.488	0.472	0.474	0.002	0.000
BH-2	22+481	7	0.023	0.775	0.798	0.438	0.581	0.337	0.194
BH-4	44+925	6	0.027	0.820	0.847	0.262	0.369	0.558	0.451
BH-7	79+873	6	0.027	0.820	0.847	0.262	0.369	0.558	0.451
BH-9	101+709	7	0.032	0.903	0.935	0.289	0.406	0.614	0.497

Table 5.1.7-14 Soil Bearing Capacity and Slope Stability of Boreholes along the Alignment

Borehole No.	Sta.	Embankment Height m.	Settlement after 2 Years	Soil Bearing Capacity FS > 1.5	Slope Stability FS > 1.5	Soil Improvement
BH-1	15+792	7	0.000	Yes	Yes	No
BH-2	22+481	7	0.194	Yes	Yes	No
BH-4	44+925	6	0.451	Yes	Yes	Adjusted by ballast filling
BH-7	79+873	6	0.451	Yes	Yes	Adjusted by ballast filling
BH-9	101+709	7	0.497	Yes	Yes	Adjusted by ballast filling

5.1.7.6.9 Erosion Protection of Slope

Generally, slope erosion often occurs from surface ground water such as rain water. The best way to protect slope is to reduce the amount of water flowing through the slope surface and construct the ditch or gutter to collect water on top, sides and base of the slope, etc. In addition, surface reinforcement to maintain soil from being eroded is another way which can be done in several forms, for example.

1) Planting is the method to have the roots in the stabilization such as vetiver or others etc. In some cases it may be necessary to use the material to hold the grass first to wait for the roots of the plant to grow so that it can hold the soil, such as soil blankets or geotextile etc.

2) Soil surface protection which is suitable for the area that cannot plant by using materials such as mattress/gabion or shotcrete or rip-rap etc.

Groundwater control is another way to increase the stability of the slope and the soil surface by installing horizontal drain which can assist reducing water pressure in the wetlands or water gushed out from the slope, etc. Either method should be designed to suit each area.

5.1.7.6.10 Pile Foundation Analysis and Design

In designing the pile foundation, the vertical load of pile consists of load of skin friction resistance and load of end bearing resistance. The vertical safe load of pile is calculated by the standard static formula with the FS of not less than 2.5.

The load capacity of the pile is calculated by the following formula:

$$Q_u = Q_f + Q_e$$

$$Q_u = \Sigma (fs \times P\Delta L) + (q_e \times A_e)$$

$$Q_a = (Q_f + Q_e)/FS - W_p$$

When Q_u = Ultimate Load of Pile

Q_a = Allowable Load of Pile

Q_f = Fiction Force of Pile

Q_e = Ultimate End Bearing Capacity of Pile

W_p = Weight of the Pile

FS = Factor of Safety (FS = 2.5)

f_s = Ultimate Friction of Pile

A_e = Area of Pile Tip

L = Length of Pile in each Soil Layer

P = Perimeter of Pile Tip

The ultimate skin friction is calculated by the following formula:

For pile in sand

$$f_s = k_s (\sigma')_{av} \tan \delta$$

For pile in clay

$$f_s = \alpha \, . \, S_u$$

When

k_s = Coefficient of the Soil Pressure

$(\sigma')_{av}$ = Average of Effective Stress on Pile

δ = Angle of Friction between soil and Pile.

α = Adhesion Factor.

S_u = Undrained Shear Strength

Coefficient α depends on the condition and strength of the clay. In addition, it also depends on the pile driving method which may cause the soil around the pile surface to deform. The value of coefficient will be reduced when the soil strength increases.

The ultimate end bearing resistance can be calculated by the following formula:

For pile tip in sand

$$q_e = N_q . \sigma'_{vo}$$

For pile tip in clay

$$q_e = N_c . S_u$$

when N_q, N_c = Bearing Capacity Factors

σ'_{vo} = Effective Stress at the Pile Tip

Table 5.1.7-15 shows the summary of pile tip level at design load.

Table 5.1.7-15 Summary of Pile Tip Level at Design Load

Type of Pile		Driven Pile		Bored Pile	
		Square 0.35	Square 0.40	ϕ 1.00	ϕ 1.20
Factor of Safety, FS.		2.5	2.5	2.5	2.5
Required Service Load (tons)/Pile		50	50	450	650
Borehole	Km.	Pile Tip for Required Service Load (m)			
BH-1	15+792	6 (41.5)	6 (49.5)	7 (313.4)	7 (424.1)
BH-2	22+481	7 (48.1)	7	9 (326.3)	9 (439.5)
BH-3	32+226	6 (19.6)	6 (25.0)	8 (264.5)	8 (365.3)
BH-4	44+925	7	6	14 (385.7)	14 (510.6)
BH-5	59+751	7 (49.9)	6	10 (279.6)	10 (383.4)
BH-6	65+678	8	8	11 (330.8)	11 (444.8)
BH-7	79+873	9	8	16 (413.8)	16 (544.3)
BH-8	88+577	10 (34.9)	10 (41.9)	13 (334.6)	13 (449.3)
BH-9	101+709	11	9	22	22 (619.2)

Note: The numbers in brackets denote the safe load of each pile which are less than design load.

5.1.7.6.11 PAVEMENT DESIGN

The design of road in the project area and at the level crossings takes into consideration the ability to accommodate vehicles especially trucks with sufficient strength to use in the long run. The road is not a main road and does not have to accommodate high traffic volumes even at the crossings. The IDT is estimated from TM. The road was design as a 2-lane asphaltic road in 2 directions with the design procedure of the Asphalt Institute (1970). Based on the CBR test from the test pits along the alignment, the CBR at 85 percentile is equal to 3. **Table 5.1.7-16** shows the pavement structures according to traffic volumes. However, after 7 years operation, the road surface and traffic volumes should be investigated to adjust the overlay thickness to be suitable for each road.

Table 5.1.7-16 Pavement Structures according to Traffic Volumes

Pavement Structure	Thickness (m) for Each Simplified Traffic Class		
IDT	<300	300-1500	>1500
	Type 1	Type 2	Type 3
Asphalt Concrete	0.05	0.08	0.08
Crushed Rock (Base Course), CBR 80% Min	0.15	0.15	0.15
Lateritic Soil (Subbase), CBR 25% Min	0.15	0.20	0.35
Selected Material "B", CBR 6% Min	0.15	0.15	0.15
Fill Embankment, CBR 4% Min	Varies	Varies	Varies

5.1.7.7 Recommendation for Subsoil Investigation for Detailed Design Phase

- For embankment design, additional soil investigation from test pits of not more than 1 km intervals should be undertaken to have sufficient data for detailed design and as information for selecting the suitable fill material with the shortest transportation distance.
- For foundation design of bridge, underpass and stations, additional soil boring should be undertaken. Soil and rock investigation at the position of bridge foundation should be undertaken for the design of bored pile for bridge foundation. The numbers of boreholes for each bridge depend on the size, bridge length and pile types. If it is a bored pile, the depth of borehole should not be less than the length of bored pile. In addition, there must be test pits of not more than 1 km intervals along the alignment for the analysis of embankment stability. If the soil or terrain changes significantly, the test pit intervals should be not more than 0.5 km.
- For tunnel design, the numbers of boreholes for soil and rock investigation at various positions, the depth, the field and laboratory tests including geotechnical testing in the field along the tunnel by geophysics shall be determined by tunnel design engineers.

5.1.7.8 Tunnel Design

1) Design of Tunnel Support

There are many types of tunnel support such as steel arch, rock bolting and/or grouting, shotcrete or shotcrete with rock bolting, reinforced concrete and segment lining etc.

However, for the construction of tunnel in rock, the rock condition or rock strength is the most important. If the rock to be excavated is very strong and water is not permeable to tunnel, the tunnel support may not be required. However, if the rock is not strong enough, the tunnel support must be installed as appropriate.

In designing and selecting the tunnel support in weak rock, the rock condition has to be investigated and assessed. Generally, the assessment of rock condition and the tunnel support in weak rock is based on the Rock Mass Rating (RMR). The RMR method classifies the rock into 5 categories as shown in **Table 5.1.7-17**.

Table 5.1.7-17 Rock Mass Rating (RMR) and the Recommended Tunnel Support (Bieniawski, 1989)

Rock Mass Class	Excavation	Rock Bolts Installation	Shotcrete Spraying	Steel Sets Installation
I - Very good rock *RMR: 81-100*	Full face, 3 m advance. Complete support 20 m from face	No support required except spot bolting		
II - Good rock *RMR: 61-80*	Top heading and bench 1.5 - 3 m advance in top heading. Commence support after each blast. Complete support 20 m from face.	Bolts in crown 3 m long, spaced 2.5 m with occasional wire mesh	50 mm in crown where required	None
III - Fair rock *RMR: 41–60*	Top heading and bench 1.5 - 3 m advance in top heading. Commence support after each blast. Complete support 10 m from face.	Systematic bolts 4 m long, spaced 1.5 - 2 m in crown and walls with wire mesh in crown	50 - 100 mm in crown and 30 mm in sides	None
IV - Poor rock *RMR: 21 - 40*	Top heading and bench 1 - 1.5 m advance in top heading. Install support concurrently with excavation, 10 m from face.	Systematic bolts 4- 5 m long, spaced 1 - 1.5 m in crown and walls with wire mesh	100-150 mm in crown and 100 mm in sides	Light to medium rib spaced 1.5 m where required.
V - Very poor rock *RMR: <20*	Multiple drifts 0.5 - 1.5 m advance in top heading. Install support concurrently with excavation. Shotcrete as soon as possible after blasting	Systematic bolts 5-6 m long, spaced 1-1.5 m in crown and walls with wire mesh. Bolt invert.	150 - 200 mm in crown, 150 mm in sides, and 50 mm on face.	Medium to heavy rib spaced 0.75 m with steel lagging and fore poling if required. Close invert

Besides RMR method to design the tunnel support, nowadays the Finite Element Method is very well-known in designing the tunnel in rock by focusing on the deformation calculation that occurs after excavation. This method can also be used to find various forces on the tunnel supports such as shotcrete, rock bolt etc. The tunnel design processes are shown in **Figure 5.1.7-22**.

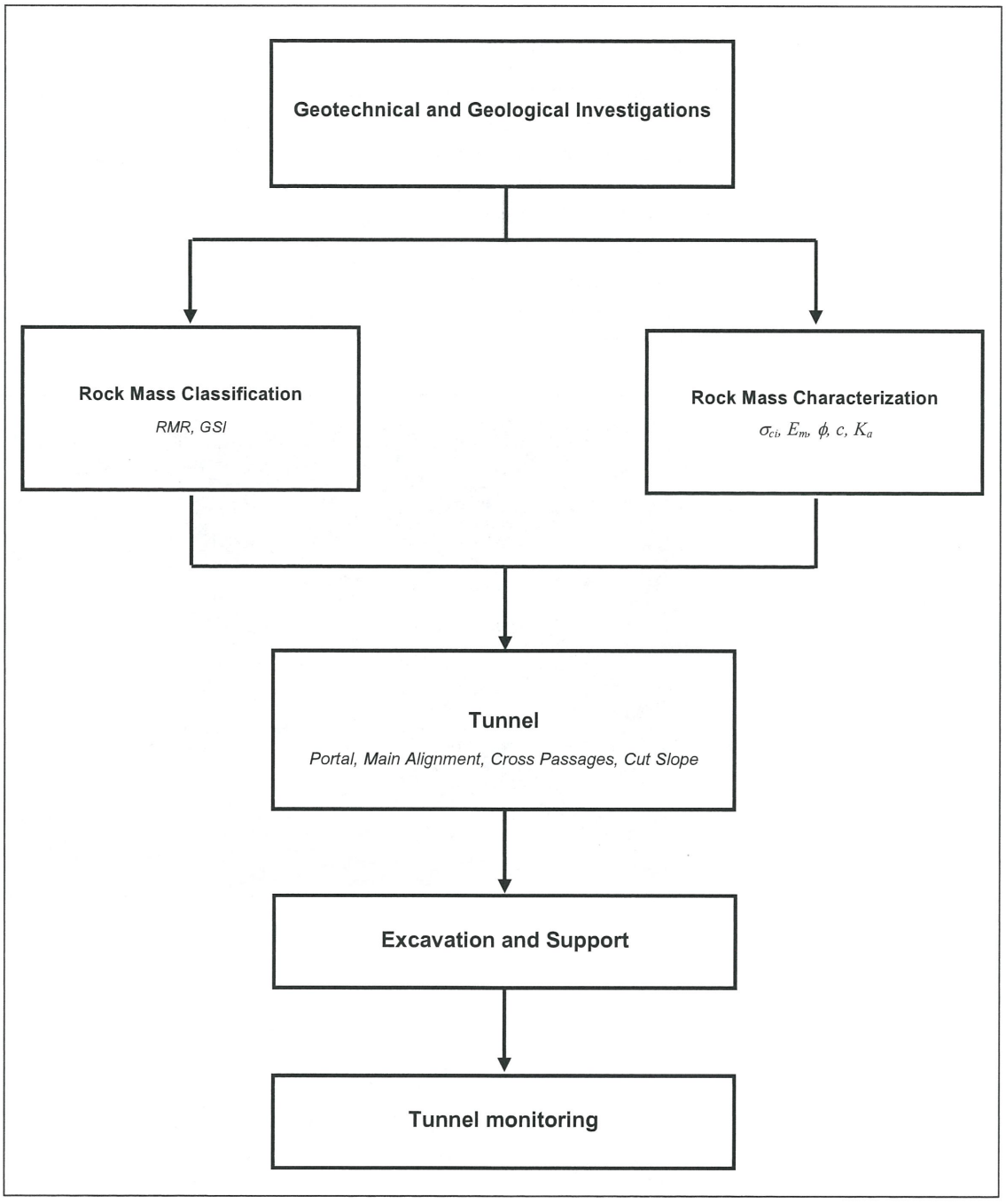


Figure 5.1.7-22 Tunnel Design Processes

2) Tunnel Components Design

(1) Ventilation System

Ventilation system in tunnel is intended to drain the dangerous mass such as carbon monoxide (CO), nitrogen oxide (NOx), smoke (diesel soot) etc. The ventilation system in tunnel has 3 systems, i.e. longitudinal ventilation, transverse ventilation and semi-transverse ventilation. **Figures 5.1.7-23** to **5.1.7-25** show the cross-section of size and position of ventilation fan. To choose which system depends on the length of the tunnel. In long tunnel, the ventilation shaft and electrostatic precipitator should be used to reduce the size of the vent for efficient ventilation and cost effective in construction and maintenance.

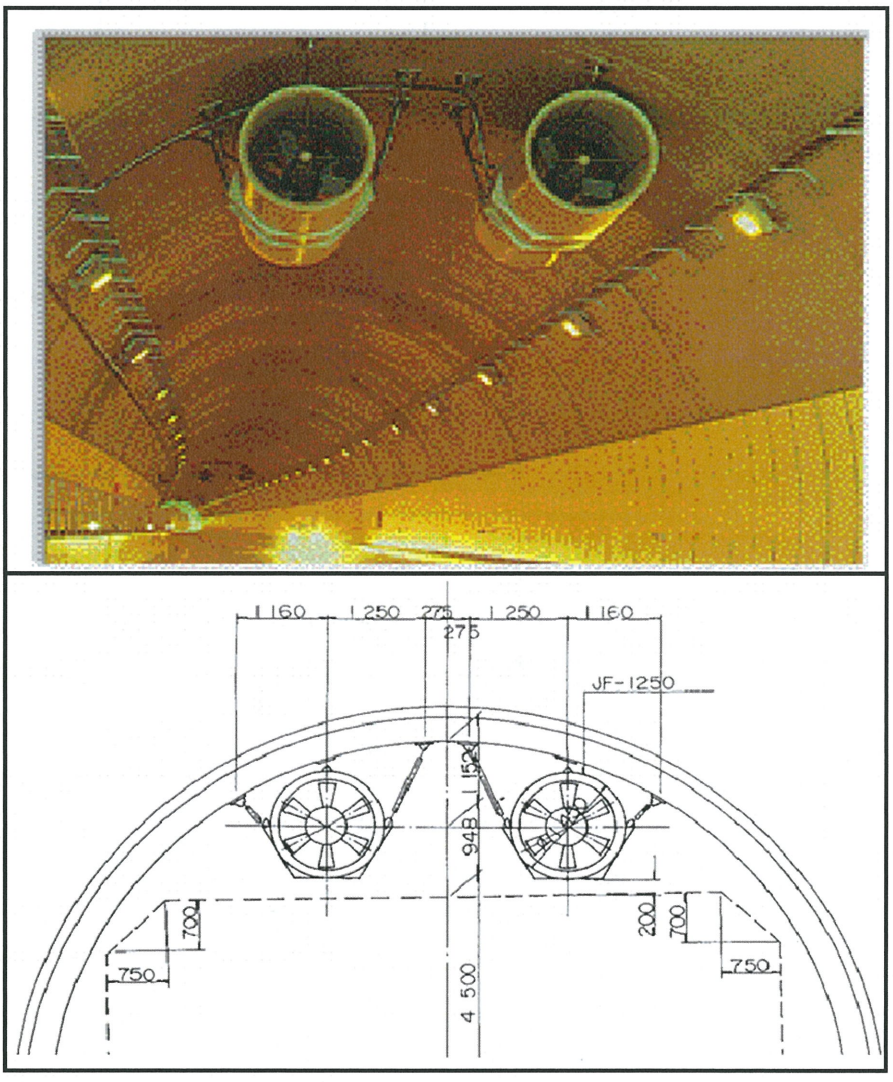


Figure 5.1.7-23 Cross-section of Size and Position of Longitudinal Ventilation Fan

(2) Emergency and Fire Protection System

Emergency equipments are designed and installed to prevent and minimize damages caused by fire or accident in the tunnel. According to Japanese tunnel design standards (1981), the tunnel is divided into 5 categories from D to AA according to the tunnel length as shown in **Figure 5.1.7-26** and **Table 5.1.7-18** shows the Japanese standard for the installation of emergency equipment according to the tunnel categories.

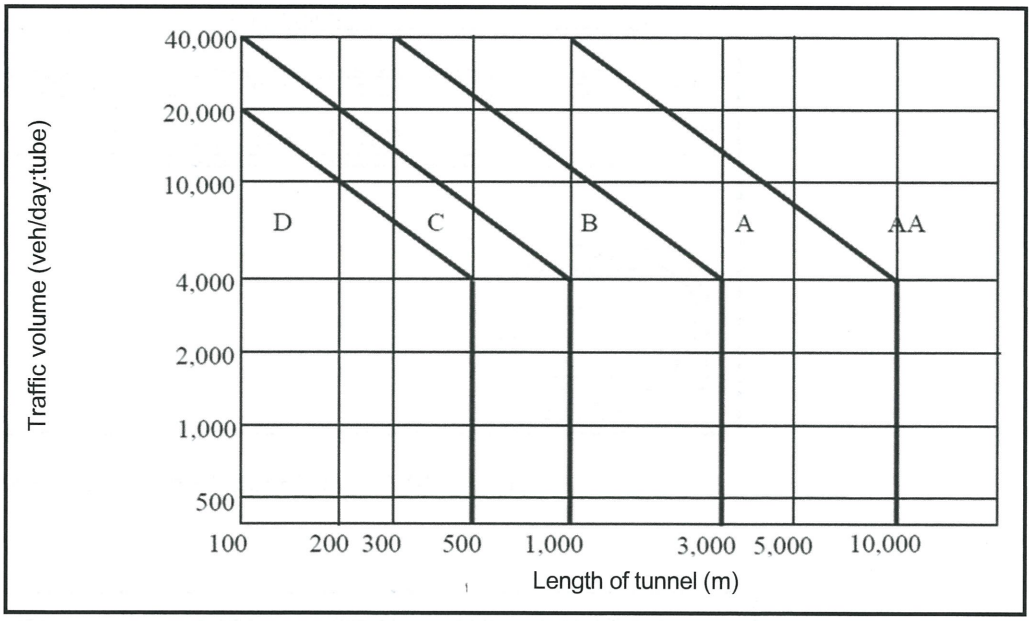


Figure 5.1.7-26 Tunnel Categories according to Tunnel Length

Table 5.1.7-18 Japanese Standard for Emergency Equipment Design

Equipment		Tunnel Categories / Minor Equipment	AA	A	B	C	D	Note
System	Item							
Information systems and alarm systems	Emergency telephone		O	O	O	O		
	Pressure warning device		O	O	O	O		
	Fire detector		O	Δ				
	Alarm equipment	Information board at the portal	O	O	O	O		
		Information board in the tunnel	O	O	O	O		
Firefighting equipment	Fire extinguisher		O	O	O			
	Sprinkler pipe		O	O				Install in Category B Tunnel if the tunnel is more than 1,000 m. long.
Evacuation equipment	Guide post	Guide post	O	O	O			
	De-smoking		O	Δ				Install de-smoking if the tunnel is more than 1,500 m. long
	Emergency tunnel		O	Δ				Install in Category AA Tunnel or the tunnel is more than 3,000 m. long and in case of Category A Tunnel, the distance between the ventilation equipment is more than 2,000 m. For other tunnels, consider traffic volumes, tunnel length and ventilation system.
Other systems	Fire plug hydrant		O	Δ				
	Wireless communication	Wireless communication system	O	Δ				Install in Category A Tunnel if the tunnel is more than 3,000 m. long.
	Radio broadcasting system		O	Δ				Install in Category A Tunnel if the tunnel is more than 3,000 m. long.
	Broadcasting system		O	Δ				Install in Category A Tunnel if the tunnel is more than 3,000 m. long.
	Sprinkler system		O					Install in Category A Tunnel if it is a 2-direction tunnel and more than 3,000 m. long.
	CCTV	CCTV	O	Δ				Install in Category A Tunnel if the tunnel is more than 3,000 m. long and if the control room is far apart from the tunnel.

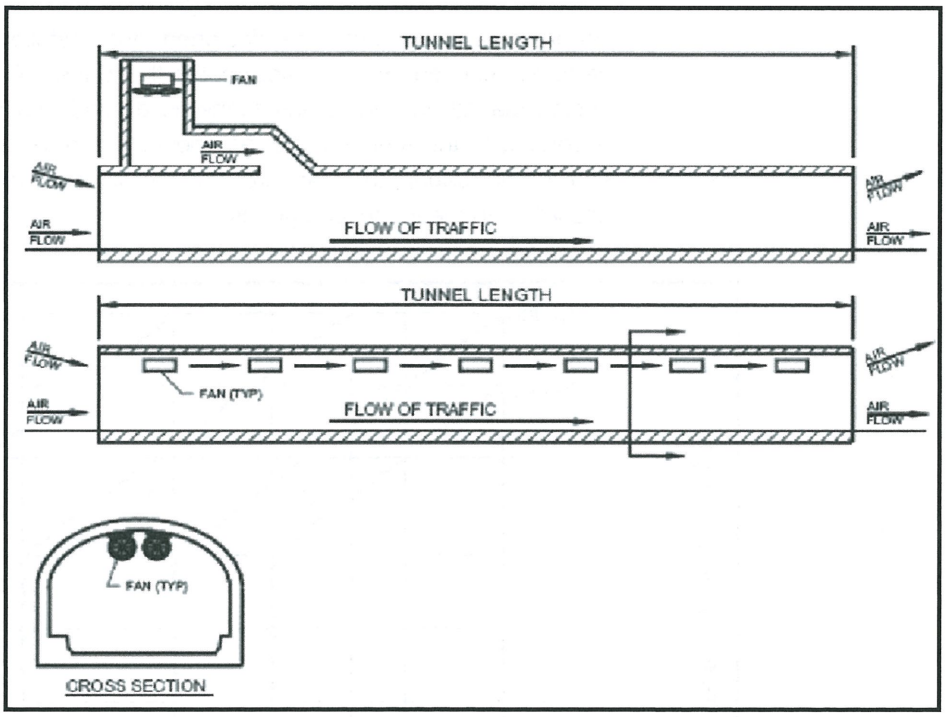


Figure 5.1.7-24 Longitudinal Ventilation System

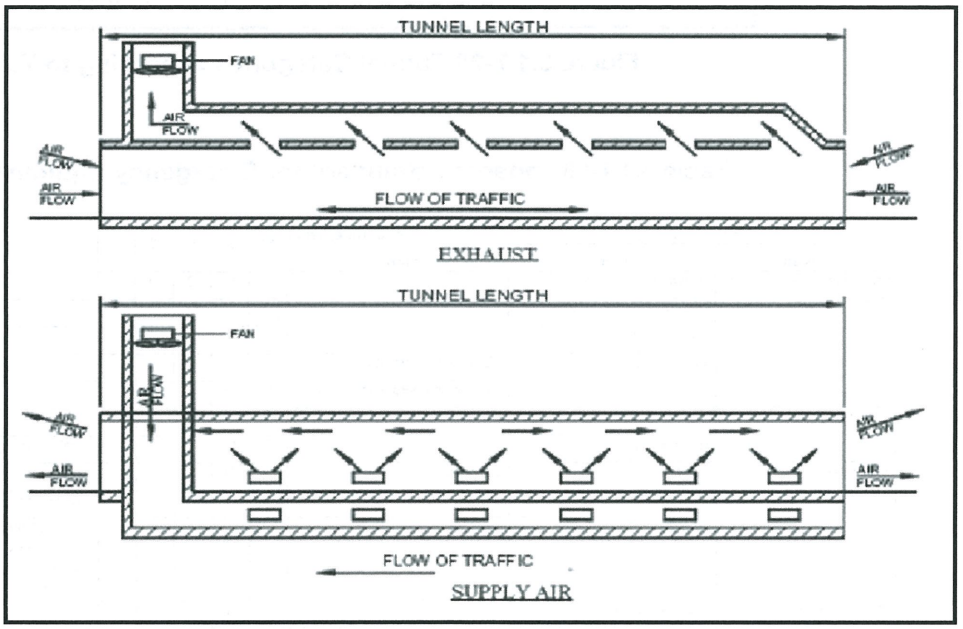


Figure 5.1.7-25 Transverse Ventilation System

(3) Drainage System

The drainage system must be able to drain water from the tunnel to keep the rails dry. The water sources in the tunnel occur from the groundwater infiltration, tunnel cleaning and fire fighting. The design criteria for the drainage system must be able to accommodate the maximum flow rate expected and prevent water from outside to flow into the tunnel as shown in **Figure 5.1.7-27**.

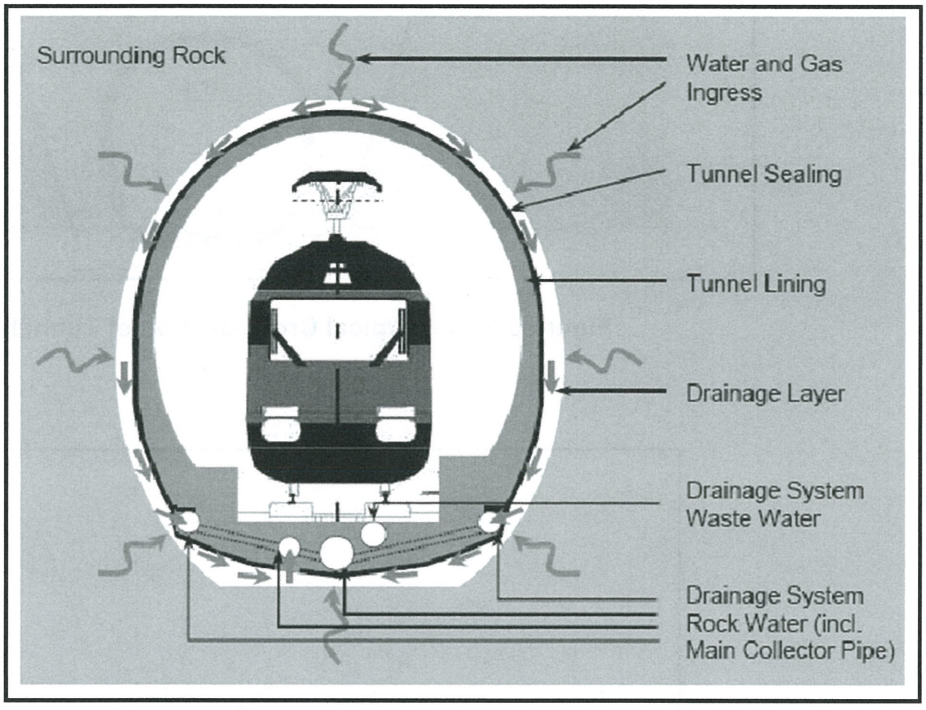


Figure 5.1.7-27 Drainage System in Tunnel

Tunnel design includes portal tunnel, tunnel portal support, cross passages used for evacuation of passengers in case of an emergency as shown in **Figures 5.1.7-28** to **5.1.7-31**. The detailed locations and sizes of tunnels of the project are shown in **Table 5.1.7-19**.

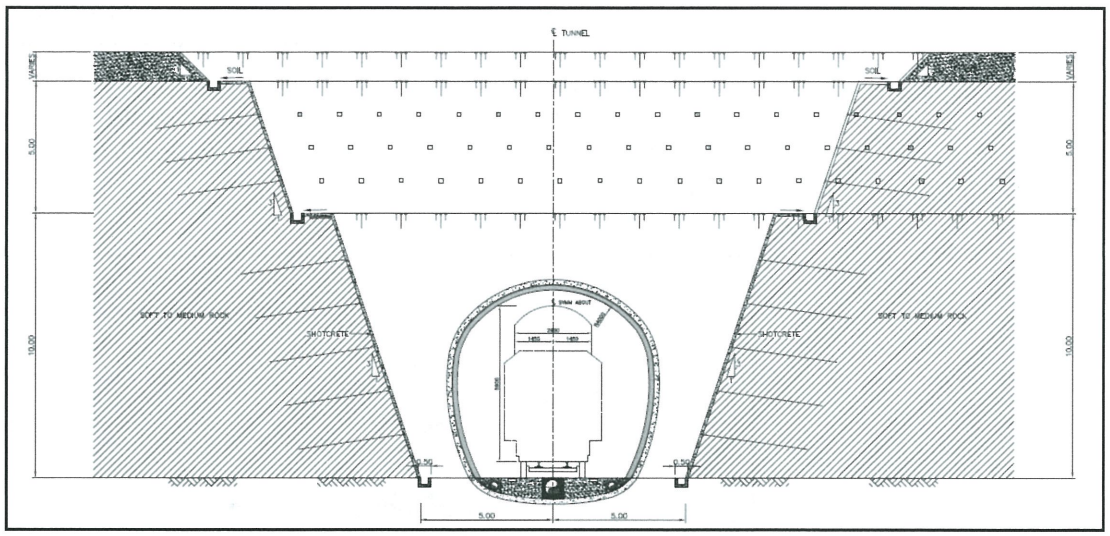


Figure 5.1.7-28 Typical Cross-section of Tunnel Portal

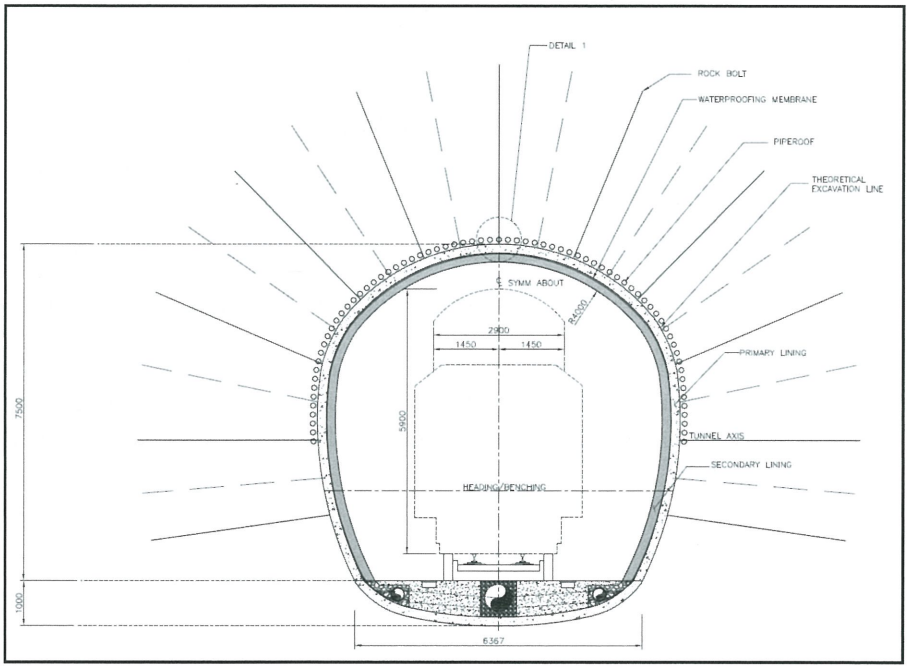


Figure 5.1.7-29 Typical Cross-section of Tunnel Portal Support

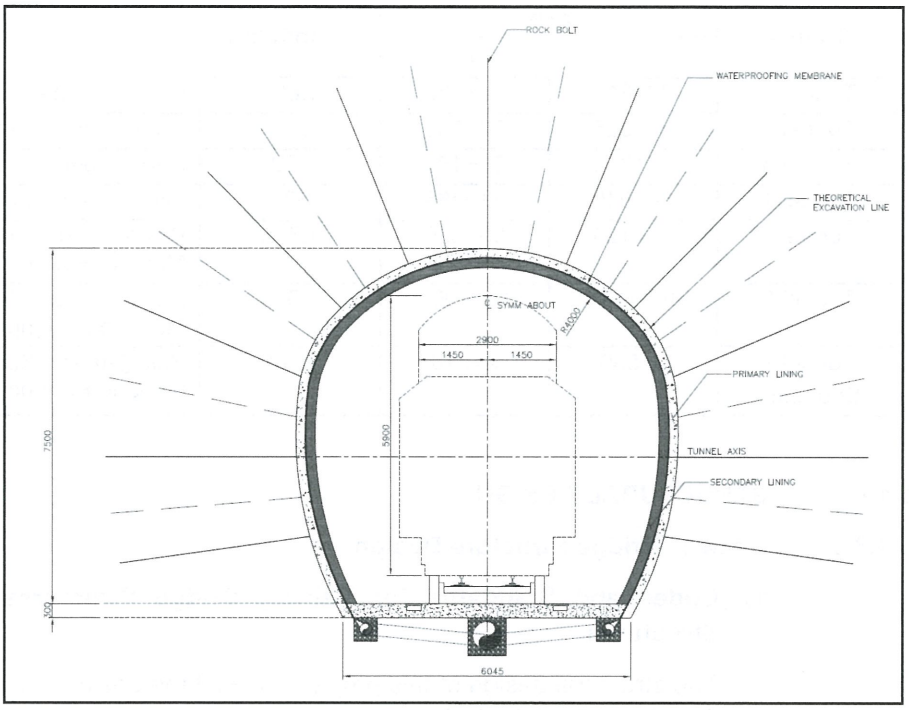


Figure 5.1.7-30 Typical Cross-section of Main Tunnel Support

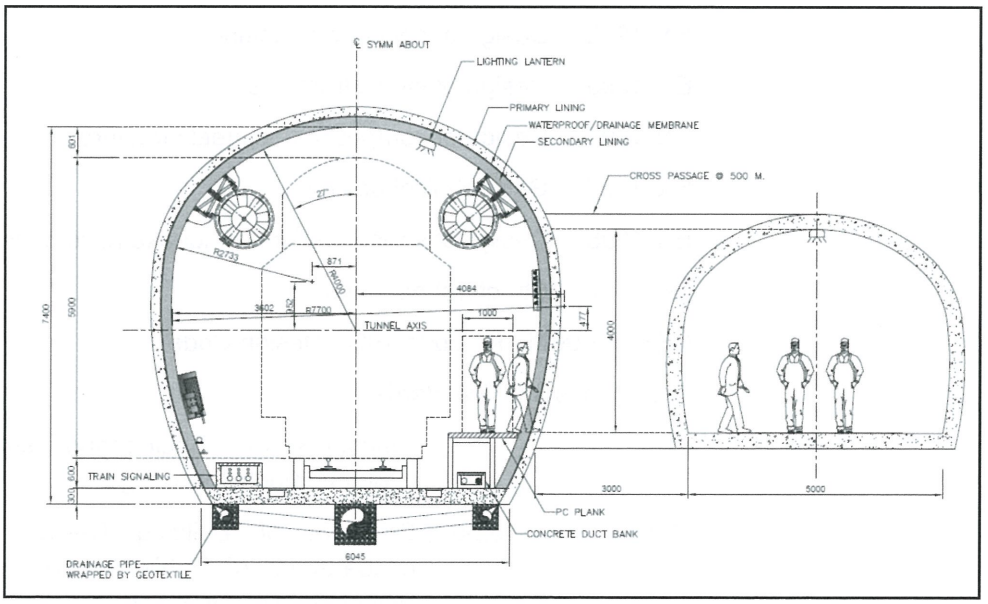


Figure 5.1.7-31 Typical Cross-section of Tunnel Cross Passage

Table 5.1.7-19 Locations and Sizes of Project Tunnels

Tunnel	STA.		Length (m)	Location
	From	To		
Tunnel 1	30+815	32+480	1,665	Choporo Sub-district, Kra Buri District
Tunnel 2	55+925	56+660	735	Nam Chuet Sub-district, Kra Buri District
Tunnel 3	58+815	59+185	370	Nam Chuet Sub-district, Kra Buri District
Tunnel 4	60+945	61+465	520	Lam Liang Sub-district, Kra Buri District
Tunnel 5	94+120	95+635	1,515	Pak Nam Sub-district, Mueang Ranong District
Tunnel 6	100+185	102+000	1,815	Pak Nam Sub-district, Mueang Ranong District
Tunnel 7 (Spur Line)	0+530	2+310	1,780	Pak Nam and Bang Non Sub-districts, Mueang Ranong District

5.1.8 STRUCTURAL DESIGN

5.1.8.1 Railway Bridge Structure Design

1) Codes and Standards for Railway Bridge Structures and Elevated Track Structures

The structural design of this project followed the design standards of Eurocode (EN-Code) and Thai-Code for design as follows:

- Codes and Standards for Railway Bridge Structures Design

  EN-Codes and Standards

  EN 1990 Basis of structural design

  EN 1991 Actions on structures

  EN 1992 Design of concrete structures

  EN 1993 Design of steel structures

  EN 1994 Design of composite and steel structures

  EN 1997 Geotechnical design

  EN 1998 Design of structures for earthquake resistance

  EN 1337 Structural bearings

  CEB-FIP 90 Model Code 1990, Design Code

  Thai-Codes and Standards

  EIT Standards of the Engineering Institute of Thailand under H.M. the King's Patronage

  Mor Yor Por. 1302-52 Standard of Building Design for Seismic Loads (Department of Public Works and Town & Country Planning, Ministry of Interior)

  Mor Yor Por. 1311-50 Standard of Wind Load Calculation and Feed Back of Building (Department of Public Works and Town & Country Planning, Ministry of Interior)

2) Types of Loads for Railway Bridge Structures Design

Various design loads to be considered in the design of railway bridges are:

(1) Dead loads are self-weight, super-imposed dead load and others.

(2) Live loads are train load (U20) according to the SRT's standard, lurching, impact factor, nosing or hunting force, centrifugal Forces, longitudinal force, earth pressure, water pressure, wind load, seismic load, and others.

3) Construction Materials for Railway Bridge Structures

The construction materials, e.g. concrete, reinforcement, prestressed concrete wire and other essential materials shall be of the domestic products which meet the important standards such as Thai Industrial Standards (TIS), ASTM-Standard, DIN-Standard, JIS-Standard or equivalent and others.

4) Railway Bridge Structures and Elevated Track Structures Design

The railway bridge structures design of the project consists of railway bridges (short span and long span) and elevated track. The railway bridges are classified according to the length and height of the bridges as follows:

(1) Short Span Railway Bridge (SS)

The short span railway bridge is from 6 m. to 15 m. long to cross the brook or small canal. There are 2 types as follows:

- Reinforced Concrete Slab (RC Slab, RS) is for the span length from 6 m. to 10 m., both single span and multi span as shown in **Figures 5.1.8-1** and **5.1.8-2** respectively.

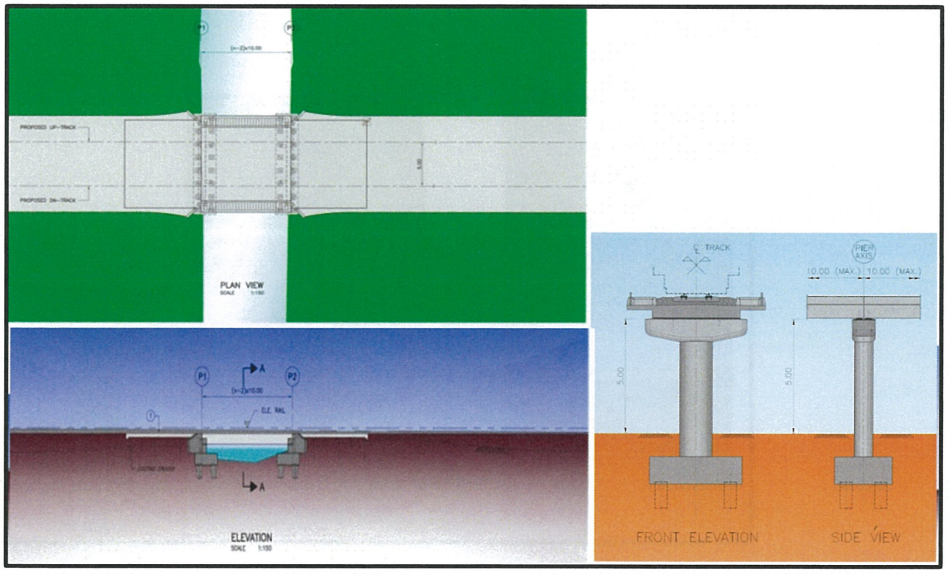


Figure 5.1.8-1 Short Span Railway Bridge, Type RS - Single Span

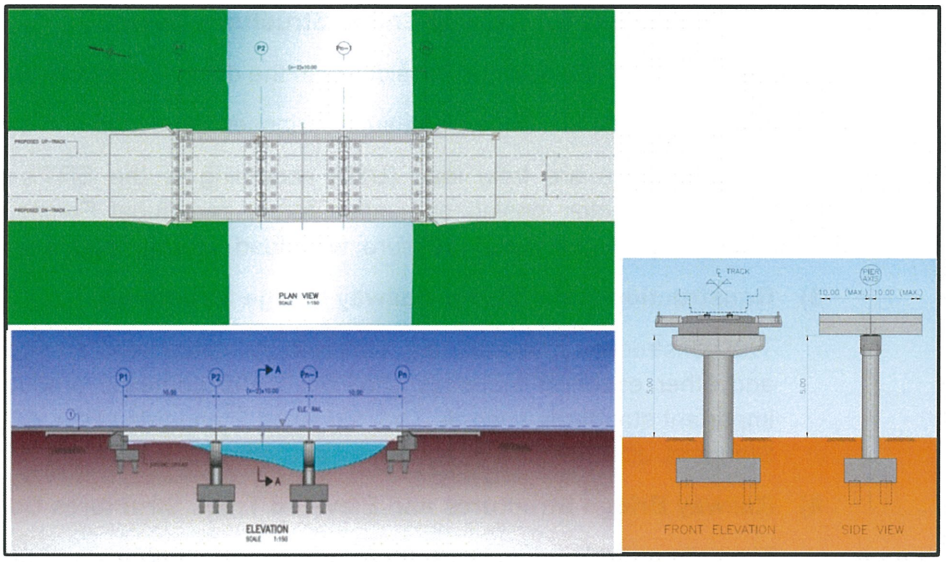


Figure 5.1.8-2 Short Span Railway Bridge, Type RS – Multi Span

- Multi box girder (BG) is for the span length more than 15 m., both single span and multi span as shown in **Figures 5.1.8-3** and **5.1.8-4** respectively.

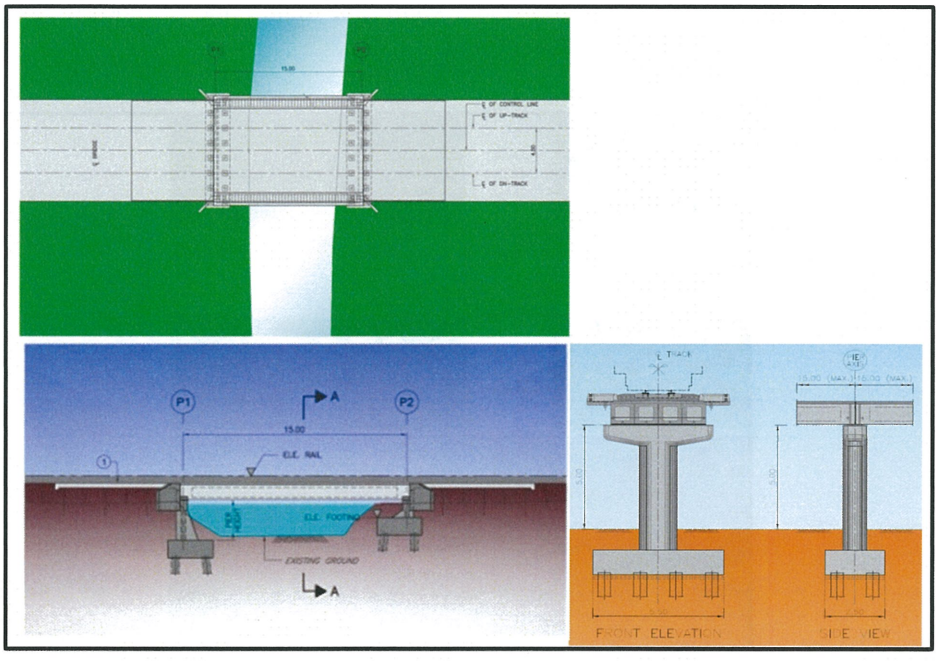


Figure 5.1.8-3 Short Span Railway Bridge, Type BG – Single Span

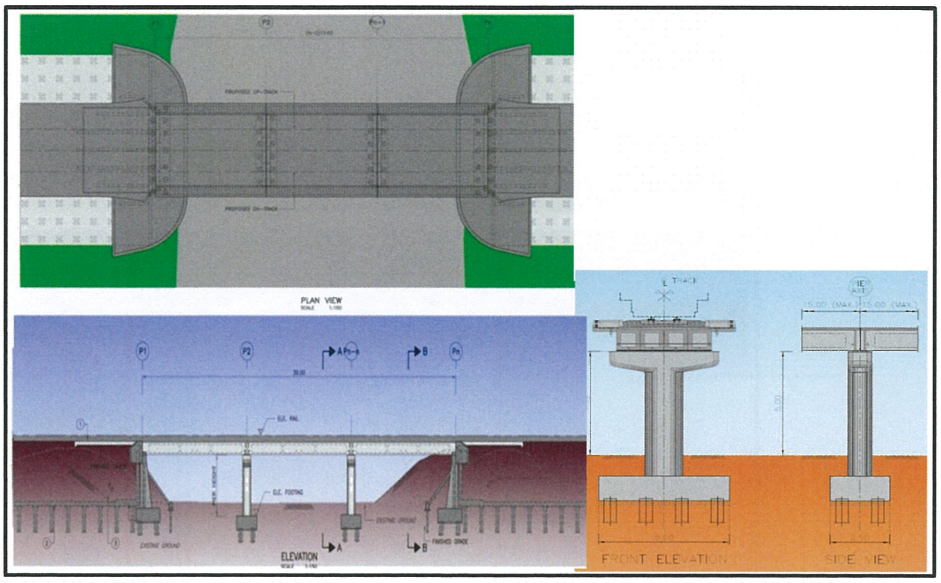


Figure 5.1.8.4 Short Span Railway Bridge, Type BG - Multi Span

(2) Medium Span Railway Bridge (MS)

The medium span railway bridge is prestressed concrete I-girder (IG) type, both single span and multi span, 20 m. to 25 m. long, to cross the road or quite large canal that has boat transportation as shown in **Figures 5.1.8-5** and **5.1.8-6** respectively.

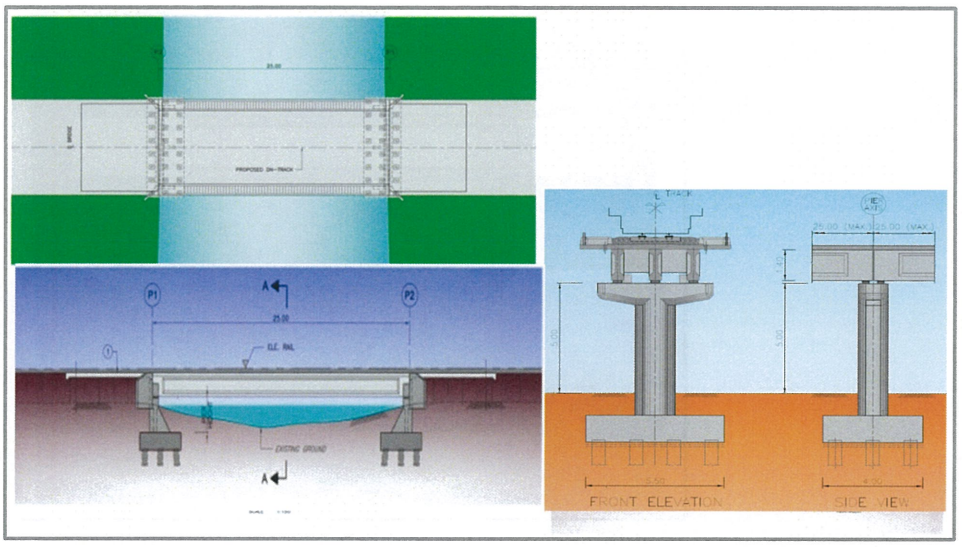


Figure 5.1.8-5 Medium Span Railway Bridge, Type IG – Single Span

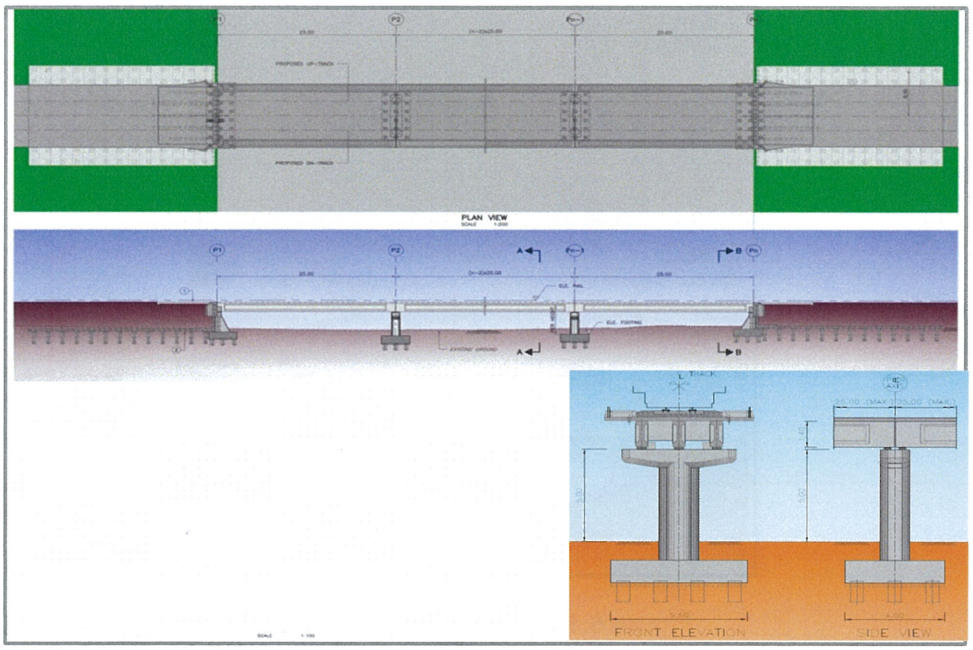


Figure 5.1.8-6 Medium Span Railway Bridge, Type IG - Multi Span

(3) Long Span Railway Bridge (LS)

The long span railway bridge is prestressed concrete U-girder (UG) type, both single and multi span, 25 m. to more than 35 m. long, to cross the road or river as shown in **Figures 5.1.8-7** and **5.1.8-8** respectively.

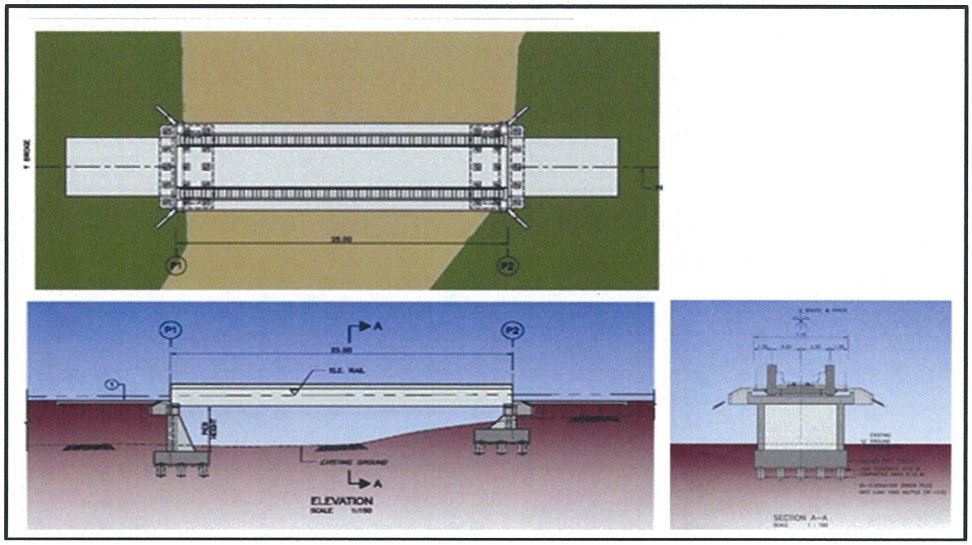


Figure 5.1.8-7 Long Span Railway Bridge, Type U-Girder – Single Span

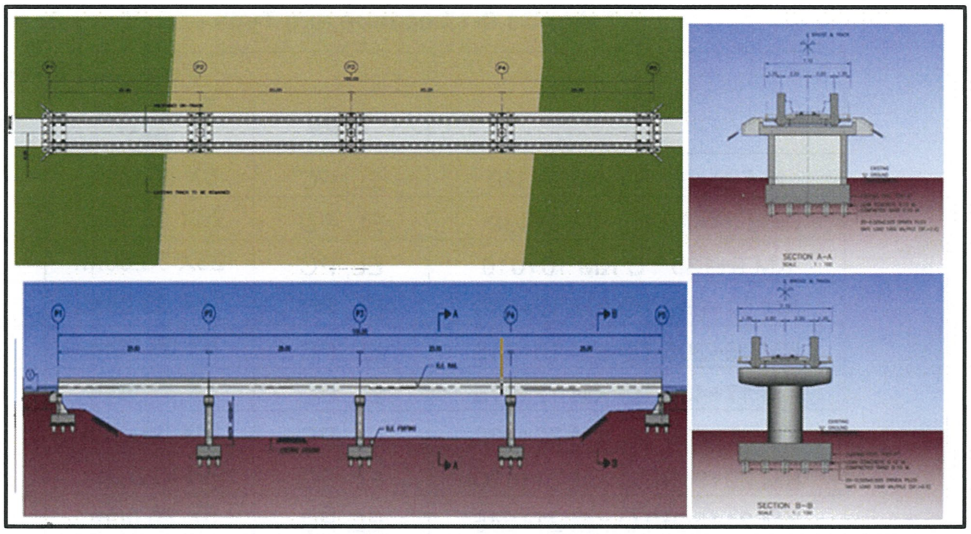


Figure 5.1.8-8 Long Span Railway Bridge, Type U-Girder - Multi Span

(4) Elevated Railway Bridge (EL)

The elevated railway bridge is segmental box girder (SG) type to cross the obstacles e.g. river, highway and others and to connect with other routes. This project shall have the elevated railway bridge with the span length of 35 m. long as shown in **Figure 5.1.8-9**

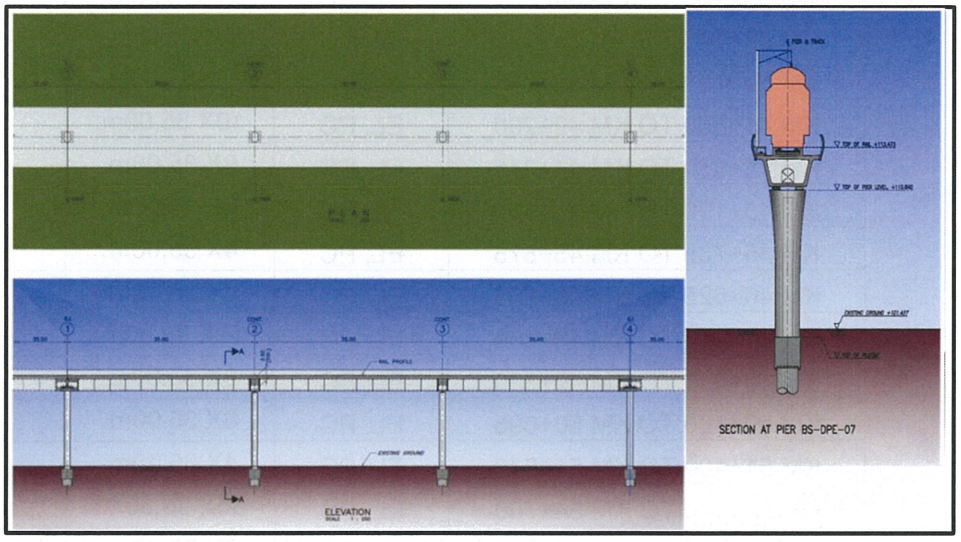


Figure 5.1.8-9 Elevated Railway Bridge, Type SG - Multi Span

5) Location and Type of Railway Bridges

Table 5.1.8-1 shows the location and type of railway bridges of the project.

Table 5.1.8-1 Location and Type of Railway Bridges

Station	Proposed Bridges		
	Type	Total Span (m)	Superstructure Type
KM 2+130 TO KM 2+340	EL, PC	6X 35.00m.	SG
KM 6+490 TO KM 7+190	EL, PC	20X 35.00m.	SG
KM 9+135 TO KM 10+010	EL, PC	25X 35.00m.	SG
KM 11+650 TO KM 12+280	EL, PC	18X 35.00m.	SG
KM 15+205 TO KM 15+415	EL, PC	6X 35.00m.	SG
KM 17+430 TO KM 17+675	EL, PC	7X 35.00m.	SG
KM 19+430 TO KM 20+060	EL, PC	18X 35.00m.	SG
KM 20+910 TO KM 21+190	EL, PC	8X 35.00m.	SG
KM 21+540 TO KM 21+645	EL, PC	3X 35.00m.	SG
KM 24+830 TO KM 25+390	EL, PC	16X 35.00m.	SG
KM 25+685 TO KM 25+860	EL, PC	5X 35.00m.	SG
KM 27+145 TO KM 27+250	EL, PC	3X 35.00m.	SG
KM 27+650 TO KM 28+105	EL, PC	13X 35.00m.	SG
KM 28+770 TO KM 28+910	EL, PC	4X 35.00m.	SG
KM 32+595 TO KM 33+750	EL, PC	33X 35.00m.	SG
KM 34+020 TO KM 34+545	EL, PC	15X 35.00m.	SG
KM 35+210 TO KM 35+455	EL, PC	7X 35.00m.	SG
KM 35+765 TO KM 36+955	EL, PC	34X 35.00m.	SG
KM 38+145 TO KM 38+320	EL, PC	5X 35.00m.	SG
KM 39+722 TO KM 39+897	EL, PC	5X 35.00m.	SG
KM 41+850 TO KM 42+200	EL, PC	10X 35.00m.	SG
KM 44+030 TO KM 44+345	EL, PC	9X 35.00m.	SG
KM 45+190 TO KM 45+505	EL, PC	9X 35.00m.	SG
KM 45+735 TO KM 45+875	EL, PC	4X 35.00m.	SG
KM 46+625 TO KM 46+905	EL, PC	8X 35.00m.	SG
KM 47+765 TO KM 48+430	EL, PC	19X 35.00m.	SG
KM 49+050 TO KM 49+330	EL, PC	8X 35.00m.	SG
KM 50+485 TO KM 50+695	EL, PC	6X 35.00m.	SG
KM 51+400 TO KM 51+540	EL, PC	4X 35.00m.	SG
KM 53+440 TO KM 54+700	EL, PC	36X 35.00m.	SG
KM 55+540 TO KM 55+785	EL, PC	7X 35.00m.	SG
KM 56+730 TO KM 56+940	EL, PC	6X 35.00m.	SG
KM 58+520 TO KM 58+765	EL, PC	7X 35.00m.	SG
KM 60+185 TO KM 60+675	EL, PC	14X 35.00m.	SG
KM 61+855 TO KM 65+600	EL, PC	107X 35.00m.	SG
KM 66+145 TO KM 66+705	EL, PC	16X 35.00m.	SG
KM 67+125 TO KM 67+755	EL, PC	18X 35.00m.	SG
KM 67+995 TO KM 69+255	EL, PC	36X 35.00m.	SG
KM 71+155 TO KM 72+940	EL, PC	51X 35.00m.	SG

Table 5.1.8-1 Location and Type of Railway Bridges (Cont'd)

Station	Proposed Bridges		
	Type	Total Span (m)	Superstructure Type
KM 74+590 TO KM 75+430	EL, PC	24X 35.00m.	SG
KM 75+715 TO KM 75+925	EL, PC	6X 35.00m.	SG
KM 77+645 TO KM 78+590	EL, PC	27X 35.00m.	SG
KM 79+935 TO KM 83+400	EL, PC	99X 35.00m.	SG
KM 85+985 TO KM 86+265	EL, PC	8X 35.00m.	SG
KM 87+910 TO KM 89+380	EL, PC	42X 35.00m.	SG
KM 89+700 TO KM 90+330	EL, PC	18X 35.00m.	SG
KM 92+300 TO KM 93+455	EL, PC	33X 35.00m.	SG
KM 95+770 TO KM 96+435	EL, PC	19X 35.00m.	SG
KM 97+405 TO KM 97+790	EL, PC	11X 35.00m.	SG
KM 98+380 TO KM 98+695	EL, PC	9X 35.00m.	SG
KM 2+500 TO KM 3+270 at Spur Line	EL, PC	22X 35.00m.	SG
KM 3+745 TO KM 4+280 at Spur Line	EL, PC	16X 35.00m.	SG

Note: EL, PC denotes prestressed concrete elevated railway bridge.
SG denotes segmental box girder type

5.1.8.2 Overpass, U-Turn Bridge and Underpass Design

1) Codes and Standards for Overpass, U-Turn Bridge and Underpass

The codes and standards for overpass, U-turn bridge and underpass design are as follows:

- Codes and Standards for Overpass, U-Turn bridge and Underpass Design

  American Codes and standards

  AASHTO 2010 LRFD Bridge Design Specifications, 5th ed., American Association of State Highway and Transportation Officials

  AASHTO 2003 Guide Specifications for Design and Construction of Segmental Concrete Bridges, 2nd Edition, with 2003 Interim Revisions

  ASBI 2005 Construction Practices Handbook for Segmental Concrete Bridges

  ACI SP-66 ACI Detailing Manual 2004

  PCI 2004 PCI Design Handbook: Precast and Prestressed Concrete, 6th Edition

  Thai Codes and standards

  EIT Standards of the Engineering Institute of Thailand under H.M. the King's Patronage

  Mor Yor Por. 1302-52 Standard of Building Design for Seismic Loads (Department of Public Works and Town & Country Planning, Ministry of Interior)

  Mor Yor Por. 1311-50 Standard of Wind Load Calculation and Feed Back of Building (Department of Public Works and Town & Country Planning, Ministry of Interior)

Announcement of the Director of Motorway, the Director of National Highway and the Director of Thailand's Concession Highway on the prohibition of heavy vehicle weights, heavy vehicle loads or heavy axle loads exceeding the prescribed use the motorway, national highway and concession highway.

Others

CEB-FIP 90 Model Code 1990, Design Code

2) Types of Loads for Overpass, U-Turn Bridge and Underpass Design

Various design loads to be considered in the design of overpass, U-turn bridge and underpass are:

(1) Dead loads are self-weight, super-imposed dead load and others.

(2) Live loads are truck load (HS20-44), tandem load, lane load, truck load plus tandem load plus lane load (HL-93), multiple presence of live load factor, dynamic load allowance, breaking force, centrifugal force, pedestrian load, surcharge load, horizontal and vertical earth pressure, water pressure, wind load, seismic load, prestressed force and others.

3) Construction Materials for Overpass, U-Turn Bridge and Underpass

The construction materials, e.g. concrete, reinforcement, prestressed concrete wire and other essential materials shall be of the domestic products which meet the important standards such as Thai Industrial Standards (TIS), ASTM-Standard and JIS-Standard etc.

4) Overpass, U-Turn Bridge and Underpass Design

The solutions for level crossing problems are to construct an overpass or U-turn bridge or underpass as deemed appropriate for the traffic volumes and condition of that area.

- Overpass (OP) & U-Turn Bridge (UT) Structures

  The Consultant has proposed I-girder bridge with single pier on foundation piles (IG) for the construction of an overpass and U-turn bridge as shown in **Figures 5.1.8-10** and **5.1.8-11** respectively as it is commonly used in Thailand, easily constructed and cheap.

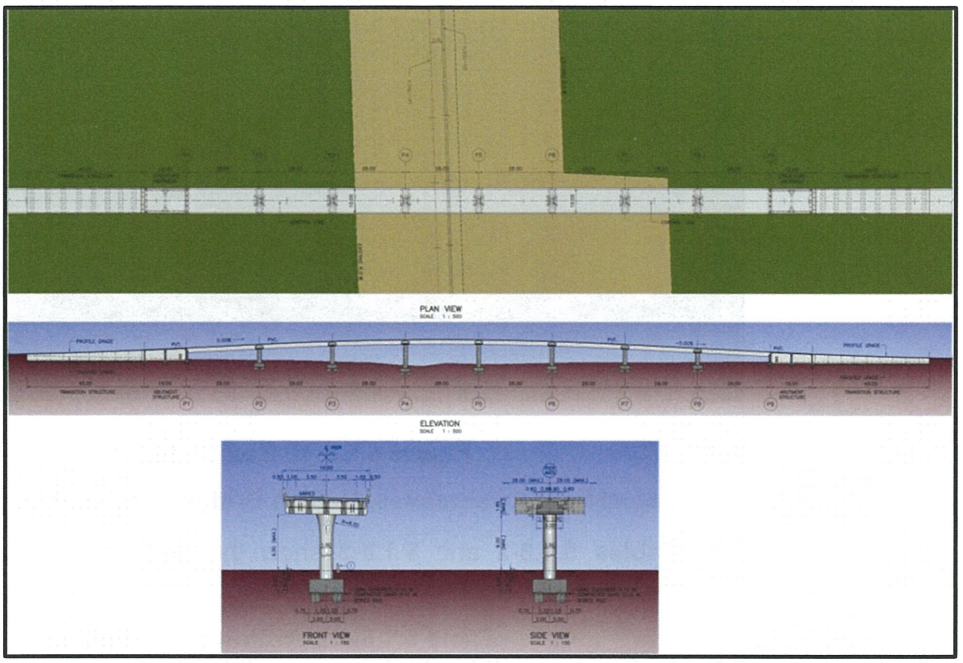


Figure 5.1.8-10 Plan and Profile of Overpass

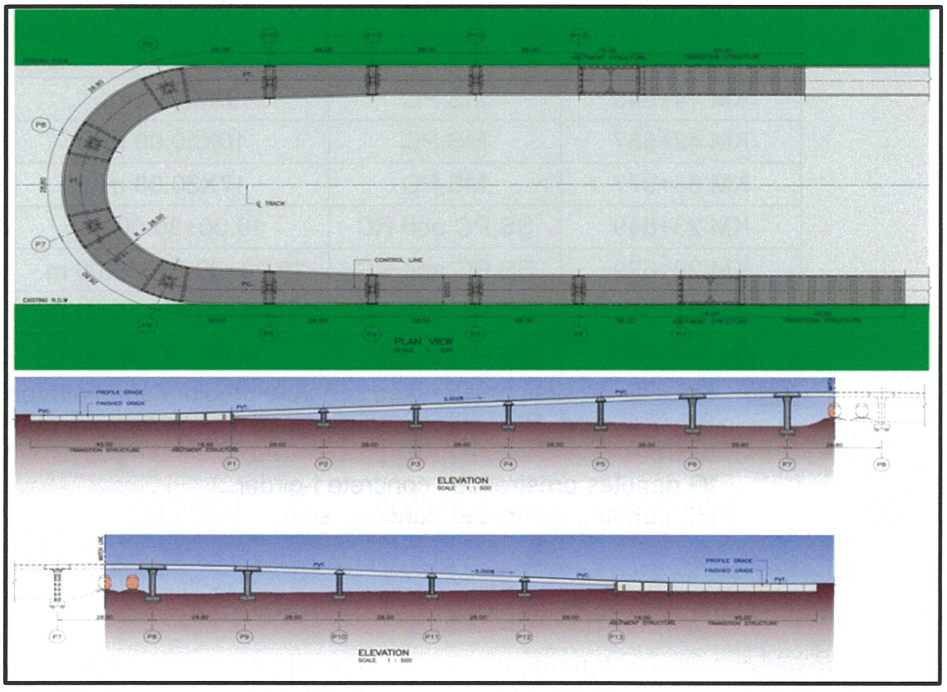


Figure 5.1.8-11 Plan and Profile of U-Turn Bridge

- Underpass Structure (UP, CIP-RC)

  The Consultant has proposed the box culvert to be placed under the railway for the construction of an underpass as shown in **Figure 5.1.8-12** to connect the route that has less traffic volumes and height constraint.



Figure 5.1.8-12 Box Underpass

5) Location of Overpasses, U-Turn Bridges and Underpasses

Tables 5.1.8-2 and **5.1.8-3** show the location of overpass, U-turn bridges and underpasses respectively.

Table 5.1.8-2 Location of Overpass

Station	Proposed Bridge		
	Type	Span (m)	Superstructure Type
KM 1+159	MS,PC	12X36.00 m.	IG
KM 4+032	MS,PC	15X30.00 m.	IG
KM 14+945	MS,PC	9X30.00 m.	IG
KM 42+587	MS,PC	10X30.00 m.	IG
KM 53+377	MS,PC	17X30.00 m.	IG
KM 23+849	SS,PC and RC	10.00+30.00 m.	RS + IG
KM 29+620	SS,PC and RC	10.00+30.00+10.00 m.	RS + IG
KM 87+354	SS,PC and RC	10.00+30.00+10.00 m.	RS + IG
KM 102+107	SS,PC and RC	10.00+30.00 m.	RS + IG

Note: MS, PC denotes prestressed concrete medium span overpass.
SS, PC and RC denote prestressed concrete and reinforced concrete short span overpass.
IG denotes prestressed concrete I-girder.
RS denotes reinforced concrete slab.

Table 5.1.8-3 Location of Box Underpass

Station	Type	Dimension
KM 7+635	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 8+305	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 16+190	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 29+970	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 38+835	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 51+660	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 76+685	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 85+463	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 96+629	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.
KM 4+452 at spur line	UP, CIP-RC	3.00x3.00m, 2Cells, L= 50.00m.

Note: UP, CIP-RC denotes box culvert underpass

5.1.8.3 STATION AND OTHER BUILDINGS DESIGN

1) Codes and Standards for Station and Other Buildings Design

Besides the American codes and standards, the Consultant has used other standards and Thai standards to design stations and other buildings as follows:

- Codes and Standards for Station and Other Buildings

  American Codes and Standards

  Codes and Standards for Reinforced Concrete and Prestressed Concrete

  ACI318M-08 Building Code Requirements for Structural Concrete and Commentary (Appendix C. adopted)

  CEB-FIP 90 Model Code 1990, Design Code

  ACI SP-66 ACI Detailing Manual 2004

  PCI 2004 PCI Design Handbook: Precast and Prestressed Concrete, 6th Edition

  Codes and Standards for Steel Structures

  AISC 316-89 Manual of Steel Construction: Allowable Stress Design, 9th Edition

  AISC 1985 Allowable Stressed Design Specification for Structural Joints Using ASTM A325 or A490 Bolts

  AWS D1.1-08 Structural Welding Code – Steel

  Thai Codes and Standards

  EIT Standards of the Engineering Institute of Thailand under H.M. the King's Patronage

  Mor Yor Por. 1301-50 Standard of Building Design for Seismic Loads (Department of Public Works and Town & Country Planning, Ministry of Interior)

  Mor Yor Por. 1301-52 Standard of Building Design for Seismic Loads (Department of Public Works and Town & Country Planning, Ministry of Interior)

Mor Yor Por. 1311-50 Standard of Wind Load Calculation and Feed Back of Building (Department of Public Works and Town & Country Planning, Ministry of Interior)

2) Design of Service Life and Durability

The station structures and building structures of this project has been designed for a 50-year service life or according to ACI and AISC standards for the followings:

Loads

(1) Dead loads are self-weight, super-imposed dead load and others.

(2) Live loads are earth pressure, water pressure, wind load, seismic load, prestressed force and others.

Structural Design

(1) ACI-Code for reinforced concrete and prestressed concrete.

(2) AISC-Code for steel structure.

3) Construction Materials for Stations and Other Buildings

The construction materials, e.g. concrete, reinforcement, prestressed concrete wire and other essential materials shall be of the domestic products which meet the important standards such as Thai Industrial Standards (TIS), ASTM-Standard and JIS-Standard etc.

4) Station and Building Design

The building structure shall be the cast in placed concrete structure for slab on beam, column and foundation as it can be constructed easily even by the small contractors. For roof structure, it shall be steel structure which is lighter and stronger than other materials and can be constructed in accordance with the architectural style..

5.1.9 Design of Entrance-Exit to Station

The station design has taken into account the entrance-exit to station conveniently with appropriate facilities for transferring to other transportation modes. The station building is a public building with a lot of passengers and a variety of usages. In planning the station layout and the entrance-exit to station, the followings have to be considered:

1) The entrance-exit to station has to connect the surrounding areas i.e. road, parking lot, pick up and drop point.

2) The entrance-exit to station should have sufficient area for the passengers and for evacuation in case of emergency.

3) The entrance-exit to station should be easily seen.

4) The determination of entrance-exit to station should consider the adjacent buildings, road, passage width, surrounding vacant area and movement direction of the passengers.

5) The construction material of entrance-exit to station should harmonize with the station, be durable and easy to maintain.

5.1.10 Signaling and Telecommunication System Design

5.1.10.1 Signaling System

Referring to the rail transportation system development of the government, prior to the implementation of the project, the existing southern main line will be upgrade to double tracking system equipped with Computer Based Interlocking Signaling System. There will be a Central Traffic Control at Chumphon Province (Chumphon CTC). So, the signaling system of the project shall have to connect and interface with the signaling system at the merging point at Saeng Dad Station.

The signaling system is designed to control and determine the movement direction of trains using the same track, merging and crossing including shunting at the station. The function of all equipment shall be designed to interlock to enable the train drivers to operate the trains with confidence and without confusion.

The signaling system of the project was designed as a single track, bi-directional, track circuit block system with continuous 2 or 3 aspect colour light lineside signaling to inform the train drivers to know the route ahead and decide to stop or slow down the speed preparing to stop the train.

1) Train Control

The local computer based interlocking (CBI), and LCD workstation local control panels shall be installed at each station interlocking. All systems were designed to be controlled by the local area control center (LACC). In controlling the train operation, it can be done from Central Traffic Control (either Chomphon or Bang Sue depends on the SRT's train operation at that time) or that station or LACC as deemed appropriate.

2) Train Detection System

The train detection system was designed to be DC rail track circuit which is currently being adopted within SRT system and suitable for the land geometry. The track circuit is divided into 1,000 – 1,500 m. intervals in accordance with the current SRT standards. The track circuit interval is determined by the ability to stop (or braking distance) of the longest train.

Electric point machine which controlled by interlocking shall be used on the main line while hand operated point shall be used at the container yard.

3) Colour Light Signal

There will be 2 traffic control districts i.e. controlled by fixed signal or controlled within station limit and control district at block section between stations.

The light bulb should be LED light instead of tungsten light bulb as shown in **Figure 5.1.10-1**. The colour light signal on the fixed signal post shall be as follows:

- 2 aspect signal has 2 colours (red +green) or 3 colours (green + red + green) for the route with low speed train. There are 2 signals for home signal and starter signal.
- 3 aspect signal for the main line consisting of warning post, in post and 5 white lights indicating shunt-ahead signal, calling-on signal and starter signal at the platform.

The control district within station – the signaling system within station arranges for the train to pass or stop in the station on the main line or siding track and passengers can detrain or entrain at the platforms in the station conveniently, safely

and fast. The design principle is fail safe system, i.e. the system must be in a safe state even if the system is not functional.

For the station that has no siding track, there is a warning signal or home signal before entering the station and the starter signal is an automatic 2 aspects (Red/Green), green light lids up when the route is clear.



Figure 5.1.10-1 Sample of Colour Light Signal

4) Design Concept

As aforementioned that this railway will connect the existing main line at Chumphon CTC, the detailed design has taken into consideration the interface of the systems.

Based on the forecast of passenger and freight volumes, it was found that the traffic volumes and the train frequencies of the project are not very high therefore the signaling system of the project is designed as an absolute block signaling system and each block is equal to the distance between each station. However, the system can be upgraded to an automatic tokenless block signaling system in the future (in case the distance between each station is more than 12 km) by having the fixed signal post installed between two stations and the distance of fixed signal post is not less than the braking distance of the train to reduce the headway to accommodate the number and frequencies of the trains. However, more train detectors have to be installed too.

As the traffic volumes are not very high, in the beginning one siding track with sufficient length for a passenger train and a freight train to stop shall be constructed for the station namely Ban Na 1 Station, Pak Chan Station, La-un Station and Ranong Station. For the stations that do not need the siding track, one single track with platform for the passenger to detrain and entrain shall be constructed. The Ranong Terminal Station shall have 2 siding tracks for the long distance train to stop and shunt.

For the container yard, there shall be a track for loading and unloading goods, a track for a freight train to stop, siding track and rail for inspection and maintain the rollingstock.

The signaling schematic diagram needs the following information:

- Passenger and Freight demands, number of trains
- Headway
- Shunting requirements

- Signal sighting requirements
- Line Speed
- Gradients

5) Future Upgrade to ETCS Level 1 / ATP System

The signaling system was designed to be upgraded to ETCS Level 1 / ATP System which can be done by overlaying ETCS on the existing lineside signaling system. The signal aspects are relayed to trains via track mounted transponders. This requires the connecting between the existing lineside cabinets and the track mounted transponders.

5.1.10.2 Telecommunication System

From the study and review of the telecommunication equipment of the previous double track projects and the Double Track Projects from Prachuap Khiri Khan-Chumphon and from Chumphon-Surat Thani which will connect the project and a Central Traffic Control shall be established at Chumphon Province.

All technologies, systems and equipment introduced for the project shall have to interface with other SRT's projects.

The sub-systems of the telecommunication system of this project shall consist of the followings:

1) Data Transmission Network

The data transmission network shall be based on SDH (synchronous digital hierarchy) or equivalent such as optical transport network (OTN) with the capacity of 2.5 GHz or 10 GHz transmitting data through fiber-optic.

The data transmission network shall connect the existing data transmission network at Chumphon Central Traffic Control. The new system design shall have to interface with the telecommunication system of the Double Track Project from Prachuap Khiri Khan-Chumphon at Chumphon Station and Saeng Dad Station (boundary station) which will be developed in the future. The interface shall be either high level or interface port level depending on the actual situation during implementation phase for the most efficient integration of telecommunication system.

The data transmission network shall have nodes equipment installed at all stations including Chumphon Central Traffic Control and linked together by dual fiber-optic rings for stability as shown in **Figure 5.1.10-2**.

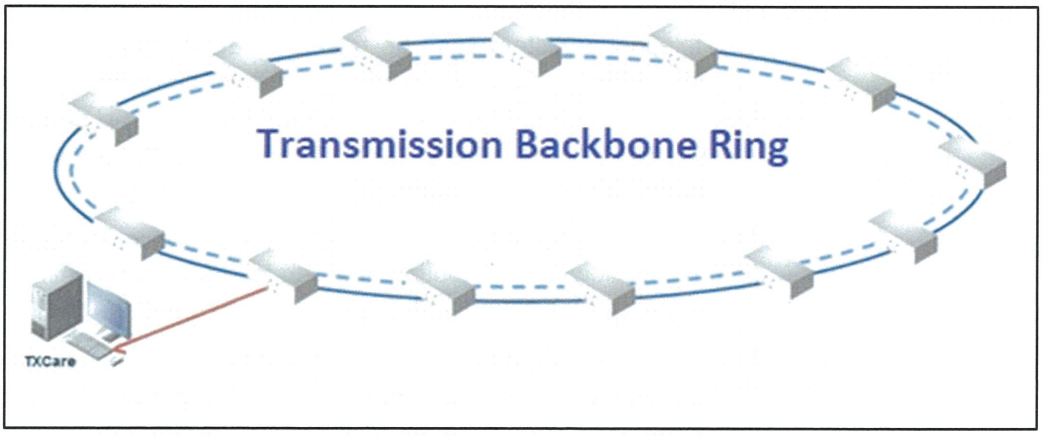


Figure 5.1.10-2 Transmission Backbone Ring

A dual ring network is aimed to prevent data transmission from being interrupted in the event of a fiber break or other network failure. This method is called path and equipment redundancy.

The fiber-optic should be laid along both sides of the railway. It may be buried or hung on the post depending on the terrain. The fiber-optic shall meet the latest ITU-T G.652 standard for the confidence that it can support the high technology of data transmission, such as dense wavelength division multiplexing (DWDM). The fiber-optic shall be able to accommodate the spectrum at wavelengths of 1310 nm and 1550 nm which are required for maximum transmission distance.

The data transmission network shall be able to interface other systems according to the following protocols:

- SDH (Synchronous Digital Hierarchy)
- Ethernet 10/100 base-TX (IEE 802.3)
- E-1(ITU-T G.703 and G.823)
- Legacy Interface such as 12LVOI-P and –T, 4WVOI-S, RS422MD4 and RS422 etc.

The data transmission network shall be able to transmit data by:

- Point to point
- Point to multipoint
- Drop and insert
- Cross connect.

The data transmission network shall function as transmission carrier for the following sub-systems;

- PABX system
- Radio communication system
- CCTV system (if any)
- Master clock system
- Signaling System (only provide fiber-optic, the transmission system shall be done by the signaling system).

2) Telephone System

The telephone system shall be based on the private automatic branch exchange system (PABX) which is currently used in other double track projects. The telephone system of the project shall connect to the SRT's telephone system which will be installed for double track projects. The connecting point shall be at Chumphon Station or Chumphon CTC.

The telephone system shall connect to the public switched telephone network (PSTN) to allow for call routing between telephone set within the project and public system, such as TOT network or concessionaire and the SRT's nationwide network.

The main PABX shall be installed at the main station (or Chumphon CTC) and shall function as the connecting center between the private branch exchanges (PBX) in remote-shelf manner installed at all stations of the project. The connecting to the public network shall be done at the main PABX or at the remote shelf.

The telephone system shall be one of the followings:

- Analogue phone
- Digital phone
- IP phone
- Wayside connection point for maintenance or emergency case.

The telephone system for train operation control is called dispatcher telephone for communicating between the train dispatcher and all stations in the project and other projects

Besides the above systems, there shall be wayside telephone system e.g. signal post telephone (SPT), CB line and block phone system.

The train operation control via the telephone system shall be recorded by a voice recorder as a witness if accident happens. The voice recorder shall have appropriate search function and convenience in using.

Figure 5.1.10-3 shows the telephone system and the communication system within the station.

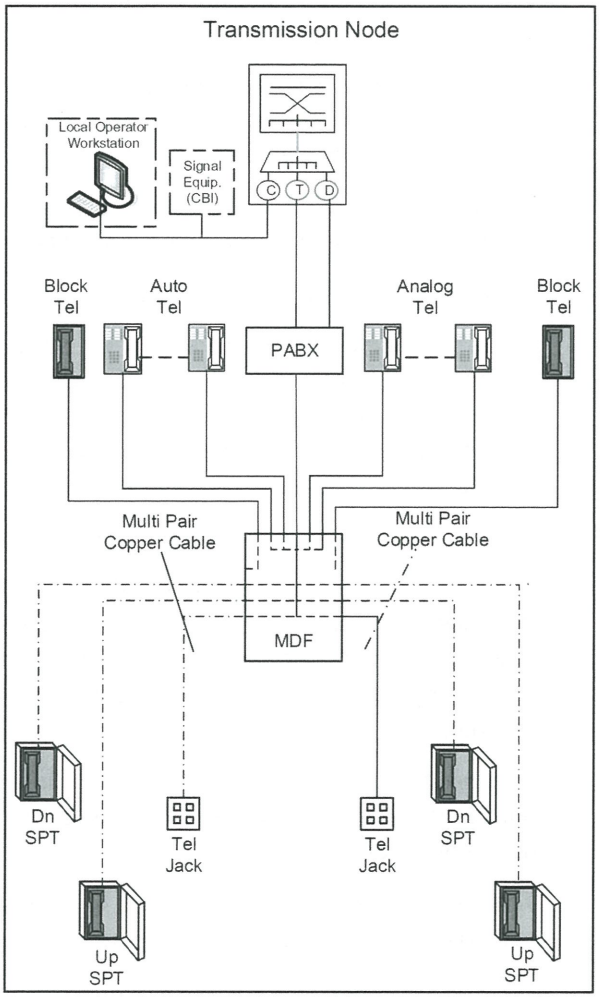


Figure 5.1.10-3 Communication System within the Station

3) Radio Communication System

The VHF wireless radio communication system with the signal covering the whole project, container yard, depot and connecting to the radio system of interconnected routes shall be provided to communicate and coordinate for train operation, between trains, control center, stations and level crossings (if any).

There shall be a repeater station as deemed necessary to ensure that there are radio signals covering the entire project area.

However, the radio communication system to be used in the project shall be consistent with the system of the SRT's development plan. The system shall be analogue or digital depending on the actual construction period.

If the SRT's system is digital, the project radio communication system should be digital as well and should consist of wayside base stations to distribute radio frequencies. However, it depends on the capabilities of the SRT's systems and the limitations of the network connection.

4) Master Clock System

A master clock system is a precision clock that provides times for passengers and staff. The system consists of central master clock, sub-master clock and slave clocks.

A central master clock receives timing signals from a GPS satellite and synchronize to sub-master clocks at all stations and slave clocks within stations e.g. platform, hall, office and ticketing room.

It provides precise times for the whole system so it is used as a reference time of the signaling and telecommunication system.

5) Power Supply and UPS System

In the beginning, the power supply for the signaling and telecommunication system of the rolling stock driven by diesel engine power shall be the AC main power supply from the Provincial Electricity Authority (PEA). There shall be a standby power supply system in case of the main power supply failure consisting of UPS and generator to ensure zero interruption of train operation.

6) Interface with SRT Nationwide Communication System in the Future

The data transmission network shall have space and slot within the node for interface expansion. At the boundary station, the data transmission network must have slot within the node to accommodate the interface expansion with the connecting route and/or the SRT's nationwide transmission backbone network in the future.

The telephone system shall have sufficient capacity for both the current function and future extension. Calls within the same main PABX must be non-blocking, i.e. no full duplex or busy call.

The radio system may be adapted to TETRA system which is used worldwide for rail business. However, it depends on the SRT's policy for the national radio system development.

5.1.10.3 Provision of Future AC Electrification

As the SRT intends to install the electric traction systems which is 25KV 50 HZ throughout the network in the future, the signaling and telecommunication system of the project whether track circuit, point machine, line side copper telephone circuits etc. must

be able to interface with the SRT's new system and prevent interference from AC power.

5.2 INFRASTRUCTURE DESIGN

The works are to design the electrical and mechanical engineering in accordance with the station requirements. The location and size of the electrical and mechanical equipment at stations shall follow the following standards and specifications.

5.2.1 Electrical Engineering Design

1) The preliminary schematic diagram was designed for power supply system for equipment with both normal and essential loads and central battery supply for very essential equipment for the following works:

- Low voltage power distribution
- Lighting and electrical outlet.
- Emergency lighting and emergency exit signs.
- Uninterrupted power supply system
- Lightning protection system
- Grounding system
- Fire alarm system
- Power supply for mechanical equipment
- Public telephone line outlet
- Emergency call for the disabled persons

2) Standards, Codes and Regulations

- EIT 2001 – 56 : Electrical Installation Standard for Thailand, 2013
- EIT 2002 – 49 : Fire Alarm System Standard
- EIT 2009 - 53 : Lightning Protection Standard for Buildings
- EIT 2004 – 54 : Standard Emergency Lighting System and Emergency Exit Signs
- Mor Or Kor : Industrial Product Standards
- IEC : International Electrotechnical Commission
- NFPA 70-2011 : National Electrical Code (NEC)
- NFPA 72-2010 : National Fire Alarm Code
- NFPA 101-2012 : Life Safety Code
- NFPA 110-2010 : Standard for Emergency and Standby Power System
- NFPA 130-2010 : Standard for Fixed Guideway Transit and Passenger Rail Systems

- NFPA 780-2011 : Standard for the Installation of Lightning Protection Systems
- IES : Illuminating Engineering Society, Lighting Handbook
- Other Equivalent International standards

3) Design Criteria

(1) Electrical Loading Criteria

Prepare a list of electrical load calculations by referring to the Electrical Installation Standard for Thailand, NFPA and Energy Conservation Requirements in order to calculate the electrical load per area.

(2) Basic information on electrical system for calculating the electrical load for the project is as follows:

- System voltage : 400 Volts. 3 Phase. 4 Wires. 50 Hz.
  230 Volts. 1 Phase. 2 Wires. 50 Hz.
- Ambient temperature : 40°C
- Load diversity : 80% overall
- Load power factor : Subjected to individual load
- Voltage drop (feeder) : 2% maximum
- Voltage drop (up to final circuit) : 5% maximum
- Earthing system : TN-S System
- Spare capacity : 25% for switchboards
  40% for all cable trays and wireway

(3) Lighting System and Electrical Outlet within Stations

Specify the lamp type which is durable, energy saving, aesthetic and distributes appropriate light for that area.

The electrical outlet is a 3-pin 16A 220V multi-purpose socket with cover for use in offices and control rooms. The floor socket is for public areas.

(4) Emergency lighting and emergency exit signs

Emergency lighting and emergency exit signs must be continuously illuminated for at least 120 minutes after the normal power supply failure.

(5) Fire alarm system

Fire alarm system is intended for the following purposes:

- To detect the smoke or fire.
- To inform people in stations urgently before the fire breaks out.

4) Load Estimation

Calculate the electrical load for stations based on the latest version of the Electrical Installation Standard for Thailand.

The calculation principles for office or general store are as follows:

- Use 155 volts per square meter for the area that has no central cooling system
- Use 85 volts per square meter for the area that has the central cooling system.
- Specific electrical equipment for the sanitary system, fire extinguishing system and air conditioning system.

The electrical loads for stations are summarized in **Tables 5.2.1-1** and **5.2.1-2**.

Table 5.2.1-1 Electrical Loads for Type A Station

Area Description	Area (m^2)	Lighting VA/SQ.M.	Small Power VA/SQ.M.	AC, V VA/SQ.M.	Total VA
Ticket Office	14	35	20	100	2,170.0
Scr Office	22	35	20	100	3,410.0
Station Master	23	35	20	100	3,565.0
Store	11	15	5	10	330.0
Ee.	11	15	5	10	330.0
Pacel	30	15	5	10	900.0
Disabled Toiled	4	15	5	10	120.0
Women Toilet	7	15	5	10	210.0
Men Toilet	7	15	5	10	210.0
Wating Area	12	10	5	-	180.0
Queueing	21	10	5	-	315.0
Parking Area	930	10	-	-	9,300.0
Platfrom	800	15	5	-	16,000.0
Lobby	30	10	5	-	450.0
Total (KVA)					**37.6**

Table 5.2.1-2 Electrical Loads for Type B Station

Area Description	Area (m^2)	Lighting VA/SQ.M.	Small Power VA/SQ.M.	AC, V VA/SQ.M.	Total VA
Ticket Office	11	35	20	100	1,705.0
Scr Office	16	35	20	100	2,480.0
Station Master	18	35	20	100	2,790.0
Store	7	15	5	10	210.0
Ee.	6	15	5	10	180.0
Pacel	15	15	5	10	450.0
Disabled Toiled	3	15	5	10	90.0
Women Toilet	4	15	5	10	120.0
Men Toilet	4	15	5	10	120.0
Wating Area	12	10	5	-	180.0
Queueing	20	10	5	-	300.0
Parking Area	930	10	-	-	9,300.0
Platfrom	800	15	5	-	16,000.0
Lobby	15	10	5	-	225.0
Total (KVA)					**34.2**

5.2.2 Mechanical Engineering Design

5.2.2.1 Air Conditioning and Ventilation System

The preliminary schematic diagram was designed for air conditioning and ventilation system for stations, offices, computer rooms and control rooms based on mechanical air conditioning and ventilation or natural air circulation systems.

1) Design Standards (Standards, Codes and Regulations)

- The Engineering Institute of Thailand Standards (EIT)
- Ministerial Regulations issued under the Building Control Act
- Mor Or Kor : Thai Industrial Standard
- ASHRAE : American Society of Heating Refrigerating and Air Conditioning Engineers
- AHRI : Air Conditioning Heating and Refrigeration Institute
- SMACNA : Sheet Metal and Air Conditioning Contractors National Association Inc.
- NEC : National Electrical Code
- Other equivalent international standards

2) Design Criteria

- Outdoor design conditions, average height of sea level is 40-70 meters.
- Dry bulb Temperature 35.1°Cdb
- Wet bulb Temperature 26.4°Cwb
- Internal design conditions
- Mechanical ventilation system for all areas shall be provided with ventilation rate not less than the Ministerial Regulations.

3) Air Conditioning and Ventilation System Calculation

Cooling load calculation of air conditioning system for stations is based on the EIT standards and ASHRAE standards as follows:

1) General office area

Use split type air conditioning system to control the system of each section in the room which is easy to maintain and save energy than other systems.

2) Central Area

Cooling load calculation for each station type is shown in **Tables 5.2.2-1** and **5.2.2-2**.

Table 5.2.2-1 Cooling Load Calculation for Type A Station

Building/Room	Area (m^2)	Temperature (°C)	(%RH)	Total load capacity(kW)	Total load capacity (BTU/hr)
Ticket Office	14	24+/-1	55+/-5	2.16	7,369
SCR Office	22	24+/-1	55+/-5	3	10,236
Station Master	23	24+/-1	55+/-5	3.46	11,805

Table 5.2.2-2 Cooling Load Calculation for Type B Station

Building/Room	Area(m^2)	Temperature (°C)	(%RH)	Total load capacity(kW)	Total load capacity (BTU/hr)
Ticket Office	11	24+/-1	55+/-5	1.86	6,346
SCR Office	16	24+/-1	55+/-5	2.29	7,813
Station Master	18	24+/-1	55+/-5	2.98	10,167

5.2.2.2 Sanitary System

1) The preliminary schematic diagram was designed for sanitary system consisting of the following sub-systems:

- Water supply system
- Drainage, sewage and ventilation System
- Rain leader system
- Wastewater treatment system.

2) Standards, Codes and Regulations

- Ministerial Regulations issued under the Building Control Act
- National Environmental Quality Promotion and Preservation Act, B.E. 2535
- Provisions or regulations of the fire-fighting department including the Department of Disaster Prevention and Mitigation
- Rules and Regulations of the Metropolitan Waterworks Authority and the Provincial waterworks authority
- Mor Yor Por. 3501-51 : Standard for plumbing installation
- Mor Yor Por. 3101-51 : Standard for sanitary pipe system
- EIT : The Engineering Institute of Thailand
- TIS : Thai Industrial Standard
- NPC : National Plumbing Code, USA
- ASPE : American Society of Plumbing Engineers
- ANSI : American National Standard Institute
- ASTM : American Society of Testing Material
- AWWA : American Water Works Association
- MWA : Metropolitan Waterworks Authority
- BS : British Standards
- NFPA : National Fire Protection Association
- UL : Underwriter's Laboratory, Inc.
- FM : Factory Mutual

3) Design Criteria

- Water, wastewater and rain water consumption
- Water Demand
  - 60 liter/person/day for staff
  - 60 liter/person/day for shop
  - 15 liter/person/day for passenger
- Wastewater will be generated about 80 percent of water consumption for shop and 100 percent of water consumption for staffs and passengers.
- Rain Intensity for water drainage from roof is 150 mm./hr.

4) Water and Wastewater Calculation

Water and wastewater calculation for stations was mainly based on EIT and NPC standards as follows:

(1) Office or Shop

- Water calculated from water consumption 60 liter/person/day with water storage for at least 1 day.
- Wastewater calculated from wastewater generated 80 percent of water consumption for shop and 100 percent of water consumption for staffs and passengers.

Water and wastewater of each station type is shown in **Table 5.2.2-3**.

Table 5.2.2-3 Water and Wastewater Calculation for Type A and Type B Stations

Station	Water Consumption (m^3/d)	Water Tank (m^3)	Wastewater Generated (m^3/d)	Wastewater Treatment Tank (m^3)
Type A	38.92	40	38.92	40
Type B	10.49	12	10.49	12

5.2.2.3 Fire Fighting System

1) Fire fighting design for stations included:
   - Portable fire extinguisher
2) Standards, Codes and Regulations
   - Ministerial Regulation No. 33 (BE 2535) on Installation of Fire Extinguishers issued under the Building Control Act BE 2522
   - EIT 3002-45 : Standard for Fire Protection System
   - NFPA 10 : Standard for Portable Fire Extinguishers
   - NFPA 14 : Standard for Installation of Standpipe and Hose system
   - NFPA 20 : Standard for the Installation of Stationary Pumps for Fire Protection
   - NFPA 24-2002 : Private Fire Service Mains and Their Appurtenances
   - NFPA 130-2003 : Standard for Fixed Guideway Transit and Passenger Rail Systems
   - NFPA 2001-2002 : Standard on Clean Agent Fire Extinguishing System
3) Design Criteria
   - The portable fire extinguisher shall be installed in an accessible and convenient area as specified in NFPA 10.

5.3 Train Operation Plan

The Chumphon–Ranong Railway Project shall separate from the existing southern railway at Chumphon Station where it is a part of the southern double track development from Prachuap Khirikhan-Chumphon and a part of the Chumphon–Ranong line shall separate from Saeng Dad Station where it is a part of the southern double track development from Chumphon–Surat Thani as shown in **Figure 5.3-1**. As in the beginning the volumes of passengers and freights shall not be very much, the track system was designed as a single track with a siding track in some stations along the

route, however, the design has taken into consideration the development to double track system in the future.

In planning the track layout, the terrain including the connecting to road infrastructure system has been taken into consideration as well for the most efficiency.

As the Chumphon-Ranong Railway Project shall separate from the existing southern main line, the service condition to correspond with the main line has to be taken into consideration too. The concepts and considerations in planning the train operation and analysing the line capacity were as follows:

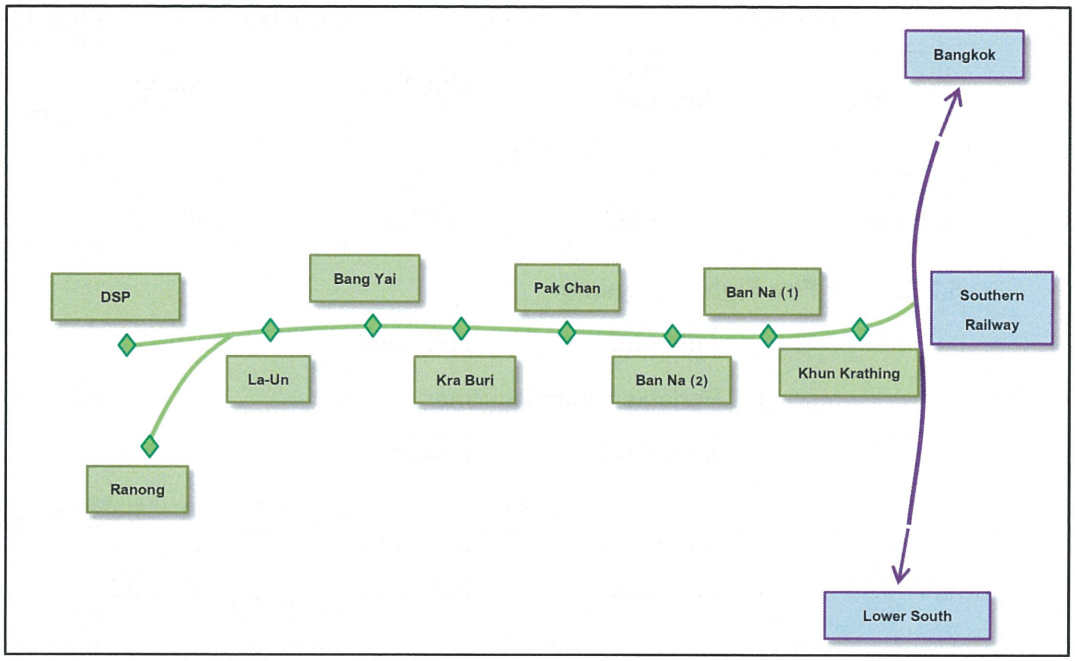


Figure 5.3-1 Train Operation Route of the Project

5.3.1 Concept for Service Operation Plan

The service operation plan has been prepared based on the forecast of passenger volumes and freight volumes, location and number of stations, freight storage and distribution, service distance and route alignment, alignment geometry, train stop locations, depot and maintenance facilities both existing and future development so that the service operation plan corresponds with the travel demands and freight transportation according to the forecast.

Service operation plan including type and number of rolling stocks to be used in the project has to consider the related components e.g. train speed, speed restriction due to alignment geometry, type of rolling stock, rolling stock capacity, and train capacity etc.

The above factors have been used as input to determine train speed, headway, and train schedule in accordance with line capacity.

Another important factor for service operation plan is journey time which includes time taken for travelling of station to the next station, dwell time, load and unloading of freight train, time taken for train preparation such as train formation and shutting, speed profile, headway, and the demand of passenger and freight during each period of time within a day

The Consultant has applied the Train Simulation Model to determine line capacity and fleet size. The following information has also been considered, trackwork design, track

schematic diagram, location of passing loops, railway signaling system as shown in **Figure 5.3.1-1**.

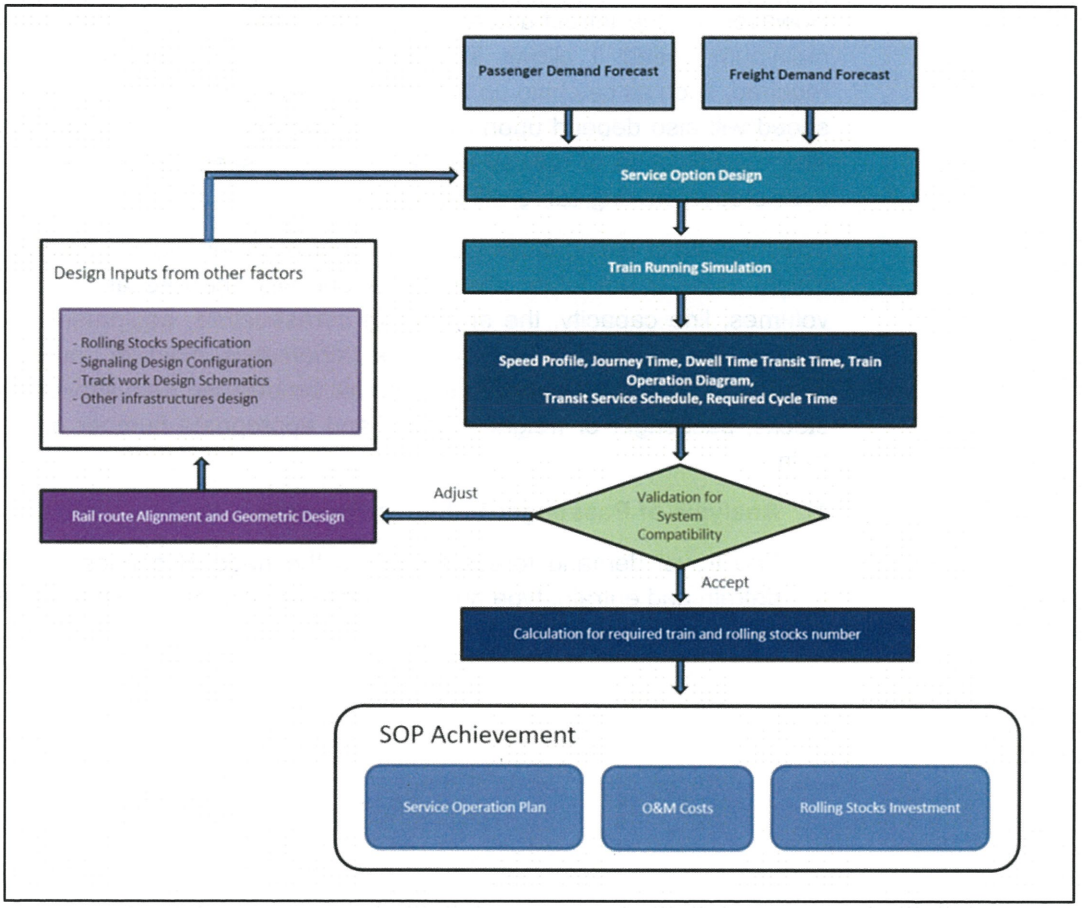


Figure 5.3.1-1 Service Operation Plan Flow

The output of this SOP will be presented in a formed of passenger or freight service capacity, train schedule and train diagram which will promote the efficiency of train services, reliability, availability, maintainability and safety: RAMS.

5.3.2 Train Service Operation Plan

Train Service and Operation Plan applies similar approach as the existing SRT service and other double tracking system. The type of service train consists of long distance train, local train and Freight Train. The location of passing loop has been defined in accordance with time table and traffic. Station Platform must have sufficient length to cover whole trainset, the height must be appropriate providing easy access for the passengers. For the freight service it is considered that the suitable facilities are to provide container yard right next to the deep sea port. As the freight forecast showed that the cargo type will be coming in a form of container, the ICD is not required for this project. The design of signalling and telecommunication system has considered the current and future technologies and the integration with CTC.

Currently, for journey time simulation the maximum train speed service for each type of train are following, 50-60 km/hr for freight, 60-70 km/hr for long distance train, and 80 km/hr for local train. Although, it can be seen that these speed are conservative figures. However, as the infrastructure has been designed to accommodate 120 – 160 km/hr maximum speed it allows sufficient margin for increasing to higher speed when required, such as catching up time table, reducing headway, etc. It is noted that the train speed will also depend upon rolling stock performance that are running in this section. The electrification of railway will also promote speed and acceleration of train as the acceleration braking curve will be steeper.

The forecast of rolling stock types, number of rolling stocks, number of passenger and freight trains in the future shall correspond with the forecast of passenger and freight volumes, line capacity, the analysis of infrastructure, equipment and appropriate train system e.g. trackwork design, track schematics diagram, number and position of passing loop, railway signaling system for considering train service types, type of rolling stocks, passenger or freight capacity and appropriate number of passengers for each train.

1) Analysis of Passenger Volumes Forecast

The travel demand forecast showed the need of service, number of passengers detrain and entrain, type and number of freights as shown in **Table 5.3.2-1.**

Table 5.3.2-1 Passenger Volumes Forecast

Station	Passenger Demand Forecast (Daily)											
	2025			2034			2044			2054		
	En-train	De-train	Line-load	En-train	De-train	Line-load	En-train	De-train	Line-load	En-train	De-train	Line-load
Chumphon – Ranong Direction												
BKK and Other Regions	663	0	663	849	0	849	1,086	0	1,086	1,377	0	1,377
Lower South	371	0	371	476	0	476	617	0	617	782	0	782
Chumphon	858	0	858	1,101	0	1,101	1,425	0	1,425	1,804	0	1,804
Khun Krathing	163	68	1,987	217	95	2,548	283	129	3,282	358	149	4,172
Ban Na (1)	76	49	2,014	97	68	2,577	121	88	3,315	144	107	4,209
Ban Na (2)	95	108	2,001	122	138	2,561	153	179	3,289	187	226	4,170
Pak Chan	280	242	2,039	349	289	2,621	438	346	3,381	540	411	4,299
Kra Buri	200	330	1,909	242	436	2,427	296	523	3,154	355	663	3,991
Bang Yai	37	25	1,921	59	35	2,451	75	67	3,162	115	84	4,022
La-un	110	177	1,854	141	228	2,364	159	294	3,027	178	370	3,830
Ranong	0	1,854	0	0	2,364	0	0	3,027	0	0	3,830	0
Total	**2,853**	**2,853**		**3,653**	**3,653**		**4,653**	**4,653**		**5,840**	**5,840**	
Ranong – Chumphon Direction												
Ranong	1,859	0	1,859	2,361	0	2,361	3,048	0	3,048	3,866	0	3,866
La-un	179	110	1,928	233	141	2,453	300	160	3,188	375	179	4,062
Bang Yai	25	40	1,913	52	63	2,442	67	81	3,174	84	122	4,024
Kra Buri	324	203	2,034	429	246	2,625	515	301	3,388	652	363	4,313
Pak Chan	241	288	1,987	288	361	2,552	345	452	3,281	408	556	4,165
Ban Na (2)	107	96	1,998	137	123	2,566	178	155	3,304	225	191	4,199
Ban Na (1)	56	78	1,976	74	97	2,543	90	121	3,273	104	145	4,158
Khun Krathing	80	170	1,886	104	225	2,422	135	294	3,114	156	372	3,942
Chumphon	0	792	792	0	1,018	1,018	0	1,317	1,317	0	1,666	1,666
Lower South	0	343	343	0	441	441	0	569	569	0	721	721
BKK and Other Regions	0	751	751	0	963	963	0	1,228	1,228	0	1,555	1,555
Total	**2,871**	**2,871**		**3,678**	**3,678**		**4,678**	**4,678**		**5,870**	**5,870**	
Total (passenger/day)	**5,724**	**5,724**		**7,331**	**7,331**		**9,331**	**9,331**		**11,710**	**11,710**	**-**
Max Line Load (passenger/day)			**2,039**			**2,625**			**3,388**			**4,313**

2) Freight Demand Forecast

Freight demand forecast showed the types and freight volumes of each type, origin and destination countries of that freight as shown in **Tables 5.3.2-2** and **5.3.2-3**.

Table 5.3.2-2 Expected Volume of Export Containers to BIMSTEC Countries to use the Ranong Port Service in 2025-2054

Freight Type	Destination Country	Export Volumes (Containers)			
		2025	2034	2044	2054
1. Cement	India	428	428	428	428
	Myanmar	620	620	620	620
	Sri Lanka	1,367	1,367	1,367	1,367
	Bangladesh	14,467	14,467	14,467	14,467
	Total	**16,881**	**16,881**	**16,881**	**16,881**
2. Plastic Resin	India	2,935	4,622	6,488	9,108
	Myanmar	230	362	509	714
	Total	**3,165**	**4,984**	**6,997**	**9,822**
3. Construction Material	India	195	195	195	195
	Myanmar	84	84	84	84
	Total	**279**	**279**	**279**	**279**
4. Consumer Goods	India	898	1,721	2,803	4,566
	Myanmar	426	818	1,332	2,169
	Sri Lanka	190	365	594	968
	Bangladesh	479	919	1,497	2,439
	Total	**1,994**	**3,822**	**6,226**	**10,141**
5. Rubber	India	75	75	75	75
	Sri Lanka	69	69	69	69
	Total	**145**	**145**	**145**	**145**
6. Sugar	Myanmar	2,264	4,340	7,069	11,515
	Sri Lanka	362	694	1,130	1,841
	Total	**2,625**	**5,034**	**8,199**	**13,356**
7. Rubber	Myanmar	576	1,049	1,645	2,579
	Total	**576**	**1,049**	**1,645**	**2,579**
8. Vehicle Parts and Components.	India	104	141	177	223
	Total	**104**	**141**	**177**	**223**
9. Steel Chips	India	1,578	3,026	4,928	8,028
	Total	**1,578**	**3,026**	**4,928**	**8,028**
Grand Total		**27,347**	**35,361**	**45,478**	**61,454**

Source: Analyzed by the Consultant

Table 5.3.2-3 Expected Volume of Import Containers from BIMSTEC Countries to use the Ranong Port Service in 2025-2054

Freight	Origin Country	Import Volumes (Containers)			
		2025	2034	2044	2054
1. Salt, Sulphur, earths and stone plastering materials	India	2,064	3,811	6,032	9,549
2. Iron and steel	India	602	602	602	602
3. Wood and articles of wood; wood charcoal	Myanmar	1,849	3,546	5,776	9,408
4. Product for consumption and Seed	India	372	372	372	372
5. Agricultural Product	India	127	127	127	127
	Bangladesh	88	88	88	88
	Total	**215**	**215**	**215**	**215**
6. Industrial Product	India	666	1,350	2,295	3,901
Grand Total		**5,769**	**9,896**	**15,292**	**24,048**

Source: Analyzed by the Consultant

3) Train Service

Planning the train service was based on the SRT existing services and practice, each type of train provides different services. Passengers are able to select the services as they desire. The project shall have 2 types of train services as follows:

- Special Express Train: It is long haul train service between Ranong town to Bangkok (can be changed to Bang Sue depending on SRT train service practice at that time). This type of train will stop at the main stations only. The train consists of modern coaches similar to the SRT's new passenger train-sets that been recently purchased and put on service in 2559. The Train-set consists of First Class air conditioned day/night coach, Second Class air conditioned day/night coaches, Air conditioned seat only coaches and Restaurant coach. The train is considered the special class train which can accommodate about 500–1,000 passengers per train depending on the train formation.
- Commuter Train: The Commuter is an ordinary train. It consists of 4-6 cars per train. The suitable rolling stock for this application is Diesel Multiple Unit (DMU). This train service is focusing on the local passengers and/or passengers that could not afford the Express train to Chumphon Station to transit to the southern line to their destination. The Commuter train service stops at every station including a halt and can accommodate about 400-600 passengers per train both seat and stand.

  In order to provide appropriate service and accommodate passenger and freight volumes according to the forecast, the Consultant has prioritized the Express Train, Commuter Train, and Freight Train for shunting and overtaking at the station yard and determine the stations to stop the train for detraining and entraining passengers and freights as shown in **Table 5.3.2-4**.

Table 5.3.2-4 Stations and Train Service in the Chumphon- Ranong Project

No.	Station	Station Size	Chainage (Km)	Distance between Stations	Type of Service	
					Express	Commuter
0	Chumphon	Big			x	x
1	Khun Krathing	Small	3+688	7.25		x
2	Ban Na(1)	Small	14+067	10.375	x	x
3	Ban Na(2)	Small	22+000	7.575		x
4	Pak Chan	Small	42+950	20.950	x	x
5	Kra Buri	Small	52+900	9.950		x
6	Bang Yai	Small	70+893	17.970		x
7	La-Un	Small	78+869	8.03	x	x
8	Ranong	Big	4+832 (Spur line)	25.234	x	x

4) Rolling Stock Type

The rolling stock to be used in this project shall comply with the SRT's current service consisting of locomotive for passenger train, locomotive for Freight train and Diesel Multiple Unit for commuter train.

- **Locomotive**

  The Locomotive for long haul passenger train shall be Diesel Electric Locomotive which has 15 tons axle load, similar to Hitachi, Alstom, and GEA that are currently used as shown on **Figure 5.3.2-1**.



Figure 5.3.2-1 Locomotive for Passenger Train

The Locomotive for Freight train will be Diesel Electric Locomotive which has 20 tons axle load, similar to CRC Locomotive that are in used currently as shown on **Figure 5.3.2-2.**



Figure 5.3.2-2 Locomotive for Freight Train

- **Diesel Multiple Unit (DMU)**

  The Diesel Multiple Unit weighs approximately 12-14 tons axel load. The train set consists of 3-4 passenger cars in consistency with the passenger volume forecast. It shall be used for commuter train running between Chumphon Station and Ranong Station for passengers both seat and stand. Each car can accommodate about 115 passengers. If the train formation is set for 3 cars per train, it can accommodate about 400–600 passengers per train as shown in **Figure 5.3.2-3**.



Figure 5.3.2-3 Diesel Multiple Unit (Ordinary Train or Commuter Train)

5) Train Formation

- Commuter train shall be Diesel Multiple Unit consisting of 4-6 cars as shown in **Table 5.3.2-5**.

Table 5.3.2-5 Train Formation for Commuter Train

Type of Coach	Pass/ Car	2025		2034		2044		2054	
		Car	Pass/ Train	Car	Pass/ Train	Car	Pass/ Train	Car	Pass/ Train
DMU Cars (seat and standing)	100	4	400	4	400	5	500	6	600

** Designed to have three diesel trains running alternately to serve passengers during rush hours, such as morning and evening.

- **Long Haul Train**

  The Long Haul service train will be an Express train service from Bangkok to Ranong. It will stop at the main stations only. The rolling stock type, quality of service and train formation is similar to the new passenger coach-sets that have been recently purchased and put in service by the SRT. It is pulled by a 15t

locomotive. The service focuses on the tourist and/or business people traveling to Ranong Province and nearby provinces. The train formation and capacity is shown in **Table 5.3.2-6** consisting of:

- Air-conditioned First Class Day & Night Coach
- Air-conditioned Second Class Day & Night Coach
- Air-conditioned Seat Car
- Restaurant Car
- Power Generation Car (if any)

Table 5.3.2-6 Long Haul Train Formation and Capacity

Type of Coach	Pass/ Car	2025		2034		2044		2054	
		Car	Pass/ Train	Car	Pass/ Train	Car	Pass/ Train	Car	Pass/ Train
1st class day/night	24	1	24	1	24	1	24	1	24
2nd class day/night	40	3	120	3	120	3	120	3	120
2nd seat only	80	5	400	7	560	10	800	11	880
Restaurant car	0	1	0	1	0	1	0	1	0
Total		**10**	**544**	**12**	**704**	**15**	**944**	**16**	**1,024**

** Number of passengers/train depend on the train formation

6) Analysis of Line Capacity and Train Running Time

This analysis has taken into consideration all factors that impact the journey time such as the alignment geometry, distance between stations, passing loops, train performance such as acceleration, braking distance, top speed, dwell time. The train journey calculation will take into account the aforementioned factors as shown in **Tables 5.3.2-7** to **5.3.2-9**.

Table 5.3.2-7 Commuter Train Journey Time

Departure	Station	Depart	Arrival	Distance	Min.	Dwell	Arrival
S1	Chumphon	-	7,250	7,250	375	0	S2
S2	Khun Krathing	7,250	17,625	10,375	522	120	S3
S3	Ban Na	17,625	25,200	7,575	390	120	S4
S4	Wang Mai	25,200	46,150	20,950	1022	120	S5
S5	Pak Chan	46,150	56,100	9,950	502	120	S6
S6	Kra Buri	56,100	74,070	17,970	881	120	S7
S7	Bang Yai	74,070	82,100	8,030	412	120	S8
S8	La-Un	82,100	107,334	25,234	1225	120	S9
S9	Ranong	107,334	107,334	-	0		
Total Running time – 1 way = 6,169 Sec = 102.8 Min.							

Table 5.3.2-8 Long Haul Train Journey Time

Departure	Station	Depart	Arrival	Distance	Min.	Dwell	Arrival
S1	Chumphon	-	7,250	7,250	505	-	S2
S2	Khun Krathing	7,250	17,625	10,375	654	-	S3
S3	Ban Na	17,625	25,200	7,575	526	120	S4
S4	Wang Mai	25,200	46,150	20,950	1,320	-	S5
S5	Pak Chan	46,150	56,100	9,950	675	120	S6
S6	Kra Buri	56,100	74,070	17,970	1,132	-	S7
S7	Bang Yai	74,070	82,100	8,030	506	-	S8
S8	La-Un	82,100	107,334	25,234	1,638	120	S9
S9	Ranong	107,334	107,334	-	-		
Total Running time – 1 way = 7,315 Sec = 121.9 Min.							

Table 5.3.2-9 Freight Train Journey Time

Departure	Station	Depart	Arrival	Distance	Min.	Dwell	Arrival
S1	Chumphon	-	7,250	7,250	572	0	S2
S2	Khun Krathing	7,250	17,625	10,375	784	0	S3
S3	Ban Na	17,625	25,200	7,575	573	0	S4
S4	Wang Mai	25,200	46,150	20,950	1584	0	S5
S5	Pak Chan	46,150	56,100	9,950	752	0	S6
S6	Kra Buri	56,100	74,070	17,970	1359	0	S7
S7	Bang Yai	74,070	82,100	8,030	607	0	S8
S8	La-Un	82,100	105,750	23,650	1807	0	S9
S9	DSP	105,750	105,750	-	0		
Total Running time – 1 way = 8,038 Sec = 134 Min.							

For freight train, it can be noticed that the volumes of outbound direction are quite more than the inbound direction. So, in planning the train service, the outbound direction must be referred mainly. The inbound train may have to pull back empty carriages to pick up containers sufficiently. However, it should be integrated with other transport lines to cut or shuffle during the way to have the least empty carriages for the utmost benefit.

For the origin and destination of freight transport, it is assumed that the freight train from the project shall run from Ranong Deep Sea Port to ICD Lat Krabang. This is because based on the forecast, either the origin or the destination, the freight train is not full so the freight collection and distribution point should be provided.

7) Train Trip and Timetable Planning

(1) Line Capacity

In accordance with the passenger demand forecast, the passenger train trip has been determined as in **Tables 5.3.2-10** and **5.3.2-11**. Passengers e.g. tourists and businessmen from Bangkok or intermediate main stations can use the

special express train. Passengers who cannot afford the special express train can use other trains on the southern line and transit to the commuter train at Chumphon Station to the project area. Passengers from or go to the lower south who travel by the southern line and transit at Chumphon Station can choose to travel by the special express train or the commuter train according to their potential and destination.

Table 5.3.2-10 Train Trips, Fleet Size and Line Capacity for Passenger Train

Type of Train	Train Trips/Day/Direction	2025	2034	2044	2054
Special Express Train	Train Trip	1	1	1	1
	Capacity – Express Train from BKK (Passenger/Train/Direction)	544	704	944	1,024
	Line Load Maximum – Express Train (Passenger/Day/Direction)	544	704	944	1,024
	Estimated Cycle Time – Express Train BKK – Ranong	0.75	0.75	0.75	0.75
	Number of trains required	1	1	1	1
Commuter Train	Train Trip	4	5	5	6
	Capacity – Commuter Train (Passenger/Train/Direction)	400	400	500	600
	Line Load Maximum – Commuter Train (Passenger/Day/Direction)	1,600	2,000	2,500	3,600
	Estimated Cycle Time – Commuter Train Chumphon – Ranong	0.16	0.16	0.16	0.16
	Number of trains required	3	3	3	3
	** Take into consideration the peak hours service schedule and spare train, 3 Train-sets are required				
Total	Total Train Trip	5	6	6	7
	Maximum Line Load (Passenger/Day/Direction)	2,144	2,704	3,444	4,624

Table 5.3.2-11 Train Trips, Fleet Size and Line Capacity for Freight Train

Type of Train	Train Trips/Day/Direction	2025	2034	2044	2054
Freight Train	Train Trips	2	3	3	4
	Capacity – Freight Train (Container/Day/Direction)	75	97	125	169
	Line Load Maximum – Freight Train (Container/Year/Direction)	27,347	35,361	45,478	61,454
	Estimated Cycle Time – Freight Train Lakrabang ICD – Ranong Deep Sea Port	1	1	1	1
	Number of trains required	4	6	8	10
	Number of Freight Wagon Required	150	194	250	338

(2) Rolling Stock Required

The rolling stock to be used in the project shall correspond with the forecast of passenger and freight volumes at the forecasted years as shown in **Tables 5.3.2-12** and **5.3.2-13**.

Table 5.3.2-12 Number of Rolling Stocks Required

Type of Rolling Stock	2025	2034	2044	2054
DMU (Car)	12	12	15	18
Locomotive (Passenger Train)	1	1	1	1
Locomotive (Freight Train)	3	4	5	6
Container Wagon	150	194	250	338
Passenger Coach (Car)	10	12	15	16

Table 5.3.2-13 Additional Rolling Stocks Required

Type of Rolling Stock	2025	2034	2044	2054
DMU (Car)	-	-	3	3
Locomotive (Passenger Train)	-	-	-	-
Locomotive (Freight Train)	-	1	1	1
Container Wagon	-	44	56	88
Passenger Coach (Car)	-	2	3	1

(3) Train Diagram and Timetable

Train diagrams are shown in **Figures 5.3.2-4** to **5.3.2-7** and Train Run Timetables are shown in **Tables 5.3.2-14** to **5.3.2-21** for the forecasted years.

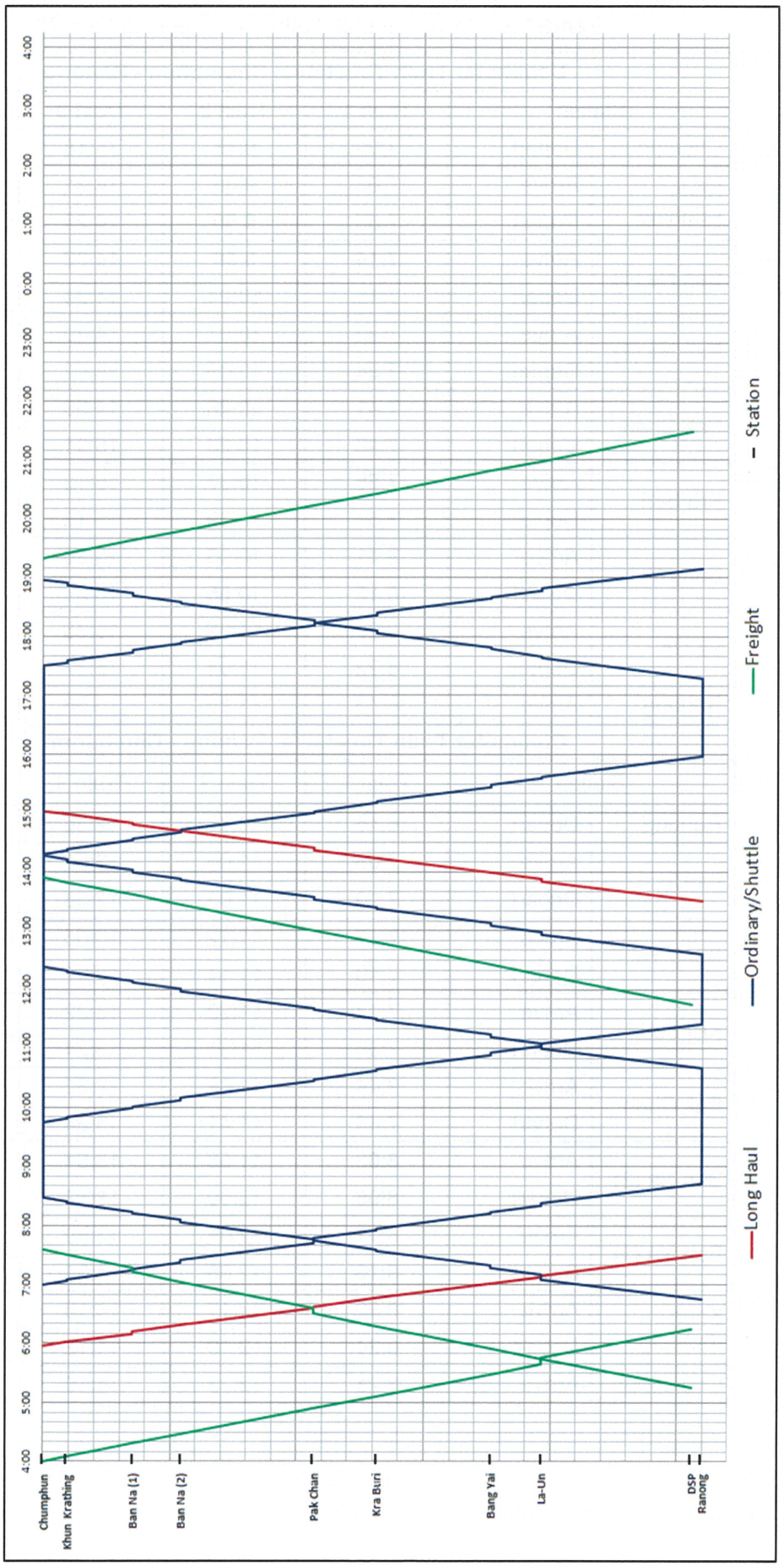


Figure 5.3.2-4 Train Diagram for Year 2025

Table 5.3.2-14 Commuter Train Timetable for Year 2025

Commuter Train Timetable: Chumphun - Ranong					
Station		Train 1	Train 2	Train 3	Train 4
Chumphun	Depart	7:00	9:45	14:18	17:30
Khun Krathing	Arrive	7:03	9:48	14:21	17:33
	Depart	7:05	9:50	14:23	17:35
Ban Na (1)	Arrive	7:14	9:59	14:32	17:44
	Depart	7:16	10:01	14:34	17:46
Ban Na (2)	Arrive	7:22	10:07	14:40	17:52
	Depart	7:24	10:09	14:42	17:54
Pak Chan	Arrive	7:41	10:26	14:59	18:11
	Depart	7:46	10:28	15:01	18:13
Kra Buri	Arrive	7:55	10:37	15:10	18:22
	Depart	7:57	10:39	15:12	18:24
Bang Yai	Arrive	8:11	10:53	15:26	18:38
	Depart	8:13	10:55	15:28	18:40
La-Un	Arrive	8:20	11:02	15:35	18:47
	Depart	8:22	11:04	15:37	18:49
Ranong	Arrive	8:43	11:25	15:58	19:10
Commuter Train Timetable: Ranong - Chumphun					
Station		Train 1	Train 2	Train 3	Train 4
Ranong	Depart	6:45	10:40	12:36	17:18
La-Un	Arrive	7:05	11:00	12:56	17:38
	Depart	7:10	11:05	12:58	17:40
Bang Yai	Arrive	7:17	11:12	13:05	17:47
	Depart	7:19	11:14	13:07	17:49
Kra Buri	Arrive	7:33	11:29	13:22	18:04
	Depart	7:35	11:31	13:24	18:06
Pak Chan	Arrive	7:44	11:39	13:32	18:14
	Depart	7:46	11:41	13:34	18:16
Ban Na (2)	Arrive	8:03	11:58	13:51	18:33
	Depart	8:05	12:00	13:53	18:35
Ban Na (1)	Arrive	8:11	12:06	13:59	18:41
	Depart	8:13	12:08	14:01	18:43
Khun Krathing	Arrive	8:22	12:17	14:10	18:52
	Depart	8:24	12:19	14:12	18:54
Chumphun	Arrive	8:28	12:23	14:16	18:58

Table 5.3.2-15 Special Express Train Timetable for Year 2025

Special Express Train Timetable: Bangkok - Ranong		
Station		Train 1
Bangkok	Depart	23.00
Chumphun	Arrive Depart	5.53 5.58
Ban Na (1)	Arrive Depart	6.10 6.12
Pak Chan	Arrive Depart	6.35 6.37
La-Un	Arrive Depart	7.07 7.09
Ranong	Arrive	7.30
Special Express Train Timetable: Ranong - Bangkok		
Station		Train 1
Ranong	Depart	13.30
La-Un	Arrive Depart	13.50 13.52
Pak Chan	Arrive Depart	14.22 14.24
Ban Na (1)	Arrive Depart	14.47 14.49
Ranong	Arrive Depart	15.02 15.07
Bangkok	Arrive	22.00

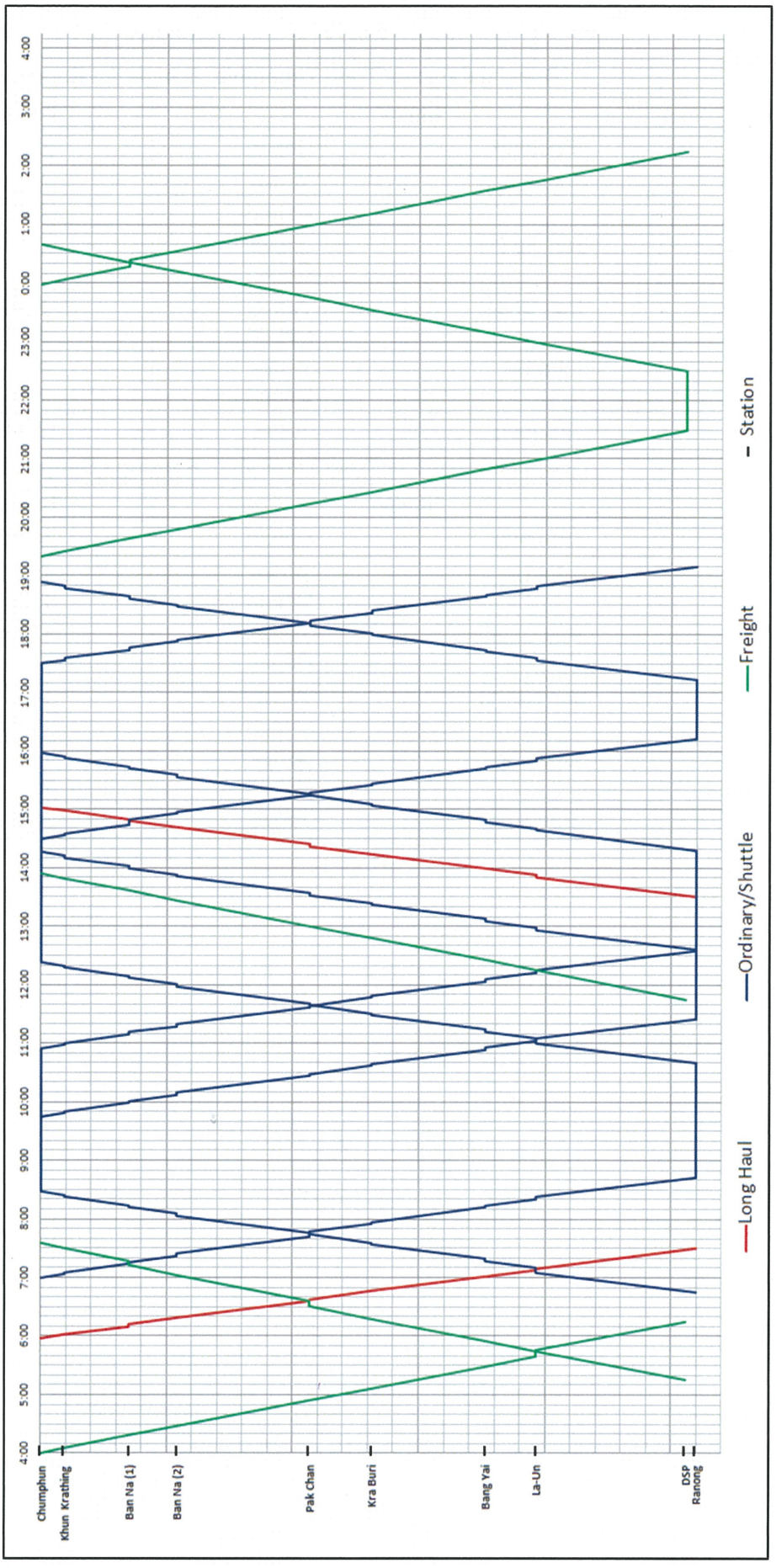


Figure 5.3.2-5 Train Diagram for Year 2034

Table 5.3.2-16 Commuter Train Timetable for Year 2034

Commuter Train Timetable: Chumphun - Ranong						
Station		Train 1	Train 2	Train 3	Train 4	Train 5
Chumphun	Depart	7:00	9:45	10:55	14:30	17:30
Khun Krathing	Arrive	7:03	9:48	10:58	14:33	17:33
	Depart	7:05	9:50	11:00	14:35	17:35
Ban Na (1)	Arrive	7:14	9:59	11:09	14:44	17:44
	Depart	7:16	10:01	11:11	14:49	17:46
Ban Na (2)	Arrive	7:22	10:07	11:17	14:55	17:52
	Depart	7:24	10:09	11:19	14:57	17:54
Pak Chan	Arrive	7:41	10:26	11:36	15:14	18:11
	Depart	7:46	10:28	11:38	15:16	18:13
Kra Buri	Arrive	7:55	10:37	11:47	15:25	18:22
	Depart	7:57	10:39	11:49	15:27	18:24
Bang Yai	Arrive	8:11	10:53	12:03	15:41	18:38
	Depart	8:13	10:55	12:05	15:43	18:40
La-Un	Arrive	8:20	11:02	12:12	15:50	18:47
	Depart	8:22	11:04	12:14	15:52	18:49
Ranong	Arrive	8:43	11:25	12:35	16:13	19:10
Commuter Train Timetable: Ranong - Chumphun						
Station		Train 1	Train 2	Train 3	Train 4	Train 5
Ranong	Depart	6:45	10:40	12:36	14:18	17:13
La-Un	Arrive	7:05	11:00	12:56	14:38	17:33
	Depart	7:10	11:05	12:58	14:40	17:35
Bang Yai	Arrive	7:17	11:12	13:05	14:47	17:42
	Depart	7:19	11:14	13:07	14:49	17:44
Kra Buri	Arrive	7:33	11:29	13:22	15:04	17:59
	Depart	7:35	11:31	13:24	15:06	18:01
Pak Chan	Arrive	7:44	11:39	13:32	15:14	18:09
	Depart	7:46	11:41	13:34	15:16	18:11
Ban Na (2)	Arrive	8:03	11:58	13:51	15:33	18:28
	Depart	8:05	12:00	13:53	15:35	18:30
Ban Na (1)	Arrive	8:11	12:06	13:59	15:41	18:37
	Depart	8:13	12:08	14:01	15:43	18:39
Khun Krathing	Arrive	8:22	12:17	14:10	15:52	18:47
	Depart	8:24	12:19	14:12	15:54	18:49
Chumphun	Arrive	8:28	12:23	14:16	15:58	18:53

Table 5.3.2-17 Special Express Train Timetable for Year 2034

Special Express Train Timetable: Bangkok - Ranong		
Station		Train 1
Bangkok	Depart	23.00
Chumphun	Arrive Depart	5.53 5.58
Ban Na (1)	Arrive Depart	6.10 6.12
Pak Chan	Arrive Depart	6.35 6.37
La-Un	Arrive Depart	7.07 7.09
Ranong	Arrive	7.30
Special Express Train Timetable: Ranong - Bangkok		
Station		Train 1
Ranong	Depart	13.30
La-Un	Arrive Depart	13.50 13.52
Pak Chan	Arrive Depart	14.22 14.24
Ban Na (1)	Arrive Depart	14.47 14.49
Ranong	Arrive Depart	15.02 15.07
Bangkok	Arrive	22.00

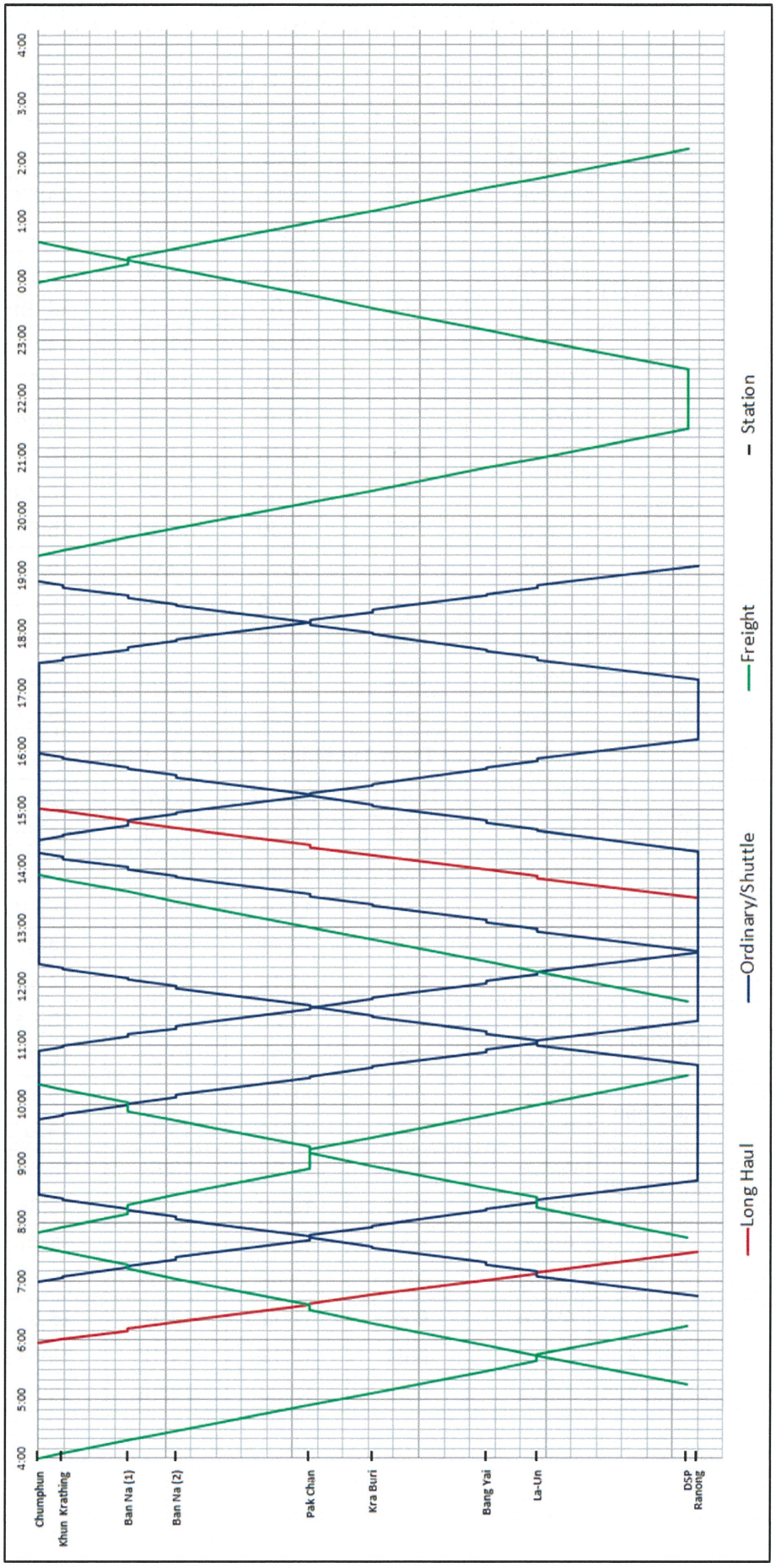


Figure 5.3.2-6 Train Diagram for Year 2044

Table 5.3.2-18 Commuter Train Timetable for Year 2044

Commuter Train Timetable: Chumphun - Ranong						
Station		Train 1	Train 2	Train 3	Train 4	Train 5
Chumphun	Depart	7:00	9:45	10:55	14:30	17:30
Khun Krathing	Arrive	7:03	9:48	10:58	14:33	17:33
	Depart	7:05	9:50	11:00	14:35	17:35
Ban Na (1)	Arrive	7:14	9:59	11:09	14:44	17:44
	Depart	7:16	10:01	11:11	14:49	17:46
Ban Na (2)	Arrive	7:22	10:07	11:17	14:55	17:52
	Depart	7:24	10:09	11:19	14:57	17:54
Pak Chan	Arrive	7:41	10:26	11:36	15:14	18:11
	Depart	7:46	10:28	11:38	15:16	18:13
Kra Buri	Arrive	7:55	10:37	11:47	15:25	18:22
	Depart	7:57	10:39	11:49	15:27	18:24
Bang Yai	Arrive	8:11	10:53	12:03	15:41	18:38
	Depart	8:13	10:55	12:05	15:43	18:40
La-Un	Arrive	8:20	11:02	12:12	15:50	18:47
	Depart	8:22	11:04	12:14	15:52	18:49
Ranong	Arrive	8:43	11:25	12:35	16:13	19:10
Commuter Train Timetable: Ranong - Chumphun						
Station		Train 1	Train 2	Train 3	Train 4	Train 5
Ranong	Depart	6:45	10:40	12:36	14:18	17:13
La-Un	Arrive	7:05	11:00	12:56	14:38	17:33
	Depart	7:10	11:05	12:58	14:40	17:35
Bang Yai	Arrive	7:17	11:12	13:05	14:47	17:42
	Depart	7:19	11:14	13:07	14:49	17:44
Kra Buri	Arrive	7:33	11:29	13:22	15:04	17:59
	Depart	7:35	11:31	13:24	15:06	18:01
Pak Chan	Arrive	7:44	11:39	13:32	15:14	18:09
	Depart	7:46	11:41	13:34	15:16	18:11
Ban Na (2)	Arrive	8:03	11:58	13:51	15:33	18:28
	Depart	8:05	12:00	13:53	15:35	18:30
Ban Na (1)	Arrive	8:11	12:06	13:59	15:41	18:37
	Depart	8:13	12:08	14:01	15:43	18:39
Khun Krathing	Arrive	8:22	12:17	14:10	15:52	18:47
	Depart	8:24	12:19	14:12	15:54	18:49
Chumphun	Arrive	8:28	12:23	14:16	15:58	18:53

Table 5.3.2-19 Special Express Train Timetable for Year 2044

Special Express Train Timetable: Bangkok - Ranong		
Station		Train 1
Bangkok	Depart	23.00
Chumphun	Arrive Depart	5.53 5.58
Ban Na (1)	Arrive Depart	6.10 6.12
Pak Chan	Arrive Depart	6.35 6.37
La-Un	Arrive Depart	7.07 7.09
Ranong	Arrive	7.30
Special Express Train Timetable: Ranong - Bangkok		
Station		Train 1
Ranong	Depart	13.30
La-Un	Arrive Depart	13.50 13.52
Pak Chan	Arrive Depart	14.22 14.24
Ban Na (1)	Arrive Depart	14.47 14.49
Ranong	Arrive Depart	15.02 15.07
Bangkok	Arrive	22.00

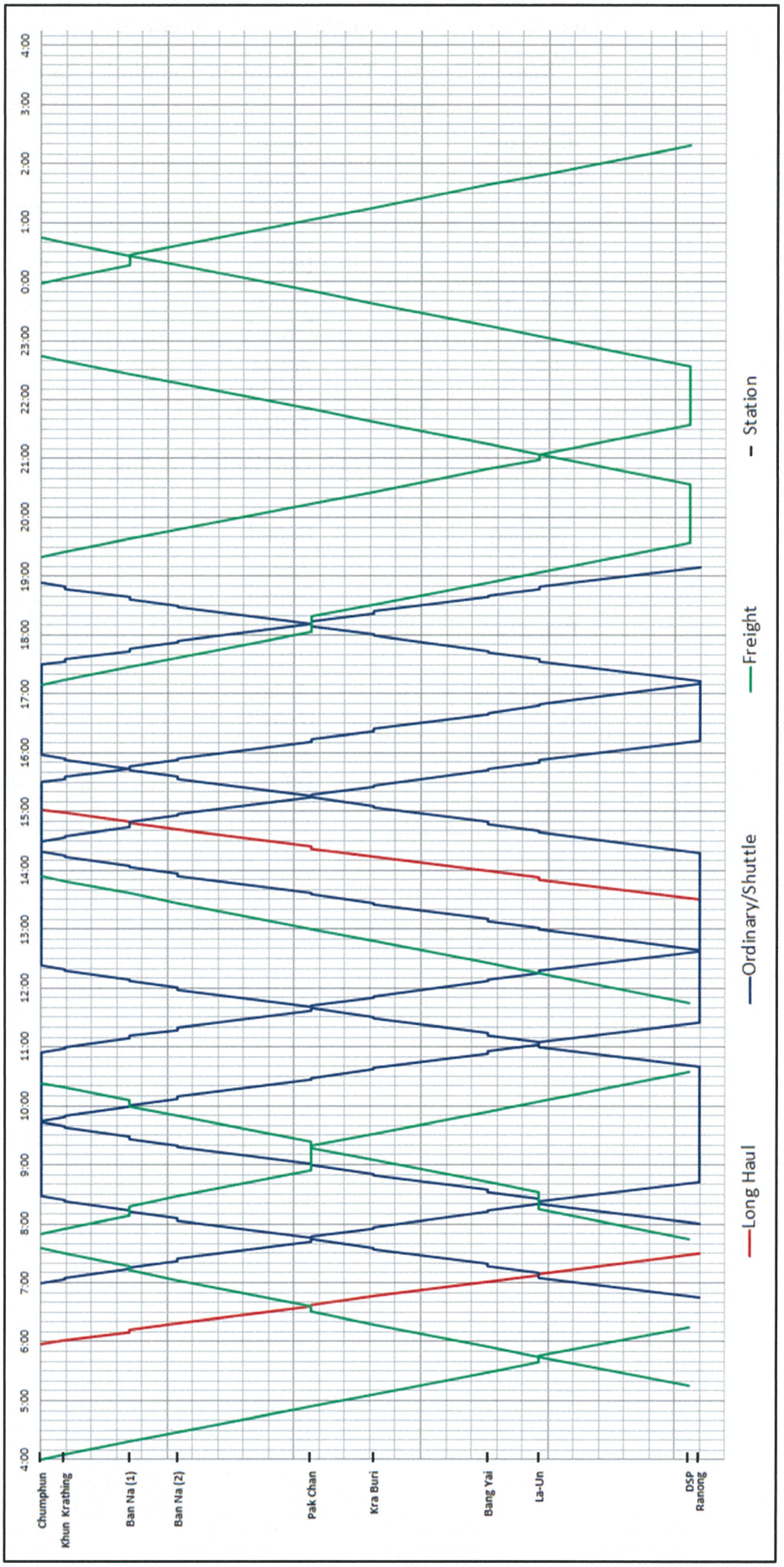


Figure 5.3.2-7 Train Diagram for Year 2054

Table 5.3.2-20 Commuter Train Timetable for Year 2054

Commuter Train Timetable: Chumphun - Ranong							
Station		Train 1	Train 2	Train 3	Train 4	Train 5	Train 6
Chumphun	Depart	7:00	9:45	10:55	14:30	15:30	17:30
Khun Krathing	Arrive	7:03	9:48	10:58	14:33	15:33	17:33
	Depart	7:05	9:50	11:00	14:35	15:35	17:35
Ban Na (1)	Arrive	7:14	9:59	11:09	14:44	15:44	17:44
	Depart	7:16	10:01	11:11	14:49	15:46	17:46
Ban Na (2)	Arrive	7:22	10:07	11:17	14:55	15:52	17:52
	Depart	7:24	10:09	11:19	14:57	15:54	17:54
Pak Chan	Arrive	7:41	10:26	11:36	15:14	16:11	18:11
	Depart	7:46	10:28	11:41	15:16	16:13	18:13
Kra Buri	Arrive	7:55	10:37	11:50	15:25	16:22	18:22
	Depart	7:57	10:39	11:52	15:27	16:24	18:24
Bang Yai	Arrive	8:11	10:53	12:06	15:41	16:38	18:38
	Depart	8:13	10:55	12:08	15:43	16:40	18:40
La-Un	Arrive	8:20	11:02	12:15	15:50	16:47	18:47
	Depart	8:22	11:04	12:17	15:52	16:49	18:49
Ranong	Arrive	8:43	11:25	12:38	16:13	17:10	19:10
Commuter Train Timetable: Ranong - Chumphun							
Station		Train 1	Train 2	Train 3	Train 4	Train 5	Train 6
Ranong	Depart	6:45	8:00	10:40	12:39	14:18	17:13
La-Un	Arrive	7:05	8:20	11:00	12:59	14:38	17:33
	Depart	7:10	8:25	11:05	13:01	14:40	17:35
Bang Yai	Arrive	7:17	8:32	11:12	13:08	14:47	17:42
	Depart	7:19	8:34	11:14	13:10	14:49	17:44
Kra Buri	Arrive	7:33	8:48	11:29	13:25	15:04	17:59
	Depart	7:35	8:50	11:31	13:27	15:06	18:01
Pak Chan	Arrive	7:44	8:59	11:39	13:35	15:14	18:09
	Depart	7:46	9:01	11:41	13:37	15:16	18:11
Ban Na (2)	Arrive	8:03	9:18	11:58	13:54	15:33	18:28
	Depart	8:05	9:20	12:00	13:56	15:35	18:30
Ban Na (1)	Arrive	8:11	9:26	12:06	14:02	15:41	18:37
	Depart	8:13	9:28	12:08	14:04	15:43	18:39
Khun Krathing	Arrive	8:22	9:37	12:17	14:13	15:52	18:47
	Depart	8:24	9:39	12:19	14:15	15:54	18:49
Chumphun	Arrive	8:28	9:43	12:23	14:19	15:58	18:53

Table 5.3.2-21 Special Express Train Timetable for Year 2054

Special Express Train Timetable: Bangkok - Ranong		
Station		Train 1
Bangkok	Depart	23.00
Chumphun	Arrive Depart	5.53 5.58
Ban Na (1)	Arrive Depart	6.10 6.12
Pak Chan	Arrive Depart	6.35 6.37
La-Un	Arrive Depart	7.07 7.09
Ranong	Arrive	7.30
Special Express Train Timetable: Ranong - Bangkok		
Station		Train 1
Ranong	Depart	13.30
La-Un	Arrive Depart	13.50 13.52
Pak Chan	Arrive Depart	14.22 14.24
Ban Na (1)	Arrive Depart	14.47 14.49
Ranong	Arrive Depart	15.02 15.07
Bangkok	Arrive	22.00

8) Cost Estimation for Train and Train Operation

The cost of rolling stock was based on other SRT and OTP projects both actual deliverables and budget estimates, as well as well-known international study reports e.g. "Price and Costs in the Railway Sector (J.P. Baumgartner, Switzerland, 2001)".

The train operation cost included salary for staff working at station, container yard and on train, maintenance staff, fuel cost and maintenance cost. The fuel cost and maintenance cost shall vary according to traveling distance of that train. The salary shall cover the distance of the project only.

5.4 Preparation of Right of Way Plan and Land Acquisition

The preparation of right of way plan and land acquisition is to provide basic information for the estimation of land expropriation cost and compensation cost for buildings. The Consultant has prepared the right of way plan on the same scale as the preliminary design by having the satellite image overlaid the cadastral map to show the cadastral boundary as a background. Then, the land expropriation cost and compensation cost were estimated based on this information. The detailed process is as follows:

5.4.1 Land Expropriation Cost

The land expropriation cost was estimated based on the appraisal cost of each land parcel of the Treasury Department for years 2016-2019. If it cannot be verified, the estimated price from the adjacent land was used for analysis e.g. land adjacent to road, lane and land without access. After multiplying the land area with the unit land price,

the result was adjusted 200% for the market price and added 10% for land devaluation. The total amount was then added 20% for litigation and appeal and for budgeting. The compensation cost for perennial trees and crops was estimated 10% of the land expropriation cost.

5.4.2 Building Compensation Cost

In estimating the compensation cost for buildings, the Consultant has classified the types, sizes, materials, number of storeys according to the types and price per square meter of the Treasury Department of March 2017. After estimating the compensation cost, this cost was added 20% for provisional sum (litigation and appeal) and for budgeting.

5.4.3 Summary of Land Expropriation Cost and Building Compensation Cost

678 land parcels or 3,840.40 rai shall have to be expropriated consisting of 1) Land that has the title deed or the certificate of utilization (N.S.3K.) 585.07 rai, 2) Royal land 54.80 rai 3) Land declared as a land reform zone under the supervision of the Agricultural Land Reform Office (Sor Por Kor.) 702.02 rai 4) Monastery land 0.62 rai 5) Occupied land 2,498.19 rai. The total land expropriation cost is 1,033.36 Million Baht. For building compensation cost, 254 buildings shall have to be compensated for the amount of 607.00 Million Baht.

The total expropriation cost was estimated at 1,640.36 Million Baht.

5.5 PRELIMINARY COST ESTIMATION

The Consultant has conducted a preliminary cost estimation based on the selected route for use in the feasibility study. The investment cost was divided into 3 periods, i.e. 1. Investment cost for pre-construction period 2. Investment cost during construction period and 3. Investment cost during operation period. The preliminary cost included materials, labor, operating costs, profits, other expenses, provisional sums and VAT **but excluding** the cost of container yard and lifting equipment at the terminal station which is the responsibility of other relevant agencies. The details of the preliminary cost estimation are as follows:

1) Investment cost for pre-construction period is the design fee.
2) Investment cost during construction period included:
   (1) Preliminary land acquisition cost based on the appraisal cost of the Treasury Department. After deriving the cost according to the Treasury Department, this cost, then, was calculated to the market price and the provisional sums by the appropriate percentage.
   (2) Preliminary building compensation cost based on the appraisal of the Treasury Department. After deriving the cost according to the Treasury Department, this cost, then, was calculated to the market price and the provisional sums by the appropriate percentage.
   (3) The cost of at-grade track was estimated by unit volume, elevated track and railway bridge by quantity take off and unit price, underground track or tunnel by linear kilometer.
   (4) The cost of overpass was estimated by number and box underpass by linear meter. These costs were based on quantity take off and unit price.
   (5) Station and staff's accommodation were estimated by number.
   (6) Maintenance base was estimated by number.

(7) Pedestrian bridge was estimated by number.

(8) Fence was estimated by linear kilometer.

(9) Box culvert was estimated by linear meter.

(10)Service Road was estimated by price per square meter.

(11)Utility relocation was estimated according to the number of level crossings.

(12) Environmental cost

- Monitoring of Environmental Quality
  - Monthly measure air quality, noise and vibration at 4 stations for 5 consecutive days throughout the construction period.
  - Annually collect surface water quality and aquatic ecology sampling at 4 stations for twice a year (dry season and rainy season) throughout the construction period.
  - Conduct a survey by questionnaire of affected people on resettlement and residents along the sensitive areas to environmental impacts once a year throughout the alignment.
- Reforestation both terrestrial and mangrove forest
  - Reforestation and replanting in designated areas during the 1-2 years of reforestation.
  - Maintenance work during the 2-10 years of reforestation.

(13) Trackwork was estimated according to quantity and unit price used for this project.

(14) Railway System consisting of signaling and telecommunication system was estimated by quantity and unit price including the cost of design, equipment, installation, test & commissioning and spare parts.

(15) Procurement cost of rolling stock depends on the types and number of rolling stocks which have to be sufficient for train operation and consistent with the forecast of passenger and freight volumes, frequencies, geometry of route alignment. So, the procurement cost was estimated according to the number of rolling stock and unit price of each type.

3) Investment cost during train operation include:

(1) Train Operation Cost

- Train operation cost consists of personnel cost, fuel cost and execution cost for train operation.
- The cost estimation was based on the SRT's rules of practices and cost estimation structures.
- The execution cost for train operation was derived from train operation formation, train type and related technical information.
- Station cost included the cost of water supply, electricity, telephone and internet, durable articles and other facilities.
- Procurement cost of rolling stock shall increase every 10 years.

(2) Maintenance cost for infrastructure, rolling stock and station throughout the operation period included regular operating and maintenance cost, periodic

maintenance cost, special maintenance and rehabilitation cost which was estimated as follows:

- Maintenance cost for infrastructure system

  The infrastructure system consists of trackwork, signaling and telecommunication system. The maintenance cost for trackwork include the cost of track inspection, tampering and ballast cleaning. The cost was estimated by linear kilometer and on the assumption that the maintenance vehicles e.g. ballast tamper, chipping spreader and bogie inspection car shall use the SRT's available equipment to reduce cost.

  The maintenance cost for signaling and telecommunication system is quite low. Besides the cost of spare parts and consumable parts which is based on the related industry, the cost includes the system improvement or replacement within 5-10 years. The first spare part cost and consumable part cost was already included in the construction cost.

- Maintenance cost for rolling stock

  As already mentioned, the depot of the project shall be for minor periodic maintenance and some special maintenance.

  The maintenance cost for rolling stock includes the cost for periodic maintenance, spare parts, overhaul and mid-life refurbishment. The frequency for each maintenance type depends on the travel distance per year and the maintenance cost depends on the type of rolling stock. If the rolling stock was used with other routes, it must estimate the maintenance cost proportion to the travel distance.

- Maintenance cost for station

  The maintenance cost for station includes the maintenance for every 10 years such as general maintenance for station, landscape, durable articles, furniture, electrical appliances and computer and radio communication etc.

(3) Cost for Monitoring of Environmental Quality

- Cost for Monitoring of Environmental Quality
  - Monthly measure air quality, noise and vibration at 4 stations for 5 consecutive days for the first 3 years of operation, after that every 5 years throughout the operation period.
  - Annually collect surface water quality and aquatic ecology sampling at 6 stations for 5 consecutive days for twice a year for the first 3 years of operation, after that every 5 years throughout the operation period.
  - Conduct a survey by questionnaire of affected people on resettlement and residents along the sensitive areas to environmental impacts once a year for the first 3 years of operation, after that every 5 years throughout the operation period.
- Maintenance Cost for Reforestation
  - Maintenance work during the 2-10 years of reforestation.

Table 5.5-1 shows the preliminary cost estimation for pre-construction period, during construction period and during operation period.

Table 5.5-1 Preliminary Cost Estimation

Description	Amount including VAT (Million Baht)
Pre-Construction Period	
1. Design Fee	**300.00**
During Construction Period	
1. Land Expropriation Cost	1,640.36
2. Construction Supervision Consultant Fee	692.16
3. Environmental Cost	
3.1 Cost for Monitoring of Environmental Quality	29.44
3.2 Cost for Reforestation and Maintenance	14.21
4. Cost for Civil work	21,548.16
5. Cost for Trackwork	1,859.12
6. Cost for Signaling & Telecomunication System	1,247.71
7. Cost for Rolling Stock	2,191.50
Subtotal : During Construction Period	**29,222.66**
Opreation Period (30 years)	
1. Execution Cost for Train Operation	9,290.66
2. Maintenance Cost	1,894.48
3. Environmental Cost	
3.1 Cost for Monitoring of Environmental Quality	10.53
3.2 Cost for Maintenance of reforestation throughout the period	65.58
4. Procurement Cost for Additional Rolling Stock	1,244.74
5. Maintenance Cost for Rolling Stock	3,815.36
Subtotal : Operation period	**16,321.35**
Total Amount	**45,844.01**

5.6 Project Implementation Plan

During this Feasibility Study Project, the Consultant has prepared the project implementation plan which was aimed to prepare the work sequences leading to the construction of the Chumphon-Ranong Railway Project. The work sequences had been prepared for a correlation and consistency in order to be able to set the opening date for operation in a timely manner.

Based on the forecast of passenger and freight volumes, it was found that a single track system shall be suitable for the project. There shall be 3 passing loops for shunting for outbound and inbound trips at 3 stations namely Ban Na (1) Station, Pak Chan Station and La-un station which are sufficient for a 30-year operation.

The Consultant has prepared the probable project implementation plan which the project can be operated soonest as shown in **Figure 5.6-1**. This plan was used with other government infrastructure projects on the assumption that the work of each sequence in the plan is smooth, continuous and effective. The sequences are as follows: after the feasibility study project was approved, the SRT will select the Consultant to undertake the detailed design and prepare the environmental impact assessment report (EIA) which will take about 12 months. The SRT will submit the EIA report to the environmental agencies such as the Office of Natural Resources and Environmental Policy and Planning (ONEP) by having the Expert Committee to Consider Environmental Impact Assessment Report initially approved the report, then the report will be submitted to the National Environment Board (NEB) for approval. After approval, the selection process of Contractor could be started. The construction is expected to take about 48 months. During submission the EIA report to the environmental agencies, the SRT will select the Construction Supervision Consultant to review and update the tender documents prior to the engagement of the Contractor which is expected to take at least 12 months. Therefore, the process after the feasibility study till the first day of operation will take approximately 7 years.

.

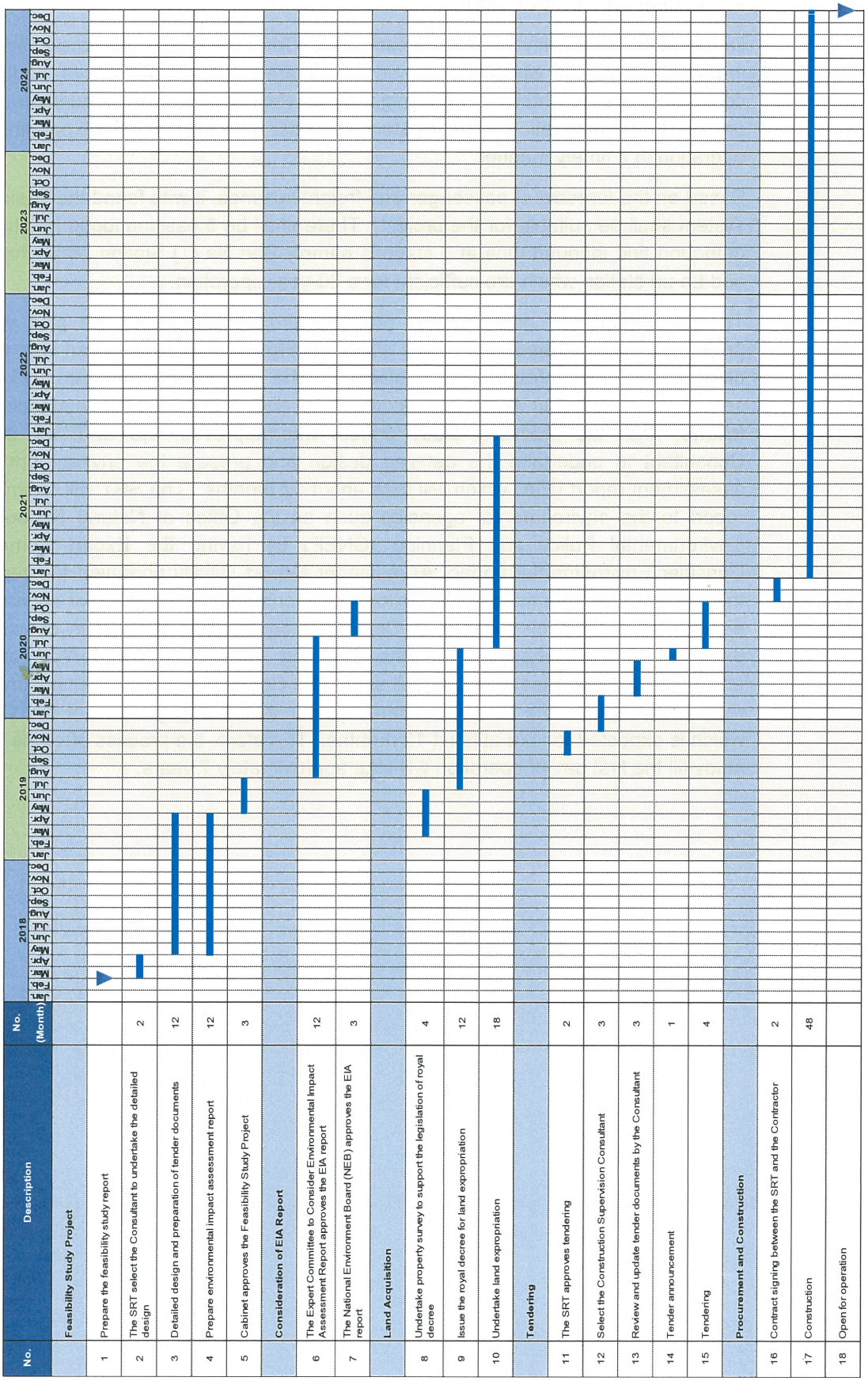


Figure 5.6-1 Project Implementation Plan (for Feasibility Study Project)

Chapter 6

Initial Environmental Examination: IEE

Chapter 6
Initial Environmental Examination: IEE

6.1 Guideline of Environmental Study

The environmental impact assessment is the processes that evaluating the effects that may occur due to development projects in both construction Phase and operation Phase that cover in four areas, which are; physical environmental resources. Biological environmental resources, human use values and quality of life. By proceed accordingly with the guidelines of the Environmental Impact Assessment Division. Natural Resources and Environmental Policy and Planning Office.

6.1.1 Study of existing environmental condition

The study of existing environmental condition focuses on factors of environmental resources and values relating to the project development, which include:

- Physical environmental resources – topography, geology and earthquakes, soil resources and soil erosion, hydrology and surface water quality, hydrology and groundwater, air and atmosphere, noise, and vibration.
- Biological environmental resources – forest resources and watershed classes, wildlife resources, and aquatic ecology.
- Human use value – land use, agriculture, transport, public utility, and flood control and drainage.
- Life quality value – socio-economics, land acquisition and expropriation, severance, public health and occupational health, sanitary, accidents and safety, specific area of local community, history and archeology site, and aesthetic and Tourism

6.1.2 Initial Impact Examination

IEE study is to evaluate the impact of activities of project. Consider the construction phase and operation phase activities. The criteria used to determine the type of impact and magnitude of the impact. It predicts or predicts changes in the magnitude and direction of human behavior. The results can be compared with standard values or carrying capacity of nature. Therefore, environmental impact assessment of the project development is defined as follows

1) Type of Impact
   - Positive impact : The activities to be carried out or the results of the development of the project are beneficial to the environment and the use of human beings.
   - Negative impact : Activities to be carried out or results from the development of the project will have an impact on the environment and human uses.

2) Magnitude of Impact
   - Highly Level (3) : The development of the project has made the environmental factors change beyond the established standards, resulting in serious and permanent environmental changes. And the scope of the impact spread out to a broad.
   - Moderate Level (2) : The development of the project has resulted in a moderate change in the environmental factors, but does not exceed the standard value compared to the standard. Or change to environmental resources, with scope of impact. In the limited line in the ROW of route alignment.

- Low Level (1) : The development of the project has made little change in environmental factors and changes in some areas of the ROW railway alignment.
- No Impact (0) : The activities of project development do not cause changes in the environment

6.1.3 Measures of Mitigation

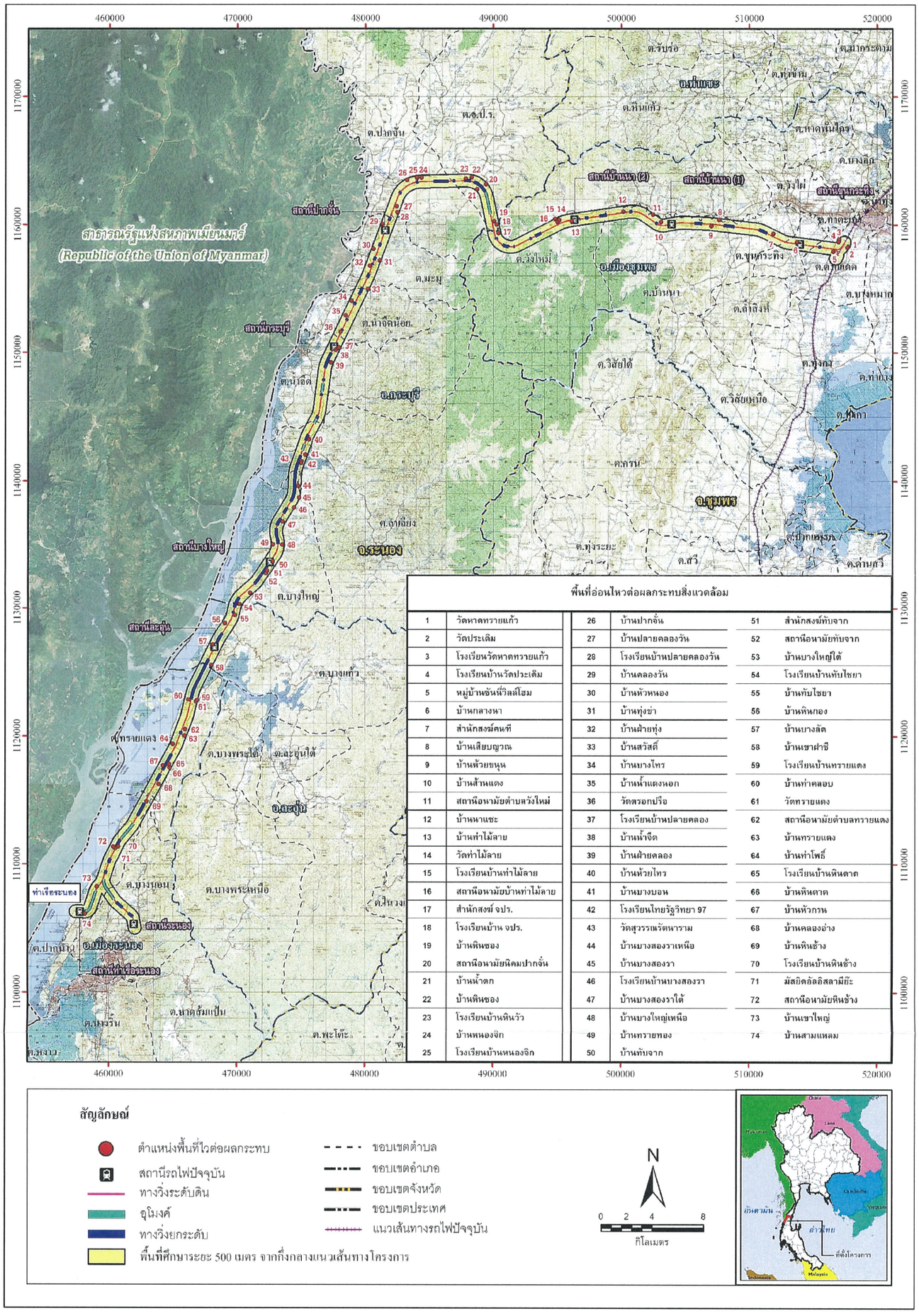
Given the measures to prevent, correct and reduce negative impacts on the environment. Including measures to improve the quality of the environment from the original. Consider the appropriate measures for the impact and practicality

6.1.4 Measures of Monitoring

To propose measures to monitor environmental impacts on significant impacts.

6.2 Location of Project And Study Area

Environmental Impact Assessment Study of the Project covers the area along the project route. Cut through and adjacent areas from the center line of the project line (center line) of 500 meters or more, if considered to be affected. It is included in 4 districts and 15 subdistricts of Chumphon and Ranong Province. By developing the project. It is a single track railway with total distance of 109 kilometers. Track structure consists of at grade, elevated and single tunnel. There are 8 new stations excluding the Container Yard (CY) at Ranong Port Station, as shown in **figure 6.2-1**


460000
470000
480000
490000
500000
510000
520000
1170000
1160000
1150000
1140000
1130000
1120000
1110000
1100000
สาธารณรัฐแห่งสหภาพเมียนมาร์
(Republic of the Union of Myanmar)
ท่าเรือระนอง
อ.เมืองชุมพร
อ.ละอุ่น
อ.กระบุรี
อ.ระนอง
อ.ปะทิว
สถานีปากจั่น
สถานีกระบุรี
สถานีบางใหญ่
สถานีละอุ่น
สถานีท่าเรือระนอง
สถานีบ้านหม (2)
สถานีบ้านหม (1)
สถานีชุมทางชุมพร
สถานีชุมทางท่าแซะ
ต.ปากจั่น
ต.ม่ะมุ
ต.น้าจืดน้อย
ต.น้าจืด
ต.ลำเลียง
ต.บางใหญ่
ต.บางแก้ว
ต.ทรายแดง
ต.บางพระใต้
ต.ละอุ่นใต้
ต.บางนอน
ต.บางพระเหนือ
ต.ปากน้ำ
ต.ราชกรูด
ต.หาดส้มแป้น
ต.บางริ้น
ต.พะโต๊ะ
ต.ทรัพย์อนันต์
ต.ท่าแซะ
ต.หินแก้ว
ต.ทุ่งคา
ต.ขุนกระทิง
ต.ตากแดด
ต.บางหมาก
ต.วังใหม่
ต.บ้านนา
ต.วิสัยใต้
ต.วิสัยเหนือ
ต.ทุ่งคา
ต.ท่ายาง
ต.ทรน
ต.ทุ่งระยะ
ต.สวี
ต.ด่านสวี
ต.ปากแพรก
ต.ทุ่งหลวง
ต.ทุ่งหลวง
ต.ทุ่งหลวง

6.3 The Result of Initial Environment Examination

The result of IEE can be summarized that the major environmental impacts of that the New Railway Project for Chumphon – Ranong Port include topography, soil resources and soil erosion, surface hydrology, forest, watershed classification, transportation, drainage control and flood prevention, land use, severance and land acquisition and expropriation . The magnitude and direction of environmental impact studies are summarized in **Table 6.3-1 and the details of the** evaluation and mitigation measures in each field can be summarized in **Table 6.3-2.**

Table 6.3-1 Summary of Magnitude and Direction of Environmental Impacts

No.	Environmental Factors	Environmental Impact			
		Construction Phase		Operation Phase	
		Direction	Magnitude	Direction	Magnitude
1	Topography	-	Moderate	0	0
2	Soil resources and soil erosion	-	Moderate	0	0
3	Geology and Earthquakes	-	Low	0	Low
4	Sub-surface hydrology	-	Low	0	0
5	Surface hydrology	-	Moderate	-	Low
6	Surface Water Quality	-	Low	-	Low
7	Air and Atmosphere	-	Low	-	Low
8	Noise	-	Low	-	Low
9	Vibration	-	Low	-	Low
10	Watershed Classification	-	Moderate	0	0
11	Forest	-	High	0	0
12	Wild Life	-	Moderate	-	Low
13	Aquatic Ecology	-	Low	-	Low
14	Transportation	-	Moderate	+	Moderate
15	Public Utility	-	Low	0	0
16	Drainage control and flood prevention	-	Moderate	0	0
17	Land Use	-	High	+	Low
18	Agriculture	-	Low	-	Low
19	Socio-Economics	-	Low	+	Low
20	Land Acquisition and Expropriation	-	High	0	0
21	Severance	-	Moderate	-	Low
22	Public Health / Occupational Health	-	Low	+	Low
23	Sanitary	-	Low	-	Low
24	Accidents and Safety	-	Low	-	Low
25	Specific area of local community	-	Low	0	0
26	Historic and Archaeology Site	-	Low	-	Low
27	Aesthetic and Tourism	-	Low	+	Low

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
1) Topographic	***Construction Phase:*** The project area along the distance 190 km is across from the coastal plain, low land, hilly and high mountains. The structure design of the railway is mainly at grade/elevated/tunnel. Anyhow the construction is limit only in the ROW of the railway. The alignment design tried to avoid high slopes except for the mountainous area that require tunnel excavation. So, the impact that occurs during the construction period is expected to be moderate.	***Construction Phase:*** - Specify the ROW and construction area clearly. And to adjust the area only in the designated area.	***Construction Phase:*** -
	Operation Phase: When construction completed. There will be no change in terrain thus there is no impact on the terrain.	***Operation Phase:*** -	***Operation Phase:*** -
2) Soil resources and soil erosion	***Construction Phase:*** During the construction period, the area will be cleared and open the ground for foundation construction and the soil shall be stock in the construction area. For the tunnel construction sites, a large number of excavations and excavations stock area is required. The construction of the tracks on the ground must be open the soil surface throughout the line. This can cause soil erosion when it is raining. However, the nature of the activity is temporary and limited to the construction area, so the impact is moderate.	***Construction Phase:*** - Important construction activities should be conducted during the dry season such as excavation and site reclamation. - When the area is leveling, the cover crops should be planted in open spaces such as mulch and grass. - Control the materials stockpile in the right place and avoid areas that are easily eroded and should not be stored for too long period.	***Construction Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
2) Soil resources and soil erosion (cont.)	***Operation Phase:*** In the operation period of the project, the area that had opened their surface will be replaced by the construction. So the soil erosion does not occur. In addition, the surrounding area of the railway station will be landscaped by planting trees and green area arrangement This allows the beautiful shady to the place and also prevents soil erosion, so it is expected that the project will not affect the soil resources and soil erosion.	***Operation Phase:*** - Take care and maintenance of the ground cover crop along the project route, such as along the embankment and the drainage way in good condition. - Followed the resolution of the Cabinet on November 7, 1989 on the definition of the watershed class in the southern area and recommendations on land use measures.	***Operation Phase:*** -
3) Geology and Earthquakes	***Construction Phase/ Operation Phase:*** The project route is located on the VII Mercury-level of the earthquake risk area, with a highly risk of damage. Active fault is close to the project route namely Ranong fault.	***Construction Phase/ Operation Phase:*** - Structural design of the railways requires AASHTO standards.	***Construction Phase/ Operation Phase:*** -
4) Sub-surface Hydrology	***Construction Phase:*** The area that is expected to be affected by groundwater is the railway tunnel construction area. This may affect the amount of flow direction and groundwater quality. However, the tunnel length is not very long. In addition to the rock layer, the water has less water, so the impact on sub-surface hydrology is low.	***Construction Phase:*** - To investigate the quantity and quality of groundwater around the construction area of the railway tunnel. - Inspect and maintain construction machinery to prevent the leaks of lubricants and hazardous substances.	***Construction Phase:*** -
	Operation Phase: Operation period of the project is expected not to affect sub-surface hydrology.	***Operation Phase:*** -	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
5) Surface Hydrology	***Construction Phase:*** Along the railway alignment of project, there are canal and natural water way. Construction activities of the project may hinder the flow and drainage capacity of the river. The impact on surface hydrology is moderate.	***Construction Phase:*** - For areas with flood problems, the contractor must prepare the water pump and the water storage to get water flowing into the drain quickly in case of rain - Set up the complaint center.	***Construction Phase:*** -
	Operation Phase: The railway of the project will designed to have drainage systems to use as a drain and pass through for those near the railroad. The impact on surface hydrology is low.	***Operation Phase:*** - Dredging and weeding at the drainage ditches at least once a year during March - April.	***Operation Phase:*** -
6) Surface Water Quality	***Construction Phase:*** The number of canals and streams that the project route intersects passes through 5 0 places. The potential surface water quality impact during construction may be caused by rainwater that leaks and sludge into the canal. And wastewater contamination from construction workers but in small quantities and temporary impact on construction period only, so it is expected that the impact on surface water quality is low.	***Construction Phase:*** - Install the mesh to prevent debris from falling beneath the construction site through the water bodies. - Construction of the temporary offices or temporary worker camps must keep a distance of at least 150 meters from the water resources.	***Construction Phase:*** - Program : Monitoring on water quality and aquatic biology 2 times a year (wet and dry period) through construction period. - Parameter : Temperature, pH, DO, BOD, TSS, TDS, Oil & Grease, Conductivity, TCB, FCB, PO_{43-}, NO_{3-} - Responsibility Unit : Third Party hired by Project owner - Budget : 140,000 baht per time - Location : Klong Chumphon, Klong Lam Liang, Klong La-Un and Klong Bang None
	Operation Phase: Contamination from the Container Yard (CY) caused by using lubricants and hazardous substances from maintenance activities. These may leachate into water resources.	***Operation Phase:*** - The treated wastewater must be considered for other uses such as watering the trees, washing the roads to reduce water consumption.	***Operation Phase:*** - Program : Monitoring on water quality 2 times a year (wet and dry period) in the first 3 years, and after that the monitoring is conducted every 5 years during. project operation. - Parameter : Temperature, pH, DO, BOD, TSS, TDS, Oil & Grease, Conductivity, TCB, FCB, PO_{43-} , NO_{3-} - Responsibility Unit : Third Party hired by Project owner - Budget : 360,000 baht per time - Location : Klong Chumphon, Klong Lam Liang, Klong La-Un, Klong Bang None, Ranong Railway Station and Ranong Port.

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
7) Air and Atmosphere	***Construction Phase:*** Construction activities Period since the preparation of space, such as demolition of buildings, open soil surface, soil excavation, compaction of soil and sand, compaction, etc. These activities cause the diffusion of dust. In addition the mechanical and vehicles for construction may cause emissions such as dust, carbon monoxide and hydrocarbons However, due to the condition of the construction site are away from the community and in the wide open agricultural area. It is expected that the spread of dust and air pollution is not so great so the expected impact is low.	***Construction Phase:*** - Provide temporary solid fence with a height not less than 2 m, block surrounding the opened soil surface or drilling area. - The trucks used for construction materials hauling must be covered with canvas and control the speed of <40 km/h. - Provide the wheel washing area to clean before leaving the construction area. - Inspection and maintenance of engine equipment to meet the standards of the Department of Land Transport.	***Construction Phase:*** - Program : Monitoring on air quality once a month through construction period - Parameter : TSP, PM_{10}, $PM_{2.5}$, NO_2, CO, THC and WS/WD - Responsibility Unit : Third Party hired by Project owner - Budget : 11,928,000 baht - Location : Wat Pradoem, Ban Plai Khlong Wan School, Sai Daeng Sub-district Health Promoting Hospital and Moo Ban Villa Boutique
	Operation Phase: Implementation of the project is the development of double tracks railway transport. The train uses diesel engines, so it can affect the exhaust emissions by the number of train trips increased and also the exhaust from the vehicle run in/out the station. But because of the route and the railway stations located in the wide open area that can be breathable, bad weather happens is well distributed and can't cause air pollution. So in the overall, it is expected that the project implementation will impact on air quality at the low level.	***Operation Phase:*** - Install the label "Do not start the engine when parking". And announcing the driver to stop the engine if the car parked for a long time especially at the railway station. - Coordinate with local traffic police. To facilitate the reduction of congestion in the project area. Especially the station area. - Establishment of buildings, ventilation control systems and safety equipment. Emergency For the tunnel structure.	***Operation Phase:*** - Program : Monitoring on air quality 2 times a year (wet and dry period) in the first 3 years, and after that the monitoring is conducted every 5 years during. - Parameter : TSP, PM_{10}, NO_2, CO, THC and WS/WD - Responsibility Unit : Third Party hired by Project owner - Budget : 540,000 baht - Location : Wat Pradoem, Ban Plai Khlong Wan School, Sai Daeng Sub-district Health Promoting Hospital and Moo Ban Villa Boutique

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
8) Noise	***Construction Phase:*** The noise level generated by the construction activity is from the machinery. The evaluation results of the compared with the standard values still in accordance with the Notification of the National Environmental Board No.15 (2540 B.E.) which specific the maximum sound level at 1 1 5 decibels (A) was found to be no more than a standard threshold. It is expected to be affected low.	***Construction Phase:*** - Provide a minimum of 2 m. high solid fences in communities and sensitive areas such as schools, religious sites and hospitals. - Set the time of constructions which generate a loud noise level between 6 am - 6 pm. to avoid public rest. - Provide the community complaint center located near the route.	***Construction Phase:*** - Program : Monitoring on noise level once a month through construction period - Parameter : Leq 1hr., Leq 24hrs., Lmax, L90 and Ldn - Responsibility Unit : Third Party hired by Project owner - Budget : 5,040,000 baht - Location : As same as air quality monitoring.
	Operation Phase: During operation, there will be source of noise from various vehicles. The train run on the railway system i.e.; passenger and freight train including the vehicles coming in/out the station. So the noise level at the station is caused by cars and trains which have a low impact on the community because of the discrete sprint and most stations are located away from the community. While the noise level from the Depot due to maintenance activities may cause noise to the surrounding community thus the impact is considered as low.	***Operation Phase:*** - Design of noise reduction materials in various components such as the railway system, the platform area and the train system. - Installing the noise barrier in the required areas adjacent to the project alignment	***Operation Phase:*** - Program : Monitoring on noise level 2 times a year (wet and dry period) in the first 3 years, and after that the monitoring is conducted every 5 years during. - Parameter : Leq 1hr., Leq 24hrs., Lmax, L90 and Ldn - Responsibility Unit : Third Party hired by Project owner - Budget : 4,212,000 baht - Location : As same as air quality monitoring.

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
9) Vibration	***Construction Phase:*** Vibration from piling in construction may affect buildings or structures within the construction area and adjacent areas But such effects will occur in a short time. It is expected that the impact during the construction period is low.	***Construction Phase:*** - Drilling, pile driving, excavation, hammering and high vibration impact activities should be done during the daytime, do not done at night because it will interfere with the people.	***Construction Phase:*** - Program : Monitoring on vibration once a month through construction period - Parameter : Peak Particle Velocity - Responsibility Unit : Third Party hired by Project owner - Budget : 10,080,000 baht - Location : As same as air quality monitoring.
	Operation Phase: Service of the project It may affect the community and some important places. But since all the trains ran with discontinuity, vibration occurs in a short period of time. The impact on vibration during the operation period is low.	***Operation Phase:*** - Monitor vibration levels in areas that are expected to be affected by vibration regularly. - Design of rail systems and types of electric vehicles with low vibration technology.	***Operation Phase:*** - Program : Monitoring on vibration 2 times a year (wet and dry period) in the first 3 years, and after that the monitoring is conducted every 5 years during operation phase. - Parameter : Peak Particle Velocity - Responsibility Unit : Third Party hired by Project owner - Budget : 1,080,000 baht - Location : As same as air quality monitoring.
10) Watershed Classification	***Construction Phase:*** The railway alignment cuts through the upstream area which can divide WSC_1 1,720 m in length, and WSC_2 17.78 km in length. The impact is moderate.	***Construction Phase / Operation Phase:*** - Followed the resolution of the Cabinet on November 7, 1989 on the definition of the watershed class in the southern area and recommendations on land use measures.	***Construction Phase / Operation Phase:*** -
	Operation Phase: When construction completed. There will not disturb the land cover of watershed class 1-2.		

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
11) Forest	***Construction Phase:*** Due to the construction area of the project will cause the loss of forest areas in many areas permanently. Classified as 337 rai of mangrove forest and 251 rai of forest land. It is expected that the impact on forest will be high.	***Construction Phase:*** - Record the species and number of trees that move out of the construction area. - Coordinate with the Royal Forest Department, Natural Resources and the Office of Natural Resources and Environment of Chumphon and Ranong Province including other associated agencies to impose the construction measures in the vicinity of the National Reserved Forests, the Mangrove Forest and the Watersheds Class 1. - Reforestation of both forest and mangroves in accordance with regulations of the Royal Forest Department (251 x 3 = 753 rai) and Department of Marine and Coastal Resources (337 x 20 = 6,740 rai).	***Construction Phase:*** - Forest plantation and maintain the seedlings to grow in the 1-2 years.
	Operation Phase: In the operation period, there are no activities that interfere with forest resources and wildlife resources. So it does not affect the ecosystem and the plant society at all.	***Operation Phase:*** - Green area or landscaping is added to reduce air pollution and noise pollution - Maintain and decorate the tree branches that are compensated regularly and continuously.	***Operation Phase:*** - Continue to replant and maintain the forest. For 30 years
12) Wild Life	***Construction Phase:*** The wildlife that can be found in the project area were mostly small birds. It were moving fast and can be lived in the nearest area. It is expected that the impact on wildlife will be moderate.	***Construction Phase:*** - If wildlife is found in the construction site, remove or relocate the wildlife. - Hunting wild animals strictly by penalties.	***Construction Phase:***
	Operation Phase: Because of environment is permanently changed. It may affect the wildlife, but it can adapt to the environment the impact on wildlife will be moderate.of the project.	***Operation Phase:*** - To maintain the trees and the environment appropriate for the livelihood of wildlife.	***Operation Phase:***

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
13) Aquatic Ecology	***Construction Phase:*** The number of canals and streams that the project route intersects passes through 5 0 places. The potential aquatic ecology impact during construction may be caused by rainwater that leaks and sludge into the canal. And wastewater contamination from construction workers but in small quantities and temporary impact on construction period only, so it is expected that the impact on surface water quality is low.	***Construction Phase:*** - Install the mesh to prevent debris from falling beneath the construction site through the water bodies. - Do not drain the project office and temporary workers' camp into natural water resources. And must treat the wastewater before venting into the water resources. - Construction of the temporary offices or temporary worker camps must keep a distance of at least 1 5 0 meters from the water resources.	***Construction Phase:*** - Program : Monitoring on aquatic biology 2 times a year (wet and dry period) through construction period. - Parameter : Plant Plankton, Zoo Plankton and Benthos - Responsibility Unit : Third Party hired by Project owner - Budget : 140,000 baht per time - Location : Klong Chumphon, Klong Lam Liang, Klong La-Un and Klong Bang None
	Operation Phase: Waste water is generated within the railway station and Container Yard (CY) may cause the effect the aquatic ecology. To install the sanitary sewage treatment system and discharge water quality standards before drain it to water resources, so it is expected that the impact on aquatic ecology is low.	***Operation Phase:*** - Provide sanitary toilets for staff and staff at all railway stations. - The treated wastewater must be considered for other uses such as watering the trees, washing the roads to reduce water consumption. - Control the collection of hazardous materials including used lubricants and contaminated containers in the proper way.	***Operation Phase:*** - Program : Monitoring on aquatic biology 2 times a year (wet and dry period) in the first 3 years, and after that the monitoring is conducted every 5 years during. project operation. - Parameter : Plant Plankton, Zoo Plankton and Benthos - Responsibility Unit : Third Party hired by Project owner - Budget : 360,000 baht per time - Location : Klong Chumphon, Klong Lam Liang, Klong La-Un, Klong Bang None, Ranong Railway Station and Ranong Port.

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
14) Transportation	***Construction Phase:*** The project will transport the materials by the railway and then transported by car through the highway. This results in more traffic on the road and possibly damage to the road surface. For the underpass/overpass crossing construction at the intersections of railways and roads may result in inconvenience of travel. But people can also use the original crossing to travel between the two sides of the railway. This is a negative impact on the moderate level	***Construction Phase:*** - Coordinate with local administration and police station to facilitate construction area. - Install warning signs and lighting signals to alert road users to aware of the vehicles entering and leaving the construction area. - Control the weight and speed of the truck as required by law.	***Construction Phase:*** -
	Operation Phase: When operating the project, this will be the new choice for traveling with the railway system that can save time and secure. The development of more efficient transportations network. At the national level, it will alleviate major highway traffic problems especially during the important festivals. In the regional and local level, the road network that connects to the railway station and container yard will make transportation more convenient. This is a positive impact on the highly level.	***Operation Phase:*** - Install the label and traffic signs to control the traffic at each station. - Design adequate access entering and leaving the station to minimize traffic congestion on main highways. - Provide staff at the entrance, exit of the railway stations and the container yard.	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
15) Public Utility	***Construction Phase:*** During the construction of railway alignment cut through the community, it is necessary to remove the public utilities, such as electricity poles, telephone lines and plumbing. However, due to the project's activities, the construction time will not be long. This is a negative impact on the low level.	***Construction Phase:*** - Inform the construction plan of the project to the local administrative organization along the railway line - Coordinate with responsible agencies such as Provincial Electricity Authority, The Electricity Generating Authority of Thailand, Provincial Waterworks Authority, etc., to inform the operation plan. And jointly set measures to reduce the impact on users of public utilities.	***Construction Phase:*** -
	Operation Phase: There is no impact on public utilities.	***Operation Phase:*** -	***Operation Phase:*** -
16) Drainage control and flood prevention	***Construction Phase:*** Construction of the railway project, especially the bridge across the river and drainage systems. The drainage channels have to be drained and the drainage conditions changed. Floods can occur in lowland areas. The impact on land use is expected to be moderate.	***Construction Phase:*** - If flooding occurs. Water supply or drainage must be provided from the flooded area. - The drainage system must be designed to be large enough or have a safety factor of more than 1.	***Construction Phase:*** -
	Operation Phase: There is no impact on drainage control and flood prevention.	***Operation Phase:*** - To ensure that the drainage of the building is fully utilized. If a defect is found, it must be corrected immediately.	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
17) Land Use	***Construction Phase:*** Most of construction area located in the forest area, agricultural area, and community areas The activities in the construction period will only be carried out in the ROW area which changes the use of land to be the railway alignment about 3,840-2-79 rai. The impact on land use is expected to be high	***Construction Phase:*** - Control construction activities to be done in the construction area only.	***Construction Phase:*** -
	Operation Phase: There is no change in the land use pattern throughout the route. There is also the development of the road network linking the railway station and the container yard causing the land use high returns such as land use change from agricultural to commercial. The expected impact is a low positive impact.	***Operation Phase:*** - Coordinate with the local government and the Department of Public Works and Town Planning to determine land use plans in both directions of the project. To ensure consistency between the expansion of the community and development of utilities to accommodate the population increase.	***Operation Phase:*** -
18) Agriculture	***Construction Phase:*** The construction of the 50 meter railroad project will cut through the various agricultural areas, such as rubber, palm oil and coconut. The loss of agricultural land is not significant compared to the total area of Chumphon and Ranong. The impact on land use is expected to be low.	***Construction Phase:*** - If it is necessary to use agricultural land for construction as worker accommodation, material stockpile, office of the construction supervision or temporary road. It should be used after harvesting.	***Construction Phase:*** -
	Operation Phase: The railroad line may block access to agricultural areas and waterways. The expected impact is a low negative impact.	***Operation Phase:*** - To control the activities of project which located in the ROW area and station location of the project.	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
19) Socio-Economics	***Construction Phase:*** Construction activities may cause nuisance to the community. The alienate labor problems. The anxiety of traveling on the construction site. Some construction areas may block entrance – exit that effected for those who come to the shop, hospital, school and community. The expected impact is a low positive impact.	***Construction Phase:*** - Training and supervision of workers not cause trouble or conflict with the people in the area	***Construction Phase:*** - Program : Survey public opinion every year through construction period. - Parameter : Acknowledgement and opinion to project, and Impact during construction phase. - Responsibility Unit : Third Party hired by Project owner - Budget : 2,000,000 baht - Location : Communities and sensitive areas nearby project area within 500 meter distance of railway.
	Operation Phase: The travel and transportation are flexible, reduce transportation costs and energy and travel safety Including growth in tourism. So, the positive impact in the low level.	***Operation Phase:*** - Survey the public opinion for the problems arising from the implementation of the project to carry out and correct it appropriately.	***Operation Phase:*** - Program : Survey public opinion every year in the first 5 years, and after that the monitoring is conducted every 5 years during operation phase. - Parameter : Opinion to project and impact during operation phase. - Responsibility Unit : Third Party hired by Project owner - Budget : 4,500,000 baht - Location : Communities and sensitive areas nearby project area within 500 meter distance of railway.
20) Land Acquisition and Expropriation	***Construction Phase:*** The construction areas involve the expropriation of 3,840-2-79 rai of additional land, most of which are forest, rubber plantations and oil palm plantations. Therefore, the effects of expropriation and compensation of property are high.	***Construction Phase:*** - Compensation of property must according to the procedures of the relevant law, transparent and fair	***Construction Phase:*** - Including in Socio-Economics monitoring.
	Operation Phase: -	***Operation Phase:*** -	***Operation Phase:*** - Including in Socio-Economics monitoring.

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
21) Severance	***Construction Phase:*** Construction activity in some areas may obstruct the access to housing or lands. It may be caused the inconvenience in communities along the railway. The impact is expected to be moderate	***Construction Phase:*** - Promote people in the vicinity of the construction site to know the construction plan. - Design the location of underpass and overpass in a suitable place.	***Construction Phase:*** -
	Operation Phase: After the construction of the project was completed. Some areas may be affected in terms of ease of access. The project has set the pattern of crossing and crossing to facilitate the commute between the community, such as overpass, service road, underpass, and minor bridge. The impact of operation phase is expected to be low.	***Operation Phase:*** - To investigate overpass, underpass and minor bridge.	***Operation Phase:*** -
22) Public Health / Occupational	***Construction Phase:*** The communities where located near the construction site may be affected by public health and occupational health during project construction. Because of dust spread noise and vibration. However, due to the project's activities, the construction time will not be long. This is a negative impact on the low level.	***Construction Phase:*** - Implement measures to prevent and reduce environmental impacts in the implementation phase, especially air quality, noise, vibration and water quality. - Provide first aid units and emergency vehicles at the construction site.	***Construction Phase:*** -
	Operation Phase: During the operation phase will improve the quality of life by the travel to access the hospital. The positive impact of operation phase is expected to be low.	***Operation Phase:*** - Implement measures to prevent and reduce environmental impacts in the implementation phase, especially air quality, noise, vibration and water quality.	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
23) Sanitary	***Construction Phase:*** During the construction phase Most of the waste is generated. The construction contractor must collect the waste at the waste container. The impact of operation phase is expected to be low.	***Construction Phase:*** - Sorting waste that can be reused and waste materials cannot be recycled. To reduce the amount of waste to be disposed of.	***Construction Phase:*** -
	Operation Phase: During the project phase waste water and solid waste are generated by the users of the train station. The project has provided sufficient waste water treatment and disposal facilities. The impact of operation phase is expected to be low.	***Operation Phase:*** - Set up a suitable bin at the appropriate station or location to match the amount of waste.	***Operation Phase:*** -
24) Accidents and Safety	***Construction Phase:*** Transportation of construction materials and large machining moves are expected to occur during the construction phase may be the risk area. Therefore, it must be careful to reduce the risk of accidents arising from project activities. The impact of construction phase is expected to be low.	***Construction Phase:*** - Controlling truck drivers for construction materials to speed up to 40 km / h while driving through the community. - Avoid transporting materials and machinery for construction in rush hour.	***Construction Phase:*** -
	Operation Phase: There is no impact on the operation phase.	***Operation Phase:*** - Training the officer to follow the rules to prevent accidents.	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
25) Specific area of local community	***Construction Phase:*** Preparation area Placement of construction materials Railways are only operated in the railway area, so the impact is expected to be low.	***Construction Phase:*** - Strictly follow the vibration measures throughout the construction period.	***Construction Phase:*** -
	Operation Phase: Based on the survey data, there is not important to the community. In the study area, so the impact is expected to be low.	***Operation Phase:*** -	***Operation Phase:*** -
26) Historic and Archaeology site	***Construction Phase:*** Project construction may obscure the scenery, the elegance of cultural sites, historic sites and archeological sites. Because some of these places are close to the route. Activities in the construction phase may effect on vibration, dust and noise, such as Chulachomklao Royal Military Academy Monument, Phra Chayang Cave, and Wat Suthawasdharam. The impact will be a short-term effect so the impact is expected to be low	***Construction Phase:*** - Use of spun piling and high frequency machinery as well as the trenching for the wave cut off from the source to the receiving point to reduce the effect of vibration. - If there are archaeological and historical evidence such as pottery fragments. Stone tools, etc. to stop the project. In that area immediately and notify the responsible agency.	***Construction Phase:*** -
	Operation Phase: When construction completed, the impact on historic sites and religious is mainly caused by the noise level, vibrations and dust. Therefore, in the design of the project, measures must be taken to prevent such effects so the impact is expected to be low.	***Operation Phase:*** - The railway line near historic sites and monuments must be provide the noise barrier to prevent noise pollution, dust and vibration to occur as low as possible	***Operation Phase:*** -

Table 6.3-2 Summary of Major Environmental Impacts and Environmental Measures of the New Railway Project for Chumphon – Ranong Port (cont.)

Environmental Factors	Environmental Impacts	Mitigation Measures	Monitoring Measures
27) Aesthetic and Tourism	***Construction Phase:*** The contractor must keep the areas and construction activities are not dirty, not to be confused and unattractive, it can also hinder travel to access to leisure and tourist attractions. It is expected to have a negative impact on low levels.	***Construction Phase:*** - Provide routing as well as signposts for easy access to the recreational and tourist attractions. - Specify a condition of the construction contract; the contractor will maintain the cleanliness of the construction site regularly. - Implement the complete landscape designed before the project is implemented.	***Construction Phase:*** -
	Operation Phase: The railway line of the project will promote direct benefits to tourism. Because it is a beautiful station design and the development of a double track system that makes travelers travel quickly. Can be seen on both sides of the train. It also encourages visitors to visit various attractions and scenic along the project line. It is expected to have a positive impact on the low level.	***Operation Phase:*** - Design the bridge buoy structure to thin and in harmony with the surrounding environment and historic sites. Focus on transparency and simple architectural style. - Tree maintenance and landscape improvements at various railway stations. It will make the scenery of the project look shady and beautiful.	***Operation Phase:*** -

Chapter 7

Economic Feasibility Study

Chapter 7
Economic Feasibility Study

7.1 Economic Analysis

7.1.1 Analysis of Economic Suitability

Analysis of economic projects the purpose is to assist the decision-making of the relevant agencies whether to proceed with the construction of the Chumphon - Ranong Railway Project. If the results of the economic analysis show that the project yields a return on investment, that project is considered to be economically feasible for the construction of the project. In addition, the analysis of economic projects can indicate the way in which the project should be implemented to maximize the benefits to the nation.

Economic analysis of the project is a study and analysis of the benefits and disadvantages of the project in view of society and the nation (Social Viewpoint) due to the limited resources available. Compare with the benefits expected from the project construction. That is the analysis of the value of resources. This is a comparison between In the case of "with project" and "without the project" cost-benefit analysis, this method is generally accepted as the basis for the appropriate reason for the analysis of the project that has an impact on society and the economy as a whole. Considering In terms of improving the efficiency of the transport network, then calculate benefits compared to the costs incurred by the project throughout the duration of the analysis, calculated in the form of the main economic index as follows.

1) NPV: Net Present Value
2) EIRR: Economic Internal Rate of Return
3) B/C: Benefit Cost Ratio

Guidelines and steps to analyze the economic suitability of the project, as shown in **Figure 7.1.1-1**.

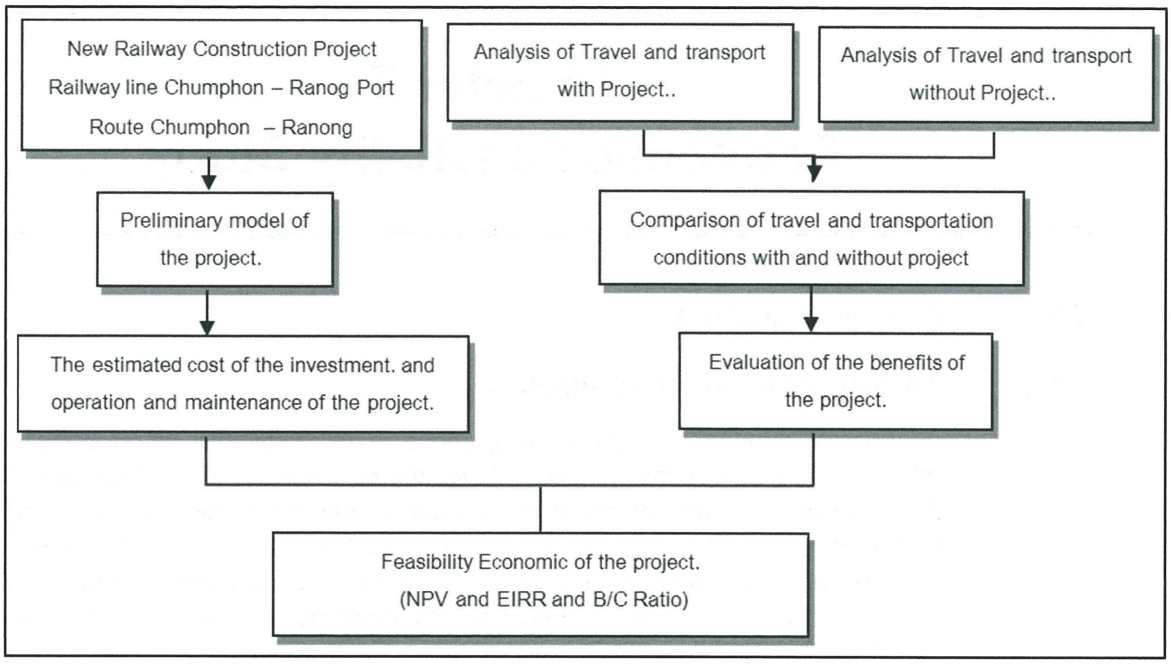


Figure 7.1.1-1 Guidelines for Economic Feasibility Analysis

7.1.2 Assumptions in Economic Analysis

The consultants have reviewed the economic analysis requirements of the past studies with the same characteristics to determine the assumptions for using in the project study as follows:

- The cost of the project consists of the investment cost and maintenance costs for both the infrastructure, the rolling stock and the signaling system.
- The benefits of the project consist of the direct benefits include saving in transport costs and indirect benefits affecting the economy and society.
- Investment value and expenses will be considered as the value at the current year (2017).
- The fastest assumed year of project launch is the year 2025 with a 30-year project analysis period after the launch year (2025-2054), excluding the construction period. The steps and timelines for the project are as follows.
  - Feasibility study 1 year (2017)
  - Project detailed design and prepare EIA 1 year (2018)
  - EIA are approved and project approval 1 year (2019)
  - Wait for issuance of decree on land expropriation and ownership 1.5 years (2020-2021)
  - Project construction 3.5 years (2021-2024)
  - Duration of project services 30 years (2025-2054)
- 12% discount rate (the rate at which the World Bank and the Office of the National Economic and Social Development Board have studied the cost of investment in Thailand. This is the rate used for analyzing public sector projects in many agency today such as the State Railway of Thailand (SRT), the Department of Highways (DOH) and the Office of Transport and Traffic Policy and Planning (OTP), etc.)
- The salvage value of the project will be determined by the infrastructure in the final year of the project. The assumption is that the average usage is 50 years and the train will have a lifetime of 30 years and will be calculated as a proportion relative to

the useful life remaining. The value of land in the final year is determined to be the same value, which will be deducted from the expense at the end of the project analysis period.

7.2 Estimation of Project Investment Costs and Operations

Valuation of investment and expenditure of the project will calculate as the financial value of the project multiplied by the multiplication factor converted from the financial value into economic value. This multiplier is calculated based on the financial value deducted by various taxable expenses because it does not reflect the true value of the resource.

In practice, the economic price can be calculated from the financial price by using a financial adjustment multiplier to be an economic value calculated from 7% value added tax and a profit tax of 20% of profit assuming 15% of the investment as shown in **Table 7.2-1**.

Table 7.2-1 Economic Price Calculation of the Project

Item	Multiplier	
Financial value	1.0000	(1)
Financial value after deducting VAT 7 % = (1) / 1.07	0.9346	(2)
Assume that the profit is 15% of the investment value, so profit = (2) x 0.15	0.1402	(3)
Taxes profit 20% of profit, so profit tax = (3) x 0.20	0.0280	(4)
Economic value (deducting VAT and profit tax) = (2) - (4)	0.9066	

Therefore, the conversion factor for each cost item is as follows.

- Costs for land ownership arrangement 100.00 %
- Compensation for building 90.66 %
- Construction and control cost 90.66 %
- Operating and maintenance cost 90.66 %
- Environment cost 90.66 %

Financial costs used in the assessment include investments, operating expenses and maintenance costs and expenditure under measures to reduce and monitor the environmental impact.. The details are as follows.

1) Project Value

The investment value of the project is the result of engineering design because it relates to the design and standards of rail design. The investment value of the project is summarized in **Table 7.2-2**. It includes the following costs:

- Cost for land ownership arrangement and compensation for buildings 1,640.36 million Baht, consist of;
  - Cost for land ownership arrangement 1,033.36 million Baht
  - compensation for buildings 607.00 million Baht
- Cost for construction project is approximately 24,654.98 million Baht, consist of;
  - Railway construction, Station construction, Related civil works construction 21,548.16 million Baht

- Track construction cost, signal system and telecommunications 3,106.82 million Baht

- Construction control cost is approximately 692.16 million Baht

Table 7.2-2 Investment Cost of the Railway Construction Project Chumphon - Ranong Deep Sea Port

Rank	Item	Financial Value (Million Baht)
1	Consultant fee for detailed design and prepare EIA	300.00
2	Cost for land ownership arrangement and compensation for buildings	1,640.36
3	Construction control cost	692.16
4	Construction cost for civil works	21,548.16
5	Construction cost for the track and signal system.	3,106.82
Total		**27,287.50**

Source: Consultant

The distribution of investment value of the project used in the assessment of economic suitability, it is accounted for the percentage of each year spent on each investment, starting from Tender, Land ownership arrangement until construction completed, as shown the assumptions for project value distribution in **Table 7.2-3**.

Table 7.2-3 Assumption on Distribution of Investment Value of the Railway Construction project Chumphon - Ranong Deep Sea Port

Unit: Million Baht

Item	2018	2019	2020	2021	2022	2023	2024	Total
Consultant fee for detailed design and prepare EIA	300.00	Approve EIA and Project Approval						300.00
Cost for land ownership arrangement and compensation for buildings			1,066.23 (65 %)	574.13 (35 %)				1,640.36
Construction control cost				103.82 (15 %)	207.65 (30 %)	207.65 (30 %)	173.04 (25 %)	692.16
Construction cost for civil works				3,232.22 (15 %)	6,464.45 (30 %)	6,464.45 (30 %)	5,387.04 (25 %)	21,548.16
Construction cost for the track and signal system.					807.28 (30 %)	1,305.11 7(40 %)	994.43 (30 %)	3,106.82
Total	300.00		1,066.23	3,910.17	7,497.37	7,977.21	6,554.51	27,287.50
Grand Total								**27,287.50**

Source: Consultant

2) Operating and maintenance cost

Expenditure assumptions in the service range consist of operating fee and annual maintenance costs, maintenance costs over a specified period of time (Periodic Maintenance), which will be divided into two parts as follows.

(1) Structural, stations and civil works maintenance

Estimation of operating and maintenance costs consist of the maintenance costs for runways and stations including the other civil works, both annual and scheduled maintenance.

- Rail maintenance expenses consist of annual expenses, including regular maintenance fees for railways, such as general repair works, replacement of mounting pins or railroad tie at some point and expenses on schedule include: stone repair costs sprinkled, change the rails and fix the railroad fence.
- Station maintenance expenses consist of annual expenses including water, electricity, communication costs, office supplies and expenses on schedule including, expenses for renovation work such as changing doors, replacing light bulbs, repainting roof repairs. Building Maintenance System

(2) Railway administration and management

It is divided into two parts: 1) Train procurement estimation 2) Estimation of service and maintenance costs.

- Train procurement costs include locomotives and trains.
- The cost of service include: the expenditures on operating staff, expenditure on fuel costs in the operating train.
- Cost of maintenance of the train
- The annual cost for the station consists of: annual expenses include electricity, water supply, phone and internet, materials and supplies and expenses on schedule include furniture for the station and office costs, Electrical appliances and Computer and the radio communication system.

3) Environmental costs

Environmental costs will consist of three plans of environmental impact mitigation plan (EIMP), which will be implemented during the construction phase including the environmental monitoring plan throughout the project implementation period.

The consultants have estimated the value and expenses in the different years throughout the analysis of the project as shown in **Table 7.2-4**.

Table 7.2-4 Investment Value and Project Implementation Costs

Unit ; Million baht

Sequence	Year	Construction cost					Environmental costs	Cost of Procurement	Operation and maintenance costs				Total cost
		Survey and Design	Expropriation and Compensation	Construction Control	Construction of civil	Construction of the rail signaling			Railway maintenance costs, roads, and terminal	Fuel costs in the march.	Cost of maintenance of the train	The cost of administering the march.	
1	2561	300.00											300.00
2	2562												-
3	2563		1,066.24										1,066.24
4	2564		574.13	103.82	3,232.22		6.04						3,916.21
5	2565			207.65	6,464.45	807.28	8.78	657.45	Period of preparation and construction (2018- 2024)				8,145.60
6	2566			207.65	6,464.45	1,305.11	18.82	657.45					8,653.48
7	2567			173.04	5,387.04	994.43	10.01	876.60					7,441.12
1	2568						3.53	-	9.30	172.32	104.40	48.42	337.97
2	2569		-	-	-	-	3.53	-	9.30	172.32	104.40	48.42	337.97
3	2570		-	-	-	-	3.53	-	9.30	172.32	104.40	48.42	337.97
4	2571		-	-	-	-	2.08	-	9.30	172.32	104.40	48.42	336.52
5	2572		-	-	-	-	0.95	-	9.30	172.32	104.40	48.42	335.39
6	2573		-	-	-	-	0.95	-	9.30	172.32	104.40	48.42	335.39
7	2574		-	-	-	-	0.95	-	9.30	172.32	104.40	48.42	335.39
8	2575		-	-	-	-	2.14	-	9.30	172.32	104.40	48.42	336.58
9	2576		-	-	-	-	0.98	-	9.30	172.32	104.40	48.42	335.42
10	2577		-	-	-	-	11.02	160.84	123.48	249.51	125.72	50.46	721.03
11	2578		-	-	-	-	2.21	160.84	10.83	249.51	125.72	50.46	599.56
12	2579		-	-	-	-	2.21	-	10.83	249.51	125.72	50.46	438.73
13	2580		-	-	-	-	3.53	-	10.83	249.51	125.72	50.46	440.04
14	2581		-	-	-	-	2.21	-	10.83	249.51	125.72	50.46	438.73
15	2582		-	-	-	-	2.08	-	10.83	249.51	125.72	50.46	438.59
16	2583	Duration of service (Year 2025- 2054)					0.95	-	10.83	249.51	125.72	50.46	437.46
17	2584		-	-	-	-	0.95	-	10.83	249.51	125.72	50.46	437.46
18	2585		-	-	-	-	2.27	-	10.83	249.51	125.72	50.46	438.78
19	2586		-	-	-	-	0.83	-	10.83	249.51	134.68	50.46	446.30
20	2587		-	-	-	-	0.98	310.49	124.11	327.93	141.35	55.26	960.12
21	2588		-	-	-	-	11.02	310.49	259.37	327.93	142.91	55.26	1,106.97
22	2589		-	-	-	-	2.21	-	571.29	327.93	142.91	55.26	1,099.60
23	2590		-	-	-	-	3.53	-	446.52	327.93	142.91	55.26	976.14
24	2591		-	-	-	-	2.21	-	10.83	327.93	142.91	55.26	539.13
25	2592		-	-	-	-	2.21	-	10.83	327.93	142.91	55.26	539.13
26	2593		-	-	-	-	2.08	-	10.83	327.93	142.91	55.26	539.00
27	2594		-	-	-	-	0.95	-	10.83	327.93	142.91	55.26	537.87
28	2595		-	-	-	-	2.27	-	10.83	327.93	142.91	55.26	539.18
29	2596		-	-	-	-	0.95	-	10.83	327.93	148.34	55.26	543.30
30	2597		-	-	-	-	0.83	302.09	123.68	410.05	176.64	62.38	1,075.66
		300.00	1,640.36	692.16	21,548.16	3,106.82	119.76	3,436.24	1,894.49	7,735.30	3,815.36	1,555.36	45,844.00

7.3 Economic Benefits Evaluation of Passenger Transport

Consultant will evaluate the economic benefits due to the implementation of the project by comparing the case study analysis with the project and without the project. Economic benefits include direct benefits and indirect benefits as follows.

7.3.1 Direct Benefits Assessment

It will consider the transport traffic benefits that occur on all transport networks due to the implementation of the project. The use of rail transport forms is a form of efficient transport, which has low cost and energy consumption and also reduces traffic on the road network. In addition when the train is used for travel and transportation, it will result in lower pollution (Environmental Cost Saving). Since railway system being more efficient in transport than the road system, making rail transport less polluting than road transport. In addition, the train is a form of transport that is more secure than the road. Benefit assessments will cover both the benefits of user who switch to rail transport and road users for both freight and travel, due to the traffic on the road is more streamlined.

The Direct Benefit Assessment of the project will be compiled based on the analysis of the conditions of travel, "with project" and "without project", which will indicate the efficiency of the transportation system under the various transport modes that will be covered by the freight. (Tons - km) and traffic conditions on the overall road network. (PCU-Kilometer and PCU-Hour), which will be used to evaluate these benefits.

1) Saving in Vehicle Operating Costs (VOC)

Vehicle Operating Cost (VOC) is the expenses about the vehicles that will occur due to the use of travel vehicles such as fuel bills. Lubricants, tires and depreciation of cars, etc. In the development of new railway construction Chumphon - Ranong route will result in a change in the volume of transportation used by the rail transport system, which result in the traffic on the highway network has decreased, the travel is more convenient. The benefits can be seen in the form of economic returns from the cost savings of using a vehicle, which the benefits will come to all those traveling on the transport network.

Studying the cost of using a vehicle has developed several equations or models to be applied in Thailand. The World Bank is an agency that supports research and development in this field. One of the most popular methods used in this study is the Highway Design and Maintenance Standard (HDM). In the study of vehicle operating costs of the project, the consultant will apply the HDM-VOC model, which is the cost of the vehicle. The analysis approach is shown in **Figure 7.3.1-1**.

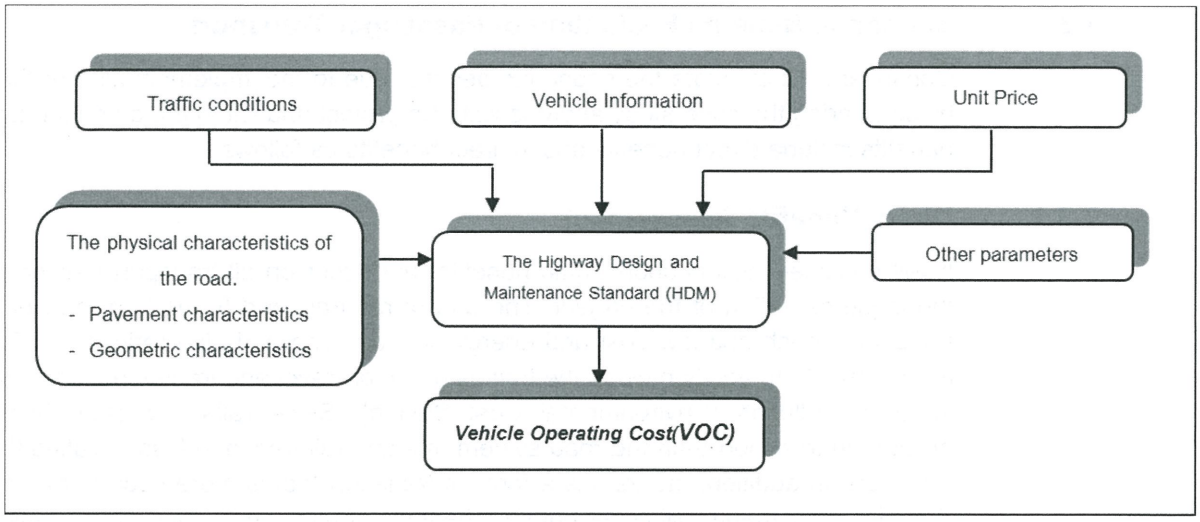


Figure 7.3.1-1 Guide to Calculate the Cost of Using a Car Using HDM-VOC.

The element of cost of using the vehicle to be consider is fuel cost, tire cost, lubricant cost, trucking cost and operating cost (Crew Cost), Maintenance Part Cost, Maintenance Labor Cost, Depreciation and Interest

(1.1) Calculating time value for each vehicle type

Calculating the cost of using the vehicle must know the characteristics of each vehicle type and use the vehicle features represented in each category to analyze the cost of using the car. The classification of vehicles for analysis into 10 categories according to the classification of vehicles of the Department of Highways, then select the vehicle representative to use in the study by vehicles of different types. The summary is shown in **Table 7.3.1-1**.

Table 7.3.1-1 Vehicle Agents

Vehicle type	Agents	Price (baht)
1.Motorcycle	Honda wave 125i	55,000
2.Personal car < 7 persons	TOYOTA COROLLA ALTIS 1.8E	874,000
3. Personal car > 7 persons	Toyota-Commuter 3.0 A/T	1,244,000
4.Light Truck	TOYOTA VIGO STANDARD 2.5J	512,000
5.Medium Truck)	ISUZU NQR75LY52E	1,155,000
6.Heavy Truck	ISUZU FXZ77QDTHZAC	2,730,000
7.Full & Semi Trailer	ISUZU DECA GXZ77NTH	2,782,000
8.Light Bus	TOYOTA VIGO STANDARD 2.5J	542,000
9.Medium Bus	TOYOTA 2KD-FTV	1,200,000
10.Heavy Bus	ISUZU TXD40	4,300,000

Source: Consultant

Once the vehicles are representative of each category, then calculate the cost of using different types of vehicles at different speeds. Calculation result of the cost of the average agent's vehicle as shown in **Table 7.3.1-2** and **Figure 7.3.1-2**, respectively.

Table 7.3.1-2 Cost of Using the Vehicle for Agent Vehicles at Current Year (2017)

Unit: Baht / Kilometer

Speed (km / h)	Vehicle Type									
	MC	Personal Car		Truck				Bus		
		PC<7	PC>7	LT	MT	HT	AT	LB	MB	HB
10	2.01	14.70	17.96	14.10	27.25	47.93	52.70	25.35	30.85	53.46
20	1.13	8.86	11.56	8.29	15.61	29.40	34.02	13.83	17.63	34.35
30	0.90	7.22	9.51	6.18	11.89	23.39	26.61	10.06	13.34	26.12
40	0.82	6.44	8.53	5.16	10.14	20.63	23.87	8.22	11.30	22.17
50	0.80	5.99	7.97	4.59	9.19	19.15	22.41	7.14	10.15	19.87
60	0.83	5.74	7.64	4.24	8.68	18.41	21.75	6.47	9.48	18.50
70	0.89	5.60	7.46	4.05	8.45	17.95	21.59	6.04	9.12	17.45
80	0.97	5.54	7.36	3.94	8.35	18.03	21.55	5.76	8.94	17.08
90	1.09	5.64	7.48	3.97	8.48	18.39	22.16	5.80	9.10	17.33
100	1.25	5.60	7.39	3.93	8.75	18.93	23.01	5.78	9.08	17.13
110	-	5.73	7.51	4.02	9.14	19.66	24.09	5.77	9.35	17.48
120	-	5.90	7.68	4.16	9.65	20.57	25.41	5.82	9.74	18.01

Source: Consultant

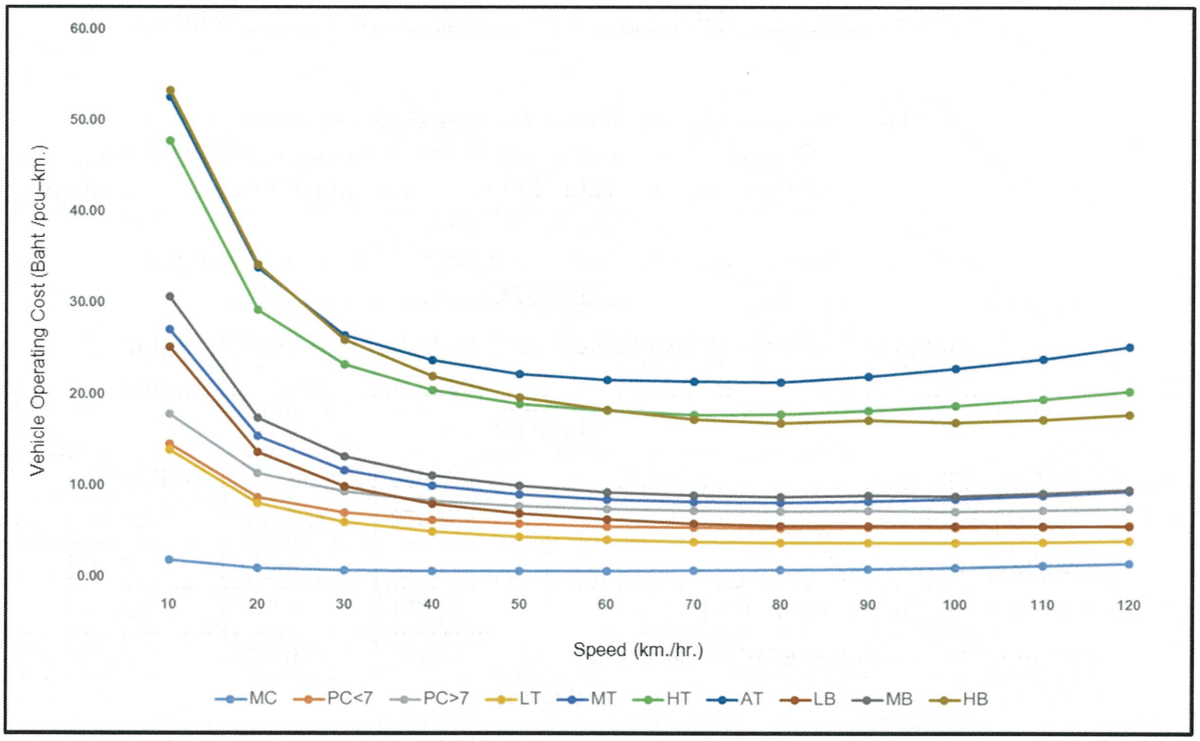


Figure 7.3.1-2 Relationship between the Costs of Using a Vehicle at Various Speeds

The value of the cost of using a vehicle by type of vehicle, then calculate the cost of using the average vehicle per car per hour (Baht / pcu-km) by using the PCU factor and the proportion of vehicle types in the study area as shown in **Table 7.3.1-3**, the value of VOCs per passenger car segment is summarized in **Table 7.3.1-4**.

Table 7.3.1-3 Proportion of Various types of Vehicles in the Study Area

Speed (km / h)	MC	PC<7	PC>7	LT	MT	HT	AT	LB	MB	HB
(1) PCU Factor	0.33	1	1	1	2.1	2.5	2.5	1.5	1.5	2.1
(2) Proportion (%)	15.95	13.83	7.68	46.57	3.34	3.98	5.12	2.60	0.58	0.36

Source: Consultant, 2017

Table 7.3.1-4 Costs of Using a Vehicle at Various Speeds by personal car equivalent units

Speed (km / h)	10	20	30	40	50	60	70	80	90	100	110	120
VOC (Baht / PCU-km)	13.87	8.30	6.42	5.55	5.07	4.81	4.69	4.66	4.78	4.86	5.06	5.33

Source: Consultant, 2017

(1.2) Calculating travel cost savings

The benefits of the project in terms of cost savings in using the vehicle (as shown in **Table 7.3.1-5**) is the difference between the value of the cost of using the vehicle of the case "with project" and "without project" as follows:

$$VOC_{economical} = (VOC_{car\ agents} \times VKT_{without\ project}) - (VOC_{car\ agents} \times VKT_{with\ project})$$

By $VOC_{economical}$ = the cost of saving the car, Baht
$VOC_{car\ agents}$ = Unit Costs of Use of Vehicles, Baht / PCU-km
$VKT_{without\ project}$ = Total distance of the system that the user travels without a project, PCU-km
$VKT_{with\ project}$ = Total distance of the system that the user travels on a project, PCU-km

Table 7.3.1-5 Average Time Value per Car (Baht / pcu-hour) in Future Years

Year	2025	2034	2044	2054
Without Project				
PCU-Kms / day	20,714,382	24,537,122	29,187,941	33,159,344
PCU-Hrs / day	434,956	529,882	709,151	848,211
Average speed (Km / hr)	47.62	46.31	41.16	39.09
Unit cost of using vehicle (Baht / PCU)	5.184	5.247	5.494	5.629
Total cost of motor vehicle use (million Baht / year)	39,195	46,995	58,535	68,127
With Project				
PCU-Kms / day	20,474,800	24,069,470	28,589,761	32,480,115
PCU-Hrs / day	425,508	514,717	687,777	825,138
Average speed (Km / hr)	48.12	46.76	41.57	39.36
Unit cost of using vehicle (Baht / PCU)	5.160	5.225	5.475	5.605
Total cost of motor vehicle use (million Baht / year)	38,565	45,907	57,130	66,453
Difference compared between cases "with project" and "without the project"				
VOT saving, unit cost of total vehicle use (million Baht / year)	**630.71**	**1,087.87**	**1,404.66**	**1,673.98**

Source: Consultant

2) Time saving for road users and train systems (VOT Saving)

The benefit of traveling time savings are analyzed by multiplying travel times as a whole with reduced time value when compared to no project. The valuation of time is based on the idea that value of time is a resource that can be used to generate additional revenue, with time saving in one activity being allocated to other activities.

In general, the valuation of time is based on the per capita income of the population and converted to a time value per vehicle unit. Factors to consider in time value analysis and calculation procedures are as shown in **Figure 7.3.1-3**. The details of the calculation are as follows.

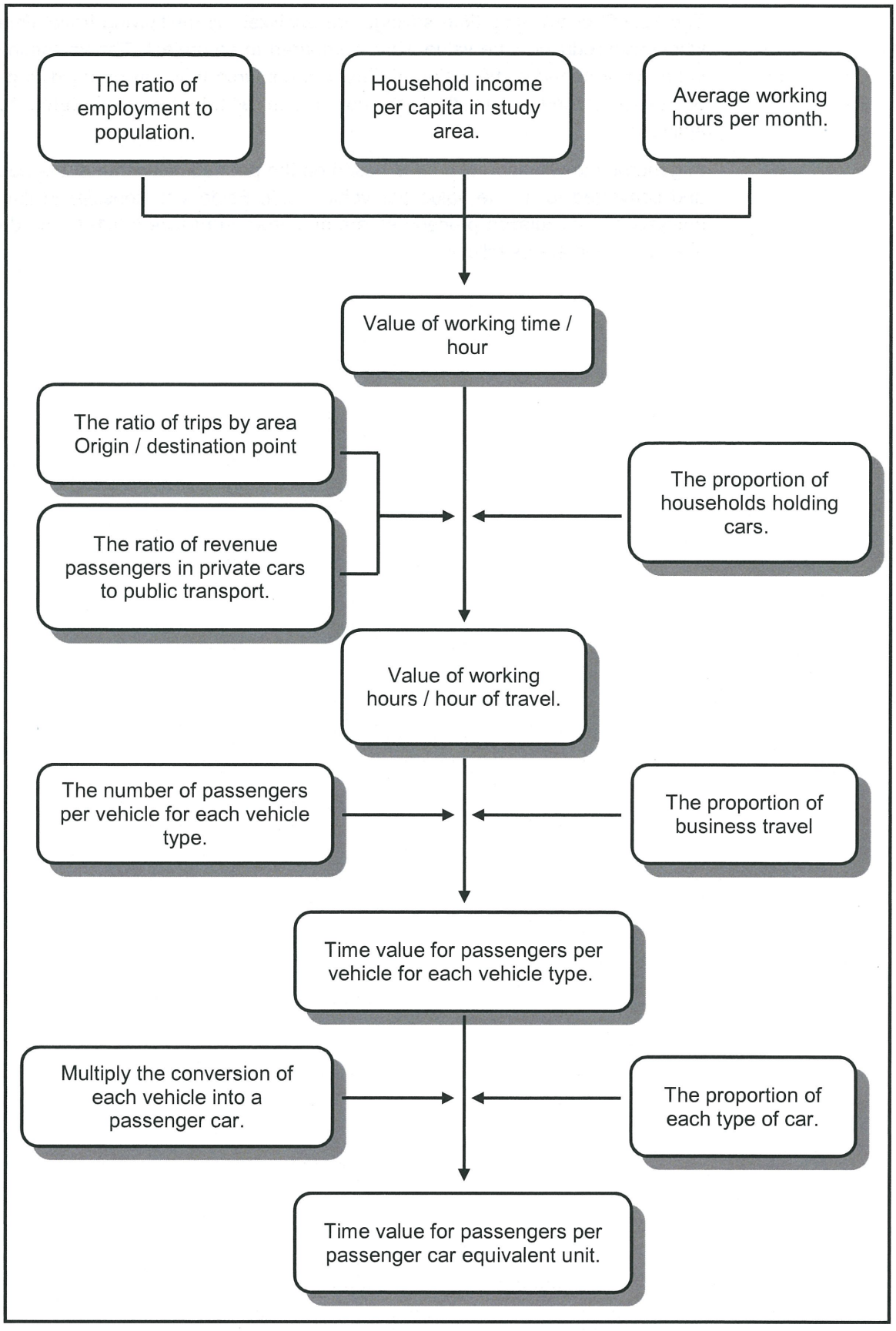


Figure 7.3.1-3 Time Estimation Procedure

(2.1) Population and labor status

Demographics and labor status are collected from the Provincial Labor Force Survey, year 2015 and 2016 from the National Statistical Office. Demographics and employed person within the study area and various regions can summarized in **Table 7.3.1-6**.

Table 7.3.1-6 Population and Labor Status in 2016

Area	Total population	Employed person	Employment-to-population ratio
Chumphon	507,604	279,529	55.07%
Ranong	189,154	140,167	74.10%
Southern (Remaining)	8,644,404	4,657,869	53.88%
All over the kingdom	65,931,550	37,692,651	57.17%

Source: National Statistical Office, 2016

(2.2) Average income per capita

The consultants collected the per capita income data from the Office of the National Economic and Social Development Board, the information collected is the latest information in 2558, so the consultant has adjusted to the value of 2016 to comply with other basic information by using the rate of change of gross domestic product, which is 3% per year, the results are shown in **Table 7.3.1-7**. It also has complied the average number of working hours per week as shown in **Table 7.3.1-8**, to calculate average income per working hours as shown in **Table 7.3.1-9** by assuming the number of working weeks in a year of 50 weeks to adjust weekly work hours to monthly (4.17 weeks per month).

Table 7.3.1-7 Average Household Income per Capita, Year 2016

Area	Average income per household in 2015 (Baht per month)	Household size (People / households)	Average income per person in 2015 (Baht per month)	Average income per person in 2016 (Baht per month)
Chumphon	29,306	3.25	9,007	9,277
Ranong	22,035	2.35	9,366	9,647
Southern (Remaining)	19,497	3.47	5,614	5,782
All over the kingdom	26,915	3.09	8,706	8,967

Source: National Statistical Office, 2016 and calculated by the consultant.

The average income data shown in Table 7.3.1-7 above is adjusted for income per working hour using employed persons-to-population ratios (Table 7.3.1-6) and average weekly working hours (Table 7.3.1-8). The results are shown in **Table 7.3.1-9**

Table 7.3.1-8 Average Number of Working Hours per Week

Area	<10 hr	10-19 hr	20-29 hr	30-34 hr	35-39 hr	40-49 hr	>50 hr	Average (hr / wk)
Chumphon	2.85%	6.43%	14.98%	9.76%	14.02%	37.72%	14.24%	37.78
Ranong	2.85%	6.43%	14.98%	9.76%	14.02%	37.72%	14.24%	37.78
Southern (Remaining)	2.85%	6.43%	14.98%	9.76%	14.02%	37.72%	14.24%	37.78
All over the kingdom	0.85%	2.06%	6.47%	4.90%	12.04%	51.48%	22.19%	43.14

Source: Statistical Tables of the Provincial Population Survey National Statistical Office

Table 7.3.1-9 Average Income per Working Hours

Area	Employment-to-population ratio	Average household income per capita (Baht)	Average income per employed person per month (baht)	Average working hours per week (hours)	Average working hours per month (Hour)	Earnings per hour worked (Baht / hour)
Chumphon	55.07%	9,277	16,846	37.78	157.42	107.02
Ranong	74.10%	9,647	13,019	37.78	157.42	82.7
Southern (Remaining)	53.88%	5,782	10,731	37.78	157.42	68.17
All over the kingdom	57.17%	8,967	15,685	43.14	179.75	87.26

Note: The weekly work week assumption is 50 weeks (4.17 weeks per month).

Source: Consultant

(2.3) Calculate the working time value per hour according to the travel proportion

The average income per hour worked by percentage of travel in the area is done by the average income per working hours calculated in Table 7.3.1-8 above to adjust the average income of people with cars and with no car by using the percentage of households with car ownership and pickup truck (Based on a survey of the National Bureau of Statistics) and the passenger income ratio in passenger cars / Pickup To passengers in public buses. (Income Factor), which is about 1.26 (from the survey Origin-Destination Survey of the project) and adjust the average income calculated by percentage of travel (% Trip) classified by province of origin and destination. (from the survey Origin-Destination Survey), as detailed in **Table 7.3.1-10**.

Table 7.3.1-10 Average Income per Working Hour Classified By Travel Proportion

Unit: Baht per hour

Area	Income per Working Hours	Occupancy rate Car and pick-up [1]	Average income		%Trips [2]	Average revenue by% Trips	
			No car	Have a car		No car	Have a car
Chumphon	107.02	21.70%	101.3	127.64	36.75%	37.23	46.91
Ranong	82.7	21.70%	78.29	98.64	51.67%	40.45	50.97
Southern (Remaining)	68.17	21.70%	64.53	81.31	6.17%	3.98	5.02
All over the kingdom	87.26	21.93%	80.39	111.74	5.41%	4.35	6.05
Total					100.00%	86.01	108.95

Source: [1] Socio-economic survey of households National Statistical Office

[2] Based on a survey of consultants, 2017

(2.4) Calculating time value for each vehicle type

Time value for each type of vehicle will be calculated based on the number of passengers and the proportion of business trips from the project's Origin-Destination Survey, and because the time spent working is greater than the time spent on other activities. Therefore, the consultant then determines that the time spent in other activities is 25 percent of the time spent working. (Study of Seventh Plan Urban and Regional Transport, SPURT, 1991) and the value of business time for motorcycles equates to 50% of passenger cars. The results are shown in **Table 7.3.1-11**.

Table 7.3.1-11 Average Time Value per Vehicle - Hour

Unit: (Baht / car - hour)

Vehicle Type	Number of passengers (person / vehicle)	Proportion of business trips	Time Value		Average time value (Baht / car - hour)
			For Business	Other purposes	
Motorcycle	1.73	37.07%	108.95	27.24	99.52
Personal Car < 7 persons	2.23	61.00%	108.95	27.24	171.89
Personal Car > 7 persons	5.21	57.50%	108.95	27.24	386.70
4 wheel truck (used as passenger car)	1.97	62.03%	108.95	27.24	153.51
Light Bus	5.87	58.97%	86.01	21.50	349.53
Medium Bus	13.23	35.00%	86.01	21.50	583.18
Heavy Bus	28.70	40.86%	86.01	21.50	1,373.59

Remarks: The value of time for other purposes is 25% of business time value and business value for motorcycles is equal to 50% of passenger cars <7 persons.

Source: Consultant, 2017

(2.5) Average time value per vehicle equivalent unit of personal car

The time value used to calculate the benefits to the project is the value in unit Baht per passenger car hour (Baht / pcu-hour). The calculation procedure is as follows: The value of the average time per vehicle - hours of each type of car calculated in the above converted to the value of average time per passenger car hour (Baht / pcu-hour) using the PCU Factor and the proportion of each type of car in the study area. The summary of the time value (VOT) in the Baht per car - hour at the value of the year 2016 is 87.14 Baht per car hour (Baht / pcu-hour). The details of the calculation are shown in **Table 7.3.1-12**.

Table 7.3.1-12 Average Time Value per Passenger Car - Hour

(1) Vehicle Type	(2) PCU Factor	(3) Proportion of cars (cars)	(4) =(2)x(3)	(5)=(4)/S(4) Car proportion (PCU)	(6) Average time value per vehicle	(7) Time Value Calculation (Baht / PCU-hour)
Motorcycle	0.33	15.95%	0.05	4.84%	99.52	4.82
Personal Car < 7 persons	1	13.83%	0.14	12.73%	171.89	21.88
Personal Car > 7 persons	1	7.68%	0.08	7.07%	386.70	27.34
4 wheel truck (used as passenger car)	1	10.05%	0.10	9.25%	153.51	14.2
Light Bus	1.5	2.60%	0.04	3.59%	349.53	12.56
Medium Bus	1.5	0.58%	0.01	0.80%	583.18	4.66
Heavy Bus	2.1	0.36%	0.01	0.70%	1,373.59	9.56
Light Truck (4 Wheels)	1	36.52%	0.37	33.62%	-	-
Medium Truck (6 Wheels)	2.1	3.34%	0.07	6.46%	-	-
Heavy Truck (10 Wheels)	2.5	3.98%	0.10	9.17%	-	-
Full / Semi Trailer	2.5	5.12%	0.13	11.77%	-	-
		100.00%	1.09	100.00%		95.02

Source: Consultant, 2017

In the future years, the value of travel time will increase continuously according to the growth of the economy in the area. The hypothesis assumes that the increase in the value of travel time in future years is the same as the increase in average income in the future. The estimated value of travel time between 2025 and 2054 is shown in **Table 7.3.1-13**.

Table 7.3.1-13 Average Time Value per Passenger Car - Hour In Future Year

Year	2016	2025	2034	2044	2054
Average time value (Baht / PCU-hour)	95.02	118.50	152.15	202.27	266.77

Source: Consultant

(2.6) Average time value of people by public transport

Calculating the time value of public transport passengers is based on the average income per working hours of the non-car person with a time value of 86.01 Baht per hour and because the time spent working is greater than the time spent in other activities. Therefore, the consultant then determines that the time spent in other activities is 25 percent of the time spent working by assuming the purpose of travel to work and travel for other activities has the same proportion (50:50) will be the passenger time in the year 2016 is 53.76 Baht per person and the value of travel time will increase continuously according to the growth of the economy in the area as shown in **Table 7.3.1-14**.

Table 7.3.1-14 Average Passenger Train Time per Person in the Future Year

Year	2016	2025	2034	2044	2054
Average time value (Baht / PCU-hour)	53.76	67.04	86.08	114.43	150.92

Source: Consultant, 2017

(2.7) Evaluating the benefits of time saving

The benefits of the project in terms of travel time savings. (shown in **Table 7.3.1-15**) is the difference in time value on the transportation network between the case of "with project" and "without project", which can be calculated from

$$\text{VOT Saving} = [(\text{PCU-HR}_{\text{With}} - \text{PCU-HR}_{\text{Without}}) \times \text{VOT}_{\text{PCU}}] + [(\text{PAX-HR}_{\text{With}} - \text{PAX-HR}_{\text{Without}}) \times \text{VOT}_{\text{PAX}}]$$

By

PCU-HR	Total travel time on road network
PAX-HR	Total travel time on rail network
VOT_{PCU}	Time value per vehicle for road users (Baht per PCU-HR)
VOT_{PAX}	Time value per person apply with rail users (Baht per PAX-HR)

Table 7.3.1-15 Average Time Value per Passenger Car - hour (Baht /pcu-hour) in Future Year

Year	2025	2034	2044	2054
Without Project				
PCU-Hrs / day	434,956	529,882	709,151	848,211
PAX –Hrs / day	70,058	88,486	110,168	138,594
Time value spent on all vehicles on the network (million Baht / year)	20,527	32,207	56,957	90,226
With Project				
PCU-Hrs / day	425,508	514,717	687,777	825,138
PAX –Hrs / day	79,351	100,396	125,406	157,791
Time value spent on all vehicles on the network (million Baht / year)	20,346	31,739	56,015	89,037
Volume of time saving (Million Baht / Year)	**181.29**	**468.01**	**941.52**	**1,189.20**

Source: Consultant

3) Accident Cost Saving

Road accidents can be caused by many factors, including road users, roads, vehicles and the environment, including road conditions, such as geometric features, cross-roads, traffic management access, control slope, characteristics of road traffic. In general, the accident rates vary with travel volume. Therefore, in the development of mass transit, which will result in the change of travel patterns and reduce the use of vehicles on the road network. This will help reduce the overall road accidents. The concept of accident value loss study consists of three main steps:

- Analysis of accident rates on highways with 2 lanes, 4 lanes, and more and the Inter-city Motorway. The accident rate is classified according to the level of violence in 4 cases,: fatal accident, severe injury accident, minor injury accident and damage accident
- Analyze the value of accidental loss per accident. It will analyze the types of costs incurred according to the types of accidents classified according to the level of severity.
- Calculate the value of accidental losses by multiplying the accident rate by the value of loss per accident will result in the total accidental loss, classified by type of highway, 2 lanes, 4 lanes and more and the Inter-city Motorway.

(3.1) Analysis of accident rate

A study on accident rates and accident victim rates on highways was conducted to classify the types of road accidents and severity of accidents. The standard unit used to compare accident rates will show in term of the number of accidents / accidents victim occurring to the measure of highway use, normally compared to the number of registered vehicles or the volume of travel (car - km). In this study, the accident rate is defined as the number of accidents in a highway per million kilometers traveled. The results of the collection and analysis of highway accidents in the years 2014 - 2016 are summarized in **Table 7.3.1-16**.

Table 7.3.1-16 Accident Victim Rate per Average Travel Volume on Highway

Highway type		Accident victim rate per travel volume (person / 100 million cars / km)	
		Deceased	Injured
Highway 2 lanes	Year 2014	1.16	5.44
	Year 2015	1.13	5.62
	Year 2016	1.28	6.53
	Average	**1.19**	**5.86**
Highway 4 or more lanes	Year 2014	1.00	6.30
	Year 2015	0.96	5.42
	Year 2016	1.04	7.30
	Average	**1.00**	**6.34**
Intercity Highway	Year 2014	0.39	2.25
	Year 2015	0.24	2.46
	Year 2016	0.45	2.54
	Average	**0.36**	**2.42**

Source: Department of Highways and analyze by the consultant, 2017

Study of loss value since the accident, the severity of the accidents is classified into four categories: death, disability, serious injury and minor injuries. Therefore, in this study, the estimated rate of injury to the volume of travel by using the proportion of casualties by severity. The study was carried out by the Accident Investigation Study of Thailand (Department of Highways, 2007). The results of the study showed that the proportion of disability: serious injury: minor injury for the southern region, the figure was 1: 24.34: 84.39. The proportion of such cases is considered in conjunction with the rate of casualties. (Table 7.3.1-16). This will result in the rate of accidents on the volume of travel of each type of accident is shown in **Table 7.3.1-17**.

Table 7.3.1-17 Accident Victim Rate per Travel Volume

Highway Type	Accident victim rate per travel volume (person / 100 million cars / km)			
	Deceased	disabled	seriously injured	Minor injury
Highway 2 lanes	1.19	0.05	1.30	4.51
Highway 4 or more lanes	1.00	0.06	1.41	4.88
Intercity Highway	0.36	0.02	0.54	1.86

Source: Consultant, 2017

The accident rate on the highway, from the statistics of the accident on the highway in the years 2014 and 2016 shows that, the average of the accident rates on the 4-lane highway was higher than the two-lane highway, but the lower accident with death rates. The average number of deaths per trip volume in the years 2014-2016 approximately 0.88 and 087 for the two-lane highway and the four-lane highway or more. The details are shown in **Table 7.3.1-18**. Based on the average number of deaths per trip, the accident rate can be estimated based on severity (death, serious injury, minor injuries and only damaged property) by using various types of accident rates compared to the accident with the dead, which is the result of the study of the Accident Investigation Study of Thailand (Department of Highways, 2007) for the study area (southern Thailand), with the accident fatalities ratio: accident with serious injuries: the only damage to the property is 1: 12.98: 32.29: 80.74.

The proportion of such cases is considered in conjunction with the rate of casualties. This will result in the rate of accidents on the volume of travel of each type of accident is shown in **Table 7.3.1-19**.

Table 7.3.1-18 Accident Rates on Highways in the Years 2014-2016

Highway Type	2014	2015	2016	Average
Highway 2 lanes				
Accident rate (times / 100 million cars - km)	4.69	5.07	5.21	4.99
Accident rate of death (time / 100 million cars - km)	0.82	0.82	0.99	0.88
Highway 4 or more lanes				
Accident rate (times / 100 million cars - km)	7.63	7.12	8.02	7.59
Accident rate of death (time / 100 million cars - km)	0.77	0.74	0.83	0.78
Intercity Highway				
Accident rate (times / 100 million cars - km)	6.62	6.84	6.13	6.53
Accident rate of death (time / 100 million cars - km)	0.41	0.20	0.33	0.31

Source: Bureau of Highway Safety, Department of Highways, 2014-2016

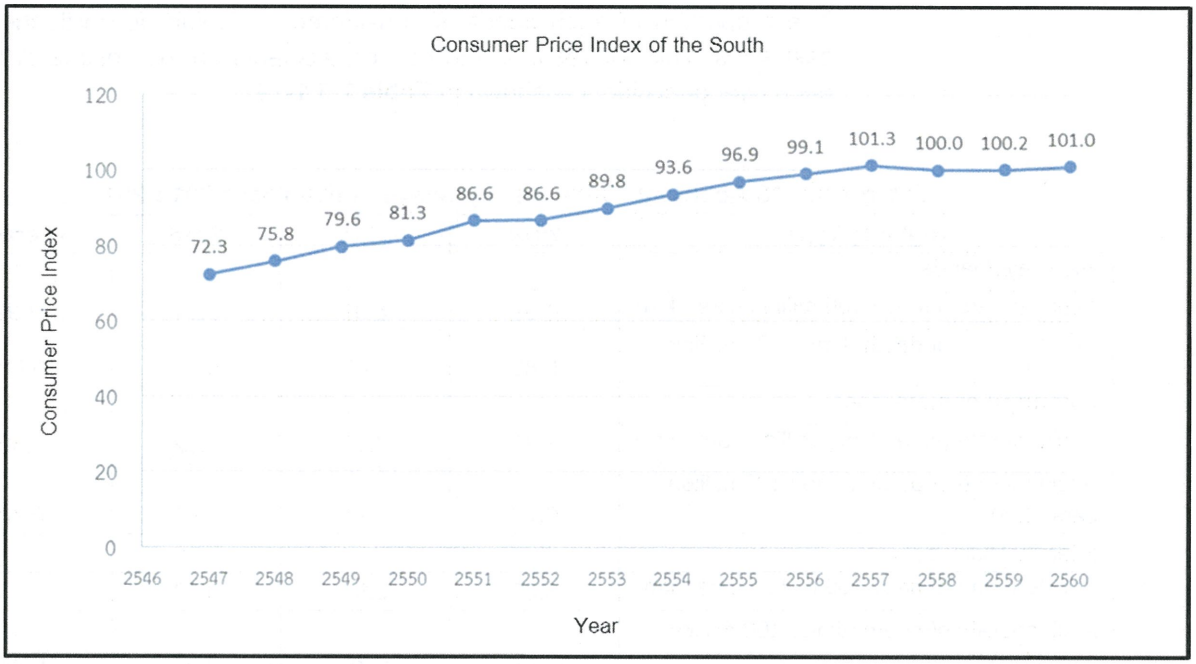
Table 7.3.1-19 Accident Rate per Travel Volume

Highway Type	Accident rate on travel volume (time / 100 million cars - kilometers)			
	Deceased	seriously injured	Minor injury	Just damaged property
Highway 2 lanes	0.88	11.38	28.31	70.77
Highway 4 or more lanes	0.78	10.13	25.20	62.99
Intercity Highway	0.31	4.06	10.09	25.22

Source: Consultant, 2017

(3.2) Valuation of accidental loss per accident

The value of accidental loss is determined by both monetary and non-monetary loss, including the results of the accident, which is not a cost and cannot be calculated in money. In this study, the results of accidental value study of the Accident Investigation Study of Thailand, Department of Highways, 2007, were used. The human capital approach was used to estimate the accidental loss. The analysts have adjusted the value from the value of the year 2004 to the value of 2017 by using the consumer price index of the South, as shown in **Figure 7.3.1-4**, the details are as follows.



Note: The consumer price index for the year 2017 is the average of January-August 2017.

Figure 7.3.1-4 Average Consumer Price Index (Southern Region) in the Years 2004 - 2017

- **Expenditures associated with humanity**

  The costs associated with human beings include: Loss of productivity Loss of quality of life Medical expenses Emergency Medical Expenses and the cost of long-term care.

  - Loss of productivity

    It is worth the loss in production due to road accident victims. Calculates the wage function, which shows the relationship between wages and age. And projections from the National Statistical Office's Labor Force Survey. Based on this study, we calculated the cost, loss, productivity. The study area is adjusted for value in the year 2017 for various types of violence. The values are shown in **Table 7.3.1-20**.

Table 7.3.1-20 Cost of Loss of Production Capability (Baht per Case)

Area	Severity of Injury			
	Deceased	Disabled	Seriously injured	Minor injury
Ranong	2,022,786	1,557,459	5,289	738
Chumphon	2,384,945	1,836,306	6,237	871
Southern (Remaining)	2,061,402	1,721,383	5,835	815

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

  - Loss of qualitative life

    The loss in this case is not a loss of income or loss directly from the accident. But the value of the accident affected the accident. And affect the people involved. This is the cause of suffering. Mental loss and the pain of an accident. Including the injury to those who cannot live normally because of the accident. The Accident Investigation

Study of Thailand calculates the cost of loss of quality of life from the loss of lost value of the accident, the loss of caregiver's loss, medical expenses. The value of loss, quality of life, and monetary loss were derived from interviews. Cost-effectiveness, quality loss, life for study area, adjusted to the value of 2017 as shown in **Table 7.3.1-21**.

Table 7.3.1-21 Costs of qualitative loss of life (Baht per case)

Area	Severity of Injury			
	Deceased	Disabled	Seriously injured	Minor injury
Ranong	2,544,198	3,492,998	23,061	382
Chumphon	2,996,897	4,029,845	23,773	415
Southern (Remaining)	2,815,795	3,815,079	21,727	402

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

- Medical expenses And the cost of an emergency medical unit.

  Medical expenses for accident victims generally, medical expenses are included. Hospital fees, surgery fees, medicine fees, room and food expenses, etc. These medical expenses include the death of a patient after hospitalization. The cost of medical treatment is calculated on the basis of these costs and the cost of an emergency medical unit in the study area, adjusted to the value of 2017 as shown in **Table 7.3.1-22** and **Table 7.3.1-23**.

Table 7.3.1-22 Cost of medical treatment (Baht per case)

Area	Severity of Injury			
	Deceased	Disabled	Seriously injured	Minor injury
Ranong	12,573	16,795	25,460	790
Chumphon	12,573	16,795	25,460	790
Southern (Remaining)	12,573	16,795	25,460	790

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

Table 7.3.1-23 Costs of Emergency Medical Unit (Baht per Case)

Area	Severity of Injury			
	Deceased	Disabled	Seriously injured	Minor injury
Ranong	2,406	2,406	2,406	2406
Chumphon	2,406	2,406	2,406	2406
Southern (Remaining)	2,406	2,406	2,406	2,406

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

- Long-term care expenses

  Long-term care expenses Costs incurred in the event of a casualty from a long-term accident. This is only the case with disabilities. Long-term care costs are divided into two parts: one is long-term care expenses of relatives or related persons, and the second is long-term care expenses due to the cost. Pay for long-term care of relatives or those involved. Has been calculated. Therefore, this section will only

consider the calculation of long-term medical expenses. Long-term medical expenses are the sum of all medical expenses incurred from the year of the accident to the year in which the person died. The cost of long-term care has been calculated from the Study on Accident Cost in Thailand for study area, adjusted to the value of 2017 as shown in **Table 7.3.1-24**.

Table 7.3.1-24 Cost of long-term care expenses (Baht per case)

Area	Severity of Injury			
	Deceased	Disabled	Seriously injured	Minor injury
Ranong	-	754,411	-	-
Chumphon	-	833,463	-	-
Southern (Remaining)	-	801,837	-	-

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

- **Cost group related to damaged property**

  The costs associated with the damaged property include expenses related to damage vehicles and expenses related to damaged property.

  - The costs associated with the damaged vehicle

    The costs associated with the damaged vehicle. The costs incurred by bringing an accidental vehicle to repair. In the study, the accident investigation study in Thailand was conducted by inquiry to the insurance company and the repair business in Bangkok. Costs related to damaged vehicles for study area, adjusted to the value of 2017 as shown in **Table 7.3.1-25**.

Table 7.3.1-25 Costs Related to Damaged Vehicles (Baht per time)

Area	Severity of Injury			
	Deceased	Seriously injured	Minor injury	Damaged property
Ranong	244,373	114,199	32,119	28,158
Chumphon	244,373	114,199	32,119	28,158
Southern (Remaining)	244,373	114,199	32,119	28,158

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

  - Expenses associated with other damaged property.

    Expenses associated with other damaged property. From the cost of damage due to the property of the Department of Highways due to accidents such as traffic surface, traffic lights, traffic signs, etc. As a result of the Study of the accident value of Thailand, the cost of the costs associated with other assets damaged for study area, adjusted to the value in the year 2017 as shown in **Table 7.3.1-26**.

Table 7.3.1-26 Costs Related to Damaged Property (Baht per time)

Area	Severity of Injury			
	Deceased	Seriously injured	Minor injury	Damaged property
Ranong	2,083	2,383	2,666	4,569
Chumphon	2,083	2,383	2,666	4,569
Southern (Remaining)	2,083	2,383	2,666	4,569

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

- **Common costs associated with collisions**

  General costs related to collisions include the cost of insurance management costs, the cost of operating the police, the cost of operating the court, the cost of emergency rescue costs. And the value of travel delays due to accidents. Study results of the accident study in Thailand. It found that the sum of costs, costs, costs, common costs associated with collisions, adjusted to the value in the year 2017, as shown in **Table 7.3.1-27**.

Table 7.3.1-27 Costs, General Costs Associated with Collisions (Baht per time)

Area	Severity of Injury			
	Deceased	Seriously injured	Minor injury	Damaged property
Ranong	109,606	90,315	79,020	73,323
Chumphon	109,606	90,315	79,020	73,323
Southern (Remaining)	109,606	90,315	79,020	73,323

Source: The Accident Investigation Study of Thailand, Department of Highways, 2007 and adjusted to the present value of 2017 by the consultant.

Based on the cost data, the accidental cost of each area as described above. Considered in conjunction with the volume of travel in the area, as shown in **Table 7.3.1-28**, the average cost of medical treatment is determined by the severity of the injury in the project area, as shown in **Table 7.3.1-29**

Table 7.3.1-28 Proportion of Travel Volume in Area

Area	Chumphon	Ranong	Others
Travel proportion (%Trip)	51.67%	36.75%	11.58%

Source: Consultant, 2017

Table 7.3.1-29 Average Cost of Medical Treatment Classified by Severity of Injury

Types of expenses	Level of severity of the accident				
	Deceased	Disabled	Seriously injured	Minor injury	damaged property
Cost of Human Trafficking Cost Expenditures (Baht per Case)	4,917,356	6,214,677	56,734	4,387	-
Cost group costs associated with the damaged property. (Baht per time)	246,456	-	116,582	34,785	32,727
Costs, costs, general costs associated with collisions. (Baht per time)	109,606	-	90,315	79,020	73,323

Source: Consultant, 2017

(3.3) Accidental Loss Calculation

The rate of accidents on the volume of travel and the rate of accidents on the volume of travel. Can be summarized as shown in **Table 7.3.1-30**, and taken into account with the cost of the accident due to the value of the accident. As shown in **Table 7.3.1-31**, the value of loss due to accidents on the volume of each type of travel. The values are shown in **Table 7.3.1-32**.

Table 7.3.1-30 Accident and Accident victims' rates per travel volume

Highway Type	Level of severity of the accident				
	Deceased	Disabled	Seriously injured	Minor injury	damaged property
Accident rate per travel volume (times / 100 million vehicles / km)					
Highway 2 lanes	0.88	-	11.38	28.31	70.77
Highway 4 or more lanes	0.78	-	10.13	25.20	62.99
Intercity Highway	0.31	-	4.06	10.09	25.22
Accident victims rate per travel volume (case / 100 vehicles / km)					
Highway 2 lanes	1.19	0.05	1.3	4.51	-
Highway 4 or more lanes	1.00	0.06	1.41	4.88	-
Intercity Highway	0.36	0.02	0.54	1.86	-

Source: Consultant, 2017

Table 7.3.1-31 Average Cost of Medical Treatment Classified by Severity of Injury

Types of expenses	Level of severity of the accident				
	Deceased	Disabled	Seriously injured	Minor injury	damaged property
Cost of Expenditures associated with humanity (Baht per Case)	4,917,356	6,214,677	56,734	4,387	-
Cost group related to damaged property (Baht per time)	246,456	-	116,582	34,785	32,727
Common costs associated with collisions (Baht per time)	109,606	-	90,315	79,020	73,323

Source: Consultant, 2017

Table 7.3.1-32 Accident Loss per Travel Volume in 2017

Highway Type	Value of accidental loss per travel volume Baht / 100 million cars - kilometers)					
	Deceased	Disabled	Seriously injured	Minor injury	damaged property	Total
Highway 2 lanes	6,937,622	349,422	2,730,574	3,645,193	8,439,535	**22,102,346**
Highway 4 or more lanes	5,488,158	419,306	2,302,711	3,057,253	7,069,318	**18,336,746**
Intercity Highway	2,122,456	139,769	979,038	1,300,434	3,007,561	**7,549,257**

Source: Consultant, 2017

Considered in conjunction with passenger car unit (PCU) and vehicle traffic volume in the study area will be the value of the accident in the passenger car unit (Baht / PCU-kilometer) for various highways, as shown in **Table 7.3.1-33**.

Table 7.3.1-33 Accident Loss per Trip Volume in 2017 (Baht / 100 million pcu-km)

Vehicle Type	PCU Factor	Proportion of cars (cars)	Value of accidental loss on travel volume (Baht / 100 million pcu-km)		
			Highway 2 lanes	Highway 4 or more lanes	Intercity Highway
Motorcycle	0.33	15.95%	10,682,801	8,862,761	3,648,808
Personal Car < 7 persons	1	13.83%	3,056,754	2,535,972	1,044,062
Personal Car > 7 persons	1	7.68%	1,697,460	1,408,262	579,783
4 wheel truck (used as passenger car)	1.5	10.05%	2,221,286	1,842,843	758,700
Light Bus	1.5	2.60%	383,107	317,837	130,854
Medium Bus	2.1	0.58%	85,462	70,902	29,190
Heavy Bus	1.5	0.36%	37,890	31,434	12,942
Light Truck (4 Wheels)	1	36.52%	8,071,777	6,696,580	2,756,989
Medium Truck (6 Wheels)	2.1	3.34%	351,533	291,642	120,069
Heavy Truck (10 Wheels)	2.5	3.98%	351,869	291,921	120,184
Full / Semi Trailer	2.5	5.12%	452,656	375,537	154,609
		100.00%	**27,392,595**	**22,725,690**	**9,356,190**

Loss calculation the average occupancy per passenger car equivalent (PCU) will be determined based on highway type ratios in the study area at the target year. Taking into account the future highway development program, then calculate the average accident per PCU-km in the study area as shown in **Table 7.3.1-34**.

Table 7.3.1-34 Value of Accidental Loss on Travel Volume

Highway Type	Road network proportion (%)				Value of accidental loss on travel volume (Baht / 100 million pcu-km)			
	2025	2034	2044	2054	2025	2034	2044	2054
Highway 2 lanes	78.39	57.03	57.03	57.03	21,472,196	15,623,258	15,623,258	15,623,258
Highway 4 or more lanes	21.61	15.73	15.73	15.73	4,911,734	3,573,798	3,573,798	3,573,798
Intercity Highway	0.00	27.24	27.24	27.24	-	2,548,588	2,548,588	2,548,588
Total	**100.00**	**100.00**	**100.00**	**100.00**	**26,383,931**	**21,745,643**	**21,745,643**	**21,745,643**

Note: No additional highway development plans after 2034.

Source: Consultant, 2017

(3.4) Calculate savings from accidental losses

The benefits of reducing accident losses are the result of reduced vehicle volumes on the road network because of the railway line project as shown in **Table 7.3.1-35**, calculated from the difference in road accident losses in the case of the "with project" and "without project" as follows:

$$\textbf{ACC Saving} = (\textbf{PCU-KM x ACC})_{\text{With}} - (\textbf{PCU-KM x ACC})_{\text{Without}}$$

By PCU-KM Total distance traveled on the road network
ACC Value of accidental loss to travel distance (Baht / 100 million pcu-km)

Table 7.3.1-35 Benefits of Accidental Loss Reduction

Case	Forecast Year			
	2025	2034	2044	2054
Without Project (PCU-Km / day)	20,714,382	24,537,122	29,187,941	33,159,344
With Project (PCU- Km / day)	20,474,800	24,069,470	28,589,761	32,480,115
Travel volume on the road network is reduced. (PCU- Km / day)	239,582	467,651	598,179	679,230
Reduction in Road Accidents (Million Baht / Year)	**23.07**	**37.12**	**47.48**	**53.91**

Source: Consultant

4) Environmental Cost Saving

Transport emissions, such as air, dust, etc., in particular greenhouse gases, are an important factor in global warming that affects global change. The human and animal well-being, such as the temperature of the air and the ocean, are higher. Severe weather variability Reduction of agricultural output and the epidemic of disease. The reduction of emissions from transport as a result of the reduction of travel by private cars. It is one of the major economic benefits of the development of mass transit projects.

Estimation of emissions there are several approaches to transporting greenhouse gases.

- Damage Cost Estimation from Greenhouse Gases
- Cost control and mitigation (Control Cost) of greenhouse gases.

- Carbon trading credit reference

For this study, we will quote the value of road traffic emissions from the MRT Assessment Standardization Report (the public debt management office) is 5 baht per kilometer (value at the year 2004). Based on the carbon price data collected over the past five years, carbon prices are likely to increase. The price of carbon in 2012 is in the range of EUR 3.19 - 8.65 per tonne (average EUR 5.92 per tree) and in the range of EUR 4.35 to EUR 7.92 per tonne (average EUR 6.14 per tonne). 0.7 per year and adjusted to the base year of study (2017), which is 5.475 Baht per kilometer - (Value at the year 2017)

The benefits of reducing emissions are due to reduced vehicle volumes on the road network. As a result of the project railway lines as shown in **Table 7.3.1-36**, which is calculated from the multiples of the value of emissions to the differences of the volume of travel on the road network between the case of "with project" and "without project" as follows.

$$ENV\ Saving = ENV \times (PCU\text{-}KM_{With} - PCU\text{-}KM_{Without})$$

By PCU-KM Total distance traveled on the road network

ENV Value of emissions to Travel distance (Baht per PCU-km)

Table 7.3.1-36 Benefit from Reducing Emissions from Transportation

Case	Forecast Year			
	2025	**2034**	**2044**	**2054**
No Project (PCUs-Kms / day)	20,714,382	24,537,122	29,187,941	33,159,344
Project case (PCUs- Kms / day)	20,474,800	24,069,470	28,589,761	32,480,115
Travel volume on the road network is reduced. (PCUs- Kms / day)	239,582	467,651	598,179	679,230
Reduce emissions from transport (million Baht / year)	**502.39**	**980.63**	**1,254.37**	**1,424.29**

Source: Consultant

The results of direct economic analysis of the new railway project Chumphon - Ranong Deep Sea Port can be summarized in the benefits. See **Table 7.3.1-37**.

Table 7.3.1-37 Travel Benefits of the Passengers of the Project

Unit: Million Baht

Year	Economic benefits				Total Economic benefits
	Saving in VOC	**Savings in Time Cost**	**Savings in Accident Costs**	**Savings in Emissions from transportation**	
2025	630.71	181.29	23.07	502.39	**1,337.46**
2034	1,087.87	468.01	37.12	980.63	**2,573.63**
2044	1,404.66	941.52	47.48	1,254.37	**3,648.03**
2054	1,673.98	1,189.20	53.91	1,424.29	**4,341.38**

Source: Consultant

7.3.2 Indirect Benefits Assessment

In addition to the direct benefit, this project railway route is also contributes to the socio-economic benefits in other ways because of the travel is more convenient and accessible and can set travel time as it does not have to face the traffic density on the road, which is an indirect benefit as follows.

- Support tourism, the area also has major tourist attractions and incentives. Transportation plays an important role in the development of the tourism industry, which is an important revenue.
- Encouraging the development of study areas contributes to urban and community development. Encourage and motivate more investment, which generate more employment in the area and makes people more income.
- Economic promotion due to increased trade and investment. It is important for business sector to transport more goods and services, making transportation of goods and services more streamlined as well as can set more accurate travel time. This will facilitate the transportation sector.
- Improve living standards, the double track railway construction will allow travel to destinations in the influence area of the project has been more comfortable and more streamlined than the single track, which must face with the problem of waiting for the train, which will increase the standard of living of the population in the community concerned

In principles, the economic benefits from development are the benefits from the additional economic activity resulting from new infrastructure investments. The new railway project, Chumphon - Ranong Deep Sea Port route, will make more tourist arrivals in such areas from the case "without" of such a project, resulting in economic benefits from the development. **The Asian Development Bank (ADB, 2013 p. 248-9)** suggest that to avoid duplicate benefit counts (Double-Counting) Economic Benefits from Development Developmental Benefits should be estimated with the benefit of induced traffic due to the construction of the railway line project. It is included in the analysis and prediction of travel volume.

7.4 Freight Benefit Assessment

7.4.1 Benefit From Total Cost Savings in Transportation

Evaluate the benefits of cost savings in transportation, which will include: Transportation costs and time costs. The costs incurred will be determined in the case of a change in the route and mode of transportation from the current route to the Laem Chabang / Bangkok Port. The freight will be used to cover both freight and transportation costs between the origin or the source of production to the port of departure.

$$TC_{saving} = (TC_{old} - TC_{new}) \times V$$

By

TC_{saving}	=	Cost of saving freight, baht
TC_{old}	=	The cost of shipping costs through the original port. (Laem Chabang Port / Bangkok Port), Baht
$TC_{new\ d}$	=	The cost of saving on rail freight through Ranong Port, Baht
V	=	Transportation volume adjusted to rail transport through Ranong port, TEU cabinets

Total cost of transportation includes the freight costs from the source (origin) to destination. Shipping costs include ocean freight and Inland Freight Charge. The time consumed in this study will be used to calculate the freight value of the container at 65.23[1] Dollar containers per day. The hypothesis is varied over time by adjusting for the next year, the GDP deflator, which is a price index that shows the change in prices of all commodities that are a component of GDP. According to the National Economic and Social Development Board (NESDB), the growth rate of the Gross Domestic Product Index 1.2 per year, as shown in **Table 7.4.1-1**.

Table 7.4.1-1 Growth rate of the Gross Domestic Product Index 2007-2016

Growth rate of the Gross Domestic Product Index 2007-2016 (%) per year					
2012	**2013**	**2014**	**2015**	**2016**	**Average**
1.3	1.7	1.0	0.4	1.8	**1.2**

Source: Economic Outlook Quarterly and Outlook for Thai Economy, 2013-2017,

Calculate the time value of the freight from the product of the time value of the container shipment. (Dollar per day) with the time it takes to ship from destination to destination (day).

The benefits of total cost savings. (Freight and time) to be transformed into rail freight through the Ranong Port. Calculate total cost savings. (Freight and time costs) in transit from the difference in total cost of freight on the current route. (Via Laem Chabang Port / Bangkok) with the total cost of transportation on the freight route via the Ranong Port. Multiply the results of forecasts for container volume in future years. In summary, the total cost savings in freight transport on the Ranong Port, as shown in **Table 7.4.1-2**.

Table 7.4.1-2 Benefits of Total Cost Savings (Freight and time) to be Transformed into Rail Freight by Railway Line Project Through Ranong Port

Case	Forecast Year			
	2025	**2034**	**2044**	**2054**
Saving time freight				
• Shipping Volume No Project (Cabinet - Day)	532,840	736,426	995,748	1,408,382
• Shipping Volume Project Case (Cabinet - Day)	285,561	394,209	532,680	753,121
• The volume of freight transport on the network decreased (Cabinet-day)	247,279	342,217	463,068	655,261
• Time saving in transportation (million Baht / year)	585.59	902.26	1,375.56	2,193.08
Saving freight costs				
• No Project (Million Baht / Year)	985.44	1,322.25	1,753.70	2,443.15
• With project (million Baht / year)	1,128.00	1,511.08	2,001.26	2,783.89
• Cost saving in transportation (million Baht / year)	-142.56	-188.83	-247.56	-340.74
Total cost savings in freight (million Baht / year)	**443.03**	**713.43**	**1,128.00**	**1,852.34**

[1] Source: Economic, Engineering and Environmental Impact Assessment Study Interstate Highway Project Kanchanaburi - Thai / Myanmar border (Ban Phu Num Ron)

Source: Analysis by consultants.

7.4.2 Benefit From Reducing Air Pollution

Emissions from transportation especially greenhouse gases are an important factor in the global warming that is affecting global change. The human and animal well-being, such as the temperature of the air and the ocean, are higher. Severe weather variability Reduction of agricultural output and the epidemic of disease. The reduction of emissions from transport as a result of the reduction of travel by private cars. It is one of the major economic benefits of the development of mass transit projects. The hypothesis is as follows.

- **Carbon dioxide emissions by mode of transport**

  The consultants collected carbon dioxide emissions from vehicles from various sources. Both domestic and international as summarized in **Table 7.4.2-1**.

Table 7.4.2-1 Amount of Carbon Dioxide Emissions of Vehicles

Vehicle	The amount of carbon dioxide emissions of vehicles (GCO_2 / Ton-km)		
	Domestic Resources [1]	Foreign Resources [2]	Average
Truck	107.375	270-490 (average 380)	**243.7**
Train	13.375	18-33 (average 25.5)	**19.4**

Source : [1] Study results of C.P. International Business Trading Group and Crop Integration Business (Maize)

[2] IPCC 5th Assessment Report (2014)

- **Carbon price**

  The consultants have collected carbon price data in the year 2017 from various sources. Both at home and abroad he summary is shown in **Table 7.4.2-2**.

Table 7.4.2-2 Carbon price (value at 2017)

Resources	Carbon price		Average
Greenhouse Gas Management Organization (Public Organization)	6.79-7.83 Euro per ton CO_2	7.31 Euro per ton CO_2	381.75 Baht per ton CO_2
CLIMATE POLICY INITIATIVE	13.58-15.28 Dollar per ton CO_2	14.43 Dollar per ton CO_2	

Note: * The average exchange rate of 1 Euro is 39.3 Baht and 1 USD is 33 Baht.

The benefits of reducing air pollution. Calculate the difference in carbon dioxide emissions when there are no Chumphon - Ranong railway projects, multiply with carbon price in summary, the benefits of air pollution reduction are shown in **Table 7.4.2-3**.

Table 7.4.2-3 Benefits of Reducing Air Pollution in the Transition to Rail Freight by Railway Project through Ranong port

Case	Forecast Year			
	2025	2034	2044	2054
The volume of cargo on the network				
• In case of no project (tons - km)	178,868,000	245,165,500	330,490,500	467,308,000
• In case of project (tons-km)	642,726,300	886,850,925	1,198,386,700	1,694,687,175
- road (tons - km)	57,730,000	85,811,250	122,075,000	180,373,750
- railway (tons - km)	584,996,300	801,039,675	1,076,311,700	1,514,313,425
Volume of Carbon dioxide emissions				
• In case of no project (ton)	43,590	59,747	80,541	113,883
• In case of project (ton)	25,418	36,452	50,630	73,335
- road (ton)	14,069	20,912	29,750	43,957
- railway (ton)	11,349	15,540	20,880	29,378
• Volume of reduced Carbon dioxide emissions (Ton)	18,172	23,294	29,910	40,548
Summary of value of saving caused by air pollution reduction in freight (Baht / year)	**6,937,315**	**8,892,660**	**11,418,299**	**15,479,274**

Source: Analysis by consultants.

7.5 Analysis of Economic Returns

7.5.1 Project's Economic Return

Analysis of economic projects will consider the investment value of the new railway route construction project at Chumphon - Ranong Deep Sea Port which was compared to the economic benefits expected from the construction of this project throughout the analysis period, is calculated in the main economic index as follows.

- **Net Present Value: (NPV)** is a computation of the value of economic investments in various years. With the expected economic benefits throughout the project life span. The discount rate is converted to current currency. In case the NPV is positive, the project yields a positive return. It is more or less dependent on the NPV that is positive or less positive. On the other hand, if the NPV is negative, the project is not worth the investment. The net present value (NPV) is shown in the following Equation:

$$NPV = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+r)^t}$$

By n = Number of years of economic appraisal

B_t = Benefit in year t

C_t = Expenses in year t

r = Discount rate

- **Economic Internal Rate of Return (EIRR)** is the discount rate that causes the net present value of the project to be zero. This rate will show the response instead of the investment in the project. This can be used to compare which projects yield higher returns. The method is calculated as follows.

$$\sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+R)^t} = 0$$

By n = Number of years of economic appraisal

B_t = Benefit in year t

C_t = Expenses in year t

R = Internal rate of return

- **Benefit Cost Ratio: (B / C)** is an economic indicator that shows the present value of the benefit to the present value of the project investment. If the benefit to cost ratio is greater than 1, the project will yield a return worth to invest. The method is calculated as follows.

$$B/C = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}$$

By n = Number of years of economic appraisal

B_t = Benefit in year t

C_t = Expenses in year t

r = Discount rate

The economic analysis of the project will consider the investment value of the new railway construction project, Chumphon route - Ranong deep sea port, which is compared to the economic benefits expected from the construction of this project throughout the 30-year analysis period shown in **Table 7.5.1-1**, this can be summarized as follows.

- Economic Internal Rate of Return (EIRR) = 8.55 %
- Net Present Value (NPV) = -4,507 Million Baht
- Benefit Cost Ratio (B/C) = 0.68

Table 7.5.1-1 Analysis of Economic Feasibility

Feasibility Study and Preliminary Design of Chumphon – Ranong Railway Project

Design consultant salary details and prepare EIA	300.00	Million Baht
The ownership of land and compensation structures	1,640.36	Million Baht
Construction control	692.16	Million Baht
Construction cost (excluding the procurement of wheeled vehicle)	24,654.98	Million Baht
Total	27,287.50	Million Baht

Economic evaluation results

Economic Internal Rate of Return	EIRR =	8.55%	
Net Present Value	NPV =	(4,507)	Million Baht
Benefit/Cost Ratio	B/C =	0.68	

Year	Investment value and cost of the project				Economic benefits from the project				The benefits of freight		Net value
	Investment value of the project	Value Investing supply	Cost maintenance operations	Environmental costs	The cost savings in using the vehicle	Saving travel time	Reducing Road Accident Loss	Reducing emissions from transport	Reducing the cost of shipping	Reducing emissions from transport	
2017	-	-	-	-	-	-	-	-	-	-	-
2018	- 271.98	-	-	-	-	-	-	-	-	-	- 271.98
2019	-	-	-	-	-	-	-	-	-	-	0.00
2020	- 966.65	0.00	0.00	0.00	-	-	-	-	-	-	- 966.65
2021	- 3,544.96	0.00	0.00	- 5.48	-	-	-	-	-	-	- 3,550.44
2022	- 6,780.80	- 596.04	0.00	- 7.96	-	-	-	-	-	-	- 7,384.80
2023	- 7,232.14	- 596.04	0.00	- 17.06	-	-	-	-	-	-	- 7,845.25
2024	- 5,942.32	- 794.73	0.00	- 9.08	-	-	-	-	-	-	- 6,746.12
2025	0.00	0.00	- 303.20	- 3.20	630.71	181.29	23.07	502.39	443.03	6.94	1,481.03
2026	0.00	0.00	- 303.20	- 3.20	670.09	201.44	24.32	541.15	467.12	7.13	1,604.85
2027	0.00	0.00	- 303.20	- 3.20	711.93	223.82	25.64	582.89	492.51	7.33	1,737.73
2028	0.00	0.00	- 303.20	- 1.88	756.39	248.70	27.03	627.86	519.29	7.54	1,881.71
2029	0.00	0.00	- 303.20	- 0.86	803.62	276.33	28.50	676.30	547.52	7.75	2,035.95
2030	0.00	0.00	- 303.20	- 0.86	853.80	307.04	30.05	728.47	577.28	7.96	2,200.54
2031	0.00	0.00	- 303.20	- 0.86	907.11	341.16	31.68	784.66	608.67	8.19	2,377.41
2032	0.00	0.00	- 303.20	- 1.94	963.75	379.08	33.40	845.20	641.76	8.41	2,566.45
2033	0.00	0.00	- 303.20	- 0.89	1,023.93	421.20	35.21	910.40	676.64	8.65	2,771.95
2034	0.00	- 145.82	- 497.88	- 9.99	1,087.87	468.01	37.12	980.63	713.43	8.89	2,642.26
2035	0.00	- 145.82	- 395.74	- 2.00	1,116.03	501.89	38.05	1,005.07	746.87	9.12	2,873.47
2036	0.00	0.00	- 395.74	- 2.00	1,144.92	538.23	38.99	1,030.12	781.89	9.35	3,145.75
2037	0.00	0.00	- 395.74	- 3.20	1,174.56	577.20	39.96	1,055.80	818.54	9.58	3,276.71
2038	0.00	0.00	- 395.74	- 2.00	1,204.97	618.99	40.96	1,082.11	856.91	9.83	3,416.02
2039	0.00	0.00	- 395.74	- 1.88	1,236.16	663.81	41.98	1,109.09	897.08	10.08	3,560.56
2040	0.00	0.00	- 395.74	- 0.86	1,268.16	711.87	43.03	1,136.73	939.13	10.33	3,712.64
2041	0.00	0.00	- 395.74	- 0.86	1,300.99	763.41	44.10	1,165.06	983.15	10.59	3,870.70
2042	0.00	0.00	- 395.74	- 2.05	1,334.67	818.68	45.20	1,194.10	1,029.24	10.86	4,034.95
2043	0.00	0.00	- 403.86	- 0.75	1,369.22	877.95	46.33	1,223.87	1,077.49	11.14	4,201.38
2044	0.00	- 281.49	- 588.07	- 0.89	1,404.66	941.52	47.48	1,254.37	1,128.00	11.42	3,917.01
2045	0.00	- 281.49	- 712.10	- 9.99	1,429.52	963.77	48.09	1,270.41	1,185.36	11.77	3,905.33
2046	0.00	0.00	- 994.89	- 2.00	1,454.81	986.54	48.70	1,286.65	1,245.64	12.14	4,037.58
2047	0.00	0.00	- 881.77	- 3.20	1,480.56	1,009.85	49.32	1,303.10	1,308.98	12.51	4,279.35
2048	0.00	0.00	- 486.77	- 2.00	1,506.76	1,033.71	49.95	1,319.76	1,375.54	12.90	4,809.85
2049	0.00	0.00	- 486.77	- 2.00	1,533.42	1,058.14	50.59	1,336.63	1,445.49	13.30	4,948.79
2050	0.00	0.00	- 486.77	- 1.88	1,560.55	1,083.14	51.24	1,353.72	1,518.99	13.71	5,092.70
2051	0.00	0.00	- 486.77	- 0.86	1,588.17	1,108.73	51.89	1,371.03	1,596.24	14.13	5,242.56
2052	0.00	0.00	- 486.77	- 2.05	1,616.27	1,134.93	52.56	1,388.56	1,677.41	14.57	5,395.47
2053	0.00	0.00	- 491.69	- 0.86	1,644.87	1,161.75	53.23	1,406.31	1,762.70	15.02	5,551.33
2054	9,877.73	463.40	- 700.57	- 0.75	1,673.98	1,189.20	53.91	1,424.29	1,852.34	15.48	15,849.01
NPV	- 11,816.31	- 944.53	- 1,171.71	- 26.47	3,075.94	1,362.40	106.85	2,652.78	2,226.15	27.99	- 4,506.90

Note: The values and costs in the table are economic cost.

Based on the economic analysis, it can be concluded that the new railway construction project Chumphon - Ranong Deep Sea Port is not economically feasible when it is constructed concurrently and opened in 2025 because it yields a Net Present Value (NPV) less than zero and returns less than 1 ratio of Benefit Cost Ratio (B / C Ratio). In addition, the Economic Internal Rate of Return (EIRR) is less than the opportunity cost of resources in a social perspective, which is equal to 12%. However, the consultant further analyzed that if the project is delayed for another 9 years (2077) after the launch year (2068), the economic return would be 12.19%. As a result of the project delay, the project will accommodate the increasing volume of traffic throughout the analysis period.

7.5.2 Sensitivity Analysis

Economic analysis and evaluation of the project, it is necessary to test the sensitivity of the project. If the value of the investment and / or the benefits of the project change due to various factors, as shown in **Table 7.5.2-1** consists of

- Sensitivity testing of the benefits of the new railroad construction project. Chumphon Railway - Ranong Deep Sea Port changed. These risks include: forecasts of passenger volume and discrepancies, which increase or decrease the benefits of the estimated 10-20%.
- Sensitivity testing on investment costs and costs of new railroad construction projects. Chumphon Railway - Ranong Deep Sea Port changed. These risks include: the value of land ownership has increased due to the area being developed, resulting in higher expropriation or more expropriated households. The construction cost due to the price of materials or labor changes so that the investment value and expenses of the project decreased or increased from the estimated 10-20 percent.

Table 7.5.2-1 Economic Sensitivity Analysis of The Project

Economic index	Basic case	Change case 10 %			Change case 20%		
		Benefit	Costs and expenses	Benefit and cost	Benefit	Costs and expenses	Benefit and cost
Benefits increases or costs and expense decrease							
EIRR (%)	8.55%	9.35%	9.43%	10.26%	10.09%	10.46%	12.15%
NPV (mil.baht)	-4,507	-3,562	-3,484	-2,166	-2,616	-1,921	175.33
B/C Ratio	0.68	0.74	0.75	0.83	0.81	0.85	1.02
Benefits decreases or costs and expense increase							
EIRR (%)	8.55%	7.72%	7.79%	6.99%	6.82%	7.13%	5.51%
NPV (mil.baht)	-4,507	-5,452	-5,903	-6,848	-6,397	-7,299	-9,189
B/C Ratio	0.68	0.61	0.62	0.55	0.54	0.56	0.45

Source: Consultant

Based on the sensitivity analysis, it was found that the economic return of the project when the project was most positively affected was in the case of a 20% increase in benefits or a reduction in project costs and a 20 percent reduction in costs, the EIRR will increase to 12.15, which is well above the set threshold of 12%, making the project economically feasible. But if there is a negative impact. In the case of a 20% reduction in project benefits or a 20% increase in project costs, the project will be worth less than the required EIRR of only 5.51.

7.6 Conclusion

7.6.1 Costs and Project Benefits

1. Evaluation of Project Costs

The financial cost used in the economic evaluation consists of the value of the investment in the construction of the railway project. Thereafter, there will be operating and maintenance costs during the project's launch and the cost of the environmental impact mitigation and monitoring measures.

Investment value of the railway construction project Chumphon - Ranong Deep Sea Port is about 27,287.50 million Baht, which is the result of the engineering design because it relates to the standard design of railways as shown in **Table 7.6.1-1**.

Table 7.6.1-1 Investment Cost of the Railway Construction Project Chumphon - Ranong Deep Sea Port

Rank	Item	Financial Value (Million Baht)
1	Consultant fee for detailed design and prepare EIA	300.00
2	Cost for land ownership arrangement and compensation for buildings	1,640.36
3	Construction control cost	692.16
4	Construction cost for civil works	21,548.16
5	Construction cost for the track and signal system.	3,106.82
Total		**27,287.50**

2. Direct Benefit Assessment Caused by the Project

Considering the traffic benefits that occur on all transportation network due to the project implementation. The use of rail transport forms would be an effective form of transportation. It has low cost and energy consumption as shown in **Table 7.6.1-2**, consist of:

- **Passenger benefits** will include the cost savings of using a vehicle, saving time cost, saving in accident costs and reducing greenhouse gas emissions. The traffic congestion on all transport networks will be considered due to the modification of the rail transport model. This will cover both the benefits of switching to user benefits and the use of road users for both freight and travel. It also evaluates the benefits of the generated traffic, which is the benefit of travelers who are induced. This is due to the fact that there are projects that make traveling more convenient and faster.
- **Cargo benefits** include cost savings and shipping time and reducing greenhouse gas emissions. It is calculated from the savings time due to the modification of the current freight transport. (Via Laem Chabang Port / Bangkok Port).

Table 7.6.1-2 Benefits of Railway Development - Chumphon - Ranong Deep Sea Port Route

Forecast Year	Economic benefits (million Baht)		Include economic benefits (Million Baht)
	Passenger transport benefits	Freight transport benefits	
2025	1,337.46	499.77	**1,837.23**
2034	2,573.63	786.98	**3,360.61**
2044	3,648.03	1,223.36	**4,871.39**
2054	4,341.38	1,982.88	**6,324.26**

Source: Consultant

7.6.2 Summary of Economic Analysis

The analysis of the economic suitability of the project is a study and analysis of the benefits and disadvantages of the project in the view of society and the nation (Social Viewpoint), due to the limited resources available from the project. Having a project Compare with investment value and cost during service. That is the analysis of the value of resources. This is a comparison between the case of "with project" and "without project" by Cost-Benefit Analysis, in terms of improving the efficiency of the transportation network, the benefits are then calculated against the costs incurred by the project throughout the 30-year analysis period, calculated in the main economic index. The economic analysis of the construction of the new railway line, Chumphon - Ranong Deep-Sea Port, can be summarized as follows.

- Economic Internal Rate of Return (EIRR) = 8.55 %
- Net Present Value (NPV) = -4,507 Million Baht
- Benefit Cost Ratio (B/C) = 0.68

Based on the economic analysis, it can be concluded that the New Railway Line Construction Project Chumphon - Ranong Deep Sea Port is not economically feasible when it is constructed concurrently and opened in 2025 because it yields a Net Present Value (NPV) less than zero and returns less than 1 ratio of Benefit Cost Ratio (B / C Ratio). In addition, the Economic Internal Rate of Return (EIRR) is less than the opportunity cost of resources in a social perspective, which is equal to 12%. However, the consultant further analyzed that if the project is delayed for another 9 years (2077) after the launch year (2068), the economic return would be 12.19%. As a result of the project delay, the project will accommodate the increasing volume of traffic throughout the analysis period.

Chapter 8

Study on Financial Feasibility and Investment Model

Chapter 8
Study on Financial Feasibility and Investment Model

8.1 Guidelines for Financial Analysis of the Project

Financial analysis aims to determine the feasibility of a financial project. Under conditions such as passenger and freight rates. Construction costs and funding conditions, etc. This study details the cost of investment and instead of receiving financial support from the project. The analysis will cover how to invest in the case of the state as a project investor or for the private sector to invest in various projects. The consultant will prepare a cash flow to evaluate the financial benefits of the project. Using financial indicators. To show whether the project is financially sound. Guidelines and procedures for analyzing the financial viability of the project, as shown in **Figure 8.1-1**.

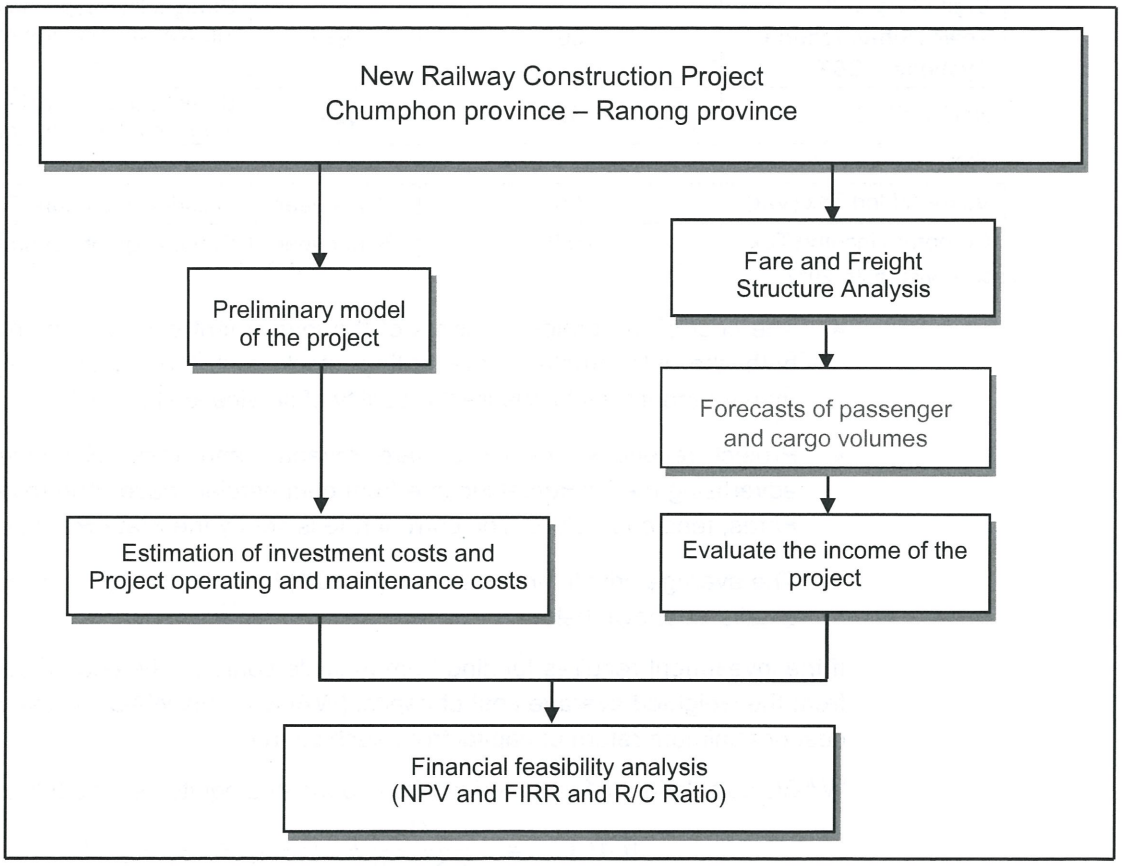


Figure 8.1-1 Financial Analysis Approach

The study and financial analysis of the new railway project in Chumphon Province - Ranong. The consultants reviewed the financial analysis requirements of the previous study. To determine the financial assumptions for the study of the project, as shown in **Table 8.1-1**.

Table 8.1-1 Financial Project Analysis Requirements

Item	Details	Unit	Remark
Price Assumptions			
Inflation	2.5	% per year	For all expenses.
Interest Rates	6.5	% per year	Use average MLR
Period Hypothesis			
Concession period	30	year	Not included construction time
Project age	30	year	Not included construction time
Discount rate	5.0	% per year	
Converter from day to year			
Passenger Demand	365	day / year	Number of days with service requirements per year
Supply of Service	365	day / year	Number of service days per year
Asset age			
Engineering - Structure, station, maintenance center and rail - Building	40 40	year year	Straight line depreciation Therefore, the residual value of the project will be 25% of the initial value.
Signalling and Telecommunication Systems : S&T	30	year	Straight line depreciation So there is no leftover value at the end of the project.
Rolling Stock	30	year	Straight line depreciation So there is no leftover value at the end of the project.
Tax			
Value Added Tax (Vat)	7.0	% per year	Included in the fare Think privately.
Corporate Income Tax	20.0	% per year	Percentage of net profit Think privately.

Source: Consultants, 2017

- The cost of the project consists of the investment cost and maintenance costs for both the infrastructure, the rolling stock and the signaling system. Including management fees to ensure the quality of service is standard.
- Project revenues consist of fare revenue and fees. Revenue from rental of advertising media Rental income from commercial space. And revenue from freight. Fares, fees and freight. The current rate is set by the State Railway of Thailand.
- The average private financial cost (WACC) is 7.71% per annum, calculated from the details as shown below.

If the investment requires funding from multiple sources, the cost of capital is calculated from the weighted average cost of capital (WACC). This WACC is the weighted average cost or minimum return of capital from each source.

WACC calculation of funds derived from loans and equity use the following formula.

$$WACC = \frac{D}{(D+E)} K_D[1-T] + \frac{E}{(D+E)} K_E$$

By D/(D+E) = The ratio of sources of funds coming from total loans to capital

E/(D+E) = The ratio of sources of funds coming from the equity to capital

K_D = Cost of loan (Interest rate)

K_E = Minimum return required by shareholders (Cost of Equity)

T = Income tax rate

Cost of Equity (K_E) can be calculated from Capital Asset Pricing Model (CAPM) as following formula.

$$K_E = R_f + \beta (R_m - R_f)$$

By R_f = Rate of return on risk-free assets (Risk free rate) Estimated from the yield of long-term government bonds. Approximately 3.00% per year

$R_m - R_f$ = Market Risk Premium or Rate of return of added market overall

β = Systematic Risk reflect the risks associated with rail transit systems.

β value of the new railway project in Chumphon – Ranong, it can be estimated from β average cost of investment in rail transit projects or projects related to transportation. These data can be found in the financial returns of listed companies on the SET.

In the case of private joint venture in the new railway project in Chumphon - Ranong, the private WACC can be calculated from the following conditions.

- Proportion of debt to private investment 2.5: 1
- Private returns (K_E) require 12 percent per year.
- The cost of a private loan (K_D) is MLR + 1.

Therefore, the proportion of investments in shareholders' equity E / (D + E) and D / (D + E) The capital cost of equity (K_E) is 12 percent and the interest rate on the loan (K_D) is 7.5 percent and the income tax rate is equal to 7.5 percent. The new railway project in Chumphon - Ranong. The average cost of private capital (WACC) is 7.71%. If the project's internal rate of return (IRR) is less than 7.71, the new rail project in Chumphon - Ranong no financial value for private equity partners. While the investment of the state may consider the cost of investment equal to the return of long-term government bonds. This is about 3% per year.

For the cost of the project contains with the investment in civil infrastructure, rail, power and mechanical (M & E) and rolling stocks, most of which are invested during the construction of the first three years (except for the northern part). In addition, in order to maintain a high level of service quality. When the project is open, the cost of maintenance and capital (O & M) will be reduced. The use of these investments and costs assesses the project's financial returns. The following guidelines.

- **Investment value** the investment in each part of the project is usually very high. It takes more than a year to complete. These investments are categorized as actual expenses each year. And it was adjusted to the value that year. The inflation rate at 2.5 percent per year is based on the current base year (2017).
- **Management and maintenance costs** this cost will be incurred when the project is open to the public. End of life Expenditures that are expected to occur each year are adjusted to the value that year. The inflation rate at 2.5 percent per year is based on the current base year (2017).

All expenses will be analyzed for financial return by cash flow analysis. (Discounted Cash Flow Analysis)

8.2 Financial Benefits of the Project

The financial benefits of the new railway project Chumphon Province - Ranong Province is the revenue generated from the bus and passenger transport services as the main revenue. The revenue from the lease of commercial land and rental income from advertising media will be secondary income and it will be included in the total revenue of the project.

1) Fare Revenue

Fare revenue is derived from the fare multiply by the number of passengers expected to use the service. So fares have a huge impact on project revenue. Proper fare structure in general, the analysis is based on the basis of the market mechanism. (Demand and Prejudice), which means the appropriate fare structure. This is the fare that the project will receive the highest financial return, should consider the following issues.

- Consideration should be given to the economic return of the project. So in practice. The fact remains that the overall project's return. It consists of commercial interests and economic and social benefits. The benefits of these two parts are often reversed, namely, the use of high fares. It will bring high commercial benefits. But the benefits to the economy and society will be reduced. People who can use the service at higher fares will have less.
- Fares must be taken into account as currently announced by the State Railway of Thailand. The fare is divided into 3 classes, namely, 1st, 2nd and 3rd class, and by distance. In addition to fare State Railway of Thailand It also collects fare based on the type of car and service.

From the point above. The advisor will set fares for the new railway project. Chumphon - Ranong Province according to the announcement of the State Railway of Thailand. The fares and fees of existing rail lines that originate or originate in Chumphon will be determined, as shown in **Table 8.2-1** to **Table 8.2-4**.

Table 8.2-1 Train fares with origin or destination at Chumphon or Ranong

Origin - Destination	Distance	Fare (Baht / person)		
		1st Class	2nd Class	3rd Class
Chumphon - Pathew	30	28 (0.93)	15 (0.50)	6 (0.20)
Chumphon – Lung Suan	64	60 (0.94)	31 (0.48)	14 (0.22)
Chumphon – Bang Saphan Noi	76	71 (0.93)	37 (0.49)	16 (0.21)
Chumphon – Ta Chana	109	102 (0.94)	53 (0.49)	23 (0.21)
Chumphon – Thap Sakae	127	119 (0.94)	61 (0.48)	27 (0.21)
Chumphon - Chaiya	129	119 (0.92)	61 (0.47)	27 (0.21)
Chumphon – Surat Thani	166	153 (0.92)	78 (0.47)	34 (0.20)
Chumphon – Prachup Khirikhan	167	153 (0.92)	78 (0.47)	34 (0.20)
Chumphon - Petchburi	319	272 (0.85)	135 (0.42)	58 (0.18)
Chumphon – Nakhon Si Thammarat	347	294 (0.85)	145 (0.42)	63 (0.18)
Chumphon - Patthalung	377	316 (0.84)	155 (0.41)	67 (0.18)
Chumphon - Bangkok	485	394 (0.81)	190 (0.39)	82 (0.17)

Source: The State Railway of Thailand, 2017
Note: (*) is the average fare (Baht / person / km)

In the study, only two routes will be considered: Bangkok – Ranong and Chumphon – Ranong and the distance in each route to calculate the fare revenue. The average distance traveled by passengers in each route is the average distance traveled between Bangkok and Ranong. Ranong and Chumphon lines are 463 and 105 km respectively. Therefore, the analysis of fare revenue in Bangkok - Ranong. Class 1, 2, and 3 were 0.81, 0.39, and 0.17 Baht / person / km, respectively. The analysis of fare revenue of Chumphon - Ranong Class 1, 2, and 3 is equivalent to the Chumphon – Ta Chana line because the distance is closest to the new Chumphon Railway – Ranong, which were 0.94, 0.49, and 0.21 baht / person / km, respectively.

In addition to the direct fare. The Railway of Thailand also charges fees of each train type, as shown in **Table 8.2-2** to **Table 8.2-4**.

Table 8.2-2 Rate of Train Ticket

Train type	Distance (kilometer)	Train ticket (Baht)
Rapid	1 – 50	20
Rapid	51 – 150	30
Rapid	151 – 300	50
Rapid	> 300 km	110
Express	150	150
Special Express	170	170
Special Express only no. 9/10, 13/14, 23/24, 25/26, 31/32 and 37/38	190	190

Source: The State Railway of Thailand, 2017

Table 8.2-3 Air Conditioning Fee

Travel distance	Air Conditioning Fee (Baht / person) by Car Type			
	Car seat 3rd class	Car seat 2nd class	Car seat 2nd class with food service	Car seat and sleeping on 1st floor 2nd floor and car specific
001-300	60	60	140	130
301-500	70	70	150	150
500 up	100	110	190	170

Source: The State Railway of Thailand, 2017

Table 8.2-4 Fee rate of car seat and sleeper car

Train type	Fee rate of car seat and sleeper car (Baht / person)	
	Upper bed	Lower bed
2nd Class, car seat and sleeper car, 32 seats	100	150
2nd Class, car seat and sleeper car, 40 seats, old model	130	200
2nd Class, car seat and sleeper car, 36 seats, modified	150	220
2nd Class, car seat and sleeper car, 40 seats, (Daewoo) new model 2nd Class, car seat and sleeper car, 40 seats (JR - WEST)	150	240
1st Class, car seat and sleeper car, 24 seats	300	500
1st Class, car seat and sleeper car, 24 seats (If traveling alone, but wish to use 1 double room)	1,000	

Source: The State Railway of Thailand, 2017

2) Freight Revenue

Freight revenue is derived from the freight rate, multiply by the amount of goods expected to use the rail transport service with the new railway project in Chumphon - Ranong. However, the goods will be transported to Ranong Port. ICD Lat Krabang is considered by the ICD Lat Krabang Special Car - Ranong. It has been estimated that the volume of cargo to be transported by rail in the future will be in the form of 20-foot containers separated by import and export at Ranong Port, as shown in **Table 8.2-5**.

Table 8.2-5 Forecasting the 20-foot Container Volume Using The New Railway Line in Chumphon - Ranong Classified by Import and Export at Ranong port

Container volume separated by import and export (cabinet)							
Year 2025		Year 2034		Year 2044		Year 2054	
Import	Export	Import	Export	Import	Export	Import	Export
5,769	27,400	9,896	35,414	15,292	45,531	24,048	61,507

Source: Consultants, 2017

Freight transport both for import and export, it is scheduled to be transported between ICD Lat Krabang – Ranong Province by the State Railway of Thailand will determine the freight rate by distance, as shown in **Table 8.2-6**.

Table 8.2-6 Container Freight Rates sort by distance (Unit: Baht / Container (1 way))

Distance (km)	20-feet container		Container over 20 feet	
	Empty	Load	Empty	Load
001 – 100	1,000	1,500	1,400	2,100
101 – 200	1,900	2,850	2,660	3,990
201 – 300	2,700	4,050	3,780	5,670
301 – 400	3,420	5,130	4,788	7,182
401 – 500	4,070	6,105	5,698	8,547
501 – 600	4,720	7,080	6,608	9,912
601 – 700	5,370	8,055	7,518	11,277
701 – 800	6,020	9,030	8,428	12,642
801 – 900	6,670	10,005	9,338	14,007
901 - 1,000	7,320	10,980	10,248	15,372
1,001 - 1,100	7,970	11,955	11,158	16,737
1,101 - 1,200	8,620	12,930	12,068	18,102
1,201 - 1,300	9,270	13,905	12,978	19,467
1,301 - 1,400	9,920	14,880	13,888	20,832
1,401 - 1,500	10,570	15,855	14,798	22,197

Source: The State Railway of Thailand, 2017

3) Revenue from the installation of billboards and the lease of commercial land.

Income from the lease of commercial land. Calculate directly from the land rental rate multiplied by the area expected to be rented. Rental rates are reversed with demand for space. From that point it shows. It is very difficult to estimate the revenue of this section by setting both rental rates and demand for land at the same time. The revenue from the installation of billboards and the lease of commercial land (Non-Fare Revenue) will account for about 5-15% of Fare Revenue. Fare revenue. (133) and revenue from the installation of advertising banners (Category 133 b) from the report "Consolidated Accounting" in the year 2017 of the State Railway of Thailand. Non-fare revenue is an average of 5.24% of fare revenue. The consultant will use this percentage to evaluate non-fare revenue.

8.3 Results of Financial Analysis of the Project

Financial return analysis of new rail projects in Chumphon - Ranong Discounted Cash Flow Analysis is used to distribute all revenues and expenditures in the year in which the revenues and expenditures are actually generated (considering the current value of each year). Financial Indicators the index was compared to the financial criteria. The list of revenues and expenditures used in the financial analysis can be divided into 2 main categories as follows:

- Free Cash Flow to Firm (FCFF) is used to assess the suitability of a project. These revenues and expenditures are not considered sources of funds. Therefore, the interest expense and loan repayment will not be considered. Because the risk of source cost is included in the average cost (WACC), it will be used against the FIRR of the project.
- Free Cash Flow to Equity (FCFE) is used to assess the value of an investor's investment. Or shareholders of the Company. These receipts and expenditures must take into account the risk of source of funds. Therefore, interest and loan repayment should be included as expenses. The return to be compared with the FIRR of the project is the cost of Equity (K_E).

  The financial analysis of this project is intended to evaluate the financial viability of the project. The cash flow used in the analysis is FCFF.

Financial suitability analysis uses all three indicators as used in economic valuation. The formula for calculating the value of each index is the same formula. But the benefits and costs of computing are different. Financial analysis uses all revenues and expenditures throughout the life of the project. To replace the benefits and costs. In addition, the criterion for evaluating financial value is different from the criterion for assessing economic value.

1) Net Present Value: NPV

Net present value refers to the difference between revenue and expenditure in years. The value is present throughout the life of the project. The discount rate is used to determine the present value.

$$NPV = \sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+r)^t}$$

By n = Number of years of economic appraisal
B_t = Benefit in year t
C_t = Expenses in year t
r = Discount rate

If the investment project has a positive net present value show that the project provides a good financial return. Or say that all receipts occurring when value is present at the current year. It is higher than the total cost of investment when it is valued at the current year.

2) Benefit Cost Ratio: B/C Ratio

The ratio between the present value of revenue per expenditure is the calculation of the present value of all revenues and expenditures. Then to make a proportion to show the revenue to cost 1 baht.

$$B/C = \frac{\sum_{t=0}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+r)^t}}$$

By n = Number of years of economic appraisal
B_t = Benefit in year t
C_t = Expenses in year t
r = Discount rate

If the investment project has a ratio between revenue and expenditure more than 1, show that the project provides a worthy financial return or say that investment 1 baht returns more than 1 baht. The value of money is the same year.

3) Financial Internal Rate of Return: FIRR

Financial return within a project means the rate of return calculated from revenues and expenditures throughout the project life or discount rate that makes the present value of the receipt and the present value of the expenditure is equal.

$$\sum_{t=0}^{n} \frac{(B_t - C_t)}{(1+R)^t} = 0$$

By n = Number of years of economic appraisal

R = Economic return within the project

B_t = Revenue in year t

C_t = Expenses in year t

If the project's internal rate of return is higher than the cost of investment funds Show that the project provides a worthy financial return. In general, the financial cost may use interest rate as a reference threshold or some agencies may have different reference criteria for the purposes of the project.

Details of investments, expenses and revenues occurring throughout the project life, as shown in **Table 8.3-1**.

Table 8.3-1 Investment, Expenses and Total Revenues throughout the Project Life
New Railway Line Chumphon - Ranong

Year	Investment				Revenue				O&M	Environment	Salvage Value	Cash Inflow	Cash Outflow	Net Cash Flow
	Civil Work	Signalling &Telecom	Rolling Stocks	Total Investment	Passenger Fare	Freight Charge	Non-Fare	Total Revenue						
2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2018	307.50	-	-	307.50	-	-	-	-	-	-	-	-	307.50	- 307.50
2019	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	1,148.22	-	-	1,148.22	-	-	-	-	-	-	-	-	1,148.22	- 1,148.22
2021	4,316.10	-	-	4,316.10	-	-	-	-	-	6.67	-	-	4,322.77	- 4,322.77
2022	8,179.89	282.33	743.84	9,206.07	-	-	-	-	-	9.93	-	-	9,216.00	- 9,216.00
2023	8,599.99	651.13	762.44	10,013.56	-	-	-	-	-	21.83	-	-	10,035.39	- 10,035.39
2024	7,272.16	519.10	1,042.00	8,833.26	-	-	-	-	-	11.90	-	-	8,845.16	- 8,845.16
2025	-	-	-	-	411.64	307.71	7.27	726.62	441.41	4.30	-	726.62	445.71	280.91
2026	-	-	-	-	433.76	328.23	7.66	769.65	462.80	4.40	-	769.65	467.21	302.44
2027	-	-	-	-	449.68	341.06	8.07	798.80	474.37	4.51	-	798.80	478.89	319.91
2028	-	-	-	-	466.19	353.88	8.50	828.57	486.23	2.73	-	828.57	488.96	339.62
2029	-	-	-	-	491.21	375.88	8.96	876.04	498.39	1.28	-	876.04	499.66	376.38
2030	-	-	-	-	509.31	389.03	9.44	907.78	510.85	1.31	-	907.78	512.16	395.62
2031	-	-	-	-	528.09	402.18	9.95	940.21	523.62	1.34	-	940.21	524.96	415.25
2032	-	-	-	-	556.45	425.71	10.48	992.64	536.71	3.10	-	992.64	539.81	452.83
2033	-	-	-	-	577.17	439.19	11.04	1,027.39	550.13	1.45	-	1,027.39	551.58	475.81
2034	-	-	244.73	244.73	598.37	452.66	11.63	1,062.66	890.62	16.77	-	1,062.66	1,152.13	- 89.47
2035	-	-	250.85	250.85	628.44	479.86	12.22	1,120.52	737.18	3.45	-	1,120.52	991.48	129.04
2036	-	-	-	-	649.89	495.75	12.84	1,158.48	755.61	3.53	-	1,158.48	759.14	399.33
2037	-	-	-	-	672.14	511.63	13.49	1,197.26	774.50	5.78	-	1,197.26	780.28	416.98
2038	-	-	-	-	705.90	540.71	14.17	1,260.78	793.86	3.71	-	1,260.78	797.58	463.20
2039	-	-	-	-	730.15	556.99	14.89	1,302.03	813.71	3.58	-	1,302.03	817.29	484.74
2040	-	-	-	-	755.45	573.27	15.64	1,344.36	834.05	1.67	-	1,344.36	835.73	508.64
2041	-	-	-	-	793.46	604.30	16.43	1,414.19	854.90	1.72	-	1,414.19	856.62	557.57
2042	-	-	-	-	821.01	620.98	17.26	1,459.26	876.28	4.20	-	1,459.26	880.48	578.78
2043	-	-	-	-	849.73	637.67	18.14	1,505.54	915.20	1.57	-	1,505.54	916.77	588.77
2044	-	-	604.77	604.77	891.28	670.72	19.00	1,581.00	1,309.11	1.91	-	1,581.00	1,915.79	- 334.79
2045	-	-	619.89	619.89	921.37	698.00	19.93	1,639.30	1,614.98	22.01	-	1,639.30	2,256.87	- 617.57
2046	-	-	-	-	952.71	725.27	20.92	1,698.89	2,293.68	4.52	-	1,698.89	2,298.20	- 599.31
2047	-	-	-	-	999.38	771.36	21.95	1,792.68	2,089.31	7.40	-	1,792.68	2,096.71	- 304.02
2048	-	-	-	-	1,033.44	799.31	23.03	1,855.78	1,204.73	4.75	-	1,855.78	1,209.48	646.30
2049	-	-	-	-	1,068.94	827.27	24.16	1,920.37	1,234.84	4.87	-	1,920.37	1,239.72	680.66
2050	-	-	-	-	1,121.27	876.60	25.35	2,023.23	1,265.71	4.69	-	2,023.23	1,270.41	752.82
2051	-	-	-	-	1,159.96	905.26	26.60	2,091.82	1,297.36	2.20	-	2,091.82	1,299.55	792.26
2052	-	-	-	-	1,200.09	933.91	27.92	2,161.91	1,329.79	5.38	-	2,161.91	1,335.17	826.74
2053	-	-	-	-	1,258.95	986.63	29.29	2,274.87	1,376.24	2.31	-	2,274.87	1,378.55	896.32
2054	-	-	753.21	753.21	1,303.16	1,016.00	30.74	2,349.90	1,972.06	2.06	8,501.67	2,349.90	2,727.32	8,124.24
NPV	22,830.38	1,076.01	2,547.28	26,453.67	7,441.00	5,684.36	151.55	13,276.91	9,028.21	84.08	1,397.98	12,610.28	35,565.96	- 20,891.08

Source: Consultants, 2017

Table 8.3-2 Results of the Financial Analysis of The Project New Railway Line Chumphon - Ranong

Financial Indicators	Analytical Results	Evaluation Criteria
NPV	-20,891 million baht	NPV › 0
FIRR	2.01%*	FIRR* › WACC**
B/C	0.39	B/C › 1

Source: Consultants, 2017

Note: * Due to the pattern of net cash flow is positive and negative alternately. Multiple IRRs or Saddle Points cannot be found. The consultants use the Modified IRR (MIRR)
** The WACC is 7.71%

Financial assessment results indicate that new railway project in Chumphon – Ranong,

Financial returns are not worth the investment. This is because this project uses high investment. But from a public project. The project cannot collect fares and fees that reflect actual project costs. In addition, the increase in fare cannot be made according to actual inflation. Resulting in an increase in cost. Which is adjusted by inflation. Faster than fares and fees.

8.4 Analysis and Suggestion of Investment Model and Sources of Funds

The consultants will study and analyze the possible investment patterns by comparing the appropriate investment form of the project. In particular, the investment budget of the agency is limited. However, the study will examine the investment model to cover the details of the investment.

1) In case of the state is an investor. The State Railway of Thailand is responsible for carrying out all projects. Costs will be spent on government budgets or loans from inside and outside the country.

2) In case of the state-owned joint venture, suitable for mega projects, which requires a lot of investment. The financial return (FIRR) of the project is too low for private investors to invest, but provides high economic returns (EIRR). The most common form of investment is in the manner in which the state acquires the expropriation of land and construction costs of the project infrastructure. The private sector is responsible for the construction costs and the remaining capital goods and project management.

8.4.1 A Comparative Study of Forms of Co-Investment between Public and Private Sector

Analysis of the suitability of forms of co-investment between public and private sector will consider only the train section. The consultant will conduct the study "Guidelines and procedures for the past implementation of the State Railway of Thailand (SRT) and other public utilities". In addition to investing in the old form, the state is invested and wholly owned operations (PSC). The Public Debt Management Office (MPI) has proposed investment opportunities that allow private sector investment in government projects. (PPP) The new investment model has three main stakeholders: the government, the state railway, and the private sector. The roles and responsibilities of each party will be differentiated according to the type of investment. In the past studies, three types of investment schemes have been studied and described, as shown in **Table 8.4.1-1**.

Table 8.4.1-1 Possible Investment Forms

Form	Investment			Management		
	Infrastructure	Signal System	Train	Maintenance	Management of train service	Revenue collection
1	State Railway of Thailand					
2	Public		State Railway of Thailand			
3	Public		- Private: train procurement, maintenance and management of the bus. Include all income. If the performance exceeds the threshold (FIRR = 8%), it must pay excess revenue to the State Railway of Thailand. - State Railway of Thailand: Infrastructure maintenance and management			

Source: Consultants, 2017

All forms of investment, the state will be responsible for the infrastructure (including land) and signaling systems (S & T). The State Railway of Thailand (SRT) will be responsible for the procurement of the train. In the third format, the state will function as the second model, but the RPF will be the same as the second one. O & M will only be responsible for maintenance and O & M costs. The private sector will play a role in the supply of buses and buses. Private car owners will be responsible for the car and maintenance and car maintenance. Private sector will collect all the income. If private income exceeds the threshold (FIRR = 8%), the private sector must pay this surplus to the RTAF.

In studying the investment patterns, it is possible to consider only practical routes. In the form of investment 1 and 2, the State Railway of Thailand is the bus service. Bus routes will take a long route between Bangkok – Ranong and a short route between Chumphon and Ranong. The car will be considered the route between ICD Lat Krabang - Ranong. Meanwhile, the third form of investment, which gives NGOs the role of providing bus and coach services. Bus routes will only be considered for the short route between Chumphon and Ranong. The car will be considered the route between ICD Lat Krabang - Ranong.

8.4.2 Analysis and Evaluation of Guidelines of Co-Investment between Public and Private Sector

Financial Return Analysis of the State Railway of Thailand and Private Joint Venture will use a different discount rate, as the two groups will have different costs of investment. The discount rate of the SRT will be discounted at 5% per year (State investment costs are equal to long-term government bond yields. This is approximately 3.15%). The private sector will use a discount rate of 8% per annum. (The private WACC is 7.71%.). Analysis will be based on the investment model, as shown in **Table 8.4.2-1** to **Table 8.4.2-6**.

Table 8.4.2-1 Financial return of investment form 1 (All SRT Investment)

Financial Indicators	Financial return analysis results
	The State Railway of Thailand
NPV (mil.baht)	-20,891
FIRR (%)	2.01*
B/C	0.39

Source: Consultants, 2017

Note: * Due to the pattern of net cash flow is positive and negative alternately. Multiple IRRs or Saddle Points can not be found. The consultants use the Modified IRR (MIRR)

** The investment pattern 1 covers the 2 bus routes: Bangkok - Ranong and Chumphon - Ranong and Freight Train has 1 route: ICD Lat Krabang - Ranong.

Formal investment 1 The State Railway of Thailand is responsible for all costs and expenses incurred contain with Land Expropriation and Compensation for Private Property Civil Infrastructure Signal system overhead, including service charges. It consists of management and maintenance costs, infrastructure and train and environmental protection measures. All revenues will be collected by SRT contain with Fare revenue However, this kind of investment will make the SRT not worth the financial return. It shows through financial indicators that do not pass all the criteria for rating.

Table 8.4.2-2 Financial Return of Investment Form 2 (State infrastructure support and the signal system)

Financial Indicators	Financial return analysis results
	The State Railway of Thailand
NPV (mil.baht)	1,409
FIRR (%)	9.87
B/C	1.12

Source: Consultants, 2017

Note: The investment pattern 2 covers the 2 bus routes: Bangkok - Ranong and Chumphon - Ranong and Freight Train has 1 route: ICD Lat Krabang - Ranong.

The private sector has no role in this investment form, but the government will take part in investing in the fundamental factor of the project consist of land expropriation and private property compensation, civil Infrastructure and the signal system. The rest is the responsibility of the State Railway of Thailand, including the expenses while serving which consists of management and maintenance costs of infrastructure and train, including environmental protection measures and all revenue are collected by the state.

The results of the financial evaluation of government agencies have shown that the SRT receiving a worthy financial return because the FIRR was 9.87% which was higher than the long-term government bond yield with a value of 3.15%. In addition, the NPV is 1,409 million baht, which is greater than zero and B / C 1.12, which is more than one.

The investment model 3, private sector will join the investment, analysis is split between bus and car, as shown in **Table 8.4.2-3**.

Table 8.4.2-3 Financial return of investment form 3 (Private sector will invest in train)

Financial Indicators	Financial return analysis results	
	Passenger train*	Freight train*
NPV (mil.baht)	-21	-692
FIRR (%)	7.73	2.76**
B/C	0.98	0.81

Source: Consultants, 2017

Note: * The investment pattern 3 covers 1 bus route is Chumphon - Ranong. Freight Train has 1 route is ICD Lat Krabang - Ranong.

** Because the net cash flow pattern is positive and negative alternately, resulting in Multiple IRRs or Saddle Points fail to find the correct FIRR, so the consultant must use the Modified IRR (MIRR)

The government will take part in investing in the fundamental factor of the project, including land expropriation and private property compensation, civil Infrastructure and the signal system. The State Railway of Thailand is responsible for the management and maintenance of infrastructure and the environment. In this investment form, the private sector will invest in parts of the train, including the management and maintenance of the train and the train operation. The private sector will collect all revenue from fares, fees and freight and will share to the State Railway of Thailand if the private sector has an internal rate of return (FIRR) higher than 8%

The results of the study, the private who operate passengers train will receive higher returns than private who operate freight train. Although both have negative NPV. However, when considering the rate of return within the project, it is found that private who operate passengers train will obtain FIRR at 7.73%, even though it is lower than the discount rate (causing negative NPV), but still higher than the average cost of capital (WACC), which is 7.71%. The FIRR of the private who operate freight train is only 2.76%. Therefore, the private sector participation in investments. It is possible only to operate the passengers train.

Total income and expenditures of all three types of investments are shown in **Table 8.4.2-4** to **Table 8.4.2-7**.

Table 8.4.2-4 Financial Analysis of the State Railway of Thailand of the investment model 1

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project

Form 1: The state is an investor. Covering civil infrastructure & signage expense, vehicle supply, environmental measures, management and maintenance

Project duration from 2025 onwards (Period of financial analysis is 2025-2054)

Financial Assessment Result — discount rate = 5%

Net Present Value — NPV = -20,891 Million Baht

Financial Internal Rate of Return — FIRR = NA

Benefit Cost Ratio — B/C = 0.39

Million Baht

Period of Project									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**
Fare									138.69	146.13	153.98	162.24	170.95	180.13	189.80	199.99	210.73	221.92	233.16	244.96	257.37	270.40	284.09
Fee									272.95	287.63	295.70	303.94	320.25	329.18	338.29	356.46	366.43	376.45	395.28	404.93	414.77	435.50	446.06
Revenue (passenger)									411.64	433.76	449.68	466.19	491.21	509.31	528.09	556.45	577.17	598.37	628.44	649.89	672.14	705.90	730.15
Freight									280.70	299.42	311.12	322.82	342.89	354.88	366.88	388.34	400.64	412.93	437.75	452.24	466.73	493.25	508.10
Lift on/Lift off									27.01	28.81	29.93	31.06	32.99	34.14	35.30	37.36	38.55	39.73	42.12	43.51	44.91	47.46	48.89
Revenue (product)									307.71	328.23	341.06	353.88	375.88	389.03	402.18	425.71	439.19	452.66	479.86	495.75	511.63	540.71	556.99
Signage and Commercial Space Rental									7.27	7.66	8.07	8.50	8.96	9.44	9.95	10.48	11.04	11.63	12.22	12.84	13.49	14.17	14.89
Total Revenue									**726.62**	**769.65**	**798.80**	**828.57**	**876.04**	**907.78**	**940.21**	**992.64**	**1,027.39**	**1,062.66**	**1,120.52**	**1,158.48**	**1,197.26**	**1,260.78**	**1,302.03**
The survey, design and expropriation cost		307.50		1,148.22	633.73																		
Consultant cost					114.60	234.93	240.81	205.69															
Civil work cost					3,567.77	7,313.93	7,496.78	6,403.50															
Construction cost for the track						631.03	862.40	662.97															
Construction cost for the signal system						282.33	651.13	519.10															
Purchasing passenger train cost						502.23	514.79	703.55										76.08	77.98				
Purchasing freight train cost						241.61	247.65	338.45										168.65	172.87				
Environmental measures cost					6.67	9.93	21.83	11.90	4.30	4.40	4.51	2.73	1.28	1.31	1.34	3.10	1.45	16.77	3.45	3.53	5.78	3.71	3.58
Passenger train management cost									92.12	94.42	96.78	99.20	101.68	104.22	106.83	109.50	112.24	122.56	125.62	128.76	131.98	135.28	138.66
Passenger train maintenance cost									49.78	51.02	52.30	53.60	54.94	56.32	57.73	59.17	60.65	64.17	65.77	67.41	69.10	70.83	72.60
Freight train management cost									193.01	197.84	202.79	207.86	213.05	218.38	223.84	229.43	235.17	358.29	367.25	376.43	385.84	395.48	405.37
Freight train maintenance cost									75.67	77.57	79.50	81.49	83.53	85.62	87.76	89.95	92.20	124.94	128.07	131.27	134.55	137.91	141.36
Infrastructure management cost									29.61	30.35	31.11	31.88	32.68	33.50	34.34	35.19	36.07	32.78	33.60	34.43	35.30	36.18	37.08
Infrastructure maintenance cost									1.22	11.61	11.90	12.20	12.50	12.81	13.13	13.46	13.80	187.89	16.88	17.31	17.74	18.18	18.64
Total Cost		**307.50**	**-**	**1,148.22**	**4,322.77**	**9,216.00**	**10,035.39**	**8,845.16**	**445.71**	**467.21**	**478.89**	**488.96**	**499.66**	**512.16**	**524.96**	**539.81**	**551.58**	**1,152.13**	**991.48**	**759.14**	**780.28**	**797.58**	**817.29**
Profit before Tax	- 307.50	-	- 1,148.22	- 4,322.77	- 9,216.00	- 10,035.39	- 8,845.16		280.91	302.44	319.91	339.62	376.38	395.62	415.25	452.83	475.81	- 89.47	129.04	399.33	416.98	463.20	484.74
Corporate Income Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Profit / Loss	**- 307.50**	**-**	**- 1,148.22**	**- 4,322.77**	**- 9,216.00**	**- 10,035.39**	**- 8,845.16**		**280.91**	**302.44**	**319.91**	**339.62**	**376.38**	**395.62**	**415.25**	**452.83**	**475.81**	**- 89.47**	**129.04**	**399.33**	**416.98**	**463.20**	**484.74**

Table 8.4.2-4 Financial Analysis of the State Railway of Thailand of the investment model 1 (Cont'd)

Million Baht

Period of Project	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Fare	298.47	313.58	329.46	346.14	362.52	380.39	399.14	418.82	439.47	461.13	483.86	507.72	532.75	559.01	586.67
Fee	456.98	479.87	491.55	503.58	528.76	540.98	553.56	580.56	593.97	607.81	637.41	652.24	667.34	699.94	716.49
Revenue (passenger)	755.45	793.46	821.01	849.73	891.28	921.37	952.71	999.38	1,033.44	1,068.94	1,121.27	1,159.96	1,200.09	1,258.95	1,303.16
Freight	522.96	551.26	566.48	581.71	611.85	636.73	661.61	703.65	729.16	754.66	799.66	825.80	851.94	900.03	926.82
Lift on/Lift off	50.32	53.04	54.50	55.97	58.87	61.26	63.66	67.70	70.15	72.61	76.94	79.45	81.97	86.60	89.17
Revenue (product)	573.27	604.30	620.98	637.67	670.72	698.00	725.27	771.36	799.31	827.27	876.60	905.26	933.91	986.63	1,016.00
Signage and Commercial Space Rental	15.64	16.43	17.26	18.14	19.00	19.93	20.92	21.95	23.03	24.16	25.35	26.60	27.92	29.29	30.74
Total Revenue	**1,344.36**	**1,414.19**	**1,459.26**	**1,505.54**	**1,581.00**	**1,639.30**	**1,698.89**	**1,792.68**	**1,855.78**	**1,920.37**	**2,023.23**	**2,091.82**	**2,161.91**	**2,274.87**	**2,349.90**
The survey, design and expropriation cost															
Consultant cost															
Civil work cost															
Construction cost for the track															
Construction cost for the signal system															
Purchasing passenger train cost					358.49	367.45									334.23
Purchasing freight train cost					246.27	252.43									418.98
Environmental measures cost	1.67	1.72	4.20	1.57	1.91	22.01	4.52	7.40	4.75	4.87	4.69	2.20	5.38	2.31	2.06
Passenger train management cost	142.13	145.68	149.32	153.06	144.18	147.78	151.48	155.27	159.15	163.13	167.20	171.38	175.67	180.06	196.05
Passenger train maintenance cost	74.41	76.27	78.18	97.15	99.58	105.17	107.80	110.49	113.26	116.09	118.99	121.96	125.01	141.35	144.88
Freight train management cost	415.50	425.89	436.54	447.45	608.71	623.93	639.53	655.52	671.91	688.70	705.92	723.57	741.66	760.20	971.31
Freight train maintenance cost	144.90	148.52	152.23	156.04	172.94	177.26	181.70	186.24	190.89	195.67	200.56	205.57	210.71	215.98	291.94
Infrastructure management cost	38.01	38.96	39.93	40.93	41.96	43.00	44.08	45.18	46.31	47.47	48.66	49.87	51.12	52.40	59.50
Infrastructure maintenance cost	19.10	19.58	20.07	20.57	241.74	517.82	1,169.10	936.61	23.21	23.79	24.39	25.00	25.62	26.26	308.38
Total Cost	**835.73**	**856.62**	**880.48**	**916.77**	**1,915.79**	**2,256.87**	**2,298.20**	**2,096.71**	**1,209.48**	**1,239.72**	**1,270.41**	**1,299.55**	**1,335.17**	**1,378.55**	**2,727.32**
Profit before Tax	508.64	557.57	578.78	588.77 -	334.79 -	617.57 -	599.31 -	304.02	646.30	680.66	752.82	792.26	826.74	896.32 -	377.43
Corporate Income Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Profit / Loss	**508.64**	**557.57**	**578.78**	**588.77 -**	**334.79 -**	**617.57 -**	**599.31 -**	**304.02**	**646.30**	**680.66**	**752.82**	**792.26**	**826.74**	**896.32 -**	**377.43**

Table 8.4.2-5 Financial Analysis of the State Railway of Thailand of the investment model 2

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project																Financial Assessment Result		discount rate = 5%							
Form 2: The state is an investor in infrastructure, civil & signage, SRTwill manage vehicle supply, environmental measures, management and maintenance																Net Present Value		NPV	=	1,409 Million Baht					
Project duration from 2025 onwards (Period of financial analysis is 2025-2054)																Financial Internal Rate of Return		FIRR	=	9.87%					
																Benefit Cost Ratio		B/C	=	1.12					
																									Million Baht
Period of Project									**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**		
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**		
Fare									138.69	146.13	153.98	162.24	170.95	180.13	189.80	199.99	210.73	221.92	233.16	244.96	257.37	270.40	284.09		
Fee									272.95	287.63	295.70	303.94	320.25	329.18	338.29	356.46	366.43	376.45	395.28	404.93	414.77	435.50	446.06		
Revenue (passenger)									411.64	433.76	449.68	466.19	491.21	509.31	528.09	556.45	577.17	598.37	628.44	649.89	672.14	705.90	730.15		
Freight									280.70	299.42	311.12	322.82	342.89	354.88	366.88	388.34	400.64	412.93	437.75	452.24	466.73	493.25	508.10		
Lift on/Lift off									27.01	28.81	29.93	31.06	32.99	34.14	35.30	37.36	38.55	39.73	42.12	43.51	44.91	47.46	48.89		
Revenue (product)									307.71	328.23	341.06	353.88	375.88	389.03	402.18	425.71	439.19	452.66	479.86	495.75	511.63	540.71	556.99		
Signage and Commercial Space Rental									7.27	7.66	8.07	8.50	8.96	9.44	9.95	10.48	11.04	11.63	12.22	12.84	13.49	14.17	14.89		
Total Revenue									**726.62**	**769.65**	**798.80**	**828.57**	**876.04**	**907.78**	**940.21**	**992.64**	**1,027.39**	**1,062.66**	**1,120.52**	**1,158.48**	**1,197.26**	**1,260.78**	**1,302.03**		
The survey, design and expropriation cost																									
Consultant cost																									
Civil work cost																									
Construction cost for the track																									
Construction cost for the signal system																									
Purchasing passenger train cost						502.23	514.79	703.55										76.08	77.98						
Purchasing freight train cost						241.61	247.65	338.45										168.65	172.87						
Environmental measures cost					6.67	9.93	21.83	11.90	4.30	4.40	4.51	2.73	1.28	1.31	1.34	3.10	1.45	16.77	3.45	3.53	5.78	3.71	3.58		
Passenger management cost									92.12	94.42	96.78	99.20	101.68	104.22	106.83	109.50	112.24	122.56	125.62	128.76	131.98	135.28	138.66		
Passenger maintenance cost									49.78	51.02	52.30	53.60	54.94	56.32	57.73	59.17	60.65	64.17	65.77	67.41	69.10	70.83	72.60		
Freight management cost									193.01	197.84	202.79	207.86	213.05	218.38	223.84	229.43	235.17	358.29	367.25	376.43	385.84	395.48	405.37		
Freight maintenance cost									75.67	77.57	79.50	81.49	83.53	85.62	87.76	89.95	92.20	124.94	128.07	131.27	134.55	137.91	141.36		
Infrastructure management cost									29.61	30.35	31.11	31.88	32.68	33.50	34.34	35.19	36.07	32.78	33.60	34.43	35.30	36.18	37.08		
Infrastructure maintenance cost									1.22	11.61	11.90	12.20	12.50	12.81	13.13	13.46	13.80	187.89	16.88	17.31	17.74	18.18	18.64		
Total Cost					**6.67**	**753.78**	**784.27**	**1,053.90**	**445.71**	**467.21**	**478.89**	**488.96**	**499.66**	**512.16**	**524.96**	**539.81**	**551.58**	**1,152.13**	**991.48**	**759.14**	**780.28**	**797.58**	**817.29**		
Profit before Tax				-	6.67	- 753.78	- 784.27	- 1,053.90	280.91	302.44	319.91	339.62	376.38	395.62	415.25	452.83	475.81	- 89.47	129.04	399.33	416.98	463.20	484.74		
Corporate Income Tax					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Net Profit / Loss				**-**	**6.67**	**- 753.78**	**- 784.27**	**- 1,053.90**	**280.91**	**302.44**	**319.91**	**339.62**	**376.38**	**395.62**	**415.25**	**452.83**	**475.81**	**- 89.47**	**129.04**	**399.33**	**416.98**	**463.20**	**484.74**		

Table 8.4.2-5 Financial Analysis of the State Railway of Thailand of the investment model 2 (cont'd)

Million Baht

Period of Project	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Fare	298.47	313.58	329.46	346.14	362.52	380.39	399.14	418.82	439.47	461.13	483.86	507.72	532.75	559.01	586.67
Fee	456.98	479.87	491.55	503.58	528.76	540.98	553.56	580.56	593.97	607.81	637.41	652.24	667.34	699.94	716.49
Revenue (passenger)	755.45	793.46	821.01	849.73	891.28	921.37	952.71	999.38	1,033.44	1,068.94	1,121.27	1,159.96	1,200.09	1,258.95	1,303.16
Freight	522.96	551.26	566.48	581.71	611.85	636.73	661.61	703.65	729.16	754.66	799.66	825.80	851.94	900.03	926.82
Lift on/Lift off	50.32	53.04	54.50	55.97	58.87	61.26	63.66	67.70	70.15	72.61	76.94	79.45	81.97	86.60	89.17
Revenue (product)	573.27	604.30	620.98	637.67	670.72	698.00	725.27	771.36	799.31	827.27	876.60	905.26	933.91	986.63	1,016.00
Signage and Commercial Space Rental	15.64	16.43	17.26	18.14	19.00	19.93	20.92	21.95	23.03	24.16	25.35	26.60	27.92	29.29	30.74
Total Revenue	**1,344.36**	**1,414.19**	**1,459.26**	**1,505.54**	**1,581.00**	**1,639.30**	**1,698.89**	**1,792.68**	**1,855.78**	**1,920.37**	**2,023.23**	**2,091.82**	**2,161.91**	**2,274.87**	**2,349.90**
The survey, design and expropriation cost															
Consultant cost															
Civil work cost															
Construction cost for the track															
Construction cost for the signal system															
Purchasing passenger train cost					358.49	367.45									334.23
Purchasing freight train cost					246.27	252.43									418.98
Environmental measures cost	1.67	1.72	4.20	1.57	1.91	22.01	4.52	7.40	4.75	4.87	4.69	2.20	5.38	2.31	2.06
Passenger management cost	142.13	145.68	149.32	153.06	144.18	147.78	151.48	155.27	159.15	163.13	167.20	171.38	175.67	180.06	196.05
Passenger maintenance cost	74.41	76.27	78.18	97.15	99.58	105.17	107.80	110.49	113.26	116.09	118.99	121.96	125.01	141.35	144.88
Freight management cost	415.50	425.89	436.54	447.45	608.71	623.93	639.53	655.52	671.91	688.70	705.92	723.57	741.66	760.20	971.31
Freight maintenance cost	144.90	148.52	152.23	156.04	172.94	177.26	181.70	186.24	190.89	195.67	200.56	205.57	210.71	215.98	291.94
Infrastructure management cost	38.01	38.96	39.93	40.93	41.96	43.00	44.08	45.18	46.31	47.47	48.66	49.87	51.12	52.40	59.50
Infrastructure maintenance cost	19.10	19.58	20.07	20.57	241.74	517.82	1,169.10	936.61	23.21	23.79	24.39	25.00	25.62	26.26	308.38
Total Cost	**835.73**	**856.62**	**880.48**	**916.77**	**1,915.79**	**2,256.87**	**2,298.20**	**2,096.71**	**1,209.48**	**1,239.72**	**1,270.41**	**1,299.55**	**1,335.17**	**1,378.55**	**2,727.32**
Profit before Tax	508.64	557.57	578.78	588.77	- 334.79	- 617.57	- 599.31	- 304.02	646.30	680.66	752.82	792.26	826.74	896.32	- 377.43
Corporate Income Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Profit / Loss	**508.64**	**557.57**	**578.78**	**588.77**	**- 334.79**	**- 617.57**	**- 599.31**	**- 304.02**	**646.30**	**680.66**	**752.82**	**792.26**	**826.74**	**896.32**	**- 377.43**

Table 8.4.2-6 Financial Analysis of Private Sector Bus Routes in Chumphon - Ranong of the investment model 3

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project																	Financial Assessment Result		discount rate = 8%						
Form 3: The government is a major investor in infrastructure, civil & IT system, infrastructure management and maintenance																	Net Present Value		NPV	=	-21 Million Baht				
The private sector will supply the train and manage & maintenance the train																	Financial Internal Rate of Return		FIRR	=	7.73%				
Project duration from 2025 onwards (Period of financial analysis is 2025-2054)																	Benefit Cost Ratio		B/C	=	0.98				
																									Million Baht
Period of Project									**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**		
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**		
Fare									24.53	25.85	27.23	28.69	30.23	31.86	33.57	35.37	37.26	39.26	41.24	43.33	45.52	47.81	50.23		
Fee									115.99	115.73	315.30	304.61	109.36	755.54	950.79	269.13	32.03	704.32	961.02	741.56	465.74	6.11	281.94		
Revenue (passenger)									140.52	141.57	342.53	333.30	139.59	787.40	984.36	304.50	69.30	743.59	1,002.26	784.89	511.26	53.93	332.17		
Freight																									
Lift on/Lift off																									
Revenue (product)																									
Signage and Commercial Space Rental																									
Total Revenue									**140.52**	**141.57**	**342.53**	**333.30**	**139.59**	**787.40**	**984.36**	**304.50**	**69.30**	**743.59**	**1,002.26**	**784.89**	**511.26**	**53.93**	**332.17**		
The survey, design and expropriation cost																									
Consultant cost																									
Civil work cost																									
Construction cost for the track																									
Construction cost for the signal system																									
Purchasing passenger train cost						296.11	303.51	414.80																	
Purchasing freight train cost																									
Environmental measures cost																									
Passenger train management cost									29.18	29.91	30.65	31.42	32.21	33.01	33.84	34.68	35.55	44.80	45.92	47.07	48.24	49.45	50.69		
Passenger train maintenance cost									34.88	35.76	36.65	37.57	38.50	39.47	40.45	41.47	42.50	43.56	44.65	45.77	46.91	48.09	49.29		
Freight train management cost																									
Freight train maintenance cost																									
Infrastructure management cost																									
Infrastructure maintenance cost																									
Total Cost						**296.11**	**303.51**	**414.80**	**64.06**	**65.66**	**67.30**	**68.99**	**70.71**	**72.48**	**74.29**	**76.15**	**78.05**	**88.36**	**90.57**	**92.84**	**95.16**	**97.54**	**99.98**		
Profit before Tax					-	296.11	- 303.51	- 414.80	76.46	75.91	275.22	264.32	68.88	714.92	910.07	228.35	- 8.75	655.22	911.69	692.05	416.10	- 43.61	232.19		
Corporate Income Tax						-	-	-	15.29	15.18	55.04	52.86	13.78	142.98	182.01	45.67	-	131.04	182.34	138.41	83.22	-	46.44		
Net Profit / Loss					**-**	**296.11**	**- 303.51**	**- 414.80**	**61.17**	**60.73**	**220.18**	**211.46**	**55.11**	**571.94**	**728.06**	**182.68**	**- 8.75**	**524.18**	**729.35**	**553.64**	**332.88**	**- 43.61**	**185.75**		

Table 8.4.2-6 Financial Analysis of Private Sector Bus Routes in Chumphon - Ranong of the investment model 3 (cont'd)

Million Baht

Period of Project	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Fare	52.77	55.43	58.23	61.17	64.25	67.39	70.69	74.15	77.78	81.58	85.58	89.76	94.15	98.76	103.21
Fee	193.56	203.19	208.05	213.03	223.57	228.55	233.65	244.84	250.30	255.92	268.16	274.16	280.28	293.73	300.38
Revenue (passenger)	246.33	258.62	266.29	274.20	287.82	295.95	304.34	318.99	328.08	337.50	353.73	363.92	374.44	392.49	403.59
Freight															
Lift on/Lift off															
Revenue (product)															
Signage and Commercial Space Rental															
Total Revenue	**246.33**	**258.62**	**266.29**	**274.20**	**287.82**	**295.95**	**304.34**	**318.99**	**328.08**	**337.50**	**353.73**	**363.92**	**374.44**	**392.49**	**403.59**
The survey, design and expropriation cost															
Consultant cost															
Civil work cost															
Construction cost for the track															
Construction cost for the signal system															
Purchasing passenger train cost					212.41	217.72									271.90
Purchasing freight train cost															
Environmental measures cost															
Passenger train management cost	51.95	53.25	54.58	55.95	44.65	45.76	46.91	48.08	49.28	50.51	51.78	53.07	54.40	55.76	68.63
Passenger train maintenance cost	50.52	51.78	53.08	71.43	73.21	75.04	76.92	78.84	80.81	82.83	84.90	87.02	89.20	104.64	107.25
Freight train management cost															
Freight train maintenance cost															
Infrastructure management cost															
Infrastructure maintenance cost															
Total Cost	**102.48**	**105.04**	**107.66**	**127.37**	**330.26**	**338.52**	**123.82**	**126.92**	**130.09**	**133.34**	**136.68**	**140.09**	**143.60**	**160.39**	**447.79**
Profit before Tax	143.85	153.58	158.62	146.83	- 42.45	- 42.57	180.52	192.07	197.99	204.16	217.06	223.83	230.84	232.10	- 44.20
Corporate Income Tax	28.77	30.72	31.72	29.37	-	-	36.10	38.41	39.60	40.83	43.41	44.77	46.17	46.42	-
Net Profit / Loss	**115.08**	**122.87**	**126.90**	**117.46**	**- 42.45**	**- 42.57**	**144.42**	**153.66**	**158.39**	**163.33**	**173.65**	**179.06**	**184.67**	**185.68**	**- 44.20**

Table 8.4.2-7 Financial Analysis of Private who operate passenger train Routes ICD Lat Krabang - Ranong of the investment model 3

Feasibility Study and Preliminary Design of Chumphon - Ranong Railway Project																		Financial Assessment Result	discount rate = 8%					
Form 3: The government is a major investor in infrastructure, civil & IT system, infrastructure management and maintenance																		Net Present Value	NPV	=	-692 Million Baht			
The private sector will supply the train and manage & maintenance the train																		Financial Internal Rate of Return	FIRR	=	2.76%			
Project duration from 2025 onwards (Period of financial analysis is 2025-2054)																		Benefit Cost Ratio	B/C	=	0.81			
																								Million Baht
Period of Project									1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	
Fare																								
Fee																								
Revenue (passenger)																								
Freight									262.34	279.83	290.77	301.71	320.46	331.67	342.88	362.94	374.43	385.92	409.11	422.65	436.20	460.98	474.86	
Lift on/Lift off									25.24	26.92	27.98	29.03	30.83	31.91	32.99	34.92	36.03	37.13	39.36	40.66	41.97	44.35	45.69	
Revenue (product)									287.58	306.76	318.75	330.73	351.29	363.58	375.87	397.86	410.45	423.05	448.47	463.32	478.16	505.33	520.55	
Signage and Commercial Space Rental																								
Total Revenue									**287.58**	**306.76**	**318.75**	**330.73**	**351.29**	**363.58**	**375.87**	**397.86**	**410.45**	**423.05**	**448.47**	**463.32**	**478.16**	**505.33**	**520.55**	
The survey, design and expropriation cost																								
Consultant cost																								
Civil work cost																								
Construction cost for the track																								
Construction cost for the signal system																								
Purchasing passenger train cost																								
Purchasing freight train cost						241.61	247.65	338.45										168.65	172.87					
Environmental measures cost																								
Passenger train management cost																								
Passenger train maintenance cost																								
Freight train management cost									193.01	197.84	202.79	207.86	213.05	218.38	223.84	229.43	235.17	358.29	367.25	376.43	385.84	395.48	405.37	
Freight train maintenance cost									75.67	77.57	79.50	81.49	83.53	85.62	87.76	89.95	92.20	124.94	128.07	131.27	134.55	137.91	141.36	
Infrastructure management cost																								
Infrastructure maintenance cost																								
Total Cost						**241.61**	**247.65**	**338.45**	**268.69**	**275.40**	**282.29**	**289.35**	**296.58**	**304.00**	**311.60**	**319.39**	**327.37**	**651.88**	**668.18**	**507.69**	**520.39**	**533.40**	**546.73**	
Profit before Tax					-	241.61	- 247.65	- 338.45	18.89	31.35	36.46	41.39	54.71	59.58	64.27	78.47	83.08	- 228.83	- 219.71	- 44.38	- 42.22	- 28.06	- 26.18	
Corporate Income Tax						-	-	-	3.78	6.27	7.29	8.28	10.94	11.92	12.85	15.69	16.62	-	-	-	-	-	-	
Net Profit / Loss					**-**	**241.61**	**- 247.65**	**- 338.45**	**15.11**	**25.08**	**29.16**	**33.11**	**43.77**	**47.67**	**51.42**	**62.78**	**66.47**	**- 228.83**	**- 219.71**	**- 44.38**	**- 42.22**	**- 28.06**	**- 26.18**	

Table 8.4.2-7 Financial Analysis of Private who operate passenger train Routes ICD Lat Krabang - Ranong of the investment model 3 (con'td)

Million Baht

Period of Project	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Fare															
Fee															
Revenue (passenger)															
Freight	488.75	515.19	529.42	543.65	571.83	595.08	618.33	657.62	681.45	705.29	747.35	771.78	796.21	841.15	866.19
Lift on/Lift off	47.02	49.57	50.94	52.31	55.02	57.25	59.49	63.27	65.57	67.86	71.91	74.26	76.61	80.93	83.34
Revenue (product)	535.77	564.76	580.36	595.96	626.84	652.33	677.82	720.89	747.02	773.15	819.25	846.03	872.81	922.08	949.53
Signage and Commercial Space Rental															
Total Revenue	**535.77**	**564.76**	**580.36**	**595.96**	**626.84**	**652.33**	**677.82**	**720.89**	**747.02**	**773.15**	**819.25**	**846.03**	**872.81**	**922.08**	**949.53**
The survey, design and expropriation cost															
Consultant cost															
Civil work cost															
Construction cost for the track															
Construction cost for the signal system															
Purchasing passenger train cost															
Purchasing freight train cost					246.27	252.43									418.98
Environmental measures cost															
Passenger train management cost															
Passenger train maintenance cost															
Freight train management cost	415.50	425.89	436.54	447.45	608.71	623.93	639.53	655.52	671.91	688.70	705.92	723.57	741.66	760.20	971.31
Freight train maintenance cost	144.90	148.52	152.23	156.04	172.94	177.26	181.70	186.24	190.89	195.67	200.56	205.57	210.71	215.98	291.94
Infrastructure management cost															
Infrastructure maintenance cost															
Total Cost	**560.40**	**574.41**	**588.77**	**603.49**	**1,027.93**	**1,053.63**	**821.23**	**841.76**	**862.80**	**884.37**	**906.48**	**929.14**	**952.37**	**976.18**	**1,682.23**
Profit before Tax	- 24.63	- 9.65	- 8.41	- 7.53	- 401.08	- 401.29	- 143.40	- 120.86	- 115.78	- 111.22	- 87.23	- 83.11	- 79.56	- 54.10	- 732.70
Corporate Income Tax	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Profit / Loss	**- 24.63**	**- 9.65**	**- 8.41**	**- 7.53**	**- 401.08**	**- 401.29**	**- 143.40**	**- 120.86**	**- 115.78**	**- 111.22**	**- 87.23**	**- 83.11**	**- 79.56**	**- 54.10**	**- 732.70**

8.4.3 Source of Investment

Government funding guidelines for financing the development of national infrastructure can be considered as follows.

1) Through budgeting, spending on a regular budget approach. If the government is required to budget more than the revenues. The Ministry of Finance will be able to borrow money in accordance with the Budget Act of 1959, section 9 bis and under the Public Debt Management Act 2005, section 21, such as the issuance of bonds the government and bills.

2) Through the loan beyond the annual budget, according to the Public Debt Management Act 2005, sections 22 and 23 require economic and social development loans when needed. In addition, Section 25 also provides that the Ministry of Finance may borrow money in foreign currency under Section 22 to bring it to state agencies, state enterprises or institutions. Financial sector to save more and more efficient, such as borrowing from abroad.

3) Through loans from state agencies, state enterprises or public financial institutions under the Public Debt Management Act, BE 2548 (2005), Sections 27 and 28 require one fiscal year. The Ministry of Finance can guarantee the repayment of state agencies, state enterprises or financial institutions. It will be fully or partially guaranteed. It must not exceed 20% of the current annual budget and the additional budget. By the way. The government should not guarantee the full amount. One of the loans should be a non-government guaranteed loan. To increase efficiency and increase the inspection of private or lender, such as the issuance of state enterprise bonds.

4) Through co-investment with the private sector under the Act on Private Joint Investment in Government Affairs, 2013, which will reduce the financial burden of the state. However, the roles and responsibilities of the government and the private sector must be taken into account. For the most benefit to the people.

In case the funding source of the project comes from the budget. However, in practice, most of the funding from the budget is insufficient and takes a long time. Therefore, borrowing through the Ministry of Finance both domestically and internationally. It is another way of financing projects that will reduce the budget constraints and timeframes. The project can be developed more quickly. But be careful of using this loan channel. Is to increase the fiscal burden and public debt to the government. The budget burden and the level of public debt will increase. The concept of public-private partnership (PPP) is emerging. This approach is one mechanism that greatly enhances the performance of national infrastructure projects. This is due to the fact that the private sector has helped finance the government's budget deficit and has reduced the borrowing by the government to develop the country.

8.5 Recommendations for Private investment

In case of private joint venture, investing in rail projects in Chumphon - Ranong is a large public investment project but the return is low. And payback period is longer than investing in general business. So if the private co-investors do not get the support or promotion from the government. This project may not get the attention of private investors. The service may not meet the quality requirements. The conditions that private sector requires for state support are as follows.

8.5.1 Request for Investment Promotion

State investment promotion measures can be divided into two main categories: tax measures and non-tariff measures, the details are as follows.

- Tax measures
  - Exemption or reduction of corporate income tax During 3-15 years
  - Exemption of import duty on machinery
  - Exemption of import duty on raw materials
  - Personal income tax exemption for international experts both in Thailand and abroad.
- Non-Tax measures
  - Allow foreigners to own land to operate their businesses.
  - Permanent Residence for International Experts
  - Provide public space for private rent at a special rate. (Department of Treasury)
  - Infrastructure Development

The main agencies promoting the investment are: The Board of Investment (BOI) and the Ministry of Finance. The new rail project in Chumphon - Ranong is a type of project supported by logistics. In the rail transport sector. And the group that promotes tourism. By type of promotion, the joint venture partner of the project should seek support including:

- **Exemption of corporate income tax** at the rate of 20% of the net profit, exempted or reduced tax during the first 3-15 years of the project. This will reduce the cost burden of private sector until the adjustment.
- **Exemption of import duty on machinery** Private Equity Partners are primarily responsible for investing in Rolling Stock and maintenance. These are mostly imported. Lowering the import duty would help the private sector reduce the cost of car maintenance. Keeps the train in good condition throughout the project life.
- **Individual income tax exemption** Because of the management of the bus. Car maintenance, it also maintains systems that are critical to the quality of service and the safety of users. These issues require expert attention. Exemption from personal income tax will be a positive factor for attracting qualified Thai and foreign workers to join the project.

In addition to the above measures. The private equity firm has to invest a lot of money. One of the investments may require a loan from the money market and the capital market. Having a government guarantee will allow the private sector to borrow capital more conveniently and get lower interest rates. The presence of a state guarantee will reduce the risk to financial institutions. In addition, the state may reduce the fees associated with private and project financing. This will increase the attractiveness of investors and attract more qualified private investors to invest in the project.

8.5.2 Supplying Land

Large-scale transport projects have contributed to the development of the surrounding area. This is the heart of the economic and social development of the community. In addition, the development of commercial space also generated significant revenue for the project. The development of such areas should give the NGOs a major role in the mission. Development work can be achieved. It is imperative that the state assists in the provision of land to support the development of new commercial and urban areas for private use. The development of the area will involve many public and private agencies. The state has a potential. Therefore, the condition of the private sector that requires the state to act is to represent the land acquisition in accordance with the development plan agreed by the state and the private sector.

Commercial space development also needs to consider the relevant legislation. In particular, the law on urban planning and the law relating to the use of land belongs to the railway. The state should play an important role in improving or amending the law to facilitate land development. Details of the relevant laws are as follows.

Town Planning Act is a law that defines the role or scope of land use in each area as commercial land. Land for living Agricultural, land for industrial or public use. The area of the city plan will be divided into colors, which will help to know how each area can benefit. The private sector is required by the government. The planning of the area around the station and the area around the station to provide space for commercial and residential areas. In order to make it easier for the private sector to develop these areas.

Laws related to land use of railways is a law that prohibits commercial development on a proprietary area of a railway. If no such law or regulation is amended, the development of commercial space on the proprietary area of the railway is not possible. Therefore, the private condition that the state requires is to improve. Modify laws or regulations so that commercial or urban areas can be developed on proprietary land.

8.5.3 Requesting State to Join Capital

As a result of the financial assessment of all investment models, if the State Railway of Thailand is responsible for investment and expenses incurred during the operation, the SRT will face severe losses. (Investment model 1) and the same. If the private sector is responsible for the investment and the costs incurred during the whole operation. Therefore, the request for government to invest in the infrastructure is necessary for the new railway project in Chumphon - Ranong.

The necessity of requesting the state to enter into the venture is clearly demonstrated when the results of the evaluation of the investment form 2 and 3. When the government assists investment in all infrastructure, you will receive a rewarding financial return. (Investment Model 2) without having any role for the private sector. But if the SRT wants private companies to invest because of the need for private sector management. (Form 3) SRT or the government may need to have other investment support measures.

SRT or the government may need to have other investment support measures to keep their financial returns are at an interesting level, such as tax measures. The study results indicated that the private bus and truck will not receive the worth financial return under the conditions of investment in the form of 3, especially the truck with very low return due to high cost of fuel.

8.6 Sensitivity Analysis

Financial education and investment model of the new railway project in Chumphon - Ranong. Project Appraisal is a study of the feasibility of a project. Therefore, it is necessary to predict the factors affecting the project's revenues and costs directly. So the risk is. Current forecasts do not come true when the project is complete and operational.

Sensitivity Analysis is an analysis of the risks that will occur if the factors. Not as expected. The analysis is divided into two groups: demand factors. And the preconceptions. The first factor will be the factor that will affect the revenue of the project, which makes the revenue not as expected. For example, the number of passengers is not as predictable. The second factor is the factor that affects the expenditure of the project, which makes the expenditure not as expected. For example, the cost of building materials is higher. These changes will inevitably affect the results of the analysis of the suitability of the projects studied in the passage.

Sensitivity analysis of this project. The consultants will analyze the changes in benefits and costs of the project. This will allow investors to assess the risks that may occur.

1) in case of change of factors in a bad way or Pessimism tests three scenarios.
   - Value of investment and expenses are the same. However, the expected revenue has been reduced by 20%
   - Value of investment and expenses increased 20%, the expected revenue to be the same.
   - Value of investment and expenses increased 20% and expected benefits decreased 20%
2) In case of change of factors in good way or Optimism test 3 situations.
   - Value of investment and expenses are the same. However, the expected revenue has been increased 20%
   - The expected revenue to be the same but Value of investment and expenses has been reduced by 20%
   - Value of investment and expenses decreased 20% and the expected revenue increased 20%

Financial return analysis when project revenues and costs change from projected. This is due to various risk factors, as shown in **Table 8.6-1**.

Table 8.6-1 Sensitivity Analysis of New Railway Project in Chumphon - Ranong in the form that the Railway of Thailand is responsible

Financial index	Base Case	Positive change			Negative changes		
		Income increased 20%	Cost decreased 20%	Income increased 20% and cost decreased 20%	Income decreased 20%	Cost increased 20%	Income decreased 20% and cost increased 20%
FIRR (%)	2.01	3.07	3.29	4.24	0.43	0.75	-1.42
NPV (Mil.baht)	-20,891	-18,236	-14,057	-11,402	-23,546	-27,725	-30,380
B/C	0.39	0.47	0.49	0.58	0.31	0.32	0.26

Source: Consultants, 2017

8.7 Conclusion

8.7.1 Financial benefits of the project

Financial benefits of the project can be classified by type of train.

- **Passenger train** include fare (1st, 2nd and 3rd class). Air Fee and seat and sleeping fees); and advertising and media rental income. Revenue from fares and fees is directly derived from the current fare and toll rates currently used by the MRT, multiplied by the number of passengers on each route and the average distance traveled by passengers on each route. Non-fare revenue is based on historical data. Non-fare revenue is approximately 5.24% of fare revenue.
- **Freight train** consists of freight. Calculated based on freight rates currently used by SRT (varying by distance) multiplied by the expected freight train freight volume of the project.

8.7.2 Results of Financial Analysis of the Project

Comparing financial return with financial costs throughout the life of the project, it is found that the new Railway Project Chumphon - Ranong provides financial returns that are not worthwhile. This is shown by the following financial indicators.

- Internal Rate of Return (MIRR) = 2.01%
- Net present value (NPV) = -20,891 million baht
- Cost to Equity Ratio (B/C) = 0.39

From the index, show that if you consider only the financial benefits of the project alone. The new Railway Project Chumphon - Ranong will not provide a rewarding financial return.

8.7.3 Analysis of the Investment Model of the Project

The investment model is divided into 3 types as shown in **Table 8.7.3-1**.

Table 8.7.3-1 Possible investment forms

Form	Investment			Management		
	Infrastructure	Signal System	Train	Maintenance	Management of train service	Revenue collection
1	State Railway of Thailand					
2	Public		State Railway of Thailand			
3	Public		- Private: train procurement, maintenance and management of the bus. Include all income. If the performance exceeds the threshold (FIRR = 8%), it must pay excess revenue to the State Railway of Thailand. - State Railway of Thailand: Infrastructure maintenance and management			

Source: Consultants, 2017

The routes to consider investment model are as follows.

- Models 1 and 2 Passenger train will consider a short bus route between Chumphon and Ranong and a long bus route between Bangkok - Ranong. The car will be considered bus route between ICD Lat Krabang - Ranong.
- Type 3 buses will only consider a short bus route between Chumphon and Ranong. The freight train will be considered a bus route between ICD Lat Krabang - Ranong.

Analysis of investment model shown in **Table 8.7-2**.

Table 8.7-2. The results of Analysis of Investment Model

Investment Model	Joint Venture	Financial Indicators		
		FIRR (%)	NPV (Mil.Baht)	B/C
1	State Railway of Thailand	2.01	-20,891	0.39
2	State Railway of Thailand	9.87	1,409	1.12
3	Private sector operate passenger train	7.73	-21	0.98
	Private sector operate freight train	2.76	-692	0.81

Source: Consultants, 2017

From the financial return of the investment model, it is found that the most likely form is the second form that gives the state the burden of investment in infrastructure, the sign system and the State Railway of Thailand is responsible for the supply of cars and buses.

8.7.4 Sources of Funding

Government funding guidelines for financing the development of national infrastructure. It can be considered as follows.

- Set a budget for normal budgeting.
- Loan beyond the annual budget.
- loans from government agencies, state enterprises or financial institutions
- Joint investment with the private sector according to the Joint Investment Act of 2013

Loan through the Ministry of Finance both domestic and abroad. It is another way of financing projects that will reduce the budget constraints and timeframes. The project can be developed more quickly. But be careful of using this loan channel. Is to increase the fiscal burden and public debt to the government. The budget burden and the level of public debt will increase. The concept of public-private partnership (PPP) is emerging. This approach is one mechanism that greatly enhances the performance of national infrastructure projects. This is due to the fact that the private sector has helped finance the government's budget deficit and has reduced the borrowing by the government to develop the country.

8.7.5 Private sector demands that the state perform

Railway Project in Chumphon Province - Ranong Province is a large public investment project but the return is low and payback period is longer than investing in general business. So if the private co-investors do not get the support or promotion from the government. This project may not get the attention of private investors. The service may not meet the quality requirements. The conditions that private sector requires for state support are as follows.

- **Application for Investment Promotion** State investment promotion measures can be divided into two main categories: tax measures. And non-tariff measures Details are as follows.
  - Tax Measures
  - Non-Tax Measures

The main agencies promoting the investment are: The Board of Investment (BOI) and the Ministry of Finance New railway project in Chumphon - Ranong It is a type of project that is supported in logistics. In the rail transport sector. And the group that promotes tourism.

- **Land acquisition** Space development should give the private sector a major role in the mission. Development work can be achieved. It is imperative that the state assists in the provision of land to support the development of new commercial and urban areas for private use. The development of the area will involve many public and private agencies. The state has the potential to operate more than the private sector, so private conditions require the state to proceed. In addition, the development of commercial areas must also take into account the relevant laws. In particular, the law on urban planning and the law relating to the use of land belongs to the railway. The state should play an important role in improving or amending the law to facilitate land development.
- **Requests for state funding** the necessity of requesting the state to enter into the venture is clearly demonstrated when the results of the evaluation of the second and third forms of investment are examined. When the government assists investment in all infrastructure, will receive a rewarding financial return. (Investment Model 2) without having any role for the private sector. If the RTA wants private companies to invest because of the need for private sector management. (Form 3) The SRT or the government may need to have investment support measures, such as tax measures for the financial return is at an interesting level.

Chapter 9

Process of Creating People Perception and People Participation

Chapter 9
Process of Creating People Perception and People Participation

9.1 Introduction

Implementation of Feasibility Study of Economics, Engineering and Environment on the New Railway from Chumphon Province to Ranong Deep Sea Port. This is a government project that may have an impact on natural resources and environmental quality that requires a process of public participation since the beginning of the project to the public and all stakeholders to know the project information properly and adequately. And also have the opportunity to exchange ideas and provide feedback on project development lead to decision making in various stages of the project carefully in order to get the project has been recognized by the people, the local community and all parties involved.

9.2 Target Groups

Target groups of people participation activities is the stakeholders which considering by the guidelines of public participation and evaluation of social impact in the process of environmental impact assessment. This will consist of:

1) Affected People : People who are migrated out from construction area of the project, Community area which located nearby Right of Way area
2) Government agency or private sector which responsible for initial environmental examination report (IEE Report) : Project owner (Office of Transport and Traffic Policy and Planning; OTP) and consultants.
3) Government agency which responsible for review the IEE/EIA report : Office of Natural Resources and Environmental Policy and Planning (ONEP)
4) Relevant Government Agency ; Forestry Department, Department of National Park, Wildlife and Plant Conservation, Department of Highway, Department of Rural Roads, Provincial Administration Organization and Sub-district Administration Organization
5) Private organization, educational institution and scholar.
6) Mass media
7) People

9.3 Target Areas

The public participation targeted areas focused on the areas along the railway alignment from Chumphon Province to Ranong Deep Sea Port and nearby, which as shown **table 9.3-1**

Table 9.3-1 Target Areas

Province	District	Sub-District	Local Administrative Organization
Chumphon	Muang Chumphon	Khun Krating	Khun Krating Subdistrict Municipality
		Tak Daet	Tak Daet Subdistrict Administrative Organization
		Ban Na	Ban Na Subdistrict Administrative Organization
		Wang Mai	Wang Mai Subdistrict Municipality
Ranong	Kra Buri	Jor Por Lor	Jor Por Lor Subdistrict Municipality
		Nam Chuet	Nam Chuet Subdistrict Municipality
		Nam Chuet Noi	Nam Chuet Noi Subdistrict Administrative Organization
		Bang Yai	Bang Yai Subdistrict Administrative Organization
		Pak Chan	Pak Chan Subdistrict Administrative Organization
		Ma Mu	Ma Mu Subdistrict Administrative Organization
		Lam Liang	Lam Liang Subdistrict Administrative Organization
	La-un	Bang Kaew	Bang Kaew Subdistrict Administrative Organization
	Muang Ranong	Sai Daeng	Sai Daeng Subdistrict Administrative Organization
		Pak Nam	Pak Nam Subdistrict Municipality
		Bang Non	Bang Non Subdistrict Municipality

9.4 Work Plan for Creating People Perception and People Participation

The activities of creating people perception and public participation and Public Relations for the project has been conducted since the beginning of the project (May, 2017) to date (February, 2018) throughout the study period. Summarizing the activities and implementation of public participation in **Table 9.4-1**

Table 9.4-1 Summarize of People Participation and Public Relation Work Plans.

Activities	Date/Venue	Objectives	No. of Participants
1. Meetings with the local government officials			
Visiting officials, government agencies, provincial and districts level of Chumphon and Ranong Province	May – September 2017	• To inform the background, objectives and implementation guidelines of the project. Including a comment on the route selection of the project.	14
2. Project Seminar			
2.1 Public Participation Meeting 1st (Project Orientation)	13 July 2017, 08.30 AM.-12.00 PM. at Pud Pitchaya Room, Nanaburi Hotel, Mueang Chumphon District, Chumphon Province	• To introduce and clarify background information of the project including the rationale for the development of the project as well as important guidelines and procedures. • To hear feedback and suggestions from attendees about the study and development planning and to determine the route selection. Including important issues that may arise from the development and recommendations and issues that should be cautious or important in the study.	100
	14 July 2017, 08.30 AM.-12.00 PM. at Ruangraj Room, Tinidee at Ranong Hotel, Mueang Ranong District, Ranong Province		121
2.2 Public Participation Meeting 2nd (Summary of Route Selection)	9 November 2017, 08.30 AM.-12.00 PM. at Pud Pitchaya Room, Nanaburi Hotel,Mueang Chumphon District, Chumphon Province		
	10 November 2017, 08.30 AM.-12.00 PM. at Ruangraj Room, Tinidee at Ranong Hotel, Mueang Ranong District, Ranong Province		106

Table 9.4-1 Summarize of People Participation and Public Relation Work Plans. (cont.)

Activities	Date/Venue	Objectives	No. of Participants
2.3 Meeting of Focus Group	1st meeting at Chumphon Province • Group 1st on 29 November 2017, 09.00 AM.-12.00 PM. at Tak Daet Subdistrict Administrative Organization Meeting Room • Group 2 nd on 29 November 2017, 14.00 PM.-16.30 PM. at Wang Mai Subdistrict Municipality Meeting Room	• To introduce the project and inform the background of the project. Including reasons for the project development as well as important guidelines and procedures of the study. • To hear the feedback and suggestions from attendees about the project study and development plan, route selection including important issues that may arise from the development. Also the recommendations and issues that should be cautious or important in the study area, the ways to deal with expected problems to occur in the area.	54 158
	2nd meeting at Ranong Province • Group 1st on 30 November 2017, 09.00 AM.-12.00 PM. at Kra Buri Vocational College Meeting Room • Group 2nd on 30 November 2017, 14.00 PM.-16.30 PM. at Bang Kaew Subdistrict Administrative Organization Meeting Room • Group 3rd on 1 December 2017, 09.00 AM.-12.00 PM. at Ranong Municipality Office Meeting Room		82 43 73
2.4 Public Participation Meeting 3rd (Summary of Project Results)	• 1 February 2018, 08.30 AM.-12.00 PM. at Pud Pitchaya Room, Nanaburi Hotel, Mueang Chumphon District, Chumphon Province	• To inform the study results on the detailed design of the project, route alignment, typical and composition of the project. • To inform the results of the environmental impact study including measures to deal with the expected impact. • To hear feedback and suggestions from attendees. This will be considered for further improvement, recommendations, measures to address the impact in the IEE report, as well as to improve the feasibility study. And as a guideline for further design of the project.	89
	• 2 February 2018, 08.30 AM.-12.00 PM. at Ruangraj Room, Tinidee at Ranong Hotel, Mueang Ranong District, Ranong Province		113

9.5 Result of the Activities of People Perception and People Participation

By the conducting of People awareness and People Public Participation has collected the comments and suggestions for improvement the feasibility study, preliminary design and initial impact examination, as shown in **Table 9.5-1**

Table 9.5-1 Suspicious issues and recommendations from the public participation

Comments / Suggestions	Improvement of the study results
1. Engineering	
1.1 Criteria and procedures for the route selection.	1.1 Consultant has considered the terrain, avoiding the conservation area, and the ability to connect to the communications network. Then, To propose the 4 routes for route selection by the scoring method or Multi-Attribute Utility Theory (MAUT). The key factors consists of economic and investment aspect, engineering factors, and environmental and social impact factors. It also has the project's committee that includes the representatives from relevant agencies, such as OTP, SRT DOH and ONEP to review and comment on the implementation of the study under the scope of work to hire a consultant (Terms of Reference: TOR).
1.2 The study and design of the railway station of project, local architectural patterns should be integrated for designing the railway station where can be promoted as the new landmark of Chomphon and Ranong Province.	1.2 The design of the project's railway stations will determine the location, utility area, and to connect the transport network. It also considers buildings and structures of historic places of Chumphon and Ranong Province, such as Krom Luang Chumphon Khet Udomsak Royal Palace and Rattanarungsan Throne Hall. The new railway station should be the sceneric place and landmark Chomphon and Ranong Province.
1.3 Providing facilities and services to passengers, including the tourist, the disabled and the elderly.	1.3 The consultants have designed various facilities. The railway station is consistent with the use of space within the station. Including designs for all types of users or Universal Design.
1.4 Because of Chumphon and Ranong Province has a high rainfall. Therefore, the design of the railway route of project must not obstruct the flow and natural drainage in the area.	1.4 The design of drainage systems throughout the project alignment has considered the catchment area, rainfall and drainage direction, the return period of 100 years to prevent the flooding problems on both sides of the railway. It also provides the measures to reduce the drainage effects in lowland areas where floods have been affected.
1.5 The railway alignment should be avoided at the railway lines used during World War II to conserve historic rail lines.	1.5 Studying the project alignment has considered the data of railway line that used in the World War II from the Fine Arts Department. It consists in the design of the railway and the location of the railway station for supporting the tourism of Ranong Province
1.6 To propose the using of rubber as the construction material for the project.	1.6 Consultants to consider this request and propose to the detailed design.

Table 9.5-1 Suspicious issues and recommendations from the public participation (cont.)

Comments / Suggestions	Improvement of the study results
2. Economics, Finance and Investment	
2.1 If developing the project, it will result in better transportation and traveling by railway. And what if can connect the route project to Ranong Airport, it will promote the rail transport and support tourism in Chumphon and Ranong	2.1 Consultants to consider this request and propose to the detailed design.
2.2 Consideration of connecting the railway route from Ranong to Phang Nga and Phuket province	2.2 Consultants to consider this request and propose to the detailed design.
2.3 To Consider indirect benefits to support future construction projects. From the result of freight forecasts of Ranong Deep Sea Port has shown that it will not be feasibility in the long term	2.3 Potential for tourism of Chumphon and Ranong will support the project such as, expenditure of tourists, urban development around the railway station that can make the indirect benefit and rewards the feasibility.
2.4 The details of sources of budget used in project construction and project investment.	2.4 The State Railway of Thailand will be the owner of the project. The source of the project budget may come from the government and the private sector that must consistent of the study of private partnership investment
3. Environmental and Social Impacts	
3.1 To consider the impact and measures for security of community, social impacts, and of the people along the project alignment.	3.1 Measures to prevent and monitor the environmental impacts will be given in IEE report. These issues will study more details on EIA report preparation.
3.2 Because of the most area in Ranong province is protected areas and unspecified certificate of ownership. The project should consider setting the measures to prevent and release the effects of land expropriation.	3.2 The project owner must comply with the expropriation law.
3.3 During construction phase may cause the noise, dust and vibration effects especially sensitive areas where located within 500 meters of the project alignment.	3.3 Measures to prevent and monitor the environmental impacts will be proposed in IEE report. This issue will be studying on EIA report.
3.4 Asking for set up the complaints center about the impact of the project.	3.4 The mitigation plan will be proposed by the project owner. Including the contact number of the agency, the project owner and the contractor. And also setting up the Complaints center to be filed and contacted 24 hours a day.

Table 9.5-1 Suspicious issues and recommendations from the public participation (cont.)

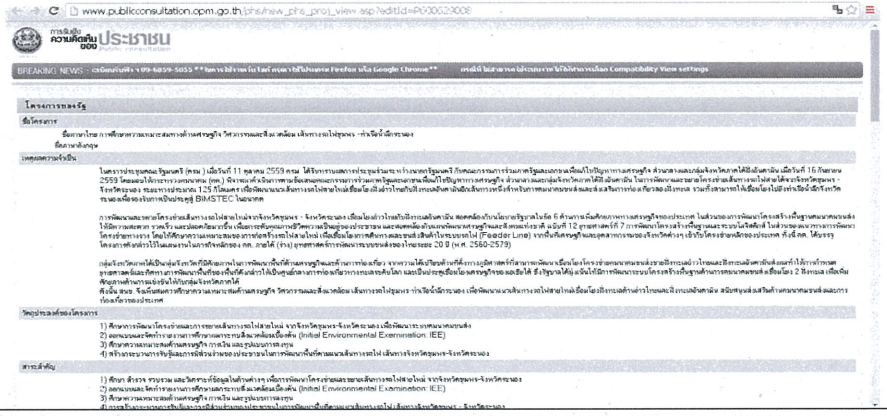
Comments / Suggestions	Improvement of the study results
4. People Participation	
4.1 The project should pay more attention of the opinions of the people fully and around. Especially those who are affected by the expropriation.	4.1 From the result of the study project, it is not possible to identify the properties plan and the owners who are expected to be affected by land expropriation. Detailed design and environmental impact assessment (EIA) reports will give the data which can identify the properties plan and invite the owners to listen to information and comment.
4.2 Should consider the activities and public relation of project's information.	4.2 Consultants to consider this request and propose to the next step of study.
5. Others	
5.1 Should give detail of project implementation plan.	5.1 When the feasibility study, preliminary design and IEE report has been completed, the next step is to study of detailed design and Environmental Impact Assessment (EIA) reports for one year, and then is to consider and propose the project for approval process about 1-2 year. Finally, when the project has been approved, the construction period will take about 3.5 years and ready for operation.

9.6 Summary of Public Relations

Public relations to disseminate the project information systematically and continuously will support the people concerned. Including of the public to generally knowledgeable, understanding the project. And they are ready to participate in the comments and suggestions that are beneficial to the project in succession. In the study stage, the consultant has conducted the preparation of media relations to distribute information and progress of project study to the public comprise of 3 fact sheets, 3 brochures, 4 project publicity boards, 1 videos and the project website. (www.chumphon-ranongrailway.com) There is also public relations through mass media such as printing media, radio and television, by providing press releases to disseminate the progress of project implementation.



Website of Project (www.chumphon-ranongrailway.com)



Website of Office of the Prime Minister (www.publicconsultation.opm.go.th)



Local News Paper



Board-Brochure-Document of Project

Figure 9.6-1 Media Relations



Daily News website (www.dailynews.co.th)



สั่งขยายทางคู่อีอีซีทะลุเขมร

●ทุ่ม5แสนล้านเชื่อมรางทุกภาค

รองโฆษกกระทรวงคมนาคม เปิดเผยว่า นายสมัคร จาตุศรีพิทักษ์ รองผู้ว่าการรฟท. ได้มอบนโยบายกับ รฟท. ซึ่งเน้นการดำเนินงานพัฒนาโครงสร้างพื้นฐานและแผนพื้นที่ศูนย์การ โดยได้สั่งการให้ รฟท.ไปเร่งดำเนินโครงการที่ต้องร่วมทุนพีพีพีให้เป็นไปตามแผน โดยเฉพาะโครงการรถไฟความเร็วสูงเส้นทางต่าง ๆ ที่มีมูลประมาณของทุนร่วมแสนล้านบาท เช่น โครงการรถไฟสายใต้ กรุงเทพฯ-หนองคาย วงเงิน 4 แสนล้านบาท โครงการรถไฟสายตะวันออก กรุงเทพฯ-หัวหิน วงเงิน 1 แสนล้านบาท และโครงการรถไฟสายเชื่อมสามสนามบิน วงเงิน 2.15 แสนล้านบาท

ส่วนการพัฒนาระบบรางในพื้นที่ระเบียงเศรษฐกิจภาคตะวันออก(อีอีซี) นั้น ได้สั่งการให้ รฟท. เร่งศึกษาแผนพัฒนาเส้นทางรถไฟเชื่อมต่อ อาทิ โครงการรถไฟทางคู่เส้นทางแหลมฉบัง-มาบตาพุด-ระยอง-จันทบุรี-ตราด ระยะทาง 107 กม. งบประมาณ 34,649 ล้านบาท โครงการรถไฟสีชมพู-ระยอง ระยะทาง 70 กม. งบประมาณ 13,357 ล้านบาท โครงการรถไฟช่วงทางคู่ชุมพร-ท่าเรือน้ำลึกระนอง ที่ 2 ชุมพร และ จ.ระนอง โดยชาวบ้านส่วนใหญ่เห็นด้วย และอยากให้เกิดขึ้น โดยเร็วเพื่อส่งเสริมการท่องเที่ยวและเศรษฐกิจภาคได้ แต่ยังมีความกังวลเรื่องเวนคืนที่ไม่มีเอกสารสิทธิ์และอาศัยอยู่ก่อนที่จะมีกฎหมายของกรมป่าไม้ออกมาบังคับใช้ ว่าจะได้รับการเยียวยาอย่างไรหรือไม่ รวมถึงความคุ้มทุน เพราะเงินทุนบางมาจากภาษีของชาวบ้าน ทั้งนี้ชาวระนองยังห่วงเรื่องสิ่งแวดล้อม ทำอย่างไรที่ไม่ให้มีผลกระทบ ดังนั้นจึงเสนอแนะให้ตั้งศูนย์ร้องเรียนตั้งแต่เริ่มก่อสร้างจนกระทั่งโครงการเสร็จสมบูรณ์

นางวิไลวัณย์ กล่าวอีกว่า การสัมมนาครั้งนี้ได้นำเสนอผลการศึกษาออกแบบโครงการรถไฟชุมพร–ท่าเรือน้ำลึกระนอง ซึ่งเป็นรถไฟรางเดี่ยว มีระยะทาง 108 กม. เบื้องต้นมี 9 สถานี ได้แก่ ชุมกระทิง บ้านนา วังใหม่ ปากจั่น กระพุรี บางใหญ่ ละอุ่น ท่าเรือน้ำลึกระนอง และระนอง รวมระยะทาง 103 กม. วงเงินลงทุนเบื้องต้น 45,300 ล้านบาท ส่วนค่าผลตอบแทนทางเศรษฐกิจ (EIRR)จะอยู่ที่ 12.20% สำหรับปริมาณคาดการณ์ผู้โดยสารในปีแรกที่เปิดให้บริการจะอยู่ที่ราว 5,724 คนต่อปี และจะเพิ่มเป็น 11,710 คนต่อปี ภายใน 30 ปี คิดเป็นปริมาณการเดินไม่ราว 100% หรือ 28% ต่อระยะเวลา 10 ปี ส่วนค่าบริษัทการท่องเที่ยวและกีฬาแห่งประเทศไทย (รฟท.) ได้ศึกษาร่วมกับ สนพ. ภายในปลายเดือน ก.พ. 61 ก่อนเสนอกระทรวงคมนาคมเพื่อขอใช้การรถไฟแห่งประเทศไทย (รฟท.) ได้ศึกษารายละเอียดออกแบบโครงการ จัดทำรายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม (อีไอเอ) ทำหนดพื้นที่รางเดินและดำเนินการก่อสร้างต่อไป.

จอแสดงโหมดขนส่ง

นายเชิดชัย สนิทวงศ์การ รองอธิบดีกรมการขนส่งทางบก (ขบ.) กล่าวถึงการประชุม กลุ่มต่อรับฟังความคิดเห็นรายงานผลการศึกษาความเหมาะสมทางด้านเศรษฐกิจ วิศวกรรมและสิ่งแวดล้อม และการออกแบบเบื้องต้น โครงการรถไฟสายใต้ ช่วง จ.ชุมพร-จ.ระนอง ว่า ขบ.ได้ร่วมกับ สนข. และ รฟท. ศึกษาความเหมาะสม

Chapter 10

Development Guidelines for Areas Surrounding the Station

Chapter 10
Development Guidelines for Areas Surrounding the Station

10.1 Concepts and Development Guidelines for Surrounding Areas of Railway Station along Chumphon - Ranong Route

10.1.1 Concepts for Developing Areas Surrounding the Station

The development of the area around the station in a way called **Transit Oriented Development (TOD)** has an important principle in developed planning, is to determine the use of land appropriately and consistent with the context of the area, easy access to and from the station or platform. The development area around the station is usually defined by the distance from the station to a radius of about 500 meters to 1,000 meters, which is the stage where several modes of transport, such as walking, bicycles, buses or private cars, can be reached less than 10 minutes.

In general, the use of the area around the station would be a high potential area for economic and social activities, as many people and transportation through this area, if without proper planning and management, the area could not be fully utilized and have a negative impact on the environment and the long-term community living. Therefore, in planning the development of the area around the station, the concept of compact development, which is defined as the development of the area in the maximum beneficial way and appropriate between the proportion of the volume of density in the utilization of the building area or the area used for activities with the volume of space used to travel in and out of the station to easily access the activity area. The land use around the station will consist of a variety of land uses and can be developed in a mixed (Mixed-Use) to be able to serve the area of the service user thoroughly (Compact), such as the area of commercial areas, service centers, government services, finance, banking, entertainment, workplace, business, recreation areas, parks and residences.

Each TODs has spatial requirements to accommodate a varying amount of users, thus the guidelines for developing areas around the station are different. The ability to achieve the highest development including restrictions and conditions of the urban community areas of Thailand, the land use shall be determined in accordance with the Ministerial Regulations, which shall apply to the consolidated plan of the locality including other requirements, which can be possible such as, the requirements under the ministerial regulations to apply the specific city plan or regulations in the area of special economic zones, etc.

10.1.2 Development Guidelines for Surrounding Areas of Railway Station along Chumphon – Ranong Route

The development of the Chumphon - Ranong railway route will be part of linking southern tourism routes between the Gulf of Thailand and the Andaman Sea, resulting in the expansion of tourism in both provinces, as well as the expansion of the city as a whole. The development of this railway line along with the development of urban areas, especially around the railway stations in both major cities, will promote and support spatial development in a way called Transit Oriented Development (TOD), which focus on compact development and incorporate into non-use of personal vehicles and quality urban design. Spatial potential analysis of Chumphon and Ranong Province based on the development of TOD, however, the development guidelines of TOD in Chumphon will be different from big city or other major cities of other regions, because the context of Chumphon is not as complicated as the city and density is not very high. Development strategies should focus on supporting the development of secondary roads, pedestrian and bicycles paths and public transport in urban areas that link the railway stations to major cities and the transit station to be able to bring passengers to other tourist attractions in the province, in particular attention should be given to infrastructure for the convenience of tourists who choose to travel by train in the future.

1) Proposal on model of developing areas surrounding the station

- Khun Krating Railway Station

  Located in Km 3 + 688 in Khun Krating District, Chumphon Province, located in the southwest of Chumphon town, 7 km from Chumphon Railway Station. This area is mostly agricultural, with low density communities living around. However, the location of Khun Krating railway Station is close to Khun Krating Sub-district Municipality, which is a suburban community adjacent to the Chumphon Town Community and is also close to Chumphon Bus Terminal, which is located adjacent to National Highway 41. If the transportation system has been developed, such areas are likely to occur urban community expansion. The development of the area surrounding the station in form of the suburban community center to accommodate the city's expansion by developing a commercial community center as a target area to support the region, there are all of transportation systems, in term of land use, there is a mix of residential areas, shops, commercial areas and task sources with a medium-high density.

- Ban Na Railway Station (1)

  Located in km 14 + 067 in the boundary of Wang Mai Sub-district and Ban Na Sub-district, Chumphon Province, away from Khun Krating Railway Station to the west of about 10 kilometers. This area is mostly agricultural, with low density communities living around, there are not many walking routes and the area is still lacking development to link effectively with the national highway 4. Land Use Requirements according to principal city plan of Chumphon Province designated as an agricultural area, so it does not appear the source of the very dense community. The development of the area around the station is designated as a community Neighborhood (Transit Neighborhood). A land use is primarily a residential area include the shops & small task source to provide community service, small transport system, community density is low.

- Ban Na Railway Station (2)

  Located at Km. 22 + 000 in Wang Mai Sub-district, Chumphon Province, away from Ban Na Railway Station (1) to the west of about 9 kilometers.The area is mostly hilly and rubbery, with low density communities living around, can connect to the national highway 4. Land Use Requirements according to principal city plan of Chumphon Province designated as agricultural area and conservation area, so it must limit the expansion of the community in some areas. The development of the area around the station is designated as a Community Neighborhood (Transit Neighborhood). A land use is primarily a residential area include the shops & small task source to provide community service, small transport system, community density is low.

- Pak Chan Railway Station

  Located in km 42 + 950 in Bang Lamu Sub-district, Ranong Province, away from Ban Na Railway Station (2) to the west of about 19 kilometers. This area is a plateau alternating with palm plantation area. The Pak Chan community is a medium community living along the national highway 4, can travel from this station to Chum Saeng Waterfall. Land Use Requirements according to principal city plan of Ranong Province are designated as forest conservation areas. The development of the area around the station is designated as a Community Neighborhood (Transit Neighborhood). A land use is primarily a residential area include the shops & small task source to provide community service, small transport system, community density is low.

- Kra Buri Railway Station

  Located at Km 52 + 900 in Nam Jued Noi Sub-district, Ranong Province, away from Pak Chan Railway Station to the south of about 10.5 kilometers. It takes about an hour to get there by train from Khun Krating and Ranong Railway Station, so it has a central character. The area is flat and rubber plantations and there are communities living along Highway 4. In addition, the location of the Kra Buri Railway Station can serve as a hub linking to the ecotourism and cultural attractions of Ranong, such as Bok Krai Waterfall, Khao Fa Shi View Point, Phra Khayang Cave. The community of Kra Buri has the potential to develop into a hub for tourism and tourist services. However, Land Use Requirements according to principal city plan of Ranong Province are designated as urban community area and agricultural area, which may require a community plan to improve land use around the station and to accommodate the expansion of the community. The development of the area around the station should be designated as a community center station (Transit Town Center). The area surrounding the station is the commercial center of the community center linked to the transportation system within the urban community and intercity. Community density is low to moderate.

- Bang Yai Railway Station

  Located at Km 70 + 839 in Bang Yai Sub-district, Ranong Province, away from Kra Buri Railway Station to the South of about 18 kilometers. The area is hilly and rubber plantations and there are communities living along main roads and secondary roads. Bang Yai Railway Station can be a point of connection to natural attractions, such as Suwansiri Waterfall, Khlong Bang Yai Forest Park and the natural scenery of the nearby hillsides. Land Use Requirements according to principal city plan of Ranong Province are designated as an agricultural area. The development of the area around the station is designated

as a Community Neighborhood (Transit Neighborhood). A land use is primarily a residential area include the shops & small task source to provide community service, small transport system, community density is low.

- La-un Railway Station

  Located at km 78 + 869 in Bang Kae Sub-district, Ranong Province, away from Bang Yai Railway Station to the South of about 9 kilometers. The area is hilly and rubber plantations and there are communities living along main roads and secondary roads. Land Use Requirements according to principal city plan of Ranong Province are designated as an agricultural area. The station can be a link to natural attractions, such as Khao Fa Chi and historical and cultural attractions. The development of the area around the station is designated as a Community Neighborhood (Transit Neighborhood). A land use is primarily a residential area include the shops & small task source to provide community service, small transport system, community density is low.

- Ranong Port Railway Station

  Located at Km 102 + 498 in Pak Nam Sub-district, Ranong Province, away from La-un railway station to the South of about 23 kilometers. The area is hilly and rubber plantations and there are communities living along secondary roads. The surrounding area has a multipurpose port in Ranong, a private port, shops and services along the coast and there are sources that link the activities from the community of Ranong. Ranong Port Railway Station is a point that connects to natural attractions such as Punyaban Waterfall, Kra Buri River National Park, etc. Land Use Requirements according to principal city plan of Ranong Province are designated as industrial area adjacent to port and is an agricultural area. The development of the area around the station is designated as a suburban center station, along with the development of a commercial community center, which will accommodate the expansion of port activities and coastal transportation that may occur in the future. Consideration should be given to linking the transportation network to the city and highway 4. The land use pattern in the areas surrounding the station should be mix of residential areas, shops and task sources with a medium density.

- Ranong Railway Station

  Located in km 4 + 832 (Spu Line) in Bang Non Sub-district, Ranong Province, away from Ranong Port to the East of about 3 kilometers. The area is flat hills, the community is densely populated. Ranong Railway Station can be a travel hub that links the tourist attractions of the coast and the islands, such as Chan Dumri Beach, Koh Chang, Koh Phayam, Bat Island, Kam Islands, natural attractions along the mountains such as mountain grass, Ngao Waterfall and cultural attractions such as Hat Som Paen Temple, etc. These attractions, although there is support from the Tourism Authority of Thailand before, but access to the area is not convenient as it should be, so there are not many tourists. The development of the area around the Ranong Railway Station should be designated as the Urban Center Station, be an important center for economic and social activities, able to support regional services. The system of transport linking all systems within the city and intercity as a whole, there are shops, services, task sources and residential areas with high – medium density.

It can be seen that the development of the Chumphon - Ranong route in such a way can be linked to many tourist attractions and communities in Ranong. The main attractions of Ranong are mostly tourist attractions along the coast and islands, all of which are located on the west side of the area. (Andaman coast) and it can also linked to the natural attractions of valley and waterfalls, which mountain range poses in the middle of the terrain of the province (**Table 10.1.2-1**).

If you consider the tourist attraction in Chumphon, the main tourist attractions are along the coast and islands as well (Gulf of Thailand). Linking characteristics of Chumphon and Ranong Railway line may have an impact on the tourist attraction as these attractions can be easily accessible. However, linking characteristics of Chumphon and Ranong Railway line is likely to affect the volume of visitors in Chumphon province as a whole, especially in the case of traveling to Chumphon Station, which is a source of distribution of people and important goods in the province.

Table 10.1.2-1 Tourist Attractions Nearby Chumphon - Ranong Railway Station and Connect to the Nearby Highway Network

Station	Nearby attractions	Category of tourism	Distance from station (km)	Travel Advice
1) Khun Krating Railway Station	NA	-	-	-
2) Ban Na Railway Station (1)	NA	-	-	-
3) Ban Na Railway Station (2)	NA	-	-	-
4) Pak Chan Railway Station	Chum Saeng Waterfall	Natural attractions	8.5	Take Road 1003 to the North parallel with the railroad for about 2 km, turn right to the local road and straight along the route about 6 km and then turn right for another 500 m.
5) Kra Buri Railway Station	Bok Krai Waterfall	Ecological and natural attractions (Thung Raya – Na Sak Wildlife Sanctuary	15.0	Take Road 1014 from the station to the Highway 4 about 2 km and take the Highway 4 to the south about 3.5 km then turn left into Road 1008 and then straight along the route about 9.5 km.
	Phra Khayang Cave	Religious and cultural attractions	11.0	Take Road 1014 from the station to Highway 4 about 2 km and take Highway 4 to the south for about 10 km then turn left into the local road.
6) Bang Yai Railway Station	Suwansiri Waterfall	Natural attractions	5.0	Take Highway 4 (Phetkasem) from the station to the south about 3 km then turn left for another 2 km.
	Khlong Bang Yai Forest Park	Natural attractions	4.5	Take Highway 4 (Phetkasem) from the station to the south about 3 km and turn left for another 1.5 km.

Table 10.1.2-1 Tourist Attractions nearby Chumphon - Ranong Railway Station and connect to the nearby highway network (cont'd)

Station	Nearby Attractions	Category of tourism	Distance from station (km)	Travel Advice
7) La-un Railway Station	Khao Fa Chi View Point	Natural attractions	4.0	Take the local road to Highway 4 (Phetkasem) about 1.5 km and take Highway 4 to the south (U-turn) and turn left into the local road along the route about 2.5 km.
	World War II Museum (Steam engine)	Historical and cultural attractions	4.3	Take the local road to Highway 4 (Phetkasem) about 1.5 km and take Highway 4 (U-turn) to the south about 2.3 km and turn left into the local road along the route about 500 m.
8) Ranong Railway Station	Raksa Warin Hot Spring	Cultural attractions	5.3	Take Highway 4 (Phetkasem) from the station to the south about 4.5 km then turn left and take Road 4005 straight about 800 m.
	Chan Dumri Beach	Natural attractions	12.8	Take Highway 4 (Phetkasem) from the station to the south about 2.6 km then turn left and take Road 4004 along the route about 10.2 km.
	Ranong Governor's Grave	Historical and cultural attractions	4.4	Take Highway 4 (Phetkasem) from the station to the south about 2.6 km, U-turn and turn left for about 1.8 km.
	Ranong King's Cemetery	Historical and cultural attractions	5.7	Take Highway 4 (Phetkasem) from the station to the south about 2.6 km. Take Road 4004 along the route about 3.1 km.
	Rattanarangsun Palace	Historical and cultural attractions	6.6	Take Highway 4 (Phetkasem) from the station to the south about 5.6 km south to the station, U-turn and turn left then take the Kamlungsup Road for about 1.0 km.
	Grass Mountain	Ecological and natural attractions	18.3	Take Highway 4 (Phetkasem) from the station to the south about 18 km, U-turn and turn left for about 300 m.
	Ngao Waterfall	Natural attractions	16.9	Take Highway 4 (Phetkasem) from the station to the south about 16.4 km then turn left for another 500 m.
	Porn Rung Hot Spring	Natural attractions	15.4	Take Highway 4 (Phetkasem) from the station to the south about 13.2 km then turn left for another 2.2 km.
	Hat Som Paen Temple	Religious and cultural attractions	10.7	Take Highway 4 (Phetkasem) from the station to the south about 4.5 km and turn left then take Road 4005 for about 6.2 km.
	Hat Som Paen Reservoir	Natural attractions	13.1	Take Highway 4 (Phetkasem) from the station to the south about 4.5 km and turn left then take Road 4005 for about 8.6 km.
	Ranong Canyon	Natural attractions	14.5	Take Highway 4 (Phetkasem) from the station to the south about 4.5 km and turn left then take Road 4005 for about 10.0 km.

The study of the context and the space condition surrounding the nine stations along the Chumphon - Ranong Railway route can be shown in **Table 10.1-1** and summarized as follows.

(1) Development of the area around the station at the Urban Center level, including *Ranong Station*

(2) Development of the area around the station at the Suburban Center level, including *Khun Krating Station* and *Ranong Port Station*

(3) Development of the area around the station at the Transit Town Center level, including *Kra Buri Station*

(4) Development of the area around the station at the Transit Neighborhood level, including *Ban Na station (1) Ban Na Station (2) Pak Chan Station*, *Bang Yai Station* and *La-un Station*

Table 10.1.2-2 Summary of Proposals for Development Guidelines for Areas Surrounding the Station

Details	Urban Center	Suburban Center	Transit Town Center	Transit Neighborhood
Station	Ranong town, Chumphon town (old or new station)	Khun Krating, Ranong Port	Kra Buri	Ban Na (1), Ban Na (2), Pak Chan, Bang Yai, La-un
Characteristics of development around the station	Provincial Economic and Cultural Center	Provincial Economic and Cultural Center	Economic centers and activities of the community and surrounding areas	Residential development and community service store system
Transportation system	All systems	Transportation system linking the main city community center / Intercity transport	Intercity Transport / Local Transportation	Community Transportation
Land use	The mix of residences, task sources, shops & services and Government office	The mix of residences, task sources, shops & services	The mix of residences, task sources, shops & services	Focus on residences and also has a system of shops & services to support
Building Development Model	High rise buildings between 2-5 floors	High rise buildings between 2-4 floors	Low-rise buildings between 1-3 floors	Low-rise buildings between 1-2 floors
Density	High - Medium	Medium	Medium - Low	Low

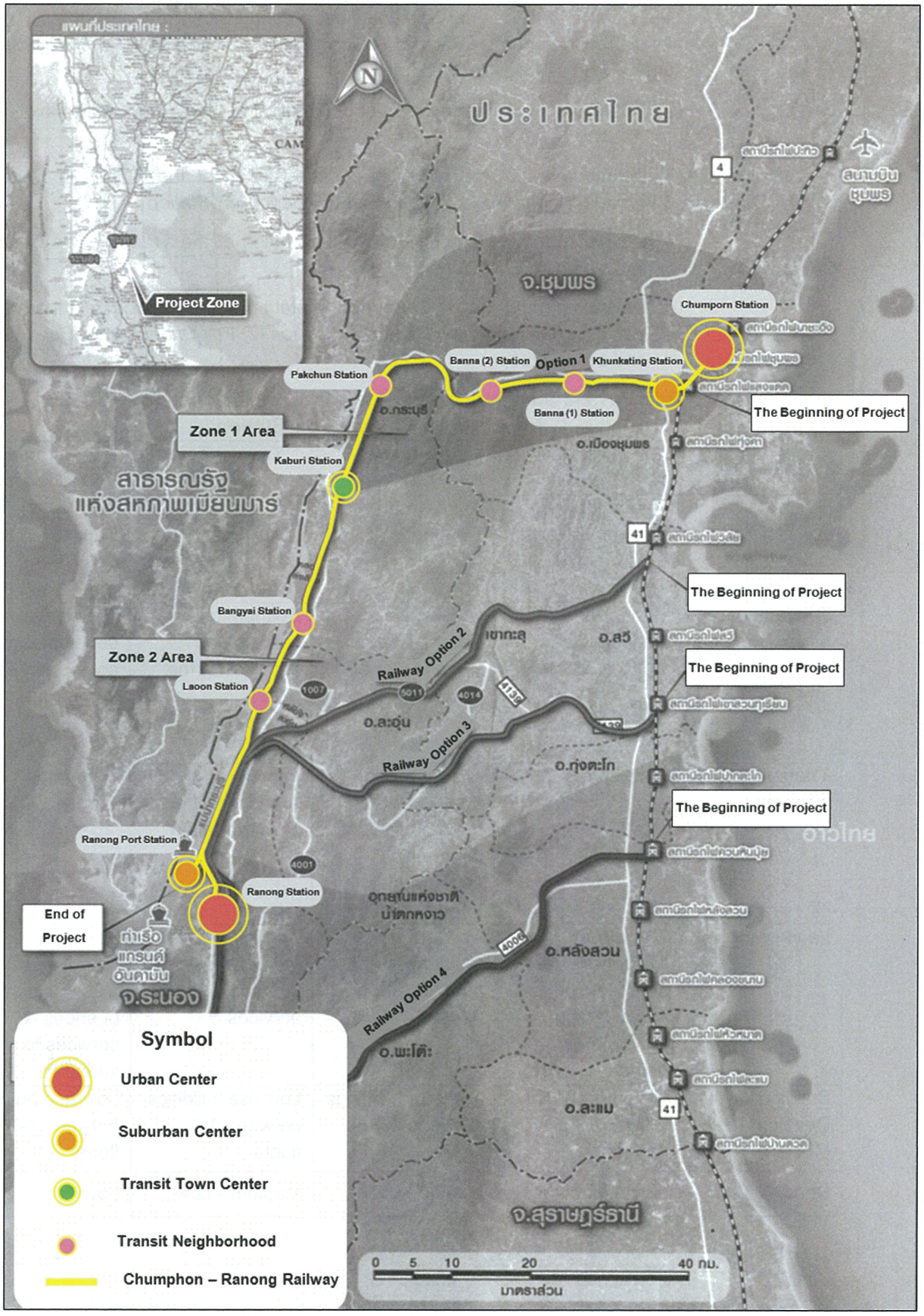


Figure 10.1.2-1 Model for Developing Areas Surrounding the Station along the Chumphon – Ranong Railway Route

2) Proposals for use of building and land surrounding the station

Land development proposal surrounding this station is detailed by considering the use of land around each type of station, all of the nine stations along the Chumphon - Ranong Railway route, as well as appropriate density for the development of the area in the context of Chumphon and Ranong Province. It can be summarize and classified context according to potential and the suitability of each type of station, which has a development approach as shown in **Table 10.1.2-3**.

Table 10.1.2-3 Proposal for developing areas surrounding the station along the Chumphon – Ranong Railway Route

Land Use Type	Proportion (%)	FAR*
Urban Center : Ranong Station		
Commercial	40	2.0
Residence	45	
Leisure space	10	
Space for public benefit	5	
Suburban Center : Khun Krating Station, Ranong Port Station		
Commercial	30	1.5
Residence	50	
Leisure space	10	
Space for public benefit	10	
Transit Town Center : Kra Buri Station		
Commercial	25	1.0
Residence	55	
Leisure space	15	
Space for public benefit	5	
Transit Neighborhood : Ban Na Station (1), Ban Na Station (2), Pak Chan Station, Bang Yai Station, La-un Station		
Commercial	20	0.5
Residence	65	
Leisure space	10	
Space for public benefit	5	

Note: * FAR or Floor Area Ratio is the ratio of building area to floor area of the building. This proposal is the minimum requirement for the development of the surrounding area.

Proposal for developing areas surrounding the station, according to FAR, as shown in Table 10.1.2-3, if fully developed according to the potential development and as defined by the FAR, the development of the building area will be maximized according to the proportion of utilization as shown in the **Table 10.1.2-4**.

Table 10.1.2-4 Volume of Buildings Area according to minimum development criteria of the areas surrounding the station along the Chumphon – Ranong Railway Route

Land Use Type	Proportion (%)	Area proposals can be fully developed based on FAR values	
		FAR*	Maximum building area that can be developed (sqm.)
Urban Center : Ranong Station			
Commercial	40	2.0	706,500
Residence	45		628,000
Leisure space	10		157,000
Space for public benefit	5		78,500
Total (Only commercial land use)			1,334,500
Suburban Center : Khun Krating Station, Ranong Port Station			
Commercial	30	1.5	353,250
Residence	50		588,750
Leisure space	10		117,750
Space for public benefit	10		117,750
Total (Only commercial land use)			942,000
Transit Town Center Station: Kra Buri Station			
Commercial	25	1.0	196,250
Residence	55		431,750
Leisure space	15		117,750
Space for public benefit	5		39,250
Total (Only commercial land use)			628,000
Transit Neighborhood Station: Ban Na Station (1), Ban Na Station (2), Pak Chan Station, Bang Yai Station, La-un Station			
Commercial	20	0.5	78,500
Residence	65		255,125
Leisure space	10		39,250
Space for public benefit	5		19,625
Total (Only commercial land use)			333,625

Note: Note: The full development of the surrounding area of the station at 500 meters (785,000 square meters) does not include consideration of the area in the existing context. If these areas have been developed. It is necessary to consider the development that appears with the land use characteristics set forth in this report. In addition to the characteristics of land ownership.

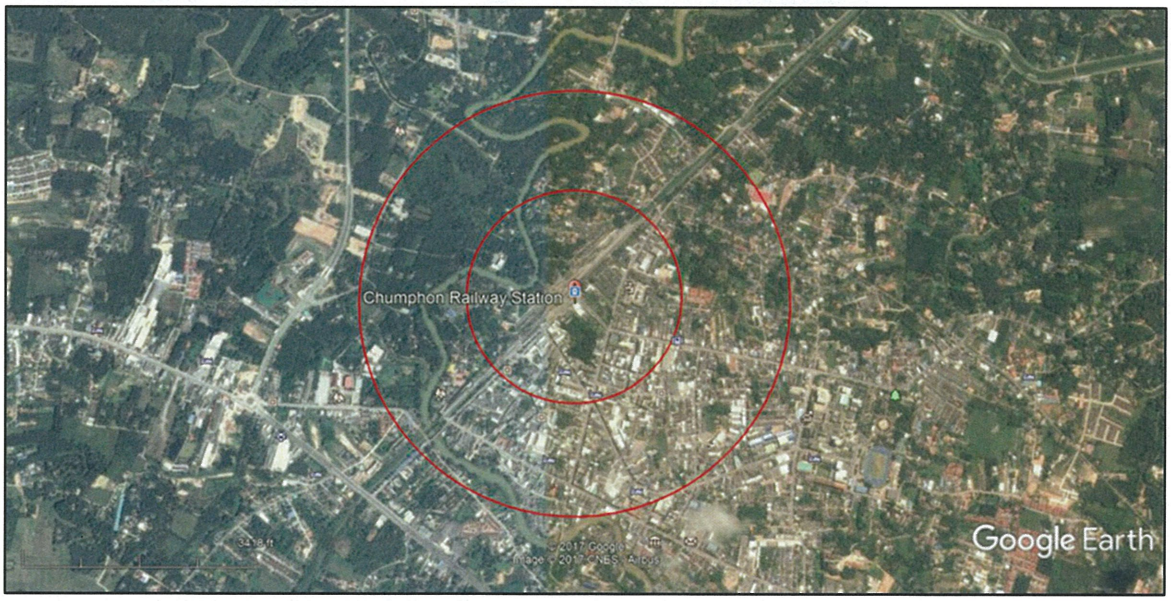
3) Proposal on method for developing areas to support the transport system

The method of developing the area to support the transport system is to guide the development of the area surrounding the railway station. This important approach is offered only in the case of Chumphon and Ranong Railway Stations, where both stations are important. Principles for developing the area around the two stations as a whole can be considered as follows.

- **The development of the area around Chumphon Railway Station**

  Chumphon Railway Station will be one of the important stations that are likely to be affected by the development of the Chumphon - Ranong Railway Line because of the location of station is the central source of travel to Chumphon, which is a community center with trade, business services and the services that link tourism activities at the level of the community in Chumphon downtown, provincial and regional. The development of this railway line will affect the increase in the number of passengers and products by train to this station.

  The area around Chumphon Railway Station is currently surrounded by residential communities. The area north of the station is mostly green and the Tha Tapao River flows through, there are less dense community settlements, while the southern area is the urban community. The land use of buildings and land is mixed between shops, markets, residential community and others with medium - high densities as shown in **Figure 10.1.2-2** and **Figure 10.1.2-3**. The buildings in this area are mostly 2-3 storey buildings with some 4-storey commercial buildings. The blocks of buildings in this area are not very large.



Source: Adapted from Chumphon City Plan in 2010

Figure 10.1.2-2 Area 500 and 1,000 meters around the railway station

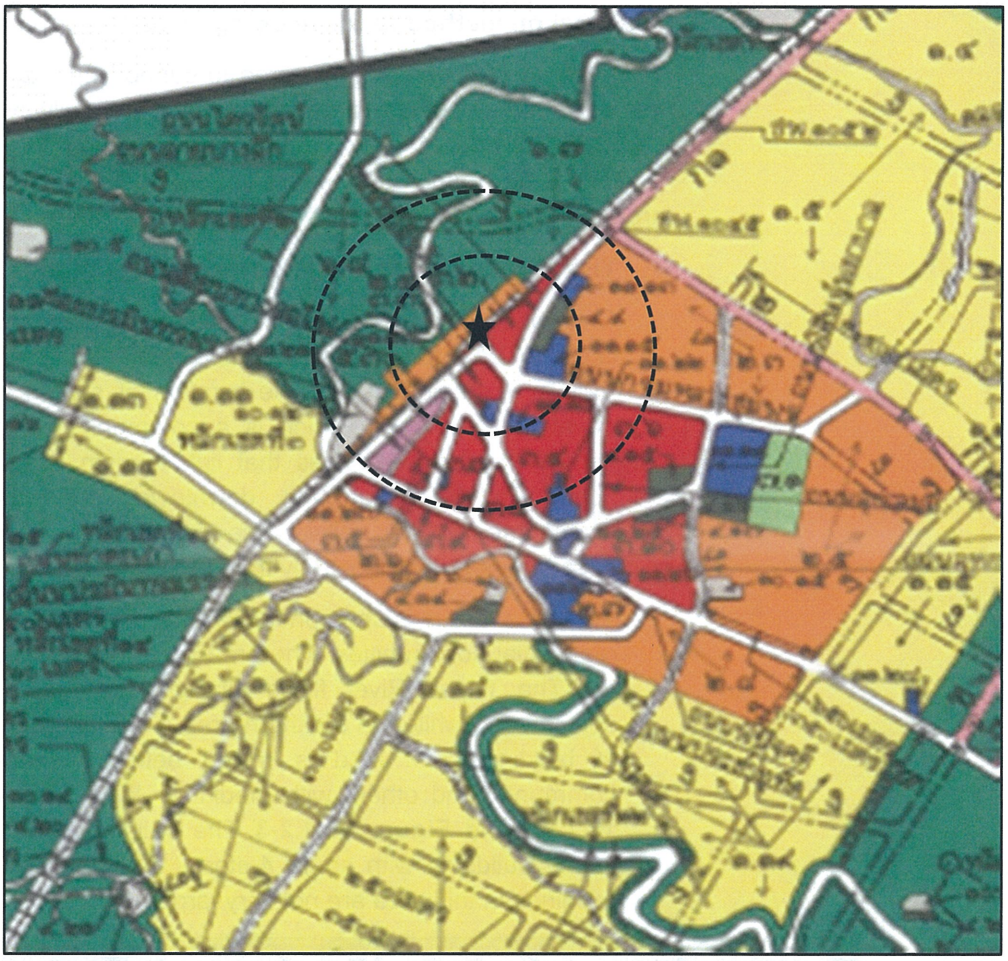


Figure 10.1.2-3 Land use around Chumphon Railway station at 500 - 1,000 meters

Area of 500 meters and 1,000 meters around the station are concentrated in a densely packed building suitable for "Compact City" development approach. Some building blocks have a walking path within blocks, but lack the development of continuous links with pedestrians along the main road, due to the physical nature of the area south of the station are densely developed, with mixed use of buildings and land, high density than other areas and has a very high community, so the area south of the railway station has the potential to develop as an area conducive to public transportation connected to the rail system (Transit-Oriented Development (TOD). However, the development guidelines of TOD in Chumphon will be different from big city or other major cities of other regions, because the context of Chumphon is not as complicated as the city and density is not very high. Development strategies should focus on supporting the development of secondary roads, pedestrian and bicycles paths and public transport in urban areas that link the railway stations to major cities and the transit station to be able to bring passengers to other tourist attractions in the province, in particular attention should be given to infrastructure for the convenience of tourists who choose to travel by train in the future. The development of the area surrounding Chumphon Railway Station can be implemented in two ways as follows.

- ***Development Guidelines "Infill-Development"***

Development of the area south of the railway station in the area that has been greatly developed, should be implemented in such a way "Infill-Development" or "Re-Development", which is a guideline to develop empty space, wilderness areas or undeveloped areas in urban areas where public utilities and public services are already developed, as shown in **Figure 10.1.2-4**, it is found that in urban areas south of the station (blocks 1-6), there are areas where "Infill-Development" approach can be used many locations, such as the 1st area, a mixed-use detached house with shops scattered on both sides of the road with low density, while the area itself is highly potential because it is the connection between the city center and the railway station. In the future,the development should consider increasing the density in such area, or the 3rd area, which is a densely populated commercial and the residential community area, may consider the development of a pedestrian precinct, bike paths within blocks to promote short trips in urban areas.

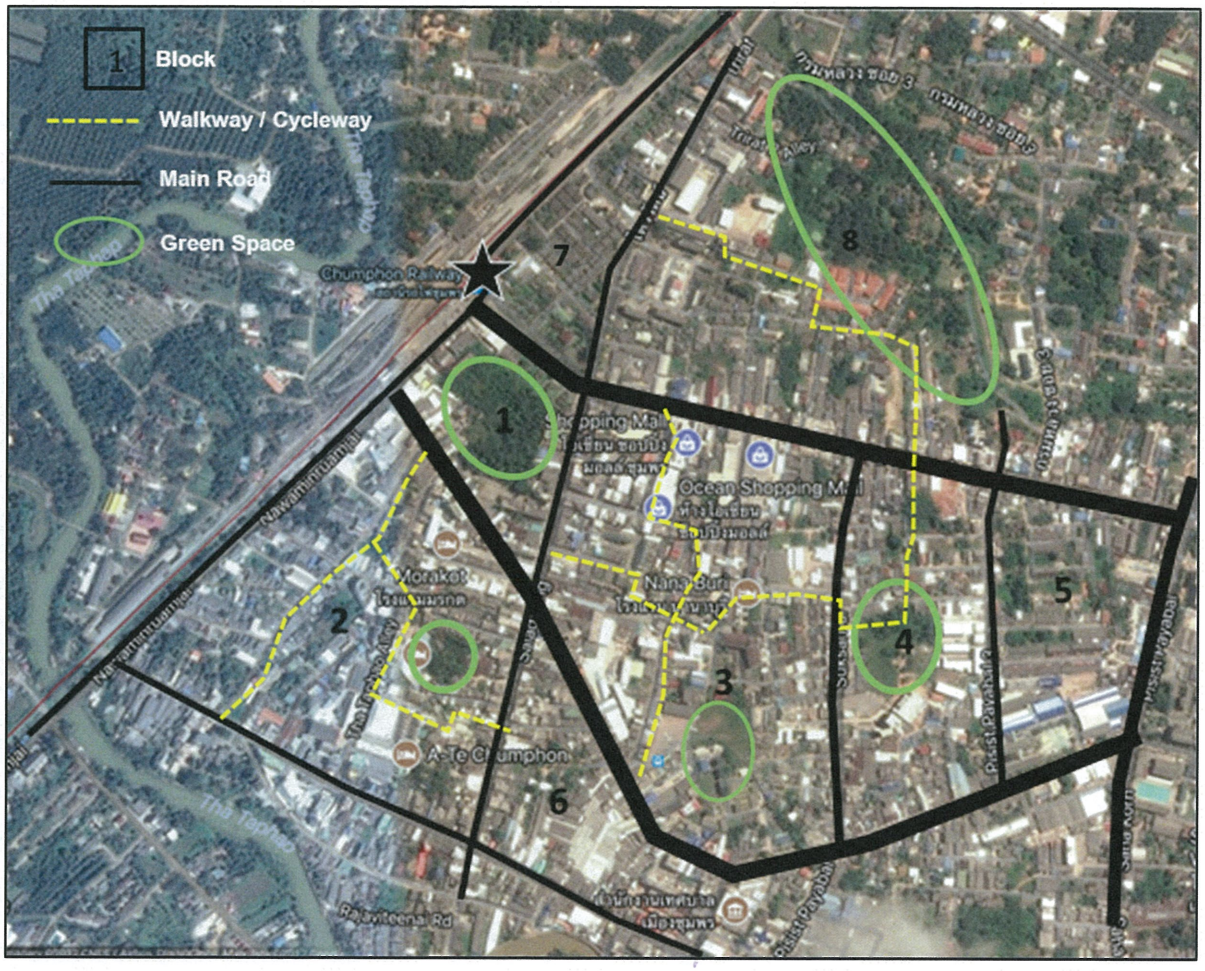


Figure 10.1.2-4. Empty Space in the Surrounding Community may develop in form of "Infill-Development" and examples of adding pedestrian and bicycle pathways within the building blocks

- ***Development Guidelines "Suburban Center Neighborhood"***

Development of Chumphon Railway Station in the future, if the city has expanded even more, the establishment of stations in existing area may have restrictions and may cause traffic problems within the city, so maybe consider adding a new station to the suburbs to accommodate the expansion of the new suburban community center in Chumphon, focusing on the convenience of traveling to other tourist attractions in the province and linking with surrounding communities such as Pak Nam Chumphon Municipality Community. The development of a new suburban transport community center should focusing on being a suburban community center such as market, shop, office, school facility, infrastructure including other public services for accommodate the expansion of Chumphon in the future. The appropriate location should be an area that can link to the outer city and travel to the city or travel to other tourist attractions in the province conveniently, as shown in **Figure 10.1.2-5**, showing the location of the new railway station likely in the future (or improve Saeng Daet railway station, Tak Daet Sub-district to become a suburban center station) to develop the area around the railway station to be the area to support the expansion of Chumphon in the future

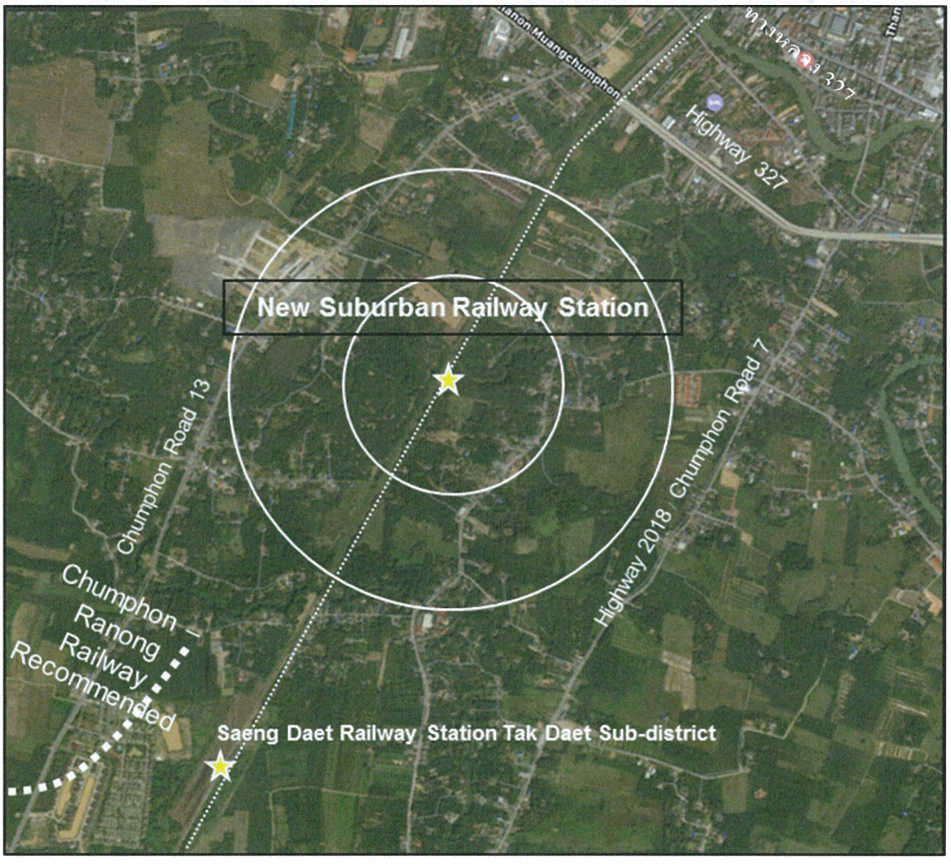


Table 10.1.2-5 Location of New Suburban Railway Station and Saeng Daet Station

Currently, the area south of Chumphon is rural and agricultural with dense residential communities scattered around, as shown in **Figure 10.1.2-6**, especially housing estate that occur several along Chumphon Road, 7, 13, and 15, and such area is the site of Saeng Daet railway station in Tak Daet Sub-district, making it an ideal area to develop as a suburban community for supporting the expansion of the city in the future and if the existing railway station (Saeng Daet Railway Station) was developed or develop new railway stations in such areas, it will make the development of the area surrounding the station in the 500 and 1,000 meters is a suburban community center, which can easily be linked to the communities of Chumphon and Chumphon Estuary Community. In addition, such areas can easily connect to the bypass and Highway AH2, making it easy to travel from this new Chumphon Station to various areas of the province and neighboring provinces.

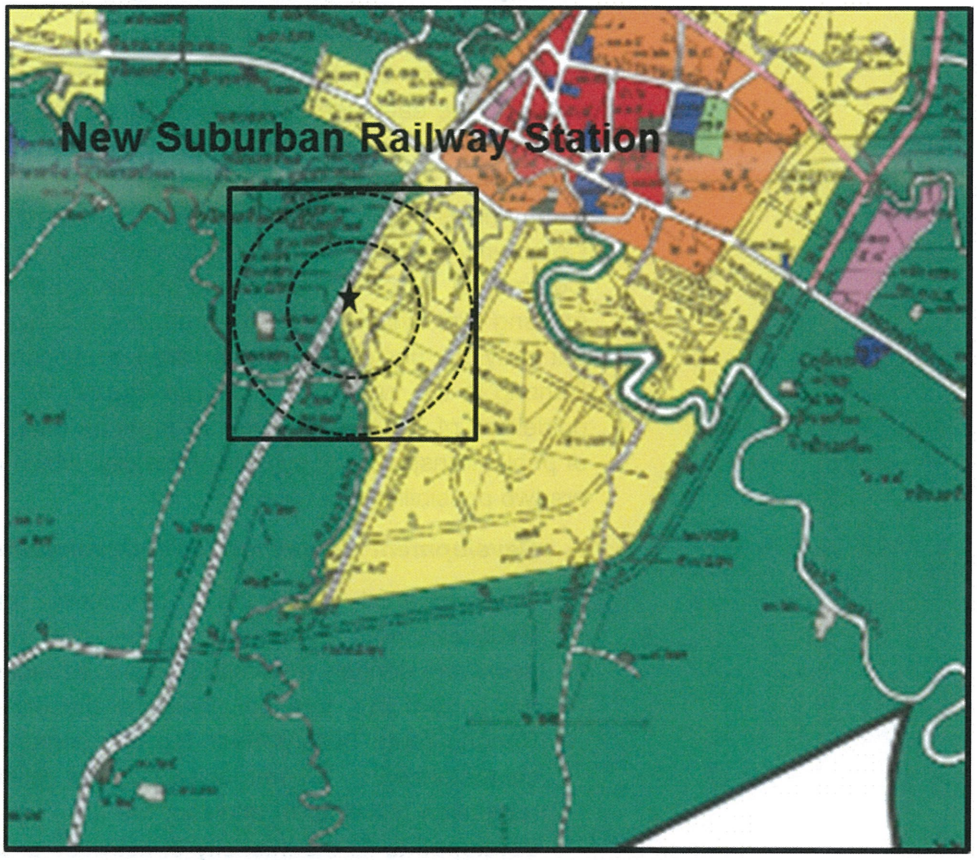


Table 10.1.2-6 Land Use in the Areas Southern of Town

Development guidelines for areas surrounding the railway station to becoming the suburban community center, where the railway station is the central, it is a way for developing a small suburban community, with a focus on being a city-level transport hub for the transition or connecting to the cities or neighboring communities. The nature of the development will be low - medium density residential areas, mixed with commercial activities, community shops, markets, schools and community service centers. Focus on the development of road networks in the area and providing the public transport system connecting to the railway station, suburban community and Chumphon Town.

- **The development of the area around the Ranong Railway Station**

  Ranong is a small town. In the past, it was not the main destination of traveling on the Andaman coast, such as Phuket, Phang Nga or Krabi, in addition, traveling to Ranong was accessible by road and air. Currently, Ranong has no railway station and the area that can develop being a community is limited because of its mountainous terrain with many forest reserves and forests. Ranong has a coastal port, but it does not have much cargo through the port. Therefore, the development of the Chumphon-Ranong route may not be able to fully meet the needs of freight but it will contribute to the development and expansion of southern tourist routes. The development of the railway line to Ranong is an opportunity for the region to develop the railway line for traveling to the Andaman coast in the future. In particular, the opportunity for the development of the Chumphon - Ranong Railway Line to the provinces in the lower South, such as Phang Nga, Krabi, Trang and Satun in the future.

  Due to Ranong City has a mountainous terrain stretching from the north to south on the east side, resulting in the settlement of Ranong community is characterized by the concentration of the community periodically in a longitudinal alignment along Highway no.4 on the coastal plain. These communities include: Ranong Town Community, Bang Rin Sub-district Community, Ngao Sub-district Community and Rajchakrud Sub-district Community, which is the location of Ranong Airport, although communities of Bang Rin, Ngao and Rajchakrud, are not included in Ranong Township, but may be designated as an area to accommodate the expansion of Ranong in the future, as shown in **Figure 10.1.2-7**. For the development guidelines of TOD in Ranong City must be integrated with the development of public transportation system of the city, which may be any system. There are two possibilities as follows.

  - ***Development Guidelines "Infill-Development"***

    Developmental guidelines in form of Infill-Development or Redevelopment are suitable for the urban areas in Ranong, which has been very densely developed before, especially in the area surrounding the current bus terminal, which is the area where the Chumphon - Ranong route passes near the city center the most. These areas is characterized by a community, such as residential areas, schools, and recreation facilities. In addition, the area has open spaces that can be developed to fill the intensity of activities and high density in the future properly, as shown in **Figure 10.1.2-8**.



Figure 10.1.2-7 Current Settlement Model of Ranong



Figure 10.1.2-8 The Area around Railway Stations in Ranong can be developed and Bus Stations according to TOD Guidelines

- ***Development Guidelines to New Suburban Community Center***

  As the area in the Ranong town near the bus station may be more densely populated in the future due to the expansion of the city as well as most of the area is occupied and developed. Developing areas around the station in such areas may be difficult. Another possible alternative is the development of a new railway station in the suburban community, especially in the community area south of Ranong such as Bang Rin Sub-district Community or Ngao Sub-district Community, due to these communities are not far from Ranong Town, therefore, it is highly possible to be a space for accommodating the expansion of the city in the future such as the site of the government center and Ranong Airport. The development guidelines of the area around the railway station in form of the suburban community center should focus on the connection between Ranong and other tourist attractions and surrounding communities, there is a mix of residential areas, department stores, commercial areas and task sources in the moderate density especially in the future, if there are policies to expand the Southern Railway along the Andaman coast. The development of the railway station and the development of the surrounding area in form of this suburban community center will provide an opportunity for Ranong to become a gateway to a new style of tourism by rail of the southern provinces along the Andaman coast.

10.1.3 Impact on the City from the Development of the Chumphon - Ranong Railway Line

Development of Chumphon - Ranong Railway Line, if the construction is completed, it will affect the growth of major cities in both provinces, especially the city / community where the train runs through, the public utility system and the infrastructure of the city will be improved, which this will affect the improvement of the composition or factors of production in the area. This will create opportunities for market expansion. Development of transport networks will result in different spatial variations, depending on the distribution of cities on the network. If the transport network has a large distribution of the city on the network, such as the road network, the differences of development between cities on the network may not be as great as in the case of urban distribution on transport network with low distribution of the city. In the case of the development of the Chumphon - Ranong Railway Line, the distribution of the cities on the network is minimal. Cities that will benefit greatly from significant developments are only two major cities, Chumphon and Ranong, which are the origin and destination of the railway line.

For the city of Chumphon, the old southern railway line has run through downtown. The development of the new railway line, Chumphon - Ranong will affect the economic growth of the city. In particular, employment in the retail sector, services and tourism-related services, such as lodging, restaurants, etc., including the expansion of real estate activities in the suburbs. (If there is a new railway station), which will affect the economy of the city as a whole. For Ranong City, there are currently no trains running through, the emergence of the Chumphon – Ranong Railway Line, expected to cause the expansion of the city as well. However, due to terrain and the fragility of environment on coastal areas, the development of the Chumphon-Ranong Railway Line, in case of choosing a route that runs to the coastal area where the port is located, it will not benefit the city fully because access and links between the train station and the city are limited, but if choose a route that runs through the city and the community along Highway 4 will benefit the city, especially the growth of the community along the railway route and developing areas around the station. Expansion of infrastructure and road networks will be emerging in these areas to support access to railway stations. The economic growth of Ranong is evident, especially in the employment of transportation and storage, including employment in wholesale, retail and tourism related services, as well as the city of Chumphon.

For tourism expansion during 2012-2015, the number of visitors in both Chumphon and Ranong Province grew at an average annual rate of 9.27% and 8.08%, respectively. The growth of tourism after the formation of the railways may increase the number of tourists and visitors by more than 10% on average per year. The growth and spatial dynamics of Chumphon and Ranong as mentioned above will greatly affect the planning of land use in the city, as a result, land use planning in the long-term should be reviewed. In the case of Ranong, it may be possible to consider extending the boundaries of Ranong's urban planning to cover areas that may have influenced the railway development and the emergence of new railway stations.

10.2 Tourist Attraction Nearby Railway Station along the Chumphon - Ranong Route and Connection with the Nearby Highway Network

There are many tourist attraction near the railway station along Chumphon – Ranong route. The details of the highway network linking the railway station to the nearby tourist attraction can be summarized as follows:

1) **Pak Chan Railway Station** The main attraction is the Chum Saeng Waterfall, which the network is linked from the station as follows.

   - **Chum Saeng Waterfall** is a natural attraction, which can be reached from Pak Chan Railway Station to Chum Saeng Waterfall by using Road 1003 to the north north parallel with the railroad for about 2 kilometers, turn right to the local road and straight along the route about 6 kilometers and then turn right for another 500 meters, including the distance from the station about 8.5 kilometers. Another route that can be reached is from Pak Chan station, turn right on the west road to take Highway 4 to the north then turn right into secondary road (about 70 meters before Pak Chan Witthaya School) straight along the road will find the railway crossing. The railway crossing is designed to terminate the route and use the serviced road under the railroad in km 39 + 700), then turn left to the local road and straight for about 6 kilometers and turn right for another 500 meters, including the distance from the station about 12.5 kilometers.

     The condition of route linking Pak Chan railway station with Chum Saeng waterfall is found that the entrance to Road 1003 is a paved road, 7 meters wide, good road surface condition and when entering the local road, which is a paved road, alternating with rocky road, 5 meters wide but when entering the waterfall along the Road 3117 is a two-lane paved road, the route will be more complete.

The network linking Pak Chan railway station with nearby tourist attractions is shown in **Figure 10.2-1**.

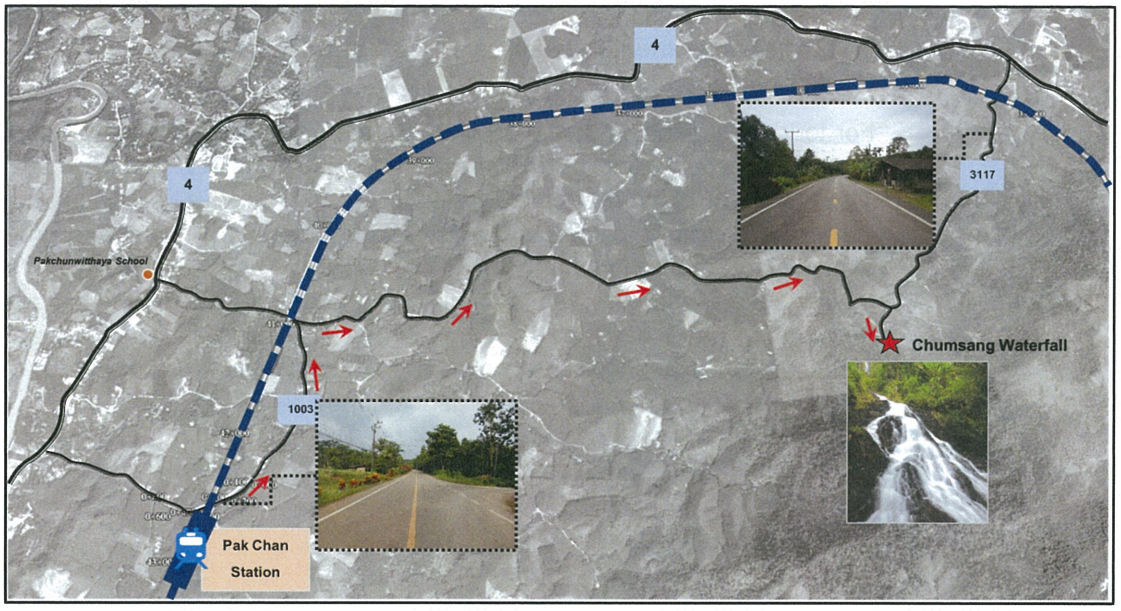


Figure 10.2-1 Network Linking Pak Chan Railway Station with Nearby Attractions

2) **Kra Buri Railway Station** Tourist attractions around the station area are Bok Krai Waterfall and Phra Khayang Caves, which the network is linked from the station as follows.

- **Bok Krai Waterfall** is an ecological and natural attraction (Thung Raya – Na Sak Wildlife Sanctuary). From Kra Buri Railway Station to Bok Krai Waterfall, take Road 1014 from the station to Highway 4 (Phetkasem) about 2 kilometers (The railway crossing at Kra Buri railway station is elevated), and take Highway 4 to the south about 3.5 kilometers, then turn left into Road 1008 (the railway crossing at km 56 + 600, is designed for elevating railway across Road 1008) and then straight along the route about 9.5 kilometers, including the distance from the station about 15 kilometers.

  The condition of route linking Kra Buri railway station with Bok waterfall is found that the entrance to Road 1008 is a paved road, 8 meters wide, winding path and completely surface condition.

- **Phra Khayang Cave** is a religious and cultural attraction. From Kra Buri Railway Station to Phra Khayang Cave, take Road 1014 from the station to Highway 4 (Phetkasem about 2 kilometers (The railway crossing at Kraburi railway station is elevated) and take Highway 4 to the south for about 10 kilometers (U-Turn) then turn left into the local road opposite Ranong Agricultural Research and Development Center (the railway crossing at km 622 + 386, is designed for elevating railway across the local road) about 1 kilometer, including the distance from the station about 11 kilometers.

  The condition of route linking Kra Buri railway station with Phra Khanom Cave is found that the entrance is a 5 meters wide concrete road and easy access.

The network linking Kra Buri railway station with nearby tourist attractions is shown in **Figure 10.2-2**.

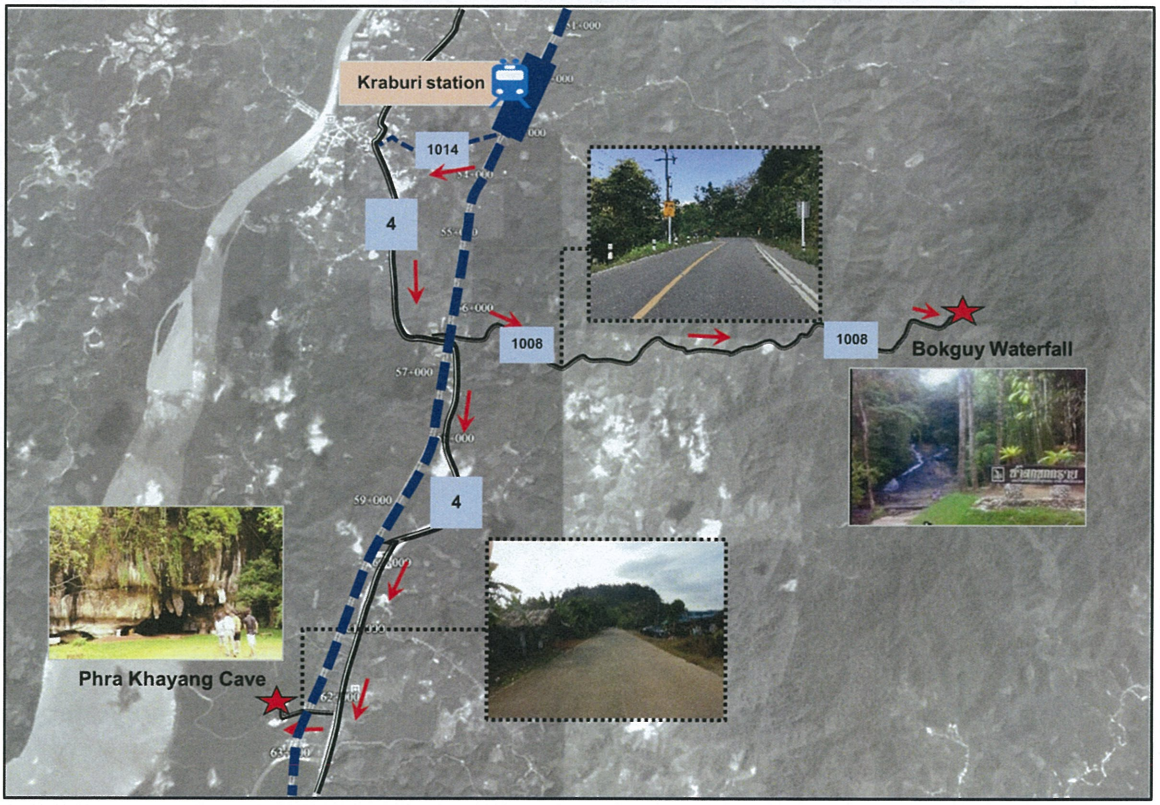


Figure 10.2-2 Network Linking Kra Buri Railway Station with Nearby Attractions

3) **Bang Yai Railway Station** Tourist attractions around the station area are Suwannasiri Waterfall and Khlong Bang Yai Forest Park, which the network is linked from the station as follows.

- **Suwannasiri Waterfall** is natural attractions. From Bang Yai Railway Station to Suwannasiri Waterfall, take Highway 4 (Phetkasem) to the south about 3 kilometers, then turn left into the local road for another 2 kilometers, including the distance from the station about 5 kilometers.

  The condition of route linking Bang Yai Railway Station and Suwannasiri Waterfall is found that the entrance is a concrete road, 3.5 meters wide, quite narrow. The Path passes through the community, completely surface condition.

- **Khlong Bang Yai Forest Park** is natural attractions, take highway 4 (Phetkasem), from the station to the south about 3 kilometers, then turn left into the local road about 1.5 kilometers, including the distance from the station about 4.5 kilometers.

  The condition of route linking Bang Yai Railway Station and Khlong Bang Yai Forest Park is found that the entrance is a concrete road, 3.5 meters wide, quite narrow. The Path passes through the community, completely surface condition.

The network linking Bang Yai Railway Station with nearby tourist attractions is shown in **Figure 10.2-3**. The network linking Bang Yai Station to both tourist sites will not find the railway crossing.

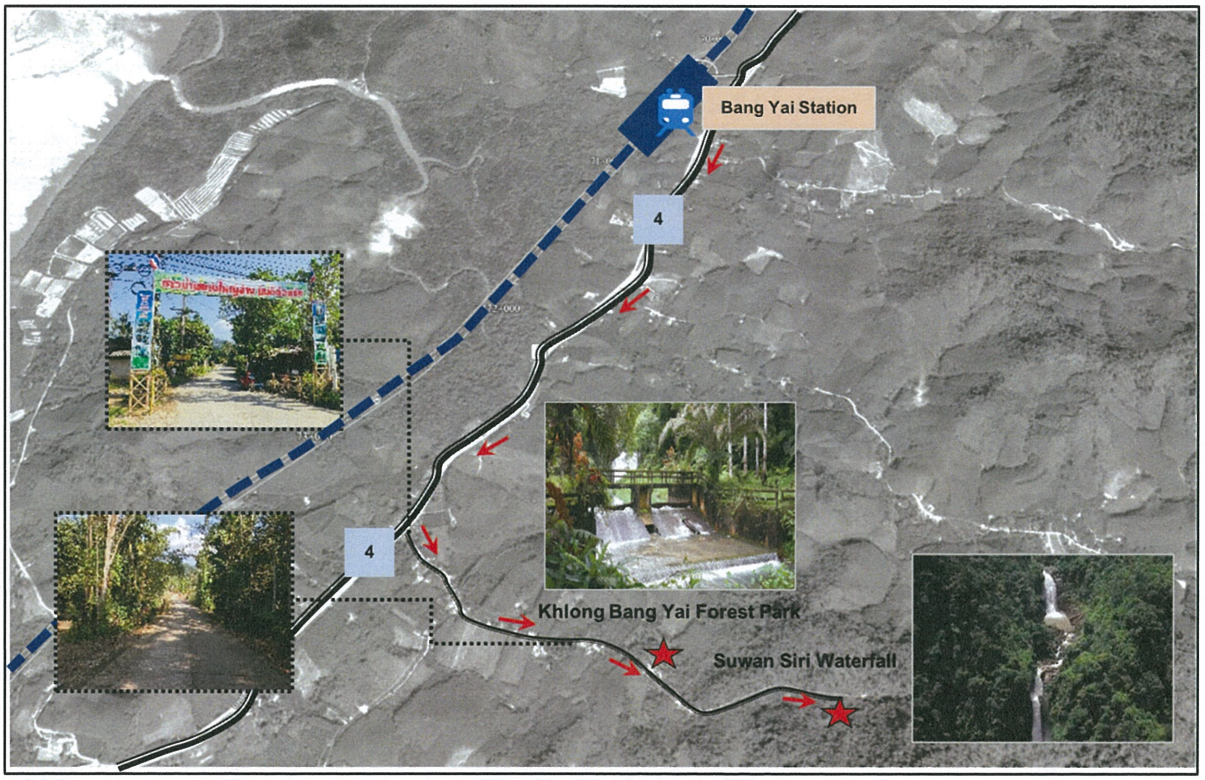


Figure 10.2-3 Network linking Bang Yai Railway Station with Nearby Attractions

4) **La-un Railway Station** Tourist attractions around the station are Khao Fa Chi View Point and World War II Museum (steam engine)

- **Khao Fa Chi View Point** is natural attractions. From La-un railway station to the subway, take the local road to Highway 4 (Phetkasem) about 1.5 kilometers and take Highway 4 to the South (U-Turn) and turn left into the local road along the route about 2.5 kilometers, including the distance from the station about 4 kilometers.

  The condition of route linking La-un railway station and Khao Fa Chi is found that the entrance is a paved road, 4 meters wide, quite narrow, steep and winding roads, big car cannot be up, and completely surface condition.

- **World War II Museum (steam engine)** is historical and cultural attractions. From the La-un railway station to the World War II museum (steam engine), take the local road to Highway 4 (Phetkasem), about 1.5 kilometers and take Highway 4 (U-Turn) to the south about 2.3 kilometers and turn left into the local road along the route about 500 meters, including the distance from the station about 4.3 kilometers

  The condition of route linking La-un railway station and World War II museum (steam train) is found that the entrance is a paved road, 7 meters wide, completely surface condition and easy access.

The network linking La-un railway station with the nearby tourist attractions is shown in **Figure 10.2-4**, where the railway crossing at La-un Railway Station is designed to use Serviced Road under the railway at km 78 + 338.

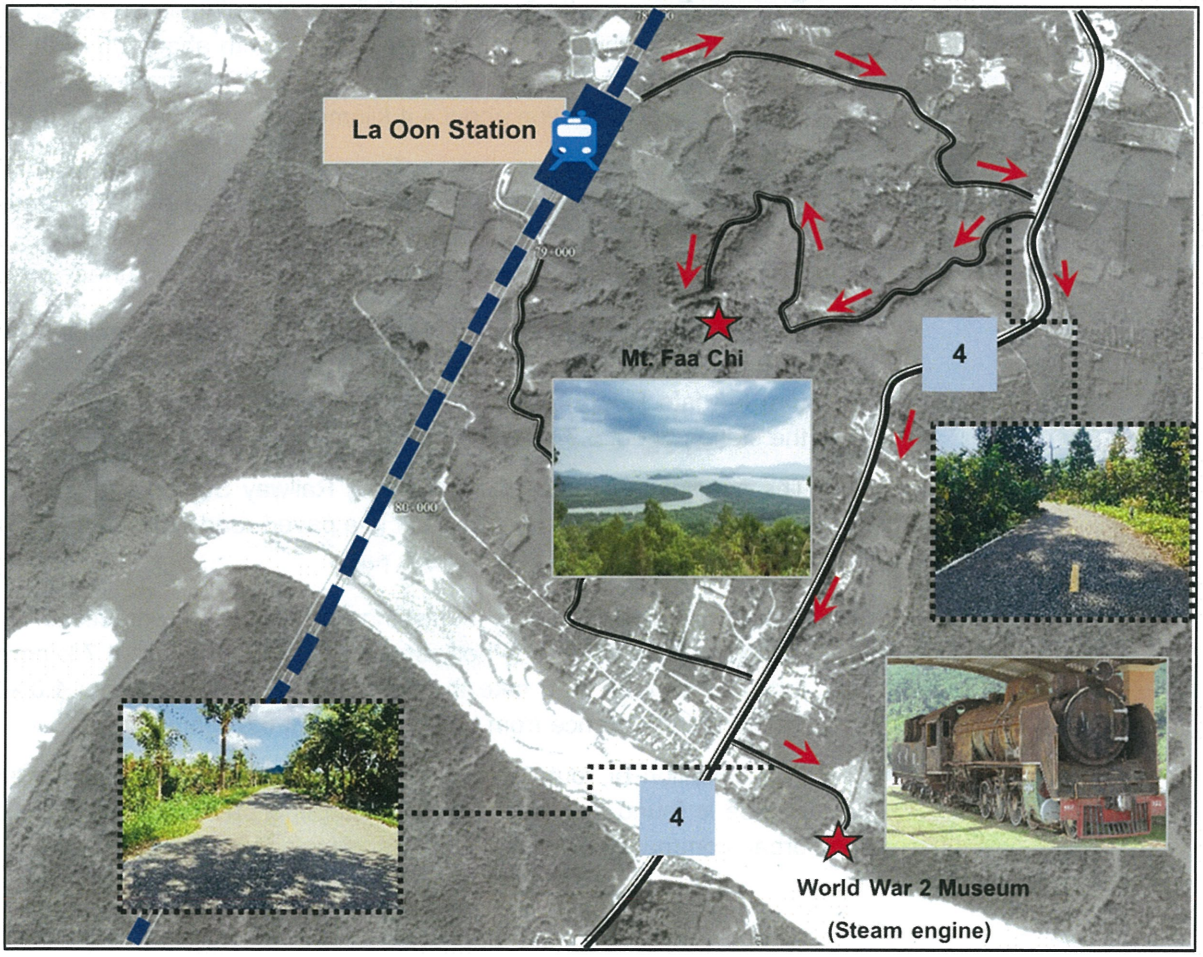


Figure 10.2-4 Network Linking La-un Railway Station with Nearby Attractions

5) **Ranong Railway Station** Tourist attractions around the station are Raksa Warin Hot Spring, Chan Dumri Beach, Governor Ranong's home, Ranong King's Cemetery, Rattanarunsun Palace, Grass Mountain, Ngao Waterfall, Porn Rung Hot Spring, Had Som Pan Temple, Had Som Pan Reservoir and Ranong Canyon, which the network is linked from the station as follows.

- **Raksa Warin Hot Spring** is a cultural attraction. From the station take Highway 4 (Phetkasem) to the south about 4.5 kilometers and turn left into Road 4005 straight along the route about 800 meters, including the distance from the station about 5.3 kilometers.

  The condition of route linking Ranong Railway Station and Raksa Warin Hot Spring is found that the entrance is a paved road, 6-meter wide, completely surface condition and easy access.

- **Chan Dumri Beach** is a natural attraction. From the station take Highway 4 (Phetkasem) to the south about 2.6 kilometers and turn left into Road 4004 about 10.2 kilometers, including the distance from the station about 12.8 kilometers.

  The condition of route linking Ranong Station and Chan Dam Beach is found that Highway 4004 is a paved road, 8 meters wide, completely surface condition and easy access path. However, the entrance to the beach is a paved road, 4 meters wide, quite narrow, dilapidated surface condition, located in a private area.

- **Ranong Governor's Grave** is historical and cultural attractions. From the station take Highway 4 (Phetkasem) to the south about 2.6 kilometers then U-Turn and turn left into Rueangrat about 1.8 kilometers, including the distance from the station about 4.4 kilometers.

  The condition of route linking Ranong Railway Station and Governor Ranong's home is found that pass through Pha Dad Alley, concrete road 2-4 lanes, easy access path or take the Kamlang Sup road and Rueangrat Road, which are paved road with 2-4 lanes, completely surface condition.

- **Ranong King's Cemetery** is historical and cultural attractions. From the station take Highway 4 (Phetkasem) to the south about 2.6 kilometers and turn left into Road 4004 about 3.1 kilometers, including the distance from the station about 5.7 kilometers.

  The condition of route linking Ranong Railway Station and Ranong King's Cemetery is found that Road 4004 is a paved road with 2 lanes, completely surface condition and easy access path.

- **Rattanarunsun Palace** is a historical and cultural attractions. From the station take Highway 4 (Phetkasem) to the south about 4.7 kilometers, U-turn and turn left then take the Kamlungsup Road for about 1.0 kilometer, including the distance from the station about 6.6 kilometers.

  The condition of route linking Ranong Railway Station and Rattanangsan Palace is found that Kamlang Sup road is a paved road with 2-4 lanes in urban community area, completely surface condition.

- **Grass Mountain** is an ecological and natural attraction. From the station take Highway 4 (Phetkasem) to the south about 18 kilometers U-turn and turn left about 300 meters, including the distance from the station about 18.3 kilometers.

  The condition of route linking Ranong Railway Station and Grassy Mountain is a completely path condition. The entrance is 8 meters wide concrete road.

- **Ngao Waterfall** is a natural attraction From the station take Highway 4 (Phetkasem) to the south about 16.4 kilometers and turn left about 500 meters, including the distance from the station about 16.9 kilometers.

  The condition of route linking Ranong Railway Station and Ngao Waterfall is found that the entrance is a paved road, 6 meters wide, completely path condition and easy access.

- **Porn Rung Hot Spring** is a natural attraction. From the station take Highway 4 (Phetkasem) to the south about 13.2 kilometers and turn left about 2.2 kilometers, including the distance from the station about 15.4 kilometers.

  The condition of route linking Ranong Railway Station and Porn Rung Hot Spring is found that the entrance is a paved road, 6 meters wide, completely path condition and easy access.

- **Had Som Paen Temple** It is a religious and cultural attraction. From the station take Highway 4 (Phetkasem) to the south about 4.5 kilometers and turn left into Road 4005 about 6.2 kilometers, including the distance from the station about 10.7 kilometers.

  The condition of route linking Ranong Railway Station with **Had Som Pan Temple** is found that Highway 4005 is a paved road, 6 meters wide with winding path and completely path condition.

- **Hat Som Paen Reservoir** is a natural attraction. From the station take Highway 4 (Phetkasem) to the south about 4.5 kilometers and turn left into Road 4005 about 8.6 kilometers, including the distance from the station about 13.1 kilometers.

  The condition of route linking Ranong Railway Station with Had Som Pan Reservoir is found that the entrance is a paved road, 6 meters wide with winding path, and easy access.

- **Ranong Canyon** is a natural attraction From the station take Highway 4 (Phetkasem) to the south about 4.5 kilometers and turn left into Road 4005 about 10.0 kilometers, including the distance from the station about 14.5 kilometers.

  The condition of route linking Ranong Railway Station with Ranong Canyon is found that the entrance is a paved road, 6 meters wide with winding path and slope, and completely surface condition.

The network linking Ranong Railway Station with nearby attractions is shown in **Figure 10.2-5**.



Figure 10.2-5 Network Linking Ranong Station with Nearby Attractions

10.3 Economic Impact of Tourism in Chumphon and Ranong

10.3.1 The Concept of Space Development and the Economic Impact of Tourism

The important role of the tourism sector to the economy and the development of competitiveness is promoting income distribution at all levels, since the community, Region to country level through the tourists spending, especially the basic necessities of living such as food, drinking water, clothing, medical services or health and accommodation, which stimulates the local economy and employment and generate income in the domestic circulation. For example the foreign tourists exchange currency in Baht Then take the bus from the airport to stay at the resort, buy a course to learn the community way and buy souvenirs from the villagers as souvenirs and learn how to cook local food, etc. It can be seen that the value of money from tourism will be distributed to various agencies in a variety of economic systems. Ultimately, these revenues will fall to the hands of people in the country from the so-called process. "Tourism Multiplier Effect", which shows that the proportion of revenue from tourism is repeatedly rotated in the economy. The more income means that everyone in the country also benefit from the expansion of tourism, therefore the tourism is a service industry that is vital to the economic and social development of the country. Because tourism is a service industry that generates revenue for the country in the top. The development of the area as a tourist attraction will generate activities and income of the area from the cost of tourism in that area. The expenditure spent on tourism activities can create jobs and the income to that area even more.

The Research Fund (TRF) has been studied. "Economic Valuation of Tourism in the South", with the aim of assessing the economic value and distribution of tourism revenue in the area and to assess the economic value of tourism routes. Travel businesses that have economic impact from tourism, such as accommodation, restaurants, entertainment venues, tour companies, souvenir shops and transportation. These activities contribute to the tourist spending in the area causing income in the area. From the study, it was found that the major variables that affected the economy from tourism were the multiplicity of tourism, which tourism multiplier, the higher the value, the higher the economic benefits of the area, as shown in **Table 10.3.1-1**.

Table 10.3.1-1 Tourism Multiplier in each business

Business	Tourism Multiplier
1. Business Accommodation	1.41
2. Restaurant	1.49
3. Transportation	1.24
4. Tour company	1.15
5. Entertainment	1.11
6. Sale of souvenirs.	1.46

Source: Economic Valuation of Tourist Paths in Southern Provinces The National Research Council of Thailand (NESDB) and the Thailand Research Fund (TRF)

From Table 10.3.1-1 shows that the restaurant business has the highest tourism multiplier. It can be explained that: "1 baht revenue from tourism will generate revenue for the area is 1.49 baht." follow by the souvenir and accommodation business, respectively, by using multipliers to find the economic impact of tourism by considering the revenue generated from the spending of tourists who have come to spend in the area in each activity, causes revenue in various business. It can be seen that the higher the tourism multiplier, it will increase the economic benefits of the area. The tourism sector is a labor-intensive industry, which will result in more job creation and revenue generation to the area also.

10.3.2 Tourism Situation Overview in Chumphon Province and Ranong Province

1) Tourism Situation Overview in Chumphon Province

Tourism situation of Chumphon province in 2012-2016 according to statistics from the Tourism Department, found that the number of visitors in Chumphon grew by 8.6% per year, with the average number of days decreasing by 0.94% per year and tourism revenue grew by 9.85% per year. In 2012, the revenue from tourism was 4,297 million baht, and in 2016, revenue was 6,240 million baht, increasing by 1,943 million baht and the tourism expenditure in Chumphon increased by 2.09 % per year.

Considering the tourism situation in Chumphon in 2016, found that the number of visitors in Chumphon was 1,357,428, with the average day of stay was 2.49 days, generated revenue of 6,240 million baht, and the average cost per visitor was 2,073 baht per day.

2) Travel Situation Overview in Ranong Province

Tourism situation of Ranong province in 2012-2016 according to statistics from the Tourism Department, found that the number of visitors in Ranong grew by 5.78% per year, with the average number of days decreasing by 1.65% per year and tourism revenue grew by 9.17% per year. In 2012, the revenue from tourism was 2,780 million baht, and in 2016, the revenue was 3,978 million baht, increased by 1,198 million baht and the tourism expenditure in Ranong province increased by 4.19% per year.

Considering the tourist situation in Ranong in 2016, found that the number of visitors in Ranong was 923,243, with the average day of stay was 2.47 days, generated revenue of 3,978 million baht, and the average cost per visitor was 1,928 baht per day. The details are shown in **Table 10.3.2-1** and **Figure 10.3.2-1.**

Table 10.3.2-1 Number of Visitors, Average day of stay, Income and Expenses of Visitors in Chumphon and Ranong Province in the Years 2012-2016

Details	2012	2013	2014	2015	2016	Average growth rate (%)
Chumphon						
Number of visitors (persons)	997,406	1,123,722	1,203,977	1,301,218	1,357,428	
Δ (%)	10.97	12.66	7.14	8.08	4.32	8.64
Average day of stay (day)	2.77	2.81	2.62	2.54	2.49	
Δ (%)	5.64	1.44	- 6.76	- 3.05	- 1.97	- 0.94
Visitor revenue (Million Baht)	4,297	5,022	5,281	5,881	6,240	
Δ (%)	9.77	16.89	5.15	11.35	6.11	9.85
Expenditure (Baht / person / day)	1,761	1,804	1,882	1,992	2,073	
Δ (%)	- 6.21	2.47	4.31	5.81	4.08	2.09

Table 10.3.2-1 Number of Visitors, Average day of stay, Income and Expenses of Visitors in Chumphon and Ranong Province in the Years 2012-2016 (cont'd)

Details	2012	2013	2014	2015	2016	Average growth rate (%)
Ranong						
Number of visitors (persons)	697,799	775,471	808,915	880,989	923,243	
Δ (%)	-0.25	11.13	4.31	8.91	4.80	5.78
Average stay day (day)	2.69	2.72	2.6	2.5	2.47	
Δ (%)	0.10	1.12	- 4.41	- 3.85	- 1.20	- 1.65
Visitor revenue (Million Baht)	2,780	3,250	3,323	3,727	3,978	
Δ (%)	7.80	16.92	2.22	12.16	6.74	9.17
Expenditure (Baht / person / day)	1,659	1,711	1,748	1,869	1,928	
Δ (%)	5.57	3.14	2.14	6.93	3.17	4.19

Source: Department of Tourism

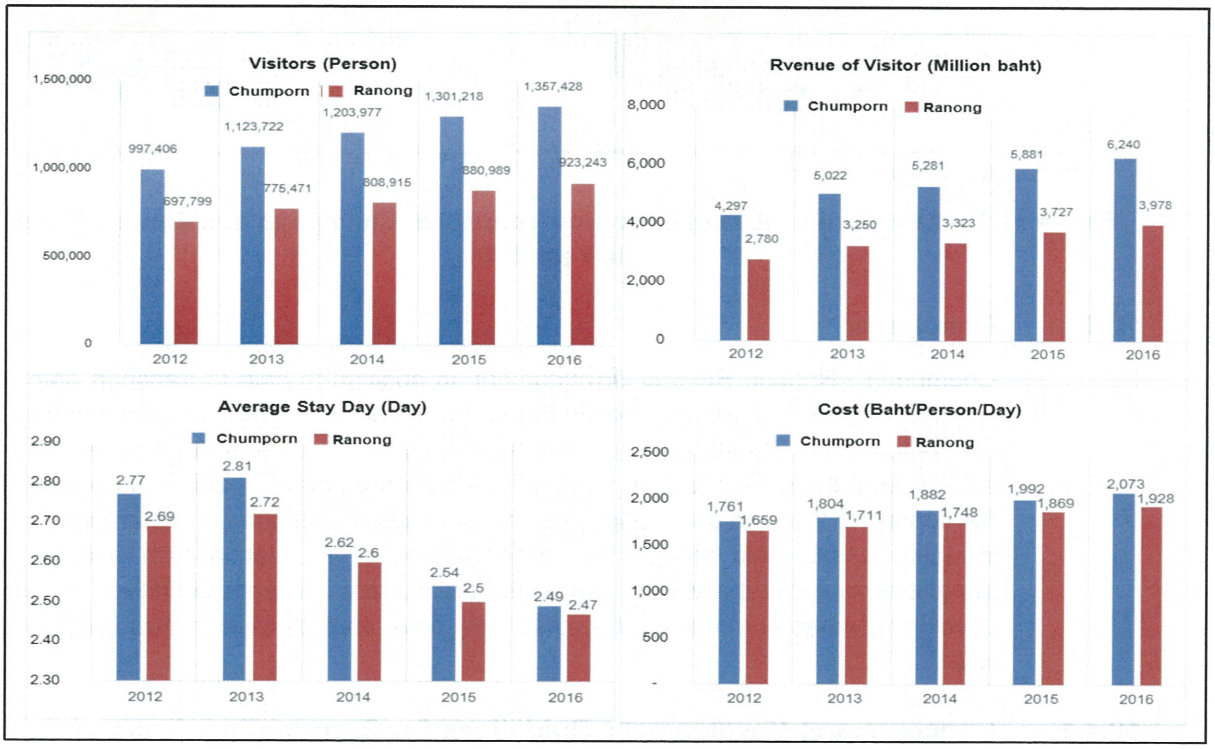


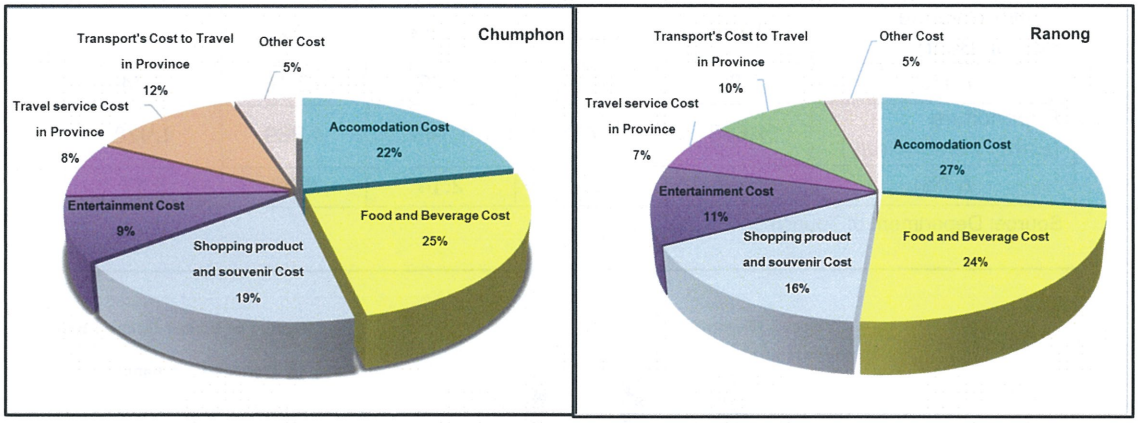
Figure 10.3.2-1 Number of Visitors, Average day of stay, Income and Expenses of Visitors in Chumphon and Ranong Province in the Year 2012-2016

Considering the income generated in Chumphon and Ranong province in the year 2016, the revenue generated from the tourism expenditures of Chumphon and Ranong province can be classified as follows.

- **Chumphon Province Tourism revenue** is generated from the expenditures of visitors in the area by spending on individual activities. According to the Tourism Department's data in 2016, the cost of tourism in Chumphon was 2,073 baht per person per day and when considering classify expense in tourism, found that the highest cost was food and beverage at about 506 baht (25%), followed

by accommodation 453 baht (22%), souvenir 388 baht (19%) and transportation cost in the province 257 baht (12%).

- **Ranong Province Tourism revenue** is generated from the expenditures of visitors in the area, by spending on individual activities. According to the Tourism Department's data in 2016, the cost of tourism in Ranong was 1,928 baht per person per day and when considering classify expense in tourism, found that the highest cost was accommodation at about 522 baht (27%), followed by food and beverage 469 baht (24%), souvenir 312 Baht (16%) and entertainment expenses 218 Baht (11%) as shown in **Figure 10.3.2-2**.



Source: Department of Tourism

Figure 10.3.2-2 Proportion of Expenditure on Tourism in Chumphon and Ranong Province in Year 2016

10.4 Conclusion

Chumphon - Ranong Railway Development, in addition to help to transport both cargo and passengers and will also contribute to the development of the surrounding area of the station. The consultant has conducted a study on the development guidelines of the area around the station to plan the land use plan appropriately and in accordance with the context of the area and along the route Chumphon – Ranong, there are many tourist attractions that have studied the network linking the station with nearby tourist attractions to know the way to travel and the current link path condition. In addition, developing areas surrounding the station will have an economic impact on tourism as well.

10.4.1 Concepts and Development Guidelines for Surrounding Areas of Railway Station along Chumphon - Ranong Route

Development of the surrounding areas around the station along the Chumphon-Ranong railway line should consider the potential of the area to affect the city's socio-economic activities. Consideration should be given to the development of the area by maximizing the benefits and appropriateness between the proportions of the volume of density used in the construction area or the area used for the activities and the amount of space used to travel in and out of the station can easily access the activity area, by focusing on compact development and incorporate into non-use of personal vehicles and quality urban design. The land use around the station will consist of a variety of land uses and can be developed in a mixed manner (Mixed-Use) to be able to support the services of service users thoroughly. The pattern of development of the area surrounding 10 stations

In addition, the development of areas around the station at the urban center level, such as Chumphon Town and Ranong Town, may be considered in two ways.

1) Development in form of "Infill Development" or "Re-Development", which is a guideline to develop empty space, wilderness areas or undeveloped areas in urban areas where public utilities and public services are already developed.

2) Development in form of "Suburban Center Neighborhood", which may be used in the case of more urban expansion, the development in existing areas may be limited.

Therefore, considering adding a new station to the suburbs, in addition to the direct development of the station itself, it is also developing to accommodate the expansion of the city in the future and connects major cities with surrounding communities, including nearby tourist attractions.

For the impact of the development of the Chumphon - Ranong Railway Line, the areas that will benefit directly include: Chumphon Station and Ranong Station, due to the city is centrally located at the origin and destination of the route. The development of the new route Chumphon - Ranong will affect the economic growth of the city. In particular, employment in the retail sector, services and tourism-related businesses, such as lodging, restaurants, etc. and the expansion of real estate activities in the suburbs (if there is a new railway station), which will affect the economy of the city as a whole, especially in the case of Ranong, if the development of the route along the route that runs through the city to the south side of the city along the route of Highway 4 will affect the development of Ranong. The growth of the community along the railway line and the development of the area around the station, infrastructure expansion and road networks are emerging in these areas to support access to railway stations.

For land use change, the development of the railway line along with the development of the area surrounding the station will have a significant impact on land use planning in the urban planning area. Therefore, the long-term use of the land of the city should be reviewed. It may consider extending the scope of urban planning to cover areas that may have influenced the development of new rail lines and the emergence of new railway stations.

Tourism expansion after the railway line occurred is expected to grow by more than 10%. At present, there is no train line, however, the growth of tourism has been growing at an average of 8-9% annually. The development of the railway lines will result in an increase in the number of tourists and visitors, as the upcoming railway station, along with the highways in the area, can link tourists to tourist destinations more convenient. From the tourism multiplier, it can be predicted that the expansion of tourism will affect the economy in related other parts, such as residential, restaurant, transportation, tour company, entertainment and souvenir shops, etc.

10.4.2 Economic Impact from Ttourism in Chumphon Province and Ranong Province

Tourism plays an important role to the economy and the development of competitiveness is promoting income distribution at all levels through the tourists spending, which stimulates the local economy and employment and generate income in the domestic circulation. The value of the money from tourism will be distributed to various agencies in a variety of economic systems. Ultimately, these revenues will fall to the hands of people in the country from the so-called process. "Tourism Multiplier Effect", which shows that the proportion of revenue from tourism is repeatedly rotated in the economy. The more income means that everyone in the country also benefit from the expansion of tourism, therefore the tourism is a service industry that is vital to the

economic and social development of the country. Based on the study of economic valuation of tourism in the southern area of the Thailand Research Fund (TRF) found that the restaurant has the highest value of Tourism Multiplier, followed by the souvenirs business and the business of accommodation, respectively, which tourism multiplier, the higher the value, the higher the economic benefits of the area. The tourism sector is a labor-intensive industry, which will result in more job creation and revenue generation to the area also, therefore, tourism promotion is to help develop the country's economy even better.

There are many tourist attraction near the railway station along Chumphon – Ranong route, such as Khao Fa Chi View Point, Raksa Warin Hot Spring, Rattanarunsun Palace, Ngao Waterfall and Porn Rung Hot Spring etc. The promotion and development of tourist attractions will further attract more tourists to visit in the province and to stimulate the economy in the area as well. The tourism situation of Chumphon and Ranong Province in the year 2012-2016 can be summarized as follows.

- The number of visitors in Chumphon and Ranong Provinces has the growth rate increased by 8.64% and 5.78% per year, respectively. By 2016, Chumphon and Ranong Provinces had 1,357,428 and 923,243 visitors, respectively, which the number of visitors is in the rank of 48th and 54th of the country, respectively, and is in the rank of 10th and 11th of the southern region, respectively.
- The average day of visitor arrival in Chumphon and Ranong Provinces has the growth rate decreased by 0.94% and 1.65% per year, respectively. By 2016, Chumphon and Ranong Provinces had the average day of visitor arrival of 2.49 and 2.47 days, respectively.
- Revenue from tourism of visitors in Chumphon and Ranong Provinces has the growth rate increased by 9.85% and 9.17% per year, respectively. By 2016, Chumphon and Ranong Provinces had revenue from tourism 6,240 and 3,978 million baht, respectively.
- Expenses for tourism in Chumphon and Ranong Provinces has the growth rate increased by 2.09% and 4.19% per year, respectively. By 2016, Chumphon and Ranong Provinces had an expenditure incurred by the average visitor of 2,073 and 1,928 baht per person per day, respectively. The expenses for tourism in Chumphon was mainly from food and beverage (25%), followed by accommodation (22%) and Souvenir (19%), respectively. For Ranong, most of the expenses came from accommodation (27%), followed by food and beverages (24%) and souvenir (16%), respectively.

Chapter 11

Conclusion and Recommendation

Chapter 11
Conclusion and Recommendation

11.1 Conclusion

As Ranong Province has no railway for transportation, there is only a road network which the route is slope and has a lot of curves due to the mountain terrain. Travelling is very inconvenient especially for freight transportation. Therefore, the construction of the new railway from Chumphon Province to Ranong Province shall connect both passengers and freight through Ranong Deep Sea Port. This study could be concluded as follows:

- In terms of the consistency between the project and the national's development policies and strategies, the project shall enhance a link between the two coasts (the Andaman Sea and the Gulf of Thailand), which shall promote tourism between the two coasts. In addition, the project shall also connect transportation between production bases to Ranong Port, which shall be the trading gateway linking the Andaman Sea to BIMSTEC countries (Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation) comprising Bangladesh, Sri Lanka, India, Thailand, Myanmar, Nepal and Bhutan through rail transportation mode that is energy efficient and environmentally friendly.
- The Chumphon to Ranong Deep Sea Port Railway Project shall be 1 m. gauge single track, pass 4 districts namely Muang District of Chumphon Province, Kra Buri District, La-un District, and Muang District of Ranong Province, having a total length of 109 km (including the main line from Chumphon to Ranong Port 103 km, the spur line to Ranong Town 5 km and the chord line linking the existing southern railway to the main line 1 km). There shall be 9 stations consisting of 1 inland container depot namely Ranong Station and 8 passenger stations namely Khun Krating Station, Ban Na-1 Station, Ban Na-2 Station, Pak Chan Station, Kra Buri Station, Bang Yai Station, La-un Station and Muang Ranong Station. The railway structures shall be composed of embankment structure, bridge structure and tunnel structure within the right-of-way of 50 m. The construction budget shall be 27,000 million Baht.
- **Table 11.1-1** shows the forecasted potential passenger and freight volumes through Ranong Port at the future years.

Table 11.1-1 Forecasted Passenger and Freight Volumes in Years 2025-2054

Forecast	Years			
	2568	2577	2587	2597
Passenger Volume (Person per day)	5,724	7,331	9,331	11,710
Export and Import Container Volume (Cabinets per Year)	33,116	45,257	60,770	85,502

- Though the economic analysis of the project shows that the project is not economically feasible for 30 years if the project is constructed and operated in year 2025 as an economic internal rate of return (EIRR) is 8.55% However, if the project is postponed for 9 years, after the opening year (2034), the economic internal rate of return (EIRR) shall exceed 12.19%.

11.2 Additional Comments and Recommendations

11.2.1 Recommendations on Traffic and Transportation

Passenger Transportation. Upon consideration of passenger volumes, it is found that there shall be small passenger volumes. This may be due to the socio-economic factors in Ranong and Chumphon Provinces which caused not much travel. The major factor contributing to the increase in travel volume is tourism, so the Consultant recommended the guidelines for further action as follows:

1) Development and extension of the new railway from Chumphon Province to Ranong Province shall be a part of infrastructure and facilities development to support the tourism growth which is consistent with the Strategy 2 of the National Tourism Development Plan No. 2. Besides this, it is consistent with Strategy 1: Development of the quality of tourist attractions, goods and services to be sustainable and balance, Strategy 3: Development of tourism personnel and enhancement of public participation for tourism development, Strategy 4: Balance Thai tourism through niche marketing, promoting Thai style living and the confidence of tourists and Strategy 5: The integration of tourism management and international cooperation, which must be implemented together.

2) In order to have the utmost benefit to the project, it is necessary to emphasize on the development of areas around stations. The recommendations are as follows:

   - In case of stations in the main town or stations at center town level, a vacant area should be developed to maximize efficiency in accordance with Infill Development or Redevelopment Guidelines. However, the development theory of mixed uses, compact, environmentally friendly and the rail network linking with other public transport systems should be considered.
   - In case of station area development at a new suburban community center, the land use plan to accommodate city expansion in the future and the development of areas around stations should be considered.
   - In case of stations at small community level or residential level, public transportation linking stations to surrounding communities and tourist attractions should be provided.

   Freight transportation. Upon consideration of the role and potential of Ranong Port, it is found that there are also opportunities and necessities for transportation through Ranong Port as an option to transport goods to BIMSTEC countries. The development of railway shall be only a part of the promotion of transportation through Ranong Port. There are also many important factors to be considered simultaneously such as:

   1) Freight transportation through Ranong Port shall have competition among transport operators between the existing routes and the new routes. Therefore, those who are involved in the transportation at Ranong Port need to have a customer base that needs to transport goods to the BIMSTEC countries and must have effective management. That is, there must be a good network of logistics and marketing to

provide cost and management to meet the customers who will use the services continuously and attract customers to switch to transport through Ranong Port.

2) Problems of rail transport services. Although the rail transportation cost is cheaper, the weakness of rail freight is irregularity and unpunctuality. The train also has problems with insufficient locomotives and freight cars. If the freight transportation cannot be done in time, it will cause damage to the owner resulting in lack of confidence in rail transport.

3) Problem of the Strait of Malacca. If in the future, the vessel volumes passing through the Malacca Strait increase drastically, the Straits of Malacca cannot serve the fleet in time and safe navigation, fleet will avoid using the Sunda and Lombok Strait routes. This will make the route longer. In addition, the Malacca Strait countries may increase the ocean freight to maintain a balance of service. As a result, the cost of ocean freight between the Indian Ocean and the Pacific Ocean will be increased.

11.2.2 Recommendations on Engineering

1) The government should have a clear policy in developing the transportation route linking to travel attractions tangibly to facilitate the comfort in traveling to various tourist attractions of both Thai and foreign tourists.

2) The government should expedite the extension of traffic lanes to 4 traffic lanes on the main route, especially on Highway Route No. 4 (Phetkasem Road), the whole route from Chumphon, Phang Nga and Phuket Provinces as Highway Route No. 4 is the main route linking to the distributor roads to travel attractions and nearby provinces, e.g. Phang Nga and Phuket etc.

3) In promoting freight transportation through Ranong Port, the government should have a clear policy in developing the port to be large enough and cost effective for freight transportation, encouraging the port to be an international port tangibly and encouraging the project to dredge watercourses to be 12-18 m deep.

11.2.3 Recommendations on Environment and Social

After completion of the feasibility study on economic, engineering and environment and the preliminary design of the project, the next process is the project owner has to prepare the environmental impact assessment report according to the Notification of the Ministry of Natural Resources and Environment (June 2012) on the type and size of the project that has to prepare the Environmental Impact Assessment Report. This project is under No. 21 of the rail transit system and No. 33 of the projects of the areas that are in Watershed Classification 1 according to the Cabinet's resolution to submit EIA report to agencies concerned for consideration and approval prior to further construction (**Figure 11.2-1**). The Consultant has the following recommendations on preparation of the Environmental Impact Assessment Report:

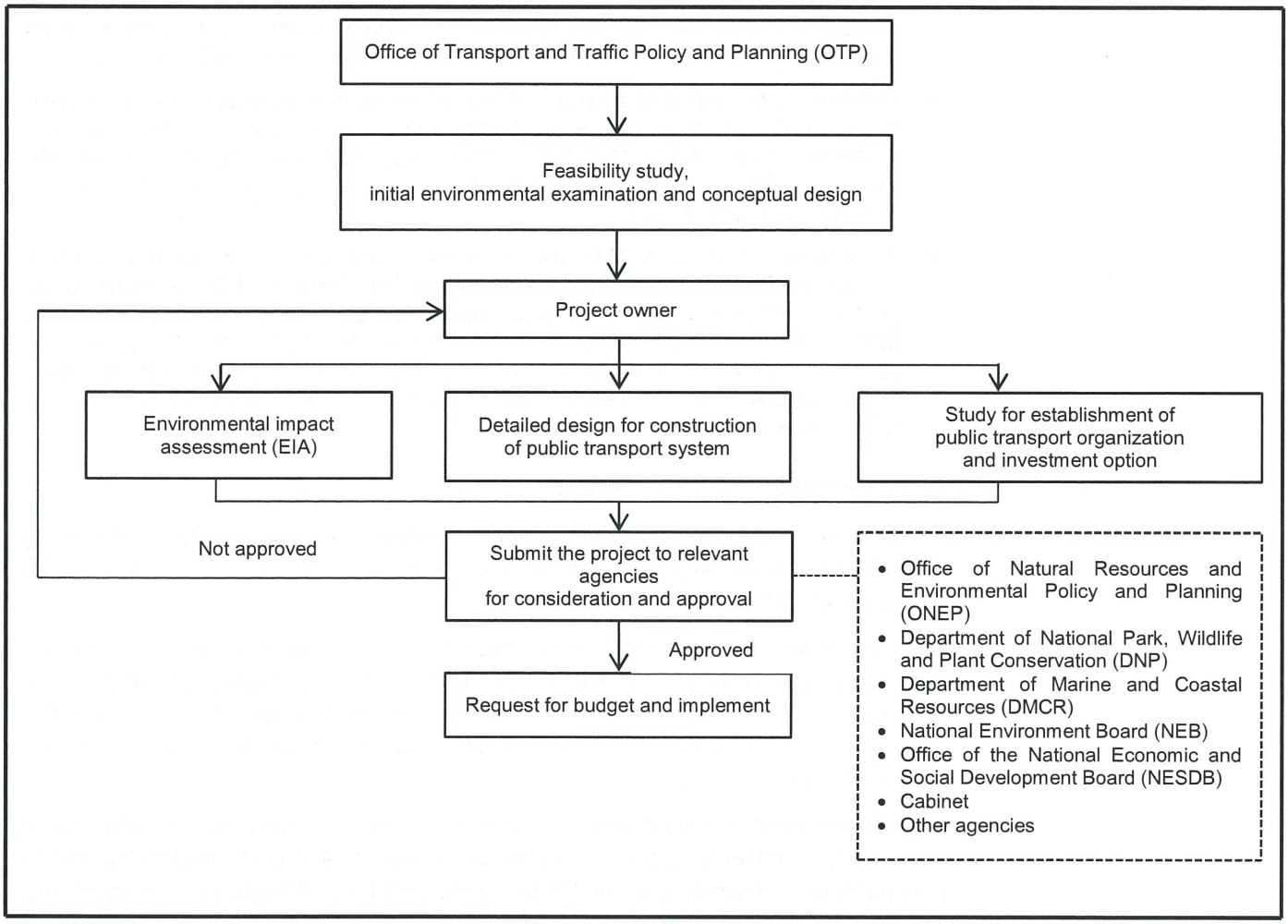


Figure 11.2-1 Next Process of Environmental Execution of the Project

1) Provide environmental information to support the consideration of detailed design to avoid environmental problems that will follow later. In the event that the environmental impacts shall occur, measures to protect and mitigate the environmental impacts, especially for the project which shall pass Watershed Classification 1, Ramsar Site, national park, mangrove forest and communities should be prepared.

2) Follow the rules and regulations of agencies responsible for conservation areas strictly, e.g. application for research in conservation area, application for use of conservation area and the request for a waiver of the Cabinet's resolution relating to the use of Watershed Classification 1 area.

3) Examine the constraints and guidelines for the implementation of the project of other agencies, e.g. Department of Highways, Department of Rural Roads, Department of Marine, Port Authority of Thailand, Royal Forest Department, Department of Marine and Coastal Resources, Department of National Park, Wildlife and Plant Conservation and Office of Natural Resources and Environmental Policy and Planning (e.g. Natural Resources and Environmental Management Coordination Division and Natural and Cultural Environmental Conservation Division) etc.

4) Execute public relations and public participation covering every stakeholder especially people who are affected from land expropriation and property compensation including agencies responsible for permitting the use of land for construction of the project etc.

5) Collect documents and evidences during the feasibility study and public participation activities to support the preparation of EIA report e.g. a summary of discussion with agencies concerned, concerns/recommendations, meeting attendant signatures, pictures or animation etc.).

11.2.4 Recommendations on Tourism Management of Ranong Province

Though the study results show that year 2034 is feasible to construct the project, Ranong Province is a province with a wide range of tourist attractions such as natural tourism, historical tourism and cultural tourism. If the government sector, travel agents and local communities jointly determine the guidelines for tourism management to be implemented seriously and successfully, it will attract both domestic and international tourists to visit tourist attractions of Ranong Province and some may want to come back again if they are impressed. These executions not only generate revenues for Ranong Province and local communities, it is also encouraging the government sector to accelerate infrastructure development and rail system development to facilitate traveling of passengers and tourists. The OTP and the Consultant have organized a workshop on tourism related issues in Ranong Province on Friday, February 2, 2018 at 13.00-16.00 hrs. at Tinidee Hotel @ Ranong (**Figure 11.2-2**) participated by representatives from government agencies, private organizations and tourism entrepreneurs etc. The key information exchanged, brainstorm and recommendations on tourism management in Ranong Province in the future can be summarized as follows:



Figure 11.2-2 Workshop with Ranong Tourism Representatives on Friday, 2 February, 2018 at Tinidee Hotel @ Ranong

1) Ranong Province is a province with a long history since the Ayutthaya period. It was a small town under the supervision of Chumphon Town. The word "Ranong" is distorted from Rae Nong due to a lot of mineral in the province. It was the residence of the Hokkien Chinese in the early Rattanakosin. It was also an important route of the Japanese military in World War II. So there are many historical and cultural attractions such as the passage of the reign of King Rama V, the old railway during World War II, Khao Fachi, the cemetery of the ruler of Ranong, Rattana Rangsan Throne Hall etc.

2) The abundance of natural attractions to accommodate eco-tourism, adventure travel and health tourism, such as mountains covered with natural forests, a variety of waterfalls and natural hot springs, the most fertile mangrove forest in Thailand and an internationally important wetland (Ramsar Site), Phu Khao Ya (grass hill), Khao Fachi View Point and beautiful snorkeling sites at Koh Phayam, Bat Island and Japan Island etc.

3) Various local and unique dishes of Ranong, such as Tub Lee Steamed Dumplings, Hokkien food, fresh coffee growing and selling (Kong Coffee), cashew nut, including the sale of seafood products, local products and processed products such as sea crab, soft shell crab, shrimp (Kraburi River), dried shrimp, shrimp paste, vegetables etc.

After the Cabinet has a policy to encourage domestic tourism, the Tourism Authority of Thailand (TAT) has launched the "Amazing Thailand Go Local" program comprising 55 secondary provinces such as Udon Thani, Mahasarakham, Lopburi, Nakhon Nayok, Suphan Buri, Prachinburi, etc. The southern secondary provinces include Nakhon Si Thammarat, Phatthalung, Trang, Satun, Chumphon, Ranong, Narathiwat, Yala and Pattani. So if the relevant authorities of Ranong Province can determine a master plan/roadmap for tourism with cooperation from enterprises and the public sector, Ranong Province may be able to be upgraded from the "secondary city" to the "main city" of tourism of the south and of Thailand, where both domestic and foreign tourists must find opportunities to visit. Followings are the overall suggestions:

1) The government sector involved in tourism development should promote and encourage the communities to aware and participate in tourism development of Ranong Province starting from drafting the policy and master plan for Ranong tourism. It can be divided into 3 phases, i.e. short, medium and long term. Operational procedures should be defined by having government agencies as mentors or followers to assess the effect of the operation at all stages and also to mitigate the negative impact that may occur in the future. Local authorities and the private sector/entrepreneurs concerned should cooperate with communities to develop tourism and to establish tourism potential for communities.

2) Public relations and marketing are key factors that will contribute to various modes of tourism development through various forms of public relations. The communities should be recommended to select the precise media especially the public relations media that the communities can manage themselves, such as brochures, tourist service center of communities and signs in the communities (Thai/English/Chinese). The media that need to coordinate with government agencies or local government organizations has a high cost, such as signs to the communities, event coordination, exhibition introducing tourist activities, festivals and occasions, travel guide website, print media related to tourism and radio etc.

3) Factors to attract tourists to Ranong Province are natural and historical attractions, a variety of lifestyles, culture and food, then the government should provide facilities and develop infrastructure for access to these sites of Ranong Province by:

- Prepare map or layout of province-district tourist attractions and public relations board (Thai and foreign language) and provide tourist service center with personnel to facilitate and give information to domestic and foreign tourists including the disabled.
- Develop transportation routes either by car, train or air, nature trails, bicycle path and pedestrians to be appropriate to travel to tourist attractions.
- Improve sanitation and garbage management, other facilities such as hygienic restrooms. Provide a garbage bin that separates the garbage type and provide appropriate and sufficient parking and provide ramps and auxiliary equipment to facilitate the disabled.

In order to obtain the appropriate and adequate information to formulate a master plan for tourism management of Ranong Province to be sustainable and with the participation of the people, the Consultant proposed the framework for further stage as follows.

Information	Tool	Knowledge	Expected Result
1. Attractiveness 2. Facilities 3. Accessibility 4. Environment	1. Related Documents 2. Explore and Observation with Local Community 3. Travel / Tourist Questionnaire	Tourist attraction Factors	Tourism Management Master Plan with Participation of People
1. Travel Resources 2. Situation, Problems and Management 3. Guidelines for the Development of tourism Management Capabilities	1. Tourism Resources Check with Local Communities 2. In-depth interview with community leaders / entrepreneurs / villagers / top executives	Tourism Management	

11.3 Guidelines for Implementation

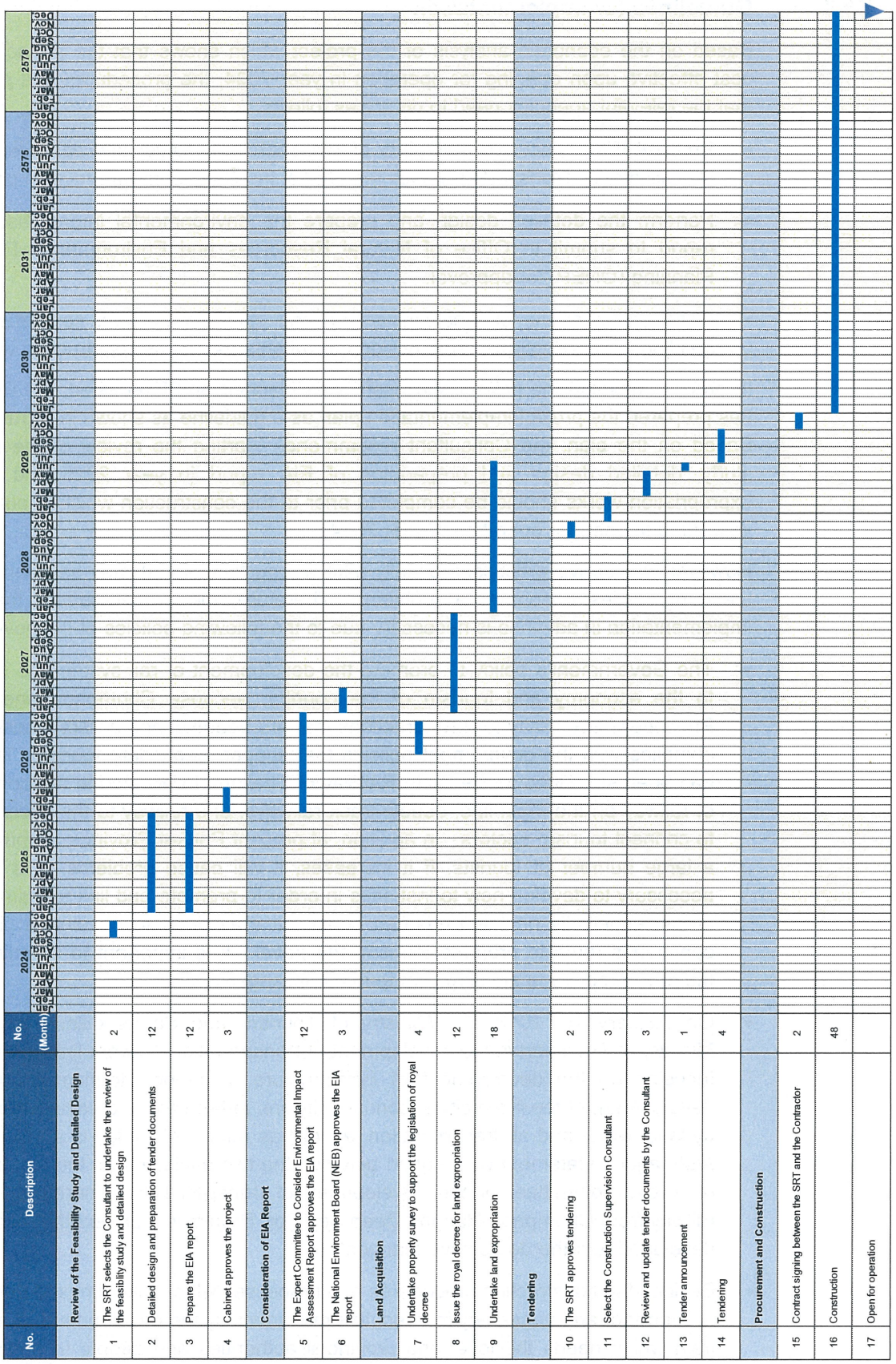
Based on the economic analysis of the project which shows that the project shall be cost effective upon opening for operation in year 2034, the procedures and processes that the relevant agencies need to do are as follows:

- Propose the project to the Ministry of Transport to consider and approve and then the Ministry of Transport proposes the project the Cabinet for approval in principle.
- Perform the detailed design and prepare the environmental impact assessment report to submit to Office of Natural Resources and Environmental Policy and Planning (ONEP) for approval.
- Construction of the project consists of land expropriation and compensation for buildings, the selection of supervision consultants as well as construction work.

In order to develop the project successfully as planned and forecasted, the Consultant has prepared the project implementation plan as a guideline as shown in **Figure 11.3-1**. Based on the plan, the Consultant recommends starting the review of the feasibility study, detailed design and preparation of EIA report in year 2025 and the land expropriation works should be completed prior to the construction which should start in year 2030 to open for operation in year 2034.

However, the above processes usually take a long time and it may be even longer if these processes encounter a problem. Therefore, the preparation of the project implementation in advance is necessary due to the following policies of the government:

- The Government's policy to promote the development of rail systems to contribute to the economy and tourism of the country, because Chumphon and Ranong Provinces have many tourist attractions that are beautiful and attract tourists. It also complies with the government policies that support secondary tourism. The policy has been submitted to the State Railway of Thailand to accelerate the construction of railway on the main line, double-track railways, and railway to the secondary city to connect tourism sectors. In addition, at present Phuket Province accommodates a large number of tourists. If it increases, it will cause problems. It is therefore necessary to develop new tourist sites in order to promote and link tourism to these areas, especially on the Andaman coast. It may need to develop a circular or continuous route to promote tourism and travel. It is important to coordinate with the private sector to develop joint tourism packages.
- On January 15, 2018, the Ministry of Tourism and Sports discussed with the Ministry of Transport in the development of transportation network linking tourism by focusing on the development of infrastructure to support tourism including the development of the main city-secondary city link to facilitate and secure travel either by land, water and air transportation, as well as rail travel, which is a unique travel. Also, a joint statement was signed between the two ministries on the establishment of a joint committee for the development of transport links. Therefore, the New railway from Chumphon-Ranong Deep Sea Port Project is a project that needs to be developed together to achieve that goal.
- Besides the construction procedures and processes which take times to complete, it is important and necessary to execute simultaneously the development of excursion train which needs the local and provincial authorities and people to motivate and coordinate with the Ministry of Tourism and Sports and the Ministry of Transport in formulating an integrated development plan.



No.	Description	No. (Month)
	Review of the Feasibility Study and Detailed Design	
1	The SRT selects the Consultant to undertake the review of the feasibility study and detailed design	2
2	Detailed design and preparation of tender documents	12
3	Prepare the EIA report	12
4	Cabinet approves the project	3
	Consideration of EIA Report	
5	The Expert Committee to Consider Environmental Impact Assessment Report approves the EIA report	12
6	The National Environment Board (NEB) approves the EIA report	3
	Land Acquisition	
7	Undertake property survey to support the legislation of royal decree	4
8	Issue the royal decree for land expropriation	12
9	Undertake land expropriation	18
	Tendering	
10	The SRT approves tendering	2
11	Select the Construction Supervision Consultant	3
12	Review and update tender documents by the Consultant	3
13	Tender announcement	1
14	Tendering	4
	Procurement and Construction	
15	Contract signing between the SRT and the Contractor	2
16	Construction	48
17	Open for operation	

Figure 11.3-1 Project Implementation Plan (Guideline)