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กระทรวงคมนาคม



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และแผนการขนส่งและจราจร



การรถไฟแห่งประเทศไทย



Executive Summary Report

April 2555

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1. Introduction

1.1 Project Rationale

The slow development or construction of new railway networks over the years has resulted in stagnant growth of rail service areas which presently cover only 47 provinces of the country. Besides, most of the railways infrastructure has been increasingly deteriorating due to various reasons, e.g. the age-old rail infrastructure, inadequate maintenance due to budget constraints, etc. At present, 93% of the rail system is still single track railways. This has led to operational delays as trains have to wait and allow trains from opposite directions to pass, and the spread of delays generally occur if one train is delayed. For some rail sections, the passenger and freight volumes exceed the railway capacity; thus creating heavy delays in passenger and freight transport.



The above reasons have culminated in the inefficiency of rail services in terms of convenience, speedy service, punctuality and fares, compared with road transport. As a result, rail service has been unable to attract passengers and entrepreneurs, bringing about a drastic decline in passenger and freight traffic during 2005–2007. The number of passengers dropped by 4.6 million trips or about 9 percent. Freight volume fell by 0.86 million tons or about 8 percent as against the overall increase in freight volume. As railway freight transport accounts for only 3 percent of the total, it cannot support logistics management system.



The Constitution of the Kingdom of Thailand, 2007, Chapter 5: Directive Principles of Fundamental State Policies, Part 7: Directive Principles of State Policies in relation to Economy, Section 84 (12) stipulates that the State shall promote and provide support to the maritime business, rail carriage as well as transportation logistics-both domestically and internationally. To this end, the Government of Thailand has introduced a policy on the rail network and service development in order to improve transport efficiency and energy efficiency in the transport sector. Consequently, it is pivotal to formulate a rail transport development plan so as to reduce transport time and enhance the efficiency of logistics management for rail-based container transport for the export sector. Moreover, this can help reduce environmental problems and road accidents.

On 22 October 2007, the Cabinet resolved to approve in principle the implementation of a pilot project for the development of logistics and service management systems. The Ministry of Transport and related agencies were assigned to jointly prepare a long-term plan and to undertake necessary works for developing rail transportation system to replace road transportation. The principal aims are to achieve energy efficiency and reduce transport costs in line with the country's economic situation. On 27 May 2008, the Cabinet acknowledged and approved rail transport development approaches according to

the resolution of the Rail Transport and Mass Rapid Transit Committee No. 2/2551 of 1 May 2008. Emphasis is given to the efficiency of operation & maintenance and transport linkage, provision of support to passenger and freight transport, reduction of the transport sector's energy consumption, and increase of regional transport capacity and connection to new trade routes.

On 27 April 2010, the Cabinet acknowledged the Committee of Economic Ministers' resolution No. 5/2553 of 26 April 2010 which approved the infrastructure investment plans of the State Railway of Thailand, Department of Highways, and Department of Rural Roads, with a total budget of 195,820.50 million Baht. The Ministry of Finance and the Bureau of the Budget were assigned to consider budget allocation from appropriate sources. The investment plans also incorporates the track doubling development (Urgent Phase) on the northern, northeastern, and southern lines, about 767 kilometers in total length. These railway networks have been bottlenecked and operating at their full carrying capacity, i.e. Lop Buri–Pak Nampho Section, Map Kabao–Chira Junction Section, Chira Junction–Khon Kaen Section, Nakhon Pathom–Nong Pladuk–Hua Hin Section, and Prachuap Khiri Khan–Chumphon Section.

The Ministry of Transport has complied with the above resolutions of the Cabinet and the Royal Thai Government's policy on the acceleration of vital investments in both continuous projects and new projects that are ready to be implemented. Therefore, top priority is given to the Study of Track Doubling Project (Urgent Phase): Chira Junction–Khon Kaen Section (The route alignment is illustrated in Figure 1.1-1) so as to boost the country's transport capacity and tourism potentials

The development of track doubling system will raise the line capacity. This will lead to substantial reduction in travel time, energy efficiency of the country's transport sector, decrease in pollution problems, and increased efficiency of public transport for rural and urban areas as well as international markets. The improved railways system will also attract more people to use rail services, thus reducing road accidents. This study emphasizes the importance of both passenger and freight transport along with tourism potentials of important places in the Northeast in order to improve the efficiency of rail transport networks.

1.2 Objectives and Scope of the Study

Objectives

- (1) To undertake Feasibility Study of the construction of track doubling project: Chira Junction–Khon Kaen Section, encompassing alignment selection, delineation of right-of-way, conceptual design of structures at the interchanges with other projects, and recommendations for necessary infrastructure as well as design for efficient intermodal linkage and infrastructure system;
- (2) To study economic, social and financial returns; environmental impact; and appropriate investment options for the project; and
- (3) To carry out detailed design, cost estimation, and preparation of bid documents.



1.3 Scope of the Work

The scope of the work comprises 4 parts as follows:

- (1) Survey, data collection, and review of related project studies and implementation;
- (2) Feasibility study covering engineering, economic, social and financial aspects as well as suitable investment options;
- (3) Detailed design and preparation of bid documents; and
- (4) Preparation of Environmental Impact Assessment (EIA) report, public relations and public participation.

1.4 Project Elements

In summary, project elements according to the design consist of the followings.

1) Railway Track

Construction of railway track in the project is the construction of a new track on the right (east side) and parallel to the existing railway, with total distance approximately 187 km. and general spacing about 6.0 meters away from the existing track. The tracks are all ground level except those at Khon Kaen Station area, which will be elevated railways with the distance of about 5.4 km. and 84 viaducts.

Design of the railway track meets the standards of the State Railway of Thailand (SRT) and the requirements of AREMA, EUROCODE, UIC, AASHTO (LRFD), AISC, BS5400, and CEB-FIP, and can support the weight of the trains in accordance with the SRT's standard type U20.

The track system is 1.0 m. wide (Meter Gauge) of Ballasted model using UIC54 rail and mono block prestressed concrete sleepers.

2) Stations

The project includes 19 train stations and 7 Stopping Places in total. In project development, all existing stations will be improved classifying into 5 types according to the amount of passengers to use the service as follows.

3) Container Yard (CY)

The project will have 3 CY locations, i.e. Ban Kra Doan Station, Bua Yai Station and Tha Phra Station. For Kra Doan Station, it is determined to be rebuilt by relocating its CY from Ban Ko Station to accommodate future growth of the transportation as well as to avoid the urban areas of Ban Ko Station.

4) Signaling System

Light signaling system will be used associated with computer-based interlocking system. Traffic management or vehicles operational control will be centralized traffic control system at Khon Kaen Station. In early stage, signaling control system at the station will be semi automatic signal.

5) Railway Crossing Solution

For solution to railways crossings in the project, the Consultant has designated appropriate models based on sensitive information such as road types, design standards, traffic volume, physical limitations, community lifestyle and conformity with the implementation plan of the road agency, for instance.

Along the path of the project are 93 railway crossings encompassing those already fixed the problem through 9 grade separated crossings (7 overpasses and 2 underpasses) and the others 84 level crossings remaining for improvement. In project development, the models to solve the railways crossings problem are designated as summarized below.

- 8 overpasses
- 26 two way U-turns
- 38 box culverts or viaducts
- 1 elevated railway (to accommodate 5 crossings)
- 1 underpass according to the construction plan of Department of Rural Roads
- 4 crossings in vicinity suggested to be used
- 2 automatic Barricades

2. Future Passenger and Freight Forecast

The objective of the study and forecast of future passengers and freight is to obtain the volumes of passengers and freight transported by the project railway. The derived forecast results were applied to the project's feasibility study in different aspects and also to the detailed design.

2.1 Assumptions for Rail Passenger and Freight Forecast

The line load forecasting was carried out based on the following assumptions.

(1) Analysis Year: The analysis period of 20 years: 2015, 2020, 2025, 2030, and 2034

(2) Traffic and Transport Models: The NAM Model used in the Feasibility Study and Preliminary Design for Track Doubling System for Transportation and Logistics Management (Phase 1)

(3) Socio-Economic Data: The socio-economic data specified in Item 2.2

(4) Speed: The maximum rail speed was 120 km/h.

(5) Number of Locomotives, Coaches, Containers, and Bogie Trucks: It was assumed that there was no limitation of equipment procurement for rail passenger and freight transportation, e.g. locomotives, coaches, containers, bogie trucks, etc.

(6) Road Networks: The development of the road networks will comply with the Highway Development Master Plan (The Pre-feasibility Study and Initial Environmental Examination for Highway Development Master Plan Project and the present highway development plans).

(7) Rail Networks: The track doubling system will be developed in accordance with the track doubling system development plan under "the Master Plan Study for Railway and High Speed Rail Development Project, 2010."

(8) Fare and Freight Rates: The fare and freight rates announced in 2011

(9) Fuel Cost: Average benzene price at 33 Baht/liter and diesel price at 30 Baht/liter

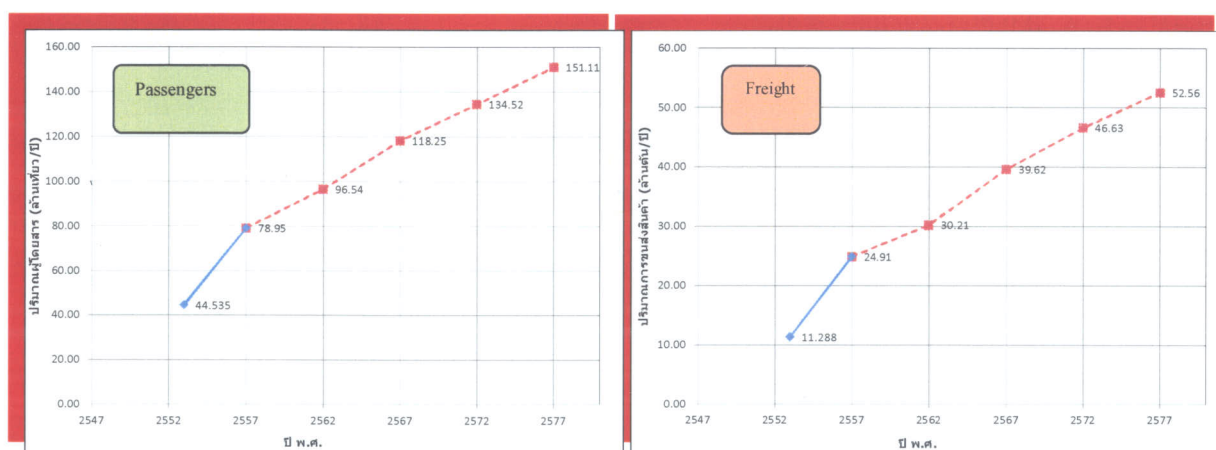
2.2 Results of Rail Passenger and Freight Forecast

The results of the line load forecast in case of the full implementation of track doubling system under the aforementioned assumptions are presented in Table 2.2-1 and Figure 2.2-1.

Table 2.2–1 Rail Passengers and Freight Volume in the Future Years

Year	Passengers (million trips/year)	Freight Volume (million tons/year)
2010	44.54	11.29
2015	78.95	24.91
2020	96.54	30.21
2025	118.25	39.62
2030	134.52	46.63
2034	151.11	52.56

Source: The Consultants

**Figure 2.2–1 Rail Passengers and Freight Volume According to Track Doubling Plan**

The forecast results of the line load (passengers) for the Chira Junction–Khon Kaen Section are presented in Table 2.2–2 and boardings at each station in Table 2.2–3.

Table 2.2–2 Line Load (Passengers) Forecast Result for Chira Junction–Khon Kaen Section

Section	2010	2015	2020	2025	2030	2034
Chira Junction–Bua Yai Junction						
- Passengers (person/day)	5,640	38,800	44,600	48,200	52,000	55,900
- Volume of Transportation (person-km/day)	446,700	3,075,400	3,533,800	3,820,300	4,120,600	4,425,000
Bua Yai Junction–Khon Kaen Section						
- Passengers (person/day)	4,660	27,200	31,700	33,100	35,400	37,700
- Volume of Transportation (person-km/day)	485,900	2,832,300	3,301,300	3,455,600	3,693,300	3,934,100

Source: The Consultants

**Table 2.2–3 Forecast Result of Boardings at Each Station for
Chira Junction–Khon Kaen Section (person/year)**

Section	2010	2015	2020	2025	2030	2034
1. Ban Ko	71,000	147,000	164,000	182,000	200,000	216,000
2. Nong Maeo	51,000	90,000	101,000	114,000	125,000	136,000
3. Non Sung	145,000	258,000	290,000	325,000	357,000	385,000
4. Ban Dong Phlong	27,000	48,000	54,000	61,000	66,000	72,000
5. Ban Makha	58,000	103,000	116,000	129,000	142,000	153,000
6. Phon Songkhram	55,000	97,000	109,000	123,000	135,000	146,000
7. Ban Don Yai	32,000	58,000	65,000	73,000	80,000	87,000
8. Muang Khong	214,000	380,000	428,000	480,000	528,000	570,000
9. Non Thong Lang	20,000	37,000	40,000	46,000	50,000	54,000
10. Bua Yai	233,000	439,000	495,000	554,000	610,000	658,000
11. Nong Bua Lai	37,000	65,000	73,000	81,000	89,000	97,000
12. Nong Makhua	8,000	31,000	34,000	39,000	42,000	45,000
13. Muang Phon	83,000	260,000	293,000	328,000	357,000	383,000
14. Ban Han	8,000	28,000	31,000	34,000	37,000	40,000
15. Ban Phai	88,000	279,000	314,000	351,000	382,000	409,000
16. Ban Haet	9,000	29,000	32,000	35,000	38,000	41,000
17. Tha Phra	9,000	28,000	31,000	35,000	38,000	41,000
18. Khon Kaen	326,000	853,000	961,000	1,075,000	1,170,000	1,252,000
Total	1,728,000	3,751,000	4,214,000	4,715,000	5,161,000	5,557,000

Source: The Consultants

The forecast results of the line load (freight) for the Chira Junction–Khon Kaen Section are presented in Table 2.2–4 and the freight volume handled through container yards in Table 2.2–5.

**Table 2.2–4 Freight Line Load Forecast Result for Chira Junction–
Khon Kaen Section**

Section	2010	2015	2020	2025	2030	2034
Chira Junction–Bua Yai Junction						
- Freight Volume (tons/day)	980	10,900	13,500	14,700	15,600	16,400
- Volume of Transportation (million tons-km/day)	77,300	865,700	1,067,000	1,164,500	1,233,000	1,302,100
Bua Yai Junction–Khon Kaen						
- Freight Volume (tons/day)	1,100	11,300	13,700	14,600	15,500	16,400
- Volume of Transportation (million tons-km/day)	114,800	1,175,800	1,432,600	1,518,700	1,612,000	1,706,400

Source: The Consultants

**Table 2.2–5 Forecast Result of Freight Volume Handled through Container Yard for
Chira Junction–Khon Kaen Section (tons/year)**

Freight	Ban Kra Doan		Bua Yai		Tha Phra	
	2025	2034	2025	2034	2025	2034
Rice	140,000	177,900	8,900	32,400	239,000	314,000
Flour	53,000	67,400	-	-	220,000	289,100
Sugar	40,500	51,500	28,000	10,300	401,000	526,900
Others	71,500	90,800	1,700	6,600	116,000	152,400
Total	305,000	387,600	38,600	49,300	976,000	1,282,400

Source: The Consultants

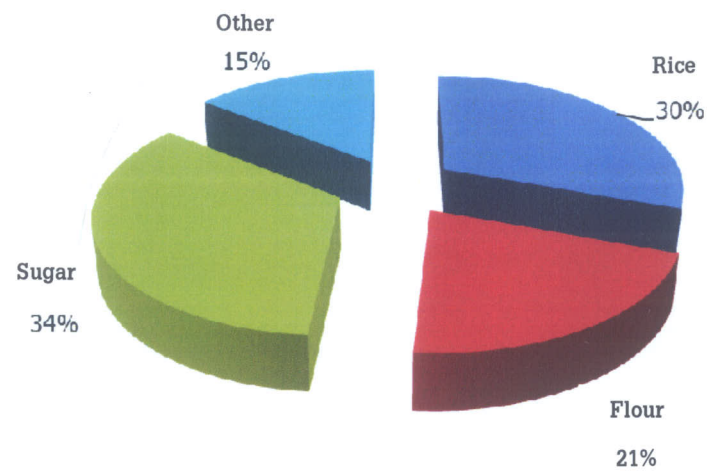


Figure 2.2-2 Proportion of Future Freight Volume for Chira Junction-Khon Kaen Section

3. Investigation of Engineering Essential Data

3.1 Survey and Preparation for Topographic Map and Utility Map

Topographic survey and topographic map, utility map have been implemented within SRTS right of way (R.O.W.) and all concerned railway crossings. Listed tasks are as the following:

High definition satellite photos, with ground sampling distance approx 0.5 m. employing Geo Eye / Quick Bird latest Archive method for accurate adjustment of coordinates. As such, the effective coverage of satellite photos will extend to determined distance perpendicular to the center line of the track 500 m. on each track side (1,000 m. extension in total) to well cover the practical R.O.W as well as all concerned railway at – grade crossings.

- Construct horizontal control points, using GPS (Global Positioning System) method by means of a couple of points arrangement. The distance between adjacent pairs will be lying in 3 – 5 km. distance. The appearance of control point will abide by the standard characteristics of survey technology. The reference control points will be as well prepared. The general assigned locations of control points are illustrated in figure 4.1.1-1
- Build up vertical control points (Benchmark, BM.) to account for MSL (Mean Sea Level) with transferring reference from Thai Survey Department/ Royal Irrigation. To facilitate convenience in use, the vertical control points will be quoted from the point of original horizontal ones.
- To perform periphery survey and construct peripheral control points for each specific 100 – 300 m. to allocate project area. Control points have been robustly constructed and installed in safe stable places free from any harmful damages with transferring coordinates and levels from previously quoted horizontal / vertical control points.
- Conducting landscape detailed survey for determined stations and necessary parking lots circumscribing Project area within R.O.W.
- Conducting landscape detailed survey for acquisitive data collection, especially sites for at – grade crossings, with perpendicular distance 1 km. extended from center line of track on each track side.
- Survey reports will consist of acquired calculation sheets concerning workable details of GPS, traverse, leveling, descriptions of control points, landscape detailed data, and other indispensable incidentals needed for detailed design.

3.2 Survey and Preparation for Cadastral Map

From survey findings and issues of cadastral, conclusion can be made on Project area acquired and concerned buildings within R.O.W. to account for necessary land acquisition, assets relocation, assets to be expropriated and assets redemption as herein specified in the following table.

Addition of Arwa Requirement	Proprietary (No. of site)		Expropriate Areal (Rai-Ngan-Square wah)			Dismantal Building (No.)		Preliminary Expropriate Compensation (Baht)		
	Public	Private	Public Section (Area Permission)	Public Section (Area Requirement)	Private Section (Expropriate)	Public	Private	Land	Building	Total
KM.315+376.994 (Ym.)	3	38	1 - 0 - 23.03	0 - 0 - 0.00	5 - 0 - 76.42	1	4	404,903.00	6,168,507.00	6,573,410.00
KM.346+470.613 (Ym.)	0	41	0 - 0 - 0.00	0 - 0 - 0.00	3 - 3 - 10.31	0	6	14,155,960.00	18,070,524.00	32,226,484.00
KM.429+168.253 (Tm.)	0	13	0 - 0 - 0.00	0 - 0 - 0.00	2 - 3 - 81.39	0	0	346,147.00	-	346,147.00
KM.435+237.749 (Tm.)	1	0	0 - 0 - 0.00	0 - 0 - 51.11	0 - 0 - 0.00	0	0	33,222.00	-	33,222.00
Total	4	92	1 - 0 - 23.03	0 - 0 - 51.11	11 - 3 - 68.12	1	10	14,940,232.00	24,239,031.00	39,179,263.00
Remark Land Assessment Price (Baht/Square Wah) is estimated from assessment price (year 2012-year 2015) Building Construction assessment price (Baht/Square meter) is Estimate From Average price (year 2011)										

3.3 Survey for Geology and Soil Properties

From field survey findings, the terrain of corridor generally comprises gently undulating topography with only some short segments of high terrain. Average height of embankment (more than 80%) is ranging between 1-3 m. with some specific section of high fill (height 6-8 m.) on approach of river crossing bridge, Chee River for example, on some segments of high terrain, cut / fill construction would be experienced but only account for moderate cutting works of around 6 m. height approximately.

In pursuance of survey findings, the consultant has adjusted determined boreholes to well conform to existing topography and existing geology of project sites. Number of boreholes comprise 126 bores in total (BH – 1 to BH – 126), depth of each individual bore would be around 30 m, or cease at stiff level with SPT N – Value more than 50 in a series of 3 consecutive drills, locations of boreholes along the project railway corridor.

Conclusion of investigative findings and tested materials, General subsoil layers in Project area.

- Soft clay layers in combination with loose sand are prevailing in project area as top soil of thickness varying between 0.5 – 2.0 m. is found lying on stiff clay / hard clay layers. In some specific areas, there would be sand layer lying on top of clay / sandy silt in medium up to dense conditions.
- Judged from available soil condition it could be concluded that bearing soil layer along transport corridor of railway line would be in possession of satisfactory soil properties which account for engineering requirements with capability to well sustain high burden load and exhibit small subsidence.

Construction material resources.

- Availability of appropriate stone resources suitable for provision of railway construction, e.g. crushed rock, stone chips, for track ballast etc. with sufficient supply to meet the railway construction requirement, have been found in Amphur Namphong, Amphur Phoopamarn in Khon Kaen Province, and Amphur Pakchong in Nakhon Ratchasima Province, with transportation distance to project area around 100 – 189 km.
- Availability of appropriate sand resources with satisfactory quality to be used for concrete works and railway construction with sufficient supply to meet determined requirement have been found in Amphur Thamenchai, Amphur Pimai in Nakhon Ratchasima Province and Amphur Namphong in Khon Kaen Province with transportation distance to project area around 60 – 100 km.
- Availability of laterite resources with satisfactory quality to be used as construction material have been also found in Amphur Namphong in Khon Kaen Province and Amphur Khamtaleso, Amphur Wangnamkeo in Nakhon Ratchasima Province with transportation distance to project area around 100 – 172 km.

4. Route Design

4.1 Route Design

Chira Junction - Khon Kaen Section Track Doubling Project is a construction project of additional new track parallel to the existing railway, with generally 6.0 m. spacing from the existing track, except Km. 441 +500 and Km. 443 +700m Section that the spacing from the old track will be 15 m. Overall length throughout the project is approximately 187 km. The right-of-way is generally 80 m. wide, but will be 80-200 m. wide for the station area according to each area condition. The Railways along the entire route are ground level, except those in Khon Kaen locality from Km. 447 +950 to Km. 453 +350, which will be elevated, with total distance of 5.4 km.

In designing the railway for the project, the Consultant has an idea to place a new rail to the right of the existing rail in line with location of the Container Yard and the future placement of the High Speed Rail (HSR) that will be on the left of the old rail. Figure 4.1-1 shows cross section of the project general Railways. Figure 4.1-2 shows cross section of the rails with High Speed Train (HSR) in the future.

The project starts behind the Chira Junction area at km. 267 +300 going to the north and ends behind the Khon Kaen Station area at km. 454 +100. The terrain is mostly flat plains along the entire route. Most of the areas are farmland. The Consultant has designed the horizontal radius of curvature from 1,600 - 3,000 m. as shown in Figure 4.1-3, and the vertical radius of curvature not less than 10,000 m., with maximum slope not exceeding 10%.

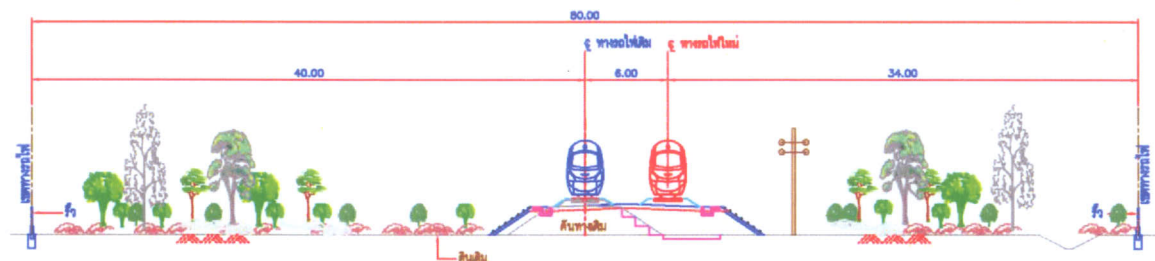


Figure 4.1-1 Cross Section of Project General Railways

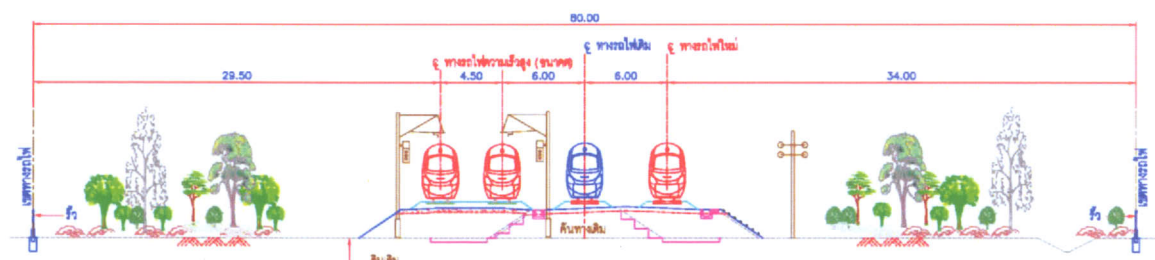


Figure 4.1-2 Cross Section of Railways with Future High Speed Rail (HSR)



4.2 Schematic Track Diagram

Schematic Track Diagram is designed based on major concepts as follows.

1. Trying to use the center line of the existing tracks as the control line of the new double track system or maybe as upward or downward center of the new double track system along the route
2. The route and the area will avoid expropriation of land or causing impacts on other related projects as much as possible.
3. To consider relations with other transportation projects that need to be done in form of overpass or underpass
4. The route must be in line with the train operating plans and locations of the stations.
5. Minimum utility relocation
6. Taking into account the ability to use a simple structure to reduce construction cost and environmental impact
7. Taking into account environmental impact caused by railways route and the changing levels of the railway due to the design of different-level crossings with other transport systems
8. A continuation of the route and the train operation for the most riding comfort of the passengers

Figure 4.2-1 Illustrates the Schematic Track Diagram.

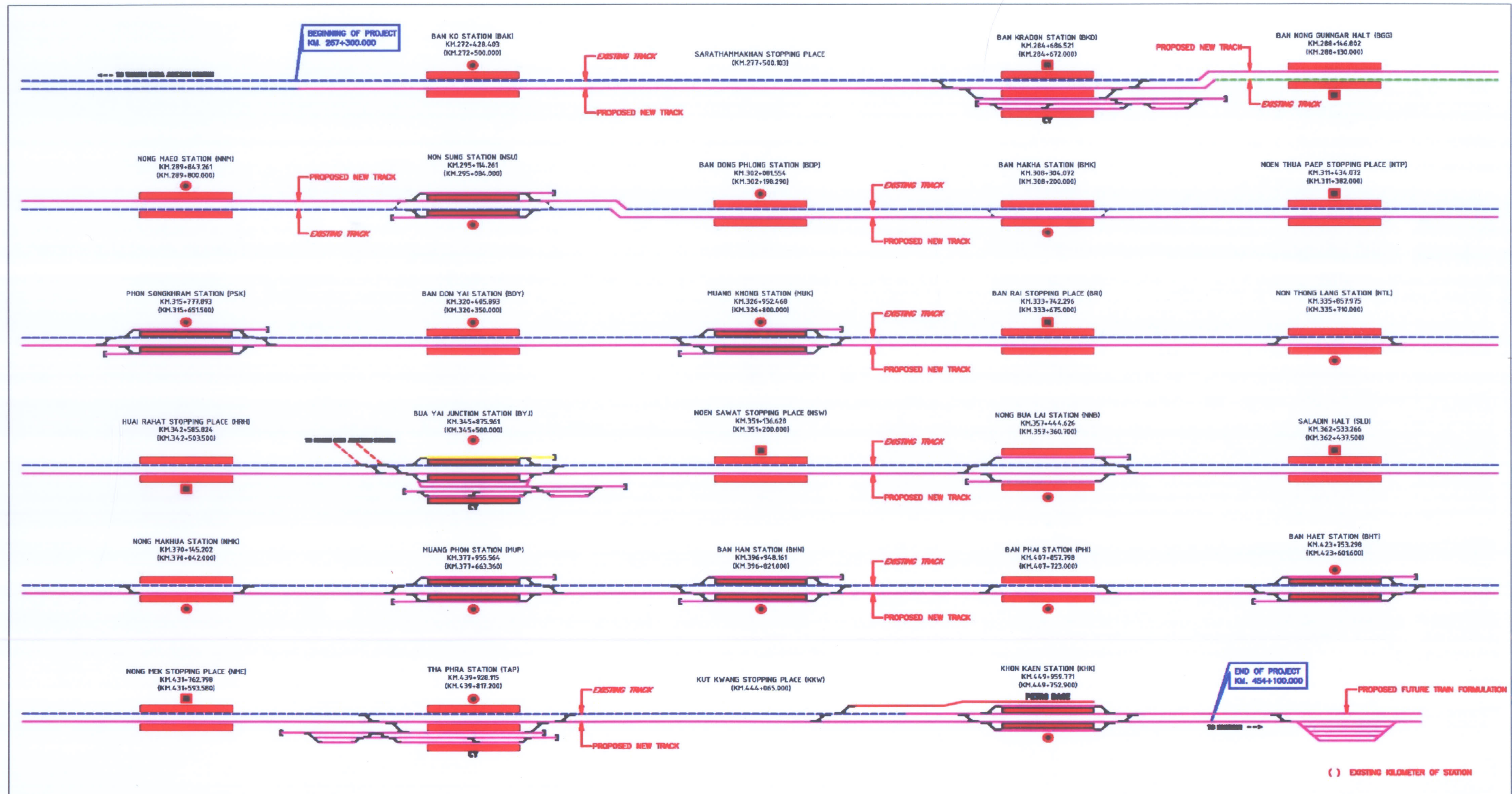


Figure 4.2-1 Schematic Track Diagram

5. Railway Structure Track System Design

5.1 Analysis and Design for Track Embankment

Analysis and design process for track embankment has to account for the stability analysis of embankment, unit of bearing stress on embankment and encountered deferred subsidence following completion of construction process for each cross section of embankment which is subject to any alteration of dimensional measures and height of embankment. Besides, provided that the height of embankment remains unchanged but the foundation alters noticeably, the three basic checkups have to be repeated again. Hence, each determined railway line will possess many relevant aspects needed to analyze and test and subject to be much time consuming and also subject to possible errors resulted by too many concerned data. Thus, the consultant has deemed to develop design chart to assist quick assessment of analysis and facilitate convenience of design. By nature of such assisting chart, the designer needs only to know the presumed height of embankment, shear strength of subsoil foundation condition by means of determined SPT N-Values, then he will be able to evaluate whether the determined embankment pass the requirement for design specifications or not, as details herein delineated in figure 5.1-1 and 5.1-2.

Design Chart for Single Track Embankment, (Subgrade = Clay)

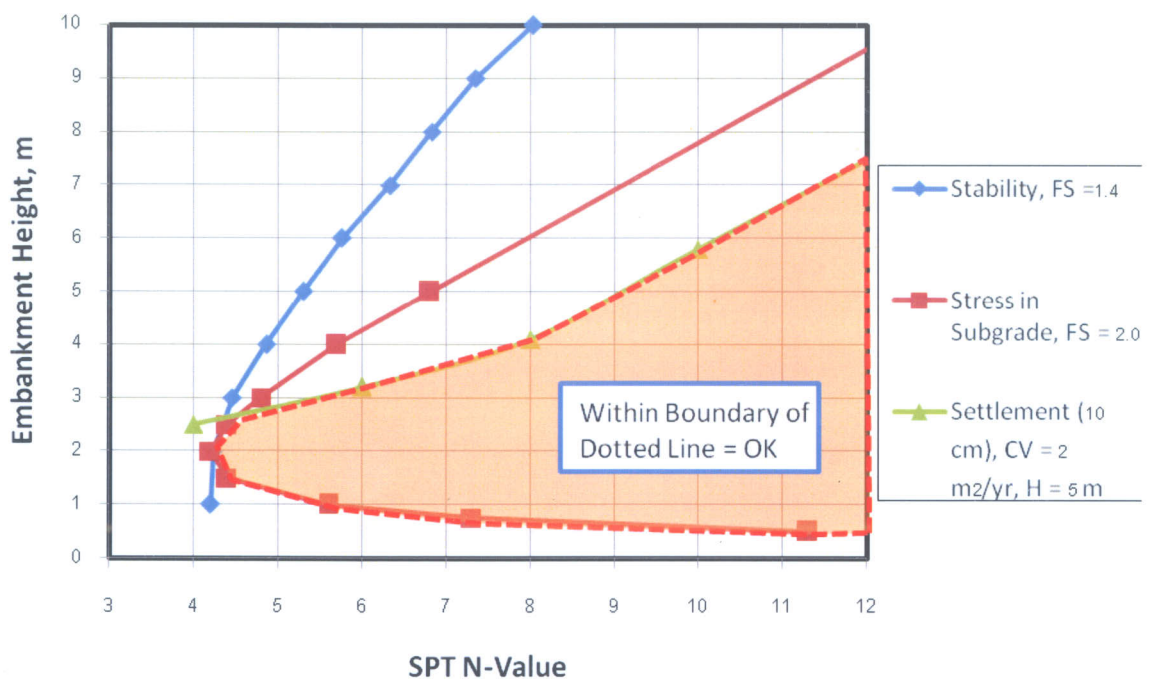


Figure 5.1-1 Clay Foundation Design Graph

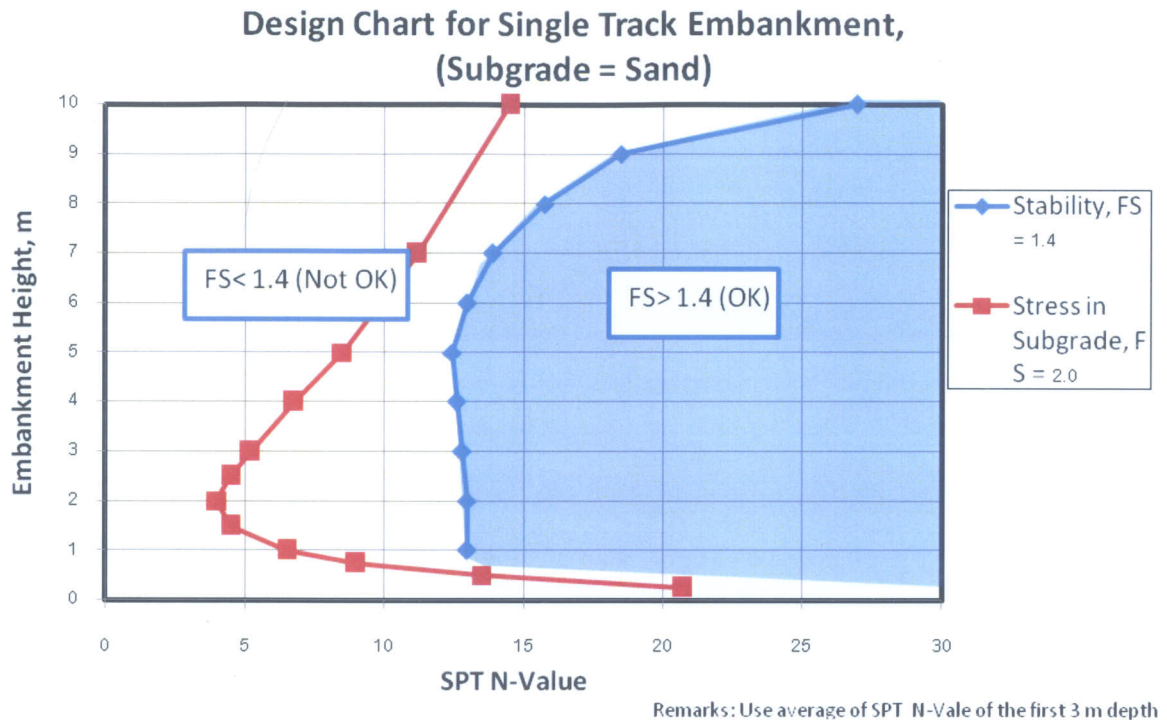


Figure 5.1-2 Sand Foundation Design Graph

5.1.1 Results of Subsoil Layers Investigation

From fact findings on field survey and material tests in soil mechanics laboratory, the characteristics of subsoil layers along the project transport corridor could be classified in segmental areas as the following:

Most foundation soil properties are composed of appropriate soils of good properties for railway engineering requirements, capable to sustain high bearing load with small subsidence, soil layers for formation generally exhibits the top layer of soft clay and some of loose sand (found only on few boreholes) of 0.5-2.5 m. depth. In some areas silty/clayey sand has been experienced in medium dense up to dense state with penetrating SPTN-Values ranging from medium to very high blow counts, that the layers of dense sand or stiff clay exhibit high SPTN-Value more than 50 blows/ft in consecutive 3 layers. This satisfactory soil property could be met around the depth 3-15 m. from top soil layer.

Only limited sections from Nong Meg Station to Tha Phra Station (Sta.431+608 to Sta.439+550) that the thick loose silty sand layer about 2.0-5.5 m. was found lying on layers of very stiff to hard clay and prone to call for foundation soil improvement such as bearing slab on foundation or else, rather than soft clay/loose sand substituted by appropriate soil replacement method.

5.1.2 Conclusion of Embankment Design assisted by ready-made Design Chart

From afore-mentioned soil layers data assessment, determined height of project trackage embankment design assisted by special chart can be concludes as the following:

- Major trackage area around 80 km. chainage or 43% of total trackage, foundation soil is composed of high bearing layer capable to sustain high

load, embankment and track can be constructed without any additional soil property improvement.

- About 60 km. of trackage, or 32%, soft clay layer or loose sand layer are found with spreading depth of 0.5-1.5 m. and exhibit poor bearing capacity. Excavation of these poor soils accompanied with good soil replacement and well compaction are called for.
- About 40 km. of trackage, or 22%, soft clay layer of thick layer of 1.5-3.0 m. is found. Soil therapy to obtain satisfied soil properties will be performed as same as above-said case.
- Only few trackage area, or about 3% of total, unsuitable soil layer of greater thickness has been experienced and either excavation to replace with good soil or bearing slab on piling foundation might be employed accordingly, depending on appropriate surrounding conditions.

Table 5.1-1 Quality Improvement of Embankment Foundation Soil

Depth of Soft Clay Excavation (m.)	Excavation Distance (km.)	Percentile of Total Distance (percent)
0.0	80.5	42.9
0.5 – 1.0	50.5	26.9
1.0 – 1.5	9.4	5.0
1.5 – 2.0	16.6	8.8
2.0- 2.5	18.5	9.9
2.5 – 3.0	5.4	2.9
≥ 3.0	6.8	3.6

5.2 Railway Bridge Design

Throughout the Project trackage total number of 84 railway bridges will be incorporated, comprising 29 bridges of each individual 5 m. span length, 22 bridges of each 10 m. span length, 13 bridges of each 15 m. span length, and likewise 13 bridges of each 20 m. span length, 3 long span bridges of 25 m. span length, 1 long span bridge of 50 m. span length and 1 extraordinary long bridge of 50 m. span length merging into adjacent bridge of 50 m. span to produce a unique continuous long bridge of 80 m. span length. Most newly implemented bridges run parallel to the original 81 bridges for bi-directional single line of existing track. Save for some special cases such as Km. 268+362 and Km.301+664 of which the original bridges have to be disposed and construct new bridges to accommodate operative double track function also an additional solution to solve problems of at-grade crossing entangled in communication across both sides of the track, a determined bridge to facilitate convenience of the said traffic has been designed at Km.326+278. For principles of railway bridge design, bridges with 5-25 m. span length would be of concrete reinforcement type and those of 30, 50 and 80 m. span length would be in the form of truss structure to mitigate concerned own weight and to be in good coordination with neighborhood existing bridges.

Structure Format

Structural design of bridges has been formulated to suit the span length in use accordingly. For 5-25 m. span length either reinforced or prestressed concrete type would be used while 30-50 m. span length, either suitable forms of steel truss would be used instead.

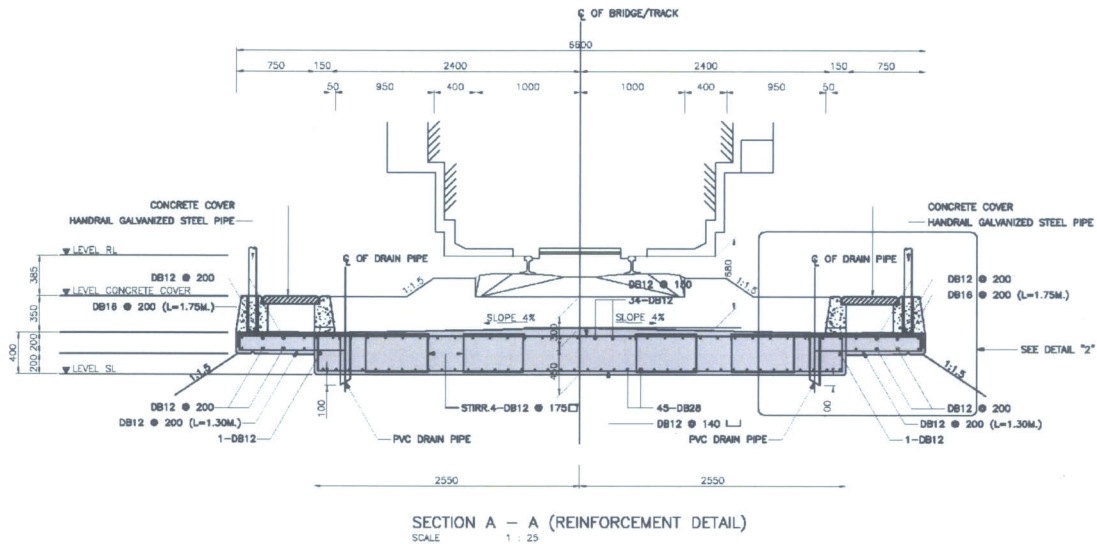


Figure 5.2-1 Cross Section of Cast in Place Reinforce Concrete Bridge Slab (5 m. Span Length)

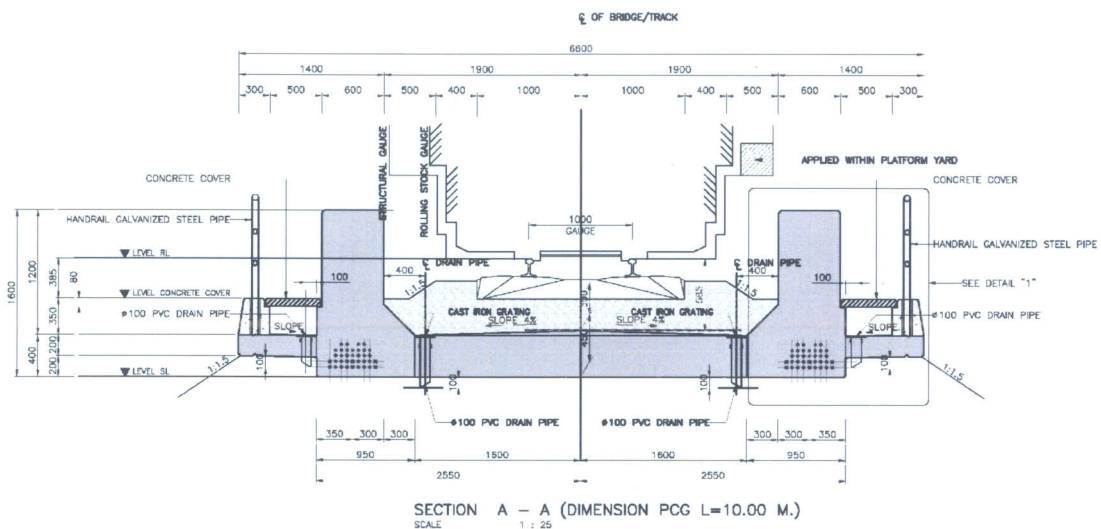


Figure 5.2-2 Cross Section of U-shaped Prestressed Concrete Bridge Structure (10 m. Span Length)

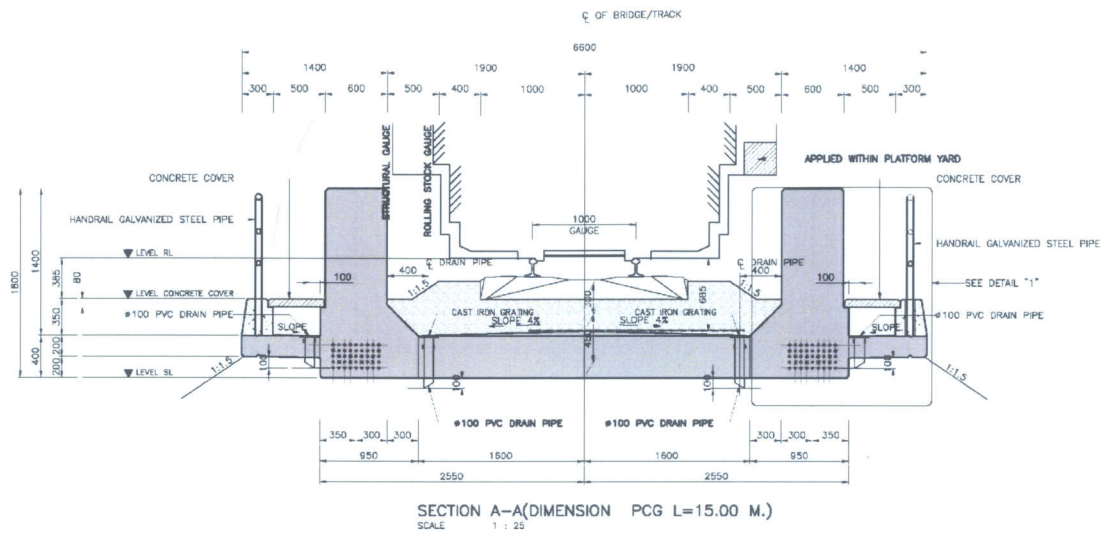


Figure 5.2-3 Cross Section of U-shaped Prestressed Concrete Bridge Structure (15 m. Span Length)

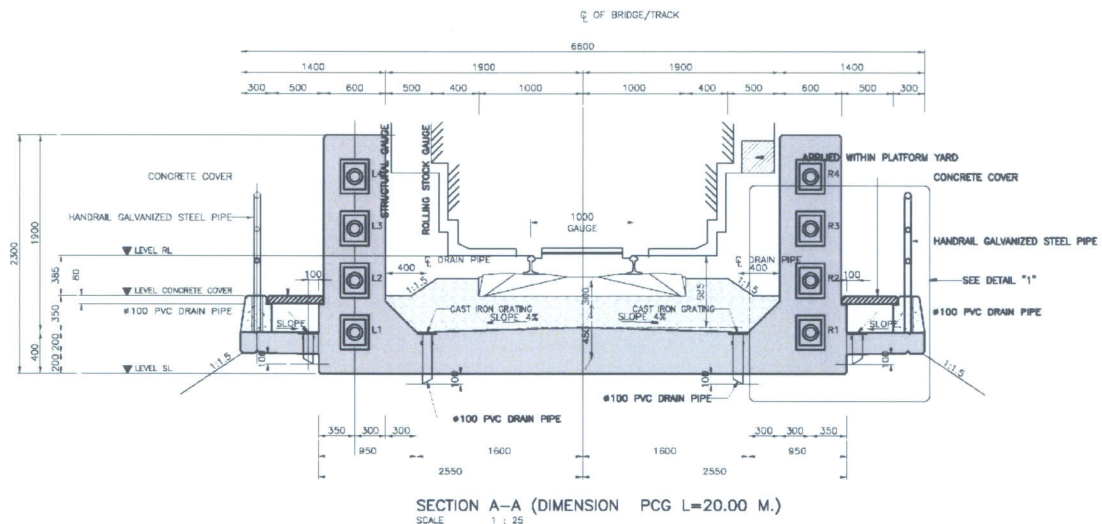


Figure 5.2-4 Cross Section of U-shaped Prestressed Concrete Bridge Structure (20 m. Span Length)

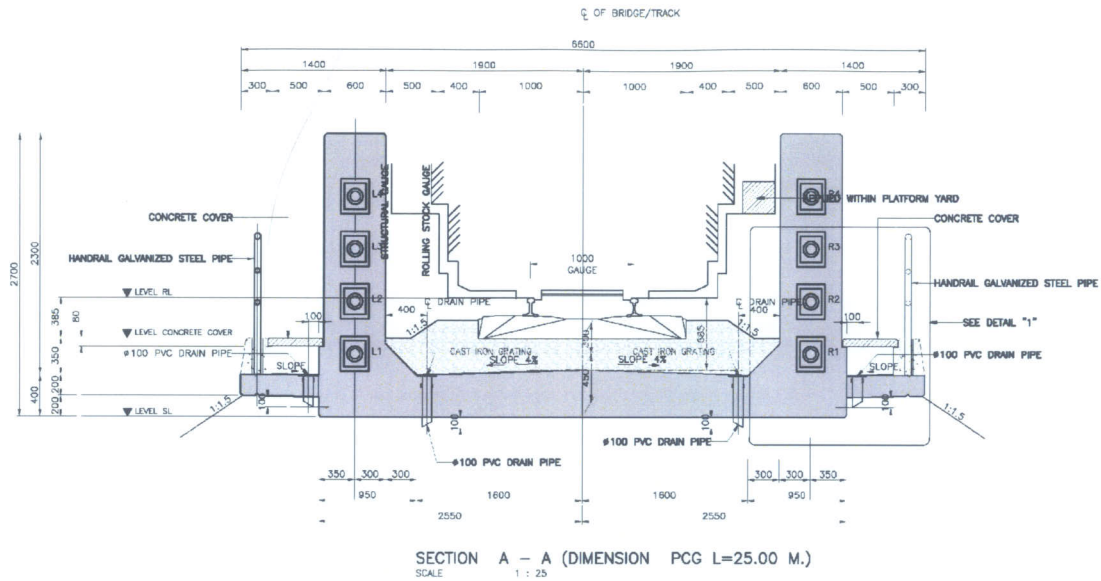


Figure 5.2-5 Cross Section of U-shaped Prestressed Concrete Bridge Structure (25 m. Span Length)

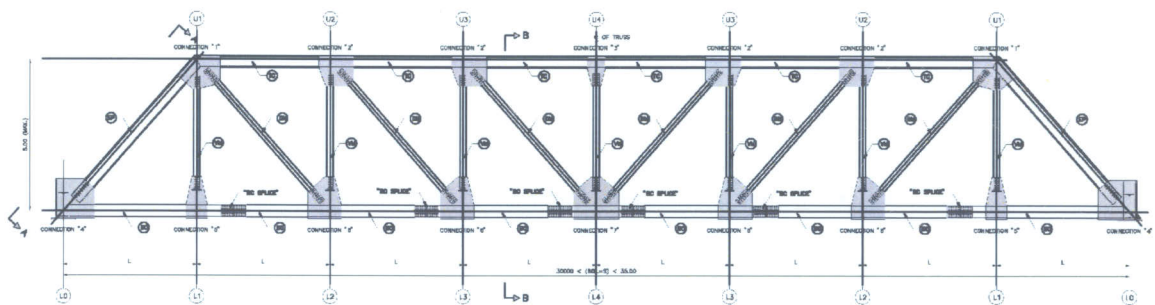


Figure 5.2-6 Cross Section of U-shaped Prestressed Concrete Bridge Structure (30 m. Span Length)

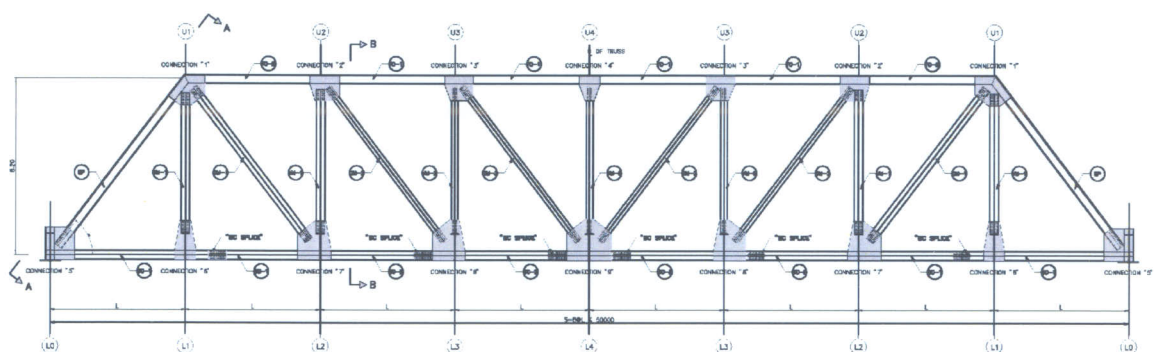


Figure 5.2-7 Cross Section of U-shaped Prestressed Concrete Bridge Structure (50 m. Span Length)

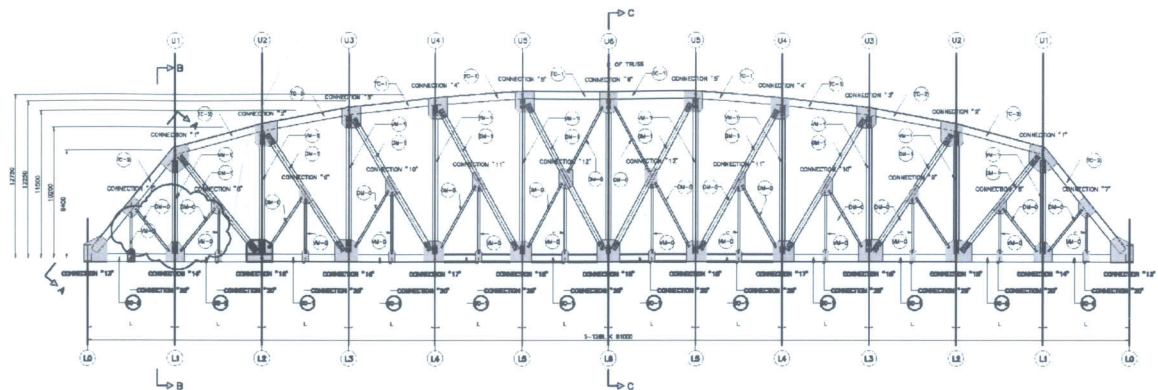


Figure 5.2-8 Cross Section of U-shaped Prestressed Concrete Bridge Structure (80 m. Span Length)

5.3 Track System Design

For at-grade railway, nominal ballasted track as shown in figure 4.2.8-1 will be implemented except for approach section of Khon Kaen Station Area that the running track will change to elevated track with conjunction of elevated station as previously mentioned which ballastless track shall be used instead, as shown in figure 5.3-2. As for specified type of rail in use, the consultant will propose the universal type of UIC 54 throughout the project trackage.

The rail fastener in use to fasten rail to the concrete sleeper of Monodock type will be the appropriate type in accordance with SRT's approved list and being in conjunction with sleeper design (i.e. to suit the dowel type embedded in sleeper). Spacing between the pair of adjacent sleepers would be 600 mm. Switch and crossing will be designed pertaining to requirement of train operation. Facing switch will be of UIC 54-1:16 or 1:12 (switch angle) and trailing switch would be of 1:10 or 1:8 (switch angle) depending on individual location demand.

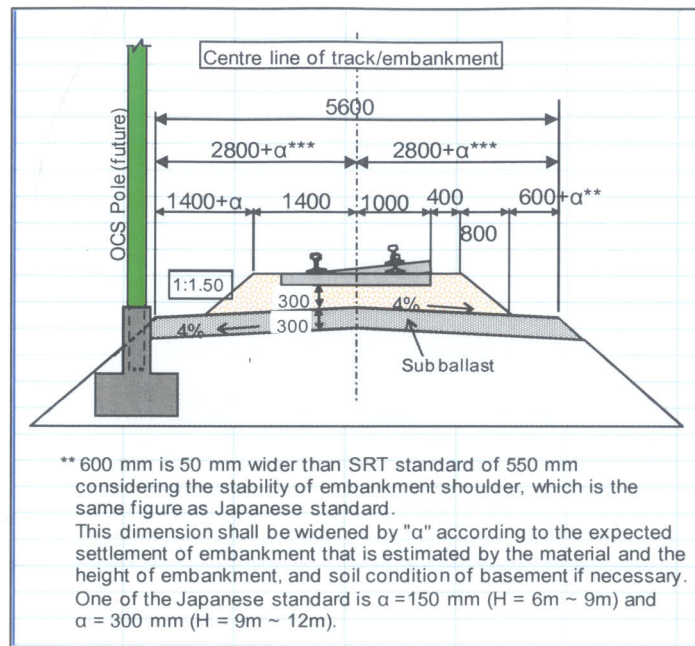


Figure 5.3-1 Cross Section of At Grade Railway with Ballasted Track

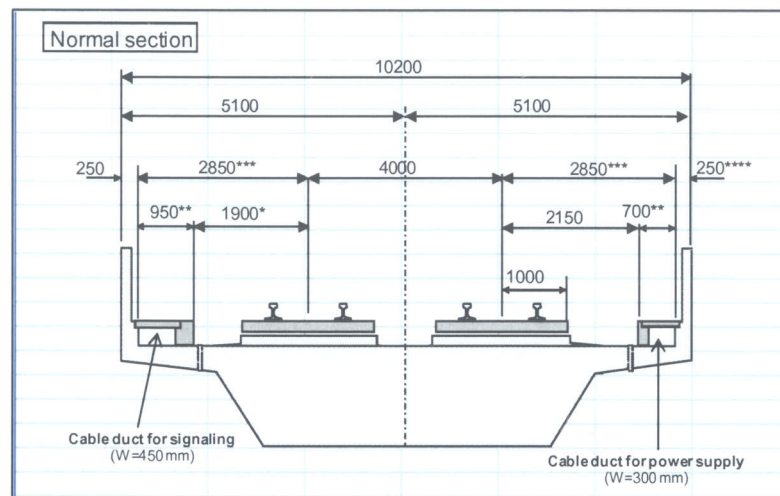


Figure 5.3-2 Cross Section of Elevated Railway with Ballastless Track

5.4 Drainage System Design

5.4.1 Current Drainage Conditions

During the years of 2008 – 2010, the study area was confronted with flooding resulted in stop of trains indefinitely, with flood water level at 0.30 - 0.50 m. The flood was due to the overflows crossing the Railways on the lowland areas which are sag curves. Calculation of the flow volume was shown in the Table. That the water gathering around the areas as aforesaid caused the openings designed insufficient to accommodate the water flow. Tables 5.4-1 and 5.4-2 show the areas of water flowing across the tracks.

Tables 5.4-1 Flooded Project Areas

Station Areas	Sta.	Water Level above Tracks (cm)
Ban Ko – Sra Thammakhan	Km. 273+000 – Km..277+000	30
Bua Yai – Noen Sawad	Km.349+000 – Km..51+000	30
Ban Phai – Ban Heat	Km.416+800 – Km.417+000	50
	Km. 421+785 – Km.422+000	50

Table 5.4-2 Flowing Volume Rate across Tracks during the Floods

Station Areas	Sta.	Water Level above Tracks, H (cm)	Length, L (m)	Flow Volum,Q (m3/s) $Q = CLH^{3/2}$
Ban Ko - Sra Thammakhan	Km.273+000 – Km.277+000	30	4000	263
Bua Yai – Noen Sawad	Km.349+000 – Km.351+000	30	2000	132
Ban Phai – Ban Heat	Km.416+800 – Km.417+000	50	200	28
	Km.421+785 – Km.422+000	50	215	31

5.4.2 Project Drainage System

- According to the data field survey of the drainage building, it was found that the existing drain outlet of the project is still in good condition and works well.
- For the areas with flood over the rails, in project development, additional outlet openings have been designed to solve such problem.

- From the analysis of the rainfall catchment areas, it was found that the outlet openings throughout the project had safety factor greater than 1. This indicates that the outlet openings are capable of discharging the maximum overflow at the 100-year recurring period.
- Drainage system in the double tracks consists of ditches in the middle of the railway, water sumps from ditches into side sewers and side sewers as shown in Figure 5.4-1.

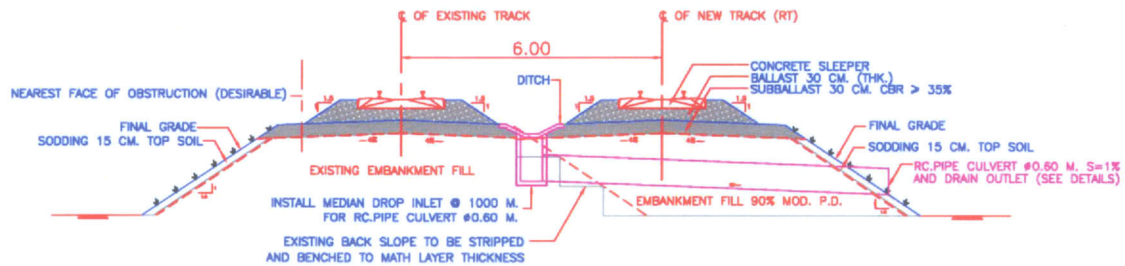


Figure 5.4-1 Drainage System in the Double Tracks

6. Railway Station Design

6.1 Station Architectural Design

6.1.1 Stations Design Concept

1) Existing Stations Renovation Concept

The site survey and evaluation of existing stations revealed that existing stations are not suitable to continue their services as stations. The supporting reasons are:

- 1.1) Most existing stations are small buildings; therefore, functional spaces are not sufficient. For example, waiting area is too small. Station Shelter are small-sized buildings and cannot be served as shelters.
- 1.2) Most existing stations are not in good condition since they have been used for many years without appropriate maintenance.
- 1.3) Most existing stations are not enabling the expansion or renovation in accordance with the modern train operating system.

However, existing stations have a very unique character and a sentimental value to community. They also represent historical value in the establishment and development of State Railway of Thailand from the past to present. The Consultant, therefore, proposes to keep these historical stations by reconstruct existing buildings in the appropriate area within station yard. Functions of reconstructed stations, such as, community library, community museum, etc. shall be suggested by SRT. The reconstructed stations shall serve as community relation.

2) New Stations Design Concept

- 2.1) The characteristic of new stations shall illustrate the local architecture identity along the route. Each station on the same route shall have the same architectural characteristic.
- 2.2) Functional spaces arrangement shall be based on the passengers' behavior and train operating system. Functional spaces arrangement shall be the same pattern in all stations to assist passengers in familiar themselves to the stations.
- 2.3) All stations shall be "Universal Design" which enable every human beings to use without any difficulty.
- 2.4) Convenience and safety of passengers and staff shall be highly considered in station design. Stations shall be designed so as to easy to control. All stations shall be fenced. Paid area and unpaid area shall be clearly separated inside station.
- 2.5) Ventilation, thermal protection, natural light and good visibility are also station design considerations.
- 2.6) Energy and environmental conservation shall be considered.
- 2.7) Building materials shall be selected based on their durability, easy to maintain and in accordance with project budget.

6.1.2 Size of Stations

Stations shall be categorized according to the number of passengers at peak hours. They are as followed:

1. Extra-large sized station to serve > 400 passengers at peak hours.
2. Large-sized station to serve 300-399 passengers at peak hours.
3. Medium-sized station to serve 200-299 passengers at peak hours.
4. Small-sized station to serve 20-199 passengers at peak hours.
5. Stopping Places to serve < 20 passengers at peak hours.

6.1.3 Criteria to Determine Station Location

In general, new stations shall be located at or close to the existing locations. The exact location shall be determined based on the following factors:

1. Convenient access to station.
2. In accordance with the train operating system, type of platform and track work.
3. Harmonize with the community both at present and in the future
4. Reduce the impact to community and station location, such as, road network, pollution, etc.

6.1.4 Determination of Number and Location of Stations

Number of stations determination is classified by station size:

- Extra-large sized station: 1 station: Khon Kaen Station
- Large-sized stations: 2 stations: Bua Yai Junction and Muang Khong Station
- Medium-sized Stations: 3 stations: Non Sung Station, Muang Phon Station and Ban Phai Station
- Small-sized Stations: 13 stations: Ban Ko Station, Ban Kra Doan Station, Nong Maeo Station, Ban Dong Phlong Station, Ban Makha Station, Phon Songkhram Station, Ban Don Yai Station, Non Thong Lang Station, Nong Bua Lai Station, Nong Makhua Station, Ban Han Station, Ban Haet Station and Tha Phra Station
- Stopping Places: 7 places: Ban Nong Mek, Noen Thua Paep, Ban Rai, Noen Sawat, Huai Rahat, Sala Din and Ban Nong Gunngar



Figure 6.1-1 Perspective of Small-sized Station



Figure 6.1-2 Perspective of Medium-sized Station



Figure 6.1-3 Perspective of Large-sized Station



Figure 6.1-4 Perspective of Extra-large sized Station (Khon Kaen Station)



Figure 6.1-5 Perspective of Extra-large sized Station (Khon Kaen Station)

6.2 Platform Height

Relevant factors in determination of the platform height are as follows.

- Loading profile and structural profile at platform
- Gaps between platform and train
- Future height of the platform ($H = 1,100$ mm.)
- Floor height of current passenger trains

1) Loading Profile and Structural Profile at Platform

Loading profile and structural profile as defined in Major Rules can be expressed as the following figures.

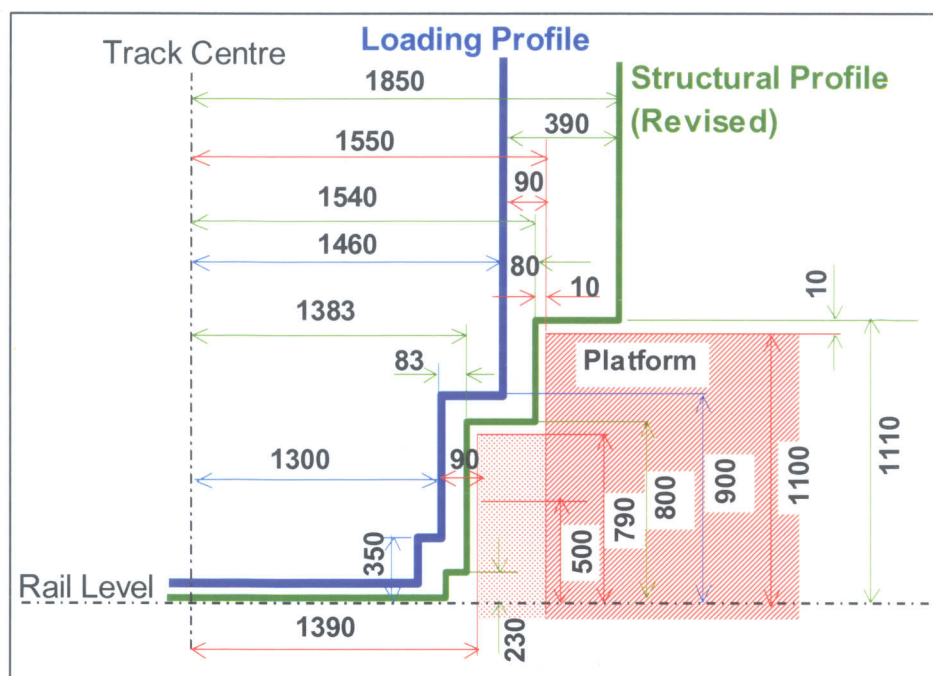


Figure 6.2-1 Loading Profile and Structural Profile at Platform

2) Platform Height Options

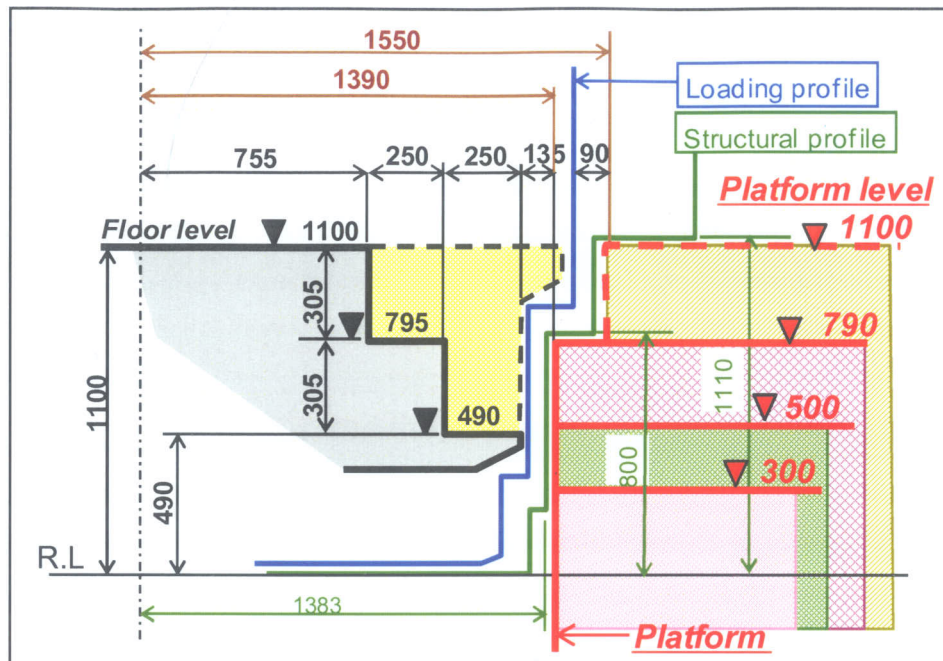


Figure 6.2-2 Platform Height Options

3) Comparison of Platform Height Options

Comparison and consideration of the platform height in each option are shown in Figure 6.2-3.

Train type Platform height	Existing Train (typical type)	Future Electric Train	Note
30 cm			Future trains need movable steps. Platform shall be lifted by 80 cm in the future.
50 cm			Future trains need movable steps. Platform shall be lifted by 60 cm.
79 cm			Steps in existing trains may need some auxiliary measures. Platform shall be lifted by 31 cm.

Figure 6.2-3 Platform Height Comparison in each Option

From the above comparisons and discussions with the relevant agencies, the Consultant suggests the platform height at 79 cm. above the rails, which is as high as the 2nd step of the train. The difference in height between the project platform and the future platform is only 31 cm. or as high as the only one step on the train, which is easy to modify in the future. For station design, the station floor has been designed to locate at 110 cm. and to be lowered twice, each time for 15 cm. and 16 cm. or made as ramp as appropriate.

6.3 Structural Design for Elevated Station

Since there exist many at – grade crossings of intown area in Khon Kaen Province, thus the Khon Kaen station at km. 449 – 959 would be designed in the form of elevated structure. Structural format of station would rest on the triple – column foundation to account for appropriate elevated railway tracks and required number of operative tracks. Frontal and crossection view of structural triple – column foundation of the above – mentioned Khon Kaen station is shown in fig 6.3–1

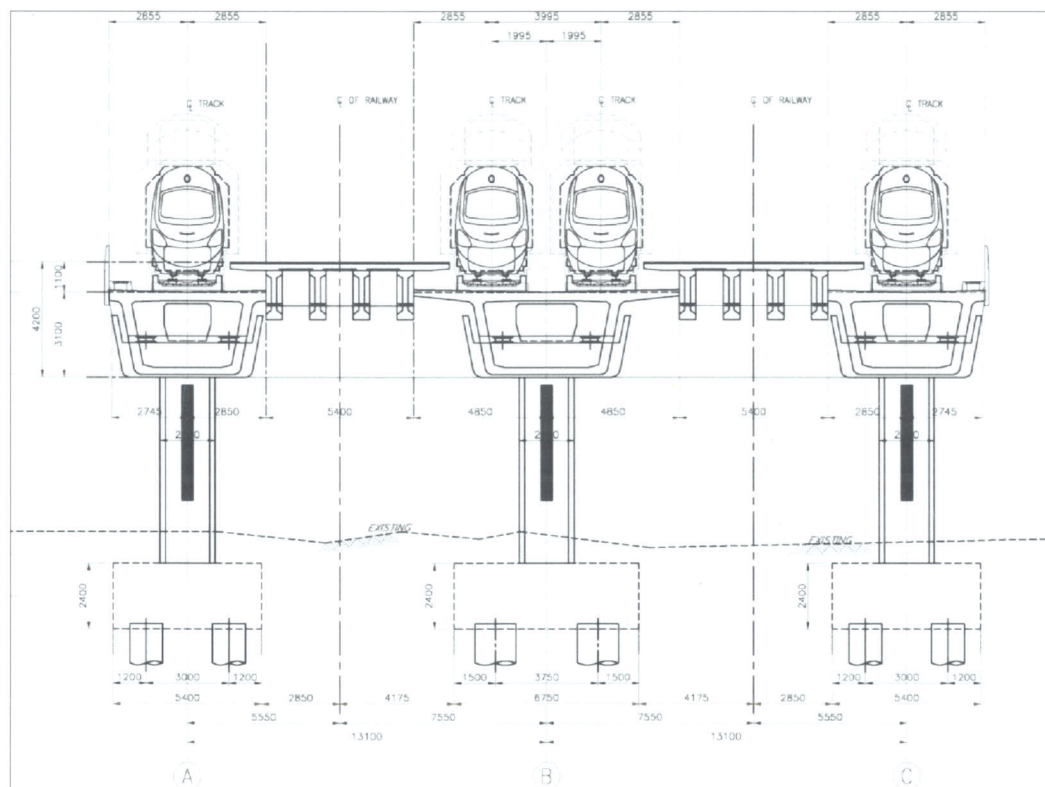


Figure 6.3-1 Cross Section of 3-column Station Structure

The main structure of station building will incorporate reinforced concrete and prestressed concrete into design since the station comprises a massive building with functions to sustain considerable applied load. Some minor sections in conjunction with the main structure will employ nominal structural steel to lessen the own weight, e.g. staircase, roofing structure of platform and other incidentals. Provision of spacing between columns of station will be 30 m. apart. The constituent structure of the station building consists of the composite parts as the following:

1) Platform Roof

Conventional plain steel will be chosen for construction works to enable small own load and convenient of roof erection. Spacing of support columns of roof will be 10 m., whilst the roof of concourse for entrance / exit of station will employ truss structure since no central supporting columns could be allowed in this open area.

2) Track Viaduct

Viaduct structure to support elevated track would utilize prefabricated precast prestressed concrete members in the form of precast segmental box girder type with 30-m. span length and 3 m. depth, The assigned segmental members would be already prefabricated from approved manufacturer and process of erection will be carried on at sites.

3) Platform Supporting Beams

Supporting beams for platform would be prefabricated precast prestressed concrete in the form of precast I – Girder with span length approx. 30 m. lying in specified spacing approx. 1.60 m. between adjacent beams. In case of assigned recesses of staircase / elevator are needed the extra space would be provided accordingly. On the contrary, wherever heavier load must be sustained the said spacing will be adjusted lesser. In general, concrete beam for platform conforms to regular 1.80 m. depth, save for the specified part which sustains extra staircase and arched roof that the beam depth must be reinforced concrete type of 6.0 m. general span. The longest beam in use is 8.50 m. span length. The biggest beam employed will measure 0.30 x 0.80 m. for its cross section.

4) Platform Floor

The platform floor would be cast in place reinforced concrete with 0.25 m. thickness. Concourse floor would be precast concrete in the form of Hollow Core with 0.20 m. thickness. As for miscellaneous floors, such as rest room, specious entrance of the station, etc. would be comprised of conventional reinforced concrete slab of 0.20 m. thickness.

5) Staircase

Staircase would be steel structure for reducing weight and convenient erection.

6) Cross Beam

Crossbeams would be comprised of cast in place prestressed concrete. The crossbeams will sustain the load transferred from both of elevated track and segmental parts of station building. The depth of crossbeam shall not greater than the depth of beams supporting the track. The suitable dimensions of crossbeam would be 2.0 m. width, 2.60 m. depth and spacing between columns would be 30.0 m.

7) Column

Columns would generally be comprised of precast reinforced concrete. Columns to constitute portal structure supporting platform would comprise dimensions of 2.0 x 2.0 m. for general columns to support concourse floor would comprise dimensions of 0.40 x 0.40 m.

8) Foundation

Foundation would be comprised of cast in place reinforced concrete in order to reduce or eliminate the differential settlement of structures affected by unequal huge bearing loads, the design of foundations was separated into 2 parts, i.e. large foundations to support load from platform with dimensions of 5.40 x 5.40 m. and 6.75 x 6.75 m. rest on large bored piles, ϕ 1.20 and ϕ 1.50 m. with 4 bored piles / foundation arrangement, and various small foundations to support loads transferred from concourse distributed around main large foundations. Provision of drive piles with dimensions of 0.35 x 0.35 m. and 0.40 x 0.40 m. will be used to support these small foundations with arrangement of 4 driven piles / foundation. Spacing between pile groups pertinent to each individual location to sustain upper applied load, will be adjusted conforming to 2.5 times of ϕ piles in use.

7. Container Yard Design

7.1 The location of Container Yard and the mobility of containers of the North-Eastern railway line.

Container Yard : Nowadays there are six container yard stations on the North-Eastern railway line, consist of the two CY belongs to the SRT and the four CY belongs to private enterprises, as shown in the figure 7.1-1

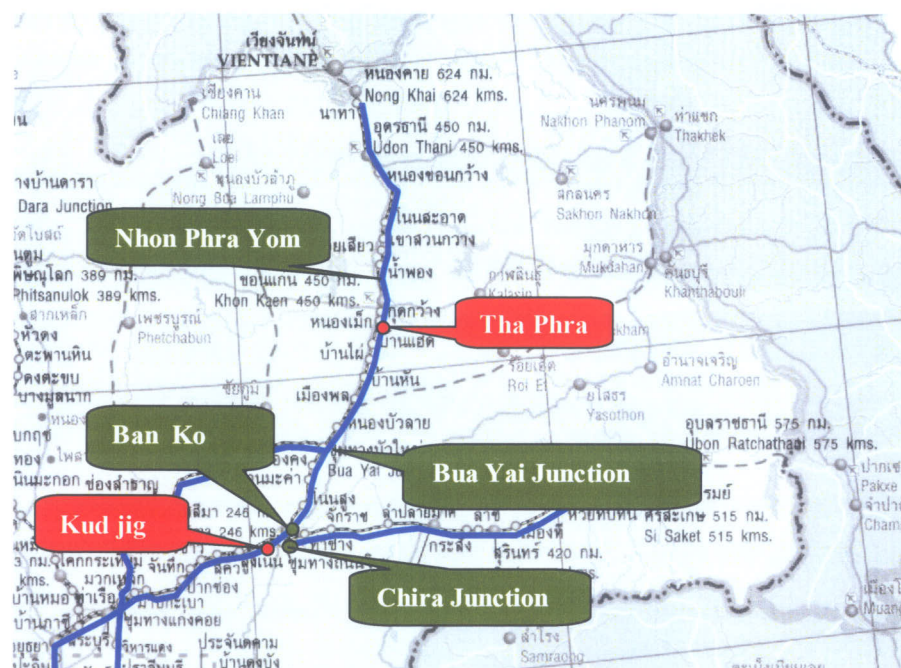


Figure 7.1-1 The locations of Container Yard on the North-Eastern railway line.

1. Container Yard on the railway line.

On the railway line: Chira Junction-Khon Kaen, three container yards are Ban Ko Station, Bua Yai Junction Station and Tha Phra Station, detailing as follow:

Ban Ko Station, Nakhon Ratchasima Province: A station on the North-Eastern railway line location in Ban Ko Tambon, Muang Amphur, Nakhon Ratchasima Province distance from Bangkok 273 kilometers on the railway line and 268 kilometers by the roadway the plot of land of container yard is about 6,250 Sqare meter., constructed by Chiameng Co., Ltd. of the 11 million Baht budget. The commodity transported by train at Ban Ko is rice of Chiameng Co., Ltd. the volume of commodity at Ban Ko in the year 2007-2009 is about 56,000 – 72,000 ton/year

Bua Yai Junction, Nakhon Ratchasima Province : A station on the North-Eastern railway line located in Bua Yai Tambon, Bua Yai Amphur, Nakhon Ratchasima Province distance from Bangkok 376 kilometers on the railway line and 350 kilometers by the road way the area of the container yard is 3,750 Sqare meter, United Standard Terminal Public Company Limited is the investor of the renovated container yard, the budget of 4 million Baht. Commodities transported by train at (Bua Yai Junction) are

sugar and cassava. The volume of commodities at (Bua Yai Junction) between B.E.2007-2009 is 13,000 – 15,000 ton/year.

Tha Phra Station, Khon Kaen Province : A station on the North-Eastern railway line, located in (Tha Phra Tambon, Muang Khon Kaen Amphur, Khon Kaen Province) distance from Bangkok 440 kilometers on the railway line and 439 kilometers by the road way. The area of the Container Yard is 14,840 Sqare meter, by the construction budget of 18.4 million Baht. (Budget of the year 2004 Transportation Supporting project in Logistic System) the commodities transported by train are mostly sugar and malt (raw material for producing beer). In the past raw materials of producing paper were transported but not for the present time (transported by truck). The volume of commodities at (Tha Phra Station) between year 2007-2009 is 70,000 – 100,000 ton/year.

2. Relocation of new Container Yard at Ban Ko Station

In the first seminar of public hearing on the 6th July 2011 at Sima Thani Hotel, Nakhon Ratchasima Province, the location of container yard at Ban Ko is not appropriate for the further expansion and for supporting the freight train on the new double track railway between Chira Junction-Khon Kean Section. The station is located in a large residential area and community. The transport by a trailer truck cause more traffic congestion and pollution to the community. The container yard should be transferred to another place.

The comparison of container yard between a potential site with Ban Ko Station. The sites consist of Sra Thammakhon Stopping Place. Ban Kra Doan Stopping Place Nong Maeo Station and Nong Sung Station, the Ban Kra Doan Stopping Place Offers high potential for further expansion of the container yard. In stead of the site at Ban Ko Station.

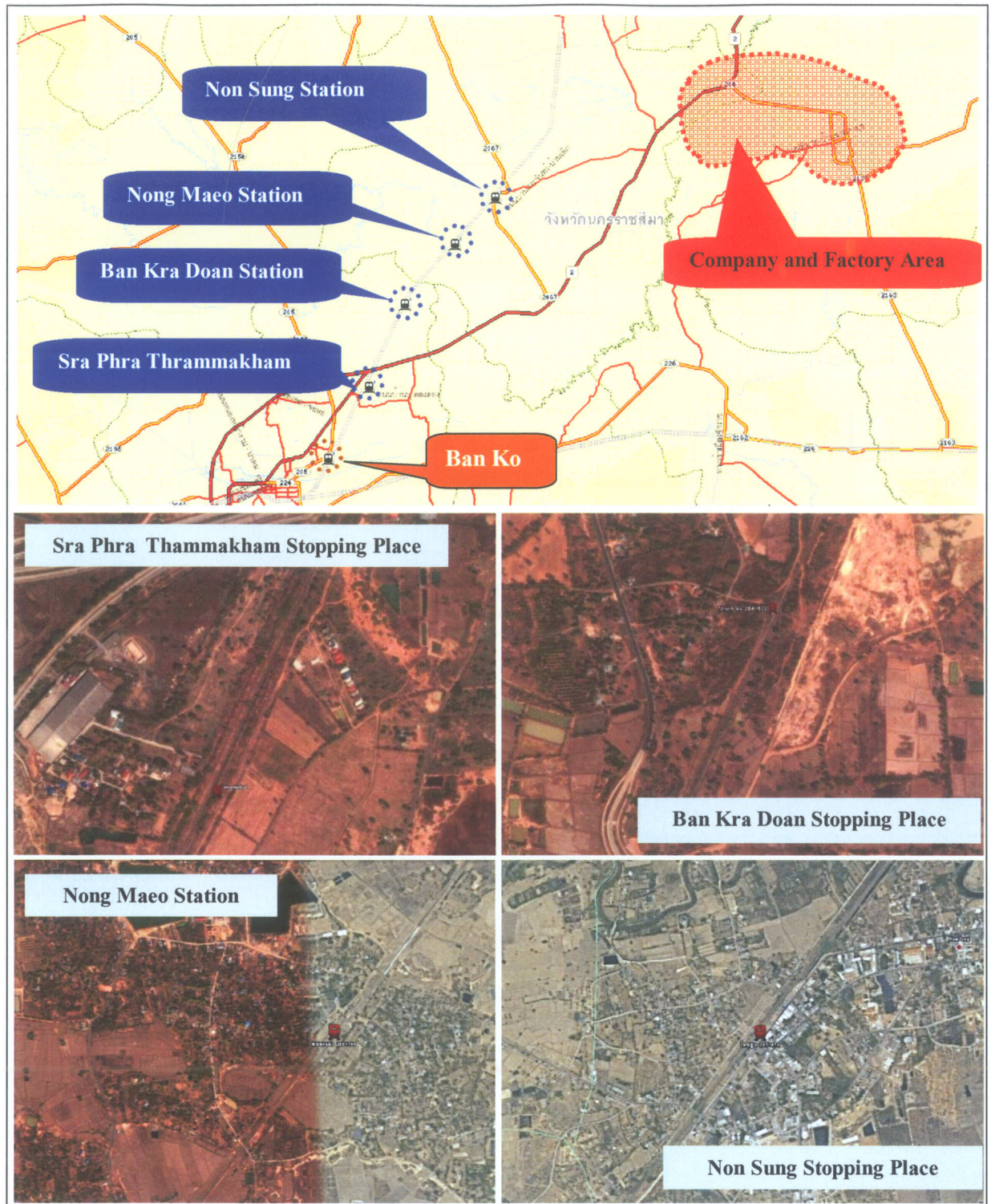


Figure 7.1-2 Railway Station location

7.2 Volume of commodities retained in Container Yard and mobility of container

The potential commodities transport by train rather than by truck. Mainly a pries per unit weight is cost so high the commodities are rice, cassava flour, rubber (Suggestion from office of the National Economic and Social Development Board). The volume of commodities in the provincial area transported by train between Chira Junction-Khon Kaen Section are shown in the Figure 7.2-1 and Figure 7.2-2

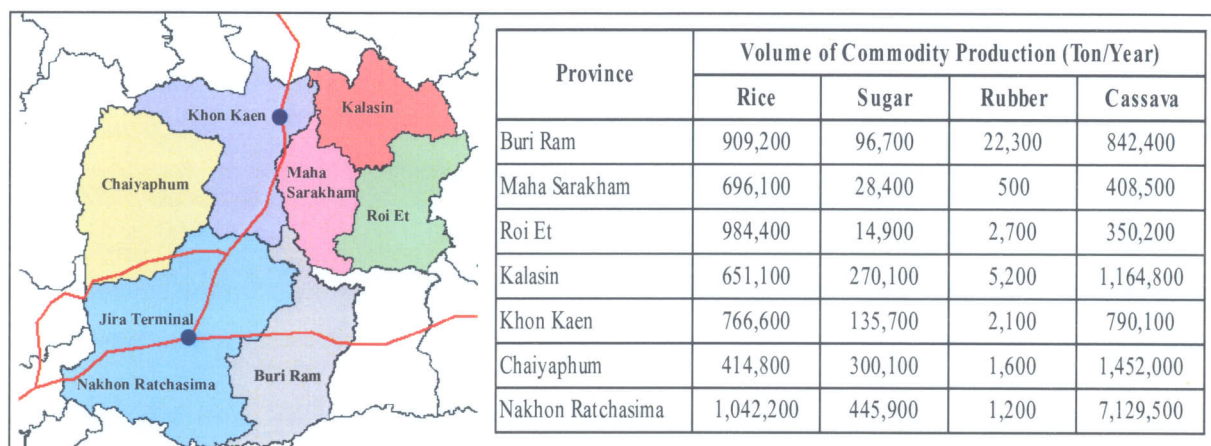


Figure 7.2-1 Volume of Commodity Production by Province (2009)



Ref : Railways Development Master Plan : RMAP

Figure 7.2-2 Potential Commodities Factory in Railway Transportation

The study on the requirement of commodity transport in the Container Yards along the railway line, when the track doubling project between Chira junction-Khon Kaen Section, is completed. Tha Phra Station and Ban Kra Doan Station offer the high potential of commodity transport. MOST of the commodities are sugar, rice and flour, as shown on Figure 7.2-3, the reutilization of the Container Yard and mobility of container and Figure 7.2-4 shows the utilization of the Container Yard and mobility of container on the commodity transport in the years 2025 and 2034.

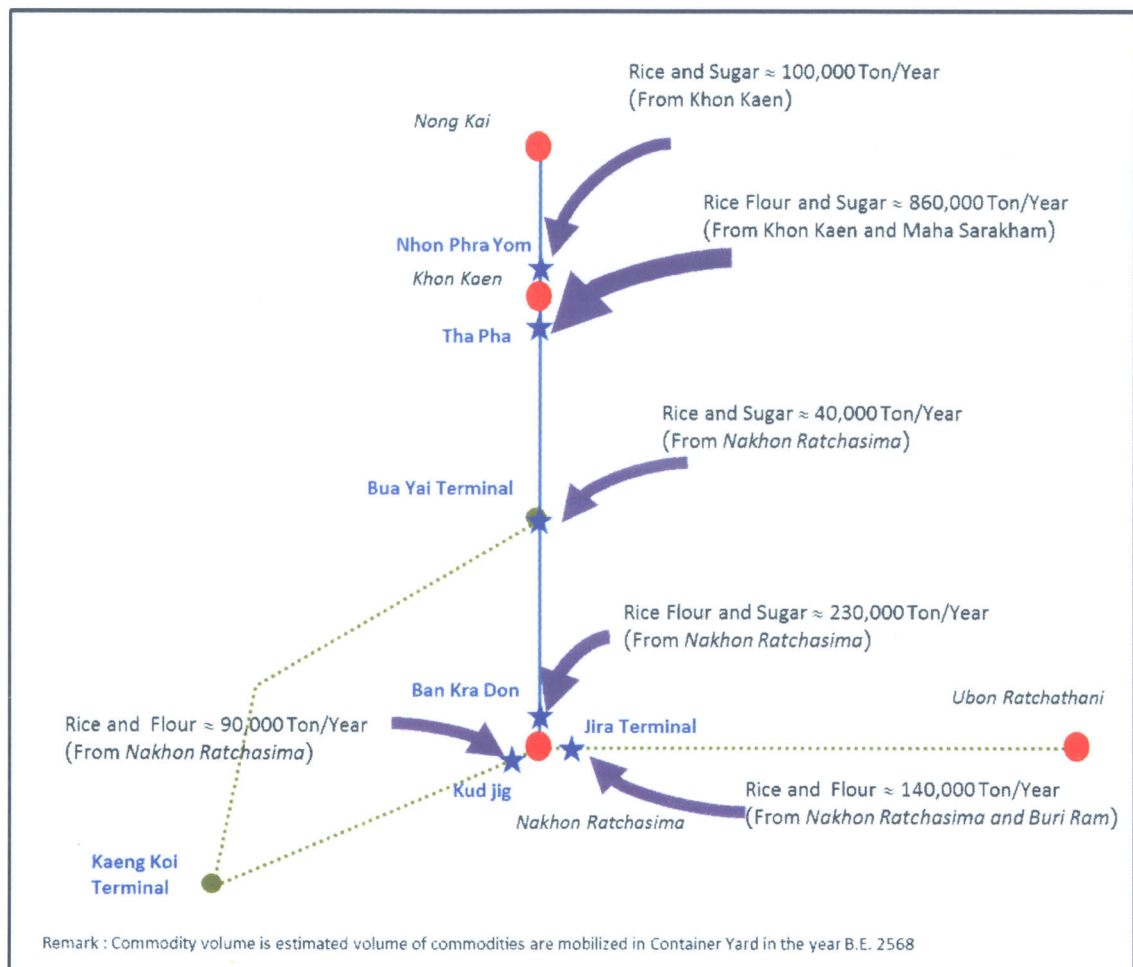


Figure 7.2-3 Container Yard Requirement in Commodity Transportation on Jira-Khon Kaen Terminal

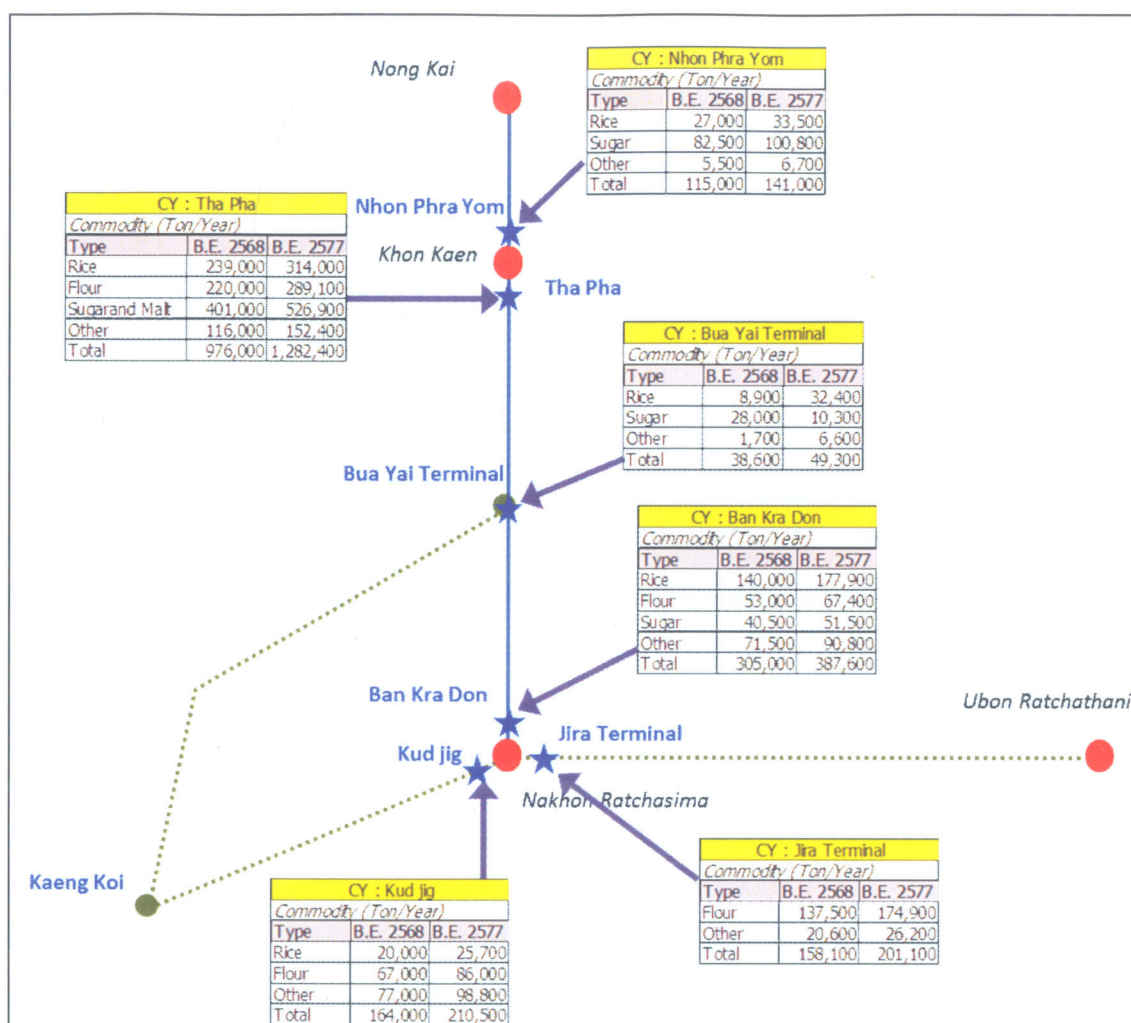


Figure 7.2-4 Container Yard Requirement in Commodity Transportation On Jira-Khon Kaen Terminal in B.E.2568 and B.E.2577

7.3 Size of Container Yard

The estimation on an area for keeping and piling containers of each station along the railway line between Chira Junction-Khon Kaen Section, it is worked on assumptions about following:

- Commodity volume : estimated volume of commodities are mobilized in Container Yard in the and 2034 (18 ton/TEU)
- Peak Factor : 1.35
- Storage Duration : 4 days
- Storage Area (including road) : 23 m² /TEU (in 3 piles)
- Storage Area (including road) : 15 m² /TEU (in 5 piles)

The estimations on an area for Container Storage Area in each station : Figure 7.3-1

Table 7.3- Side of Container Yard for each Station

Station	Container Yard Area Requirement (ton/year)		Minimum Container Yard Area Requirement (m2)	
	2025	2034	2025	2034
Ban Kra doan Station	305,000	387,600	7,700	9,750
Bua Yai Junction Station	38,600	49,300	1,200	1,600
Tha Phra Station	976,000	1,282,400	24,500	32,200

: The Consultant

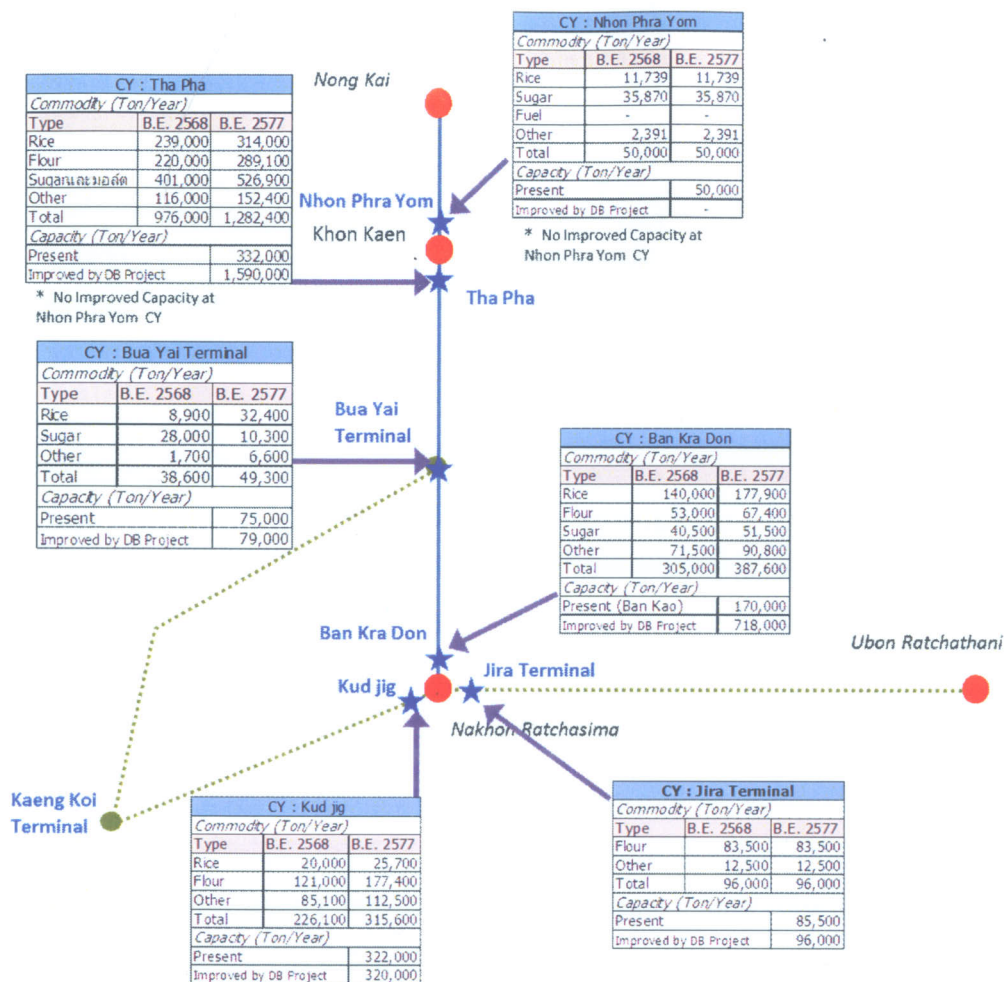
7.4 Conclusion

The study and improvement on Container Storage Area are as following:

- Kud Jig Station and Chira Junction Station: Feasibility Study and Preliminary Design Track Doubling Project for Transportation and Logistic (Phase 1), The construction of two Container yard at the two station are submitted. Chira Junction Station, The land is very limited and large communities all around. The expansion of the container yards, (Commodity Capacity 96,000 ton/year, Commodity transportation Requirement in 2025 about 158,000 ton/year), are not suitable for the Kud Jig Station, which is close to Chira Junction Station. The two container yards can be combined in are at Kud Jig Station with the high capacity at Chira Terminal (Commodity Capacity 320,000 ton/year, Commodity transportation Requirement in 2025 about ton/year)

- The container yard is preferred to locate at Ban Kra Doan Station in stead of Ban Ko Station, The Ban Ko container yard impacts greatly on the community in the vicinity of station.

- The renovation of container yard at Nhon Pha Yom Station to transport Commodities (Master Plan for Railway Track Development and High Speed Train are Preoposs to improve Container yard at Non Phra Yom Staion in 2015-2019) : The Nhon Pra Yom container yard has an enough capacity to transport and store an amount of surplus commodities of container yard at Tha Phra Station



Remark:

- Commodity volume : Estimated incase single track rail is renovated to double track rail
- Capacity of CY calculated by depend the CY's area
- Ban Kra Don Railway Shelter Offers for further expansion of the Container Yard. Instead of the sBan Kao Station
- Nhon Phra Yom Station was renovated to CY (RMAP Project)

Figure 7.4-1 Commodity Demand in Jira-Khon Kean Terminal Usability and Container Yard Capacity (Double Track Case)

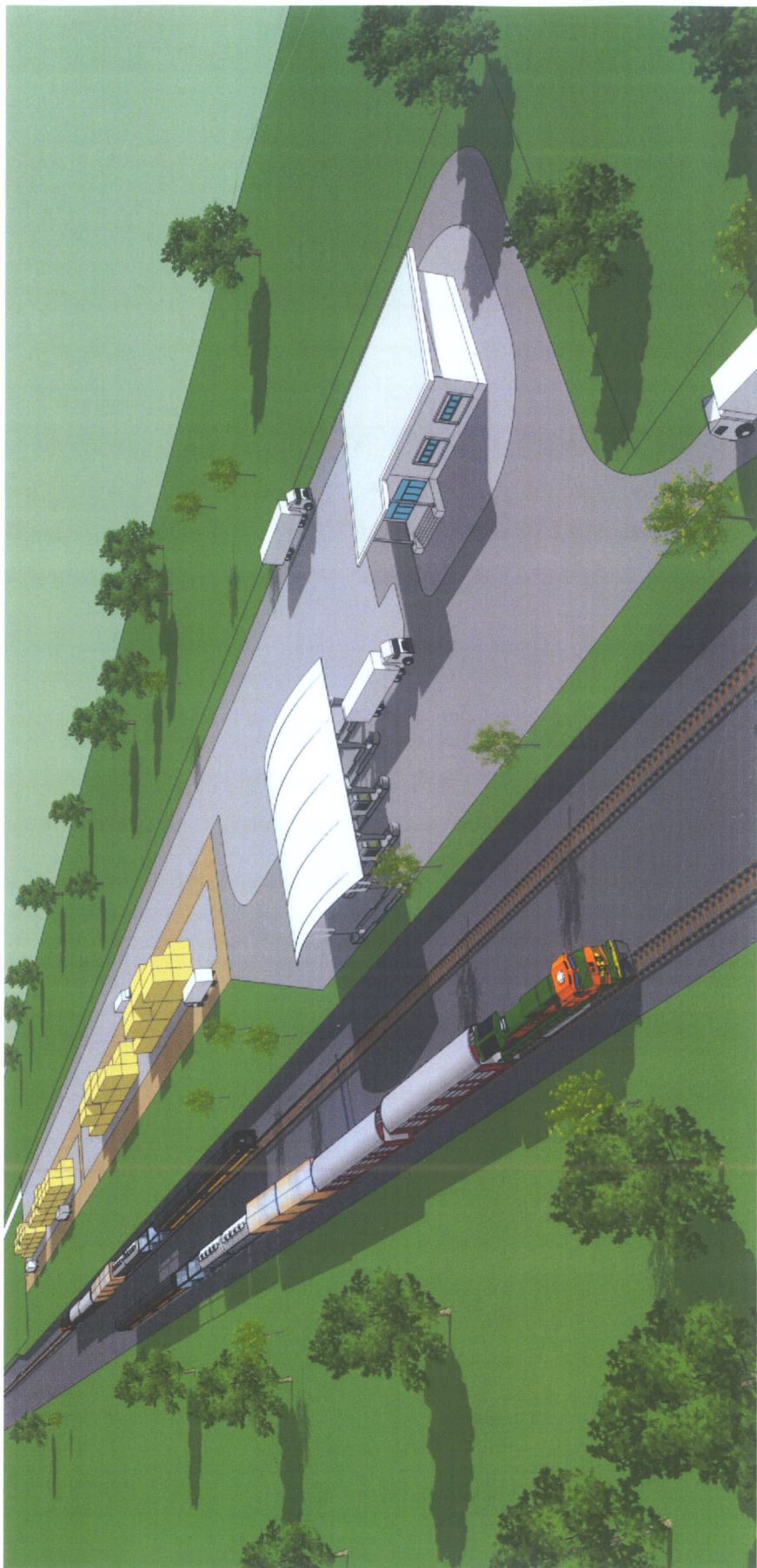


Figure 7.4-2 Perspective of CY

8. Design Concept to Solve Problems of at-grade Crossings between Railway and Roadway

From survey findings concerning railway crossings within project trackage, conclusion could be drawn that there still exist problematic 93 at-grade crossings. Nine crossings out of total have been already solved by means of grade separation construction (i.e. 7 overpasses and 2 underpasses) and 84 crossings have remained for further counter measures. There exist 23 crossings with provision of operative barriers, 50 crossing with traffic alert signs and warning signs installation and 11 crossings of illegal trespassing. The consultant has derived 4 countermeasures to arrive at ultimate solutions, as the following:

Alternative 1: Overpass Method

This method is theoretically ideal for railway track entangled with medium to high traffic arterial roads with high standardized method of designs, e.g. provision of overpasses authorized by Department of Highway and Department of Rural Roads etc. Throughout overpass, it must be free from any possible obstruction or blockage liable to obstruct the non-stop flow of through traffic

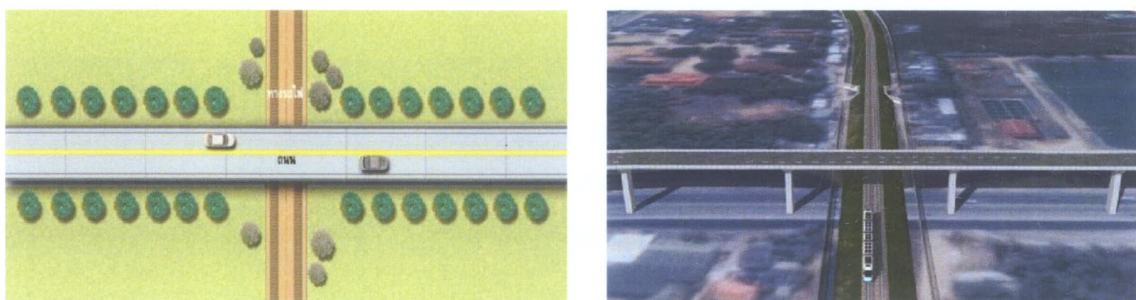


Figure 8-1 Overpass above Railway

Alternative 2: Two Way U-turn Bridge Utilization

This method is selectively determined for railway tack entangled with light traffic access roads with foreseen obstruction of traffic flow whereas available R.O.W. is not adequate for conventional design standard, so that two-way U-turn bridge within R.O.W. is conclusively adopted.

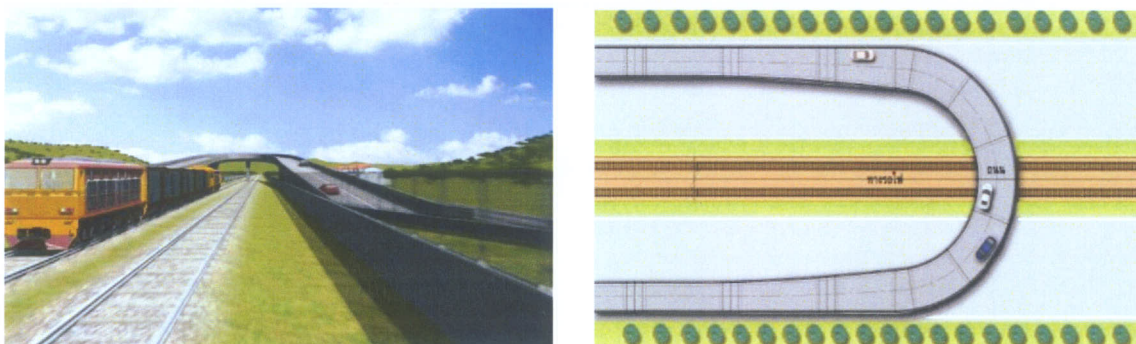


Figure 8-2 Two way U-turn Bridge

Alternative 3: Underlying Box Culvert

This method is to solve problems of crossings where the roadway traffic movement is lower than track level, especially within agricultural premises where peasants in community have to rely on uses of roadway traffic. Design of underlying box culvert would concern measures of box culvert 3.00×2.50 (Width×Height) m. with single or double openings corresponding to the physical characteristics of the roadway in use. These box culverts will also serve as effective drainage facility during flood seasons.



Figure 8-3 Box Culvert under Railway

Alternative 4: Elevated Track

This method is ideal for implementation in big intown area where many arterial roads and access roads passing through determined area, or allocation of upcoming arterial road system lying close to the railway track is likely possible and cause some foreseeable problems in design procedures. Hence, elevated track in town area would assure the effective solution and help minimize many foreseeable impacts.

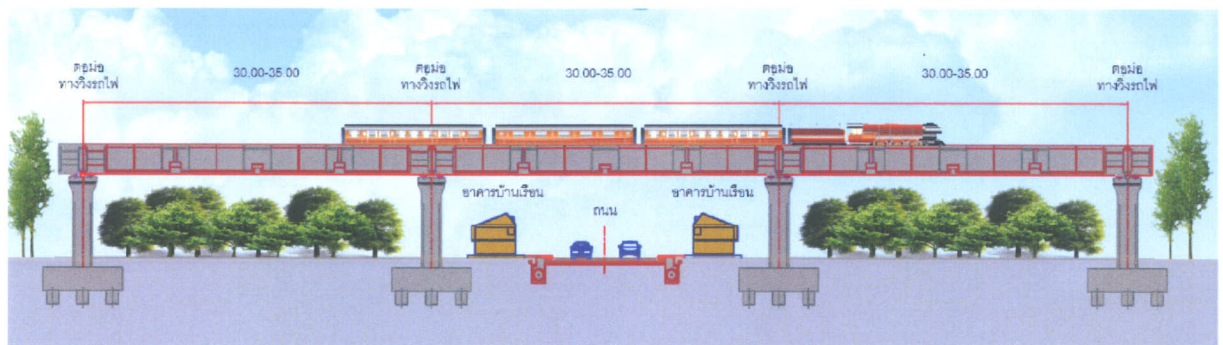


Figure 8-4 Elevated Railway

From available investigative crossings collections, the Consultant has derived the appropriate methods to solve problematic issues of each individual location by scrutinizing major concerned data such as road type, connected standard of design traffic volume, physical constraints and good coordination to harmonize with progressive implementation in the future of authorized owner of premises etc. Conclusive results of determined plans for countermeasure tasks are tabulated in Table 8-1 and design detailed drawings are shown in separate copies as attachment to this submission.

In conclusion, overall solutions to solve problems of crossing will be as follows:

- 8 Overpasses will be performed
- 26 Two way u-turn will be performed
- 38 Box Culverts or railway bridges will be installed
- 1 Elevated track segment (to accommodate 5 crossings with 2 crossings inherent in this Project) will be implemented.
- 1 Underpass will be implemented by Department of Rural Roads
- Propose to undertake other nearby crossings instead for 4 locations
- 2 Automatic crossing barriers are applied

Table 8-1 Railway Crossing with Road Condition and Solution

No.	NAME	KM. POST	EXISTING LEVEL CROSSING	WIDTH (M)	CONNECTION BETWEEN	NO. OF LANE	TYPE OF SURFACE	LOCATION		LEVEL CROSSING AGENCY	ADT VEH / DAY	TM CAR-TRAIN / DAY	TYPE OF LEVEL CROSSING
								AMPHU	CHANGWAT				
	สถานีชุมทางพนัธิระ												
1	ทล.พ.บ.สอ 224	267+477.347	Overpass	8.0		4	ถนนสายบาง	เมือง	นครราชสีมา	มท.	Overpass	Overpass	-
2	ถ.บ้านวังขอน, ถ.พยับพิศ	269+805.000	เคื่องกั้น	6.0	ร.ร.วัดทุ่งสว่างกับร.ร.บ้านภูสีฐาน	2	ถนนสายบาง	เมือง	นครราชสีมา	เทศบาล	9,343	186,500	U-Turn 2 way+ สะพานลอย
3	ทางัดผ่าน	269+880.000	ทางัดผ่าน	4.0	ม.เทศบาลวัดราชมงคลวัดศาลาแก้ววัดระดองเก่า	2	ถนนคูวัง	เมือง	นครราชสีมา	เทศบาล	60	1,200	Close ไข้วไปจุดตัดที่ 2
4	ถ.บ้านเกาะ - สถานีรถไฟ	271+655.000	บ้านจางร	7.0	หมู่บ้านสีวลีกับวัดระดองเก่า	2	ถนนสายบาง	เมือง	นครราชสีมา	เทศบาล	3,304	66,100	Close U-Turn 2 way
	สถานีบ้านเกาะ												
5	ถ.เข้าหมู่บ้าน (พร. ม.ม.2036)	276+140.000	เคื่องกั้น	6.0	วัดโคกกลางกับหมู่บ้านสระธารจันทร์	2	ถนนสายบาง	เมือง	นครราชสีมา	เทศบาลต.พอ	8,300	166,000	U-Turn 2 way + Box 2 cell
	สถานีบ้านสี												
6	ถ.ทางฝั่งมิตรภาพ (ทล.๕ 2)	278+847.897	Overpass			4	ถนนสายบาง	เมือง	นครราชสีมา	มท.	Overpass	Overpass	-
7	ถ.มิตรภาพ - บ้านเก่า	279+260.000	บ้านจางร	4.0	หมู่บ้านหนองสีกับหมู่บ้านหนองห้	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต.บ้านเก่า	126	2,600	Close ไข้วไปจุดตัดที่ 8
8	ถ.มิตรภาพเก่า - บ้านกระโดน	279+780.000	บ้านจางร	4.0	บ้านสีกับเทศบาลบ้านสีนครราชสีมา	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต.หนองไข้วน้ำ	214	4,300	Box 2 cell
9	ถ.มิตรภาพเก่า - บ้านกระโดน	280+970.000	บ้านจางร	4.0	บ้านสีกับเทศบาลบ้านสีนครราชสีมา	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต.หนองไข้วน้ำ	194	3,900	Box 2 cell
10	ถ.มิตรภาพเก่า - บ้านกระโดน	283+000.000	บ้านจางร	4.0	หมู่บ้านทุ่งธนะสมัคกับบ้านสี	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต.หนองไข้วน้ำ	181	3,700	Box 1 cell
11	มิตรภาพ-บ้านโคกสูง (พร. ม. 1049)	284+085.650	Overpass			2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. โคกสูง	Overpass	Overpass	-
	ที่ศูนย์บริการรถโตน												
12	ถ.บ้านกระโดน - มิตรภาพ	286+235.000	บ้านจางร	4.0	ร.ร.บ้านกระโดนกับวัดบ้านทุ่งธนะ	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต.หนองไข้วน้ำ	183	3,700	Box 2 cell
13	ถ.บ้านคัน - มิตรภาพ (หนอง ทราย)	287+804.898	บ้านจางร	4.0	ร.ร.บ้านกระโดนกับวัดบ้านทุ่งธนะ	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	166	3,400	Box 2 cell
	ที่ศูนย์บริการหนองบ้าน												
14	ถ.บ้านหนองร้อย - หนองงั่ว	288+485.000	บ้านจางร	4.0	หนองงั่วกับร.ร.บ้านหนองงั่ว	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	1026	20600	Box 2 cell
15	ถ.บ้านคันค้อ - บ้านคัน (ม.5)	288+590.000	บ้านจางร	4.0	วัดคันค้อกับร.ร.บ้านหนองงั่ว	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	1894	37900	U-Turn 2 way
	สถานีหนองแก้ว												
16	ถ.บ้านหนองไร่ - บ้านโคกกรั่น	291+380.800	บ้านจางร	4.0	บ้านคันค้อกับบ้านสี (วัดค้อ)	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	1084	21700	Box 2 cell
17	ถ.บ้านค้อน้อย-หนองทรายขาว	292+900.000	บ้านจางร	3.0	ร.พ. หนองกับกับบ้านค้อน้อย	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	211	4300	Box 2 cell
18	ถ.บ้านค้อเก่า - บ้านคัน (พร. ม. 5019)	293+785.000	บ้านจางร	4.0	บ้านคันค้อกับร.ร.หนองร้อย	2	ถนนสายบาง	เมือง	นครราชสีมา	เทศบาลโคกสูง	5694	113800	U-Turn 2 way+ สะพานลอย
	สถานีหนอง												
19	ถ.บ้านคัน - ตลิ่งใหม่	295+700.700	บ้านจางร	7.0	หนองบ้านคันกับร.ร.หนองศรีฐาน	2	ถนนสายบาง	เมือง	นครราชสีมา	เทศบาลโคกสูง	2782	55700	Box 2 cell
20	ถ.บ้านสระแดง - บ้านบัว (ทล. หมายเลข 2067)	297+350.000	บ้านจางร	7.0	บ้านคันกับบ้านสีพิเศษพิเศษที่6	2	ถนนสายบาง	เมือง	นครราชสีมา	เทศบาลโคกสูง	5299	106000	U-Turn 2 way + Box 2 cell
21	ถ.บ้านบัว - ทุ่งนา	297+500.700	บ้านจางร	3.0	บ้านคันกับบ้านสีพิเศษพิเศษที่6	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. หนองไข้ว	44	900	Box 2 cell
22	ถ.ทุ่งนา - หนอง (เคื่องกั้น สะพานขาว)	298+280.700	บ้านจางร	3.0	บ้านสีกับบ้านสีพิเศษพิเศษ	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. หนองไข้ว	28	600	Box 2 cell
23	ถ.บ้านค้อเก่า - บ้านหนอง	301+415.000	บ้านจางร	4.0	ร.ร.บ้านค้อกับบ้านสีหนอง	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. หนองไข้ว	165.6	3400	U-Turn 2 way + สะพานลอย
	สถานีบ้านค้อหนอง												
24	ถ.บ้านค้อน้อย-บ้านสีน้อยใหญ่	305+068.831	บ้านจางร	4.0	ร.ร.บ้านค้อกับบ้านสีน้อย	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	220	4400	Box 2 cell
25	ถ.บ้านกระดอ - บ้านคัน	307+050.000	บ้านจางร	7.0	บ้านคันค้อกับเทศบาล	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	708.3	14200	U-Turn 2 way + Box 2 cell
	สถานีบ้านคัน												
26	ถ.บ้านคัน - บ้านโคก	309+489.898	บ้านจางร	4.0	ร.ร.บ้านคันกับร.ร.บ้านสี	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	617.4	12400	Box 1 cell
27	ถ.บ้านค้อม่วง - บ้านสี	311+040.000	บ้านจางร	7.0	บ้านค้อม่วงกับบ้านคัน	2	ถนนสายบาง	เมือง	นครราชสีมา	มท.	908	18200	U-Turn 2 way
	ที่ศูนย์บริการบ้าน												
28	ถ.บ้านค้อ - บ้านสี	312+142.294	บ้านจางร	4.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	355	7100	Box 2 cell
29	ถ.หนองบัว - หนองไข้ว	315+376.835	บ้านจางร	8.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนสายบาง	เมือง	นครราชสีมา	มท.	1295	25900	Overpass + สะพานลอย
	สถานีชุมทาง												
30	ถ.หนองทราย - ไร่สี	316+429.898	บ้านจางร	3.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	12	300	Box 2 cell
31	ถ.บ้านค้อ - บ้านค้อน้อย	319+035.000	บ้านจางร	3.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	257	5200	U-Turn 2 way + Box 2 cell
	สถานีบ้านค้อใหญ่												
32	ถนนบ้านสีกับบ้านสี	321+128.831											Box 2 cell
33	ถ.บ้านค้อ - บ้านสี	324+918.831	บ้านจางร	4.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนคูวัง	เมือง	นครราชสีมา	อบต. บ้านคัน	677.6	13600	Box 2 cell
34	ถ.บ้านค้อ - บ้านสี	325+524.900	Overpass		เทศบาลบ้านสีกับบ้านสี	2	ถนนสายบาง	เมือง	นครราชสีมา	มท.	Overpass	Overpass	-
35	ถ.บ้านค้อ - บ้านสี	326+282.750	เคื่องกั้น	10.0	บ้านค้อกับบ้านสี	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	11413.6	228300	สะพานรถไฟ
	สถานีบ้านค้อ												
36	ถ.บ้านค้อ - บ้านสี	327+698.830	บ้านจางร	6.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	636.8	12800	Box 2 cell
37	ถ.บ้านค้อ - บ้านสี	329+600.000	บ้านจางร	4.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	578	11600	U-Turn 2 way + Box 2 cell
38	ถ.บ้านค้อ - บ้านสี	333+500.000	บ้านจางร	4.0	ร.ร.บ้านค้อกับบ้านสี	2	ถนนสายบาง	เมือง	นครราชสีมา	อบต. บ้านคัน	524.3	10500	Box 2 cell

Table 8-1 Railway Crossing with Road Condition and Solution

NO.	NAME	KM POST	EXISTING LEVEL CROSSING	WIDTH (M)	CONNECTION BETWEEN	NO. OF LANE	TYPE OF SURFACE	LOCATION		LEVEL CROSSING AGENCY	ADT VEH /DAY	TM CAR-TRAIN /DAY	TYPE OF LEVEL CROSSING
								AMPHU	CHANGWAT				
	สถานีบ้านมด	423+755											
77	ถ.บ้านโนนผารักษ์ - บ้านวังค้อ	426+080.000	บ้านจางร	7.0	วัดพุทธรังษิกับวัดศรีบุญ	2	ถนนลาดยาง	บ้านมด	ขอนแก่น	ทต.บ้านจางร	1088	21800	U-Turn 2 way + Box 2 cell
78	ถ.บ้านหนองเตา - นิตกราว	426+704.500	Underpass		วัดป่าเขาแป้นจระกวนกับหนองจำ	2	ถนนคอนกรีต	บ้านมด	ขอนแก่น	เทศบาล	Underpass	Underpass	-
79	ถ.โนนทัน - นิตกราว	429+167.666	ทางสี่แยก	6.0	วัดศรีจำอาขิกับรร.บ้านโนนทัน	2	ถนนลูกรัง	บ้านมด	ขอนแก่น	อบต.โนนสนวนรัตน์	24	500	Overpass
	พื้นที่อุตสาหกรรมใหม่	431+608											
80	ถ.บ้านหนองเป็ก - นิตกราว	433+000.000	บ้านจางร	7.0	วัดแสนชัยเตาประสิทธิ์กับวัดสว่างแสนสุข	2	ถนนลาดยาง	บ้านมด	ขอนแก่น	อบต.โนนสนวนรัตน์	1136.8	22800	U-Turn 2 way + Box 2 cell
81	ถ.บ้านหนองนาง - นิตกราว	435+237.162	เครื่องปั้น	7.0	วัดภูพิศฐานกับวัดสุทธาวารณสิทธิ์	2	ถนนลาดยาง	บ้านมด	ขอนแก่น	ทต.บ้านพระ	1757/6	35200	Overpass + Box 2 cell
82	ถ.บ้านหนองนาง - นิตกราว	436+648.930	บ้านจางร	6.0	ทางพระใหญ่บนกับวัดบ้านขุขอต	2	ถนนลาดยาง	บ้านมด	ขอนแก่น	ทต.บ้านพระ	668.4	13400	Box 2 cell
83	ถ.หนองบัวลำภูมี - พุมพญูคำ	438+437.600	บ้านจางร	6.0	หนองเม็กกับรร. หนองบัวลำภูมี	2	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.บ้านพระ	1429	28600	Box 2 cell
84	ถ.มหาสารคาม - นิตกราว	439+170.768	เครื่องปั้น	18.0	หนองเม็กกับวัดวิฑาธิยสารพชรข้างของนทัน	2	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.บ้าน	DOH Plan	DOH Plan	Overpass + Box 2 cell
85	ทางสี่แยก	439+820.000	บ้านจางร	7.0	วัดศรีมงคลกับหนองเม็กกับ	2	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.บ้านพระ	56	1120	Close
	สถานีบ้านพระ	439+550											ไฟฟ้เปิดที่ 64
86	ถ.ศูนย์มิตร - บ้านพระ	440+437.320	บ้านจางร	7.0	วัดศรีมงคลกับวัดบ้านโนนผารมณ	2	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.บ้านพระ	3164	63300	Box 2 cell
87	ถ.ภูเกว้ง - เมืองเก่า	443+957.233	เครื่องปั้น	10.0	รร.บ้านโนนแสนสามัคคีกับภูเกว้ง	4	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.เมืองเก่า	DOH Plan	DOH Plan	Overpass
88	ถ.เมืองเมืองขอนแก่น	445+430.000	Overpass			4	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.เมืองเก่า	Overpass	Overpass	-
	พื้นที่อุตสาหกรรม	444+080											
89	ถ.โนนคำดี	448+517.300	เครื่องปั้น	18.0	ถนนพลาสน์กับ2131	4	ถนนลาดยาง	เมือง	ขอนแก่น	เทศบาล	37114	742300	เกาะต้นรถไฟ
90	ถ.บ้านหนอง	449+132.800	เครื่องปั้น	12.0	ถนนสุรนัยกับบ้านนอก	4	ถนนลาดยาง	เมือง	ขอนแก่น	เทศบาล	26827	536600	เกาะต้นรถไฟ
	สถานีขอนแก่น	449+962.000											
91	ถ.ศรีจันทร์ (ทล. 209)	450+500.000	เครื่องปั้น	12.0	อ.เมืองกับ จ.กาฬสินธุ์	4	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.บ้าน			เกาะต้นรถไฟ
92	ถ.ประจักษ์มิตร (ทล. 12)	451+400.000	เครื่องปั้น	25.0	ทางหลวง ทล. 12 กับ จ.กาฬสินธุ์	4	ถนนลาดยาง	เมือง	ขอนแก่น	ทต.บ้าน			เกาะต้นรถไฟ
93	ถ.พหลโยธินการ	452+400.000	เครื่องปั้น	7.0	นิตกราวกับศูนย์ราชการ	4	ถนนลาดยาง	เมือง	ขอนแก่น	เทศบาล			เกาะต้นรถไฟ

9. Train Operation Design

9.1 Future Number of Trains

Estimates of number of trains in the future years are based on number of anticipated passengers and freight volume transported by rail. The estimates will be divided into passenger trains (social and commercial trains) and freight trains. The assumptions used in estimating the number of trains are as follows.

1. Passenger Trains

- 1.1 The trains will be divided into 2 types, i.e. social and commercial trains.
- 1.2 The maximum number of bogies per train during the considering year is determined at 6 bogies per train for social trains, and 20 bogies per train for commercial trains.
- 1.3 The maximum number of passengers per bogie is determined at about 40 for the first and the second class trains, and about 80 persons per bogie for social trains.
- 1.4 Average number of passengers per bogie and average number of bogies per train will be calculated at 80 per cent of the maximum.

2. Freight Trains

- 2.1 Maximum containers per trains are determined at 40 TEU/trains.
- 2.2 Maximum load per container is determined at 20 tons/TEU.
- 2.3 Average number of containers per railcar and average weight per container will be calculated at 80 percent of the maximum value.

According to the above assumptions, the number of trains in future years can be estimated as shown in Table 9.1-1.

Table 9.1-1 Number of Trains in Future Years Estimation for Chira Junction - Khon Kaen Section

Distance	Passengers					Commodity				
	2015	2020	2025	2030	2043	2015	2020	2025	2030	2043
Chira Road Junction – Khon Kaen	53	62	67	73	78	26	32	34	37	39

9.2 Train Diagram

1. Train Diagram Preparation

In analysis of the train diagram as presented in the report, the Consultant has used the train performance input, road conditions, such as slope and curvature of the route, to calculate the running time of the train between stations as accurate value close to the actual running. The Consultant discussed and exchanged the views and information in preparation of the train diagram with the SRT officials, who are directly responsible for the matter, and conclusions were reached as shown in Figure 9.2 - 1.

2. Summary of traveling time and average speed of the Train Diagram

According to the preparation of the Train Diagram 2034 as aforesaid, the speed of the train can be summarized as follows.

Table 9.2-2 Comparison of the Trip Duration

Schedule Time of The Section (Schedule Speed : km/h)			
Passenger Train			Freight Train (Ordinary)
Express	Rapid	Local	
1 h 22 min (134 km/h)	1 h 43 min (107 km/h)	3 h 4 min (60 km/h)	2 h 10 min (85 km/h)

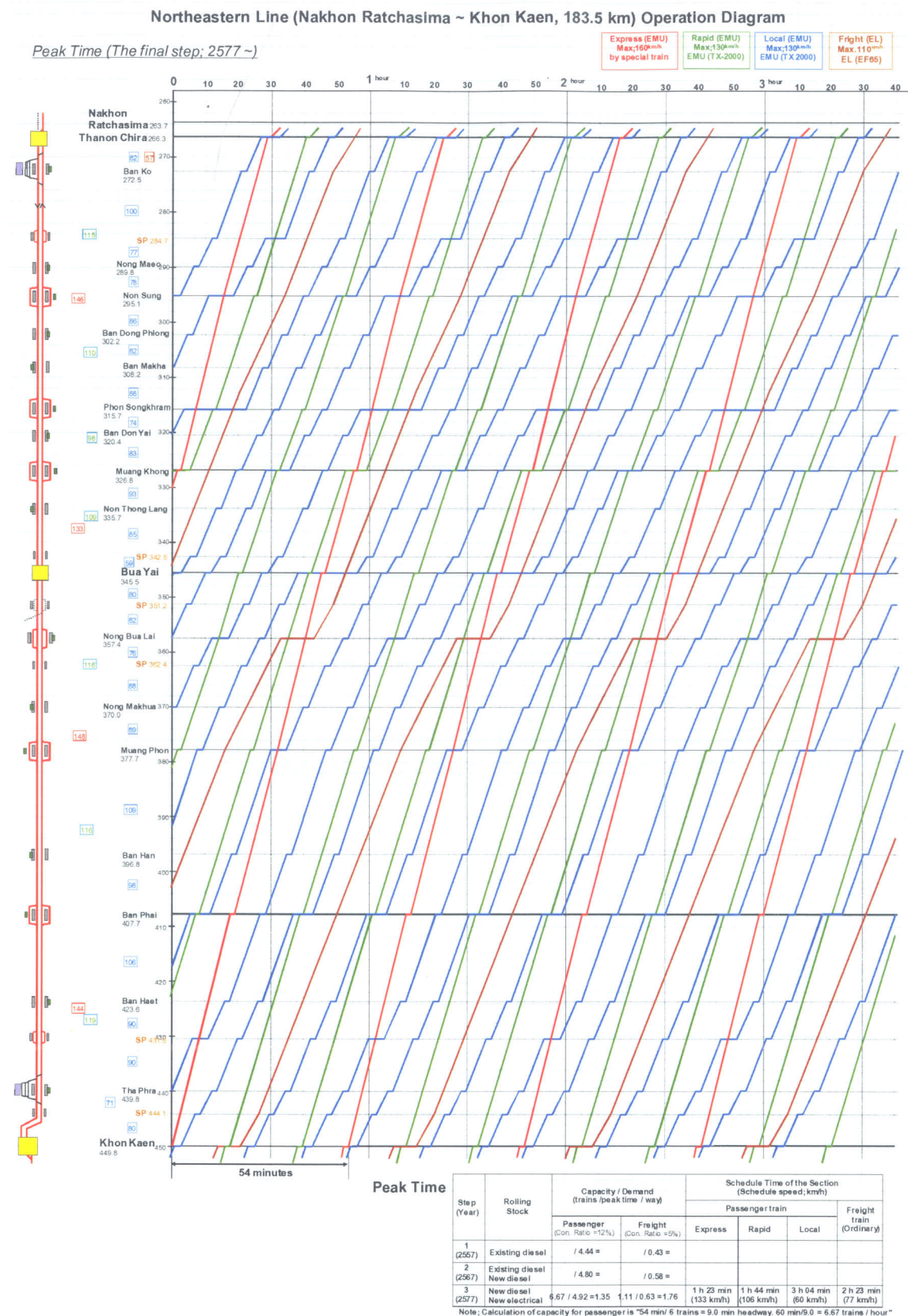


Figure 9.2-1 Train Diagram during Peak Period in 2034

10. Signalling and Telecommunication Design

10.1 Signalling System

The existing signalling is mechanical operated by means of mechanical interlocking using Semaphore Signal. It is planned to use Colorlight Signals with Computer Based Interlocking System. Currently 40 percent of SRT track nationwide uses color light signals. The project has been designed for a maximum speed of 160 Km /hrs. Two trains arriving from opposite directions can enter the station in the same time (Simultaneous Entry). This is done with the addition of 50 meters (or more) overlap track on the loop line for each direction (Please see Signalling Layout).

Signalling control can be from either locally at each station or remotely from CTC (Centralized Traffic Control) Center at Khon Kaen Station. The Typical Standard Signalling Layout is shown in Figure 10.1-1.

The length of track between signals is 1500 meter, which is equal to Service Braking Distance of SRT's Locomotives. The train will stop in front of the signal without overshoot the stop signal. This is assisted by the warning signal locating 1500 meter ahead of the stop signal.

The length of 1500 meter is considered to be suitable for the location of the beacons of ATP and the pattern of Automatic Braking Control of ATP (Automatic Train Protection)

For ATP (Automatic Train Protection) in the future, the layout with overlap of 150 meter has been planned. When ATP equipment on locomotive has been installed the ATP System on ground can be fulfilled.

To control trains between stations (Block Control) an axle Counter System shall be installed instead of Track circuit system. This eliminates the cost of cable and insulated rail joint between stations. This will save cost in maintenance. The Axle Counter System is now reliable to enhance Interoperability System.



Figure 10.1-2 The Picture show Color Light Signals and Control Workstation at Station

10.2 Telecommunication System

The Design will be as follows:

1. Optical Fiber network

SRT Optical Fiber Network can be used for one more year as Comlink. This is a concessionaire from TOT. This concessionaire with Comlink will be terminated at the end of the year. SRT extend the use of network from TOT until SRT has setup his own network.

An Optical fiber network will be installed between Chira Junction to Khon Kaen Section as the Trunk line transmission system between the Khon Kaen CTC Station, and the Khonkhan to Thanon Chira rail line. This will be the main trunk line for any data and voice communication on the project and support the main SRT Trunk Line.

2. Train Radio Trunk Line

The Train Radio Trunk Line will be the main digital network in future. The train control of the European Train Control System by the Global System Mobile Network for Railways (GSM-R) which has been widely used for Worldwide High Speed Train. It is highly accepted and competitively used among all European Signalling Contractors and enhanced Interoperability between rail lines in Europe.

Train Radio System uses a Digital Transmission System can be integrated with Existing Train Control Network. This will extend the efficient communication between Train Dispatcher and Train Driver.

The use of the GSM-R Network in this project is designed initially to provide Train Radio to communicate between rail operating, maintenance, and construction staff on ground and on board. In the future Train control can be used by the CBTC (Communication Based Train Control System) according to European Train Control System. In this project, Signal Post Telephone will be replaced by GSM-R Train Radio.

3 Automatic Ticket Reservation and other facilities :

The optical fiber network will be used by the Ticket Reservation and Public Address System will be installed at new station building. CCTV (Closed Circuit Television) and access control to CTC Khon Kaen Station will be furnished.

4 Future Equipment addition :

Future equipment to be added for GSM-R is as follows:

- 1 Shunting Train Radio System
- 2 Train Operation Control through Train Radio
- 3 WAN (Wide Area Network)
- 4 Dedicated Radio for particular area (Local Radio System)

The future Expansion of Train Radio System is out of scope for this project. It will be considered by SRT when ATP is added.

11. Construction Cost Estimates

The Consultant has estimated the construction cost of the project by adhering to the calculation rules of the referenced price of the Comptroller, Ministry of Finance, and to the SRT's regulations. The construction cost of the project was equal to 25,534.33 million Baht. Details of the construction cost are shown in Table 11-1.

Table 11-1 Construction Cost

item	Type of work	Total Cost (baht)
1	General Requirement	505,705,329
2	Railway	
	2.1 Trackworks	5,813,162,472
	2.2 Elevated Railway	1,490,298,283
	2.3 Railway Bridge	637,631,603
	2.4 Cut and Fill	2,039,882,861
	2.5 Drainage works	120,844,835
	2.6 Fencing	523,600,000
	2.7 Railway Relocation	35,000,000
3	Station and Stopping Place	2,963,759,426
4	Level Crossing	
	4.1 Overpass and U-Turn Bridge	5,758,690,951
	4.2 Box Culvert	1,104,420,376
5	Signalling & Telecom	3,572,633,477
6	Relocation work / Expropriate work	
	6.1 Station relocation work	921,669
	6.2 Railway Crossing Area Expropriate	46,215,011
	6.3 Dislocation Cost for Inhabitant in Right of way	560,986,663
7	CY	360,579,795
	รวม	25,534,332,751

12. Construction Plan

Chira Junction – Khon Kaen Section Railway Construction Project is approximately 187 km. in length including the key components as follows.

- Construction of the ground-level railway including the viaducts at the area of CHIRA Junction Station (Km.267 +300 – Km.447 +950) and at the area of Khon Kaen Station (Km.453 +350 – Km.454 +100) (the end of the project), with total distance of 181.60 km.
- Construction of an elevated railways between Tha Phra Station (Km.447 +950.000) – Khon Kaen Station (Km.453+350.000), with total distance of 5.40 km.
- Construction of 18 ground-level railway stations and 7 stopping place building facades
- Construction of an elevated train station. (Khon Kaen)
- Construction of Container Yards (CY) at 3 stations, i.e. Ban Kradon, Bua Yai Junction and Tha Phra. Of these, Ban Kra Doan Station is the CY that the Consultant has considered relocation as a result of the public hearing that need to use locality of Ban Ko Station as residential areas.
- Installation of signaling and telecommunications systems
- Civil construction work and others of the project, such as drainage systems, flyovers, fence works along the project
- Construction of overpasses or U-turn overpasses to solve the level rail-road crossing problem

In implementation of the above, the Consultant will divide the work to be done into 2 groups, that is, all tasks must be carried out by SRT, except construction of automobile overpasses and U-turn bridges as well as connected roads to those bridges. These tasks will be transferred to other related agencies, such as Department of Rural Roads, to operate. This will include expropriation in order to carry out such work too.

In construction of the said projects, both construction activities that must be conducted under the SRT's supervision and the automobile overpass construction to solve the railway crossing problem must be related. Therefore, by the time the trains start provision of service, they can be operated without any of such rail-road crossings.

The construction contracts are divided by the Consultant into 6 contracts consisting of:

- Contract 1 : Railway Work ((Km.267 +300 to Km.320 +600)
- Contract 2 : Railway Work (Km.320 +600 to Km.371 +000)
- Contract 3 : Railway Work (Km.371 +000 to Km.424 +500)
- Contract 4 : Railway Work (Km.424 +500 to Km.454 +100)
- Contract 5 : Installation of Signaling and Telecommunications Systems
- Contract 6 : Automobile Overpass Construction to solve the rail crossing problem

Anyhow, construction under each contract will be carried out simultaneously, with construction periods approximately 3 years. The Consultant proposed the construction plan of the project railway in Table 12-1.

Table 12-1 Project Construction Plan

Activity	Quarterly											
	1 st Year				2 nd Year				3 rd Year			
	1	2	3	4	1	2	3	4	1	2	3	4
Railway Construction Work												
1. Construction of Preparation	■	■	■									
2. Railway		■	■	■	■	■	■	■	■	■	■	■
3. Station		■	■	■	■	■	■	■	■	■	■	■
4. Container Yard		■	■	■	■	■	■	■	■	■	■	■
5. Drainage System, Fencing and Predestrian Bridge					■	■	■	■	■	■	■	■
6. Signalling and Telecommunication System					■	■	■	■	■	■	■	■

13. Economic and Financial Analysis

13.1 Economic Viability Analysis

The economic viability analysis encompasses the following steps.

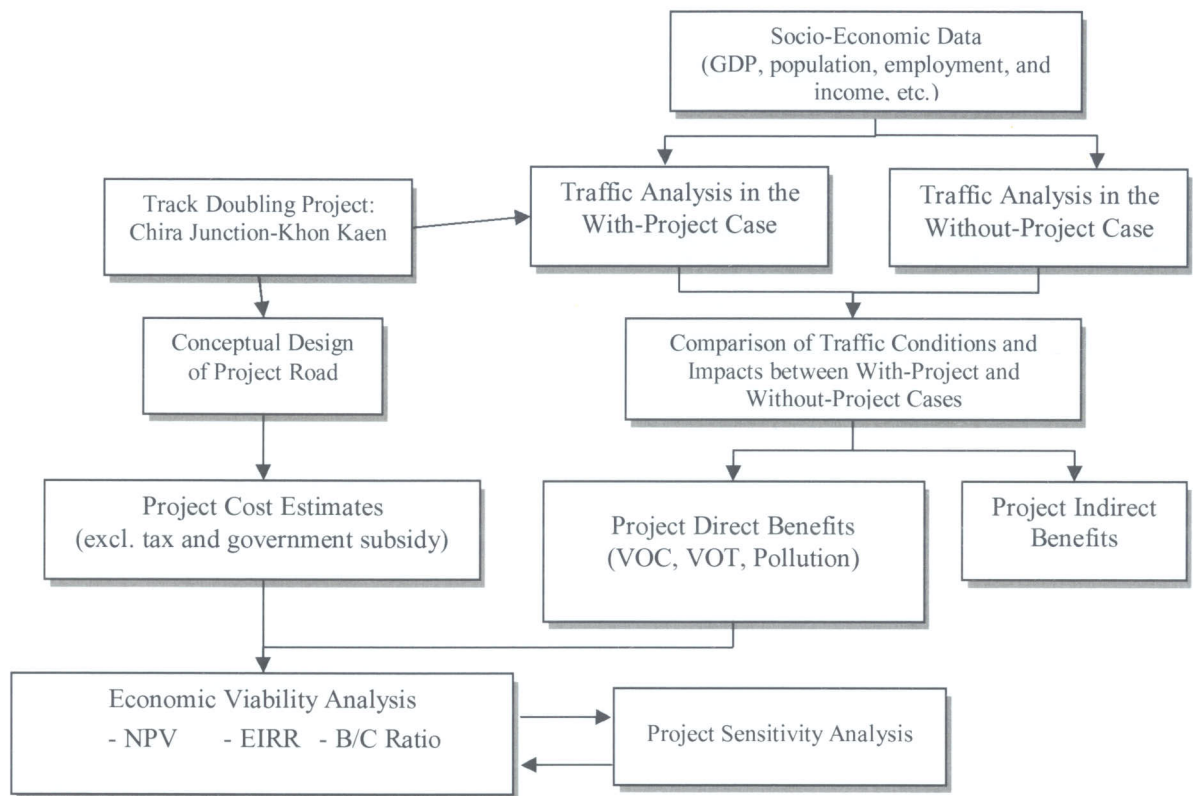


Figure 13-1 Economic Analysis Process

13.1.1 Criteria for Project Economic Analysis

The project economic analysis was performed based on the following criteria.

- Project period was assumed to be 30 years (excluding construction period);
- Opportunity cost of capital was 12% per annum. (This reference rate was taken from the study of capital cost in Thailand conducted by the World Bank and Office of the National Economic and Social Development Board (NESDB). It is presently adopted for economic analysis of public projects by many agencies, e.g. Royal Irrigation Department, Expressway Authority of Thailand, State Railway of Thailand, Office of Transport and Traffic Policy and Planning, etc.)
- Project costs were set at constant 2012 prices;
- The economic value is estimated by subtracting the financial price to adjust price distortion as the market prices are distorted due to various causes, e.g. imperfectly competitive market, market intervention by government, external impacts on production, and others. Financial values do not reflect the willingness to pay and the opportunity cost of the society. Therefore, the

financial values were converted to economic values, using conversion factors adopted from the World Bank's study;

13.1.2 Project Cost Evaluation

The project financial cost was converted to economic value, using conversion factors adopted from the World Bank's study of Thailand case as follows:

- Detailed design cost 0.92
- Building compensation cost 0.92
- Land compensation cost 1.00
- Construction cost 0.88
- Construction supervision cost 0.92

Table 13-1 Summary of Economic Values of Project Investment and Implementation Costs

Unit: million Baht

Description	Economic Value
Demolition and Relocation Costs	618.10
Infrastructure and Railways Track Costs including Signaling and Telecom System	19,869.41
Construction Supervision costs	1,123.51
Total investment Costs	21,611.02
Operation & Maintenance Costs (throughout the Project Life)	30,668.23
Grand Total	49,804.96

Source: The Consultant, 2012

13.1.3 Project Benefit Analysis

The project benefits are classified into direct and indirect benefits, with details provided as follows:

13.1.3.1 Direct Project Benefits

The implementation of Track Doubling Project: Chira Junction-Khon Kaen Section will significantly raise the line capacity, leading to substantial reduction in travel time. The improved rail service will be capable of supporting commodity and passenger transportation in the future. This will have positive impacts on the overall economy and every level of society as the transport costs will become lower. There are three direct benefits in the form of savings of road and train users' as travel time Saving (VOT Saving), Operating Cost Saving (VOC Saving) and Environment Cost Saving.

1) Travel Time Savings of Road and Train Users (VOT Saving)

Value of time (VOT) is the value (equivalent to money) that road users spend on their trips. If the time lost during a trip can be used to conduct other activities, it will create added value to the economy.

2) Vehicle Operating Cost Saving (VOC Saving)

Vehicle Operating Cost (VOC) is an important economic benefit of transport network improvement. The VOC was analyzed and adjusted to reflect the current conditions in terms of topography, traffic, and ratio of vehicular use in the project influence areas, using

the internationally recognized VOC module of Highway Development & Management Model (HDM-4).

3) Environmental Cost Savings

The environmental cost savings were computed by multiplying the benefit of reduced pollution by the difference in the total distance traveled by car and by road in the without-project case and the with-project case. The environmental cost savings are based on “Final Report: Master Plan for Railway System and High Speed Train Development,” (2010) and MRT Assessment Standardization (Public Debt Management Office and Red Line Project of the State Railway of Thailand) where the environmental cost savings are determined at 5 Baht/vehicle/km.

The project implementation will bring about the aforementioned three benefits to the whole society, resulting in faster road travel and travel time saving. Furthermore, the rail service will be able to meet the travel demand of regular rail users and those passengers who switch their mode of travel from car to rail system. The project benefits are presented as Table 13.1-2:

Table 13.1-2 Project Economic Benefits

Unit: million Baht/year

Year	Road User Baht/year		Passenger Baht/year		Commodity Baht/year		Pollution	Total
	VOC	VOT	VOC	VOT	VOC	VOT		
2015	1,453	324	1,264	91	345	342	1,345	5,164
2017	1,676	374	1,459	105	395	392	1,552	5,953
2020	1,974	441	1,719	123	462	458	1,827	7,004
2025	2,216	495	1,930	139	519	514	2,018	7,831
2035	3,112	695	2,709	195	714	707	2,414	10,546

Source: The Consultant, 2012

13.1.3.2 Indirect Project Benefit

Implementation of mega projects will have positive impacts on the overall economic system. Travel convenience will induce land development along the project alignment and around the stations, thus opening new land areas that are yet to be fully developed. This will attract private investment in several sectors and create greater land demand along the project route. As a result, the land price is expected to rise, leading to better land use efficiency. Moreover, economic activities will expand along the route and create more employment opportunities and income distribution to the household sector.

Construction costs mainly cover procurement of local goods and services for the project construction. When sellers and service providers receive payment, they will buy goods and services from suppliers who will in turn invest in raw material purchase or expansion of production in response to the said demand. This will have multiplier effects on the manufacturing and employment in various sectors. The money flows in the economy will result in systematic economic stimulation or “**Economic Multiplier Effect**” which will be a catalyst for the country’s economic growth that is greater than the project investment cost. The calculation was based on the Input-Output Table and the results show that the project’s economic multiplier effects are equivalent to 2.45 times of the total investment (excluding labour wages) or 47,870 million Baht. The multiplier effects are classified into

income distribution of 14,701 million Baht for the whole economy and an employment increase of 6,141 million Baht which are equally distributed over 30 years throughout the project life, as presented in Table 13.1-3.

Table 13.1-3 Economic Multiplier Effects of the Project

Description	Investment Expenditure ¹	Multiplier Matrix ²			Output Effect	Wages & Salaries Effect	Income Effect ³
		Output Multiplier	Wages & Salaries Multiplier	Income Multiplier			
1.Mining	7,899	1.74	0.29	0.71	13,770.52	2,269.73	5,638.55
2.Petroleum	1,061	2.48	0.25	0.64	2,630.97	269.10	674.12
3.Non metal	2,123	2.46	0.30	0.77	5,225.50	630.03	1,631.32
4.Basic metal	3,440	3.21	0.32	0.78	11,030.61	1,112.32	2,700.19
5.Fabricated metal	896	3.13	0.32	0.82	2,801.40	284.14	731.42
6.Machinery	3,005	3.46	0.29	0.79	10,392.40	878.36	2,360.78
7.Service	1,124	1.80	0.62	0.86	2,018.80	697.50	964.67
รวม	19,548				47,870.20	6,141.19	14,701.04
				Multiplier	2.45		

Source: The Consultant, 2012

13.1.4 Economic Viability Analysis Results

The economic viability analysis was performed for the 30-year project life.

Base Case		
EIRR (%)	=	24.55
NPV (million Baht)	=	25,425.51
B/C Ratio	=	2.18

Source: The Consultant, 2012

It is concluded that the project investment will create economic benefits for the society as a whole as the economic indicators are higher than the project investment costs.

13.1.5 Project Sensitivity Analysis

The sensitivity analysis was carried out for 9 scenarios as follows

- (1) Investment costs are unchanged, with a decrease in project benefits by 20%
- (2) Increase in investment costs by 20% and project benefits are unchanged
- (3) Increase in investment costs by 20% and decrease in benefits by 20%
- (4) Investment costs including costs of railways crossings
- (5) With Economic Multiplier Effects
- (6) A two-year delay in construction of Map Kabao–Chira Junction Section
- (7) With high speed train service
- (8) With the current fuel price
- (9) Base case including locomotive cost.

Table 13.1-4 Results of Project Economic Sensitivity Analysis

Case 1: 20% Decrease in Project Benefits	Case 2: 20% Increase in Investment Costs	Case 3: 20% Decrease in Benefits and 20% Increase in Investment Costs
EIRR (%) = 20.38	21.10	17.36
NPV (million Baht) = 16,053.86	21,105.82	11,734.18
B/C Ratio = 1.74	1.81	1.45
Case 4: Investment Costs including Costs of Railways Crossings	Case 5: Economic Multiplier Effects	Case 6: 2-year Delay in Construction of Map Kabao–Chira Junction Section
EIRR (%) = 19.56	29.40	23.69
NPV (million Baht) = 19,492.35	35,672.19	24,380.32
B/C Ratio = 1.71	2.65	2.14
Case 7: With High Speed Train Service	Case 8: With the Current Fuel Price	Case 9: With Additional Locomotive Cost
EIRR (%) = 21.16	29.73	24.38
NPV (million Baht) = 18,135.76	37,458.16	25,029.73
B/C Ratio = 1.88	2.61	2.14

Source: The Consultant, 2012

The sensitivity analysis results indicate that the project is economically feasibility even if unmanageable external impacts or factors bring about an increase or reduction in costs and benefits, resulting in higher EIRR, NPV and B/C Ratio than the specified criteria. In the worst case (20% decrease in benefits and 20% increase in investment costs), the economic indicators are still greater than the criteria. In the case with additional locomotive cost where the economic indicators are lower than the base case, the derived EIRR of 24.38% is relatively comparable to the base case. This evidently shows that the benefits can compensate for the investment costs and the project implementation will create both project and social benefits.

13.2 Financial Viability Analysis

Assumptions for financial analysis of this project were adjusted mainly based on those used in the Feasibility Study and Preliminary Design for Double Track System for Transportation and Logistics Management (Phase 1). Other documents were also considered, e.g. framework for negotiations on foreign loans under the Public Debt Management Plan for the budget in 2010 (Public Debt Management Office), and other economic analyses, to be consistent with the current economic conditions and sufficient for this study.

The Consultants carried out the project's financial projection, comprising estimation of project capital cost, additional O&M costs and incremental revenue in the without-project case according to the previously-mentioned assumptions. Then, the financial indicators, e.g. financial internal rate of return (FIRR), and net present value (NPV), were analyzed to consider the financial viability of the project.

1) Capital Costs

The capital costs were divided into two groups: railway construction and signaling system. The capital cost of railway construction covers land acquisition; civil works; railway structure and stations; and track works as shown in Table 13.2-1.

Table 13.2-1 Project Capital Costs

Item	Description	Total Price (Baht)
1	General requirement	505,705,329
2	Track works	10,660,420,054
3	Stations	2,963,759,426
4	Crossings	6,863,111,327
5	Signaling & telecommunication	3,572,633,477
6	Relocation/land acquisition	608,123,342
7	CY	360,579,795
	Total	25,534,332,751
	Consultation fee (4%)	1,021,373,310
	Total	26,555,706,061
	Contingencies (10%)	2,655,570,606
	Grand Total	29,211,276,667

2) O &M Costs

There are two main groups of O&M costs: maintenance of infrastructure and signaling system; and train operation for passenger and Commodity transportation. The infrastructure and signaling system maintenance cost was estimated on the basis of design results, and the operating cost.

In this project, the rolling stocks previously procured by SRT will be used. Therefore, there is no rolling stock cost. However, the O&M costs were also forecast by taking into account the cost of procuring rolling stocks computed in the form of train-km for a service life of 30 years. The estimated cost for passenger train is 25.11 Baht/train-km and for Commodity train is 23.21 Baht/train-km.

Table 13.2-2 Forecast of Passenger & Commodity Volumes and Operating Cost

Passenger & Commodity Trains		2015	2020	2025	2030	2035
Passenger	train-km/day	3,183	4,930	5,593	6,279	6,485
	passenger-km/day	1,998,981	2,773,652	3,302,420	3,969,521	4,241,420
Commodity	train-km/day	2,328	2,774	2,853	3,107	3,252
	ton-km/day	1,192,234	1,420,670	1,460,838	1,591,250	1,665,035
Operating Cost (MB)		481.79	700.72	863.11	1,087.55	1,303.08
Rolling Stocks (MB)		48.89	68.68	75.43	83.87	86.99

3) Estimated Revenue

To estimate the revenue, analysis was made on SRT's revenue in the past, including fare and fee rates as follows.

(1) Passenger Fare Rate

The SRT's fare rates were adjusted to obtain the average rates for estimation of passenger fare revenue.

Table 13.2-3 Average Fare Rates

	Fare Rate (Baht/km.)
(2) Fee Rate 1 st Class	0.86
2 nd Class	0.42
(2) Passenger Fee 3 rd Class	0.18

According to SRT's revenue in 2005, the fee revenue amounted to 1,779.32 million Baht from the total passenger fare of 3,872.75 million Baht, accounting for 45.94%. The fee revenue of about 1,700 million Baht was nearly equal to the passenger fare revenue. Therefore, the fee income is important for analysis and estimation of the total project revenue. The ratio between the fee revenue to the fare revenue used in this study remains close to SRT's ratio.

(3) Commodity Rate

After discussion with SRT, the actual freight rates are lower than the announced ones due to competition with road transportation. During 2008-2009, SRT's average revenue of container transportation nationwide was 0.519 Baht/ton-km. The revenues of container transportation were 0.593 Baht/ton-km in the East, 0.347 Baht/ton-km for the land bridge, and 0.500 Baht/ton-km for others. The Consultants employed the Commodity rate of 0.59 Baht/ton-km in this study.

The estimated volumes of passengers and Commodity together with the assumptions are presented in the following table.

Table 13.2-4 Forecast of Passenger & Commodity Project Development

Passenger & Commodity Trains		2015	2020	2025	2030	2035
Passenger	train-km/day	3,183	4,930	5,593	6,279	6,485
	passenger-km/day	1,998,981	2,773,652	3,302,420	3,969,521	4,241,420
Commodity	train-km/day	2,328	2,774	2,853	3,107	3,252
	ton-km/day	1,192,234	1,420,670	1,460,838	1,591,250	1,665,035
Revenue (MB)		689.47	1,108.24	1,472.47	2,019.18	2,575.85

Apart from the revenue from transportation services, the rental of commercial areas at train stations was also considered. Preliminarily, the estimated rental income will amount to 2.16 million Baht in 2015 based on the designed areas.

4) Analysis Results

Based on the estimation of capital costs, revenue and O&M expenses, the Consultants prepared the financial statements and conducted the financial return analysis in the form of FIRR and NPV. For the base case, the capital costs include civil works,

track works, signaling system, and stations with exclusion of rolling stocks. It was compared to the case with inclusion of rolling stock provision as shown in Table 13.2-5

Table 13.2-5 Project Financial Returns

Project Financial Returns	Base Case	In Case of Provision of Rolling Stocks
Financial Internal Rate of Return (FIRR)	5.90%	5.65%
Net Present Value (NPV) at the 5% Discount Rate	5,571 MB	3,963 MB
B/C Ratio	1.04	1.01

In case of provision of rolling stocks, FIRR is 5.65%, and the Free Cash Flow to the Firm (FCFF) at the 5% discount rate equal to 3,963 million Baht. When comparing FIRR with the Financial Costs, the financial returns are higher than the weighted average cost of capital (WACC) which is 4.32%. The Free Cash flow to Equity (FCFE) is equivalent to 7.41% and NPV to 7,443 million Baht. Therefore, the project is viable for investment.

However, in case of without government's subsidies, SRT has to seek additional sources of funds for the project operation and repayment of loan interest for 11 years from the project start, totaling 2,723 million Baht. This is because the revenue during this period will not be sufficient for repaying the interest. Moreover, 2044 (the 30th year of operation period) is the year in which SRT has to repay the principal of the long-term loan mobilized through the government bonds but SRT will not have enough cash to make a full repayment. Therefore, in 2044, SRT will need additional fund of 4,500 million Baht to support the project operation.

5) Financial Sensitivity Analysis

The financial sensitivity analysis was conducted in cases of changes in revenue and O&M costs. Other possible cases were also analyzed, for example, delay of Map Kabao–Chira Junction section for 2 years; implementation of high-speed train; and increase in oil price to 35 Baht/liter. Comparison of different cases is presented in Table 13.2-6.

Table 13.2-6 Financial Sensitivity Analysis Results Based on Project Operation

Sensitivity		O&M Costs		
FIRR		90%	100%	110%
Revenue	70%	2.99%	2.07%	0.98%
	80%	4.29%	3.67%	2.97%
	90%	5.25%	4.78%	4.26%
	100%	6.04%	<u>5.65%</u>	5.22%
	110%	6.73%	6.37%	6.01%
NPV (MB)		90%	100%	110%
Revenue	70%	-8,870	-11,550	-14,017
	80%	-3,697	-6,407	-9,054
	90%	1,455	-1,217	-3,886
	100%	6,619	<u>3,963</u>	1,295
	110%	11,730	9,058	6,435

According to the financial sensitivity analysis results, in case of increase in O&M costs by 10%, FIRR will be lower by 0.43% or NPV by 2,668 million Baht. The decrease in revenue will have more effect. In case of decline in revenue by 10%, FIRR will be lower by 0.87% or NPV by 5,180 million Baht. Therefore, it is essential to closely monitor the operational performance which will cause changes in revenue.

Table 13.2-7 Financial Sensitivity Analysis Results based on External Factors

Cases	FIRR	NPV at 5% Discount Rate	B/C Ratio
Base case	5.90%	5,571	1.04
Delay of Map Ka bao–Chira Junction Section for 2 Years	5.83%	5,109	1.03
Implementation of High-speed Train	5.11%	610	0.93
Increase in Oil Price to 35 Baht/liter	7.06%	14,236	1.18

14. Environmental Impact Assessment

The environmental impact assessment (EIA) of this project was performed in compliance with the guidelines for EIA of mass transit rail system established by the Office of Natural Resources and Environmental Policy and Planning. It covers 20 environmental parameters in four tiers: physical resources, biological resources, human use value, and quality of life value, as follows.

(1) **Physical Resources**, i.e. topography, soil resources and erosion, geology and earthquake, surface water hydrology, surface water quality, air quality and meteorology, noise, and vibration

(2) **Biological Resources**, i.e. aquatic ecology and terrestrial ecology

(3) **Human Use Value**, i.e. land use, transportation, flood control and drainage, public utilities and facilities

(4) **Quality of Life Value**, i.e. community severance, relocation and expropriation, sanitation, history & archaeology, and aesthetics & landscape

(5) **Social Impact Assessment**

(6) **Health Impact Assessment**

Survey of the existing environmental conditions was carried out via site investigation and collection of secondary data including the aforementioned environmental parameters to evaluate the probable impacts from the implementation of the Track Doubling Project for Transportation and Logistics Management (Section : Chira Junction–Khon Kaen). The project details and the existing environmental conditions were considered as the fundamental data for assessment of each environmental impact.

Major Environmental Issues

There are three major environmental issues as follows.

1. People Living within SRT Right-of-Way

A lot of people are found living and encroaching upon the 80-m wide SRT's right-of-way, particularly the Khon Kaen municipality area. According to the site survey, out of the total 3,417 households in the SRT right-of-way, there are 1,653 households built along the 20-m distance from the center line of the right-of-way. Meetings with people living within the right-of-way were held to explain them about the project details and to establish the suitable mitigation measures. These affected people wished to rent the land from the SRT and requested the railway design should not affect the 20-m area next to the edges within the right-of-way. The Consultants coordinated and had the meeting with the Community Organizations Development Institute in Khon Kaen province. The meeting resolved that this would be a good opportunity to organize communities within the SRT right-of-way.

2. Solutions to Crossing Problem and Land Expropriation

Upon completion of the track doubling project, fences will be installed along both sides of the railway without level crossings. According to the survey, there are totally 84 level crossings along the project railway alignment. Four solutions were considered: overpass, U-turn bridge, box culvert underpass, and elevated railway. These solutions were proposed to all communities along the project railway to select the most suitable one.

3. Flood Control and Drainage

During the rainy season, water levels are higher than the track height in many areas, e.g. Ban Ko, Sra Thammakhan, Ban Bua Yai, Noen Sawat, Ban Phai, and Ban Haet stations. Structures, bridges, and box culverts for water drainage were designed based on the rain intensity at the return period of 100 years. The box culverts and bridges must be placed corresponding to the existing channels to mitigate the flood impact.

15. Public Participation and Public Relation

Public participation opportunities for people to participate and to comment on the project. And operated in accordance with the Constitution Act 2550 and the regulations of the Prime Minister on the 2548 public hearings.

Table 15.1-1 Summary of opinion and suggestion for the MRT Pink Line (Khae Rai – Min Buri) Project

Table 15.1-1 Summary of Opinions from People Living Along the Chosen Route

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
Chosen Route and Development Format for the Project	Local people want to know when the detailed design will be concluded.	Conclusion is made in March, 2012.
	Local people wonder if Thailand's rail-based transportation system is compatible with that of other ASEAN nations.	ASEAN nations and Greater Submekong Region countries have agreed to connect their train routes right from Malaysia to China's Kunming. In Malaysia, the double-track railway is in place with its tracks at 1.0-meter width. In Cambodia, railway will be developed till Poi Pet with one-meter-wide tracks too. Right from Singapore to Kunming, train tracks come with 1.0 meter width. As for the 1.435-meter-wide tracks, they are designed for speed train. This Project, therefore, is not redundant.
	Local people suggest that new train network should expand to cover the central and upper zones of the Northeast.	Presently, the State Railway of Thailand has been considering projects to link the central and upper zones of the Northeast with train route running from Khon Kaen, to Maha Sarakham,

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		to Roi Et, to Mukdahan, and to Nakhon Phanom.
	Local people suggest that the container yard from Ban Ko Train Station should be relocated to Ban Kradon Train Station, not the Ban Sa Thammakhan Train Station. They believe the Ban Kradon Train Station will be a better location because it will serve the transportation of both cargoes and passengers. According to them, the Ban Sa Thammakhan Train Station will serve just the cargo transportation.	The Consulting Firm has chosen the location of container yard based on its access to main roads and possible impacts on local communities. After taking these factors into account, the Consulting Firm has found that the Ban Sa Thammakhan Train Station is a more appropriate choice. The location of this station is nearer to the main road, which is Highway 2 in this case. Also, it has space vast enough to ensure that a container yard here will not affect local communities. The area, after all, is not densely populated.
	Local people ask whether Nern Tua Paeb bus-stop will be removed.	Nern Tua Paeb bus-stop will remain in service. Buses will stop at this spot for passengers to get in and get off just like before.
	Local people ask how wide the new train tracks will be.	The new train tracks will be 1.0 meter wide. If improved and equipped with electric system, the train will be able to run at the maximum speed of 160 kilometers an hour on these new tracks.
	Local people wonder which types of vehicles will be able to use a box culvert that comes in the size of 2.5 x 3.5 meters.	Small vehicles, vans, and motorized farm carts will be able to use such box culvert.
	Local people ask about remedial actions for land expropriation.	There will be three remedial actions. 1. Offering new land plots to affected

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		people 2. Compensation for buildings and structures on expropriated land plots 3. Compensation for crops and other lost opportunities. For example, if people's trade activities have to end due to land expropriation, there will be compensation for the loss of livelihood too.
	Local people ask about the differences between a pedestrian bridge and a box culvert.	The walking distance required by a pedestrian bridge will be three times longer than what is required by a box culvert. This is because to construct a pedestrian bridge across the railway, it must be at least six meters above the ground.
	Local people want U-turn bridges in both the northern and southern parts of Kong district.	An assessment shows expected traffic volume will not require such U-turn bridges. The Consulting Firm proposes that development efforts go step by step and in line with real needs.
	Local people ask whether rice-harvesting trucks will be able to cross the train tracks.	The trucks will be able to cross the train tracks via a U-turn bridge in Non Sung district.
	Local people ask whether land expropriation will take place to pave way for U-turn bridge construction.	For U-turn bridges, no land expropriation will take place because land plots required by the construction belong to the State Railway of Thailand.
	Local people want to know why the double-track railway will head eastward.	The double-track railway is planned in that direction because all three container yards are located in the eastern zone.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	Local people ask about space usage in train- station areas and whether the Project will affect the stations' current tenants.	Although the train stations will get new design and floor plan, the design guideline is to minimize impacts on for-rent commercial space.
	Local people suggest that frontage roads be built along the railway from Ban Kradon Train Station to Ban Ko Train Station so as to ease heavy road traffic in urban zones and to complement train network.	The Consulting Firm has agreed to present this suggestion to the Project's Committee. So far, the Consulting Firm does not think that this suggestion can be followed because the Project's main objectives are about designing double-track railway and solving problems relating to railroad crossings.
	Local people ask as to which side the added track will lay.	The added track will be east of the current track.
	Local people suggest that a container yard be created in Non Sung district to accommodate cargoes from Tambon Kham Sakae Saeng, Tambon Non Thai, and Tambon Phra Thong Kham.	The Consulting Firm will look further into this suggestion to determine whether it should be followed.
	Local people ask whether fences along the railway will block roads that are located within the zone of the railway.	Fences will go up next to the roads to ensure that people can still use the roads.
	- Local people suggest that facilities such as parking space be planned and provided in a way that they will be adequate even when demands rise in the future.	Future demands have already been taken into account when planning the facilities such as parking space. They will be adequate not just now but also in the future.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	Local people ask whether box culverts will be vulnerable to floods.	The box culverts will be located at a level just a little lower than current road surface. This is because the railway will be raised and the road level around the crossings or the box culverts will get just a little lower than the current road-surface level. Drainage system will also be in place to ensure that culverts are not flooded and stay usable all year long.
	Train tracks between the Ban Ko Train Station and Ban Sa Thammakhan Train Station are usually flooded. Local people ask for solutions.	The new design will put the train tracks at the level higher than floodwater level that has been seen in the past.
	Tambon Dan Kla Municipality has underground tap-water pipes under the railway. Local people ask if the Project will affect the tap-water services.	The Consulting Firm asks that Tambon Dan Kla Municipality submit the plan of underground tap-water pipes to it so that the Project can be designed in a way that will not disrupt the tap-water services during the construction for the Project. Constructors will be instructed to be extra careful about the underground tap-water pipes.
	Current train tracks have blocked water flow causing flooding in many areas during the wet season. People, therefore, ask that the Project increase water-flow channels under its planned double-track railway in Tambon Dan Kla Municipality's area.	The Project has already prepared effective flood-prevention system based on the average rainfall in the past 100 years.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	Local people ask why the Ban Phai Train Station will be developed as a middle-sized station.	The Project has set the size of the station based on its expected number of passengers in the future. However, if the actual number of passengers exceeds the estimated figure later on, the State Railway of Thailand can redevelop the Ban Phai Train Station as a big station.
	Local people ask about water-drainage system at the Bua Lai Train Station, pointing out that recent track rehabilitation has taken away the scuppers and as a result caused flooding.	Affected people can lodge complaints at a local office that has supervised the works at the time of construction. They may also directly file a complaint with the governor of the State Railway of Thailand.
	Local people recommend providing a box culvert with extra height in Bua Lai district to ensure it can accommodate large vehicles too. They believe such culvert is more appropriate than an overpass.	The Consulting Firm has agreed to take this suggestion into consideration and determined whether it is practical. Local landscape and surroundings must be taken into account in choosing a solution for the crossing.
	Local people say the box culvert in Bua Lai district may be prone to flooding. They, therefore, recommend elevating the train tracks instead.	If the Consulting Firm proposes a box culvert, a proper design will be worked out to ensure the culvert has efficient water-drainage system and can be used throughout the year.
	People express concerns about the safety on two-way, U-turn bridges.	The Project has designed the bridges based on safety standards. Traffic models have been developed and assessed. Assessments have showed even trucks can run past each other in

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		two different traffic directions on the U-turn bridges without any problems.
	▪ Fences erected by the Project may divide local communities. Local people want to know whether the project has measures that will reduce such impacts.	▪ The Project will provide culverts to link local communities. For example, there will be two-cell box culverts in the size of 2.5 x 3.5 meters for automobiles. Also, there will be one-cell 2 x 2 meter box culverts for people and herded animals.
	▪ Local people ask about the exact location of the elevated track portion in Mueang Khon Kaen district. They want to know its starting point and ending point.	▪ The train tracks will start to rise in level at railway kilometer marker 447+500 and lower to ground level at railway kilometer marker 454+050.
	▪ Local people suggest that the Project elevate train tracks at crossings with roads in Ban Phai district.	▪ The Project has planned to provide automatic barrier gates for the railway's crossings with two roads (Chaeng Sanit and Montri roads) in Ban Phai district. As for the crossings with other roads, two-cell box culverts will be provided in accordance with the presentation at the 2nd focus-group session. If the elevated track portions are used to solve problems at the railroad crossings under the Project, other train-development projects may be affected and further development efforts may be deprived of flexibility. However, if elevation option is to be chosen, the train tracks will be elevated by just half of the level needed and the road level will have to

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		be reduced to compensate for the difference.
	Local people suggest that the oil depot be relocated from the Khon Kaen Train Station to Samran Train Station for safety reason. The Khon Kaen Station is now located in the heart of Khon Kaen town.	The Consulting Firm has agreed to present this suggestion to the Project's Committee.
Improvement at Railroad Crossings	Crossing with Ban Hua Thanon – Payap Tis Road at railway kilometer marker 268+944	- The Consulting Firm proposes a U-turn bridge for road traffic here because the area around the crossing is densely populated. This solution is appropriate and recommended because the bridge construction will not require the expropriation of communities' land plots. - The meetings wanted a 2-cell box culvert be installed for small vehicles with the maximum height of 2.5 meters at this crossing too. However, Consulting Firm already explained to the meetings that further review was needed because there were gutters along the railway. - During the design process, it is clear that the box culvert is not possible at this crossing because it is too close to a public canal. The Consulting Firm, therefore, proposes building a pedestrian bridge instead.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	▪ Crossing at kilometer marker 269+880	▪ The Consulting Firm's proposal that this crossing be closed to road traffic has not met with any opposition.
	▪ Crossing with the road leading to Bu Village at railway kilometer marker 276+642	▪ The Project organized two meetings to gather opinions on how to solve problems at this crossing (one on Feb 3 in Tambon Jor Hor Municipality and the other on Mar 1 in Tambon Talad Administrative Organization). From the meetings, it is concluded that a U-turn bridge should be built at this crossing and also a two-cell box culvert should be provided to accommodate the traffic of small vehicles with maximum height of 2.5 meter. ▪ At the meetings, it is agreed that a U-turn bridge, not an overpass, should be built because it will not require the expropriation of land plots along the road. People say the overpass is not necessary because local communities are accessible via many routes. Large vehicles can use one of these routes without the need to rely on the overpass.
	▪ Crossing with (Mitrapap – Ban Kao Road at railway kilometer marker 279+260 and crossing with (Old Mitrapap – Ban Kradon Road at railway kilometer marker 279+780)	▪ At the meetings, it was agreed that the crossing at railway kilometer marker 279+260 would be closed to road traffic but a new road would be constructed to channel road traffic to a U-turn Bridge that would be

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		constructed at the next crossing or the crossing at the railway kilometer marker 279+780. Moreover, a two-cell box culvert would also be provided in the area. During the design process, the Consulting Firm has found that a U-turn bridge will be redundant because a culvert will be sufficient. Therefore, only a culvert will be installed to accommodate small vehicles with the maximum height of 2.5 meters. As for large vehicles, they are recommended to use the bridge at Mitrapap Road instead.
	Crossing (at railway kilometer marker 280+857)	- The meetings agree with the Consulting Firm's proposal that a two-cell box culvert (up to 2.5 meters in height) be used to solve problems at this crossing. - The meetings, however, also ask for a one-cell box culvert in the size 2 x 2 meters for pedestrians and herded animals. It was proposed at the meetings that this small convert should be located at a spot north of Ban Kradon Train Station.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	▪ Crossing with (Mitrapap – Ban Kao Road at railway kilometer marker 279+260) and crossing with (Mitrapap – Ban Kradon Road at railway kilometer marker 279+780)	▪ There is no objection to the plan to construct a U-turn bridge for these two crossings. However, it is suggested that a community-link box culvert should be provided for motorized farm trucks too because these vehicles will have difficulty moving up the U-turn bridge. ▪ The U-turn bridge will be constructed in an area north of the crossings and a new road will be built to directly channel road traffic from the crossings to the bridge. Also, a box culvert in the size of 2.5 x 3.5 meters will be provided for small vehicles at a spot between the two crossings.
	▪ Crossing with Ban Dan – Mitrapap Road at railway kilometer marker 287 + 054	▪ The Consulting Firm proposes a two-cell box culvert (up to 2.5 meters in height) to accommodate the traffic of small vehicles at this crossing. For large vehicles, they are advised to use a nearby overpass. ▪ The meetings agree with Consulting Firm's proposal. However, it is suggested that a one-cell box culvert in the size of 2 x 2 meters be constructed at a spot south of the crossing with Ban Nong Roi – Nong Wa Road at railway kilometer marker 288 + 360 too. The proposed location is 450 meters away from the Nong Kan Nga bus-stop.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	▪ Crossing with Ban Nong Roi – Nong Wa Road at railway kilometer marker 288 + 360	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meter in height) at this crossing.
	▪ Crossing with Ban Thanon Tua – Ban Dan Road at railway kilometer marker 289 + 070.	▪ The Consulting Firm proposes a U-turn bridge as a solution for this crossing. ▪ The meetings agree with the Consulting Firm's proposal. However, it is suggested at the meetings that a one-cell box culvert should also be provided at a spot south of Nong Maew Train Station. ▪ The other request from the meetings is another one-cell box culvert to be located at a spot 100 meter north of Nong Maew Train Station.
	▪ Crossing with Ban Don Rai – Ban Kok Krern Road at railway kilometer marker 291 + 215	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at this crossing.
	▪ Crossing with Ban Korn Noi – Nong Ya Khao Road at railway kilometer marker 292 + 753	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at this crossing. ▪ At the meetings, it was suggested that a one-cell box culvert should be provided at a spot 300 meters north of the crossing with Ban Korn Noi – Ban Nong Ya Khao Road at railway

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		kilometer marker 292 + 753 too. However, during the design process, the Consulting Firm has found that it is not possible to provide the one-cell box culvert at the aforementioned spot because there is a frontage road along the railway. If its level is dropped to link to the one-cell box culvert there, it will face water-drainage problems.
	Crossing with Ban Taew – Ban Perm Road (Rural Road 5019 in Nakhon Ratchasima) at railway kilometer marker 294 + 644	- Because many deaths have taken place at this crossing, the meetings agree with the Consulting Firm's proposal that a U-turn bridge should be built here. However, the meetings also demand that convenient link between the U-turn bridge and all six local sois in the area be provided. Moreover, the meetings suggest that a box culvert should be installed at the crossing for handcarts and bicycles. - During the design process, it becomes clear that a box culvert is not possible at the spot. The Consulting Firm, therefore, proposes building a pedestrian bridge to provide convenience to people instead.
	Crossing with Ban Perm – Talad Mai Road at railway kilometer marker 295 + 432	- The Consulting Firm proposes closing down this crossing. - The meetings ask for a two-cell box culvert at this crossing.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	▪ Crossing with Kham Sakae Saeng – Ban Bua Road (Highway 2067) at railway kilometer marker 296 + 941	▪ The meetings agree with the Consulting Firm's proposed construction of a U-turn bridge and the proposed installation of a two-cell box culvert (up to 2.5 meters in height) at this crossing. ▪ However, the meetings also ask for a one-cell box culvert in the size of 2 x 2 meters at a spot between the crossing with Kham Sakae Saeng – Ban Bua Road (Highway 2067) at railway kilometer marker 296 + 941 and the crossing with Ban Bua – Thung Na Road at railway kilometer marker 297 + 616. ▪ During the design process, the Consulting Firm has found that the one-cell box culvert cannot be added there because the spot will be home to a two-cell box culvert.
	▪ Crossing with Ban Bua – Thung Na Road at railway kilometer marker 297 + 616	▪ The meetings agree with the Consulting Firm's proposal to install a two-cell box culvert (up to 2.5 meters in height) for local people to travel around and conduct their farming activities.
	▪ Crossing with Thung Na – Non Sung Road at railway kilometer marker 298 + 340	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at this crossing. ▪ The meetings, however, also ask that

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		the Consulting Firm consider constructing a U-turn bridge at a spot between the crossing with Thung Na – Non Sung Road at railway kilometer marker 298 + 340 and the crossing with Non Mueang Kao – Ban Dong Plong Road at railway kilometer marker 301 + 850. The proposed location is about one kilometer south of the Dong Plong Train Station. The U-turn bridge is recommended to accommodate the traffic of big farm trucks in the local areas, which are mainly farmland.
	▪ Crossing with Non Mueang Kao – Ban Dong Plong Road at railway kilometer marker 301 + 850	▪ The meetings agree with the Consulting Firm's proposal to either provide an underpass with the minimum height of three meters at the crossing or provide a U-turn bridge, a two-cell box culvert, and a frontage road to channel road traffic smoothly to the U-turn bridge. The proposed solution must accommodate the needs of large farm vehicles. ▪ During the design process, the Consulting Firm has found that the two-cell box culvert is not possible at the crossing because it is located in a low-lying area and has ponds nearby. Therefore, the Consulting Firm will replace the box culvert with a pedestrian bridge.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	▪ Crossing with Ban Huai Noi – Ban Huai Yai Road (at railway kilometer marker 305 + 204)	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at this crossing.
	▪ Crossing with Mitrapap – Nong Hua Fan Road (Rural Road 1015 in Nakhon Ratchasima) at kilometer marker 315 + 247	▪ The meetings agree with the Consulting Firm's proposal to provide an overpass and a two-cell box culvert (up to 2.5 meters in height) as solutions at this crossing, because they are the safest option. ▪ The meetings, however, also ask for a one-cell box culvert at a spot north of the Phon Songkhram Train Station explaining that this additional measure is needed to link communities on different sides of the railway and for farming activities in the area. ▪ Acting on the recommendations from participants at the meeting held on 2 Feb 2012, the Project visited local communities one more time (on 1 Mar 2012 at Tambon Phon Songkham Administrative Organization) to explain about the Project to people to be affected by land expropriation. ▪ During the design process, the Consulting Firm has found that the two-cell box culvert is not possible in the area because of water-drainage issue. Therefore, the Consulting Firm recommends constructing a pedestrian bridge in place of the box culvert.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	▪ Crossing with Ban Maklua – Ban Makha Road at railway kilometer marker 307 + 388.5	▪ The meetings agree with the Consulting Firm's proposal to construct a U-turn bridge and install a two-cell box culvert (up to 2.5 meters in height) for small vehicles at this crossing. ▪ The meetings, however, ask that a one-cell box culvert in the size of 2 x 2 meters be provided at a spot located 300 meters south of Makha Train Station too. ▪ In addition, the meetings also want another one-cell box culvert in the size of 2 x 2 meters be installed at a spot located 300 meters north of the Makha Train Station.
	▪ Crossing with Ban Makha – Ban Kroke Road at railway kilometer marker 309 + 487	▪ The Consulting Firm proposes a one-cell box culvert in the size of 2 x 2 meters at this crossing. ▪ The meetings disagree with the proposal, saying that a number of parents have used the road traffic at this crossing to send their children to and pick up them from schools around here. The meetings want a box culvert in the size of 2.5 x 3.5 meters as a solution
	▪ Crossing with Ban Don Muang – Ban Ya Ka Road (Rural Road 4011 in Nakhon Ratchasima) at railway kilometer marker 310 + 557	▪ The meetings agree with the Consulting Firm's proposal to construct a U-turn bridge at this crossing.

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
	Crossing with Nern Tang Pap – Ban Salao Road at railway kilometer marker 311 + 842	- The Consulting Firm proposes closing this crossing to road traffic. - The meetings disagree, suggesting that a two-cell box culvert (up to 2.5 meters in height) should be provided to provide convenience to local communities.
	Crossing with Ban Hua Beung – Ban Don Noi Road at railway kilometer marker 319 + 412	- The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height). - The meetings, however, also ask that a one-cell box culvert in the size of 2 x 2 meters be provided at a spot 300 meters north of the Ban Don Yai Train station for students to use in crossing the railway there.
	Crossing with Non Maklua – Si Nimit Road at railway kilometer marker 324 + 755	The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	Crossing with Ban Wat – Mueang Kong Road at railway kilometer marker 326 + 292	The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a box culvert (up to 2.5 meters in height). According to the proposal, the U-turn bridge will be located near the crossing with Highway 2160 to accommodate large vehicles. The box culvert, meanwhile, will be located at the crossing with Ban Wat – Mueang Kong Road. The meetings have an additional request

Points	Opinions/Recommendations from Local People	Opinions of Consulting Firm
		that box culvert be designed in a way that can accommodate four traffic lanes. During the design process, the Consulting Firm has found that the above proposed solutions are not possible because the Highways Department's U-turn bridge there will not leave enough space to construct a frontage road that will direct traffic from the crossing with Ban Wat – Mueang Kong Road to the U-turn bridge. Therefore, the Consulting Firm has decided to solve problems at this crossing by elevating the train tracks with the rail bridge to go over the road.
	Crossing with Ban Takraw – Ban Nong Suang Road at railway kilometer marker 327 + 788	The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at the crossing.
	Crossing with Mueang Kong – Ban Kok Ped Road (Rural Road 2061 in Nakhon Ratchasima) at railway kilometer marker 329+046	- The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height). - The meetings, however, also ask for the additional installation of the one-cell box culvert for pedestrians at a spot 480 meters south of the crossing with Mueang Kong – Ban Kok Ped Road (Rural Road 2061 in Nakhon Ratchasima) at railway kilometer marker 329+046.

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	▪ Crossing with Ban Rai – Non Thong Luang Road at railway kilometer marker 333 + 580	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Non Thong Lang – Ban Nong Muang Road at railway kilometer marker 336 + 030	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Nong Na Kok – Bua Yai Road (Rural Road 2061 in Nakhon Ratchasima) at railway kilometer marker 337 + 513	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Nong Pai Lom – Bua Yai Road at railway kilometer marker 338 + 385	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Jarm – Ban Don Khun Sanid Road at railway kilometer marker 342 + 841	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge. However, they also ask for the additional installation of a one-cell box culvert in the size of 2 x 2 meters at the crossing for handcarts, bicycles and pedestrians.
	▪ Crossing with Rotfai – Tessabarn Road at railway kilometer marker 344 + 471	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Bua Yai District – Tambon Seeda Road (Highway 202) at railway kilometer marker 346 + 307	▪ The Consulting Firm proposes a four-lane overpass at this crossing. However, according to the proposal, the overpass will stretch across

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		Tessaban 12 and Tessaban 1 area too for travel convenience in Bua Yai Municipality area. ▪ The Project's team has already met with local people so as to explain about the overpass solution and to listen to the locals' opinions. A total of three meetings with local people were held. The first one took place on 31 January 2012 at the Bua Yai District Office's meeting room. The second one was held on 29 April 2012 at the meeting room of Bua Yai Municipal Office. The third meeting took place on 15 March 2012 at the Bua Yai Municipal Office's meeting room.
	▪ Crossing with Ban Tha Nern – Nong Ta Kai Road at railway kilometer marker 347 + 895	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with the road leading to the Nong Bua Lai Train Station at railway kilometer marker at 356 + 950	▪ Presently, the elevation has already been used to solve problems at this crossing. However, the meetings suggest that a culvert should be provided here for vehicles of up to a medium size too. ▪ In addition, the meetings want a one-cell box culvert in the size of 2 x 2 meters to be installed at a spot 270 meters south of the railway's crossing with the road leading to the Nong Bua Lai Train Station at railway kilometer

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		marker at 356 + 950 for local monks, pedestrians and herded animals.
	▪ Crossing with Mitrapap – Ban Non Khu Road at railway kilometer marker 358 + 156	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge at this crossing. They, however, also ask for the installation of a one-cell box culvert in the size of 2 x 2 meters for locals to conveniently cross the railway.
	▪ Crossing with Ban Sa Krok – Phu Khad Road at railway kilometer marker 362 + 692.	▪ The Consulting Firm proposes closing this crossing to road traffic. However, the meetings ask that a one-cell box culvert in the size of 2 x 2 meters be provided.
	▪ Crossing with Mitrapap – Ban Khok Si Road (Highway 2246) at railway kilometer marker 369+672.500	▪ The meetings agree with the Consulting Firm's proposal to provide an overpass and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing at the railway kilometer marker 372+800.000	▪ The Consulting Firm proposes closing this crossing to road traffic. However, the meetings ask that a two-cell box culvert (up to 2.5 meters in height) be provided.
	▪ Crossing with Ban Non Tan – Nong Saeng Road at railway kilometer marker 373+638.400	▪ The meetings agree with Consulting Firm's proposal to install a two-cell box culvert (up to 2.5 meters in height) at this crossing. ▪ However, the meetings have an additional request that a one-cell box culvert be also installed at a spot one kilometer away from the crossing with Ban Non Tan – Nong Saeng Road at

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		railway kilometer marker 373+638.400.
	▪ Crossing with Mueang Phon District – Chaiyaphum Road (Highway 2065) at railway kilometer marker 376+218.000	▪ The Consulting Firm met with locals twice to explain about proposed solutions for this crossing. The first meeting took place on 27 January 2012 while the second meeting took place on 29 February 2012. At the meetings, the Consulting Firm proposed an overpass and a two-cell box culvert (up to 2.5 meters in height). However, the meetings resolved to reject the proposal based on ground that the locals did not want the expropriation of land plots along the road. According to the locals at the meeting, these land plots are commercial and community zones. The meetings suggest that the appropriate solutions for this crossing should come in the form of a U-turn bridge and a two-cell box culvert. ▪ The Consulting Firm has agreed to raise this suggestion with the Highways Department, which has the mandate over the road in question. ▪ During the design process, it is concluded that the U-turn bridge and the two-cell box culvert (up to 2.5 meters in height) will be used as solutions for this crossing.
	▪ Crossing with Mueang Phon District – Ban Pek Yai Road	▪ The meetings propose that a U-turn bridge and a two-cell box culvert (up

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	(Highway 2233) at railway kilometer marker 377+215.000	to 2.5 meters in height) be used as solutions at this crossing. During the stage of drawing up detailed design, it becomes clear that only a two-cell box culvert (up to 2.5 meters in height) will be needed here because large vehicles will be able to conveniently use the U-turn bridge at the crossing with the Highway 2065 via the frontage road provided by the Project.
	Crossing with the road in front of Mueang Phon Train Station (at railway kilometer marker 378+043.000)	The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge.
	Crossing with Wat Nong Wa Road at railway kilometer marker 381+440.100	- The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height). - The meetings, however, have an additional request that a one-cell box culvert be also installed at a spot 800 meters north of the crossing for local communities.
	Crossing at railway kilometer marker 382+228.514	- The Consulting Firm proposes closing this crossing to road traffic. - Local people, however, ask that a two-cell box culvert (up to 2.5 meters in height) be provided as a solution at the crossing instead.

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	▪ Crossing with the road leading to Hua Saphan (Rural Road 2021 in Khon Kaen) at railway kilometer marker 385+412.000	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height)
	▪ Crossing with Phon District – Ban Nong Kae Road at railway kilometer marker 386+853.500	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Khon Sak – Mitrapap Road at railway kilometer marker 395+111.290	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Han – Pa Por Road (Rural Road 2102 in Khon Kaen) at kilometer marker 396+474.670	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Non Rang – Mitrapap Road at railway kilometer marker 399+716.000	▪ The Consulting Firm initially proposed a two-cell box culvert (up to 2.5 meters in height) as a solution at this crossing. However, local communities point out that the road is sandwiched by creeks and its portion just before the crossing has usually been severed during rainy season (wet season). They believe the box culvert will not be usable during the wet season. ▪ In response to information provided by the locals, the Consulting Firm has inspected the site and concluded that a U-turn bridge – not a box culvert – will be provided at this crossing.

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	▪ Crossing with Ban Napo – Mitrapap Road at railway kilometer marker 402+740.820	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Nong Tao – Mitrapap Road (Rural Road 3027 in Khon Kaen) at railway kilometer marker 423+192.820	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with Ban Non Sawan – Ban Wang La Road at railway kilometer marker 425+134.740	▪ The meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height). ▪ The meetings, however, also call for a study on possible noise problems because there are many communities in the area.
	▪ Community-Link Routes	▪ The meetings ask for a one-cell box culvert at a spot 900 meters north of Ban Had Train Station for local communities. ▪ The meetings ask for a one-cell box culvert at a spot 800 meters south of Ban Had Train Station for local communities. ▪ The meetings ask for a one-cell box culvert at a spot 1,600 meters south of Ban Had Train Station for local communities. ▪ The meetings ask for a one-cell box culvert at a spot 4,700 meters south of Ban Had Train Station for local communities.

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		The meetings ask for a pedestrian flyover across train tracks at the Ban Had Train Station to link communities on the different sides of the railway.
	Crossing with Ban Nong Tao – Mitrapap Road at railway kilometer marker 426+704.000	The meetings suggest that the road in the railway's zone should be improved and maintained in good, usable conditions in all seasons.
	Crossing with Ban Non Tan – Mitrapap Road at railway kilometer marker 429+375.000	- The Consulting Firm initially proposed a two-cell box culvert (up to 2.5 meters in height). However, at the meetings, locals said many sugarcane trucks had traveled past the crossing and thus they wanted an overpass instead. - The Consulting Firm already explained to the meetings that an overpass would require the expropriation of land plots along the road, which were being occupied by local communities. - The meetings still approved the overpass solution. - The Consulting Firm, therefore, visited the local communities on 28 February 2012 to explain about the Project's and chosen solution to people to be affected by land expropriation.
	Crossing with Ban Nong Mek – Mitrapap Road (Rural Road 3203 in Khon Kaen) at railway kilometer marker 432 + 255)	The Meetings agree with the Consulting Firm's proposal to provide a U-turn bridge and a two-cell box culvert (up to 2.5 meters in height).

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	▪ Crossing with Ban Nong Wang – Mitrapap Road (Rural Road 3024 in Khon Kaen) at railway kilometer marker 435 + 075.85	▪ The meetings agree with the Consulting Firm's proposal to provide an overpass and a two-cell culvert box (up to 2.5 meters in height) at the crossing. Therefore, on 28 April 2012, the Consulting Firm had a meeting with and provided explanation to people to be affected by land expropriation, which will be necessary for the overpass construction, at Tambon Ta Phra Administrative Organization's meeting room.
	▪ Crossing with Ban Nong Wang – Mitrapap Road at railway kilometer marker 436 + 407.77	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at the crossing.
	▪ Crossing with Ban Nong Bua Dee Mee – Lum Ya Ka Road at railway kilometer marker 438 + 366.9	▪ The meetings agree with the Consulting Firm's proposal to provide a two-cell box culvert (up to 2.5 meters in height) at the crossing.
	▪ Crossing with Maha Sarakham – Mitrapap Road (Highway 208) at railway kilometer marker 438 + 940	▪ The meetings agree with the Consulting Firm's proposal to provide an overpass and a two-cell box culvert (up to 2.5 meters in height).
	▪ Crossing with an illegal road at railway kilometer marker 439+820	▪ The Consulting Firm proposes closing this crossing to road traffic but the meetings ask that a two-cell box culvert (up to 2.5 meters in height) be installed at the rim of a nearby train station and a new road be constructed to provide road-based vehicles with

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		convenient access to the culvert. During the design process, it becomes clear that the two-cell box convert cannot be provided here because the site is chosen for a container yard.
	Crossing with Lao Nadi Road at railway kilometer marker 448 + 517.3 □	The meetings agree with the Consulting Firm's proposal to elevate train tracks at this crossing.
	Crossing with Ban Nong Wat Road at railway kilometer marker 449 + 132.8	The meetings agree with the Consulting Firm's proposal to elevate train tracks at this crossing.
	Crossing with Si Chan Road (Highway 209) at railway kilometer marker 450 + 500	The meetings agree with the Consulting Firm's proposal to elevate train tracks at this crossing.
	Crossing with Pracha Samosorn Road (Highway 12) at railway kilometer marker 451 + 400	The meetings agree with the Consulting Firm's proposal to elevate train tracks at this crossing.
	Crossing with Lang Soon Ratchakarn Road at railway kilometer marker 452 + 400	The meetings agree with the Consulting Firm's proposal to elevate train tracks at this crossing.
Environmental Concerns and Proposed Environmental Measures	Local people ask about the Project's impacts.	The number of passing trains on the railway will increase significantly or a train may arrive at a spot along the chosen route every 15 minutes. The level of noise will also rise because with the double-track railway, two trains can run past the same spot at the same time. Model-based assessments thus will be conducted to determine which spots will be affected by noise pollution. Sound-proof barriers will be provided for affected schools and

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		temples to ensure that the level of noise does not exceed safe limits there.
	Local people express concerns about the risk of motorists throwing down glass bottles or other types of garbage down to their communities from the overpasses that are longer than 800 meters and erected at crossings.	It is proposed that nets be installed on the overpasses to prevent such risk.
	Local people ask about what will happen to shop houses for rent near the Khon Kaen Train Station.	The train tracks at the Khon Kaen Train Station will be raised under the Project but the elevation will not affect the for-rent shop houses, which are located on a 20-meter-wide plot of land just outside the station.
	Local people express concerns about water-drainage system.	In drawing up the Project's detailed design, the overall water-drainage capacity of areas along the chosen route will be assessed and taken into account to ensure that there are adequate and proper drains under the railway for flood-prevention purpose.
	Local people have concerns about the effectiveness of the railway's signaling system especially during the Project's constructions. Presently, the system has caused some accidents.	Any problem about the railway's signaling system should be reported to the Khon Kaen Railway Office or the State Railway of Thailand's Complaint-Receiving Center. As for the Project's constructions, the risk of accidents will be minimized because constructors will have officials on duty at all crossings.

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	Local people ask whether Lak Mueang Community will be affected by the Project.	Under the Project, a 20-meter area on each side of the current train tracks will be used. The 20-meter distance is counted from the center of the tracks. If the Lak Mueang Community is located in such area, locals must move out for safety reasons.
	Local people ask about compensation for communities in the railway's zone. These communities agree to cooperate with the State Railway of Thailand's plan to develop the 40-meter-wide area along the railway. However, the locals want the Project to help them gain access to public infrastructure.	- The State Railway of Thailand has a policy to not allow any residence/community inside the Project's 40-meter-wide area. Therefore, the Project will erect fences along its entire stretch of double-track railway. Under the Project, the fences will cover the entire railway's zone (within 80-meter radius of the railway) at spots that have no obstructive buildings. - The Project has contacted Community Organizations Development Institute (CODI) about the local people's demand. According to CODI, all affected communities can be relocated to 20-meter-wide plots of land just outside train stations. The Project will coordinate with CODI and community leaders for further details about this plan.
	Local people ask about compensation for communities located within the 40-meter-wide area of the railway.	In Khon Kaen Municipality's area, the Project will use the 40-meter-wide area along the current train tracks. Affected communities and people shall be

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		entitled to compensation as stated in environmental measures.
	Local people express concerns about noise pollution from the U-turn bridge when large vehicles rev up their engines.	The Consulting Firm will introduce measures to ensure that the noise level will not rise beyond safe limits. Sound-proof barriers shall be installed at spots affected by noise pollution.
	Local people suggest that the State Railway of Thailand give greater opportunities to small communities in renting its land plots.	Communities inside the train stations must move out because the areas are destined for development. These communities should urgently contact CODI for advice and assistance.
	Local people ask about relocation plan.	The Project is still in the stage of design and feasibility study. During this stage, local people should give opinions, make recommendations, and identify what types of help they want. However, the payment of compensations from the Project is subject to rules and regulations just like other government projects.
	Local people ask that community-link culverts be arranged in a way that responds to their local ways of life.	The Consulting Firm will prepare the culverts in a way that responds to the travel needs of the local communities.
Public Participation and Public Relations	Local people suggest that the Project's owner should also meet local people and directly listen to their opinions.	The Consulting Firm will present this suggestion to the Project's owner and ask that it assign its officials to join the meetings with local people in the future.
	Local people want to see their municipal leaders, local leaders,	The Consulting Firm has already drawn up a list of people to be affected

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	and human-rights groups take part in the formulation of remedial measures for community relocation.	by the Project. The Consulting Firm will formulate measures to minimize the impacts on these people later on.
	Local people suggest that information on crossings be made available on the Project's web site.	The Consulting Firm will act on this suggestion.
Others	Local people ask how much the train fares will be after the Project's double-track railway springs into operation.	Fares for passengers will remain the same. However, the service fee for cargo transportation may be adjusted in line with market conditions so as to stay competitive against other means of transport.
	Residents in Ban Phai Municipality's area want to hear the conclusion on the Project as soon as possible because they are worried about its design.	The Consulting Firm will urgently work on this. However, it should be noted that no land expropriation will take place in the Ban Phai Municipality's area under the Project.
	Local people suggest that the road network and train network be well integrated right from the planning stage.	All relevant parties have now shared information for solving problems at railroad crossings. People, the Highways Department, the Rural Roads Department, Office of Transport and Traffic Policy and Planning, and the State Railway of Thailand have joined hands in a bid to get the best solution possible.
	Local people point out that the Project's double-track railway alone will not guarantee	The Consulting Firm has a much similar opinion on integrated approach. If development efforts are well

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	successes in train-services development. Other factors include the development of locomotives, an ability to provide adequate trains, efficient management, quality services and proper integration to other transport systems for both cargoes and passengers.	coordinated, the overall transportation cost in the country will drop while the country's competitiveness will rise.
	Local people call for the improvement of State Railway of Thailand's services in regards to punctuality and frequency of train departures. These people feel train services do not attract passengers much because the interval between train departures for a route is too long.	Presently, the State Railway of Thailand has faced constraints in providing the train services. Its existing tracks are not fully efficient, thus making it impossible for its trains to run at their maximum speed. Moreover, it does not have an adequate number of locomotives.
	- Local people say they are willing to pay a higher fare if the State Railway of Thailand can deliver greater punctuality and higher frequency of train departures. - Local people believe the double-track railway will definitely enhance cargo transportation in the country if the relevant system is well developed too. - Local people suggest that train stations' areas be developed as shopping centers so that the State Railway of Thailand can reap more income.	The Consulting Firm has agreed to look into these suggestions. It is agreed that if train stations' areas are developed for commercial purpose, the State Railway of Thailand will be able to generate more income.

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	Local people suggest that trains should install closed sanitary system.	State Railway of Thailand has planned to purchase trains with closed sanitary system within the next two years.
	Local people ask whether the State Railway of Thailand has any plan to purchase more locomotives.	The State Railway of Thailand board has already approved the plans to purchase new locomotives, which will be able to run at the maximum speed of 120 kilometers per hour. Moreover, the State Railway of Thailand has planned to purchase new diesel railcars too. According to the purchase plans, at least new 50 locomotives and railcars will be bought.