Ministry of Ports and Shipping

TECHNICAL ASSISTANCE FOR CONNECTIVITY FACILITIES BETWEEN COAL HANDLING TERMINAL AROUND PORT QASIM AND RAILWAYS IN PAKISTAN

FINAL REPORT

June 2016

Japan International Cooperation Agency (JICA)

NIPPON KOEI CO., LTD.

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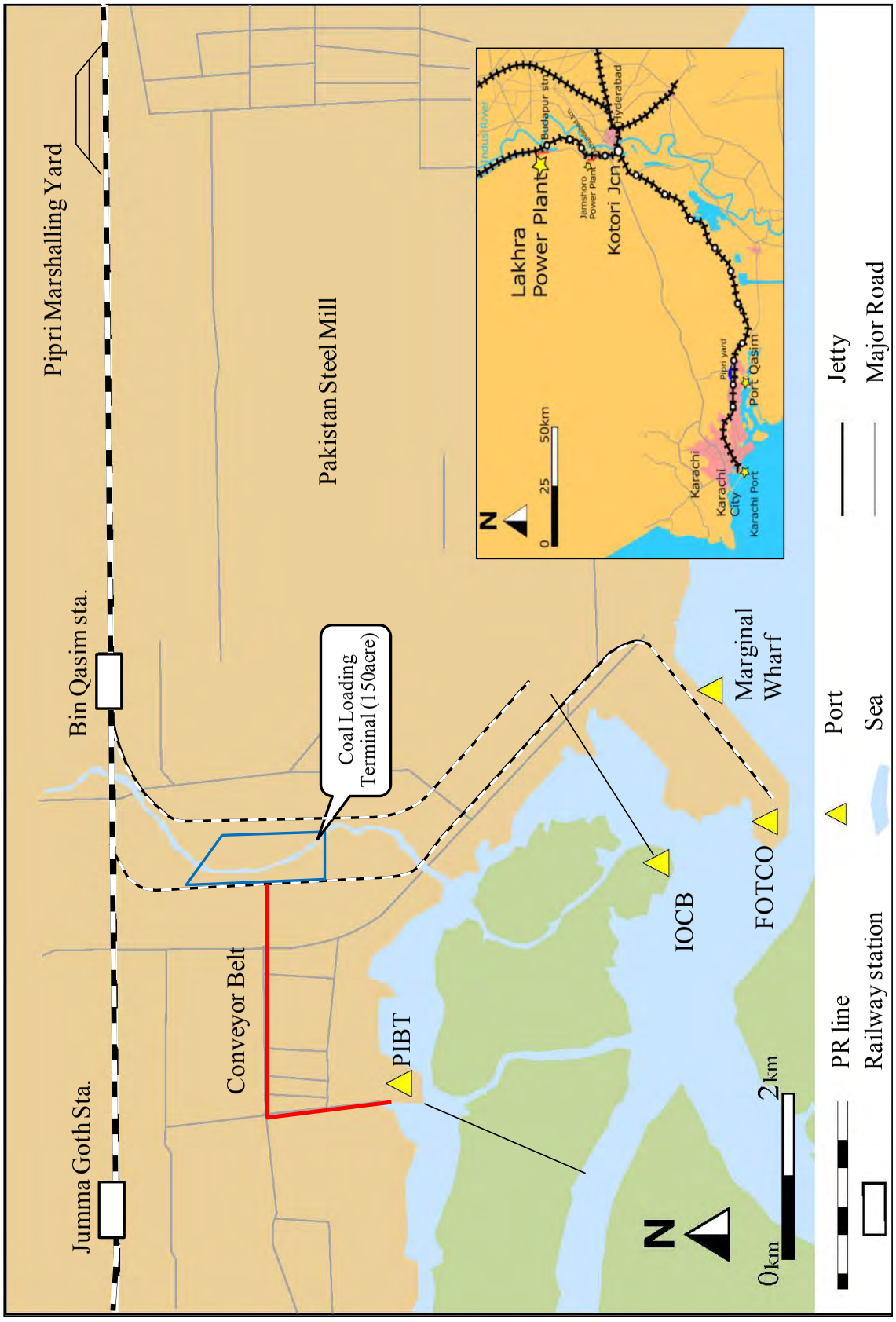

LOCATION MAP

Technical Assistance
for
Connectivity Facilities Between Coal Handling Terminal Around Port Qasim and Railways in Pakistan

Final Report

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ABBREVIATIONS

Abbreviation	Official Term
ADB	Asian Development Bank
BOO	Build Own and Operate
BOR	Berth Occupancy Rate
CBI	Computer Based Interlocking
CDTO	China Overseas Investment Company
CMEC	China Machinery and Engineering Company
COD	Commercial Operation Date
CPEC	China-Pakistan Economic Corridor
CPPA	Cenntral Power Purchase Anthority
CSA	Coal Supply Agreement
DWT	Dead Weight Tonnage
EIA	Environmental Impact Assessment
EOI	Expression of Interest
EPA	Environmental Protection Agency
EVTL	Engro Vopak Chemical Terminal
FAPGT	Fauji Akbar Portia Grain and Ferilizer Terminal
FBC	Fluidized Bed Combustion
FFBL	Fauji Fertilizer Bin Qasim Limited
FGD	Flue Gas Desulfurization
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FOTCO	Fauji Oil Terminal and Distribution Co., Ltd.
FPCL	FFBL Power Company
FRP	Framework of Resettlement Policy
FS	Feasibility Study
FSA	Fuel Supply Agreement
GDP	Gross Domestic Product
GENCO	GENCO Holding Company Limited
GOP	Government of Pakistan
GPL	Grange Power Limited
GRC	Grievance Redress Committee
HUBCO	Hub Power Company
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
IA	Implementation Agreement
ID	Identification
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IOCB	Iron Ore and Coal Berth
IsDB	Islamic Development Bank
JDA	Joint Development Agreement
JICA	Japan International Cooperation Agency
JPGP	Jamshoro Power Generation Project
JST	JICA Study Team

Abbreviation	Official Term
KAPCO	Kot Addu Power Company
KE	K-Electric
KESC	Karachi Electric Supply Company
L/A	Loan Agreement
LAA	Land Acquisition Collector
LCPP	Lakhra Coal Fired Thermal Power Plant
LCT	Liquid Bulk Terminal
LNG	Liquefied Natural Gas
LOA	Length Overall
LOC	Letter of Comfort
LOI	Letter of Intent
LOS	Letter of Support
LPG	Liquefied Petroleum Gas
MoR	Ministry of Railway
MoPS	Ministry of Ports and Shipping
MOU	Memorandum of Understanding
MoWP	Ministry of Water and Power
mtpa	Million ton per annum
MW	Megawatt
M/W	Marginal Wharf
NCPL	Nishat Chunian Power Limited
NEL	Nishat Energy Limited
NEPRA	National Electric Power Regulatory Authority
NEQS	National Environmental Quality Standards
NESPAK	National Engineering Services Pakistan
NGO	Non-governmental Organization
NTDC	National Transmission Dispatch Board
O&M	Operation and Maintenance
ODA	Official Development Assistance
PC-I	Planning Commission-I
PEPA	Pakistan Environmental Protection Agency
PG	Performance Guarantee
PGA	Peak Ground Acceleration
PIBT	Pakistan International Bulk Terminal Limited
PM	Project Manager
PMU	Project Management Unit
PPA	Power Purchase Agreement
PPDB	Punjab Power Development Board
PPIB	Private Power and Infrastructure Board
PPR	Project Progress Report
PQ	Port Qasim
PQA	Port Qasim Authority
PQEPCL	Port Qasim Electric Power Company Limited
PR	Pakistan Railways
PSM	Pakistan Steel Mill
RAP	Resettlement Action Plan
QICT	Qasim International Container Terminal

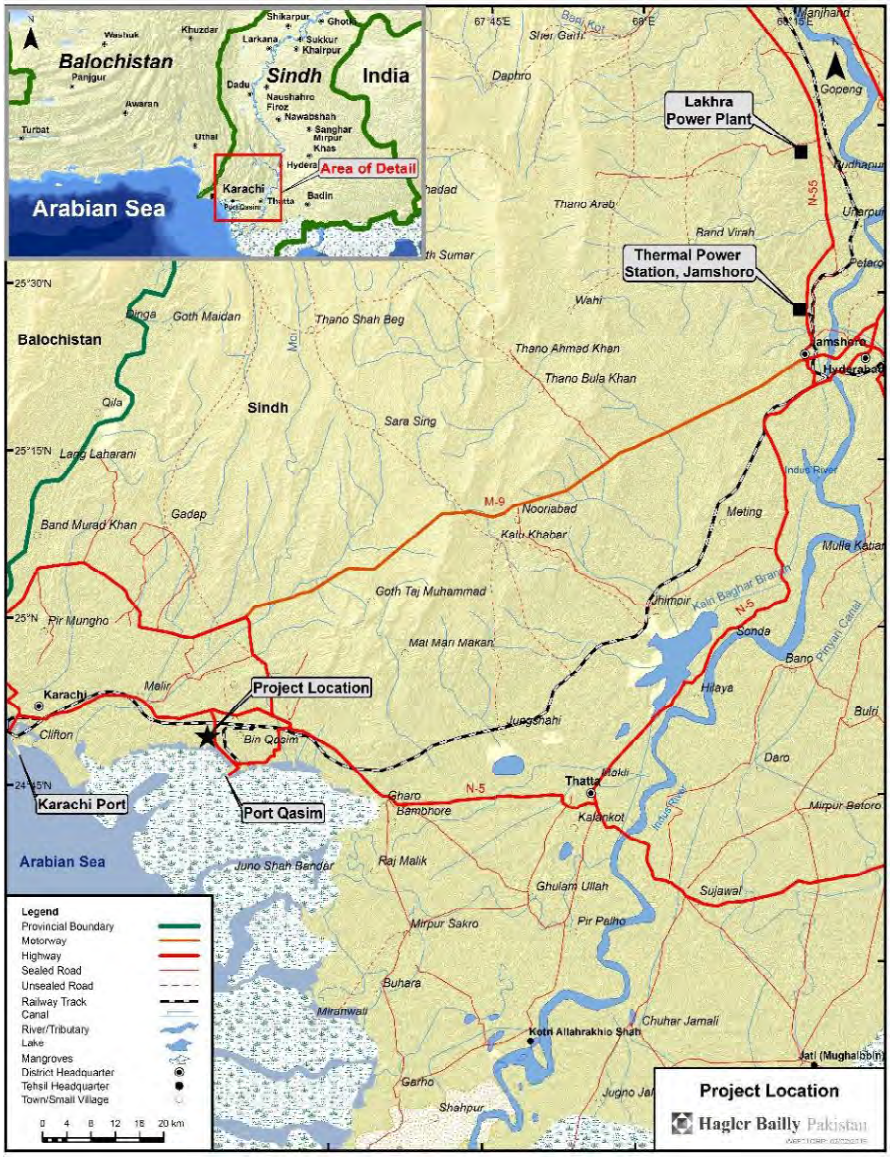
Abbreviation	Official Term
QT2	Qasim Container Terminal 2
SC	Super Critical
SDSEL	Siddiqsons Energy Limited
SEPA	State Environmental Protection Agency
SEQS	State Environmental Quality Standards
SHM	Stakeholder Meeting
SPV	Special Purpose Vehicle
SSGC	Sui Southern Gas Company Limited
TEU	Twenty-foot Equivalent Unit
TOR	Terms of Reference
USAID	United States of Agency for International Development
USC	Ultra Super Critical

Chapter 1 Introduction

1.1 Description of the Project

1.1.1 The Project Location

The proposed coal transport project is located in the northwestern industrial zone of Port Qasim (PQ) in Karachi (Figure 1-1). The coal will be transported through a conveyor belt, with total length of 4-4.5 km. The project will also include associated facilities such as reclaimer at PIBT coal stockyard and unloading facilities at coal stockyard at PR station terminal. The coal yards at the two ends, unloading from ship, loading of coal to train, and the transportation of coal between train and ship are not within the scope of this project.



Source: EIA Report

Figure 1-1 Location of Proposed Project

1.1.2 Background of the Study

Due to the rapid growth of economy in Pakistan, electricity demand is increasing by 6% annually in the past ten years. Although the power supply capacity in 2011 was 23,538 MW, the actual effective power supply was 16,104 MW due to the shortage of fuel supply. The maximum gap between the demand and supply of electricity at peak hour during the summer season in 2011 was 6,000 MW. In order to avoid blackout, a planned outage of 10 hours on the average was implemented throughout the country. In order to improve such situation, it is urgently required to invest in the electric power sector in Pakistan.

Approximately 34% of the total power generation relies on oil thermal power which has relatively higher cost. This requires the import of fuel which negatively impacts the balance of international payments. In addition, the national finance deficit is expanding because the power generating cost is covered by subsidy. Furthermore, stable power generation is exacerbated by the inadequate fuel procurement because of delays in fee collection and subsidy availability.

Under these circumstances, the Government of Pakistan (GOP) has implemented the "National Power Policy 2013" in the power sector. The main feature is to use coal as a lower cost energy source.

From September 2013, the Japan International Cooperation Agency (hereinafter JICA) has been implementing the "Preparatory Survey on Lakhra Coal Fired Thermal Power Plant Construction Project" (hereinafter referred to as Lakhra Study) to support the construction of high efficiency Lakhra Coal Fired Thermal Power Plant (hereinafter referred to as LCPP), which is an ultra supercritical power plant with 600 MW (net) rated power, in Sindh State.

This project plans to transport 2 million tons of imported coal to the power plant by railway after unloading at Port Qasim. However, there is no concrete plan for coal transportation and facilities from the coal unloading terminals to the existing railway main line. Pakistan Railways (PR) is specifically considering the improvement of Port Qasim Station and spur line between Port Qasim Station and Bin Qasim Station for the Jamshoro Power Generation Project (hereinafter referred to as JPGP) planned by the Asian Development Bank (hereinafter referred to as ADB). Although connection of coal unloading terminal and loading facility are considered in the study, the cost of the coal loading facility was not included in the budget requirement document (PC-I) which was prepared to request budget from the Government of Pakistan.

Although unloading facilities from ship, coal stockyard, and jetty including conveyor belt are under construction at the Pakistan International Bulk Terminal (hereinafter referred to as PIBT), connection facility to railway and loading facility for railway wagons at the terminal are not considered.

Due to the circumstances mentioned above, it is a concern that the coal transportation between coal unloading terminal and coal loading station will not be ready although the coal transportation to the power plant by rail will be ready.

1.2 Objectives of the Study

Considering the above background, coal unloading terminal shall be identified shortly to convey the imported coal to the coal fired thermal power plant prior to the commencement of the commercial operation. The objectives of the study are to recommend coal unloading site, conveying route and method, location of coal loading station, and coal loading method to coal wagons. In addition to the above, the study also aims to provide technical transfer to the authorities concerned about the planning process to conduct similar studies by themselves in the near future.

1.3 The Study Area

The strudy area shall be defined as the area between potential coal unloading terminals within Port Qasim and PR stations nearby Port Qaim, including potential coal conveying routes within Port Qasim Industrial Zone as shown on the Figure 1-1. The potential coal unloading terminals are PIBT, FOTCO, IOCB and Marginal Wharf, and the potential coal loading terminals are Jumma Goth Station, Bin Qasim Station, Pipri Marshalling Yard, Port Qasim Station, and a new station to be constructed within the area. The coal conveying route shall be passing within Port Qasin Industrial Zone.

Source: JST

Figure 1-2 The Study Area

1.4 Authorities Relevant to the Project

Main counterpart of this study is the Ministry of Ports and Shipping (MoPS). Other related authorities and organizations are the Ministry of Railway (MoR), the Ministry of Water and Power (MoWP), PR, PIBT, Fauji Oil Terminal and Distribution Co., Ltd. (FOTCO), GENCO Holding Company Limited (GENCO), Pakistan Steel Mill (PSM), and the National Electric Power Regulatory Authority (NEPRA).

Chapter 2 Review of the Coal Fired Thermal Power Plant Projects including the Imported Coal Demands

2.1 General Overview of the Power Sector

2.1.1 Latest Situation in the Power Sector

The current level of power shortages in Pakistan requires the addition of base-load, shoulder and peak-load generation, with priority for additional affordable base load generation. The energy sector is currently experiencing an acute and worsening energy crisis, which is devastating for the economy, as well as for the well-being of the population. The energy shortage peaked at 5,4001 MW in the summer of 2013-14, representing around 21% of unfilled demand. Depletion of domestic natural gas and delays in development of indigenous coal and hydro resources have increased reliance on imported fuels. Data from the National Electric Power Regulatory Authority (NEPRA) shows that the total amount paid for furnace oil procurement for the oil-fired power stations during 2012~2013 reached about US$2.6 billion. This has increased the circular debt of Pakistan – the cash shortfall within the Central Power Purchase Authority (CPPA) that it cannot pay to the power supply companies – amounting to about US$ 5billion, or about 4% of the nominal GDP loss annually. The growing dependence on expensive imported furnace oil for power generation has added to the difficulties in meeting demand, and has led to widespread load shedding, interruption of industrial and commercial activities, lost productivity and public dissatisfaction. Fuel oil was expected to generate only about 38% of power, even though it accounts for 79% of costs. Compared to 2006, the dependence on fuel oil has gone up from 16% to 38%, and costs have increased by 236%. Primary energy supplies by source in Pakistan in 2014 are shown in Table 2-1. To reduce load shedding, the government has committed to adding affordable generating capacity with higher efficiency power technology. Power generation by technology in Pakistan in 2013 is shown in Table 2-2.

Table 2-1 Primary Energy Supplies by Source (MTOE)

	MTOE	**%**
Gas	31.14	48.22%
Oil	20.79	32.47%
LPG	0.31	0.48%
Coal	3.68	5.98%
Hydro	7.13	11.03%
Nuclear	1.08	1.68%
Imported Electricity	0.14	0.14%
	64.59	100.00%

Source: Pakistan Energy Yearbook 2014 (page 68 Table 1 Primary Energy Supplies by Source (MTOE)

[1] State of Industry Report 2014, NEPRA (page 105 Table 28 Surplus Deficit in Demand and Supply during NTDCs System Peak Hours 4,406MW plus Table 29 same for K-Electric System 978MW, in total 5384MW in 2013-14.

Table 2-2 Power Generation by Technology

	Generation		Energy Charge		Cost per kWh
	GWh	Share %	million PR	%	Rs
Hydro	32,294	34.0	1,768	0.24	0.10
Coal	112	0.12	419	0.06	3.74
HSD	1,653	2.0	32,888	5.0	19.9
Residual Fuel Oil	37,277	39.0	541,622	77.0	14.53
Natural Gas	18,341	19.0	101,648	14.5	5.54
Nuclear	4,402	5.0	5,820	0.83	1.32
Mixed	1,108	1.0	11,283	1.61	10.18
Import from Iran	419	0.44	4,416	0.63	10.54
Wind	263	0.27	0.5879	0.0001	0
Bagasse	23	0.02	143	0.03	6.22
Total	95,892	100	701,499	100	7.92

Source: Determination of the Authority in the matter of Islamabad Electric Supply Company Limited No. NEPRA/TRF-278/IESCO-2014 Page 38 Power Purchase Price (PPP)

The condition of the Pakistan power sector has received greater attention with the advent of the new administration in Islamabad. Shortly after its inauguration, the new Prime Minister stated that although relief from load shedding in the power sector will take some time, his government would plan to address the electricity supply problem to revive the economy. He also highlighted the fact that Pakistan had enough coal reserves to generate power for 100 years, but billions of dollars are needed to produce electricity from these reserves. The biggest deposit in Thar coal has yet to be developed. Despite these large deposits, coal makes up only 5.98 % of primary energy, and only 0.06 % of electricity is generated by coal fired plants. Pakistan has a very low carbon footprint at only 19 % of the global average. The cost of electricity tariff is $0.15 per kWh, compared to $0.07in China,$0.11in the US and $0.27 in Germany, which depends on coal for over 30 % of power generation.2

Demand is expected to exceed 32,000 MW3 by 2020, with current available capacity at 18,000MW4. Therefore, all affordable generation must be expanded. The sector would need to add base load and peaking plants to ensure this demand is met.

2.1.2 Effect of CPEC on Power Sector

Because of the power shortage in Pakistan, many power projects are planned. In addition, some power projects are on the list of prioritized projects in the China-Pakistan Economic Corridor (CPEC) 5. Therefore, the progress of several projects is anticipated in the future. In order to design the facilities of coal transportation between the Pakistan International Bulk Terminal (PIBT) and the railway system, it is necessary to clarify which project would surely be developed and to estimate the coal amount which would be transported by railway from PIBT.

[2]Figures show prices for the 1001st kWh used based on monthly consumption only. Source: Power in G-20 and N-11 Countries – At What Cost. GTZ. September 2010.

[3] State of Industry Report 2014 (NEPRA) P105 Table28 Surplus Deficit in Demand and Supply during NTDCs Systems Peak Hour plus Table 29 same for K-Electric System (forecasted 5% demand growth rate in 2017 to 2020)

[4] Same as above, 18,121MW= 18,000MW

[5] China and Pakistan signed an agreement to commence work on the US$45.6 billion investment by China. Key projects are development of energy generation infrastructure, Gwadar Port, road infrastructure, railway infrastructure and liquefied natural gas transportation.

Table 2-3 Coal Fired Power Projects on Prioritized Projects' List in CPEC

Sr. No*	Projects	Capacity, MW
1	2×660 MW Coal Fired Power Plants at Port Qasim Karachi	1,320
3	Sahiwal (2×660 MW) Coal Fired Power Plants	1,320
4	Engro Thar (2×330 MW) Coal Fired Power Plants and Surface Mine in Block II of Thar Coal Field, 3.8 million tons/year	660
6	Gwadar Coal Power Project	300
7	Muzaffargarh (2×660 MW) Coal Fired Power Project	1,320
12	Rahim Yar Khan (2×660 MW) Coal Power Project	1,320
13	SSRL Thar Coal Block-I, 6.5 mtpa and CPIH Mine Mouth Power Plant (2×660 MW)	1,320
Total Capacity of Coal Power Plants		7,560

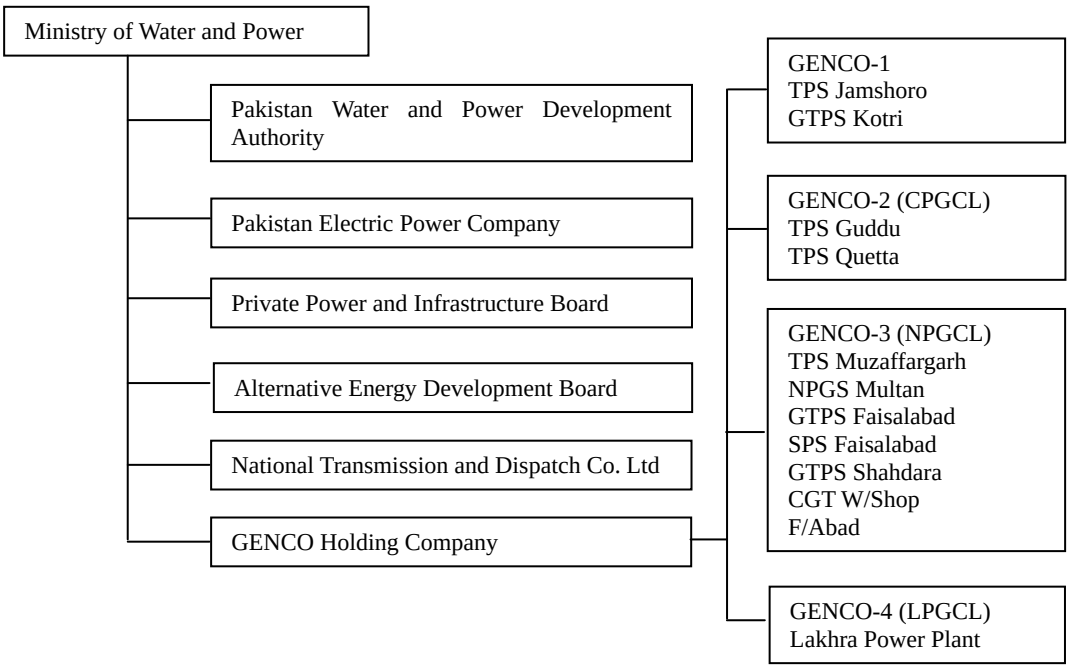
*Sr numbers are original sr number of the list in CPEC. There are 14 power projects including hydel and renewable power projects.

Source: Prepared by JST based on the list in CPEC Brochure

2.1.3 Public Sector Projects

The organization chart of the public sector for thermal power is shown in Figure 2-1. GENCO is an umbrella company which looks after the affairs of four generation companies. All public thermal power stations have been restricted to four corporatized companies, namely; Jamshoro Power Generation Company Ltd. (GENCO-1), Central Power Generation Company Ltd. (GENCO-2), Northern Power Company Ltd. (GENCO-3), and Lakhra Power Generation Company Ltd. (GENCO-4).

A new 2×660 MW coal fired power project is undertaken by GENCO-1, located next to the existing Jamshoro power plants. Another 1×660 MW power plant in the premises of the Lakhra power station is under feasibility study by JICA. Descriptions of these plants are presented in Section 2.2 and 2.3.



Source: Prepared by JST based on each authority's organizational chart

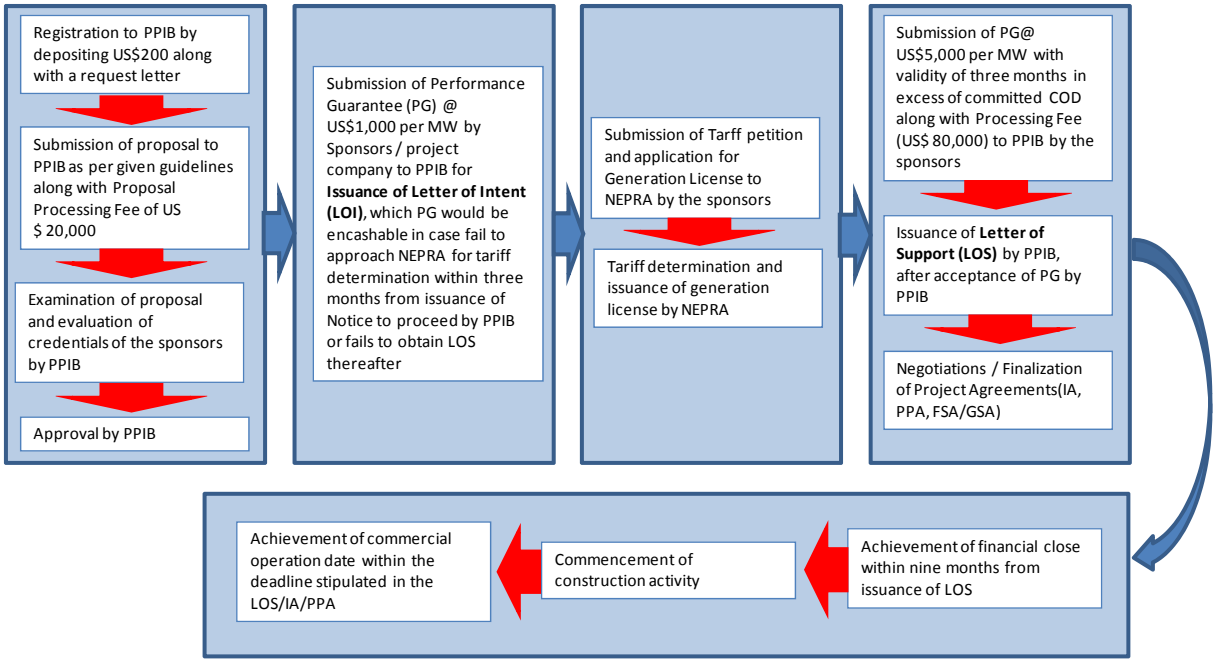
Figure 2-1 Organizational Chart of Public Power Sector in Pakistan

2.1.4 Private Sector Projects

The Private Power and Infrastructure Board (PPIB) was established in 1994 as a "single-window facilitator" to promote private sector participation in the power sector in Pakistan. PPIB facilitates investors in establishing private power projects and related infrastructure, executes implementation agreement (IA) with project sponsors and sovereign guarantees on behalf of the Government of Pakistan.

Figure 2-2 shows the process of setting up private power projects in Pakistan. All independent power producers (IPPs) have to register with PPIB in the beginning of power projects, and their proposals have to be approved by PPIB with processing fee. After approval, the Letter of Intent (LOI) shall be issued upon payment of performance guarantee (PG). Tariff petition is to be submitted generally after LOI receipt, and generation license is given with tariff determination. Letter of Support (LOS) shall be issued after acceptance of PG. The security package, including IA and the Power Purchase Agreement (PPA), and the Fuel Supply Agreement (FSA) are finalized before the implementation stage.

Alternatively, the provincial board, such as Punjab Power Development Board (PPDB)[6], can play the role of the one-window facilitator through the issuance of LOI instead of PPIB for projects planned in the province. Some projects in Punjab such as Sahiwal, Muzaffargarh, and Rahim Yar Khan have been registered with PPDB and received LOI from PPDB before conducting feasibility study (F/S).



Source: Prepared by JST based on Guideline for Setting Up of Private Power Projects published by PPIB

Figure 2-2 Standard Project Implementation Process in Private Sector

[6] Government of Punjab established PPDB in 2006 for the implementation of the Power Generation Policy 2006.

Table 2-4 Coal Fired Power Plants Registered with PPIB

Sr. No	Projects	Sponsor/Company Name	Location	Capacity, MW
1	1,320 MW Imported Coal-based Power Projects at Qadarabad Dist Sahiwal	Huaneng Shandong Ruyi(Pakistan) Energy (Pvt) Limited	Qadarabad District Sahiwal	1,320
2	660 MW Thar Coal-based Power Project	Engro Powergen Thar Limited (EPL)	Thar Block-2, Sindh	660
3	1,320 MW Imported Coal-based Power Project	Sinohydro Resources Limited, China / Al Mirqab Capital, Qatar	Port Qasim Karachi	1,320
4	1,320 MW Thar Coal-based Power Project	Shanghai Electric	Thar Block-1, sindh	1,320
5	1,320 MW Imported Coal-based Power Project at HUB	HUB Power Company	HUB, Balochistan	1,320
6	300 MW Local Coal-based Power Project	China Machinery Engineering Corporation	Salt Rang Pond Dadan Khan, Punjab	300
7	660 MW Imported Coal-based Power Projects	Lucky Electric Power Company Limited	Port Qasim, Sindh	660
8	350 MW Imported Coal-based Power Projects at Port Qasim	Siddiqsons Limited	Port Qasim, Sindh	350
9	150 MW Imported Coal-based Power Projects at Arifwala	Grange Power Limited	Arifwala, Punjab	150
Total Capacity of Coal Power Plants				7,400

Source: Prepared by JST based on website of PPIB

Table 2-4 shows the new power projects registered with PPIB. The individual power projects planning to use imported coal are reviewed hereinafter.

2.2 New Power Projects in the Public Sector

2.2.1 Lakhra Power Plant

(1) Existing Lakhra Power Project

Lakhra Power Generation Co. Ltd (GENCO-4), which is a public limited company under GENCO Holdings, operates the existing 3×50 MW fluidized bed combustion (FBC) power plant. The power station is the first and only coal power plant in Pakistan at present.

Local domestic coal was supplied from Lakhra mine, located 20 km west from the power station. Heat value and sulfur content are around 3,400 kcal/kg and 5.0%, respectively. Due to lots of technical problems, the plant's capacity factor is low since its commissioning in 1995. For example, low purity limestone is used against high sulfur content; therefore, chemical reaction is not enough to mitigate sulfur oxide and the inside of the furnace is affected through de-sulfurization.

Rehabilitation work was completed and the plant was re-commissioned in 2007. Then, Unit 1 operates at 31 MW to 50 MW of the installed capacity. However, Units 2 and 3 were not renovated due to financial problem.

(2) New Lakhra Power Project

Preparatory survey for new 1×660 MW project is being carried out by JICA, as of April 2016.

New plant is planned to be installed at a vacant plot in the premises of the existing power station. Ultra Super Critical (USC) technology and imported coal use are adopted in the conceptual design. Imported coal of 2 mtpa will be transported through railway from Port Qasim area to the new plant. After the development of Thar coalfield, local coal will be blended up to 20%. The target commercial operation date (COD) is planned in June 2022.

Table 2-5 Summary of Lakhra Power Plant

Existing Plant		
✓	Capacity	3×50 MW
✓	Fuel Type	Indigenous coal (from Lakhra coal mine)
✓	Generation System	FBC boiler and steam turbine
Planned New Power Project		
✓	Capacity	1×660 MW
✓	Fuel Type	Blended coal (Imported coal: 80%; Thar coal: 20%[7])
✓	Generation System	USC technology
✓	COD	June 2022
✓	Coal Consumption	2 mtpa
✓	Coal Transportation	By railway from Port Qasim (PIBT)

Source: JST

Note: Red lines illustrate PR railway systems which pass nearby the project sites.

Source: Prepared by JST on Google Earth Image

Figure 2-3 Location of Planned Power Plants' Power Stations

2.2.2 Jamshoro

(1) Existing Jamshoro Power Station

Jamshoro Power Company Limited (GENCO-1), which is also managed by GENCO Holdings, operates 850 MW (Unit 1: 250 MW, Unit 2-4: 200 MW). As for Unit 1, boiler and turbine generator were supplied by Mitsui Engineering Shipbuilding Works and Fuji Electric

[7] The project plans to utilize blended coal; hoewever, development of Thar coalfield has already been delayed several years. At the beigining, 100 % of imported coal will be used in case further delay occur. Regarding transportation of coal from the coalfield, railway link will be required to the existing Mirpur Khas-Khokhropar line (approx. 150 km).

Ltd., respectively. Units 2 to 4 adopted Harubine Boiler and Harubine Turbine/ Electric. Unit 1 and Units 2 to 4 have different operation systems, so that Unit 1 (block 1) is discriminated against Units 2 to 4 (block 2) and operation data is collected individually. There is also a difference in fuel use between block 1 and block 2; block 1 uses residual fuel oil (RFO) only while block 2 uses both RFO and gas, i.e., dual firing.

Large-scale rehabilitation works to recover heat rate were conducted by the United States of Agency for International Development (USAID) in FY 2012-13 except for Unit 1. Net dependable capacity of the power station is about 649 MW of 880 MW.

(2) New Jamshoro Power Project

2×660 MW USC coal fired thermal power plant are planned next to the existing Jamshoro power plant. Loan Agreement (L/A) was concluded between the Asian Development Bank (ADB) and the Government of Pakistan (GOP) in February 2014 for US$900 million while the Islamic Development Bank (IsDB) approved US$220 million in March 2014. Blending coal with 80% of imported coal and 20% of lignite coal is planned. Imported coal is expected to be transported from Port Qasim area to the new power plant by railway. Expected coal consumption is 4.2 mtpa for 2×660 MW.

As of January 2016, an implementation consultant has been mobilized at the site and is reviewing bidding document. In terms of coal supply procurement, prequalification (PQ) has been ongoing as of January 2016 and pre-bid meeting was held in February 2016 in Jakarta.

COD is announced to be in 2018; however, the schedule is 2 years behind compared with the bar chart in the F/S report; therefore, operation is expected in September 2020 for the 1st unit and in December 2020 for the 2nd unit.

Table 2-6 Summary of Jamshoro Power Plant

Existing Plant	
✓ Capacity	880 MW (250 MW (Unit 1), 210 MW (Units 2 to 4))
✓ Fuel Type	Dual Fuel Firing (RFO and Gas)
✓ Generation System	Steam Turbine
Planned New Power Project	
✓ Capacity	2×660 MW
✓ Stem Temperature	593 ^{o}C/593 ^{o}C
✓ Steam Pressure	24.1 MPa
✓ Fuel Type	Blended Coal (Imported coal 80%: Thar coal 20%)
✓ Generation System	Ultra Super Critical (USC) technology
✓ COD	September 2020 for 1st unit, December 2020 for 2nd unit
✓ Coal Consumption	4.2 mtpa
✓ Coal Transportation	By railway from Port Qasim (PIBT)

Source: JST

2.3 New Power Projects in the Private Sector

2.3.1 Sahiwal Power Project

Source: Prepared by JST on Google Earth Image

Figure 2-4 Satellite Image of Sahiwal Power Station, as of January 2016

The project is ongoing in Qadirabad, Sahiwal District, Punjab Province by the joint consortium of Huaeng Shandong (Chinese), which holds 51% share, and Shandong Ruyi Science and Technology (Chinese), which holds 49%. The designed installed capacity is 2×660 MW and it is planned to use imported coal. Initially, the project was registered with PPDB and PPDB issued LOI. Letter of Support (LOS) was issued by PPIB, and IA and PPA were already signed. Water supply agreement was concluded between the irrigation department and the project.

Although the groundbreaking ceremony was held in May 2014, actual civil works commenced in February 2015 through their equity. Figure 2-4 shows the satellite image of the Sahiwal project site, as of January 2016. Construction work of the two circular cooling towers, buildings, and other works can be observed on the image.

The project plans to transport imported coal by railway from PIBT, which is currently being constructed and whose COD is expected in 2017, which is prior to COD of this project. Coal Supply Agreement (CSA) was entered between the project and PIBT; this is the only contract PIBT entered so far. Pakistan Railway (PR) issued a letter of comfort (LOC) and committed to transport imported coal of 4.2 mtpa for Sahiwal. PR has placed an order for 55 new locomotives and 800 wagons for coal transportation to the upper part of the country including this project. A spur line of around 4 km from the PR main line is planned and the budget will be from the Government of Punjab. Port Qasim Authority (PQA) has hired a local consultant, NESPAK, to study coal transportation by belt conveyor from PIBT to the railway system for this project. According to PQA, imported call shall be delivered from March 2017, six months prior to COD of the 1st unit.

As mentioned in Section 2.1.1, this project is on the prioritized projects list of CPEC and also one of the most promoted projects of Port Qasim Electric Company in Pakistan.

Table 2-7 Summary of Sahiwal Power Project

Planned Power Plant	
✓ Capacity	2×660 MW
✓ Stem Temperature	571 °C/569 °C
✓ Steam Pressure	25.5 MPa
✓ Fuel Type	Imported Coal
✓ Generation System	Super Critical (SC) technology
✓ COD	September 2017 for 1st unit, December 2017 for 2nd unit
✓ Coal Consumption	4.2 mtpa
✓ Coal Transportation	By railway from Port Qasim (PIBT)

Source: Prepared byJST based on Generation License and information from PPIB

2.3.2 Power Projects in Rahim Yar Khan

There are two 1×660 MW projects in Rahim Yar Khan District, Punjab Province. Each project plans to transport 2 mtpa of imported coal from Port Qasim area by railway.

(1) Nishat Energy Limited (NEL) Project

Nishat Energy Limited NEL is one of the Nishat group companies and it carried out F/S by hiring local consultant after receipt of LOI from PPDB and then submitted the F/S to PPDB. The project is waiting for the approval of Punjab Environment Protect Agency (EPA) and LOC from the National Transmission Dispatch Company (NTDC). PR already issued LOC. A captive siding shall be constructed by the project. After tariff determination, the project will be registered with PPIB to obtain LOS and sovereign guarantee.

COD is announced to PPDB as the end of 2018; however, in consideration of the progress of the project, PPDB expects it to be in the middle of 2019.

(2) Nishat Chunian Power Limited (NCPL) Project

Nishat Chunjan Power Limited NCPL is also one company under the Nishat group. It received LOI from PPDB in the beginning and reported that it would finish F/S by the end of 2015. However, no report has been submitted to PPDB yet. In accordance with the progress, PPDB expects COD to be in June 2019 similar to the NEL project. However, any progress on the project has not been informed to PPDB after the issuance of LOI. Hence, in accordance with the construction work arrangement with the NEL project, it is estimated that the project will be delayed for at least six months more and would start operation in December 2019.[8] On the other hand, PR already issued LOC.

Table 2-8 Summary of Power Projects in Rahim Yar Khan

NEL Project	
✓ Capacity	1×660 MW
✓ Fuel Type	Imported Coal
✓ COD	June 2019
✓ Coal Consumption	2 mtpa
✓ Coal Transportation	By railway from Port Qasim area
NCPL Project	
✓ Capacity	1×660 MW
✓ Fuel Type	Imported Coal
✓ COD	December 2019

[8] Since JST started the survey in the end of November 2015, no progress has been observed as of February 2016, which is the time for the 2nd survey. In addition, three months are considered for construction work arrangement with the NEL site which is next to the NCPL site. Therefore, six months will be added to PPDB's expected schedule.

✓	Coal Consumption	2 mtpa
✓	Coal Transportation	By railway from Port Qasim area

Source: Prepared by JST based on information from PPDB

2.3.3 Power Projects in Muzaffargarh

There are two 2×660 MW projects in Muzaffargarh District, Punjab Province. Each project plans to transport 2 mtpa of imported coal from Port Qasim area by railway.

(1) Kot Addu Power Company (KAPCO) Ltd Project

KAPCO has submitted the F/S report in January 2016 and the report is under evaluation by PPDB. PPDB currently studies the report considering Section 4 of the Land Acquisition Act 1894. Any problem on social consideration has not been reported so far to PPDB. PR already issued LOC. The PR main line passes on the boundary of the project site so that a dedicated spur line with short distance shall be required.

KAPCO is ready to submit tariff petition to NEPRA after the approval of F/S by PPDB. The project will be registered with PPIB after receipt of tariff determination by NEPRA. PPDB expects COD in September 2019 taking the progress into account.

(2) China Machinery and Engineering Company Project

China Machinery and Engineering Company (CMEC) has not reported the detail of the project to PPDB after receipt of LOI from PPDB. PPDB expects COD in September 2019 based on KAPCO's COD. No progress has been observed so far although PR already issued LOC.

Table 2-9 Summary of Power Projects in Muzaffargarh

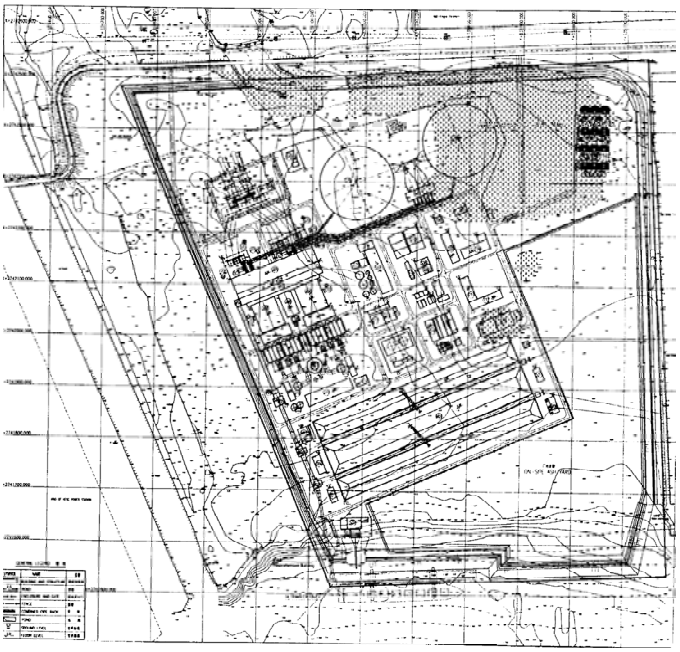
KAPCO Project		
✓	Capacity	1×660 MW
✓	Fuel Type	Imported Coal
✓	COD	September 2019
✓	Coal Consumption	2 mtpa
✓	Coal Transportation	By railway from Port Qasim area
CMEC Project		
✓	Capacity	1×660 MW
✓	Fuel Type	Imported Coal
✓	COD	March 2020
✓	Coal Consumption	2 mtpa
✓	Coal Transportation	By railway from Port Qasim area

Source: Prepared by JST based on information from PPDB

2.3.4 Other Power Projects

(1) Port Qasim Electric Power Company Limited Project

Al Marqab Group of Qatar and Sino Hydro Resources Limited China are sponsors of the project, and they incorporated a special purpose vehicle (SPV) in the name of Port Qasim Electric Power Company (Private) Limited (PQEPCL). The project is currently ongoing at Port Qasim. Layout plan and satellite image are shown in Figure 2-5.



Source: Upper: NEPRA, Bottom: Google Earth

Figure 2-5 Overview of Port Qasim Electric Power Company

Upper: Layout of the Power Station; Bottom: Satellite Image, as of December 2015

Source: JST

Figure 2-6 Photo Image of Construction Site of Port Qasim Electric Power Company

The designed installed capacity is 2×660 MW and it plans to use imported coal. The power plants will connect to K-Electric (KE) grid. The project includes a dedicated jetty to handle imported coal of 4 mtpa. LOS was issued by PPIB, and IA and PPA were already signed. The project adopts natural draft cooling technology in spite of seashore location. The cooling water is from adjacent sea channel of Port Qasim south of the site.

Construction work started in May 2015 through their equity, and the project achieved financial close in December 2015. Figure 2-5 shows the plant layout plan and satellite image as of October 2015. Foundations of cooling towers and stack and turbine and boiler building construction works are observed. COD is expected in December 2017 for 1st unit and June 2018 for 2nd unit.

As listed in Section 2.1.1, this project is one of the prioritized projects of CPEC.

Table 2-10 Summary of PQEPCL's Project

Planned Power Plant		
✓	Capacity	2×660 MW
✓	Stem Temperature	566 ^{o}C/566 ^{o}C
✓	Steam Pressure	24.2 MPa
✓	Fuel Type	Imported Coal
✓	Generation System	Super Critical (SC) technology
✓	COD	December 2017 for 1st unit, June 2018 for 2nd unit
✓	Coal Consumption	4 mtpa
✓	Coal Transportation	Dedicated Jetty

Source: Prepared by JST based on Generation License and information from PPIB

(2) Lucky Electric Imported Coal Based Power Project

Lucky Electric Power Company Limited (LEPCL) was incorporated in Pakistan in 2014 aiming to set up 1×660 MW power plant in Deh Ghangiaro in Bin Qasim Town near the Port Qasim area. The project is to be based on state of the art SC thermal technology with 200 m high chimney and has systems for emissions control, sea water flue gas desulfurization

(FGD) system, wastewater treatment, dust suppression, and other environmental mitigation measures. According to PPIB, the project plans to use 2 mtpa of imported coal which will be transported for around 1.5 km by conveyor belt from PIBT. LEPCL has already contacted PIBT for conclusion of the agreement regarding coal handling. PIBT disclosed it would be done in several weeks from February 2016.

At present, LOS has been issued by PPIB, and IA and PPA are being finalized. Expected COD of the project is March 2019.

Table 2-11 Summary of LEPCL's Project

Planned New Power Project	
✓ Capacity	1×660 MW
✓ Steam Temperature	566 °C/566 °C
✓ Steam Pressure	24.2 MPa
✓ Fuel Type	Imported Coal
✓ Generation System	Super Critical (SC) technology
✓ COD	March 2019
✓ Coal Consumption	2 mtpa
✓ Coal Transportation	By conveyor belt from PIBT

Source: Prepared by JST based on EIA report and information from PPIB

(3) Siddiqsons Imported Coal Based Power Project

Siddiqsons Energy Limited (SDSEL) was incorporated in 2014 to deliver both coal fired thermal power generation and solar generation in Pakistan. SDSEL is in development phase for the 350 MW imported SC coal fired thermal power plant at Port Qasim. LOS was issued by PPIB, and IA and PPA are to be finalized. Once-through sea water cooling system will be adopted for plant design. SDSEL plans to transport imported coal by trucks or barge from PIBT. SDSEL and PIBT exchanged memorandum of understanding (MOU) in terms of handling 1.2 mtpa so far.

LOS was already issued by PPIB, and IA and PPA are being finalized. COD is expected in March 2019.

Source: Prepared by JST on Google Image

Figure 2-7 Location Map of Power Plants at Port Qasim

Table 2-12 Summary of SDSEL's Project

Planned New Power Project	
✓ Capacity	1×350 MW
✓ Fuel Type	Imported Coal
✓ Generation System	Super Critical (SC) technology
✓ COD	March 2019
✓ Coal Consumption	1.2 mtpa
✓ Coal Transportation	By conveyor belt from PIBT

Source: Prepared by JST based on LEPCL website and information from PPIB

(4) Hub Power Company's Imported Coal-Based Project

Hub Power Company (HUBCO) is the first IPP established based on the Power Policy of 1994 in Pakistan. It operates 4×323 MW oil-based sub-critical thermal power plant in Lasbela District, Balochistan. The boilers were supplied by IHI, a Japanese manufacturer, and the turbine generators were supplied by Analdo, Italy.

HUBCO is going to install new 2×660 MW coal-based power plants next to the existing power station. These will consume 4 mtpa of imported coal transported through their own dedicated jetty and belt conveyor system.

LOI was issued by PPIB, and tariff determination and issuance of generation license are being processed by NEPRA. IA and PPA are also being finalized at present. COD is expected in 2018. So far, bidding for the EPC contract was conducted in Beijing in November 2015.

Table 2-13 Summary of HUBCO's Project

Planned New Power Project	
✓ Capacity	2×660 MW
✓ Fuel Type	Imported Coal
✓ COD	2018
✓ Coal Consumption	4 mtpa
✓ Coal Transportation	By conveyor belt through dedicated jetty

Source: Prepared byJST based on information from PPIB

(5) Grange Holdings Power Plant Project

The project is being executed by Grange Power Limited (GPL), which is a subsidiary of Grange Holdings Group of United Kingdom. GPL proposed 163 MW coal-based power plant in Arifwala District, Punjab. About 0.5 mtpa of imported coal is estimated to be consumed and planned to be transported by truck from PIBT. LOS was already issued by PPIB, and IA and PPA are being finalized. COD is expected in January 2019.

Table 2-14 Summary of GPL's Project

Planned New Power Project	
✓ Capacity	1×163 MW
✓ Fuel Type	Imported Coal
✓ COD	January 2019
✓ Coal Consumption	0.5 mtpa
✓ Coal Transportation	By truck from PIBT

Source: Prepared by JST based on information from PPIB

(6) K-Electric Project

K-Electric (KE) Limited, which provides electricity to Karachi and nearby city, and Hub, Utal, Vindarand, and Bela in Balochistan, is the only vertically integrated power utility in

Pakistan that manages generation, transmission, and distribution. KE was formerly known as Karachi Electric Supply Company (KESC), which was a government-owned company in 2005. It was then privatized and renamed as K-Electric with a new management in 2014. KE supplies power with installed capacity of 2,422 MW.

KE plans to install new 2×350 MW coal-based power plant which will bring an investment of over US$1 billion at Port Qasim. About 3.5 mtpa of imported coal is estimated for the 2×350 MW and MOU for handling the amount of imported coal has already been exchanged. In January 2015, KE has signed an agreement with CMEC to set up the project, and China Overseas Investment Company (CDTO) is onboard in this joint development agreement (JDA). KE announced that the power utility has acquired land at Port Qasim in January 2016. COD is expected in March 2018.

Generated power by KE is consumed within the KE grid network and does not transfer to the NTDC grid; therefore, new projects of KE are not required to be registered with PPIB for sovereign guarantee.

Table 2-15 Summary of KE's Project

Planned New Power Project	
✓ Capacity	2×350 MW
✓ Fuel Type	Imported Coal
✓ COD	December 2018
✓ Coal Consumption	3.5 mtpa
✓ Coal Transportation	From PIBT

Source: Prepared by JST based on website of KE and information from PIBT

(7) Fauji Power Plant Project

Fauji Foundation is one of the biggest groups in Pakistan and Fauji Fertilizer Bin Qasim Limited (FFBL) is one of its subsidiaries. FFBL Power Company (FPCL) was incorporated in June 2014 for setting up a coal fired generation power plant to sell 60 MW of power (1×60 MW steam turbine generator) to KE and other bulk consumer and 58 MW (2×24 MW steam turbine generators and 1×10 MW back pressure steam turbine) for in-house use and FFBL.

The 60 MW power outflow to the KE grid would not evacuate to the NTDC grid; therefore, the project is not required to register with PPIB. FPCL submitted tariff petition to NEPRA and exchanged MOU with PIBT. Moreover, job opening was publicized in August 2015. Financial close was achieved in December 2015 and COD is expected in March 2017.

Source: JST

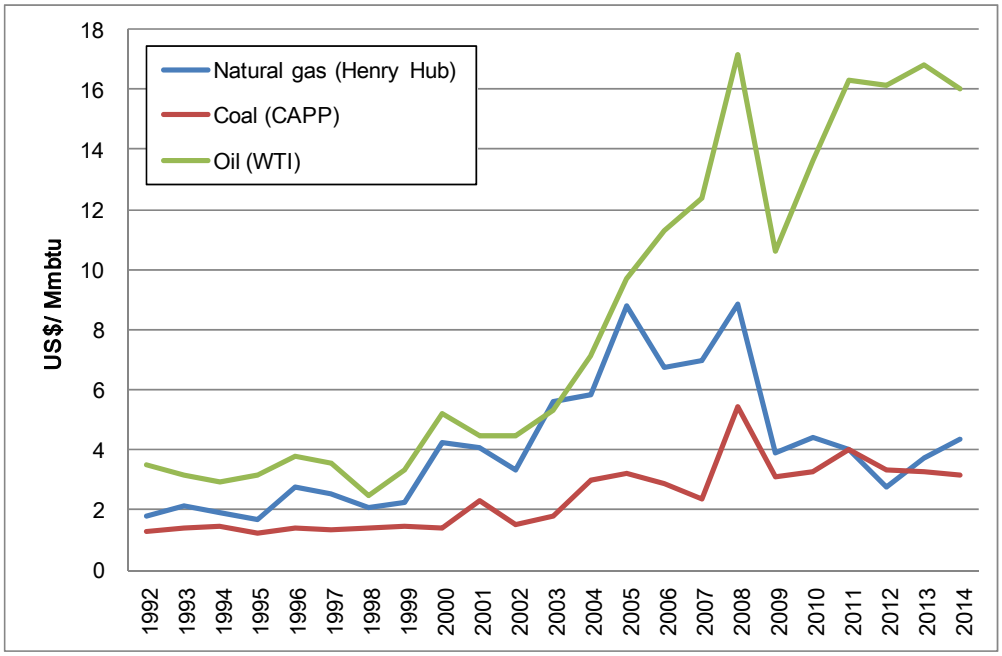
Figure 2-8 Photo Image of Construction Site of FFBL

Table 2-16 Summary of FPCL's Project

Planned New Power Project		
✓	Capacity	118 MW (1×60 MW, 2×24 MW, 1×10 MW)
✓	Fuel Type	Imported Coal
✓	COD	March 2017
✓	Coal Consumption	0.5 mtpa
✓	Coal Transportation	By truck from PIBT

Source: Prepared by JST based on tariff petition and information from PIBT

(8) Coal Conversion Projects



Source: Prepared by JST based on BP Statistical Review of World Energy, June 2015

Figure 2-9 Price History of Natural Gas, Coal and Oil in US$/Mmbtu

Figure 2-9 shows the historical prices of natural gas, coal and oil in US$/Mmbtu from 1992 to 2014. Oil price rapidly increased, and the price in 2014 was more than 4.5 times that in 1992. Price of natural gas fluctuated most intensely through the period whereas the price of coal is steadier and lower than the others. On account of the above situation, there are some plans to convert fuel from oil to coal.

Table 2-17 shows the coal conversion projects in the private sector.

Table 2-17 List of Coal Conversion Projects

Sr no	Implementation Body	Location	Capacity (MW)	Coal Consumption (mtpa)	Coal Transportation	Status	Financial Close	COD	Construction period
1	K-Electric	Port Qasim	420 (1×210)	1.5	-	Tariff awarded	-	-	28 months for 1st unit 32 months for 2nd unit
2	AES LALPIR	Muzaffargarh	362	0.93	By railway from Port Qasim/PIBT	Tariff awarded	-	-	36 months
3	Pakgen	Muzaffargarh	362	0.93	By railway from Port Qasim/PIBT	Tariff awarded	-	-	36 months
4	Saba Power Company	Farouqabad	136	0.4	By truck	Tariff awarded	-	-	30 months

Source: Prepared by JST based on information from PIBT

All entities have obtained generation license for the plants at which conversion project is to be implemented; therefore, they do not need to submit license application to NEPRA. On the other hand, they have to submit tariff petition in order to include the cost of the construction work for coal conversion into the tariff. For obtaining sovereign guarantee, issuance of LOI is not required for all projects; however, LOS is essential to connect to the NTDC grids except for the KE project. It is only possible to observe the progress of the projects after the NEPRA process unless the projects are publicized. As for transportation of imported coal, AES Lalpir and Pakgen are in Muzaffargarh, and the coal will be transported by railway from Port Qasim/PIBT. The amount of coal is estimated at 1.86 mtpa for both plants.

Before, Muzaffargarh (GENCO 3) in the private sector planned to implement coal conversion; however, it was canceled.

The summary of new projects reviewed in Section 2.2 and 2.3 is presented in Table 2-18.

Table 2-18 Summary of New Coal Projects in Pakistan Using Imported Coal

	Project Name	Implementing Body	Location	Capacity (MW)	Coal Consumption (mtpa)	Coal Transportation	Status	Financial Close	COD	Forecast of PPDB	Expectation by JST
1	Lakhra Power Plant	GENCO	Lakhra, Sindh	660	2	Railway from PIBT	Feasibility Stage	JICA	June 2022		
2	Jamshoro Power Plant	GENCO	Jamshoro, Sindh	1320	4.2	Railway from PIBT	Bidding Doc is under Review by Mott MacDonald. Tender floating: end of 2015 ⇒**Delayed.** PQ floating for coal: Jan. 2016	ADB LA Dec2013 (ADB and IsDB US$ 1,120 million)	in 2018		Considering 2 years delay against the bar chart in FS Report, →1st 2020 Q3, 2nd 2020 Q4
3	Sahiwal Imported Coal Based Project	Shandong	Sahiwal, Punjab	1320	4.2	Railway from PIBT	Tariff awarded. LOS issued. IA and PPA signed. The construction is ongoing by their own equity.	End of 2015 ⇒**Delayed**	1st Sep 2017, 2nd Dec 2017		
4	NEL Project	Nishat Energy Ltd (NEL)	RahimYar Khan, Punjab	660	2	Railway from PIBT	LOI issued by PPDB F/S report has been approved by PPDB. (EIA: approved, connection to grid: under evaluation by NTDC, Land acquisition: in process) NOT registered to PPIB yet			PIBT and Railway COD: Jun 2019	COD: Jun 2019
5	NECL Project	Nishat Chunian Power Ltd (NCPL)	RahimYar Khan, Punjab	660	2	Railway from PIBT	LOI issued by PPDB feasibility stage Not registered to PPIB yet			PIBT and Railway COD: Jun 2019	COD Dec 2019
6	KAPCO Coal Fired Power Project	KAPCO (Kot Addu Power Company)	Muzaffargarh, Punjab	660	2	Railway from PIBT	LOI issued by PPDB Feasibility stage (F/S report is under evaluation by PPDB.) not registered to PPIB yet			PIBT and Railway COD: Sep 2019	COD :Sep 2019
7	CME Coal Fired Power Project	China Machinery Engineering Corp	Muzaffargarh, Punjab	660	2	Railway from PIBT	LOI issued by PPDB Feasibility stage Not registered to PPIB yet			PIBT and Railway COD: Unknown	COD: Mar 2020

	Project Name	Implementing Body	Location	Capacity (MW)	Coal Consumption (mtpa)	Coal Transportation	Status	Financial Close	COD	Forecast of PPDB	Expectation by JST
8	Port Qasim Power Project	Sinohydoro and AL Mirqab Capital	Port Qasim, Sindh	1320	4	Dedicated jetty and belt conveyor	Tariff awarded. LOS Issued. IA and PPA signed. The construction was started by their own equity.	Dec 2015 **Achieved**	1st: end of 2017, 2nd: Jun 2018		
9	Lucky Electric Imported Coal Based Power Project	Lucky group	Port Qasim, Sindh	660	2	Conveyor Belt from PIBT MOU	Tariff awarded. LOS issued. Security Package are being finalized.	Jun 2016	Mar 2019		
10	Siddiqsons Imported Coal Based Power Project	Siddiqsons	Port Qasim, Sindh	350	1.2	Truck/Barge from PIBT MOU	Tariff awarded. LOS issued. Security Package are being finalized.	Mar 2016	Mar 2019		
11	HUBCO Imported Coal based Power Project	HUBCO	Hub, Balochistan	1320	4	Dedicated jetty and belt conveyor	LOI issued. Tariff determination and issuance of generation license: second week of Dec2015 Security Package are being finalized.	Apr 2016	in 2018		
12	Grange Holdings Power Plant	Grange Holdings	Arifwala, Punjab	163	0.5	Truck from PIBT	Tariff awarded. LOS Issued. Security Package are being Finalized.	Feb 2016	Jan 2019		
13	K-Electric 2 × 350 MW	K-Electric	Port Qasim, Sindh	700	3.5	PIBT MOU	Not registered to PPIB JDA was concluded. Land acquisition 's done.	not announced	Mar 2018		
14	Fauji Power Plant Project	FFBL PowerComapny	Port Qasim, Sindh	118	0.5	Truck from PIBT MOU	No need to register to PPIB	Dec2015 **Achieved**	Mar 2017		

Source: JST

2.4 Demand Forecast

It is essential for designing coal handling facilities at port area and the section between port area and newly installed coal loading station to estimate the quantity of imported coal which will be consumed at thermal power stations. In the present JICA study, demand forecast is estimated from conservative point of view; namely, all possible coal power plants which are registerd to PPIB, listed in CPEC list and GENCO's planned project.

2.4.1 Coal Handling at PIBT

(1) Coal Demand for Agreement and MOU

With reference to Section 2.2 and 2.3, the projects which concluded agreement and exchanged MOU with PIBT are listed in below.

Table 2-19 List of Projects which Concluded Agreement and Exchanged MOU

	Project Name	Location	Capacity (MW)	Coal Consumption (mtpa)	Coal Transportation from PIBT	COD
Coal Handling Agreement						
1	Sahiwal Imported coal based project	Sahiwal, Punjab	1320	4.2	Railway	1st Sep 2017 2nd Dec 2017
sub-Total				4.2		
Exchange MOU						
2	K-Electric 2×350 MW	Port Qasim, Sindh	700	3.5	not announced	Mar 2018
3	Siddiqsons imported coal based power project	Port Qasim, Sindh	350	1.2	Truck or Barge	Mar 2019
4	Fauji Power Plant Project	Port Qasim, Sindh	118	0.5	Truck	Mar 2017
5	Lucky Electric Imported Coal based power project	Port Qasim, Sindh	660	2	Conveyor Belt	Mar 2019
sub-total				7.2		
Total of Agreement/MOU				11.4		

Source: JST

Sahiwal is the only project which entered into coal supply agreement with PIBT. KE, Siddiqsons, and Fauji have exchanged MOUs, and LEPCL is going to exchange in the near future. The total amount of coal handled at PIBT is 11.2 mtpa as against the Phase 1 capacity

of 12 mtpa. Even though Sahiwal is the only project with assured coal unloading terminal and KE and Fauji projects have not registered with PPIB, Phase 1 capacity is almost full at present. PIBT plans to develop Phase 2 to enhance the handling capacity to 20 mtpa in order to address the demand increase.

(2) Coal Demand for All Projects Planning to Use Coal at PIBT

Table 2-20 shows the list of projects which plan to handle imported coal at PIBT.

Table 2-20 List of Projects which Plan to Handle Coal at PIBT

	Project Name	Location	Capacity (MW)	Coal Consumption (mtpa)	COD
By Railway from PIBT					
1	Lakhra Power Plant	Lakhra, Sindh	660	2	at the end of June 2022
2	Jamshoro Power Plant	Jamshoro, Sindh	1320	4.2	in 2020 (estimated)
3	Sahiwal Imported coal based project	Sahiwal, Punjab	1320	4.2	1st Sep 2017, 2nd Dec 2017
4	NEL Project	RahimYar Khan, Punjab	660	2	Jun 2019 (estimated)
5	NECL Project	RahimYar Khan, Punjab	660	2	Dec 2019 (estimated)
6	KAPCO coal fired power project	Muzaffargarh, Punjab	660	2	Sep 2019 (estimated)
7	CME coal fired power project	Muzaffargarh, Punjab	660	2	Mar 2020 (estimated)
8	AES LALPIR (sub critical)	Muzaffargarh, Punjab	362	0.93	-
9	Pakgen (sub critical)	Muzaffargarh, Punjab	362	0.93	-
sub-Total				20.26	
By Others from PIBT					
10	Grange Holdings power Plant	Arifwala, Punjab	163	0.5	Jan 2019
11	Lucky Electric Imported Coal based power project	Port Qasim, Sindh	660	2	Mar 2019
12	Siddiqsons imported coal based power project	Port Qasim, Sindh	350	1.2	Mar 2019
13	Fauji Power Plant Project	Port Qasim, Sindh	118	0.5	Mar 2017
14	K-Electric 2×350 MW	Port Qasim, Sindh	700	3.5	Mar 2018
sub-Total				7.7	
Total of Handling at PIBT				27.96	

Source: JST

Total demand of coal handling at PIBT is estimated at 27.96 mtpa for all transportation modes from PIBT. The amount of coal exceeding the capacity of 20 mtpa is considered for Phase 2. On the other hand, it is not assured that all projects listed above will be developed and will transport coal from PIBT as planned except for the Sahiwal project. On account of the situation, PIBT will develop Phase 2 by observing the actual progress of projects.

(3) Coal Demand to be Transported by Railway from PIBT

As shown inTable 2-20, coal demand to be transported by railway from PIBT is estimated at 20.26 mtpa (Sr no. 1 to 9 in Table 2-20). Meanwhile, there is no information regarding the progress of coal conversion projects at present except tariff determination. KE plans both new power projects and coal conversion, and only the new projects are making progress. From this viewpoint, the progress of coal conversion projects (Sr nos. 8 and 9 in Table 2-20) is not clear.

In terms of Sr nos. 4 to 7 in Table 2-20, these projects are still at the feasibility stage and have not registered with PPIB yet. On the other hand, projects in Muzaffargarh and Rahim Yar Khan are on the CPEC list as nos. 7 and 12, respectively. Moreover, construction works at Port Qasim (no. 1) and Sahiwal (no. 3) will be completed and trial run will only be conducted for 2.5 years from commencement. In consideration of this situation, coal demand of these projects is included in this survey, resulting in 18 mtpa of imported coal to be transported to the northern part of the country by railway from PIBT. Focusing on financial possibility, Sahiwal, Jamshoro, and Lakhra are taken into account and the amount of consumption is estimated as 10.40 mtpa; however, 20.26 mtpa is adopted in the present JICA study to be on a more conservative side in planning the coal handling facilities,

Table 2-21 Summary of Amount of Coal Transported by Railway at PIBT

Unit: mtpa

Handling at PIBT (all)	27.96
Handling at PIBT and transported by railway (including coal conversion)	20.26 adopted
Handling at PIBT and transported by railway (excluding coal conversion)	18.40
Handling at PIBT and transported by railway (excluding FS stage) with high reliability of finance	10.40

Source: JST

2.4.2 Coal Deamand Forecast for 30 years

Coal demand forecast for 30 years is estimated in Table 2-22 based on 20 mtpa. The required amount of coal for trial run is assumed at 40% of full load based on experience of Japanese USC plant. Trial run period is considered to be nine months before COD for Jamshoro and Lakhra projects. As for Sahiwal project, PQA mentioned that coal would be transported six months before COD, thus coal demand on the site is estimated as well. Only PPDB has information regarding the two projects in Muzaffargarh and two projects in Rahim Yar Khan. Based on hearing from them, construction periods are considered to be only 2.5 to 3 years to usual period of four years. Accordingly, 6.75 months are expected for these four projects. Finally, the coal demand transported by railway from PIBT is 20.26 mtpa after COD of the Lakhra power project.

Table 2-22 Demand Forecast of All Imported Coal which will be Transported by Railway from PIBT

year	C.Y.	Sahiwal	Jamshoro	Lakhra	Rahim Yar Kahn (NEL)	Rahim Yar Kahn (NCPL)	muzaffargarh (KAPCO)	muzaffargarh (CME)	AES LARPIL (coal conv)	Pakgen (coal conv)	Total
0	**2016**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
1	**2017**	1.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**1.79**
2	**2018**	4.20	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	**4.25**
3	**2019**	4.20	0.00	0.00	1.40	0.45	0.95	0.25	0.65	0.65	**8.55**
4	**2020**	4.20	1.79	0.00	2.00	2.00	2.00	1.70	0.93	0.93	**15.55**
5	**2021**	4.20	4.20	0.20	2.00	2.00	2.00	2.00	0.93	0.93	**18.46**
6	**2022**	4.20	4.20	1.40	2.00	2.00	2.00	2.00	0.93	0.93	**19.66**
7	**2023**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
8	**2024**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
9	**2025**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
10	**2026**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
11	**2027**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
12	**2028**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
13	**2029**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
14	**2030**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
15	**2031**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
16	**2032**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
17	**2033**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
18	**2034**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
19	**2035**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
20	**2036**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
21	**2037**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
22	**2038**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
23	**2039**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
24	**2040**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
25	**2041**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
26	**2042**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
27	**2043**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
28	**2044**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
29	**2045**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**
30	**2046**	4.20	4.20	2.00	2.00	2.00	2.00	2.00	0.93	0.93	**20.26**

Source: JST

Chapter 3 Coal Transportation Plan between Coal Unloading Terminal and Coal Loading Station

3.1 Coal Unloading Plan at PQA

There are few existing facilities for unloading coal at Port Qasim Authority (PQA), such as Marginal wharf and Iron Ore and Coal Berth (IOCB). Marginal wharf is handling general cargo and limited quantity of coal. Pakistan Steel Mill (PSM) is handling coal for its own use through Iron Ore and Coal Berth (IOCB). A new facility is being developed for handling bulk at the Pakistan International Bulk Terminal (PIBT) under the build-operate-transfer (BOT) scheme.

The location of these facilities is shown in Figure 3-1.

Source: JST

Figure 3-1 Existing Coal Handling Facilities at PQA

3.1.1 Marginal Wharf

Marginal wharf has shallow draft (9.0 m) and will berth 25,000 to 35,000 DWT. PQA is planning to utilize marginal wharf berth for imported coal handling purpose, giving a concession to single investor of power plant for its own use. PQA has officially announced the plan and few companies have already visited the site. The coal handling capacity will be 4 mtpa approximately. Photos show the unloading of coal at Marginal wharf and Port Qasim station located behind of Marginal wharf in Figure 3-2.

Source: JST

Figure 3-2 Unloading Coal from Ship and Port Qasim Station Yard

3.1.2 Iron Ore and Coal Berth (IOCB)

IOCB can berth ships of up to 50,000 DWT, and can handle up to 3 mtpa of cargo. However, due to the privatization process of PSM, it is difficult to confirm the future operation of IOCB by new investor, capacity of IOCB may be studied in future but not be counted in this repot

3.1.3 Pakistan International Bulk Terminal (PIBT)

PIBT has been planned as a dedicated terminal for coal, clinker, and cement at Port Qasim, and construction work is ongoing. The planned maximum bulk handling capacity for Phase 1 is 12 million tons per annum (mtpa) for coal and 4mtpa for cement & clinker. The planned setup of the wharf is characterized as follows:

(1) Length of wharf: 460 m with mooring dolphins along both sidesof the wharf, which is able to simultaneously berth two 55,000 DWT coal carriers.
(2) Capacity and units of unloader: 1,850 t/hr and 2 units.
(3) Draft of the wharf: -12.5 m
(4) The wharf is connected to the storage area via trestle bridge of 2.5 km in length
(5) Two conveyor belts will be provided on trestle bridge, one for coal imports and the other for exports of cement and clinker

PIBT expressed that it would expand the capacity of the terminal in accordance with the demand of the clients and that, in Phase 2, the maximum handling capacity would together be further expanded up to 20 mtpa by installing two additional units of unloaders. However, based on the analysis of the JICA Study Team (JST), refer to section 3.2 of this report, it will be possible to handle 28 mtpa when Phase 2 is completed. If coal handling capacity of more than 28 million tons will be required, additional one berth with unloaders shall be constructed.

3.2 Potential Capacity of Coal Unloading Terminal

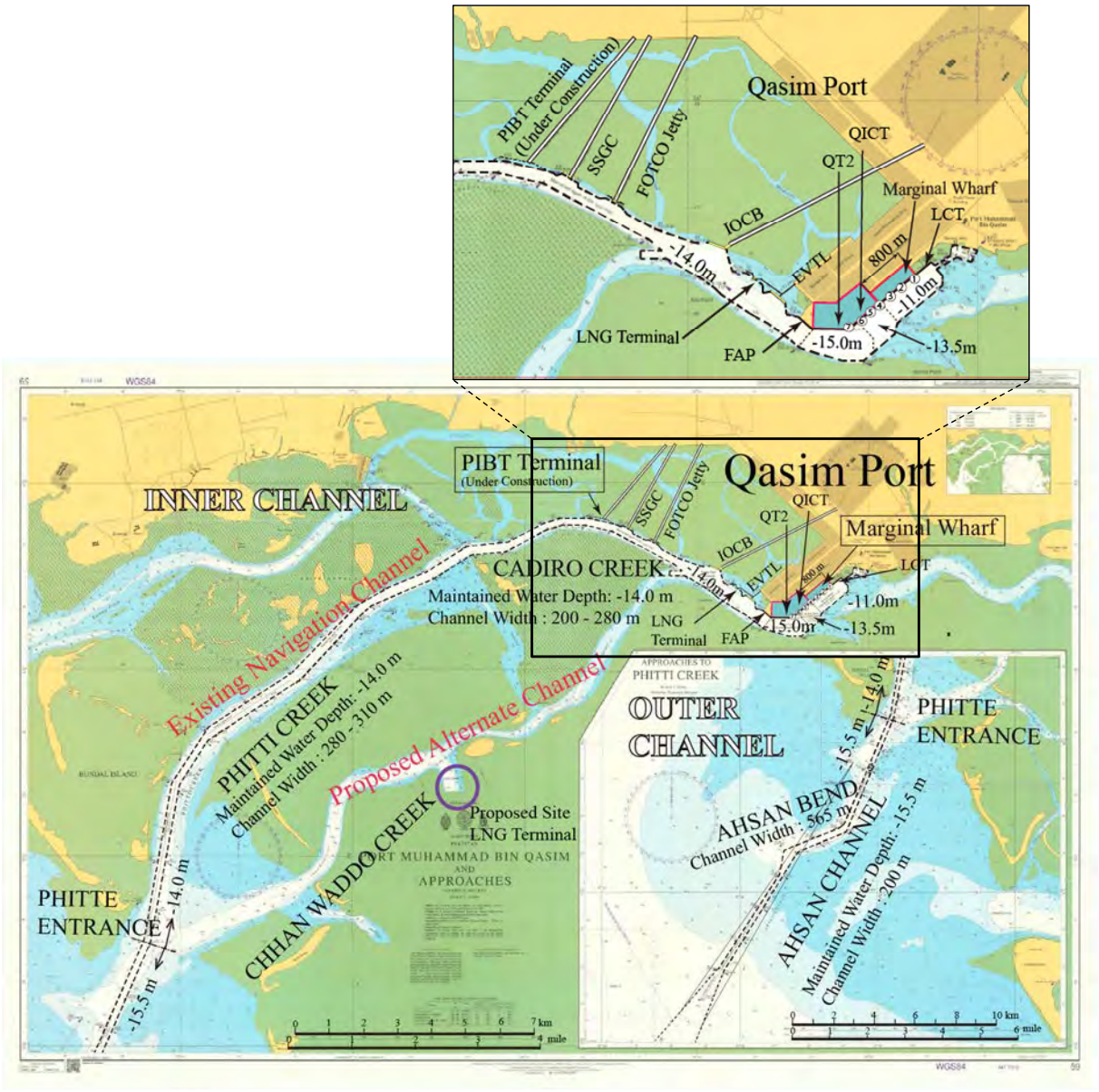
3.2.1 Premises (Conditions of Calculation)

There are various factors that affect the capacity of PIBT berth. Some quantities are given or determined by the channel configuration, while others are given by the port regulation or chosen as planning and design criteria of the PIBT coal terminal.

(1) Quantities Determined by the Configuration of the Navigation Channel

The configuration of the access navigation channel to the Port of Qasim is shown in Figure

3-3.



Source: British Admiralty Sea Chart, edited by JST

Figure 3-3 Access Navigation Channel and Locations of Port Terminals at the Port of Qasim

The access navigation channel comprises the Outer Channel, which is called the Ahsan Channel, and the Inner Chanel, which is composed of the Phitti Creek and the Cadiro Creek. The Outer Channel is -15.5 m deep, while the Inner Channel is -14.0 m deep. The width of the channel varies from 200 m to 310 m. Currently, the channel provides one-lane navigation channel.

The total length of the navigation channel is 45 km including the outer and the inner channel.

At the end of the navigation channel, there is a PQA wharf that comprises the liquid cargo terminal (LCT), the marginal wharf, container terminals (QICT and QT2), and grain and fertilizer terminal.

The southeast side of the wharf has a 1,500 m long quay wall that comprises two parts,

namely, 800 m long marginal wharf, which is divided into four berths having a water depth of -11 m, and 700 m long QICT container terminal that is divided into two berths having a water depth of -13.0 m.

The southern side of the wharf is the newly developed QT2 container terminal that has a 600 m long quay wall divided into two berths having a water depth of -15 m.

The triangular area at the tip of the wharf is the grain and fertilizer terminal, which is called Fauji Akbar Portia Grain and Fertilizer Terminal (FAP GT).

To the west of the wharf and toward the downstream of the navigation channel, there are five jetties, namely: Engro Vopak Chemical Terminal (EVTL), LNG Terminal, IOCB, FOTCO Oil Jetty, and SSGC (LPG Terminal). While FOTCO was constructed under the Build, Own and Operate (BOO) scheme, other jetties were constructed under the Build, Operate and Transfer (BOT) scheme. These jetties are operated by respective companies to load and unload their own commodities. In addition, another jetty, i.e., PIBT, is now under construction.

The structure type, commodities, maximum length and draft of ship, and the maximum and minimum lengths and cargo volumes of the ships that dock at each terminal are summarized in Table 3-1.

Table 3-1 Characteristic Quantities of Each Terminal in Port Qasim

Berth/Terminal	Name of Terminal	Structure type	Commodity	Permissible Draught (m)	Permissible LOA (m)	Ships docked in Jan 24 - Mar 15, 2016			
						LOA (m)		Cargo Volume handled (ton/ TEU*)	
						Max	Min	Max	Min
LCT	Liquid Cargo Terminal	Pier	Eddible oil	10	210	183	128	34,000	9,999
MW Berth No.1	Multi-purpose Wharf	Wharf	Break Bulk, General Cargo	10	225	144	100	16,500	4,616
MW Berth No.2						200	32	40,000	329
MW Berth No.3						200	32	23,532	359
MW Berth No.4				10.5		200	32	42,470	1,120
QICT - 1	Qasiom International Container Terminal	Wharf	Container	12	310	337	207	4,670*	588*
QICT - 2				13		354	199	4,111*	3131*
QT2-I	2nd CONTAINER TERMINAL		Container			334	255	2637*	630*
QT2-II						334	222	3,743*	970*
FAP G.T.	Fauji Akbar Portia Grain & Fertilizer Terminal	Wharf	Grain, Fertilizer	13 Max. 75,000DWT	250	229	185	64,581	28,845
EVTL -13	ENGRO VOPAK CHEMICAL TERMINAL	Pier	Chemical Products, LPG	11	225	178	99	22,074	1,600
LNG - 1	LNG Terminal	Pier		12	295	315	291	143,352	63,920
IOCB	IRON ORE & COAL BERTH	Pier	Iron Ore, Coal	12.00 Max. 75,000DWT	230	0	0	0	0
FOTCO Oil Jetty		Pier	Fuel Oil, Crude Oil	13 Max. 75,000DWT	245	250	180	69,999	10,033
SSGC / LPG	LPG Terminal	Pier	LPG	10	163	139	99	6,821	1,697
PIBT	Pakistan International Bulk Terminal	Pier	Coal, Clinker						

Note *: Total of unloaded and loaded containers

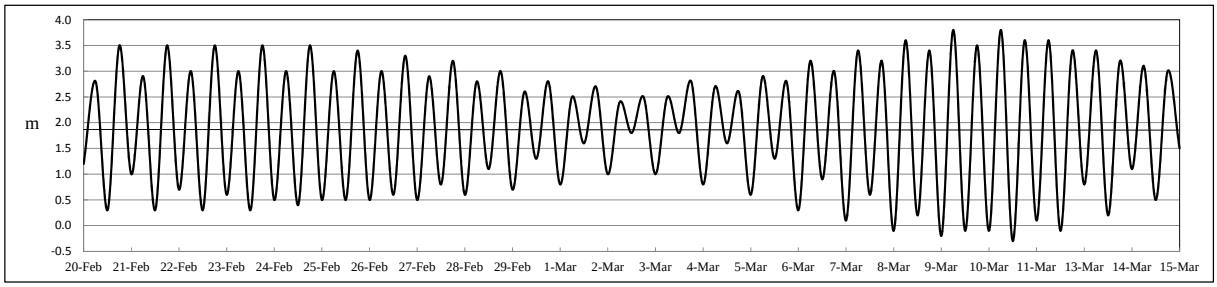
Source: Notice to Mariner No.76/2015 and Daily Vessel Movement (PQA Website, edited by JST)

Ships larger than 40,000 DWT dock at the marginal wharf, while post-panamax size container carriers call at the container terminals (QICT and QT2). Ships over 60,000 DWT dock at the FAP GT and LNG Terminal and FOTCO Oil Jetty.

In general, calling ships are docking during daytime, while some ships calling on container terminals and LNG terminal dock during nighttime.

Figure 3-4 shows the fluctuation of tide level from February 20 to March 15, 2016. The

fluctuation is semi-diurnal.



Source: Daily Vessel Movement from PQA Website

Figure 3-4 Tide Level Fluctuation from February 20 to March 15, 2016

The characteristic tidal levels are listed in Table 3-2. The tidal range is about 4 m at the largest.

Table 3-2 Tide Table at Port Qasim

Parameter	Unit	Channel Entrance	Port Qasim
Highest Astronomical Tide	H.A.T.	+3.67 m	+4.01 m
Mean Higher High Water	M.H.H.W.	+3.10 m	+3.45 m
Mean Lower High Water	M.L.H.W.	+2.42 m	+2.66 m
Mean Sea Level	M.S.L.	+2.87 m	+2.03 m
Mean Higher Low Water	M.H.L.W.	+1.32 m	+1.40 m
Mean Lower Low Water	M.L.L.W.	+0.64 m	+0.62 m
Lowest Astronomical Tide	LAT	-0.50 m	-0.57 m

Source: Pakistan Tide Tables 2015 from the Hydrographic Department Pakistan Navy

The tidal current at the navigation channel is shown in Table 3-3. In the Inner Channel, the current is usually longitudinal in line with the navigation channel, while in the outer area of the Phitti Creek System, two directions of currents are noticed, namely, westerly current during the northeast monsoon and easterly during the southwest monsoon. Maximum velocities are about one to two knots during the monsoon periods. Tides are generally stronger during falling tide than during rising tide.

Table 3-3 Tidal Current (knot)

Location	Flood		Ebb	
	Maximum	Average	Maximum	Average
Approach Channel	2.0	1.1	2.5	1.0
Phitti Creek	2.2	1.3	2.8	1.1
Kadiro Creek	1.2	0.8	1.9	1.0

Source: Port Qasim Project, Navigational Study Report, February 1975

Based on the information given in the chart and the announcement of PQA, the following quantities are employed for the examination of the capacity of PIBT:

a. Channel length: 45 km (24.3 mile)
b. Channel width: 200 m （One-way traffic）
c. Passing lane: Sometimes allowed except LNG carriers
d. Inner Channel depth: - 14 m

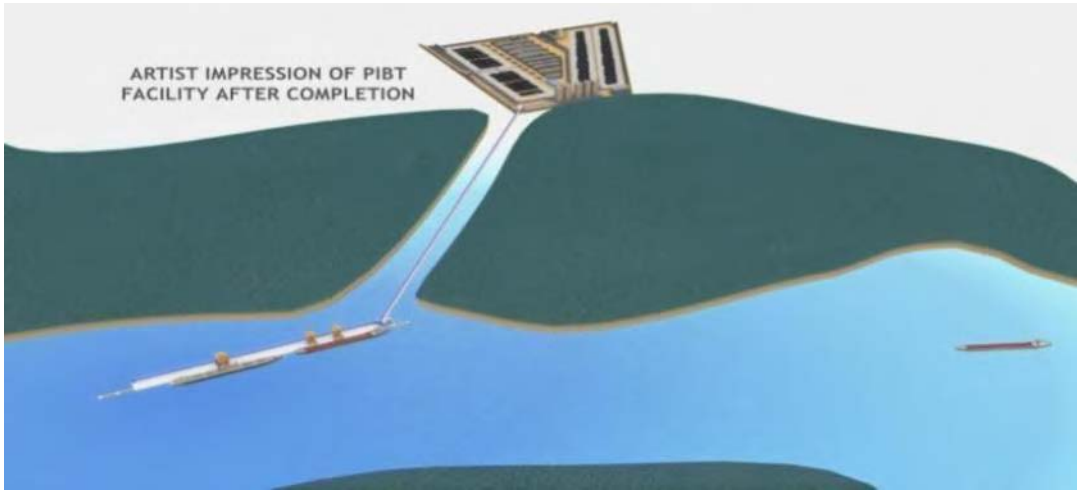
(2) Quantities Regulated by PQA

The following quantities related to the current operation of PQA are given by the PQA officials during the interview:

a. Channel operation hour: 24 hours a day, 365 days a year (Night navigation is allowed)
b. Navigation speed: 6 to 12 knots
c. Navigation time is 3.5 hours up to marginal wharf and 2.5 hours up to the LNG terminal

(3) Quantities Selected as Design/Planning Criteria

The setup of the PIBT is schematically shown in the website of PIBT (see Figure 3-5).



Source: Website of PIBT

Figure 3-5 Schematic Image of PIBT

The following quantities are given in PC-1:

a. Design ship size: Coal carrier of 55,000 DWT
b. Length of wharf: 460 m with two mooring dolphins on both sides of the wharf.
c. Number of berth: 2 berths
d. Number of units of unloader: 2 units (1 unit per berth)
e. Average productivity of the unloader: 1,350 t/hr/unit

(4) Other Quantities

The following quantities related to the operational aspects are not specified in the PC-1 report:

a. Workdays of the wharf per year,
b. Hours required for docking and mooring a ship.
c. Hours required for custom, immigration and quarantine (CIQ) procedures and preparation for unloading.
d. Hours required for preparation for departure (ending unloading work), and
e. Hours required for unmooring and departure of ship.

For the purpose of examining the coal unloading capacity of the PIBT berths, the above quantities are quantified by JST as listed in Table 3-4 on the basis of commonly observed figures in many ports around the world. It should be noted that the hours required for

unloading 55,000 t of coal per berth, i.e., 40.7 hours denoted with * in the table is calculated under the condition that just one unit of unloader with a productivity of 1,350 t/h is employed: 55,000 t / (1,350 t/h) = 40.7 hours. Thus, it is expected that the unloading time will be reduced to half or 20.4 hours with simultaneous operation of two unloader units per ship.

Table 3-4 Work Steps at Wharf and Required Time for Each Step

Work Step	Estimated Time
1) Docking and mooring of ship	1.0 hour
2) CIQ procedure and preparation of unloading	1.5 hours
3) Unloading 55,000 t of coal per berth (with one unloader)	40.7 hours*
4) Removal of equipment and preparation for departure	1.5 hours
5) Unmooring and departure of ship	1.0 hour
Total hours for the whole cycle	45.7 hours

Note: * one unit of unloader per ship, prepared by JST

3.2.2 Examination of the PIBT

(1) Examination of Wharf Operation Proposed in the PC-1 Plan

The following examination of the capacity of PIBT Berth considers that there is no restriction imposed on navigation along the channel. Thus, it is assumed that ships can dock and leave the PIBT Berth at any time.

The total hours required for unloading coal from a ship loaded with 55,000 t is estimated as the total of the times required for the following work steps: 1) docking of a ship, 2) preparation for unloading, 3) unloading coal, 4) ending the unloading work, and 5) unmooring the ship. The total time required to complete one cycle of the activities is 45.7 hours (see Table 3-4).

The PIBT has a phased development plan, i.e., 8 mtpa for the beginning stage and 12 mtpa for Phase 1. Further expansion plan is called Phase 2. Under the assumption that coal is brought by ships loaded with 55,000 t, the total number of ship calls per year for the beginning stage and Phase 1 are estimated at 145.5 and 218.2 ships, respectively (see Table 3-5). Since the whole cycle of the unloading operation of a ship requires 45.7 hours, the total operation hours for Phase 1 and Phase 2 are estimated at 3,327 hours (or 139 days) and 4,990 hours (or 208 days), respectively.

The Berth Occupancy Ratio (BOR), which is shown in the right column of Table 3-5, is a parameter that is often utilized to indicate the magnitude of the congestion of berths. BOR is calculated as the ratio of the total hours that ships are docked at the berth to the total hours in a year: in general, the hours required for docking (mooring) and releasing (departure), namely, work steps 1) and 5) in Table 3-4, are not included. It is generally recognized that ship waiting queue occurs if BOR is higher than 60% and that, with the assumption of random arrival of ships, the waiting time of ships sharply increases as BOR increases beyond 70%.

Table 3-5 Calculation of Total Ship Calls and the Berth Occupancy Rate

Phase	Volme per Year (t/year) (1)	Volume per ship (ton) (2)	Number of ships per year (ship) (3) [= (1) / (2)]	Total hours required (hour/year) (4) [= (3) x 45.74]	Number of berth (5)	Total hours per berth (hour) (6) [=(4)/(5)]	Berth Occupancy Ratio (7)
Phase I	8,000,000	55,000	145.5	6,653	2	3,327	34.7%
Phase II	12,000,000	55,000	218.2	9,980	2	4,990	52.0%

Source: JST

The BOR of Phase 2 of PC-1 is 52%, which is less than 60%. Therefore, it is assessed that even in Phase 2, the PITB wharf can smoothly operate without making calling ships wait before docking provided that there is no restriction for channel navigation. On the average, the frequencies of ship calls at Phase 1 and Phase 2 are once every four days and every three days, respectively.

3.2.3 Possible Ways to Increase the Unloading Capacity at the PIBT Berth

(1) Capacity Enhancement at the Wharf

The wharf can handle more volume by accepting more ships. Possible steps to increase the number of ships are as follows:

Step 1: To reduce the idle time of the wharf, i.e., to allow higher BOR, by reducing the interval between departure and the arrival of next ship.
Step 2: To install additional unloaders to increase unloading productivity so that the operation hour per ship is shortened.
Step 3: To expand wharf and install additional unloaders so that PIBT can operate three ships simultaneously.

(2) Step 1 for Capacity Enhancement

Table 3-6 shows how the BOR increases in accordance with the increase of the total unloading volume per year.

Table 3-6 Annual Unloading Volume vs. Berth Occupancy

Volme per Year t/year (1)	Volume per Ship (ton) (2)	Number of ships (ship) (3) [(1) / (2)]	Units per berth (Unloader) (4)	Operation hours per ship (hour) (5)	Total hours required (hour) (6) [(3) x (5)]	Hours required per berth (7) [(6)/2]	BOR (%) (8)
4,000,000	55,000	72.7	1	45.7	3,327	1,663	18.2%
8,000,000	55,000	145.5	1	45.7	6,653	3,327	36.3%
12,000,000	55,000	218.2	1	45.7	9,980	4,990	54.5%
18,000,000	55,000	327.3	1	45.7	14,970	7,485	81.7%
20,000,000	55,000	363.6	1	45.7	16,633	8,316	90.8%

Source: JST

The proposed plan (PC-1) does not specify the total working days of PIBT Berth. However, it seems realistic to assume that actual working days should be less than 365 days per year and that 20 to 30 days should be required for scheduled facility maintenance and occasional suspension of work due to bad weather or mechanical breakdown. With the assumption that

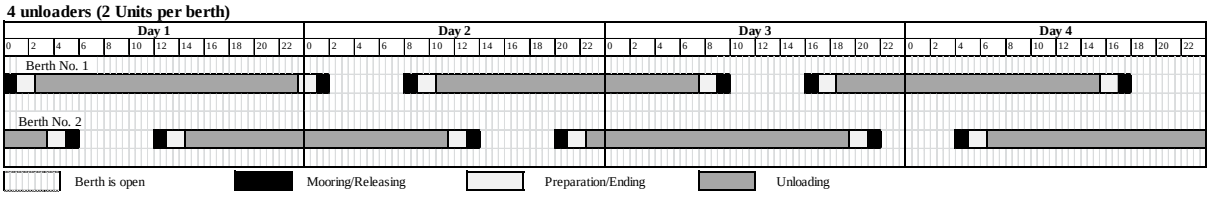
monthly maintenance of equipment should require one full-day stop of the operation, i.e., a total of 12 days per year), and 13 days should be reserved as non-working days for unexpected suspention of the operation due to bad weather or mechanical breakdowns, annual workable days should be 340 days. The total operation hours per berth should be less than 8,160 hours (= 24 hours x 340 days). Therefore, as observed in Table 3-6, the maximum capacity of the proposed setup of PIBT is assessed to be 18 mtpa. It should be noted that, when the terminal handles 18 million tons of coal, the BOR exceeds 80%. This implies that ships have to queue and wait at the offshore anchorage for few days before they dock at the PIBT Berth.

(3) Step 2 for Capacity Enhancement

By introducing an additional unit of unloader per berth and unloading with the simultaneous operation of two units per ship, the productivity of unloading is doubled and the hours required for the discharge of coal from a ship is reduced to 20.4 hours (= 55,000 [t] /1,350 [t/h]/ 2 [unit]). Hence, the total operation cycle time at the wharf is reduced to 25.4 hours including additional hours for the docking/releasing and preparation for starting/ending the unloading work.

Taking into consideration the location of the PIBT Berth, which is situated 4.3 miles from the marginal wharf to the downstream of the navigation channel, and of the navigation speed of about 8 knots, the navigation time between the entrance of the navigation channel and the PIBT Berth should be 0.5 hours shorter than the navigation time to the marginal wharf, which is said to be 3.5 hours. Thus, the total operation cycle time including navigation time along the channel to and from the PIBT Berth is estimated at 31.4 hours (=25.4 + 3.0 + 3.0), which is less than 32 hours.

As a practical operation scheme, the wharf operation should be performed in a certain routine work cycle. Since the whole cycle of handling a ship can be done within 32 hours, three ships can be handled at a berth in four days. This operation scheme is schematically shown in Figure 3-6.



Source: JST

Figure 3-6 Anticipated Operation Scheme of PIBT Berth

As explained above (2) Step 1, the working days are assumed to be 340 days, and the total volumes handled in a year are estimated at 28.1 million tons (see Table 3-7, column (5)).

Table 3-7 Capacity of PIBT Berth with Additional Units of Unloaders

Total Working days (day)	Ships per year (ships)	Volume per ship (tonne)	Volume per berth (tonne)	Total volumeof PIBT (2 berths) (tonne)	Hours the berth is occupied (hour)	BOR (%)
(1)	(2) [(1) x (3/4)]	(3)	(4) ['2) x (3)]	(5) [(4) x 2]	(6) [(2) x 23.4 hr]	(7) [(6)/365day /24hr]
330	247.5	55,000	13,612,500	27,225,000	5,791.5	66.1%
340	255.0	55,000	14,025,000	28,050,000	5,967.0	68.1%

Source: JST

The BOR of this case is 68.1%. The berth is assessed to be congested and it is foreseen that

ship would queue at the offshore anchorage of Qasim Port.

In order to handle these volumes of coal, ships should dock at the wharf in accordance with the schedule as shown in Figure 3-6. To this end, ships should wait at the offshore anchorage so that as soon as a ship at the PIBT Berth gets out of the channel to the open sea, the next ship will be ready to enter the navigation channel. In order to maintain the scheduled operational cycle at the wharf, PIBT should request shipping agents to operate ships strictly in accordance with the schedule.

In addition, it is also required that ships calling at PIBT Berth be allowed to enter the navigation channel at any time so as to dock at PIBT Berth on time. Therefore, the navigation channel should have capacity large enough to allow ships to navigate at any time. This is achieved by having two-way navigation channel. The restriction that may occur without two-lane channel will be analyzed in Section 3.2.4.

(4) Step 3 for Capacity Enhancement

By constructing the third berth, the capacity of PIBT Berth is enhanced by 1.5 times of that estimated for two berths. However, just as mentioned for Step 2, capacity enhancement can be achieved provided that no restriction is imposed on the navigation channel so that ships are allowed to enter the navigation channel and leave berths at any time.

3.2.4 Restrictions of the Navigation Channel and Countermeasures

It is most desirable that PQA widen the navigation channel so that two-way traffic is possible. With two-lane channel, it is possible that all ships can enter and leave the port at any time.

PQA official said that a study is currently underway for the development of the construction of an alternate navigation channel. One of the possible ways is to develop the Chhan Waddo Creek (see Figure 3-3).

While waiting for the two-way navigation channel system to be completed either by widening the existing channel or developing a new channel, some measures should be taken to enhance the existing channel to cope with the rapid increase of ship calls. Some possible measures to enhance the capacity of the one-way channel are examined hereunder. These measures may be employed until PQA complete the widening of the channel.

(1) Capacity of One-way Navigation Channel

The statistics of PQA show the annual ship calls over the past five financial years (see Table 3-8). The total number of ship calls dropped from 1,229 in Financial Year (FY) 2010-11 to 1,083 in FY 2011-12. The decrease is remarkable in the number of container ships. Considering the fact that the navigation channel was dredged and deepened from -12 m to -14 m in 2012, it is very likely that shipping lines started to deploy larger size container ships. In fact, the container cargo volumes (in TEU) increased from 1,197 TEU/ship in FY 2010-11 to 1,394 TEU/ship in FY 2011-12 even though the number of container ships decreased from 651 ships to 525 ships (see Table 3-9).

In Table 3-8 and Table 3-9, it is observed that in FY 2014-15 the number of ship calls increased to 1,280, which corresponds to 3.5 ships per day on the average. This increase coincides with the increase in GDP growth rates in recent year, i.e.: 1.6% (2010), 2.7% (2011), 3.5% (2012), 4.4% (2013), and 4.7% (2014) (World Bank Data, Annual GDP Growth Rate, Pakistan).

Table 3-8 Number of Ships Docked at Each Terminal of PQA

Terminal	Financial Year Ending June				
Liquid Cargo Terminal	138	135	113	121	122
Multi-purpose Terminal (Marginal Wharf, 4 berths)	124	62	115	103	142
Grain & Fertilizer Terminal (FAP) :	-	49	61	43	46
Engro Vopak Chemical Terminal (EVTL)	125	123	130	126	153
LNG Terminal (EEPTL)	-	-	-	-	5
Iron Ore & Coal Berth (IOCB)	17	10	13	8	21
FOTCO Oil Terminal	166	144	130	112	144
SSGC LPG Terminal	8	84	9	-	-
Container Terminal (4 berths)	651	525	545	559	647
Total Ship-calls	**1,229**	**1,083**	**1,055**	**1,072**	**1,280**

Source: PQA Website, Edited by JST

Table 3-9 Statistics of Container Cargo Volumes and Ship Calls

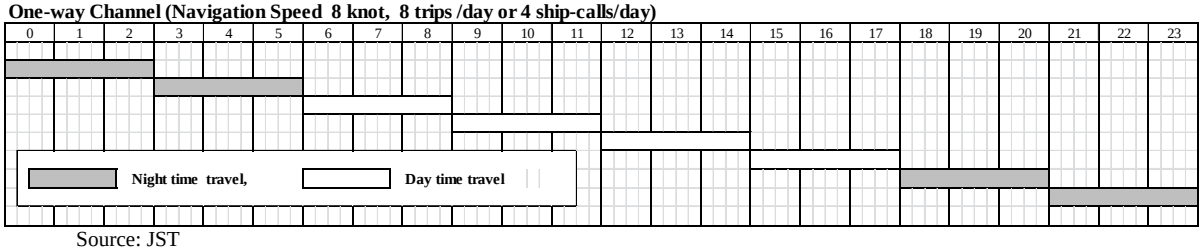
Description	Financial Year Ending June				
	2010-11	2011-12	2012-13	2013-14	2014-15
Container Terminal (4 berths)					
Cargo Volume handled (1,000 TEU)	779	732	722	854	971
Ship-calls	651	525	545	559	647
TEU/ship	1,197	1,394	1,325	1,528	1,501
Weight of Containers (1,000 t)	**10,027**	**9,820**	**10,245**	**10,988**	**12,643**
t/TEU	12.9	13.4	14.2	12.9	13.0
Total Cargo Volume in PQA (1,000 t)	**25,168**	**24,025**	**24,859**	**25,775**	**30,014**

Source: PQA Website, edited by JST

In accordance with the economic growth of the country and opening of new terminals including PIBT, the number of ship calls tends to increase and may exceed the capacity of the navigation channel in the near future. Examination of the capacity of the existing navigation channel, which may become a restriction for the ships calling on the terminals of PQA, and possible measures to enhance the capacity are discussed below.

The existing navigation channel is one-way and only one ship is allowed to travel along the channel at a time.

With the assumption that night navigation is allowed and that the average travel time of a ship between the entrance of the navigation channel and terminals of PQA is three hours (or navigation speed is 8 knots), eight trips are possible in a day (see Figure 3-7). Since two trips are necessary for a ship to come in and to leave the port, only four ship calls are possible per day, which corresponds to 1,460 ship calls per year.



Source: JST

Figure 3-7 Operational Scheme of One-way Navigation Channel (Ship Speed = 8 knots)

Since the number of ship calls last year was 1,280 and this will be increasing in accordance with the economic growth of the country, some measure should be taken to expand the capacity of the navigation channel in order to accommodate about 500 ships that will be calling on PIBT when it is fully operational in the near future.

(2) Measures to Expand the Capacity of the Navigation Channel

a. Building a Passing Lane

One of the possible ways to increase the capacity of one-way navigation channel is to provide passing zone, i.e., two-way portion, midway of the channel, so that an incoming ship and an outgoing ship can pass by at the passing lane.

The latest Google photo (taken on December 22, 2015, Figure 3-8) shows the scenario when two container carriers, one is Panamax and the other is Post Panamax, are navigating along Phitti Creek at the same time and at opposite direction to each other. This scenario implies that the two container carriers passed each other in the middle of the channel. Thus, it seems that PQA might have allowed ships to travel in opposite direction.

Source: Google Earth, Edited by JST

Figure 3-8 Two Ships Moving along One-way Navigation Channel at the Same Time Toward Opposite Directions

With a passing lane in the midway of the channel, two ships can travel in opposite directions at one time. If passing is allowed during daytime only, two more ship calls are possible, which correspond to a total of 2,190 ships a year, while if passing is allowed during nighttime also, four more ship calls are possible, i.e., a total of 2,920 ships a year. Table 3-10 shows the calculation of the total ship calls in cases where faster navigation speeds are allowed.

Table 3-10 Capacity Enhancement of the Navigation Channel with a Midway Passing Lane

Navigation Speed	Travel hour	Number of shipcalls per day			Maximum shipcalls per year		
		Single lane			Single lane		
		No passing	Passing is allowed		No passing	Passing is allowed	
knot	hour	24 hours	Day time only	24 hours	24 hours	Day time only	24 hours
8	3.0	4	6	8	**1,460**	**2,190**	2,920
10	2.5	5	7.5	10	1,825	2,738	3,650
12	2.0	6	9	12	2,190	3,285	4,380

Source: JST

b. Setting Directional Time Windows for Incoming and Outgoing Ships

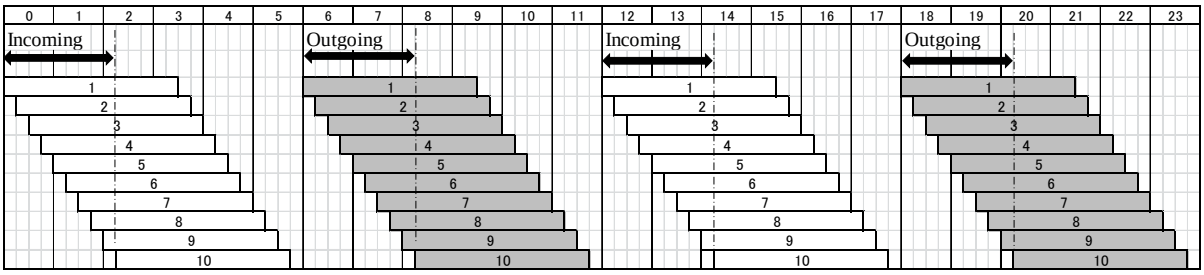
Another way to increase the capacity is to alternate navigation direction at certain time interval, which is called the directional time window hereafter, for one direction or the other, i.e., setting time windows for incoming ships and outgoing ships. Within a directional time window, ships pass the channel in one direction only.

The Suez Canal was able to enhance its capacity as a one-way canal through the combination of both measures mentioned above. The annual number of canal transits amounts to 15,000*.

Note * 15,000 is the number of passage of ships and, if converted to port measure, the number of ship calls will be half since a ship should pass the channel twice, i.e., in and out.

Since the tide in the Port of Qasim is semi-diurnal, it is realistic to assume that the direction of navigation in the channel should alternate every six hours and that the interval of ships is 15 minutes (or two miles). The operation scheme is drawn as shown in Figure 3-9. According to the channel operation scheme exhibited in Figure 3-9, the directional time windows allotted to incoming ships are 00:00 – 02:15 and 12:00 – 14:15, while those allotted to outgoing ships are 06:00 – 8:15 and 18:00 -20:15. The duration of each time window is two hours and 15 minutes.

Through this operation, a maximum of 20 ships are allowed to enter the port and 20 ships can leave the port. However, it should be noted that, since there is no anchorage in the port area, incoming ships are allowed to enter the navigation channel only when berths are available for the ships at the port. Thus, the capacity of the channel is also limited by the operation schemes of the wharves in the port.



Source: JST

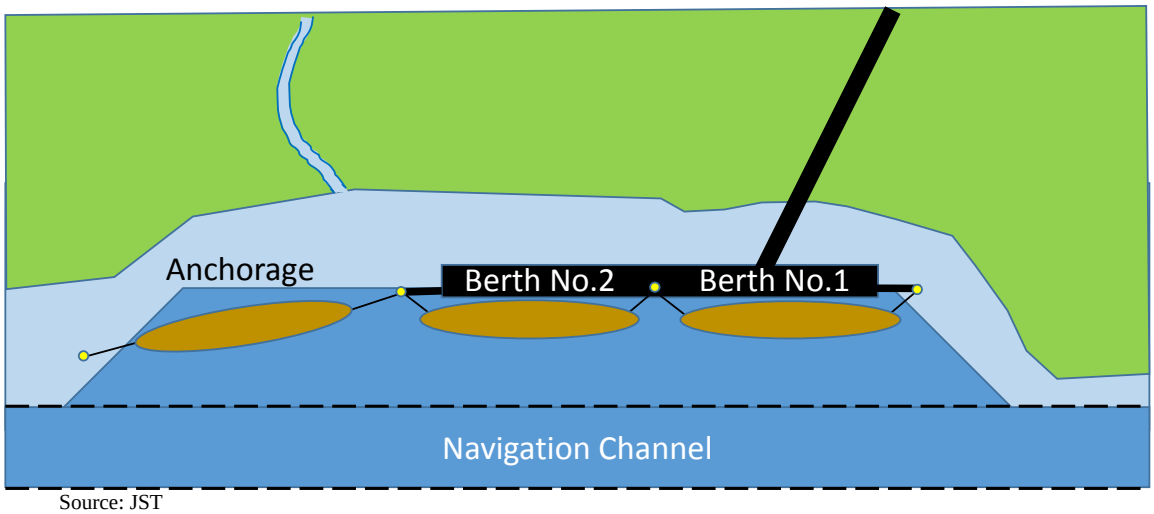
Figure 3-9 Navigation Schedule under Alternate Time Windows

3.2.5 Ship Operation Scheme at PIBT Berth under Directional Time Windows

Since the cycle time of the operation at PIBT Berth does not match the directional time windows of the channel, outgoing ships may have to wait for the time window allotted for departing ships and, likewise, incoming ships may not enter the channel even though a berth

is vacant due to the directional time window. The delays of the arrival and the departure of ships at the wharf result in reduction of the capacity of PIBT.

In order to avoid the delay of arrival and departure, an anchorage or mooring basin is required. A basin adjacent to the wharf is the most desirable (see Figure 3-10).

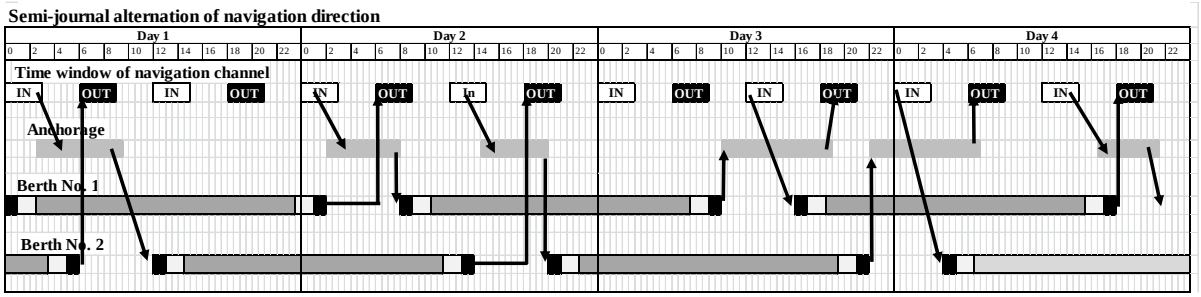


Source: JST

Figure 3-10 Recommended Location of Anchorage for PIBT Berth

The wharf operational scheme is schematically drawn in Figure 3-11 for such case that the directional time window alternates every six hours.

By utilizing the anchorage, it is possible for PIBT to handle three ships every four days and to unload 27–28 million tons of coal a year.



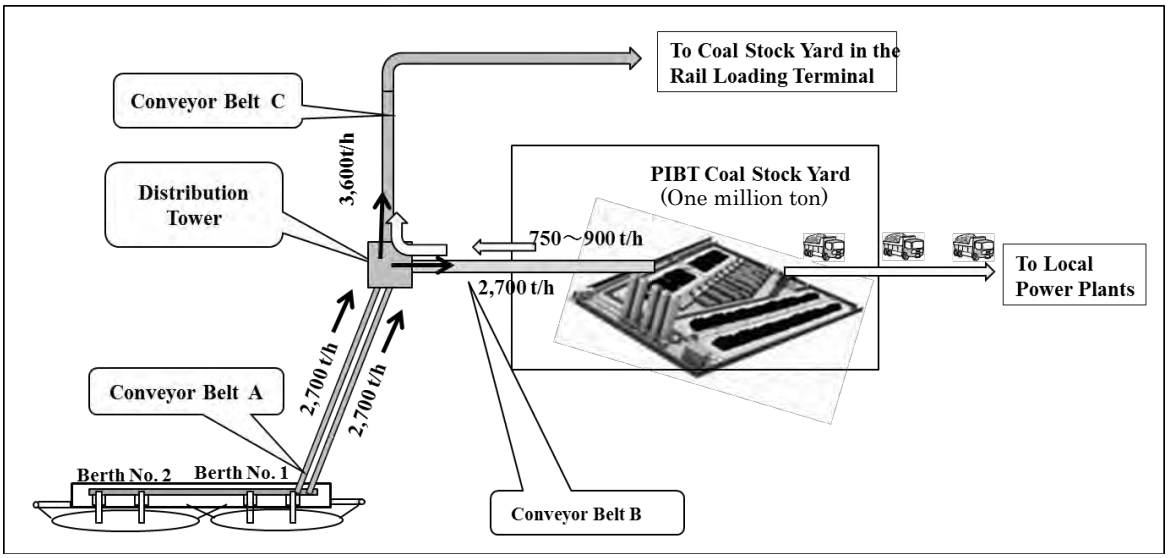
Source: JST

Figure 3-11 Ship Operation Scheme Under the Directional Time Window Control of the Channel

3.2.6 Capacity Required for the Belt Conveyor System

The conveyor system that carries coal from the wharf to the stockyard of PIBT and stockyard at rail terminal consists of the following three elements (see Figure 3-12):

a. Conveyer belt connecting the wharf and the distribution tower, which controls the flow of the coal either to the coal stockyard of PIBT or the coal stockyard of the rail loading terminal,
b. Conveyer belt connecting the distribution tower and the coal stockyard of PIBT, and
c. Conveyer belt connecting the distribution tower and the coal stockyard of the rail loading terminal.



Source: JST

Figure 3-12 Conveyer Belt System and Required Capacity

Conveyor Belt A should be simultaneously operated with the unloaders on the wharf. When unloading work is performed for two ships at a time, each of the four unloaders discharges coal at the rate of 1,350 t/h/unit. Therefore, the total capacity of Conveyer Belt A should be 5,600 t/h (=1,350 x 4).

It is designed that coal unloaded from a ship is directly transported to the coal stockyard of the rail loading terminal at a rate of 2,700 t/h (=1,350 x 2). Therefore, when unloading work is performed for two ships simultaneously, the coal unloaded from the second ship should be transported to the coal stockyard of PIBT at a rate of 2,700 t/h. Thus, Conveyor Belt B should have a capacity of 2,700 t/h.

In accordance with the operational scheme as shown in Figure 3-6, six ships are unloaded within four days. Thus, average unloading volume at the wharf is 82,500 t/day (=55,000 t x 6 ships/4 days), which corresponds to 3,438 t/h (=82,500 t/24 hr). Therefore, Conveyer Belt C must have a capacity of 3,500 t/h or larger, so that the coal temporarily stocked at PIBT coal stockyard is transported to the stockyard of the rail loading terminal.

Though actual maintenance procedure and schedule for the conveyer belt system shall be prepared in the detail design stage, the capacities of the three elements of the conveyer system illustrated in Fig.3-12 are assessed to be enough to handle 28 million tons of coal a year taking into considerations of the suspension of operation for the regular maintenance, The following is a basic idea of the maintenance:

- Full scale maintenance; once a year, the whole system is stopped over three days,
- Monthly maintenance; the maintenance of the conveyer system is performed by unit once a month, i.e., while a units is under maintenance, other units are in operation:

Conveyer Belt A comprises two units and full-day maintenance can be done one after the other by suspending unloading operation at one of the two berths. While one berth stops operation for the maintenance of one of the two units of Conveyer Belt A, the maintenance of either Conveyer Belt B or C can be done. Since each berth stops operation once a month respectively one after the other, full-day maintenance of Conveyer Belt B and C can be done once a month.

Weekly and Daily maintenance can be done while no ship is moored at a berth (the interval between the departure of a ship and the arrival of the next ship is 6 hours).

3.2.7 Conclusion

In order to expand the capacity of the PIBT Berth up to 28 million t/year,

PIBT should:

(1) Add two units of unloaders; in addition, two units of unloaders should simultaneously operate for a ship;
(2) Operate the wharf 340 days a year;
(3) Construct anchorage adjacent to the wharf in such case that the navigation channel is not widened to allow for two-way traffic; and
(4) Request shipping agents to schedule the voyages so that ships should arrive at the anchorage of Port of Qasim in a timely manner.

PQA should:

(1) Expand the capacity of the navigation channel either by constructing passing lane or traffic control for time window operation.
(2) Enhance the navigation channel further by widening and making two-way traffic possible.

3.3 Potential Capacity of Marginal Wharf

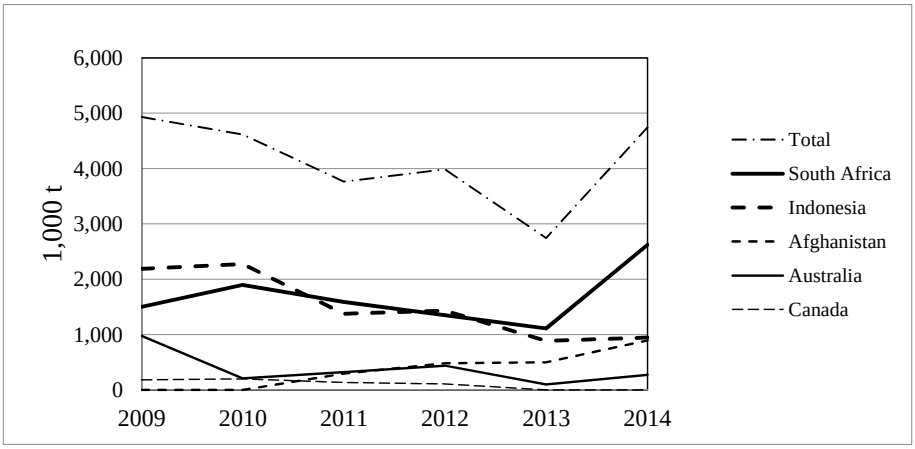
It is the policy of PQA that, while PIBT is the sole bulk terminal to handle coal on commercial basis, Berth No. 3 and No. 4 of the marginal wharf shall be leased to a company under concession agreement for the purpose of handling the company's own cargoes. PQA has publicly called for proposals from private companies for the concession of the marginal wharf. It seems most likely that Berth No. 3 and No. 4 of the marginal wharf will be used for coal import for a power plant.

In this section, the coal handling capacity of Berth No. 3 and No. 4 of the marginal wharf is examined when they are converted to a dedicated coal terminal.

3.3.1 Estimation of the Size of Coal Carriers Calling at the Marginal Wharf

The major origin countries of import coal in Pakistan have been South Africa and Indonesia (see Figure 3-13). The share of the coal import volumes from these two countries has been 70% or higher over the period between 2009 and 2014.

The sea distances from Richards Bay Coal Terminal (near Durban), South Africa, and from North Pulau Laut Coal Terminal. Kalimantan, Indonesia to Qasim Port are almost the same (a little longer than 3,800 nautical miles). Since the distances from the two coal exporting countries are quite large, and for the sake of taking advantage of economies-of-scale, shipping lines and consignees tend to employ and permit large size ships to dock.



Source: UN Comtrade Database (http://comtrade.un.org/) Edited by JST

Figure 3-13 Coal Import Volumes by Origin Country

The water depth of the marginal wharf is -11 m and PQA permits ships having draught of 10.5 m or less. Therefore, the maximum size of coal carriers allowed to dock at the marginal wharf should be 35,000 DWT, which has a full load draught of 10.5 m. During the period from January 24 to March 15, 2016, three coal carriers docked at the marginal wharf (see Table 3-11). The volume of coal brought by these three ships varied from 35,000 t to 42,750 t. Unloading work of all the three ships was completed within 3 days. The maximum volume unloaded in a day was 23,120 t, which corresponds to 963 t/ hour. It is observed in Table 3-11 that the average coal unloading productivity at the marginal wharf (with ship gears) is about 15,000 t/day.

Table 3-11 Coal Carriers that Docked at the Marginal Wharf (From January 24 to March 15, 2016)

Berth	Ship Name	LOA (m)	Draught (m)	Arrival (Date) (Time)	Volume (t)	Dayly Unloaded volume Date (t)	Date (t)	Date (t)	Departure Date Time
M/W-IV	M.V- KONKAR THEODOROS	198	-	19-Feb 10:30	42,470	19-Feb 15,760	20-Feb 23,120	21-Feb 3,590	22-Feb 7:40
M/W-II	M.T- STAR GLOBE	190	9.36	27-Feb 16:02	35,000	27-Feb 7,028	28-Feb 15,738	29-Feb 12,234	1-Mar 6:30
M/W-II	M.V- ALAM MUTIARA	200	9.85	1-Mar 10:00	40,000	1-Mar 13,100	2-Mar 15,214	3-Mar 11,686	4-Mar 7:05

Source: PQA Website, Daily Vessel Movement, Download Report, Edited by JST

3.3.2 Examination of the Potential Coal Handling Capacity of the Multi-purpose Berth No. 3 and No. 4 at the Marginal Wharf

The capacity of the multi-purpose berths No. 3 and No. 4 is examined under the following conditions:

a. Average volume per ship is assumed to be 40,000 t on the basis of the berthing records.
b. Coal unloading productivity is assumed to be 600 t/hour (=14,400 t/day).
   Note: Although it was recorded that 23,120 t of coal was unloaded in a day on February 29, 2016, for the sake of stable and continuous operation, lower productivity is used for the examination. The productivity is estimated assuming that four ship cranes with a grab bucket capacity of 6 t are operated simultaneously at a cycle time of 2.4 minutes (or 25 cycles per hour).
c. Additional time per ship required for mooring/unmooring and starting/ending the unloading work: 5 hours.

d. Operational cycle should be one ship every three days; actual operational cycle observed in the ship berthing record (Table 3.3.1) is employed.
e. Annual working days is 300 days.
f. Berth No.3 and No. 4 are used as alternate berths; unloading work is performed for one ship at a time, while another berth is used for the mooring of the next ship.

Table 3-12 shows the calculation of the capacity. It is assessed that 4 million tons can be unloaded at Berth No. 3 and No. 4 of the marginal wharf.

Table 3-12 Calculation of the Coal Unloading Capacity at Berth No. 3 and No. 4

Item	No.	Calculation	Quantity	Unit
Average ship size	(1)		40,000	t/ship
Producvtivity of unloader	(2)		600	t/hour
Unloading hours per ship	(3)	[=(1)/(2)]	66.7	hour
Additional hours per ship	(4)		5	hour
Required time of unloading per ship	(5)	[=(3)+(4)]	71.7	hour
Work cycle for actual operation	(6)		3 (72)	day (hour)
Annual working days	(7)		300	day
Total number of ship-calls	(8)	[=(7)/3]	100	ship
Annual import volume	(9)	[=(1) x (8)]	4,000,000	t
BOR (with 2 berths)	(10)		39.9	%

Source: JST

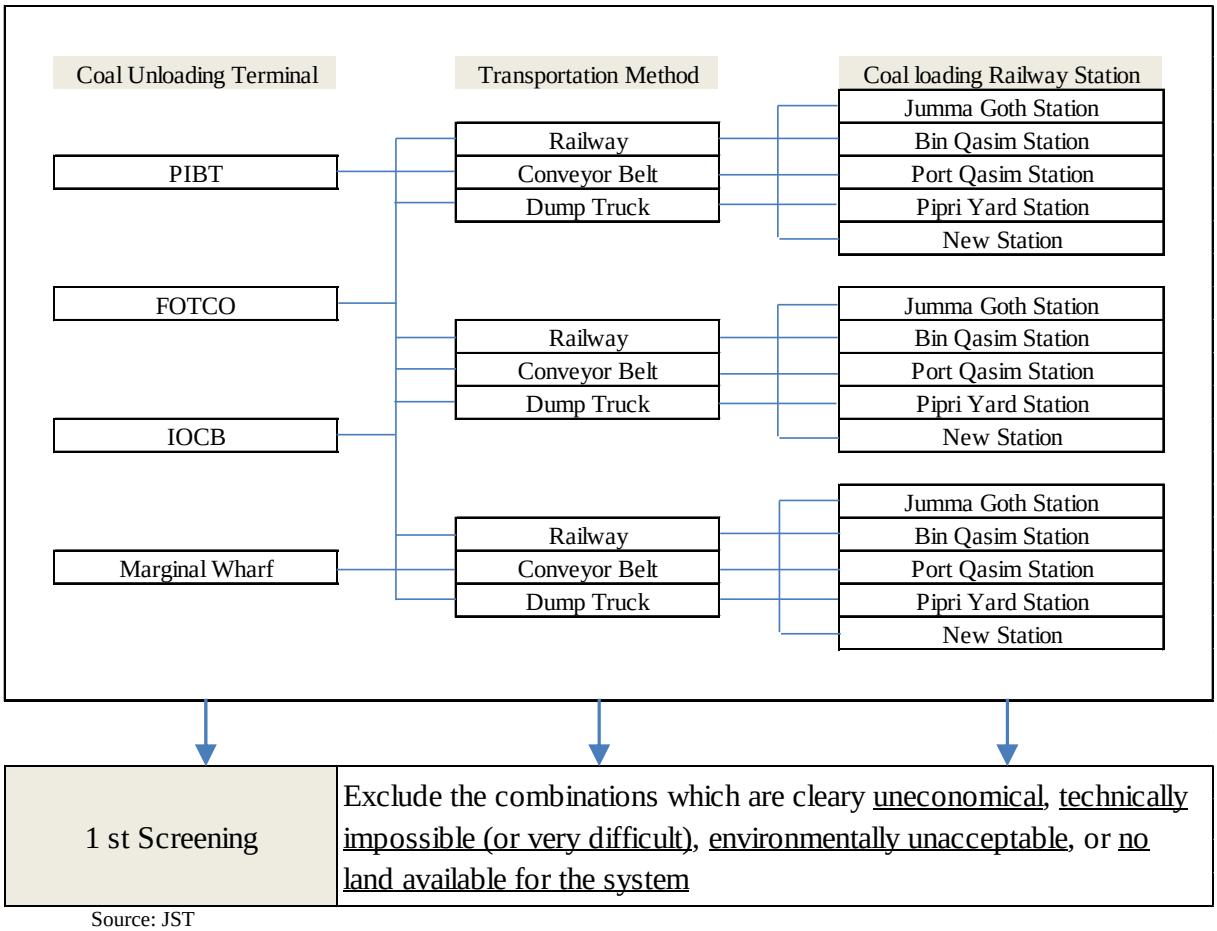
3.4 Screening of Coal Transportation Plan

3.4.1 Procedures for First Screening

Combinations among coal unloading terminal, transportation method, and coal loading railway station are selected based on the first screening in order to select the most suitable combination.

Among various combinations, the combinations which are clearly uneconomical, technically impossible, environmentally unacceptable, and which have no available land will be excluded in the first screening.

All possible combinations are compared in the first screening,



Source: JST

Figure 3-14 Schematic Figure of Combination

3.4.2 Evaluation Items

(1) Topographic Condition

In the case of railway transportation, the maximum gradient of the track shall be less than 5‰ (0.5%) as designed by PR standards as shown below.

Table 3-13 Specification of Pakistan Railways

Items	Specification
Track gauge	Broad-gauge 1,676 mm Meter-gauge 1,000 mm
Axle load	Group I: 23.3 t, 22.86 t, 19.3 t Group II: 17.78 t Group III: 17.27 t Group IV: 16.76 t Group V: 13.21 t
Minimum curve radius	10 degree (=175 m)
Maximum gradient	5‰ (0.5%)
Maximum speed	120 km/h (planned and designed; depends on the condition of line during operation)

Source: Pakistan Railways

If the site condition requires a gradient steeper than 5‰, the track alignment shall be diverted in order to ease the gradient. And if the diversion of track is not applicable, civil construction, such as bridge, tunnel, or deep cut of the ground will be applied.

When abovementioned measures are not economically/financially feasible, other transportation measure shall be applied.

Topographic condition will not be an issue for conveyor belt system and transportation by dump trucks.

(2) Hauling Route and Distance

Because of the technical restrictions, such as, the minimum radius and the maximum gradient, selection of hauling route is very limited for railway transportation. Even at flat area, if there are obstacles, such as oil/gas pipes crossing the railway alignment, construction cost will increase due to diversion of these facilities.

Conveyor belt system has fewer restrictions than railway in terms of route selection. Due to the mechanical nature, route of conveyor belt system shall be a combination of straight lines. At the points where the direction of the conveyor belt changes, junction tower shall be constructed. Even at the straight section, there is a limitation of the length. Therefore, conveyor belt system is not suitable for a route that has many turning points and very long hauling distance due to higher construction and O&M costs.

Transportation by dump truck is the most flexible measure for coal hauling in terms of route and distance aspects. However, because of the loading capacity of a dump truck, it is not suitable for huge volume and long distance coal transportation. It will be possible if these trucks can use the route exclusively. However, it is not preferable if these trucks use the route with other vehicles because of high occupancy of the road.

(3) Environmental Issue

Environmental issue is unavoidable in any case when transporting and handling coal at urban area because of scattering of fine dust. It is possible to reduce the scattering of coal dust during transportation by providing dust cover for railway wagon and dump truck cases. In

the case of conveyor belt system, it will be required to cover the system by constructing floor, wall and roof structures when passing the urban area.

Dust problem will arise if coal stockyard is constructed at an urban area because coal stockpile cannot be covered. Therefore, coal loading terminal shall not be constructed adjacent to an urban area.

(4) Availability of Land for Construction and Space for Coal Stockyard

When railway system or conveyor belt system is selected for coal transportation from coal unloading terminal, land for construction of structures will be required. If land acquisition for this purpose is not possible (or very difficult), this option cannot be selected.

There shall be coal stockyard adjacent to the coal loading terminal if the system will handle different types of coal for efficient coal loading operation. If no space is available, loaded coal on the conveyor belt shall be cleared when different types of coal will be transported. Huge size of coal loading bin with separator can be adopted in such case. However, the efficiency of the loading operation is lower than the case with coal stockyard.

3.4.3 First Screening

As described in Section 3.4.1, all the combinations of (Coal Loading Terminal) – (Transportation Method) – (Coal Loading Station) are evaluated in the following three categories considering the evaluation points detailed in Section 3.4.2:

Table 3-14 First Screening Evaluation Category

Evaluation Category	N.A.	Not applicable
	N.R.	Not recommendable
	A.P.	Applicable

Source: JST

(1) From PIBT

When transporting coal from PIBT, only two options are applicable as shown in Table 3-15.

Table 3-15 Coal Transportation from PIBT

Coal Unloading Terminal (CUT)	Coal Transportation Method	Coal Loading Railway Station (CLS)	Evaluation	Remarks
PIBT	Railwyay	Jumma Goth Station	N.A.	Slope between CUT and CLS is too steep for coal trains.
		Bin Qasim Station	N.A.	ditto
		Port Qasim Station	N.A.	No land is available for new track.
		Pipri Yard	N.A.	ditto
		New Station (planned by NESPAK)	N.A.	ditto
	Conveyor Belt	Jumma Goth Station	N.R.	Environmental problem is anticipated at coal stock yard with local residents.
		Bin Qasim Station	N.R.	ditto
		Port Qasim Station	N.R.	Hauling distance is very long (9.2 km).
		Pipri Yard	N.R.	Hauling distance is very long (14.5km).
		New Station (planned by NESPAK)	A.P.	Hauling distance is 4.8km.
	Dump Truck	Jumma Goth Station	N.R.	Environmental problem is anticipated at coal stock yard with local residents.
		Bin Qasim Station	N.R.	ditto
		Port Qasim Station	N.A.	No permission is available from PQA.
		Pipri Yard	N.A.	Hauling distance is very long (14.5km).
		New Station (planned by NESPAK)	A.P.	Hauling distance is 4.8km.

Source: JST

(2) From FOTCO

Although FOTCO has an advantage of location close to Port Qasim Station, they have no intention to join the coal handling business at present. Therefore, FOTCO will not be considered for this study.

Table 3-16 Coal Transportation from FOTCO

Coal Unloading Terminal	Coal Transportation Method	Coal Loading Railway Station	Evaluation	Remarks
FOTCO	Railwyay	Jumma Goth Station	N.R,	FOTCO has no intention to handle coal transportation at present.
		Bin Qasim Station	N.R.	
		Port Qasim Station	N.R.	
		Pipri Yard	N.R,	
		New Station (planned by NESPAK)	N.R.	
	Conveyor Belt	Jumma Goth Station	N.A.	FOTCO has no intention to handle coal transportation at present. However, it shall be noted that FOTCO has advantage in the railway connection to Port Qasim Station.
		Bin Qasim Station	N.A.	
		Port Qasim Station	N.R.	
		Pipri Yard	N.A.	
		New Station (planned by NESPAK)	N.R,	
	Dump Truck	Jumma Goth Station	N.A.	FOTCO has no intention to handle coal transportation at present.
		Bin Qasim Station	N.A.	
		Port Qasim Station	N.A.	
		Pipri Yard	N.A.	
		New Station (planned by NESPAK)	N.A.	

Source: JST

(3) From IOCB

Connection to Port Qasim Station and the new station by conveyor belt system and dump truck method is applicable.

Table 3-17 Coal Transportation from IOCB

Coal Unloading Terminal	Coal Transportation Method	Coal Loading Railway Station	Evaluation	Remarks
IOCB	Railwyay	Jumma Goth Station	N.A.	Environmental issue and difficulty of train operation.
		Bin Qasim Station	N.A.	Environmental issue.
		Port Qasim Station	N.R.	Coal loading operation requires twice.
		Pipri Yard	N.A.	Hauling distance is too long
		New Station (planned by NESPAK)	N.R.	Coal loading operation requires twice.
	Conveyor Belt	Jumma Goth Station	N.A.	Environmental issue and long hauling distance.
		Bin Qasim Station	N.A.	ditto
		Port Qasim Station	A.P.	Distance is 2.2km.
		Pipri Yard	N.A.	Very long hauling distance.
		New Station (planned by NESPAK)	A.P.	Distance is 5.1km.
	Dump Truck	Jumma Goth Station	N.A.	Environmental issue and long hauling distance.
		Bin Qasim Station	N.A.	ditto
		Port Qasim Station	A.P.	Dedicated road shall be constructed.
		Pipri Yard	N.A.	Very long hauling distance.
		New Station (planned by NESPAK)	A.P.	Dedicated road shall be constructed.

Source: JST

(4) From Marginal Wharf

Connection between marginal wharf and Port Qasim Station by either conveyor belt or dump trucks is applicable.

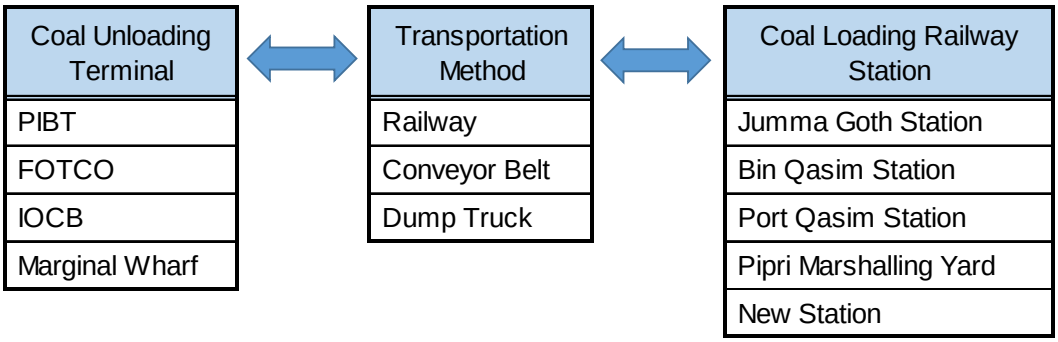
Table 3-18 Coal Transportation from Marginal Wharf

Coal Unloading Terminal	Coal Transportation Method	Coal Loading Railway Station	Evaluation	Remarks
Marginal Wharf	Railwyay	Jumma Goth Station	N.A.	Environmental issue and difficulty of train operation.
		Bin Qasim Station	N.A.	ditto
		Port Qasim Station	N.R.	No land available for new track.
		Pipri Yard	N.R.	Very long hauling distance.
		New Station (planned by NESPAK)	N.R.	Coal loading operation requires twice.
	Conveyor Belt	Jumma Goth Station	N.R.	Environmental issue and difficulty of train operation.
		Bin Qasim Station	N.R.	ditto
		Port Qasim Station	A.P.	Very short distance.
		Pipri Yard	N.A.	Very long hauling distance.
		New Station (planned by NESPAK)	N.R.	Long distance (7.5km) and land availability.
	Dump Truck	Jumma Goth Station	N.A.	Environmental issue and difficulty of train operation.
		Bin Qasim Station	N.A.	ditto
		Port Qasim Station	A.P.	On-going
		Pipri Yard	N.A.	Very long hauling distance.
		New Station (planned by NESPAK)	N.R.	Requiring use of PQA main road.

Source: JST

3.4.4 Results of the First Screening

There are 60 combinations of connection between (Coal Unloading Terminal) – (Transportation Method) – (Coal Loading Railway Station) as mentioned above.



Source: JST

Figure 3-15 Combination of Connections

Among those, the following combinations have passed the first screening;

Table 3-19 Results of the First Screening

No.	Applicable Combination	No.	Applicable Combination
1	PIBT-Conveyor Belt-New Station	8	IOCB-Dump Truck-Port Qasim Station
2	PIBT-DumpTruck-New Station	9	IOCB-Dump Truck-New Station
3	FOTCO-Railway-Port Qasim Station	10	M. Wharf-Railway-Port Qasim Station
4	IOCB-Railway-Port Qasim Station	11	M. Wharf-Railway-New Station
5	IOCB-Railway-New Station	12	M. Wharf-Conveyor Belt-P. Qasim Station
6	IOCB-Conveyor Belt-Port Qasim Station	13	M. Wharf-Dump Truck-P. Qasim Station
7	IOCB-Conveyor Belt-New Station	14	M. Wharf-Dump Truck-New Station

Source: JST

3.4.5 Recommended Combination – Results of the Second Screening

- FOTCO has no intention to participate in coal unloading business at present, although they have advantages in the railway connection. Thus, FOTCO is not considered for the coal unloading terminal in this study.

- Bulk handling facility of IOCB is ready for use. However, IOCB cannot be considered for the coal unloading terminal of this project because of the on-going privatization process of PSM.

- Marginal Wharf can be used for a coal unloading terminal. However, due to the shallow draft and available space, the maximum coal handling capacity will be 4 mtpa. Therefore, Marginal Wharf will be the secondary option and cannot be the main coal unloading terminal.

- Due to the potential capacity, only PIBT can be the main coal unloading terminal of this project. According to JST's analysis, potential capacity of PIBT will be 28 mtpa as detailed in the Clause 3.2. Considering the volume and transportation efficiency, transportation from PIBT to the new coal loading station shall be by conveyor belt system, not by dump trucks.

- IOCB will be the third option because of the uncertain availability of the facility.

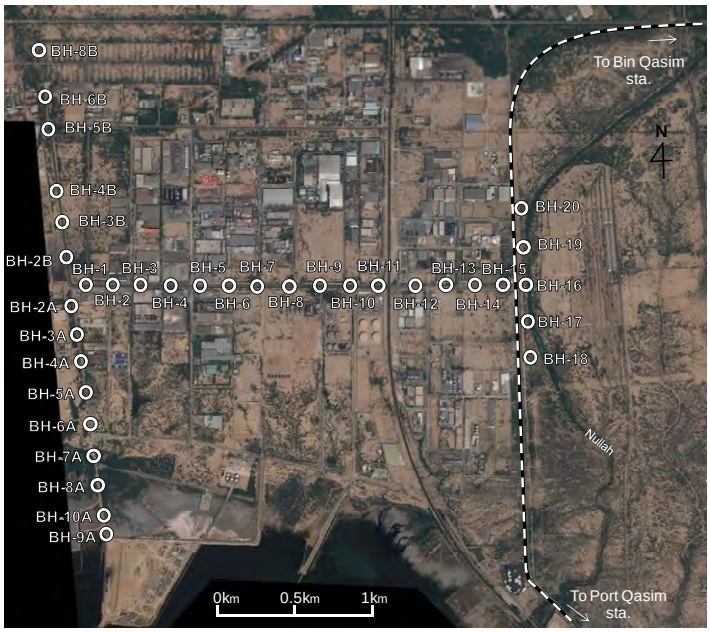
3.5 Geological and Topographical Condition of the Site

3.5.1 Geological Survey

Boreholes were conducted at 35 locations from January 3 to February 16, 2016 at Port Qasim area as shown in Figure 3-16 below. High potential conveyor belt routes were selected as the site of Boreholes.

306 standard penetration tests (SPTs) were performed and 129 core samples were collected. Laboratory tests, such as shear test and unconfined compression test, were conducted on these core samples. Detailed records are attached in Appendix-1.

Geological survey result will be utilized for the design of the structure foundation of conveyor belt between coal unloading terminal and coal loading terminal. Possibility of consolidation settlement at the coal stockyard in the coal loading terminal can be determined through the laboratory test results.



Source: JST

Figure 3-16 Location Map of Boreholes

3.5.2 Geological Condition and Assumed Foundation

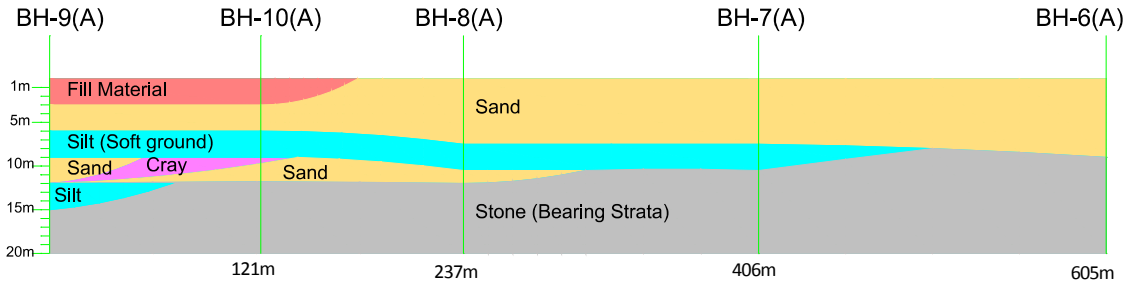
Average depth of bearing strata is around 12 m at the seaside and 3 m at the hillside. The deepest bedrock is encountered at a depth of 15.5 m at BH-9(A). Although soil condition is soft up to 10 m depth at the seaside, rock layer is lying between 12 to 15.5 m depth.

Foundation structure shall be designed separately between the seaside and hillside because geological condition shows different soil conditions.

(1) Geological Condition around the Seaside and Assumed Foundation

According to the result of the SPTs (BH-09(A), BH-10(A), BH-8(A), BH-07(A)), N count is

less than 10 at the silt layer of 6~9 m depth from PIBT to approximately 400 m north. Therefore, soft ground exists around the seaside area. Profile figure is shown in Figure 3-17.



Source: JST

Figure 3-17 Profile Figure of Geological Condition

Depth of the bearing strata of each SPT site is summarized in Table 3-20.

Table 3-20 Depth of the Bearing Strata

Site	Boreholes	Depth of Bearing Strata
North (Jumma Goth)	BH-06 (A)	6 m
↑	BH-07(A)	10.5 m
	BH-08(A)	12 m
↓	BH-10(A)	12 m
South (PIBT)	BH-09(A)	15 m

Source: JST

Hence, it is recommended to provide PC concrete pile foundations from PIBT to the end of the soft ground layer (around 400 m north of PIBT). Considering the design load of the structure, four piles are assumed per pier. 40 cm diameter for conveyor belt foundation and 60 cm diameter for other equipment are assumed.

(2) Geological Condition Around the Hillside and Assumed Foundation

Geological condition on hillside is quite good compared with the seaside area. There is bearing strata within a depth of 3 m. There is no soft ground above the bearing strata.

Thus, spread foundation is applied after the soft ground layer. The assumed size of the spread foundation is 6 m x 2 m x 0.6 m.

(3) Possibility of Consolidation Settlement at the Coal Stockyard

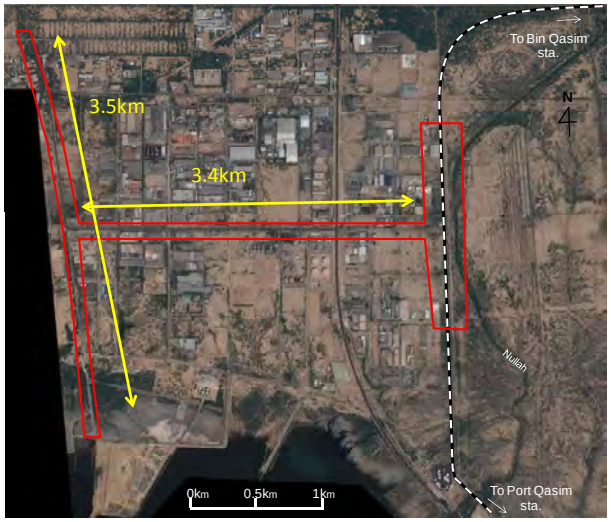
Heavy reclaimer, stacker, and stockpile will be installed at the coal stockyard.

According to the result of the SPTs (BH-16, BH-17, BH-18, BH-19, BH-20), the layer is all sand but the actual stockyard is approximately 1 km far from the survey site. In general, consolidation settlement occurs at the clay layer. There is no possibility to incur consolidation settlement at the site of boreholes; however, borehole survey shall be conducted at the exact place of the coal stockyard.

3.5.3 Topographical Survey

Topographic survey was conducted at the area shown in Figure 3-18 with a center line survey for a total length of 6.9 km, cross section survey, profile survey, and 54 ha topographic survey from December 26, 2015 to January 15, 2016. The objective of the topographical survey is to prepare necessary data for design and cost estimation.

The coordinates were referred to PIBT benchmarks for cross section and profile survey. The coordinates for topographic survey were given by JST.



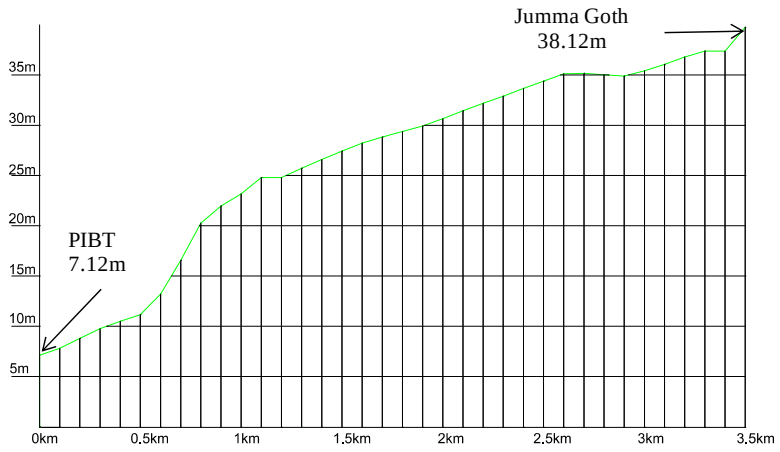
Source: JST

Figure 3-18 Location Map of Topographic Survey

3.5.4 Topographic Condition of the Site

(1) Topographic Condition along the Alignment

According to the topographic survey, elevation of Jumma Goth is 38.12 m and elevation in front of PIBT is 7.12 m. Since the distance between Jumma Goth and PIBT is 3.5 km and allowable distance of height is 31 m, the average gradient is 0.89%. Tunnel or deep cut of the ground will be required to provide the railway from Jumma Goth to PIBT because maximum gradient is 0.5% according to the PR design standards. On the other hand, it is possible to install a conveyor belt because allowable gradient is much higher than railway structure. Thus, installation of conveyor belt is recommended from the viewpoint of the topographic condition. Average elevation of the East-West line is 29 m and difference of elevation is within 1 m. Profile drawing is shown in Figure 3-19. Detailed survey result is shown in Appendix-2.

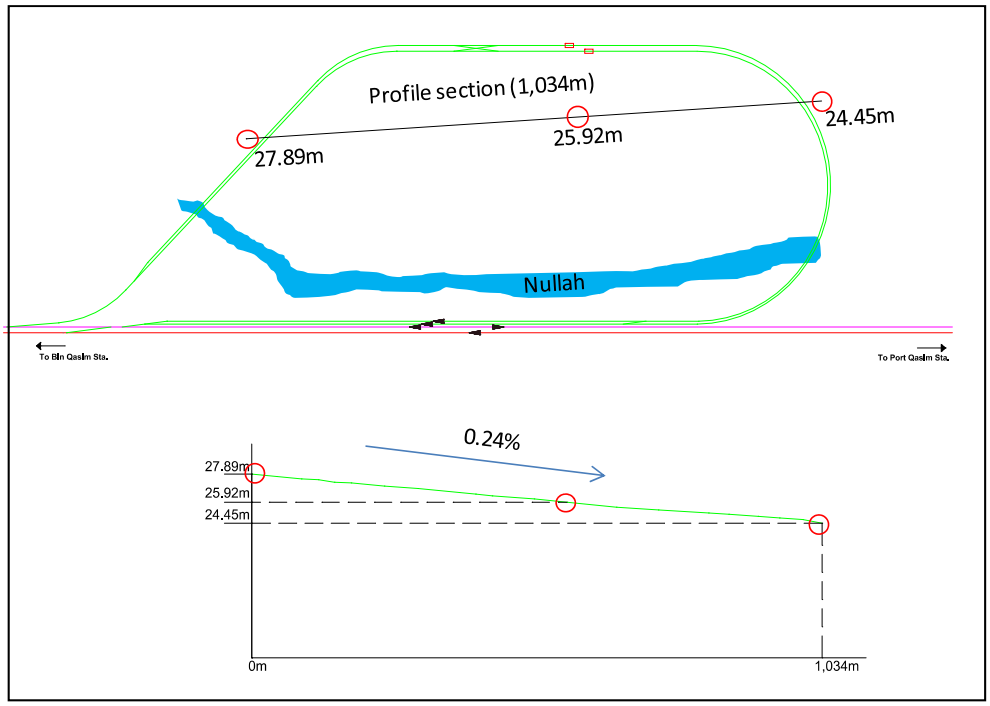


Source: JST

Figure 3-19 Profile Drawing from PIBT to Jumma Goth

(2) Topographic Condition at the Coal Loading Terminal

Although there is also a difference of the north-south gradient at the coal stockyard as mentioned above, average gradient for a length of 1,034 m is 0.24% according to the topographic survey as shown in Figure 3-20. Loop railway lines can be installed in the coal loading terminal with the present condition because it meets the PR design standards. Detail loading track layout will be mentioned in section 5.1.



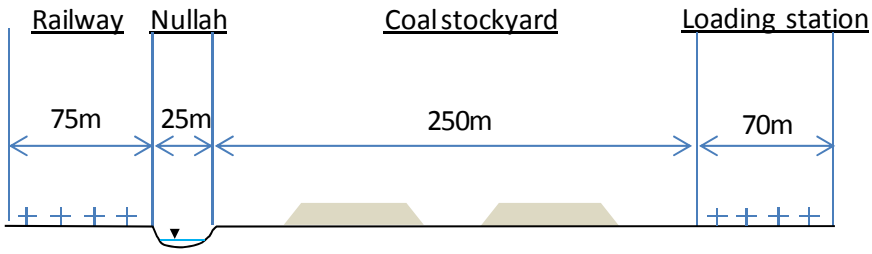
Source: JST

Figure 3-20 Schematic Diagram of the Elevation in the Coal Loading Terminal

(3) Need of Covering the Nullah

There is a large natural drain (*nullah*) between the existing railway line and the proposed

coal stockyard[9]. In case the loop tracks overlap the *nullah* fully, the whole *nullah* within the coal loading terminal shall be covered. However, according to the topographic survey, loop loading tracks at the coal loading terminal can be constructed without covering the existing *nullah*. Box culverts shall be constructed at the points of the *nullah*. Schematic cross section diagram is shown in Figure 3-20 below.



Source: JST

Figure 3-21 Schematic Cross Section Diagram with Box Culverts for Nullah

[9] In case estimated high water level is as same as or higher than G.L. of stock yard, it is required to widening the river channel or dredging the riverbed in order to prevent the process of box culvet. Estimated high water level shall be confirmed or surved because PQA doesn't have any information about it.

Chapter 4 Coal Handling Plan

4.1 Review of the Feasibility Study Prepared by NESPAK

The National Engineering Services Pakistan (NESPAK) has studied the coal conveyance system between the Pakistan International Bulk Terminal (PIBT) and the coal loading terminal along the Pakistan Railway (PR) Port Qasim spur line. The plan is based on the following assumptions:

(1) Imported coal will be unloaded at the PIBT wharf through ships of up to 55,000 DWT.
(2) For power plants upcountry, coal will be loaded to the conveyor provided by PIBT with direct connection to the Port Qasim Authority (PQA) conveyor which has been studied in PC-1.
(3) Coal will be stocked at PQA's stockyard which is developed by PQA and exclusively used for railway transportation and transported through conveyor belt to the coal loading system at the railway network.
(4) Coal will be loaded onto railway wagons through the coal loading system.
(5) In the first phase, capacity of coal stockyard is 4.0 million tons per annum (mtpa), and it will be developed up to 8.0 mtpa as demand rises.

4.1.1 Candidate Site for Coal Stockyard

The following factors are considered for site selection and development of the coal stockyard:

(1) Availability of adequate parcel of land
(2) Suitability of land with respect to topography so that earthworks cost is minimized.
(3) Access to site is available
(4) Proximity to load out station
(5) Relocation of any existing utilities
(6) Capital and O&M cost of the conveyance system with respect to site location

Based on the above criteria, the following four sites have been studied for the development of PQA's coal yard. Location of four sites is shown in Figure 4-1.

Source: NESPAK

Figure 4-1 Four Potential Sites of Coal Stockyard

Site-1

Area is the east side of the PQA North-West Industrial Zone (NWIZ) and owned by Pakistan Steel Mill (PSM). A large natural drain (*nullah*) traverses through the site and the construction of two railway bridges for crossing over the *nullah* will be required to access the site. Land required for coal terminal will be 200 acres. However, land acquisition at this site may be a time-consuming exercise and might delay the project.

Site-2

An area of 75 acres is available between the existing railway track and PQA main access road near the South-West Industrial Zone. The topography of the land comprises uneven terrain and ground levels vary from 7 m to 22 m. One high tension line also crosses this land.

The construction of coal stockyard will involve considerable earthworks and relocation of high tension line; as a result, development at this site will expect a significant cost implication.

Site-3

An area of 53 acres is located in the North-Western Industrial Zone on the west side of the existing railway track. PQA has informed that this land has been allotted to a private investor but not been handed over to the private investor due to payment issues. The site is fairly leveled, has easy access to the existing road, and very close to the railway line.

Site-4

An area of 78 acres is available to the north of the PIBT back up area. PQA has informed that 36 acres of land will be made available for the coal stockyard. This site is fairly leveled without major earthworks; however, sub-soil condition is relatively poor and will require improvement work. Site is far from the proposed coal loading system at loading terminal

near Port Qasim spur line and need to be connected by long conveyor belt.

4.1.2 Present Status of Candidate Sites and Selection by NESPAK

The summary of the site selection analysis showing comparison of different sites is presented in Table 4-1.

Considering the operation strategy for handling different types of coal for various power plants, it is advantageous to have the coal stockyard located near thecoal loading system.

Site-1 and Site-3 are both suitable sites for stockyard. If adequate area of land can be available, Site-1 can have a loop arrangement for railway track. Site-2 is considered unsuitable due to the reason above. Site -4 is far away from the coal loading system, and handling of coal will require careful stockpile and dispatch arrangement to ensure efficient and smooth functioning of the conveying and loading operation.

It is recommended to PQA to ensure the availability of land near the railway track (i.e., Site-1).

Table 4-1 Coal Stockyard Site Selection Analysis

S.No	Description	Site 1	Site 2	Site 3	Site 4
1	**Land Availability**	Owned by Pakistan Steel. Availability is not confirmed	Owned by PQA. Availability is confirmed	Owned by private party. Availability is not confirmed	Owned by PQA. Availability is not confirmed.
2	**Suitability of land w.r.t -topography -geotechnical conditions**	-Moderate amount of earthwork required. -Suitable Sub-soil conditions	-Undulating terrain. Extensive earthwork required. -Moderate subsoil conditions.	-Leveled. -Suitable sub-soil conditions	-Leveled but needs earth fill -Relatively poor sub-soil condition
3	**Access**	Presently no access. Roads will need to be developed	Link Roads will need to be developed	Available	Available
4	**Hindrance / utility Re-location**	-Nallah Crossing -Railway Crossing	HT Lines and Pylons	None	None
5	**Proximity to load-out Station**	Close	Far	Close	Far
6	**Operational Advantage w.r.t to handling of different coal types for various power plants**	Good. Easily managed due to short feed conveyor length.	Poor, Will require strict coal handling management due to long feeding conveyor length (2 km)	Good. Easily managed due to short feed conveyor length.	Poor, will require strict coal handling management due to long feeding conveyor length (4.5 km)
7	**Capital cost of conveying system w.r.t to site location**	High, due to higher capacity of main conveyor.	High, due to higher capacity if main conveyor and supporting structure and foundation.	High, due to higher capacity of main conveyor.	Low, due to lower capacity of main conveyor
8	**O & M cost of conveying system w.r.t site location**	Low Less stoppages of long conveyor	High Frequent stoppages of 2km long feeding conveyor	Low Less stoppages of long conveyor.	High Frequent stoppages of 4.2 km long feeding conveyor.
9	**Overall site suitability**	**Good, but land availability is yet to be confirmed by PQA.**	**Poor and not suitable for stockyard.**	**Good but land availability is to be confirmed by PQA.**	**Moderate and availability of land is to be confirmed by PQA.**

Source: NESPAK

4.1.3 Equipment for PIBT Terminal

The imported coal is unloaded at the PIBT jetty and transferred to PIBT through 2.5 km conveyor belt on trestle. The equipment utilized is presented in Table 4-2.

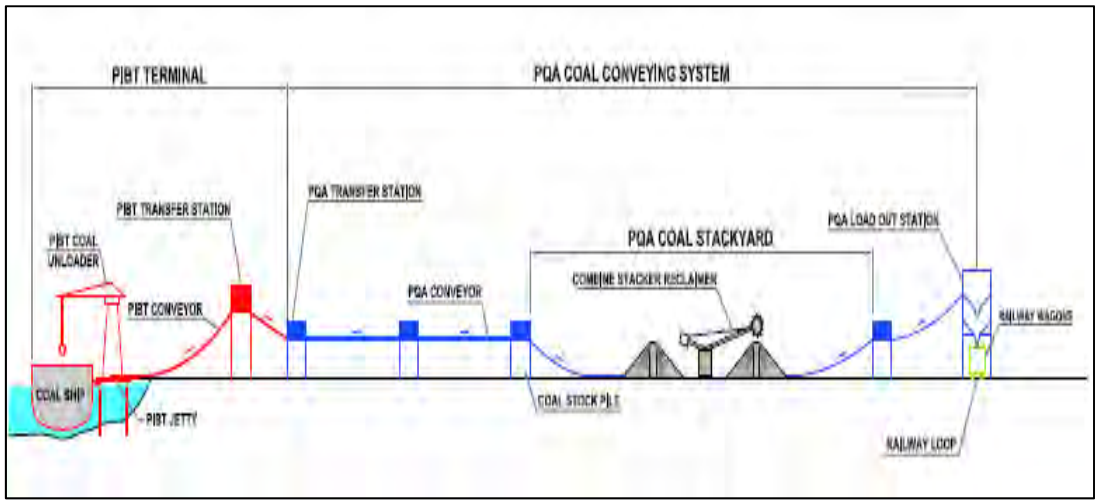
Table 4-2 Equipment for PIBT Jetty and Conveyor System

Location	Equipment	Capacity	Quantity
PIBT Jetty	Unloader	1,850 t/h (design) 1,350 t/h (operation)	2
PIBT Jetty to PIBT terminal	Conveyor belt	3,600 t/h (coal) 1,200 t/h (cement, clinker)	1 1

Source: JST

4.1.4 Proposed Coal Handling System and Equipment by NESPAK

Coal conveyance system is shown in Figure 4-2.



Source: NESPAK

Figure 4-2 Coal Handling System Material Flow Diagram

(1) PIBT Terminal to PQA Coal Stockyard

Direct connectivity will be provided from within PIBT terminal to a transfer station just outside PIBT terminal from where the PQA' conveyor will take the coal to PQA's coal stock yard through 4.5 km conveyor belt.

(2) Coal Stockyard Near Coal Loading System.

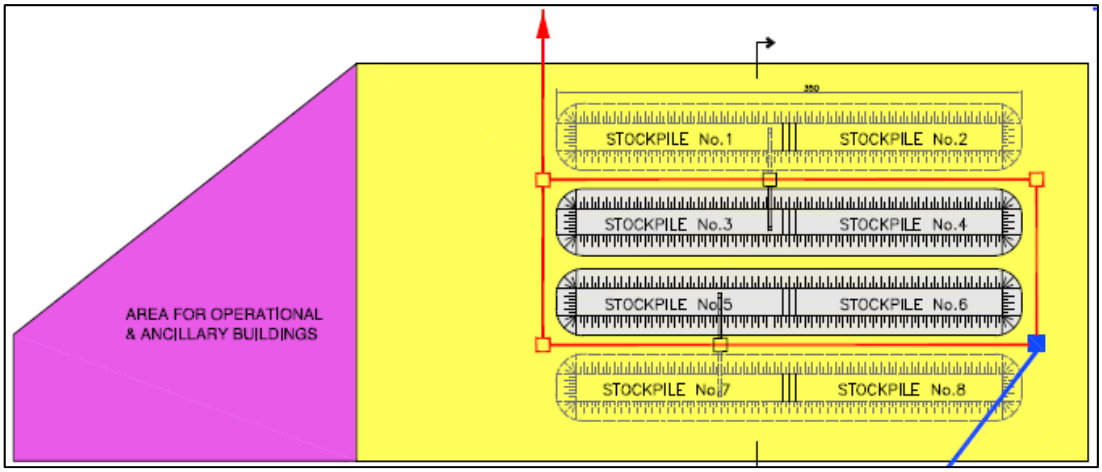
The coal stockyard will have eight stockpiles with 55,000 t of coal each. Each stockpile will be 50 m wide, 115 m long, and 15m high.

- First phase stacking area will be developed only for four stockpiles to handle coal up to 4.0 mtpa.
- Second phase stacking area will be developed up to 8 mtpa as demand rises.

Layout of coal stockyard is shown in Figure 4.3.

(3) Transfer of Coal from Stockyard to Loading System

Combined stacker reclaimer or reclaimer is used for reclaiming coal from stockpile and transferring coal to the loading system.



Source: NESPAK

Figure 4-3 Layout of Coal Stockyard planned by NSPAK

(4) Loading of Coal from Loading System to Railway Wagon

One set of coal loading system will be provided on the loop line and will consist of surge bin, weighing bin, and loading chute. The rake will be moving below the loading chute with uniform speed while weighed coal in the bin will be discharged into the wagons. The rake will consist of 40 wagons of ZBKC type having a capacity of 70 t with a payload of 60 t. The loading capacity from the loading system is 2,400 t per rake with loading time of 40-60 s per wagon.

Equipment to be utilized for the coal handling system are presented in Table 4-3.

Table 4-3 Proposed Equipment for Coal Handling System by NESPAK

Location	Equipment	Capacity	Quantity
PIBT terminal to PQA's stockyard	Conveyor belt	3,600 t/h	1 no (4,500 m)
PQA's stockyard	Stacker-Reclaimer	Stacking : 3,600 t/h Reclaiming: 2,400 t/h	2 no
PQA's stockyard to loading system	Conveyor belt	2,400 t/h	1 no
Coal loading system	Surge bin, Weighing bin, Loading chute	2,400 t/train 40~60 sec/wagon	1 no.

Source: NESPAK

4.2 Review of the Existing Facility of IOCB

Iron Ore and Coal Berth (IOCB) specializes in handling raw materials such as iron ore, coal, and manganese for PSM. The 279 m long jetty is equipped with two grab unloaders, and can

berth 55,000 DWT ships. The jetty is connected to PSM coal stockyard through double lines of conveyor belt with length of 4.5 km each on trestle bridge to deliver raw material.

Source: NESPAK

Figure 4-4 Location of IOCB

With regard to the ownership of facility, PQA owns the jetty infrastructure and navigates the ships to the jetty, while Pakistan Steel Mill owns and operates the two unloaders, double lines of conveyor belt, and other cargo facilities, and handles ship arrangement.

Current steel production capacity of PSM is 1.1 mtpa. It also produces 3.0~3.5 mtpa of iron ore and coal. However, when the production capacity of steel mill will increase in the future, the development of the jetty extension and two additional unloaders will be required.

4.2.1 Existing Equipment of IOCB

Equipment utilized by IOCB are presented in Table 4-4.

Table 4-4 Existing Equipment of IOCB

Location	Equipment	Capacity	Quantity
IOCB Jetty	Unloading machine	700 t/h	2 nos.
Jetty to PSM Stockyard	Conveyor belt	1,000 t/h (Coal) 1,200 t/h (Ore)	1 no. x 4,500 m 1 no. x 4,500 m

Source: JST

Source: JST

Figure 4-5 IOCB Jetty and Unloader and Conveyor Belt on Trestle

Source: JST

Figure 4-6 27.5 ton Grab Bucket and Receiving Hopper and Conveyor Belt at PSM Land

4.2.2 Application of IOCB for Coal Handling

The capacity of coal handling, unloading and transfer of coal, of IOCB is estimated about 10 million ton per year with the condition of working hour of 24 hours per day and 340 days per year same condition of 3.2.3 (2). The production of steel of 1.1 mtpa of PSM needs the handling capacity of 3.0~3.5 mtpa of coal and iron ore. It is estimated that IOCB has handling capacity of 6.5~7.0 mtpa in reserve and this capacity of coal handling can be used as the transfer of coal from ship to coal trains. The following three sites are the possible sites for coal stock and loading to the coal train.

Site 1: Existing coal stock yard of PSM

The new coal stock yard will be constructed beside the existing coal stock yard and extend the railway track from nearby railway track of PSM. This site is easier and cheaper because of the utilization of existing facilities. The possibility of this site depends on the policy of the privatized new steel mill company. The study will be done by privatized new steel mill.

Site 2: Between existing railway spur line to Port Qasim and PSM

The new coal loading station including coal loading system will be constructed at the PSM side of the existing spur line to Port Qasim and the coal stock yard will be adjacent to this station. There are many electric towers of high voltage in this area, to construct station and coal stock yard it is necessary to relocate these towers and the cost will be very high. This site is not recommendable.

Site 3: West side of IOCB jetty near Qasim Port Road

It is proposed to construct the coal stock yard at the reclamation of shallows at the west side of jetty and sea side of Qasim Port Road. The coal will be transferred by the conveyor belt from the coal stock yard to Port Qasim station beside of marginal wharf and loading the coal to the train as same method of 4.3.3. This area is a part of the planned new Marginal Wharf of the future plan of PQA. The reserved coal handling capacity of IOCB is depend on the plan of the privatized new steel mill. After the decision of the new steel mill company and their production plan, the plan how to use the IOCB will be studied.

4.3 Review of the Existing Facility of Marginal Wharf

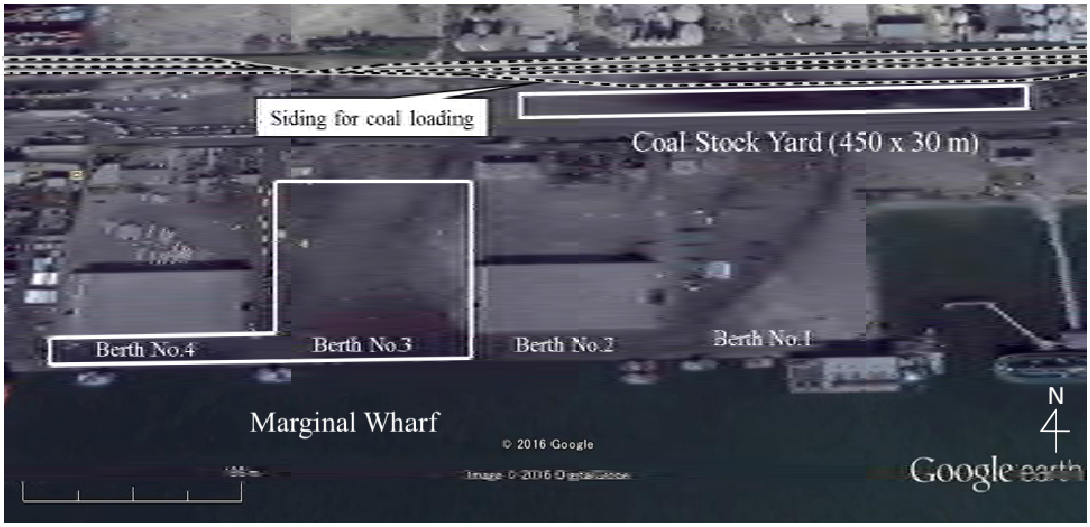
4.3.1 Conditions for the Discussion of the Coal Handling Plan at the Marginal Wharf

PQA is planning to lease Berth No. 3 and No. 4 of the marginal wharf as a dedicated coal terminal. There are some physical restrictions for these berths to be renovated to a coal terminal, namely: 1) water depth of the berths is currently -11 m, 2) the quay structure may not be strong enough to be loaded with heavy equipment for cargo handling, and 3) the space for coal stockyards.

These restrictions can be surpassed through a large-scale investment that includes reconstruction of the berth structure, dredging of the basin, and procurement of large coal stockyard. The examination of the coal handling plan discussed hereunder shall be done under the conditions that ship-to-quay unloading is performed without heavy equipment and the coal stockyard is limited to the existing designated area only.

4.3.2 Review of the Current Coal Unloading Operation

The current facility layout of the marginal wharf, including the coal stockyard and the rail siding for coal loading, is shown in Figure 4-7. Just behind the marginal wharf, there is a coal stockyard along the rail siding for cargo loading. The area designated for coal stockyard is approximately 450 m x 30 m.



Source: Google Earth, edited by JST

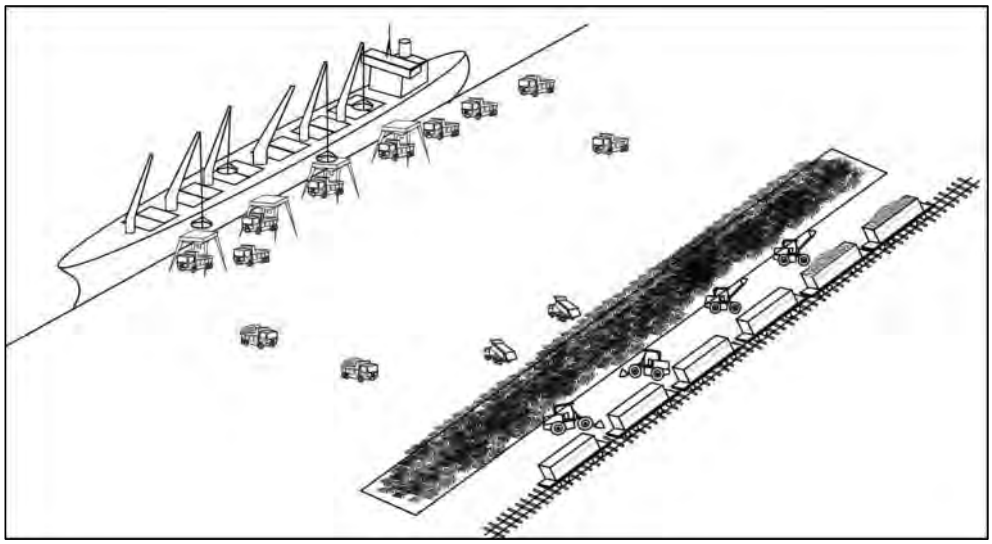
Figure 4-7 Current Facility Layout of the Marginal Wharf

The vessel berthing record shows that three coal carriers docked at the marginal wharf from January 24 to March 15, 2016 (see Table 3-11). Since there is neither heavy equipment nor conveyor system at the wharf, it seemed that the unloading work was done by ship gears and coal was carried by dump trucks to the stockyard. Due to the limited size of the coal stockyard, coal must have been transported immediately by railway.

As discussed in Section 3.3, the productivity of ship-to-quay unloading work should be 600 t/h or larger, the transportation between the quay and the stockyard must have been done at the same rate. Thus, assuming that the load capacity of a dump truck is 15 t, 40 dump trucks (or 10 dump trucks per ship gear) should be operated in an hour between the quay and the stockyard in an hour. In other words, dump trucks come to and leave a hopper every 6 minutes (=60 min. /10 Trucks). The number of units of dump trucks varies depending on the

time required for a truck to complete one cycle, which comprises of travel form the hopper at the wharf to the stock yard, dumping of coal and returning to the hopper at the wharf. If the cycle time is less than 6 minutes, which is the same rate of that of a ship crane, 2 trucks per crane, i.e., a total of 8 trucks for 4 cranes, are enough. If the cycle time is longer than 6 minutes additional truck unit per crane is required for excess of every 6 minutes, e.g., for the case of the cycle time is 12 minutes, 3 trucks per crane (a total of 12 trucks) are required.

The maximum coal storage capacity of the stockyard is estimated at 40,000 t assuming that the height of the pile of coal is 3.0 m. However, it is unrealistic to pile up coal to such a height, and it is likely that coal trains are also operated simultaneously with the unloading work at the quay.



Source: JST

Figure 4-8 Current Coal Handling Scheme at the Marginal Wharf

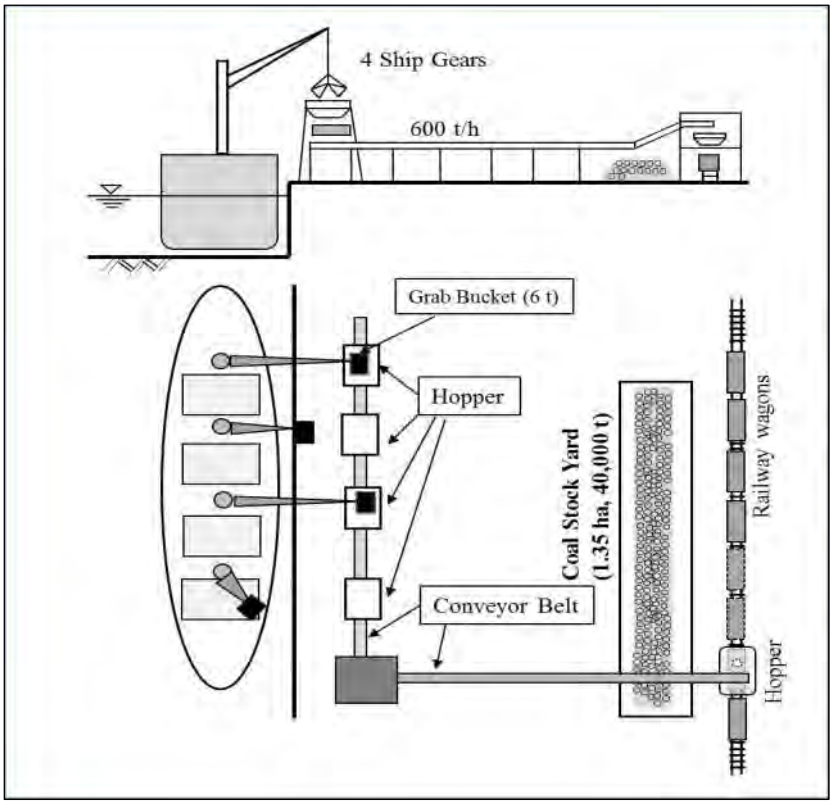
4.3.3 Coal Handling System for a Dedicated Terminal at the Marginal Wharf

In Section 3.3, the examination of the coal unloading capacity of Berth No. 3 and No. 4 showed that if these berths are fully used, 4 million tons of coal can be unloaded per annum. In order to utilize these berths at full capacity, the transportation system from the berths to the coal storage yard and the coal loading system to the rail wagons should be enhanced.

The most efficient alternative to the coal transfer system with dump trucks is the installation of conveyor belt system. In addition, taking into consideration the space limitation of the stockyard, it is necessary to construct a coal loading station where coal transported from the berths by the conveyor belt is directly loaded to rail wagons. One of the possible conveyor belt systems is schematically shown in Figure 4-9.

On the basis of the assumption that the productivity of unloading at the berths should be 600 t/h, the capacity of the conveyor belt system should be 600 t/h or larger. Likewise, the productivity of the coal loading system at the rail station should be 600 t/h or larger. The load capacity of a rail wagon is 60 t and the loading productivity of 600 t/h is achieved by filling 10 wagons per hour or by filling a wagon in 6 minutes.

Summary of the preliminary cost estimation based on the schematic layout is shown in Table 4-5. It costs 482.9 million PKR. This is the schematic showing of the concept of one of the ideas therefore, the detail study shall be done in a separated study.



Source: JST

Figure 4-9 Schematic of a Possible Conveyor Belt System of the Marginal Wharf

Table 4-5 Preliminary Cost Estimation

No.	Item	Total Cost (Rs. in million)
1	Mechanical & Electrical	402.4
1-1	Receiving Hopper	7.3
1-1	Conveyor belt	360.8
1-1	Feeding conveyor belt	33.7
1-1	Coal loading system	0.6
2	Expense (20%)	80.5
	Total	482.9

Source: JST

4.4 Recommended Coal Handling Plan by JST

Coal handling plan is based on the following assumptions:

(1) Capacity of imported coal handling at PIBT will be 28 mtpa and 20 million tons out of 28 million tons will be transported by PQA conveyor belt to the railway coal loading system.

(2) At initial stage of the PIBT operation, coal handling capacity will be less than 20 mtpa. Thus, Stage-wise plan based on the demand of coal is studied in this report as follows:

Stage-1 : Coal handling of 10 mtpa in the initial stage, and provision of two loop tracks with two coal loading systems.

Stage-2 : Coal handling for future demand of 20 mtpa, and provision of additional loop tracks and three coal loading stations.

(3) PSM land near PR Port Qasim spur line will be secured for coal loading terminal and area of land is 150 acres.

(4) PQA coal loading terminal comprised coal stockyard, coal loading system, and loading track.

(5) Imported coal is transported directly from PIBT terminal to PQA conveyor belt.

Project location map is shown in Figure 4-10.

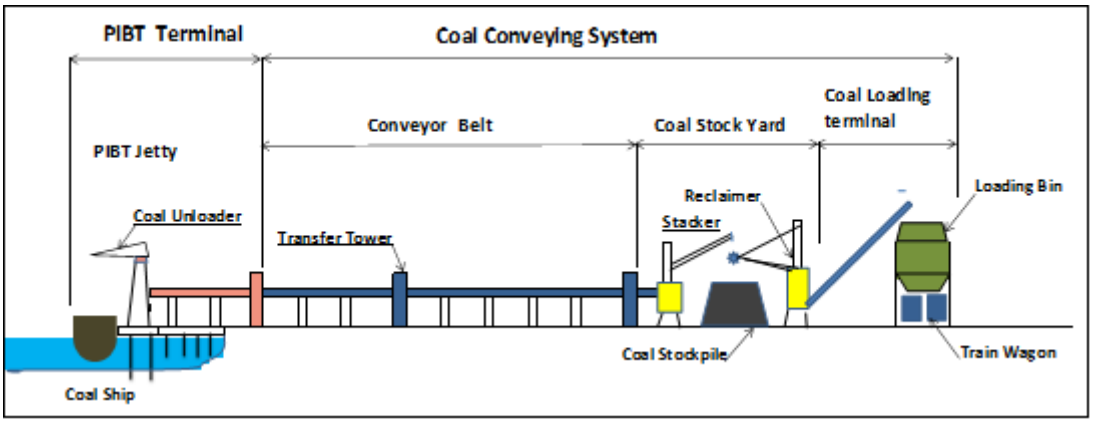
Source: JST

Figure 4-10 Project Location Map

Coal handling plan is based on Stage-2 as mentioned above and comprises the following parts:

- Coal conveyance system from PIBT terminal to PQA coal stockyard.
- PQA coal stockyard.
- Coal loading system at station.

Schematic coal handling plan is shown in Figure 4-11, and Layout of coal handling plan is shown in Figure 4-12.



Source: JST

Figure 4-11 Schematic Coal Handling Plan

(1) Coal Conveyance System from PIBT Terminal to PQA Coal Stockyard

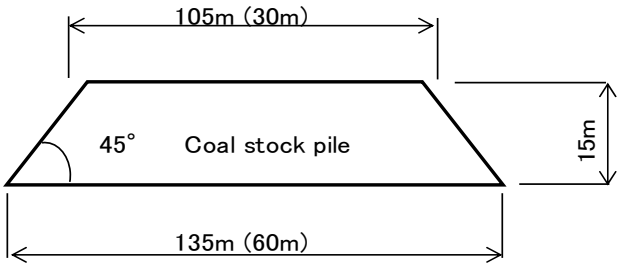
Two types of foundation are adopted for the main conveyor belt, namely; piling foundation, which is used for soft subsoil condition near the sea side, and spread foundation for firm ground of hill side.

Direct connectivity will be provided from PIBT terminal to coal stockyard through single line of elevated conveyor belt with length of 4,500 m. Two conveyor belts will be installed and intersect at the transfer tower. Conveyor belt will be constructed along the existing road and its foundations are within the center median of road.

(2) PQA Coal Stockyard

Coal stockyard is located on the east side of Pakistan Railway Port Qasim spur line. The coal is transported from PIBT terminal by conveyor belt crossing over the railway track and a large natural drain (*nullah*).

Coal stockyard has six stockpiles each with capacity of 70,000 t. Each stockpile is 60 m wide, 135 m long, and 15 m height. Total storage capacity is 420,000 t. Layout of coal stockyard is shown in Figure 4.13. Pile foundation is adopted for the foundation of heavy equipment such as stacker, reclaimer, and stacker/reclaimer. Cross section of coal stock pile is shown in below



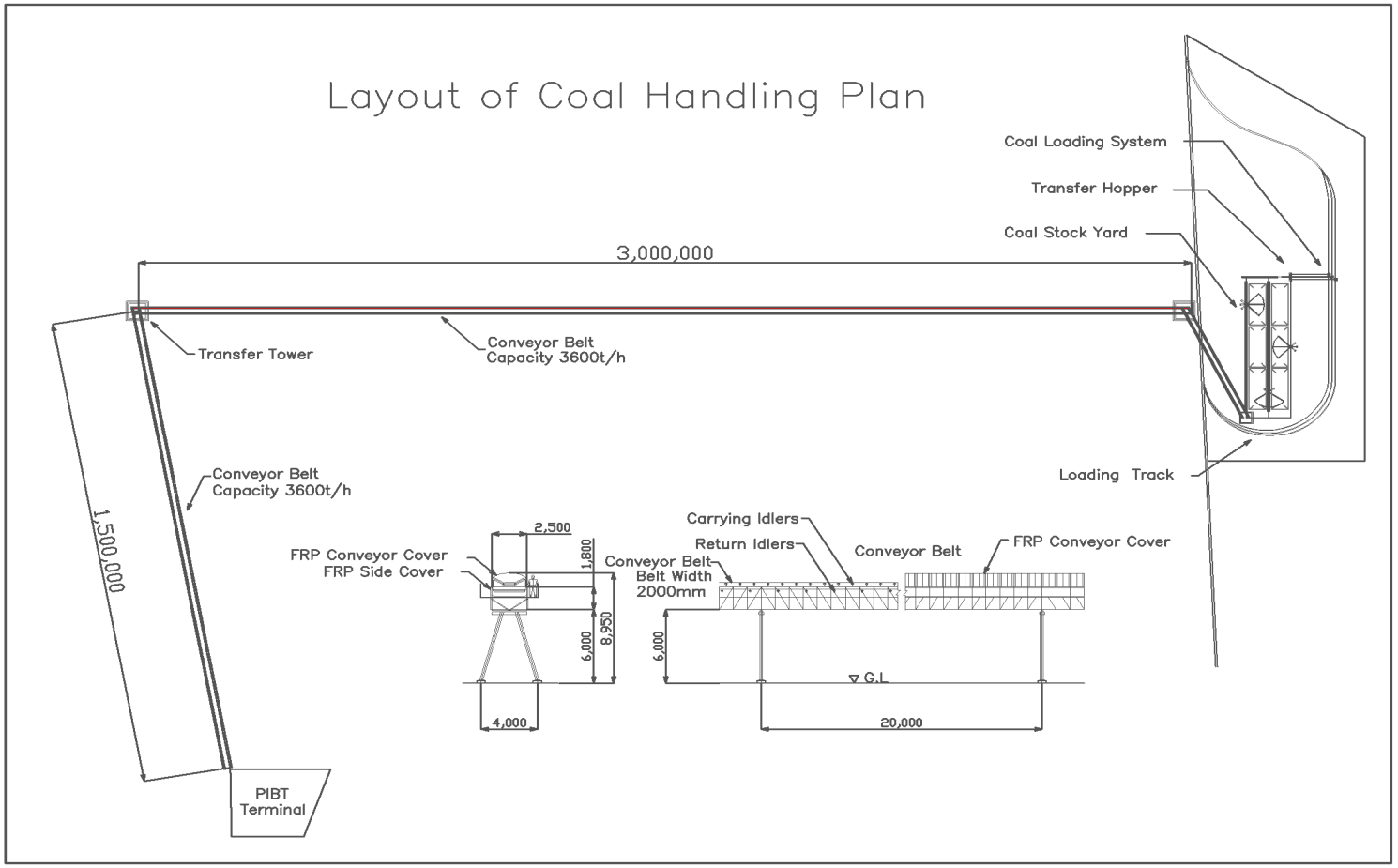
Gravity of coal : 0.8 t/m3
Repose angle of coal : 45°

(3) Coal Loading System

According to the information of Pakistan Railway, it can handle 2,400 ton of coal per train which makes up 40 wagons by taking 60 ton per each. Based on JST's study, 27 trains per

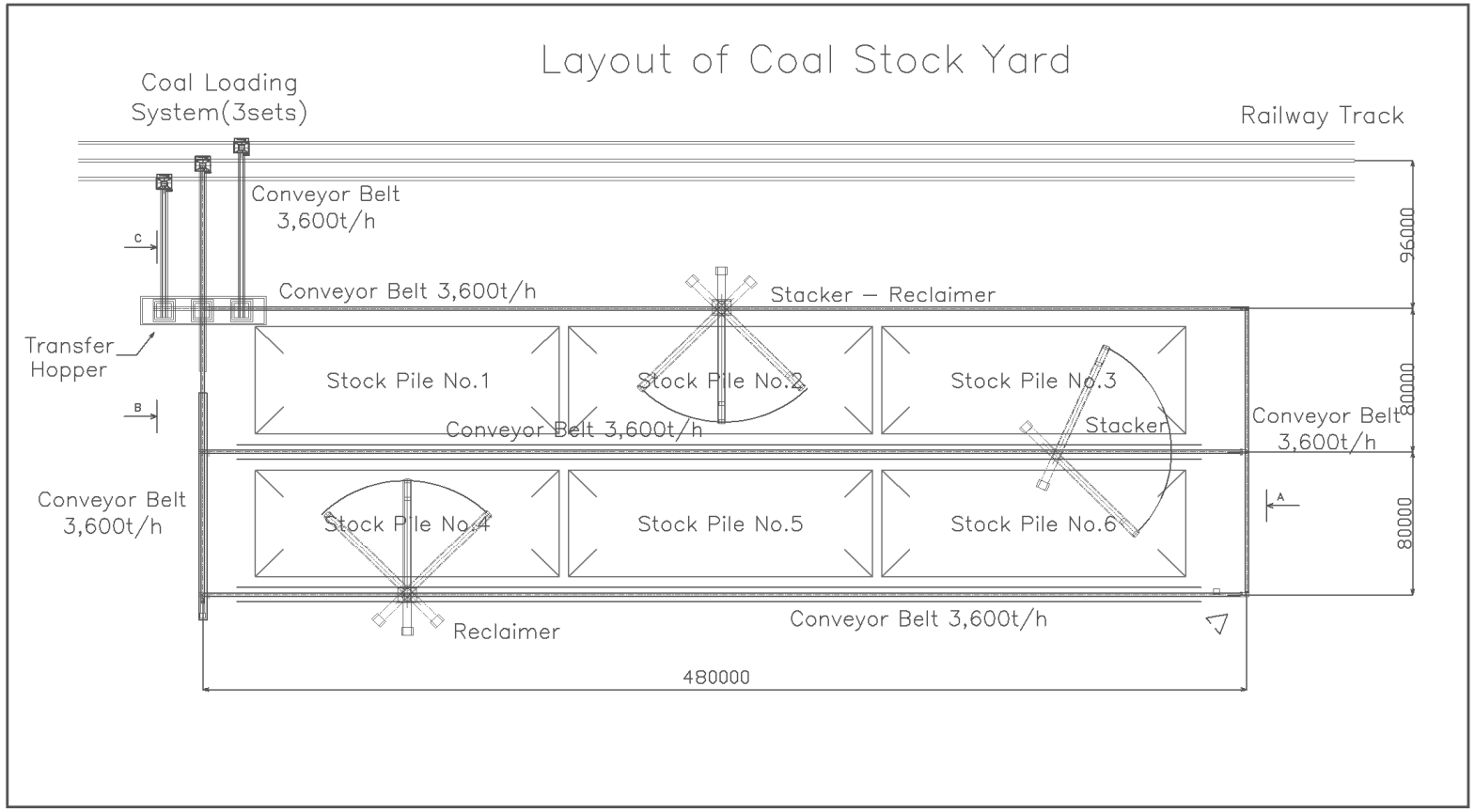
day for transportation of the future demand of 20 mtpa of coal. Coal loading system is shown in Figure 4-14.

As a result of the examination of the number of coal loading system, one loading system will be able to handle 11 trains per day based on the operation time of 20 hr/day. Thus, the number of required sets of coal loading system is three for 20 mtpa, two for 10 mpta and one for 4 mtpa.



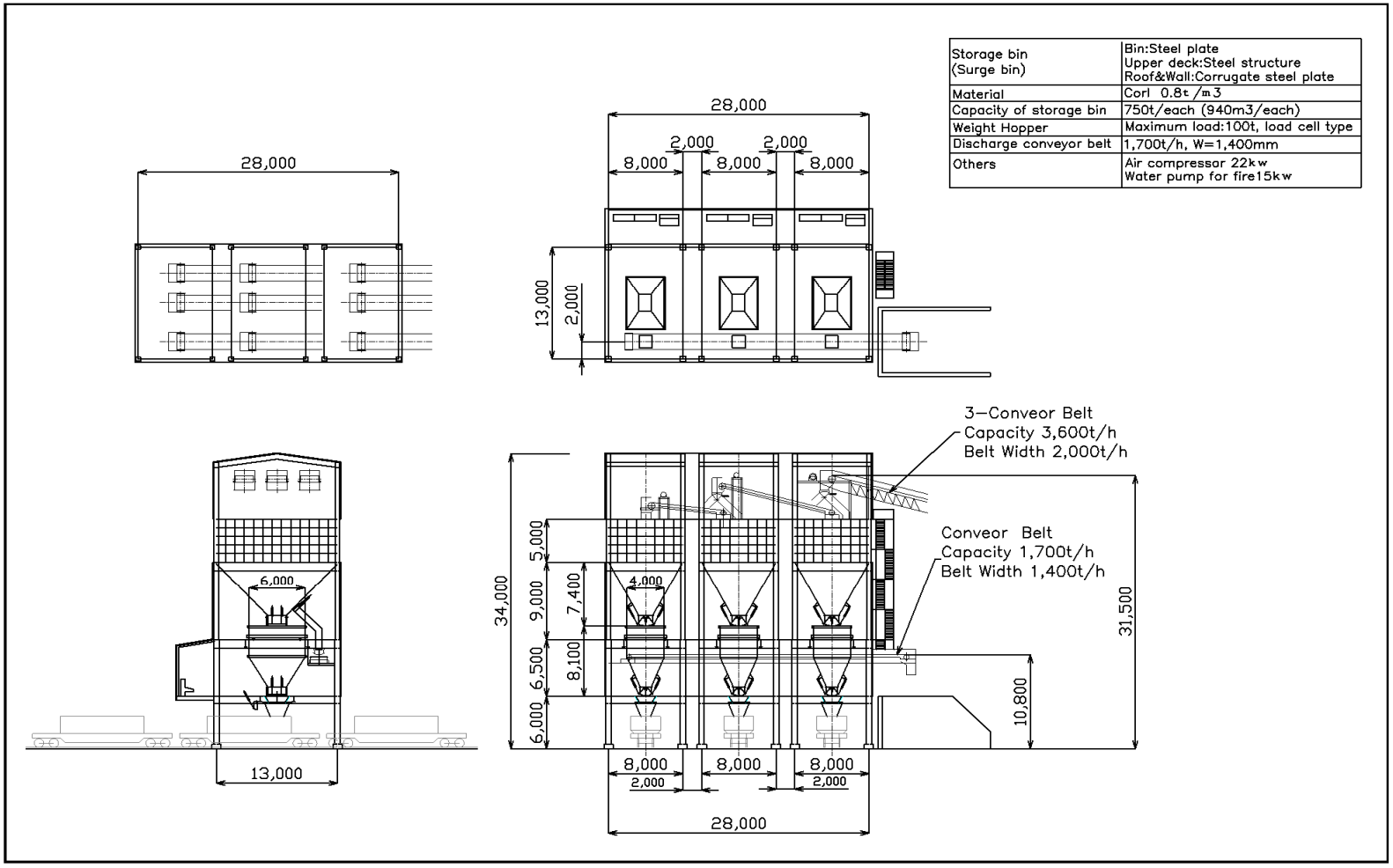
Source: JST

Figure 4-12 Location of Coal Handling Plan



Source: JST

Figure 4-13 Layout of Coal Stockyard



Source: JST

Figure 4-14 Coal Loading system

(3) Coal Loading System

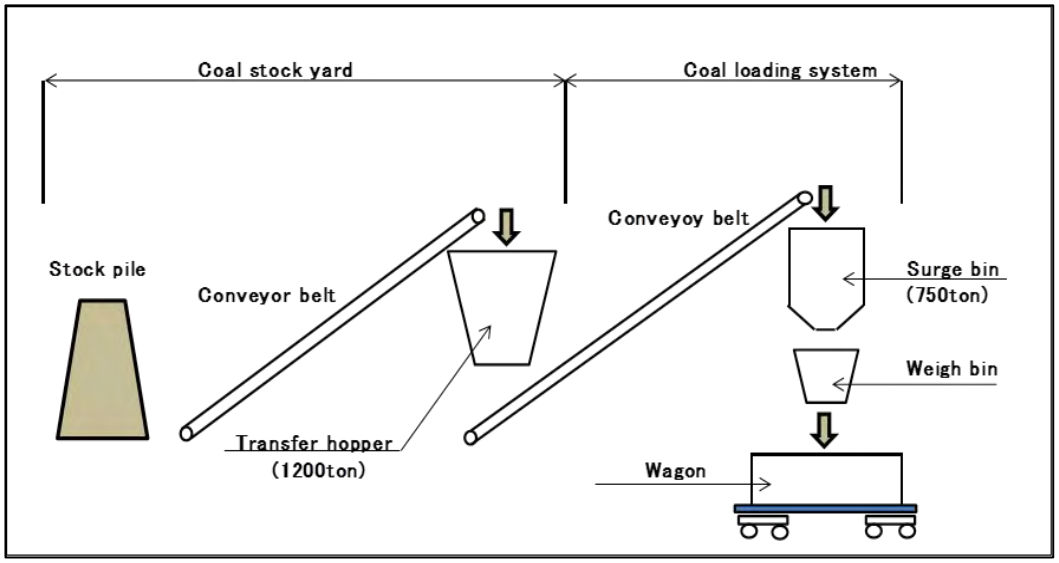
According to the information of Pakistan Railway, it can handle 2,400 ton of coal per train which makes up 40 wagons by taking 60 ton per each. Based on JST's study, 27 trains per day for transportation of the future demand of 20 mtpa of coal. Coal loading system is shown in Figure 4-14.

As a result of the examination of the number of coal loading system, one loading system will be able to handle 11 trains per day based on the operation time of 20 hr/day. Thus, the number of required sets of coal loading system is three for 20 mtpa, two for 10 mpta and one for 4 mtpa.

(4) Coal handling operation

- Capacity of reclaimer and feeding to coal loading system

Figure 4-15 shows schematic coal flow from stock yard to loading sytem.



Source: JST

Figure 4-15 Schematic coal flow

Number of train will be calculated based on capacity of reclaimer as follow,

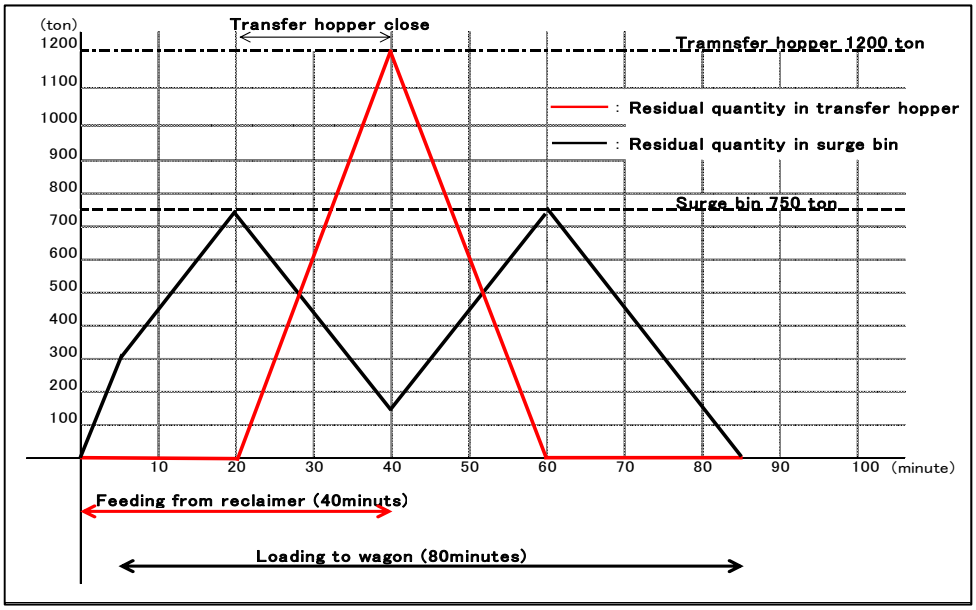
N = To / (Tf + Tm) = 1200 / (40+4.4) =27.03 > 27 = numbers of trains required herein
N: Number of train
To: Operation hour per day 60minutes * 20 hours =1200 minutes
Tf: Feeding time to train 60minutes * 2400/3600 = 40 minutes
Tm:Traveling time of reclaimer to next stock pile 220m/50m =4.4 minutes

- Coal loading operation

For continuous operation of coal loading to wagon, feeding coal to surge bin shall be adjusted by transfer hopper due to different rate of feeding from stock yard and loading to wagon. Transfer hopper is located at coal stock yard and having capacity of 1200 ton/no for

each loading system.

Figure 4-16 shows residual quantity of coal in transfer hopper and surge bin at loading system.



Source: JST

Figure 4-16 Residual coal volume in Transfer hopper and surge bin

- Procedure of operation
- Prior to loading coal to wagon, coal will be stocked in surge bin for 5minutes.
- Surge bin will be full 15 minutes after start of loading coal to wagon.
- Close gate of transfer hopper and stock coal in hopper until being full, i.e. 20 minutes after closure of hopper gate.
- Then open gate of transfer hopper until being empty, i.e. 20minutes after open of hopper gate.
- Surge bin continues to load coal to wagon for 80 minutes after start loading

4.4.2 Equipment for Coal Handling System

The following equipment will be installed for the coal handling system:

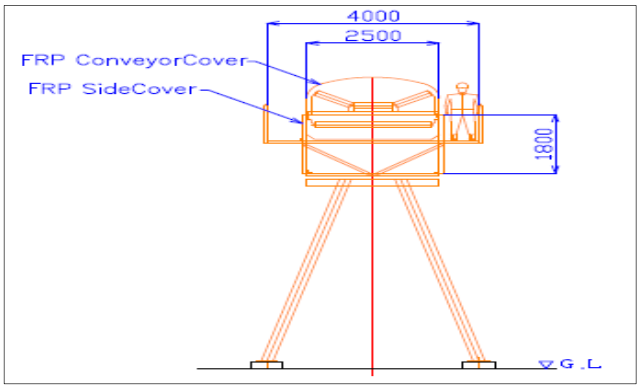
(1) Conveyor Belt from PIBT Terminal to PQA Stockyard

Take up coal from PIBT backup terminal and deliver to PQA stockyard through the main conveyor belt. Capacity of conveyor belt is 3,600 t/hr which shall be accommodated at the maximum rate of PIBT unloading capacity. Conveyor belt is heavy duty type with steel cord belt and covered with Fiber reinforced plastics (FRP) roof and side panel to prevent coal dust from being scattered. The lengths of the two conveyor belts are 1,500 m and 3,000 m and it will be connected at the intermediate transfer tower.

Two transfer towers are provided on the route of the conveyor belt. Towers are constructed with steel frame covered by corrugated steel sheet to shut in the coal dust.

Specification of Equipment

- Conveyed Material : Coal
- Conveying Capacity : 3,600 t/hr
- Belt width : 2,000 mm
- Belt speed : 3.3 m/s, (200 m/min)
- Inclination : Maximum 15 degrees
- Dust suppression : Fiber Reinforced Plastic (FRP) roof and side cover



Source: JST

Figure 4-17 FRP Conveyor Cover

(2) Equipment at Coal Stockyard

Coal stockyard has two rows for stockpile. Conveyor belt will be installed on both sides and in between the two rows of stockpile.

Three stacking and reclaiming machines are provided, one stacker is in between the rows, one reclaimer and one combined stacker-reclaimer are installed on both sides of the rows. For coal dust suppression measure, the following will be taken at the coal stockyard in order to prevent the coal dust from being scattered.

- Dust suppression net for north and west sides of the stockyard
- Provision of sprinkler with water pipe and pump

Source: Mitsui Miike Machinery Pamphlet (Left), JFE Civil E & C Pamphlet (Right)

Figure 4-18 Stacker Reclaimer and Dust Suppression Net

Specification of Equipment

- Combined stacker/reclaimer : Stacking 3,600 t/h
  Reclaiming 3,600 t/h
- Stacker : Stacking 3,600 t/h
- Reclaimer : Reclaiming 3,600 t/h
- Belt width : 2,000 mm
- Belt speed : 3.3 m/s (200 m/min)
- Track span (rail gauge) : 8,000 mm
- Longitudinal travel : 480 m
- Boom reach : 45 m

(3) Coal Loading Station

Coal loading system consists of a storage silo (surge bin), discharge conveyor belt, weigh bin, and discharge gate. To avoid the mixture of different types of coal, discharge conveyor belt is installed between the surge bin and weigh bin to remove the residual coal in the surge bin. The coal loading system is mounted above the railway track. Train is moving below the loading gate with low constant speed while the weighed coal in the bin will be discharged into wagons.

Surge Bin

The surge bin is a steel cylinder cone type and has the line with the angle of repose of coal. Surge bin has a capacity of 750 t for receiving coal supplied from stockpile.

Charging gate

Chaging gate under surge bin is a fully sealed air pressure fan type gate. The gate opening size is 2000mm for quick charge of coal to weigh bin.

Discharge Conveyor Belt

Residual coal in the surge bin shall be removed before feeding different types of coal into the surge bin in order to avoid the mixture of different types of coal. Small size conveyor belts, 1,400 mmwill be installed between surge bin and weigh bin.

Weigh Bin

Weigh bin is a steel cylinder cone type and has the line with the angle of repose of coal. Bin has a capacity of max load 100 t with load cell. Two discharge gates are provided with weigh bin in order to make continuous discharge into wagons. The opening size of gate is 800 mm. Hopper chute is provided under surge bin to prevent coal being spread out of wagon.

Discharge Gate

Discharge gate under the weigh bin is a fully sealed air pressure fan type gate with misalingned upper and lower blades. The gate opening size is 1500 mm for quick discharge of coal on to wagons.

Specification of Equipment

- Feeding capacity : 3600 t/h
- Loading time : single wagon :120 seconds, whole train: 80 minutes
- Train speed : 0.45 km/h
- Wagon model : Capacity: 70 t, Pay load: 60 t
- Capacity of weight bin : 60 t

- Capacity of surge bin : 750 t
  Discharge conveyor belt : W=1,400 mm

4.5 Operation and Maintenance Plan

Coal handling system consists of three activities, i.e. conveyor belt, coal stock yard, loading system, and operation will be synthetically controlled.

(1) Operation

Operational staff will be assigned management and operation respectively.

- Overall management staff :

General manager	1 no
Mechanical engineer	1 no
Electrical engineer	1 no
Instrument engineer	1 no

- Operation staff

General team	5 nos (electronics, mechanical, process)
Central control Operator	4 nos
Skilled operational staff	14 nos (Stacker, reclaimer, conveyor, loading system)
Unskilled labor	10 nos

(2) Maintenance

Maintenance of coal handling system will be carried out daily, monthly and yearly as following frequency and check item.

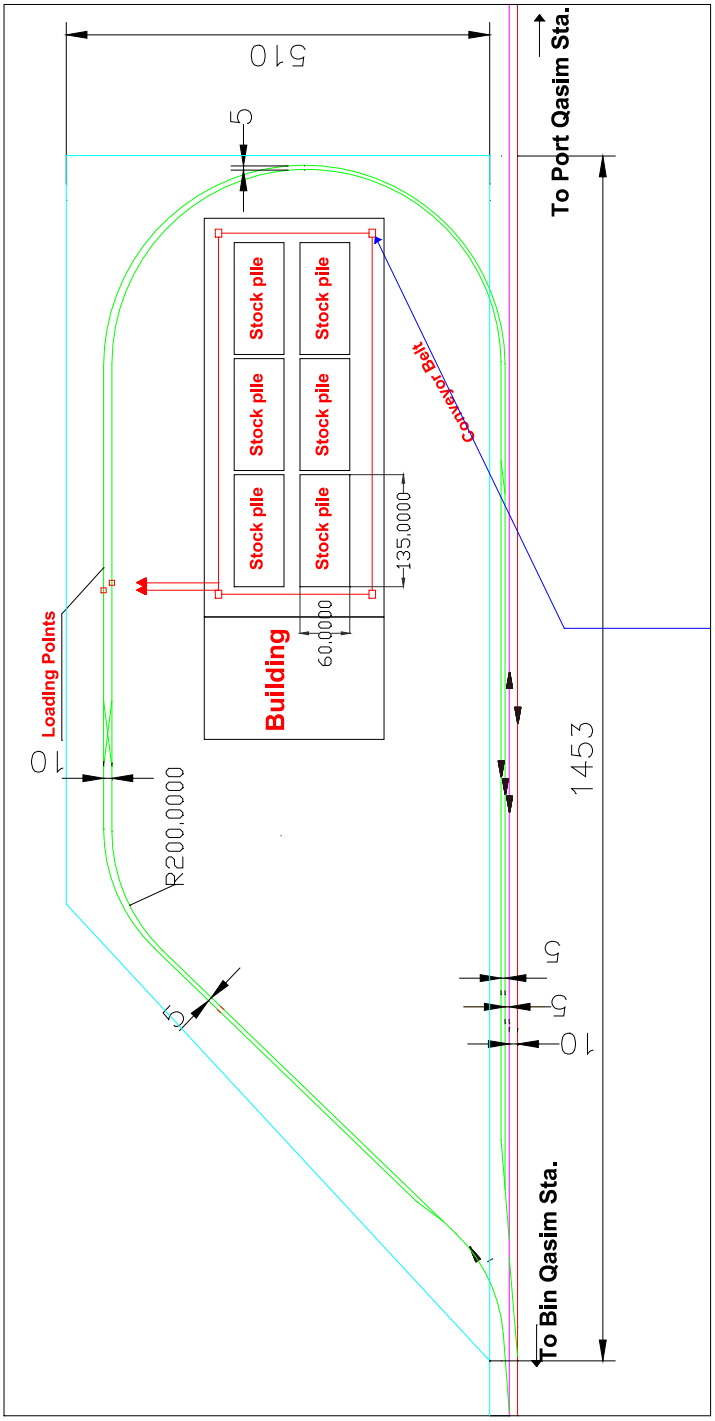
Daily : 1~2 hours/day Sound, heat, oil leak (mortor, reducer, shaft bearing),etc
Monthly : 1 day/mth Minor part exchange, weigh system, etc
Yearly : 3~5 days/mth Control system, belt exchange, bend of stacker reclaimer and major part exchange, etc.

Daily and monthly maintenance will be carried out by maintenance team(8-10nos), and yearly maintenance will be carried out by manufacturer and maintenance team.

Chapter 5 Coal Transportation by Railway

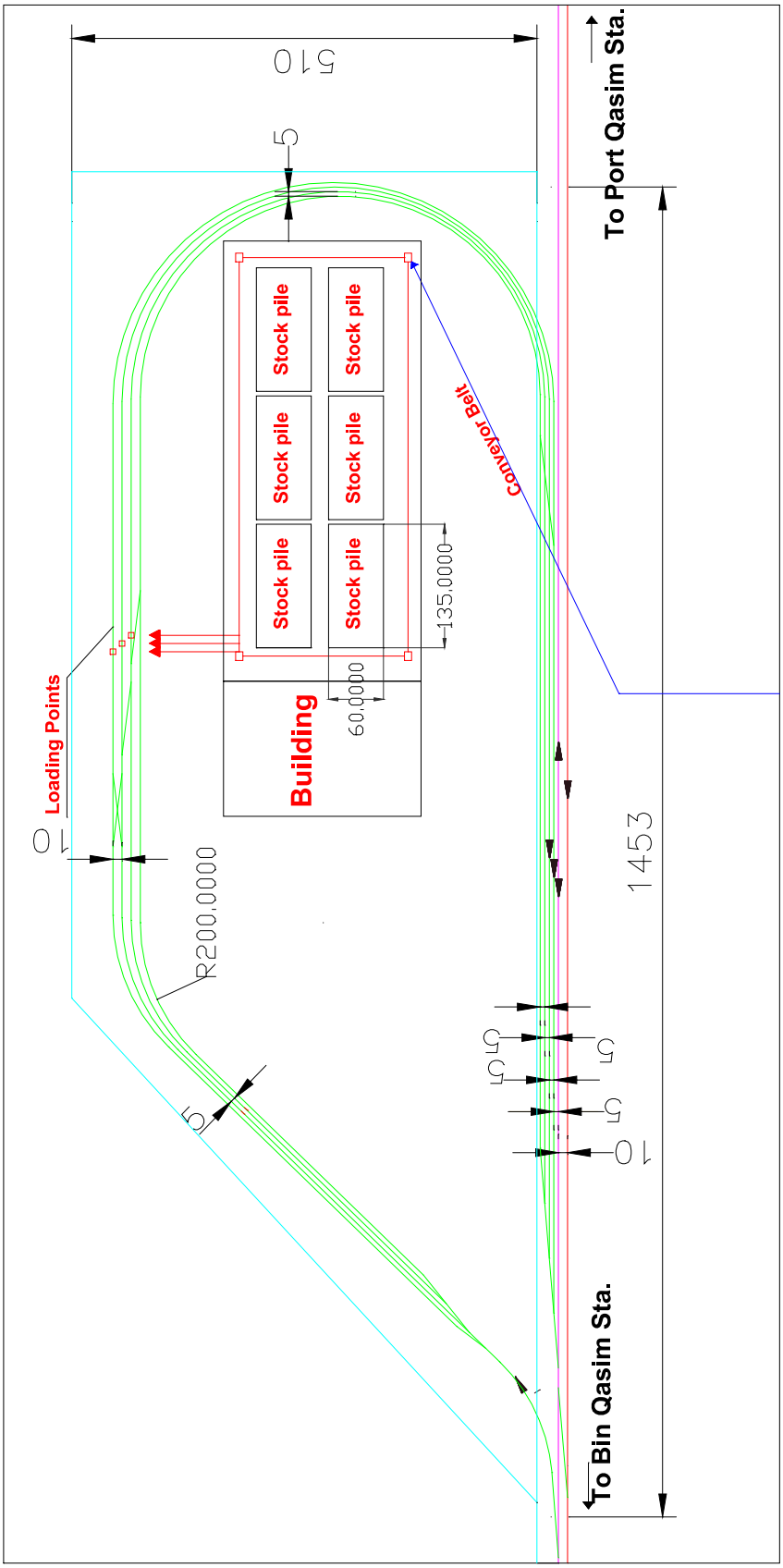
5.1 Track Layout at Coal Loading Terminal

Track layout plan at the coal loading terminal is shown in Figure 5-1 for Phase 1 and Figure 5-2 for Phase 2, respectively, to meet the coal loading capacity for future coal demand.



Source: JST

Figure 5-1 Track Layout at Coal Loading Terminal in Phase 1



Source: JST

Figure 5-2 Track Layout at Coal Loading Terminal in Phase 2

As a result of the comparison study between the linear and loop model of track layout, loop model is recommended due to the following advantages:

- Increasing the capacity of coal train operation
- Reducing the shunting operation time
- Efficient and smooth train operation

Two loop tracks are required in Phase 1 for 10 mtpa.

In Phase 2, coal handling capacity can be increased up to 20 mtpa with two additional loop tracks to meet the future coal demand.

Installation of loop tracks required for each phase will be executed as follows:

Phase 1: Two loop tracks with required turnouts.

Phase 2: Two additional loop tracks with required turnouts.

Track layout shows that coal train comes from the left side of Bin Qasim Station and enters the loop line clockwise and stops just before the coal loading system and wait for the clearance of the line ahead.

Once the line is clear and coal loading operation is ready, coal train starts and keeps moving through the coal loading system at very low speed around 0.5 km/h until 40 wagons have been loaded. After loading of coal, the train moves on the loop line towards the down track at around 20 km/h, then crossing the down track and moving on the up track towards Bin Qasim Station.

To ensure safe and efficient coal train operation according to the planned track layout, advanced signaling system with computer based interlocking system (CBI), color light signal, electric point machine, and track circuit device shall be installed.

For the execution of the abovementioned railway track facilities, the Ministry of Ports and Shipping (MoPS) needs to closely coordinate with the Ministry of Railways.

5.2 Train Operation Plan

5.2.1 Condition of Train Operation

The concept of train operation for coal loading to the coal train at the Coal Loading Terminal station is as follows:

- All the coal trains arrive and leave to/from Pipri Marshalling Yard,
- All the coal train sets leave from the reception yard of Pipri Marshalling Yard and go to the Coal Loading Terminal station for loading coal then go back to the Pipri Marshalling Yard reception yard via Bin Qasim Station,
- The shunting time of the coal trains inside Pipri Marshalling Yard will not be counted as train operation for coal loading operation; this shunting time shall be counted for the whole train operation schedule and train operation on main line,
- The coal train is fixed train set with 1 locomotive + 40 coal hopper wagons for 60 t coal load + 1 brake van,
- There is one block signal system between the reception yard of Pipri Marshalling Yard and

Bin Qasim Station and between Bin Qasim Station and the Coal Loading Terminal station,

- The kind of coal for each power plant is different but the kind of coal for NECL (Rahim Yar Khan) 1 and 2 are same, and
- Changing of the kind of coal loading to the coal train will be minimized and will be done during nighttime maintenance, if possible.

5.2.2 Demand of Coal Transportation

The project will be studied under two stages to accelerate the first stage construction work and minimize the initial investment.

Stage 1: 10 mtpa; Sahiwal, Jamshoro and Lakhra

Stage 2: 20 mtpa; nine power plants

The details of the coal demand are shown in Table 5-1.

Table 5-1 Coal Demand for Each Power Plant

Stage	Power Plant	Location	Capacity	Coal Consumption	Coal Transport
			MW	t/year	t/day
Stage 1	Sahiwal	Sahiwal /Punjab	1,320	4,200,000	12,728
	Jamshoro	Jamshoro /Sindh	1,320	4,200,000	12,728
	Lakhra	Lakhra /Sindh	660	2,000,000	6,061
	Subtotal		3,300	10,400,000	31,517
Stage 2	NECL 1	Rahim Yar Khan /Punjab	660	2,000,000	6,061
	NECL 2	Rahim Yar Khan /Punjab	660	2,000,000	6,061
	KAPCO	Muzaffargarh /Punjab	660	2,000,000	6,061
	CME	Muzaffargarh /Punjab	660	2,000,000	6,061
	AES LALPIR	Muzaffargarh /Punjab	362	930,000	2,819
	Pakgen	Muzaffargarh /Punjab	362	930,000	2,819
	Subtotal		3,364	9,860,000	29,882
Total			6,664	20,260,000	61,399

Note: Working days per year are 330 days.
Source: JST

5.2.3 Dimension of Coal Wagon

PR plans to procure one of following two types of wagons.

Table 5-2 Type of Coal Hopper Wagons

Item	Unit	Type A	Type B
Length	mm	14,364	15,257
Width	mm	3,220	3,220
Height	mm	3,560	3,560
Height of coupler	mm	1,100	1,100
Axle load	t	23	23

Source: JST

The difference of these two types is the length of frame and coupler of the wagon. The other dimensions of the wagons, such as the dimension of bogies and body, are the same for the two types of wagons.

The following dimensions of wagon are used in this report to study the capacity and coal loading time:

- Length of wagon: 15 m
- Width of wagon: 3.22 m
- Height of wagon: 3.56 m
- Length of wagon body: 10 m
- Capacity of coal: 60 t

5.2.4 Coal Loading Time for Coal Wagon from Coal Loading System

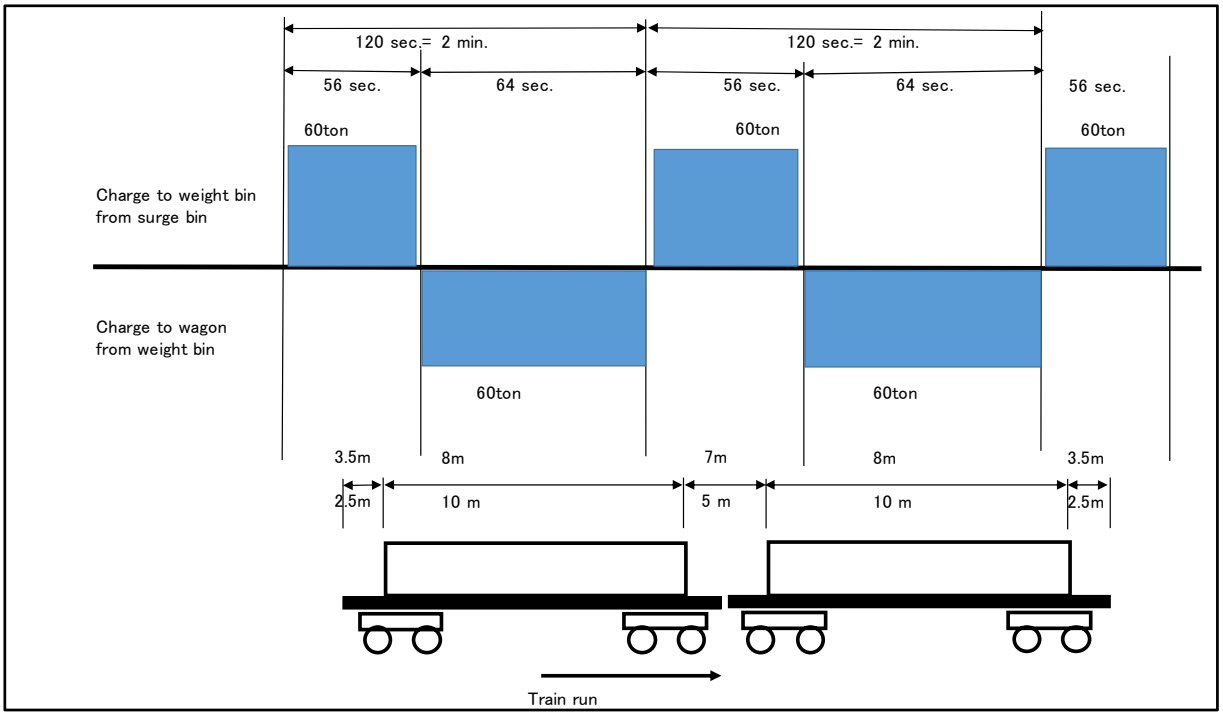
The empty coal wagons run beneath the coal loading system with constant speed, and 60 t of coal is discharged in the coal wagon evenly on 10 m length of the wagon body. The size of the loading chute beneath the weigh bin of coal loading system is about 2 m square (2 m x 2 m).

When the whole loading chute of the coal charger comes upon the wagon body, the discharge of coal will be started and stopped when the loading chute of coal charger reached at the other end of the wagon body, then the discharge of coal will continue 8 m running of the wagon.

During 7 m run of wagon, this means that the distance from the end of the wagon body of one wagon to the other end of the wagon body of the next wagon, the discharge gate under the weigh bin will be closed and the weigh bin will be charged 60 t of coal from the surge bin.

The train will run at a speed of 450 m/h beneath the coal loading system; one coal wagon with 15 m length will pass in 2 minutes. In this case, the speed of wagon is 1 m per 8 s, the time for loading of 60 t of coal on the wagon body will be 64 seconds (8 m x 8 s), and the time for loading of 60 t of coal to charge the weigh bin from surge bin will be 56 s (7 m x 8 s).

Two minutes for coal charging in one coal wagon will be adopted in the following study.

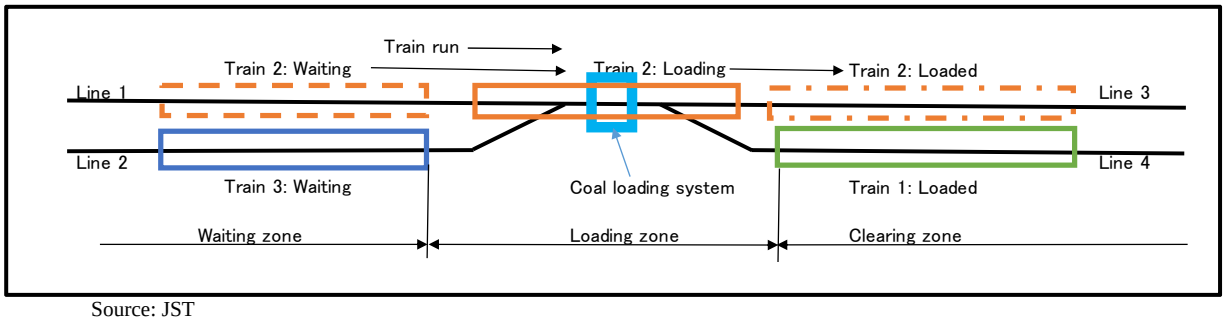


Source: JST

Figure 5-3 Coal Loading Time

5.2.5 Coal Loading Operation for Train

The following Figure 5-4 shows the sample of the arrangement of track and loading system in case of maximized use of the coal loading system.



Source: JST

Figure 5-4 Train Operation for Coal Loading

Train 2 will wait at the waiting zone of Line 1 and when Train 1 finishes loading and arrives at the clearing zone on Line 4, Train 2 will start at the waiting zone to the coal loading line and will be loaded with coal from the coal loading system then move to Line 3. When Train 2 arrives at Line 3 and Line 1 and the coal loading line is cleared, Train 3 will start at the waiting zone on Line 2 to the coal loading line. Train 1 shall leave Line 4 as soon as possible to the main line.

The train speed is 450 m/hour at the coal loading system; the train starts at the waiting zone of Line 1 and Line 2 from a speed of 0 km/h and accelerates and adjusts to the speed of 450 m/h at the position of chute of loading system at a distance of about 150 m. This distance is not long but the train shall run at a very slow speed to adjust the required speed. The cycle time of coal loading in case of the track alignment of Figure 5-4 is shown in Table 5-3.

Table 5-3 Cycle Time of Coal Loading in case of Figure 5-4

Item	Unit/Length	Speed	Time/Min.	Phase 2
Line 1/2 waiting zone				
	150 m	1 km/h	9 min.	
Coal loading line	20 m	450 m/h	80 min.	
	120 m	1 km/h	7 min.	
Line 3/4 clearing zone				
Subtotal			96 min.	
Number of trains			14 trains/day	27 trains/day
Total loading time			1,344 min.= 22.4 hours	2,592 min.= 43.2 hours
Change kind of coal for loading system				
Empty conveyor and surge bin			50 min.	
Charge conveyor and surge bin			10 min.	
Subtotal			60 min. x 2= 120 min.	
Total			1464 min.= 24.4 hours	

Source: JST

The kind of coal for each power station is different and the coal loading to the train shall be changed according to the destination of the train. It is necessary to clear the conveyor and coal loading system including surge bin and weigh bin; this work means that the remaining coal in the surge bin shall be removed and stocked outside of the loading system.

In case of Stage 1, coal for Sahiwal, Jamshoro, and Lakhra, the total loading time for 14 trains is estimated at 24.4 hours including the time to change the kind of coal. One coal loading system is not enough to complete the loading of coal for 14 trains.

JST proposes to install two sets of coal loading system for Stage 1 with 10 mtpa and three sets for Stage 2 with 20 mtpa considering the maintenance of the system and machine trouble.

The proposed track layout of the Coal Loading Terminal station is different from the above shown track layout, the proposed track layout is considered the future track layout for Stage 2. In this proposed track layout, one coal loading system has one waiting track and one clearing track and there are three coal loading systems for smooth and efficient coal loading. Detailed track layout of the coal terminal station is shown in Chapter 5.1 Track Layout at Coal Loading Terminal.

5.2.6 Number of Trains Required

(1) Capacity of Train of Coal Transport

The coal train consists of 1 locomotive, 40 wagons with 60 t coal capacity, and 1 brake van. The capacity of coal transport of one coal train is 2,400 t.

The average of the days of train operation is set as 330 days per year.

Under this condition, the calculated required number of coal trains is as shown in Table 5-4 Number of trains.

The number of trains calculated is not a round number but the actual train operation shall be rounded up number. And the rounded up number of trains shall be shown in the timetable for

train operation, such as for 31 trains for Stage 2. When all trains in the timetable will be operated, the transported volume of coal is too much for coal demand of power plant and the stockyard will overflow.

The number of actual operation trains shall be adjusted slightly to satisfy the coal demand; the sample of adjustment of number of coal trains is shown in Table 5-5.

Table 5-4 Number of Trains

Stage	Power Plant	Coal Consumption	Coal Demand	No. of Trains		Cycle Days	No. of Trains	Transported Coal	
				Calculation	Time table				
		t/year	t/day	/day	/day	days	/cycle	/day	/year
Stage 1	Sahiwal	4,200,000	12,728	5.4	6	2	11	13,200	4,356,000
	Jamshoro	4,200,000	12,728	5.4	6	2	11	13,200	4,356,000
	Lakhra	2,000,000	6,061	2.6	3	5	13	6,240	2,059,200
	Subtotal	10,400,000	31,517	13.4	15	N.A.	N.A.	32,640	10,771,200
Stage 2	NECL 1	2,000,000	6,061	2.6	3	5	13	6,240	2,059,200
	NECL 2	2,000,000	6,061	2.6	3	5	13	6,240	2,059,200
	KAPCO	2,000,000	6,061	2.6	3	5	13	6,240	2,059,200
	CME	2,000,000	6,061	2.6	3	5	13	6,240	2,059,200
	AES	930,000	2,819	1.2	2	5	6	2,880	950,400
	Pakgen	930,000	2,819	1.2	2	5	6	2,880	950,400
	Subtotal	9,860,000	29,882	12.8	16	N.A.	N.A.	30,720	10,137,600
	Total	20,260,000	61,399	26.2	31	N.A.	N.A.	63,360	20,908,800

Source: JST

Table 5-5 Sample of Number of Train Operation to Power Plants

Stage	Plant	Distance from Pipri Yard	Cycle	No. of Trains	Number of Trains Each Day										Total
		km	days	/cycle	1	2	3	4	5	6	7	8	9	10	No.
Stage 1	Sahiwal	1,002.32	2	11	5	6	5	6	5	6	5	6	5	6	55
	Jamshoro	130.45	2	11	6	5	6	5	6	5	6	5	6	5	55
	Lakhra	163.08	5	13	2	3	2	3	2	3	2	3	3	3	26
	Subtotal	-	-	-	13	14	13	14	13	14	13	14	14	14	136
Stage 2	NECL 1	599.58	5	13	3	3	3	3	3	2	3	2	2	2	26
	NECL 2	599.58	5	13	3	2	3	2	3	2	3	3	2	3	26
	KAPCO	896.73	5	13	2	3	2	3	2	3	2	3	3	3	26
	CME	896.73	5	13	3	2	3	2	3	2	3	2	3	3	26
	AES LALPIR	896.73	5	6	1	1	1	1	1	2	1	2	1	1	12
	Pakgen	896.73	5	6	1	2	1	2	1	1	1	1	1	1	12
	Subtotal	-	-	-	13	13	13	13	13	12	13	13	12	13	128
	Total	-	-	-	26	27	26	27	26	26	26	27	26	27	264

Source: JST

Number of coal trains to be operated is 13 or 14 trains per day in Stage 1 to transport 10 mtpa of coal and 26 or 27 trains per day inStage 2 to transport 20 mtpa of coal.

5.2.7 Train Operation Plan for Coal Loading from Bin Qasim Station to Coal Loading Terminal Station

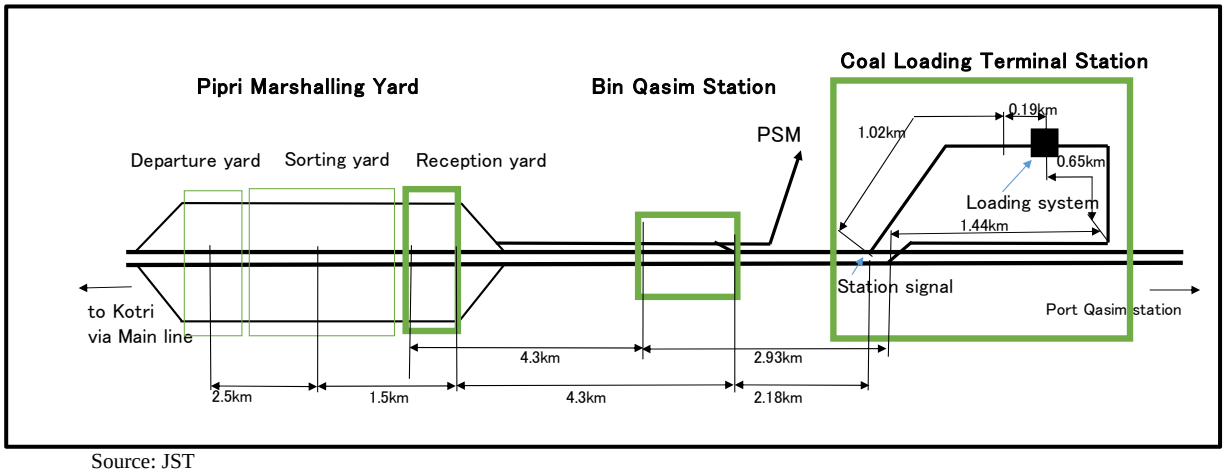
(1) Track Condition from Pipri Yard to Coal Terminal Station

Pipri Marshalling Yard is located beside the main line (Karachi to Kotri junction) and connected to the main line via Bada Nala station (45.00 km) and Gaddar station (50.94 km). The spur line to Port Qasim is branched at Reception Yard of Pipri Marshalling Yard, and connected to Bin Qasim station with 3 lines. One line from Bin Qasim station is connected to Pakistan Steel Mill and one line is to Port Qasim (Muhammad Bin Qasim station) and the planned new station, Coal Loading Terminal station, will be constructed beside this spur line between Bin Qasim station and Port Qasim station.

Pipri Marshalling Yard is not effectively used as marshalling yard, and this yard has enough capacity to operate the new coal trains as reception, stabling and departure of the trains.

The spur line between Bin Qasim station and Port Qasim is planned to improve with track doubling under the PC-I of "Dualization and rehabilitation of track between Port Qasim and Bin Qasim stations". The improvement work is already started at Bin Qasim station on February 2016.

The distance of the stations from Pipri Marshalling Yard to the Coal Loading Terminal Station via Bin Qasim Station is shown in Figure 5-5.



Source: JST

Figure 5-5 Track Layout from Pipri Marshalling Yard to Coal Loading Terminal Station

(2) Train Operation for Coal Loading

The sequence of loading of coal to the coal train is as follows:

- The empty train arrives at Pipri Marshalling Yard and waits for loading at the sorting yard or reception yard of Pipri Marshalling Yard;
- The empty train leaves the reception yard and goes to Bin Qasim Station then waits to go to the Coal Loading Terminal station;
- When a previous train finishes loading of coal and the waiting line of the coal terminal station is cleared, the empty train starts from Bin Qasim Station to the coal terminal station;
- The empty train will be loaded with coal at the coal loading system; loading of 60 t coal for one coal wagon is 2 minutes as shown in Section 5.2.4; and

- The loaded train will go back to Pipri Marshalling Yard via Bin Qasim Station.

The detailed cycle time of coal loading to the empty train is shown in Table 5-5.

Table 5-5 Cycle Time of Train Operation for Coal Loading

Station		Distance (km)	Speed (km/h)	Running Time (minutes)
Pipri Marshalling Yard	Departure yard	9.5 km : 2.5 km	-	
	Sorting yard	5.8 km : 1.5 km	-	
	Reception yard	4.3 km	20 km/h	(12.9 min.)
Bin Qasim Station		0 km		
Coal Loading Terminal Station	Station signal	2.18 km	20 km/h	6.54 min.
	Waiting line	3.20 km : 1.02 km	20 km/h	3.06 min.
	Coal loading system	3.39 km : 0.19 km	1 km/h	11.4 min.
	Clearance zone	4.04 km : 0.65 km	0.45 km/h	86.67 min.
	Subtotal	4.04 km		108 min. = 1 h 48 min.
	Spur line connection	5.48 km : 1.44 km	20 km/h	4.32 min.
Bin Qasim Station		8.41 km : 2.93 km	20 km/h	8.79 min.
Total		8.41 km		121 min. = 2 h 1 min.

Prepared by JST

The cycle time of coal loading from Bin Qasim Station to Bin Qasim Station is 121 minutes (2 hours and 1 minute). However, when a train finishes coal loading and the waiting line is cleared, next train can start at Bin Qasim Station, and this time, cycle time is calculated as 108 minutes (1 hour and 48 minutes); the train operation of coal loading is possible with this 108 minutes interval.

In case of 20 hours working time for 1 day, 11 trains for coal loading is possible by one line with one coal loading system (20 hours = 1,200 minutes, 108 minutes x 11 train sets = 1,188 minutes).

(3) Train Operation Plan for Coal Loading in Stage 1, 10 mtpa

The necessary number of trains to transport 10 million tons of coal for three power plants is 14 trains as shown in Table 5-5, and the destination stations are the three stations for the three power plants. Numbers of trains for each power plant are 6, 5, and 3, respectively.

The kind of coal of the power plant is not yet fixed. JST expects three different kinds of coal for the three power plants. It is necessary to change the kind of coal in the coal loading system of the Coal Loading Terminal station and the time duration to change the kind of coal is estimated at 1 hour as explained in Section 5.2.5.

The capacity of one loading system on one line is 11 trains as explained in Section 5.2.7 (2), and two sets of coal loading system are necessary for 14 trains in Stage 1.

One coal loading system is for six trains of one power plant and one other coal loading system is for 5 + 3 = 8 trains of two power plants.

The necessary time for coal loading operation for five trains plus three trains is:

- 5 trains: 5 x 108 minutes =540 minutes
- One time of change of coal: 1 hour = 60 minutes
- 3 trains: 3 x 108 minutes =324 minutes
- Total: 924 minutes =15 hour and 24 minutes < 20 hours

Two sets of coal loading system with two lines are capable for 10 million tons of coal for the three power plants.

(4) Train Operation Plan for Coal Loading in Stage 2, 20 mtpa

Thirteen coal trains for six power plants are added to the 14 trains of Phase 1.

In Stage 2, 27 coal trains for nine power plants shall be operated to satisfy the requirement of coal transportation.

The additional power plants are six plants; JST assumed that NECL 1 and NECL 2 are the same system and the kind of coal is the same. Therefore, there are five additional kinds of coal. There are two destination stations, namely; Rahim Yar Khan for 2 NECL and Muzaffargarh for KAPCO, CME, AES LALPIR, and Pakgen.

The number of added trains is 13, 5 + 3 +3 +1 + 1; there are five kinds of coal.

Total number of trains is 27 and eight kinds of coal, the composition of trains are:

6 + 5 + 3 + 5 + 3 + 3+ 1 +1 =27

JST proposes to install three sets of coal loading system with three lines.

The necessary time for coal loading operation for five trains plus three trains is:

- 6 trains: 6 x 108 minutes =648 minutes
- 5 trains: 5 x 108 minutes =540 minutes
- 3 trains: 3 x 108 minutes =324 minutes
- 1 train: 108 minutes
- One time of change of coal: 1 hour = 60 minutes

The combination of trains for different kind of coal is:

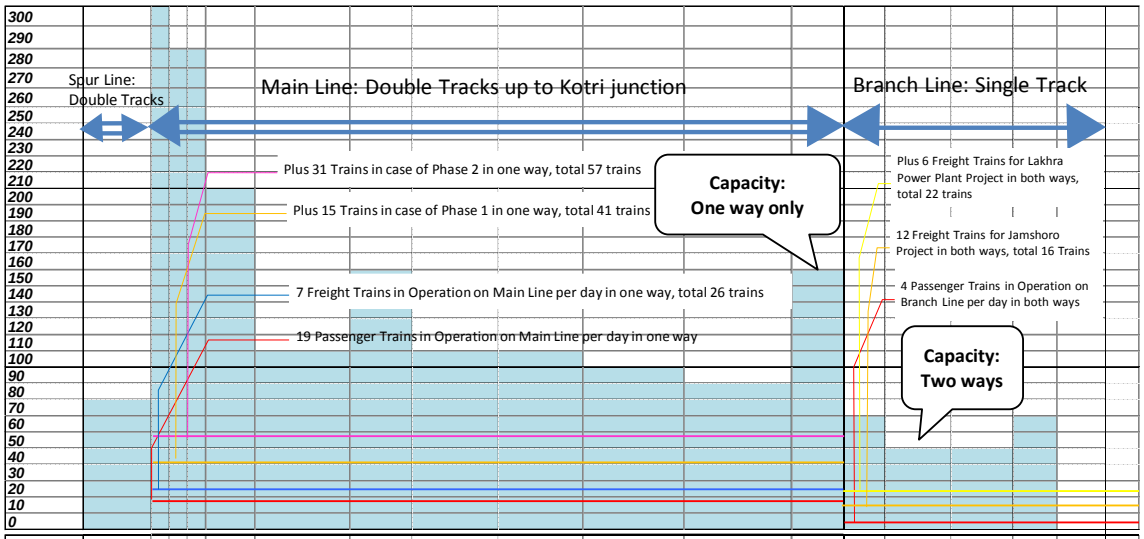
- 6+3 =9 ;648+324+60=1,032=17 h 12 min.< 20 hours
- 5+3+1=9 ;540+324+108+60+60=1,092=18 h 12 min.<20 hours
- 5+3+1=9 ; 540+324+108+60+60=1,092=18 h 12 min.<20 hours
- Total: 9x3=27 trains, 1,032+1,092+1,092=3,216 min.

Three sets of coal loading system with three lines are capable for 20 million tons of coal for nine power plants and 27 coal trains can transport 20 mtpa of coal.

5.2.8 Line Capacity of Main Line between Pipri Marshalling Yard and Kotri Junction (From the Report of Lakhra Power Plant Study)

As shown in Figure 5-6 below, the section between Meting and Bholari stations has the most severe line capacity, N=90, against 26 trains in operation a day at present. However, even in case of Stage 1, the number of coal trains is 15 in the timetable while the total number of trains is 41. And in the case of Stage 2, the number of coal trains will be 31 in the timetable and total number of trains will be 57 under the train operation plan. Furthermore, 33 capable

trains are still available (90 – 57 =33).



Station Name	Port Qasim	Bin Qasim	Badal Nala (Marshalling Yd.)	Gaddar	Dabehji	Ran Pethani	Jungshahi	Braudabad	Jhimpir	Meting	Bholari	Kotri Jcn.	Sindh Univ.	Cadet College Petaro	Unarpur	Budapur	Khanot
Sta. dist. [km]	13.0	2.9	5.9	9.3	18.4	11.9	16.6	16.2	19.6	20.9	9.9	7.7	12.7	11.8	8.2		
Track Capacity N	75	480	288	205	102	160	110	110	96	90	160	67	45	49	63		

Source: JST

Figure 5-6 Line Capacity of Main Line from Bin Qasim Station to Kotri Junction

Chapter 6 Railway Signal and Telecommunication

6.1 Current Signaling and Telecommunication Systems

6.1.1 System Overview in PR

In Pakistan Railways (PR), signaling and interlocking at station are classified into three different standards as shown in Table 6-1. Standards I and II of signaling are purely mechanical interlocked provided on branch lines where the sectional speed of the trains is low.

Standard III signaling is composed of some of the following systems:
(1) Relay Interlocking or Electronic Interlocking (CBI: Computer Based Interlocking)
(2) Automatic Block Signaling
(3) Remote Control Signaling (Control of point machine and signals from remote location)
(4) Cabin Interlocked Mechanical Signaling (Control of train movement manually from signal cabin)

Table 6-1 Signaling System Classification in PR

	STANDARD – I	STANDARD - II	STANDARD I - III
Speed	50 km/h	75 km/h	Unrestricted
Signals	(1) Compulsory Outer and Home Signal (2) Optional Starter and Warner Signal	(1) Compulsory Warner, Outer and Home Signal (2) Optional Starter Signal	(1) Compulsory Warner, Outer, Home, Starter and Advance Starter Signal
Points	Fitted with Key Locks	Fitted with Hand Plunger Locks and Key Locks	(1)Fitted with Locks and Lock Bars (2)Fitted with Electric Operated Points Machine
Interlocking	Indirect	Indirect	Direct

Source: JST

PR telecommunication system comprises microwave, ultra high frequency and very high frequency (UHF & VHF) radios, telephone exchange networks through overhead wires along the railway track and underground cable.

Radio systems were installed in 1981-82 on the main line from Rawalpindi to Karachi and on important branch lines covering 2,700 route kilometers nationwide. For the stations between Karachi and Kotri Junction, a train radio system with VHF is used for communications between crews, train dispatchers, and station staff.

UHF radio system was installed on the branch line of Kotri Junction to Dadu same as on the main line in 1981-82. For the stations between Kotri Junction and Budapur Station, a train radio with VHF similar to the main line is mainly used among dispatchers, train drivers, station staff, and maintenance staff.

Table 6-2 Telecommunication System in PR

Telephone Exchange	No. of lines	3,000 Nos.
Microwave Radio	Route km covered	1,850 km
UHF Radio	Route km covered	2,700 km
VHF Radio	Route km covered	6,000 km

Source: JST

6.1.2 Current Signaling and Telecommunication System between Bin Qasim, Kotri and Budapur

At present, signaling system between Bin Qasim and Kotri, which is double track, is equipped with automatic block signal and relay interlocking, while the single track section of the branch line between Kotri Junction and Budapur Station is provided with the blocking system of outdated tablet instrument and mechanical interlocking.

Table 6-3 Signaling System between Bin Qasim - Kotri - Budapur

	Interlocking System	Block System	System Standard
Bin Qasim to Kotri	Automatic	Relay Interlocking / Electronic Interlocking (CBI)	Standard III
Kotri to Budapur	Mechanical	Single Line Token Instrument	Standard I

Source: JST

During the riot in December 2007, a total of 65 stations were seriously burnt and damaged in PR Karachi Division and Sukkur Division. Many signaling systems were badly damaged as well. Due to extensive damage to signal equipment, the train operation was affected significantly. In order to recover, rehabilitate, and rebuild the damaged railway assets, "Rehabilitation of Railway Assets Damaged during the Riots of 27th and 28th December 2007" has been implemented by PR till now.

The signaling system of main line stations between Bin Qasim and Kotri has been restored and modernized by introducing Electronic Interlocking (CBI) or Relay Interlocking except Bin Qasim Station as shown in Table 6-4.

Table 6-4 Damaged Station of Signaling System on Bin Qasim and Kotri Main Line

No	Station Name	Damage	Present Status
1	Bin Qasim	Damaged	To be replaced with CBI
2	Badar Nara	Nil	Being used
3	Gaddar	Damaged	Replaced with Relay Interlocking
4	Dabheji	Damaged	Replaced with Relay Interlocking
5	Ran Pathani	Nil	Being used
6	Jungshahi	Damaged	Replaced with Relay Interlocking
7	Braudabad	Nil	Being used
8	Jhimpir	Damaged	Repaired
9	Meting	Nil	Being used
10	Bholari	Nil	Being used
11	Kotri	Damaged	Repaired

Source: PR

The signaling system of the branch line stations between Kotri and Budapur has been repaired by using released materials as well as procured materials as shown in Table 6-5.

As mentioned above, signaling system between Bin Qasim and Kotri section except Bin Qasim station as well as between Kotri and Budapur section have been repaired until now. However it is recommended that outdated signaling equipment between Kotri and Budapur

will be upgraded to advanced system from tablet blocking equipment and mechanical interlocking.

Table 6-5 Damaged Station of Signaling System Kotri and Budapur Branch Line

No	Station Name	Damage	Present Status
1	Sind University	Damaged	Repaired
2	Cadet College	Damaged	Repaired
3	Unapur	Damaged	Repaired
4	Budapur	Damaged	Repaired

Source: PR

During the riot, telecommunication equipment provided in the station offices such as control telephone, wireless telephone, VHF radio sets including power supplies, batteries, etc., were totally burnt on the main line between Kotri and Karachi and on the branch line between Kotri and Dadu. Six UHF sites, 53 VHF radios with accessories, 54 control phones, 37 V-wireless telephones, 77 batteries, 70 telephone sets, and 7 diesel generators were also burnt.

VHF radio equipment was quickly replaced due to urgency. It was originally planned to restore the telecommunication system by providing underground copper cable in various sections, however, in revised PC-1, Fiber Optic Cable for signaling equipment and Digital Transmission Equipment has been provided on the section where new signaling system is installed.

6.1.3 Current Signaling System at Bin Qasim Station

Bin Qasim Station has an important role of connecting new coal loading terminal to Pipri Marshalling Yard. However, current temporary signaling system is not capable of handling the required number of coal trains.

There are no interlocking system, no electrical point machines, no track circuits but only color light signals which are manually controlled by station dispatcher.

It is an urgent issue that signaling system of Bin Qasim Station shall be rehabilitated to enhance the reliability and safety of the coal train operation both from and to Port Qasim spur line.

Signaling cabin and equipment in Bin Qasim Station is completely destroyed as shown in Figure 6-1.

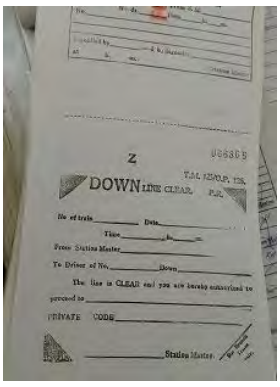
Source: JST

Figure 6-1 Signaling Cabin and Coal Train in Bin Qasim Station

6.1.4 Current Signaling System between Port Qasim Station and Bin Qasim Station

Presently, a small number of trains are operated between Port Qasim and Bin Qasim Station. Outdated signaling system of line clear paper ticket is adopted for train operation between stations.

Trains are operated by single block system for approximately 13 km between Port Qasim and Bin Qasim Station. Half portion of line clear paper ticket is handed over to the driver as an authority to proceed. Only the driver who has received paper ticket can enter the block section.



Source: JST

Figure 6-2 Line Clear Paper Ticket and Coal Train at Port Qasim Station

6.1.5 Current Status of Rehabilitation Works of Bin Qasim Station

Contract of signaling system rehabilitation project of railway asset damaged during riot was awarded to Bombardier Transportation.

Computer Based Interlocking (CBI), electric point machines, track circuits, color light signals, UPS, and lightning protection will be installed in Sukkur Division and Karachi

Division under the project.

According to the chief signal engineer of PR in Lahore, most of the works have been completed in Sukkur Division, and the rehabilitation works for Bin Qasim Station in Karachi Division will start in 2016 soon after the completion of works in Sukkur Division.

In Bin Qasim Station, temporary signaling control panel and manual point machine are installed for the time being as shown in Figure 6-3.


Source: JST

Figure 6-3 Temporary Signaling Control Panel and Manual Point Machine

6.2 Signaling System to be Installed at Coal Loading Terminal

6.2.1 System Overview

Pakistan Railway intends to rehabilitate and modernize its existing signaling system on the main line section including Bin Qasim Station with Relay Interlocking or Electronic Interlocking System (CBI) at stations and Automatic Block System between the stations. Color light signals and electric point machines will also be provided together.

In the coal loading terminal, signaling system shall be compatible with that of Bin Qasim Station where the new signaling system will be installed under the rehabilitation project "Rehabilitation of Railway Assets Damaged during the Riots of 27th and 28th December, 2007" shortly. Therefore, to ensure the safe and efficient coal train operation, the same advanced signaling system of Bin Qasim Station with computer based interlocking system (CBI), color light signal, electric point machine, and track circuit device shall be installed according to the track layout in the coal loading terminal.

These systems will enhance the efficiency and capacity of coal train operation within the station yard, reduce the travel time between block sections, protect trains from accidents, operate trains safely, and increase train speed and line capacity.

6.2.2 Signaling System to be Installed

The signaling equipment shown in Table 6-6 such as CBI, electric point machines, track circuits, color light signals, control panel, and power supply system with UPS shall be installed to establish the consistent signaling system with the main line.

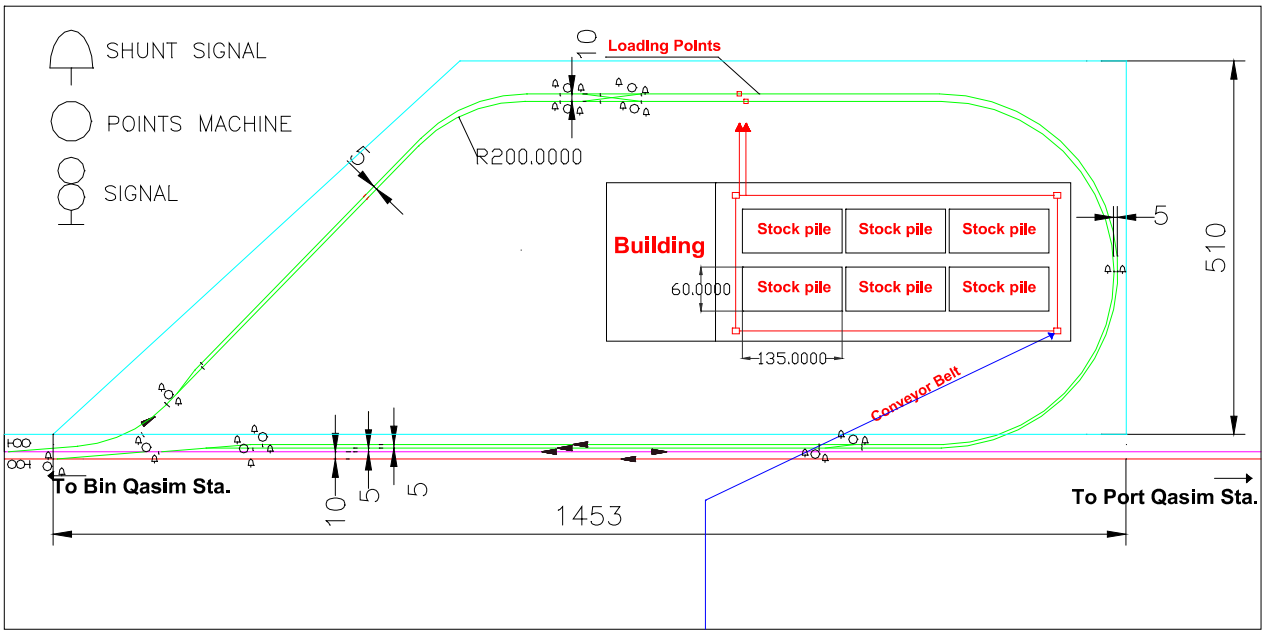
In compliance with the track layout shown in Figure 5-2 and the Train Operation Plan described in Section 5.2, appropriate signaling system for safe train operation shall be provided. Track circuits for train detection shall be installed for clearance/occupancy of track and block system.

Loop track consists of (1) Waiting line for coal loading (about 1 km), (2) Coal loading line

(about 0.2 km), (3) Clearance line (about 0.7 km), and (4) Connecting line (about 1.5 km) to down track. Track layout shows that coal train comes from Bin Qasim Station on the left side in Figure 6-4 and enters the loop line clockwise and stops just before the coal loading system and wait for the clearance of the line ahead.

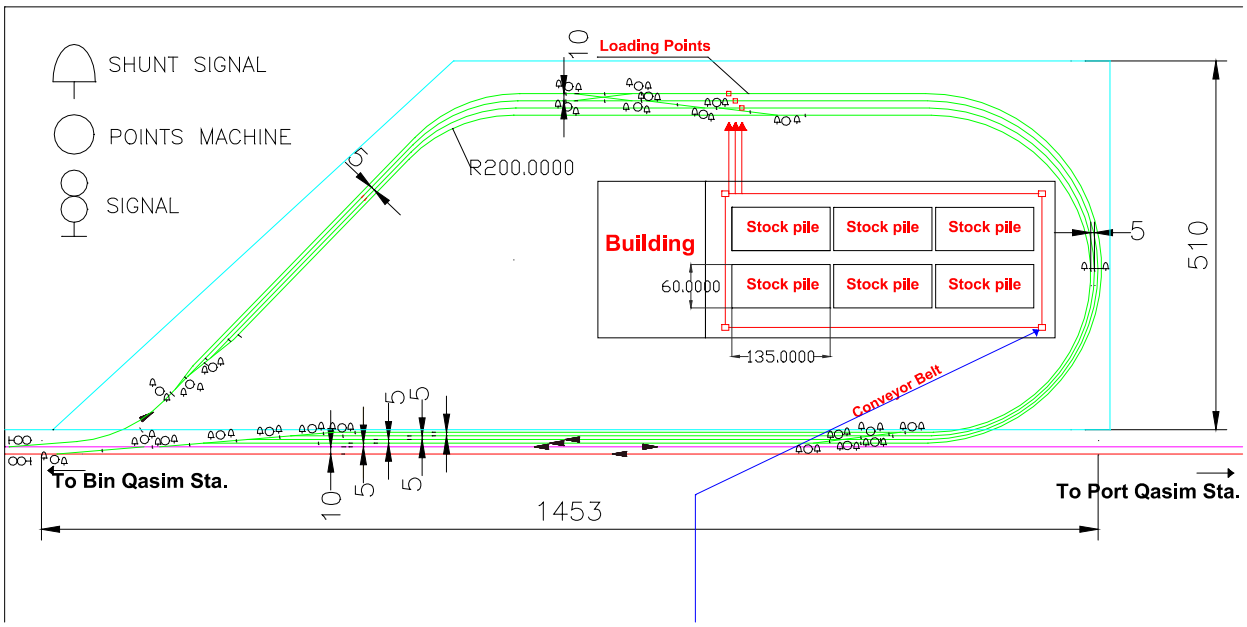
One block signal system shall be applied between Bin Qasim Station and the coal loading terminal.

Conceptual diagrams of the signaling system are shown in Figure 6-4 and Figure 6-5.



Source: JST

Figure 6-4 Conceptual Diagram of Signaling System in Stage 1



Source: JST

Figure 6-5 Conceptual Diagram of Signaling System in Stage 2

Table 6-6 Signaling Equipment to be Installed

	Major Equipment
1	Electronic Interlocking Equipment (CBI)
2	Electric Point Machines
3	Track Circuit Equipment
4	Main Color Light Signal
5	Ground Shunt Signal
6	Power Supply Equipment ・Generator Set ・UPS and Battery and Power Control Unit
7	Control Panel
8	Lightning Protection Equipment

Source: JST

(1) Electronic Interlocking System (CBI)

Electronic Interlocking System (CBI) which will be installed in Bin Qasim Station adjacent to the coal loading terminal shall be provided.

CBI shall comprise dual interlocking systems operating actively redundant with one online and the other in hot standby mode to ensure that any single malfunction, hardware failure, and disconnection shall not shut down the interlocking system or any major portion of interlocking system. Status of the field conditions such as locked routes, locked points, and signal aspects shall not change position during switch over.

(2) Electric Point Machines

Electric point machines together with appropriate locking arrangement and all necessary fittings shall be installed.

Point machine shall have the following functions:

a. In case of emergency and power failure, the station master can operate the points manually by hand cranking and set a route and clear relevant signals in the desired direction.

b. Point machine moves a turnout in accordance with the control information from CBI, and then sends back its status information to CBI. In case of failure of receiving control information, point machine holds turnout position continuously and steadily with mechanical lock.

c. Point machine sends its alarm information to CBI in case that point machine detects a gap exceeding the permissible figure between point blade and rail.


Source: JST

Figure 6-6 Relay Type Interlocking and Electric Point Machine

(3) Track Circuit Equipment

Track circuits shall be installed in the coal loading terminal for train detection of clearance/occupancy of track.

Each track circuit should have independent feed unit and both transmitter and receiver shall be in the signaling equipment room. Length of track circuit shall be carefully determined according to soil and ballast conditions.

Equipment of the track circuit shall be suitably protected against atmospheric effects by installing lightning arrestors in each track circuit. Lightning arrestors shall operate in case surge voltage rises as a result of atmospheric electrical discharge or as a consequence of any other external voltages.

(4) Color Light Signal and Ground Shunt Signal

Color light signal device, which shows a signal indicator to a train driver visually in accordance with the control information from the interlocking device, shall be installed at station yards. Sufficient visible distance shall be assured on various weather conditions.

Home, Outer, Starter, and Advance starter signals shall be of long-range signal of the multiple color light type attached to the signal post.

Ground shunt signal shall be of position light type mounted on signal posts or concrete blocks on the ground.

(5) Power Supply Equipment

Uninterrupted power supply (UPS) consisting of battery chargers and static invertors in a compact unit with external batteries shall be provided. Power supply arrangement shall cater to the load requirements for the whole signaling system in the coal loading terminal.

In case of fault in the UPS system, it should be possible to switch manually to the commercial supply/diesel generator supply to feed the signaling system. By-pass switch shall be provided in the power supply system.

Diesel Generator Set of suitable capacity to meet the load requirements shall be installed as backup power supply system. The generator shall automatically start in case of power failure. However, manual start shall also be provided.

(6) Control Panel

Control panel consisting of large color monitor and keyboard shall be provided as per the system offered for control and display of the station yard layout.

Control panel shall have the following functions:
a. Operation of points, signals, and routes setting shall be done by the station master from the control panel.

b. Track diagram and indications shall be available on the monitor.

c. Position of "Normal" or "Reverse" points and aspect of the signals shall be displayed on the track diagram on the monitor.

d. Clearance/occupancy status of track circuit shall be displayed on the monitor.

(7) Signaling System to be Installed at Port Qasim Station

To enhance the future transportation capacity as well as for safe and efficient operation, outdated signaling system of spur line in Port Qasim shall be replaced with same advanced signaling system which will be installed at Bin Qasim Station and Coal Loading Terminal.

The project "Dualization and Rehabilitation of Track between Port Qasim and Bin Qasim" is including remodeling of signaling system from Port Qasim to Bin Qasim. Therefore, it is expected that signaling system in Port Qasim station will be upgraded from outdated system.

6.2.3 Telecommunication System to be Installed

The following telecommunication equipment such as telephone system, microwave/UHF/VHF radio system, and public address (PA) system shall be provided in the coal loading terminal for communications among the station master, assistant station master, other station staff, drivers, train dispatchers, and maintenance staff.

Table 6-7 Telecommunication Equipment to be Installed

	Major Equipment	Unit
1	Telephone System	No
2	Radio System	No
3	Public Address System	Set
4	Closed Circuit Television (CCTV) System	Set

Source: JST

Telecommunication system shall comprise the following:

(1) Telephone System
Independent dispatcher telephone shall be provided to talk to adjacent station's train dispatchers exclusively used for the train operation.

(2) Radio System
Radio system shall ensure the communications between the stations and moving trains as well as among the railway staff working in the coal loading terminal through mobile radio handsets.

(3) Public Address (PA) System

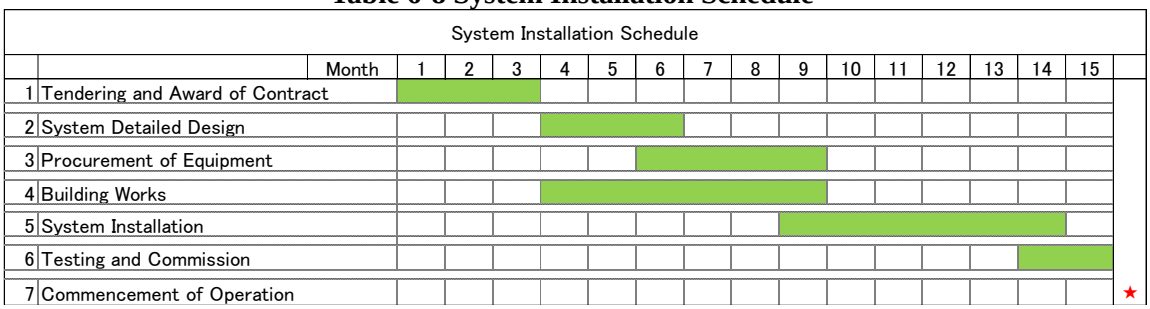
PA system shall be installed to ensure the safety of operation and maintenance staff by delivering announcements/messages to draw attention and give instructions to the workers in the station yard.

(4) Closed Circuit Television (CCTV) System
CCTV system has the function of monitoring and supervising coal loading operation as well as train movement in the station yard. The images shall be monitored and supervised from the station control rooms, and these video signals can be transmitted to the operation control center (OCC) for remote supervision with additional data transmission device.

6.2.4 System Installation Schedule

System installation schedule is shown in Table 6-8.

Table 6-8 System Installation Schedule



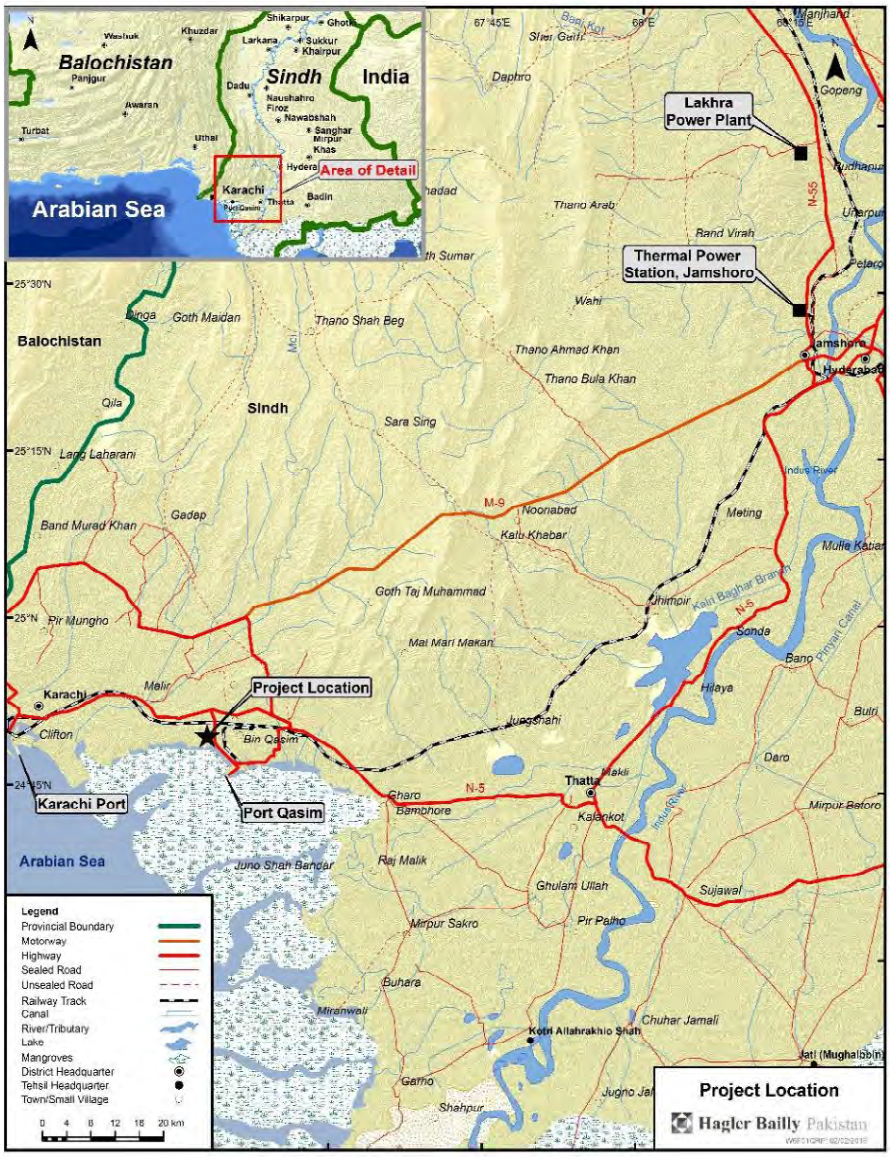
Source: JST

Chapter 7 Environmental and Social Considerations

The Study on Environmental and Social Considerations is aiming at providing PQA necessary advice and support in order that they will prepare reports of Environmental Impact Assessment (EIA) and Resettlement Plan Framework (RPF) in accordance with the requirements of laws/regulations in Pakistan.

Adverse impacts will be assumed when Juma Goth station, Bin Qasim station or Pipri yard is selected as transport route. The route will affect environmental and social issues because of the land acquisition or increase of noise level against project affected persons (PAPs).

The proposed coal transport project is located in the northwestern industrial zone of Port Qasim (PQ) in Karachi (Figure 7-1).



Source: EIA Report

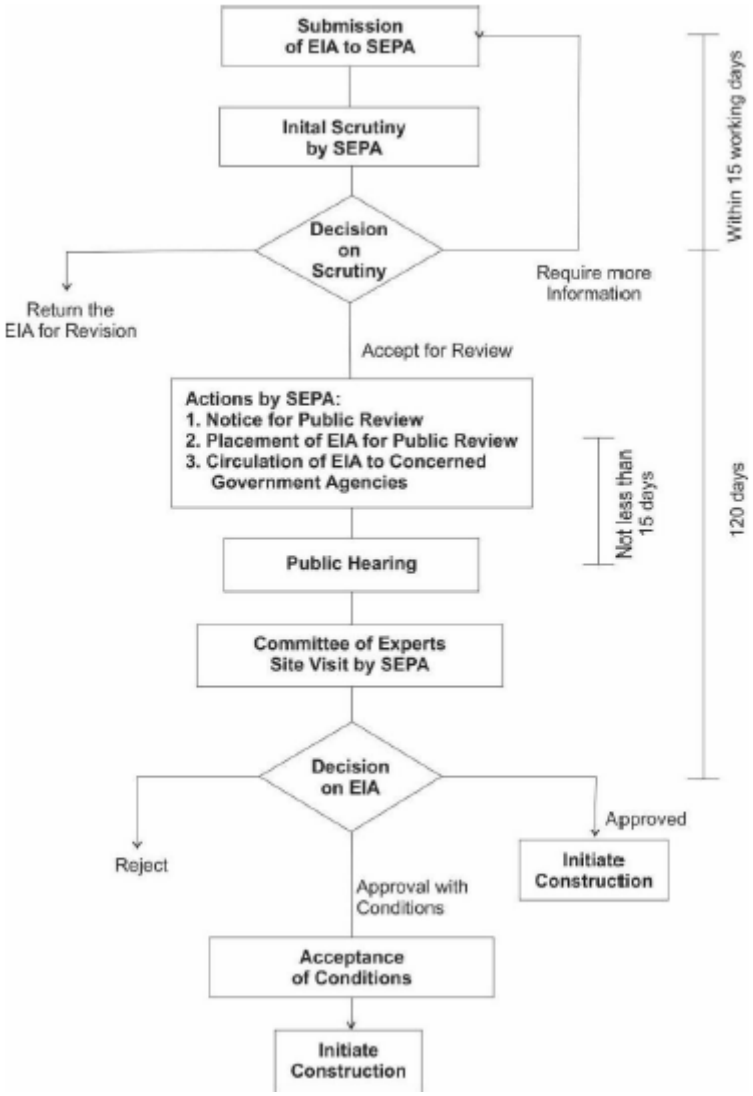
Figure 7-1 Location of Proposed Project

7.1 EIA System in Pakistan

Pakistan Environmental Protection Agency (PEPA), under the powers conferred upon it by the Pakistan Environmental Protection Act, prepared "The Pakistan Environmental Assessment Procedures" in 1997. "The PEPA review of IEE and EIA regulations, 2000" provides the necessary details on the preparation, submission, and review of the initial environmental examination (IEE) and EIA as guidelines. The regulation classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule-I lists projects that may not have significant environmental impacts and therefore they require an IEE. Schedule-II lists projects with potentially significant environmental impacts and thus they require the preparation of an EIA. The package of regulations prepared by PEPA relevant to IEE or EIA includes:

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments;
- Guidelines for the Preparation and Review of Environmental Reports; and
- Guidelines for Public Consultation.

The proposed "Connectivity Facilities between Coal Handling Terminal around Port Qasim and Railways in Pakistan" Project is included in Schedule-II which is related to railway transport works. It requires proponents to prepare the terms of reference for the environmental assessment reports. The process from submission of the application to approval of the result of EIA study is schematized in Figure 7-2.



Source: EIA Report

Figure 7-2 Flow of EIA Process

7.2 Natural Conditions in the Project Area

7.2.1 Natural Characteristic

The study area of 500 meters around the project footprint is referred to as the “Study area”.

(1) Geology

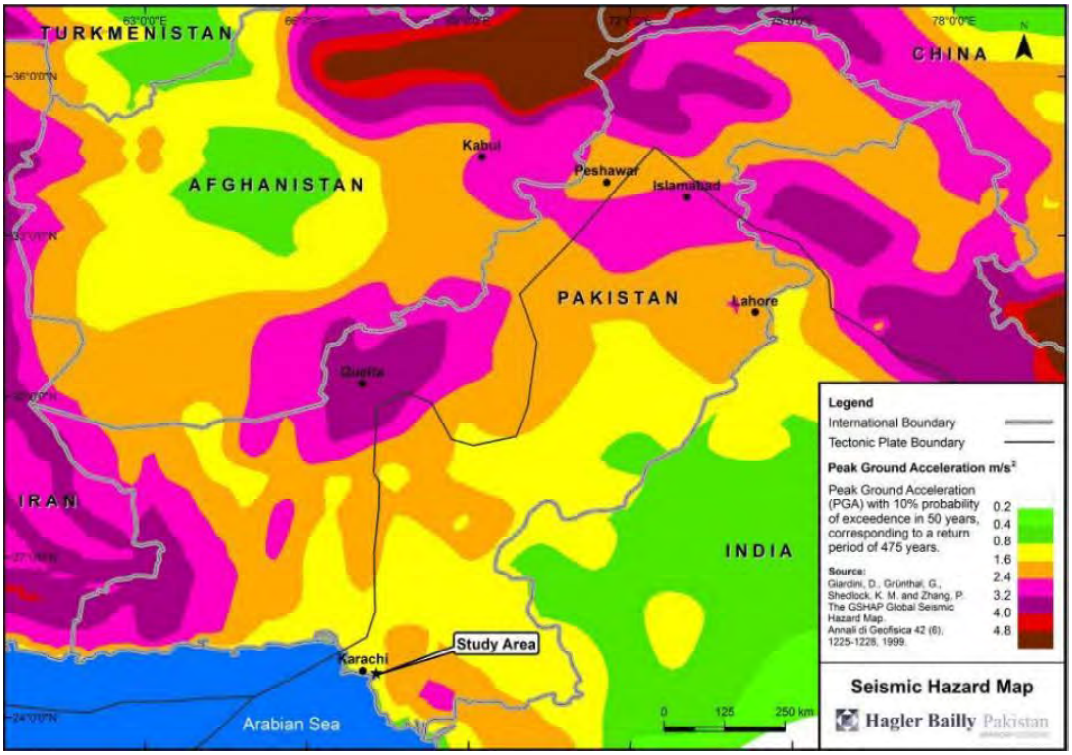
The Study area consists of uniform sedimentary rocks associated with the southern extension of the Kirthar Range. It is in the Manchar formation, mostly Pliocene in age consisting of shale, sandstone, and conglomerate with thickness up to 4,500 feet.

(2) Seismology

Port Qasim is located adjacent to an active tectonic setting, and is approximately 190 km east of the triple continental junction between the Arabian, Eurasian, and Indian plates.

The Global Seismic Hazard Map Project (GSHAP) is shown in Figure 7-3. The peak ground

acceleration (PGA) with 10% probability of exceedance in 50 years is between 0.8 and 1.6 m/s^2.



Source: The GSHAP Global Seismic Hazard Map. .

Figure 7-3 Seismic Hazard Map of Pakistan

(3) Hydrology

The water resources in the macro-environment of the Project site are extremely limited. Despite being the drainage basin of the Malir River in the west and the Ghaggar Nalo, Dhabeji Nalo, and the Ren Pethani River in the east, the area has to depend on the supplies from Kalri-Baghar Feeder for its entire fresh water requirement.

The Malir River and the nalos as well as several channels including those in Cattle Colony and the one that passes through Jumma Goth are carriers of sewage and effluent discharged from industries and the Cattle Colony.

(4) Climate

The climate at Port Qasim is characterized as hot and dry during summer, and mild during winter with heavy, sporadic rainfall during the monsoon. The southwest monsoon prevails in the Study area from April to October. The monsoon is characterized by a reversal in wind direction during the remaining months and heavy rainfall over most of the Indian Subcontinent.

(5) Temperature

The air temperature of the entire coastal zone of Karachi is invariably moderate. The mean maximum summer temperature is 32 ℃, while the mean minimum temperature is 10 ℃. There are occasion when the coastal belt is in the grip of heat wave and the maximum temperature exceeds 40 ℃ but this happens only a few times in a year and lasts for a

maximum of three days.

(6) Precipitation

The mean relative humidity in summer is 60-70% while the mean relative humidity during winter is 25-30%. The rainfall in the Karachi coastal zone is extremely low and erratic; therefore, this region falls in the semi-arid climatic zone. Heavy rainfall is not unusual since it is caused by the general monsoon system that travels from across Rajasthan and lays over Sindh. The monsoon weather system does not move towards Baluchistan but the penetration of moist currents from Sindh brings scattered to heavy rain in southern Baluchistan, particularly along its coastal regions.

Table 7-1 Precipitation in the Study Area

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rainfall (mm)	6.0	9.8	11.7	4.4	0.0	5.5	85.5	67.6	19.9	10.0	1.8	4.4

Source: EIA Report by Hagler Bailly

(7) Cyclone

The tropical cyclones generally develop over the south of the macro-environment in the Arabian Sea at low latitude, i.e., 5- 20 degree north and dissipate after moving over land. The maximum frequency of tropical cyclone formation occurs in two periods, namely: (i) between April and June and (ii) in October/November. The month of June receives the least tropical cyclones in the region.

On an average, 76% of tropical cyclones approach the coastline of Sindh from the south through the east. Their intensity generally weakens when they approach the proximity of Karachi. The one that moved into the coastal area on May 12, 1999 changed direction and hit the coastal area of Badin; Karachi was then in the peripheral area and only rain showers of moderate intensity were recorded.

(8) Tsunami

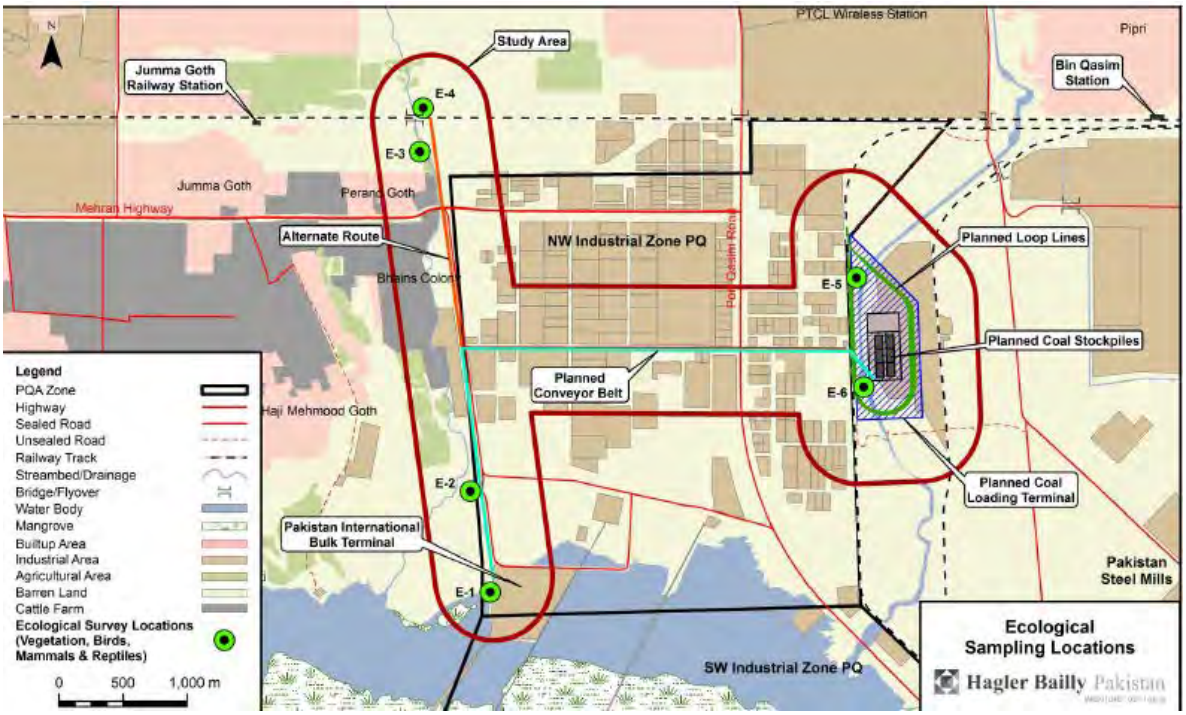
Tsunami occurs due to the generation of high seawater waves as a result of underwater earthquake. Seismic records and data available on incidence of tsunamis along Pakistan coast do not show major damages done here. Increasing seismic activity in the region and the existence of a confluence of fault zone in the coastal region in the northern Arabian Sea has raised the probability of triggering tsunami along the coastal belt of Sindh and Baluchistan.

There are evidences of one tsunami generated by an offshore earthquake of magnitude 8 (on Richter scale) in 1945, which caused a 1.2 m tsunami in Port Qasim area but led to only minor damages. The tsunami of December 26, 2004 had no impact on Port Qasim and adjoining areas.

(9) Fauna and Flora

Sampling locations for ecological surveys were selected based on coverage of the different types of habitats. The focus was on locations where Project-related developments are most likely to take place. These areas include vegetation near the loading of coal onto the conveyor belt, areas which may be affected by coal dust and storage, and areas which will most likely be cleared for the coal stockyard site.

A total of six sampling locations have been identified. The land use classification, coordinates, and justification for selection of each sampling point are given in Table 7-2. The sampling locations are shown in Figure 7-4.



Source: EIA Report by Hagler Bailly

Figure 7-4 Ecological Sampling Points

Table 7-2 Sampling Points, Associated Habitat Classifications, and Justifications for Selection

Sampling Point ID	*Classification by Habitat Type*	*Coordinates*	*Justification*
E-1	Sea and Associated Coastal Area	24°48'38.3" 67°17'16.9"	Area may be affected by construction and operational activities, mainly pollution. Already disturbed by industrial activity
E-2	Vegetation Cluster	24°49'03.9" 67°17'11.0"	Area may be affected due to loading of coal onto conveyor belt
E-3	Vegetation Cluster near Built Up Area (Settlement)	24°50'30.01" 67°16'55.75"	Area may be affected due to coal dust generation
E-4	Relatively Thick Vegetation Cluster near Agricultural Fields	24°50'41.1 67°16'56.5"	Vegetation may be cleared for coal stockyard and water may be affected due to coal storage
E-5	Westward Water Channel and Vegetation Cluster	24°49'59.4 67°18'57.5"	Vegetation may be cleared for coal stockyard and water may be polluted due to (improper) coal storage
E-6	Westward Water Channel and Vegetation Cluster	24°49'31.6 67°18'59.9"	Vegetation may be cleared for coal stockyard and water may be polluted due to (improper) coal storage

Vegetation: The vegetation has characteristics of xerophytic plant communities. During the January 2016 survey, a total of eight plant species were observed in the terrestrial habitat. Two of these were observed in the limited aquatic bodies found within the terrestrial habitat.

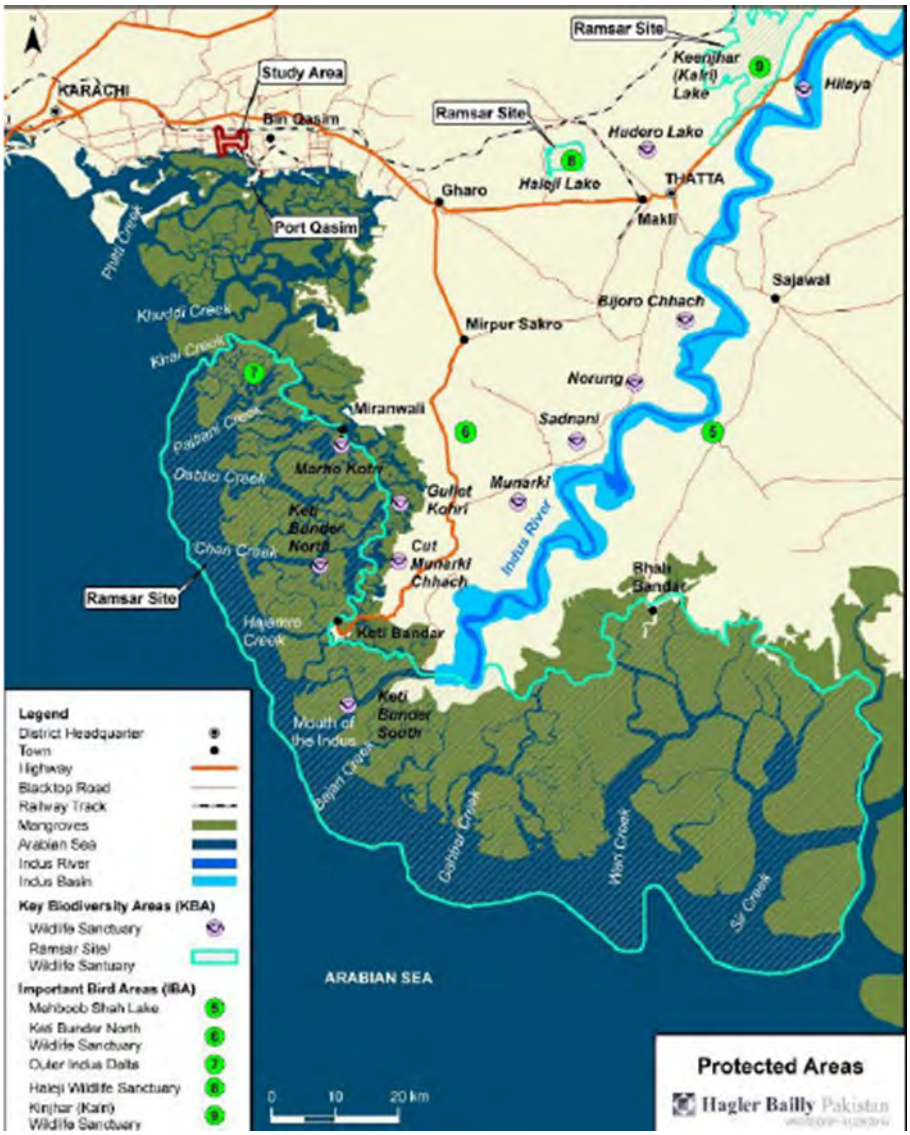
***Mammals*:** During the survey conducted in January 2016, evidence of Asiatic Jackal *Canis aureus* and Indian Hare *Lepus nigricollis* was observed. Pug marks of both species were

observed at sampling point E-4 and anecdotal evidence of locals hearing sounds of the Asiatic Jackal was also recorded at the same location. An ecological survey carried out in July 2013 also found pug marks of the Asiatic Jackal as well as that of the *Vulpes vulpes* fox.

Reptiles and Amphibians: During the survey conducted in January 2016, no reptile or amphibian species were observed in the Study area.

(10) Protected Area

The protected areas around the Study area are shown in Figure 7-5. It can be observed that the Study area is located well within a developed area. The nearest protected area, the Haleji Wildlife Sanctuary, is 43 km away from the Study area.



Source: The Protected Area by Hagler Bailly

Figure 7-5 Relative Locations of Protected Areas and the Study Area

7.2.2 Scoping and TOR of EIA Survey

A reconnaissance survey was carried out to take the natural environment and social conditions of the Project area into account. The “predicted scoping matrix”, which expresses

environmental impacts in the context of pollution, natural and social environment, and other points of view, is prepared in Table 7-3. The Terms of Reference (TOR) for the EIA is prepared in Table 7-4.

Table 7-3 Predicted Scoping Matrix

No.	Items of Impact	Predicted Impact		Reason for Assessment
		Before/ During Construction Stage	Operation Stage	
Anti-Pollution Measures				
1	Air pollution	B-	C	Construction Stage: Vehicular emissions and dust blowing are causes of air pollution. Operation Stage: The impact is not clear at this moment.
2	Water pollution	C	C	Construction Stage: The impact is not clear at this moment. Operation Stage: The impact is not clear at this moment.
3	Soil pollution	D	D	No impact is assumed.
4	Waste	C	D	Construction Stage: The impact is not clear at this moment. Operation Stage: The impact in the operation stage will almost be nil.
5	Noise and vibration	B-	B-	Construction Stage: Noise level may increase. Operation Stage: It is assumed that increased noise level will remain.
6	Ground subsidence	D	D	There is no activity which requires pumping up of groundwater; therefore, no ground subsidence is expected.
7	Offensive odors	D	D	No offensive odor is assumed at any stage of the project.
8	Global warming/ Climate change	D	C	Construction Stage: Very small impact is anticipated. Operation Stage: Impact is not clear at this moment.
Natural Environment				
9	Topography and geology	D	D	The project will not cause any change of topography and geology.
10	Bottom sediment	D	D	The project will not affect any bottom sediment.
11	Biota and ecosystem	C	C	The impact is not clear during construction and operation stages.
12	Hydrology	D	D	The project will not cause any change of hydrology.
13	Water use	C	C	Impact to present water use is not clear during construction and operation stages.
14	Protected area	D	D	There is no protected area in the neighborhood.
Social Environment				
15	Involuntary resettlement	C	-	Before Construction Stage: The impact is not clear at this moment.
16	Local economies such as employment, livelihood, etc.	B+	B+	New job will be offered both during construction and operation stages.
17	Land use and utilization of local resources	B+	B+	The barren land will be changed to a coal stockpile.

No.	Items of Impact	Predicted Impact		Reason for Assessment
		Before/ During Construction Stage	Operation Stage	
18	Social institutions and local decision-making institutions and social service facilities	D	D	No impact is assumed.
19	Poor	D	D	No impact is assumed.
20	Indigenous or ethnic minority people	D	D	No impact is assumed.
21	Misdistribution of benefits and damages	D	D	No impact is assumed because the conveyor belt will be provided either within the median curbs or vacant land.
22	Local conflicts of interest	D	D	No impact is assumed.
23	Gender	D	D	No impact is assumed.
24	Children's right	D	D	No impact is assumed.
25	Cultural heritage	D	D	No cultural or historical relics exist in the neighborhood.
26	Infectious diseases such as HIV/AIDS	B-	D	Construction Stage: Influx of workers may increase the possibility of infectious diseases. Operation Stage: The impacts might be very small.
27	Landscape	D	D	No impact is assumed.
28	Working conditions	B-	B-	Construction Stage: Insufficient safety management may cause accidents. Operation Stage: Insufficient safety management may cause accidents.
Others				
29	Accident	B-	B-	Construction Stage: Inappropriate traffic control or nature of the project will induce accidents. Operation Stage: The nature of the project will keep the possibility of accidents.

Note: A+/- Remarkable positive/serious negative impact is predicted.
B+/-: Positive/negative impact is expected to some extent.
C: Extent of impact is unknown. (A further examination is needed and the impact could be defined as study progresses)
D: Impact is very small or nil and further survey is not required
Source: JST

Table 7-4 TOR of EIA

Items of Impacts	Items to be Studied	Study Method
Air pollution	• Confirm the environmental standards in Pakistan • Confirm the present level of pollution • Check the location of neighboring residences, schools, hospitals located near the project site • Review the impacts during construction stage	• From the existing data • Sampling, testing and analysis through EIA activity • Assessment in accordance with site survey results
Water pollution	• Confirm the environmental standards in Pakistan • Confirm the present water quality level • Review the impacts during construction stage	• From the latest standards • Sampling, testing, and analysis through EIA activity • Assessment in accordance with site survey results

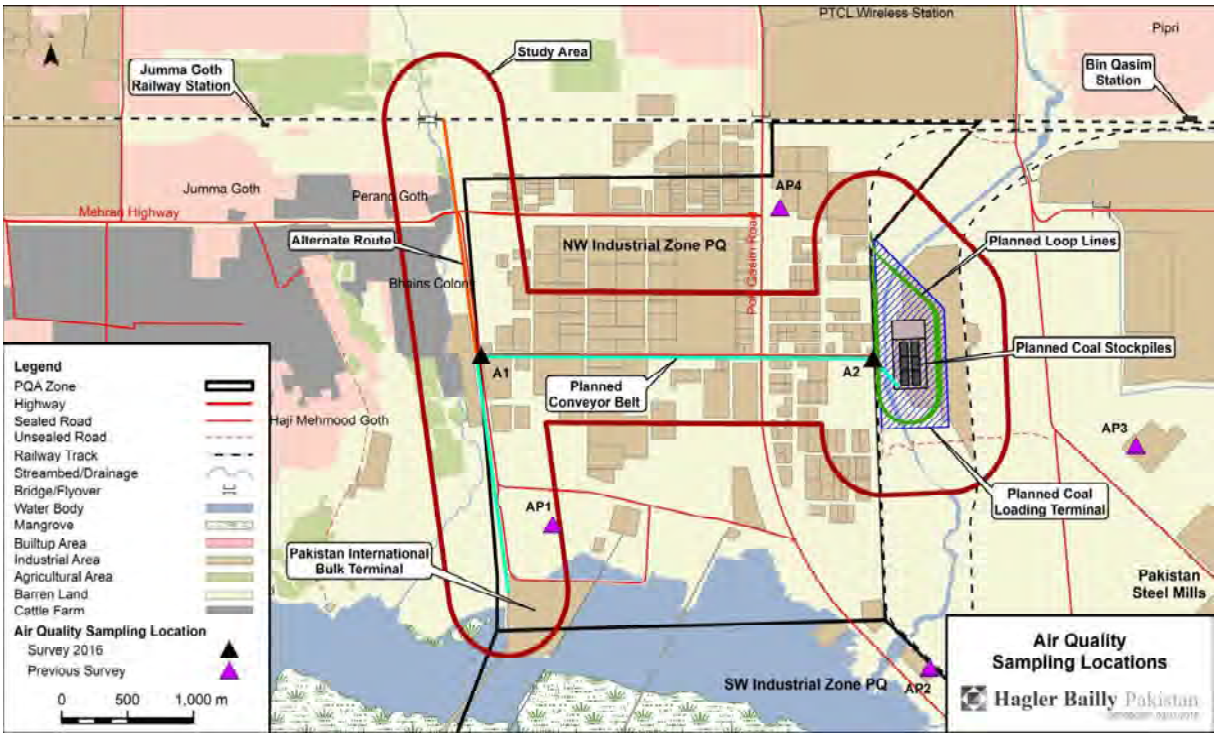
Items of Impacts	Items to be Studied	Study Method
Waste	• Review the waste treatment method during construction stage	• From similar and neighboring construction activity
Noise	• Confirm the environmental standards in Pakistan • Confirm the distance from noise source to residential areas, hospitals, schools • Review the impacts during construction stage	• From the latest standards • Assessment in accordance with site survey results
Global warming/Climate change	• Confirm the present level of pollution • Review the impacts during operation stage	• By secondary data related to Karachi/ Sindh
Biota and ecosystem	• Confirm the species existing in/around the project area	• In accordance with site survey results
Water use	• Confirm the present situation of water use	• In accordance with site survey results
Involuntary resettlement	• Confirm the number of displaced persons/affected households • Prepare FRP	• From related ordinances in Pakistan or Sindh • FRP in accordance with JICA's guidelines
Local economy such as employment and livelihood	• Confirm the new jobs (category and number of employment) through the Draft Final Report	• In accordance with site survey results
Land use and utilization of local resources	• Confirm the present status of the proposed land	• In accordance with study results
Infectious diseases such as HIV/AIDS	• Present distribution of HIV/AIDS infected people	• By secondary data in Karachi/ Sindh
Working conditions	• Confirm the measures to provide worker's safety during construction stage	• In accordance with study results
Accidents	• Review the necessity of safety equipment/tools to prevent accidents during construction stage	• In accordance with study results

Source: JST

7.2.3 Result of EIA Survey

(1) Air Pollution

The results of ambient air quality sampling are tabulated in Table 7-5. The results are compared with the National Environmental Quality Standards (NEQS) and Sindh Environmental Quality Standards (SEQS).



Source: EIA Report

Figure 7-6 Ambient Air Quality Sampling Locations

Table 7-5 Ambient Air Quality Sampling Results

Sample ID	NO_2	NO	SO_2	CO	CO_2	O_3	$PM_{2.5}$	PM_{10}	TSP
	µg/m³	µg/m³	µg/m³	mg/m³	mg/m³	µg/m³	µg/m³	µg/m³	µg/m³
A1	14.18	6.76	14.18	1.71	323.47	12.18	26.06	118	362
A2	14.12	7.06	20.12	1.63	338.71	16.76	27.53	133	371
AP1	18.27	8.10	30.92	1.73	na	na	na	124	na
AP2	10.10	6.10	11.80	na	na	na	20.80	89	216
AP3	na	na	na	2.00	na	na	na	144	na
AP4	na	na	na	1.00	na	na	na	91	na
Average	14.17	7.01	19.26	1.61	331.09	14.47	24.80	117	316
NEQS (24-hour)	80		120	-	-		35		400
NEQS (8-hour)	-		-	5	-		-		-
SEQS (24-hour)	80		120	-	-		75	150	500
SEQS (8-hour)	-		-	5	-		-		-

Source: EIA Report

The following conclusions can be drawn from the sampling results:

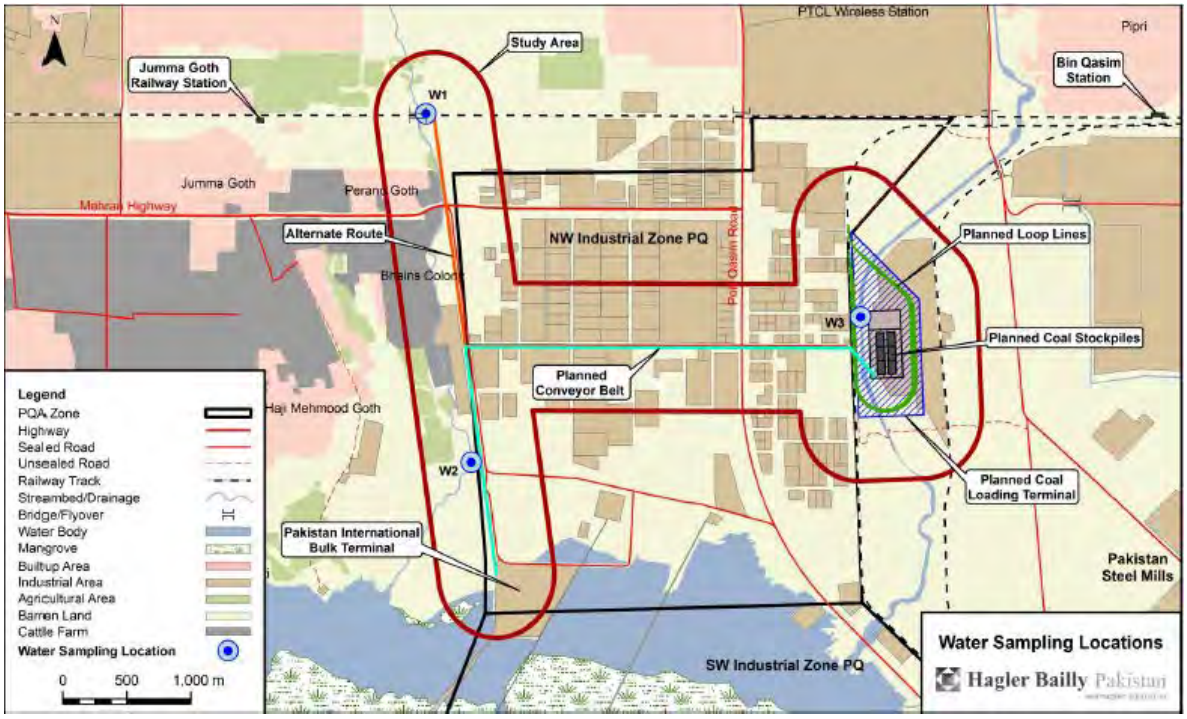
- All sampled points are within the limits of the NEQS and SEQS guidelines for ambient air quality for all pollutants sampled.

- The results are fairly homogenous across the Study area reflecting similar air quality across the North-West Industrial Zone (NWIZ).

- AP3 has the highest PM_{10} reading of 144 µg/m^3 which is very close to the standard of 150 µg/m^3. The likely cause is its proximity to the Pakistan Steel Mill (PSM). A2 has the second highest PM_{10} of 133 µg/m^3 possibly because of its closeness to the railway track, barren and dry land, and disturbed PSM yard.

(2) Water Pollution

The two surface water channels were tested for basic water quality parameters and selected metals. Sampling was conducted on January 13, 2016, and lab analysis was performed by SUPARCO. The sampling locations are presented in Figure 7-7 and shown in Table 7-6.



Source: EIA Report

Figure 7-7 Surface Water Quality Sampling Locations

Table 7-6 Surface Water Quality Sampling Results

Parameter	Unit	LOR	NEQS Guideline Values		Sample ID		
			Liquid Effluents	Drinking Water	W1	W2	W3
General Parameters							
Temperature	°C	0.1	–	–	28.6*	27.8*	22.8*
DO	%	0.1	–		2.1*	15.3*	14.5*
BOD	mg/L	1.0			5072	109	53
Conductivity	mS/cm	1.0	–		8.91 6.5*	20.90 OL*	2.17 2.10*

Turbidity	NTU	1	–	5	719	120	14
pH		0.1	6 to 9	6.5 – 8.5	6.74 6.99*	8.50 8.54*	8.27 8.45*
TSS	mg/L	1.0	200		1670	217	9
Metals							
Arsenic	mg/L	0.001	1.0				0.013
Boron	mg/L	0.001	6.0	0.3			0.044
Cadmium	mg/L	0.001	0.1	0.01			<0.001
Calcium	mg/L	1.0	–	–			286.358
Magnesium	mg/L	1.0	–	–			194.001
Copper	mg/L	0.001	1.0	2			0.037
Iron	mg/L	0.001	8.0	–			0.192
Nickel	mg/L	0.001	1.0	0.02			0.028
Potassium	mg/L	0.001	–	–			0.016
Sodium	mg/L	0.001	–	–			24.142
Strontium	mg/L	0.001	–	–			253.818
Zinc	mg/L	0.001	5.0	5.0			0.371

Note: * indicates readings performed onsite with a portable multimeter.

OL indicates that the measurement was above the limit of the portable instrument

Source: EIA Report

The results are compared against both drinking water and liquid effluent standards. This is because the water in the drains, while not used for drinking, is used for other purposes such as irrigation water and comes into contact with flocks of livestock.

Water quality sampling results show the following:

- Turbidity is very high in all samples and above the drinking water guidelines.
- Total suspended solids of the eastern channel (W1 and W2) are very high and are above the NEQS guidelines for liquid effluents. This is because of the direct discharge and lack of regulations on the cattle farms through which this channel passes.

There is no major metal contamination (for metals tested) in the water for which there exist SEQS guidelines.

(3) Waste

It was observed that much solid waste was disposed on barren lands surrounding the industrial area. This included both industrial waste (such as used insulation, cloth and other materials) as well as domestic waste. Burning seemed to be the common method of disposal. Burning waste and piles of burnt and unburnt waste can be seen in Figure 7-8.

At several locations, liquid effluent was seen to be disposed of into the water channels in the area.

Source: EIA Report

Figure 7-8 Waste Disposal in the Study Area

(4) Noise

A sound level survey was conducted between January 11 and 13, 2016 at three locations for 8 hours at each location. Corresponding traffic counts were also conducted to gauge what level of noise was originating from the traffic. Details of sampling locations are presented in Table 7-7.

Table 7-7 Sound Level Survey Locations and Durations

Sample ID	Coordinates	Location	Rationale for Location	Date and Duration
N1	24° 50' 15.8" N 67° 17' 02.8" E	Intersection of Mehran Highway and corner of NWIZ	Near receptor (Jumma Goth)	Jan. 13, 2016 0900 - 1700
N2	24° 49' 40.5" N 67° 17' 09.0" E	Intersection of road toward PIBT and NWIZ main road	Near receptor (Bhains Colony)	Jan. 12, 2016 1000 – 1800
N3	24° 49' 40.7" N 67° 18' 55.6" E	Road near proposed coal stockyard	Possible site of coal stockyard	Jan. 11, 2016 1000 – 1800

Source: EIA Report

A summary of the results and SEQS noise standards are provided in Table 7-8**.** The results include following explanation.

- L_{90} is the sound level that is exceeding 90% of the time. It is representative of the background sound levels.
- L_{10} is the sound level that is only exceeding 10% of the time (higher than L_{90}).
- Leq is the average of the total sound level in decibels.

Table 7-8 Summary of Sound Levels during the Survey

Sample ID	N1	N2	N3	SEQS Limits for Industrial Areas
LA_{eq}, 8 hour (dBA)	65.9	63.4	56.4	75
L_{90}, 8 hour (dBA)	55.9	50.7	50.7	-
L_{10}, 8 hour (dBA)	69.2	65.9	56.8	-

Source: EIA Report

- Noise levels are well within the SEQS limits as the area is zoned for industrial activity.
- N2 and N3 lie in the east and west of NWIZ. The L_{90} value is 50.7 at both these locations and represents the background noise level in the industrial zone.
- N1 and N2 have LA_{eq} of 65.9 and 63.4, respectively. Both these readings were taken on intersections that experience a high volume of traffic.
- N3, near the proposed coal stockyard, has an LA_{eq} of 56.4, which is the lowest of the three locations. The area is empty towards the south, and has warehouses to the north. There is very little traffic. Other noise sources include trains on the nearby track. Two trains were observed during the survey period.

(5) Land Use and Utilization of Local Resources

Land in the Study area consists mainly of industrial land with a large amount of barren land.

Industrial Area (55%)

The majority of the Study area falls under a notified industrial area - the Port Qasim Industrial Zone. The conveyor belt passes through the extensively developed North Western Industrial Zone which has a total area of 2,920 acres of which 904 acres are reserved for port services and the remaining 2,016 acres are for industrial units. Industrial units include automotive assembly, pharmaceutical, food and edible oil processing, among others.

Barren Land (38%)

A large portion of the Study area consists of barren land. Certain portions of the land are vegetated which are used by goat herders as grazing land. A large portion of this barren land is within the industrial zone and it is expected that industrial units will be developed on it in the future.

Cattle Farms (4%)

While only accounting for 4% of land use, cattle farms are a dominant feature of the communities in the Study area.

Agricultural Area (2%)

Limited agricultural activities are practiced in and around the Study area. Water is obtained from surface drains that receive liquid effluent from cattle farms which is rich in nutrients.

Residential Area (1%)

The two major residential areas in the vicinity of the Project are Jumma Goth and Bhains

Colony. These settlements consist of urban communities that are mixed with cattle farms. Bhains Colony is dominated by cattle farms whereas Jumma Goth is mostly residential with some farms present as well. Construction is almost exclusively masonry.

7.2.4 Environmental Impact Assessment

In accordance with the EIA survey results, various impacts during before construction and during construction, and operation stages are indicted in Table 7-9.

Table 7-9 Environmental Impact Assessment Results

No.	Items of Impact	Assessed Results		Reason for Assessment
		Before/ During Construction Stage	Operation Stage	
Anti-Pollution Measures				
1	Air pollution	B-	B-	Construction Stage: Vehicular emissions and dust blowing are causes of air pollution. Operation Stage: It is assumed that dust blowing from conveyor belt and coal stockyard will cause air pollution.
2	Water pollution	B-	B-	Construction Stage: The impact is assumed when the coal stockyard is constructed. Operation Stage: The impact from the coal stockyard is assumed.
3	Soil pollution	D	D	No impact is assumed.
4	Waste	B-	D	Construction Stage: The impact due to culvert construction activity is assumed. Operation Stage: The impact will almost be nil.
5	Noise and vibration	B-	B-	Construction Stage: Present noise level will increase. Operation Stage: It is assumed that increased noise level will remain.
6	Ground subsidence	D	D	There is no activity which requires pumping of groundwater; therefore, no impact is assumed.
7	Offensive odors	D	D	No offensive odor is assumed.
8	Global warming/ Climate change	D	D	Construction Stage: Impact will almost be nil. Operation Stage: Impact will be very small.
Natural Environment				
9	Topography and geology	D	D	The project will not cause any change on topography and geology.
10	Bottom sediment	D	D	The project will not affect any bottom sediment.
11	Biota and ecosystem	D	D	Impact due to the crossing of Nula will be very small.
12	Hydrology	D	D	Impact due to the crossing of Nula will be very small.
13	Water use	D	D	Impact is not assumed.
14	Protected area	D	D	It is approximately 3 km from the coal stockyard to the neighboring mangrove forest; therefore, impact might be very small.
Social Environment				
15	Involuntary resettlement	D	-	Before Construction Stage: Impact is not assumed.

No.	Items of Impact	Assessed Results		Reason for Assessment
		Before/ During Construction Stage	Operation Stage	
16	Local economies such as employment, livelihood, etc.	B+	B+	New job will be offered both during construction and operation stages.
17	Land use and utilization of local resources	B+	B+	The barren land will be changed to a coal stockpile.
18	Social institutions and local decision-making institutions and social service facilities	D	D	No impact is assumed.
19	Poor	D	D	No impact is assumed.
20	Indigenous or ethnic minority people	D	D	No impact is assumed.
21	Misdistribution of benefits and damages	D	D	No impact is assumed because the conveyor belt will be provided either within the median curbs or vacant land.
22	Local conflicts of interest	D	D	No impact is assumed.
23	Gender	D	D	No impact is assumed.
24	Children's right	D	D	No impact is assumed.
25	Cultural heritage	D	D	No cultural or historical relics exist in the neighborhood.
26	Infectious diseases such as HIV/AIDS	B-	D	Construction Stage: Influx of workers may increase the possibility of infectious diseases. Operation Stage: The impacts might be very small.
27	Landscape	D	D	No impact is assumed.
28	Working conditions	B-	B-	Construction Stage: Insufficient safety management may cause accidents. Operation Stage: Insufficient safety management may cause accidents.
Others				
29	Accident	B-	B-	Construction Stage: Inappropriate traffic control or nature of the project will induce accidents. Operation Stage: Transportation by conveyor belt will keep the possibility of accidents.

Note: A+/- Remarkable positive/serious negative Impact is predicted.
B+/-: Positive/negative impact is expected to some extent.
C: Extent of impact is unknown. (A further examination is needed and the impact could be defined as study progresses)
D: Impact is very small or nil and further survey is not required
Source: JST

7.2.5 Mitigation Measures and Costs

Table 7-10 presents the mitigation measures against the adverse impacts during the before construction/construction stage, and Table 7-11 presents those during operation stage.

Table 7-10 Mitigation Measures before Construction and Construction Stage

Item of Impact	Mitigation Measures	Implementing Organization	Responsible Organization
Air Pollution	- Dust prevention by sprinkler truck.	Contractor	PMU
Water pollution	- Temporary coffer dam must be provided to accelerate sedimentation of turbid water and prevent straight water flow into the existing waterway. - Temporary sanitation facilities such as portable toilets and garbage bins will be provided by the contractors to ensure that the domestic wastes to be generated by the construction personnel are properly handled and not thrown into the existing waterway.	Contractor	PMU
Waste	- Contractors are required to facilitate proper disposal plan and manage the construction waste.	Contractor	PMU
Noise and vibration	- Noise suppressors such as mufflers will be installed whenever deemed necessary to maintain the noise generated by the heavy equipment and other construction machinery within permissible limits. - Contractor is required to use low-noise equipped machinery whenever it is necessary.	Contractor	PMU
Infectious diseases such as HIV/AIDS	- Contactor is required to conduct a periodical health education to his personnel.	Contractor	PMU
Working conditions	- Contractor must provide hard hat and safety belt as necessary. - Contractor must provide temporary scaffolding, landslide protection wall, etc., to protect his workers.	Contractor	PMU
Accident	- A sound traffic management and detour plan must be strictly implemented. - Traffic enforcers and flagmen must be designated when heavy equipment/vehicle are operated adjacent to the public road.	Contractor	PMU

Source: JST

Table 7-11 Mitigation Measures during Operation Stage

Item of Impact	Mitigation Measures	Implementing Organization	Responsible Organization
Air pollution	- The closed type conveyor belt will be applied; therefore, dust might be minimized. Furthermore, dust net will be applied at the coal stockyard and sprinkle water over the stocked coal as well as coal cargo train at loading terminal.	Outsourced Contractor	PQA
Water pollution	- Water treatment plant must be provided in the coal stockyard.	Outsourced Contractor	PQA
Noise level	- Periodical monitoring must be conducted by PQA. - Where noise level exceeds the environmental standards, provide hump/planting strip.	Outsourced Contractor	PQA
Working conditions	- Monitor by the outsourced contractor	Outsourced Contractor	PQA
Accident	- Provide hump where the factory workers cross the road.	Outsourced Contractor	PQA

Source: JST

The following Table 7-12 presents the costs of the mitigation of impact during construction stage including environmental enhancement activities such as prevention of dust and water pollution. It is included in the project costs estimate.

Table 7-13 presents the cost borne by the contractor which is included in the project costs estimate, and Table 7-14 presents the cost borne by PQA during the operation stage.

Table 7-12 Estimates of Environmental Costs in Construction Stage

	Description of Items	Cost (US$ in millions)	Remarks
A	Dust control		By the Contractor
a-1	Cover by FRP above conveyor belt	5.50	Personnel expense is included in the Contract
a-2	Sprinkler	0.24	Personnel expense is included in the Contract
a-3	Dust net	1.40	Personnel expense is included in the Contract
B	Water control		By the Contractor
b-1	Water treatment system	0.03	
b-2	Sanitation	0.01	
C	Noise and vibration	0.01	By the Contractor
D	Infection diseases such as HIV/AIDS	0.01	By the Contractor
E	Working conditions	0.80	By the Contractor
G	Accident	0.72	By the Contractor
Total Sum		8.72	

Source: JST

Table 7-13 Estimates of Environmental Costs in Operation Stage

	Description of Items	Cost per One Year (US$ in million)	Remarks
A	Dust control	0.50	By the Contractor
B	Water control	0.10	By the Contractor
C	Noise and vibration	0.01	By the Contractor
D	Working conditions	0.05	By the Contractor
E	Accident	0.05	By the Contractor
Total Sum		0.71	

Source: JST

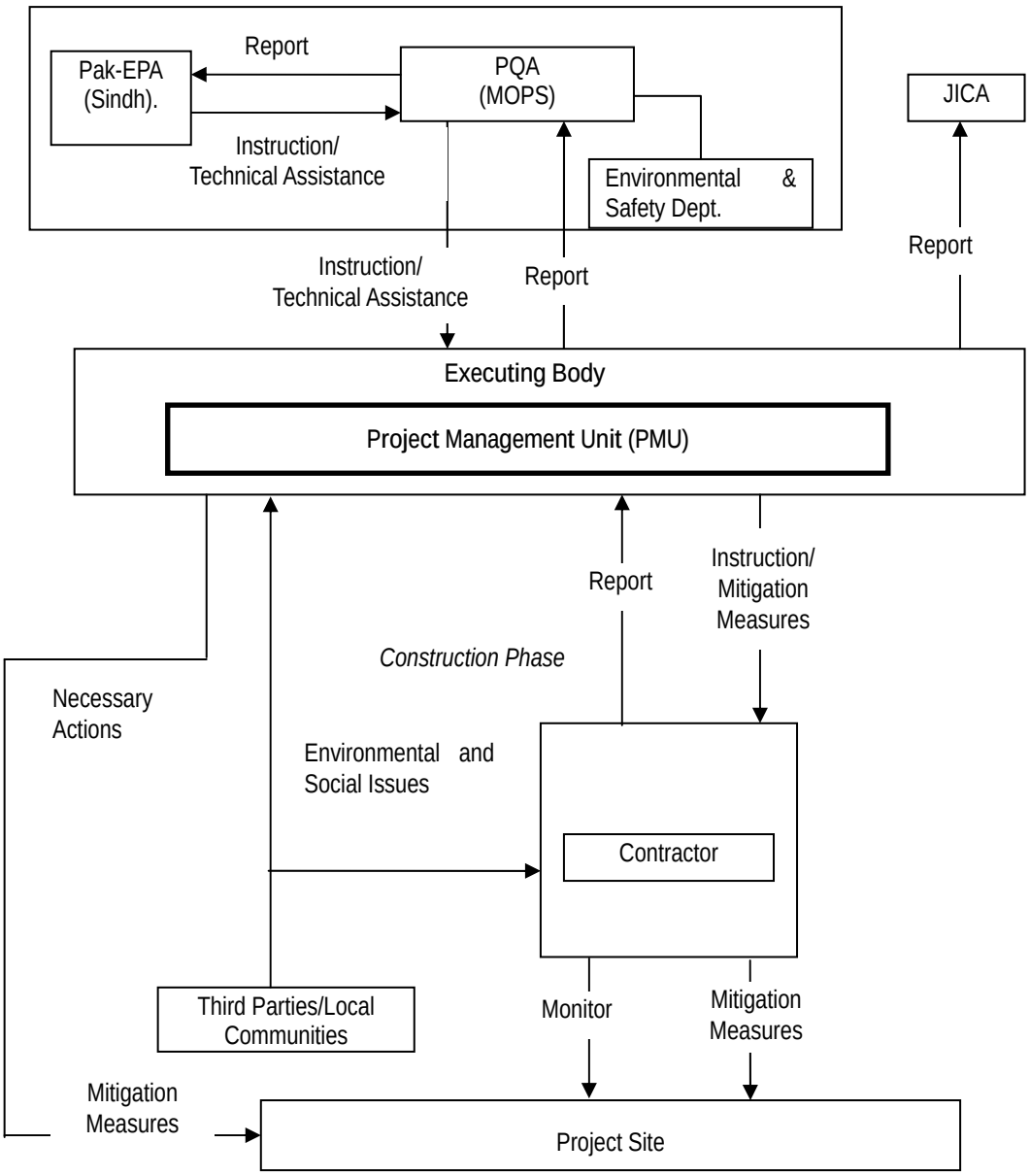
Table 7-14 Estimates of Environmental Costs in Operation Stage

	Description of iIems	Cost (US$ in millions)	Remarks
I	Hiring NGO	0.05	By PQA
II	Hiring External Monitoring Consultant	0.05	By PQA
Total Sum		0.10	

Source: JST

7.2.6 Environmental Monitoring

The institutional framework for environmental management and monitoring is presented in Figure 7-9.



Source: JST

Figure 7-9 Institutional Framework for Environmental Management and Monitoring

Environmental monitoring is required to be performed periodically during the project implementation stages. Two approaches are followed usually during monitoring of environmental impacts. These are monitoring of impacts on environmental components during construction and operation stages. The monitoring form is attached in Appendix-3: Form of Monitoring.

Table 7-15 Environmental Monitoring during Construction Stage

No.	Environmental Indicator	Parameters /Units	Means of Monitoring	Frequency	Implementing Organization	Responsible Organization
1	Water Quality	Turbidity, pH	Visual inspection	Daily	Contractor	PMU
2	Dust Control	Working condition of water sprinkle tanker	Visual inspection	Daily	Contractor	PMU
3	Waste Management	Garbage, toilet at contractor's office and work camp	Visual inspection	Daily	Contractor	PMU
4	Noise Level	Monitor the (dB) caused construction activity	Monitoring by tool	Daily	Contractor	PMU
5	Working Conditions and Accident	Monitor tools, equipment, and temporary facilities	Visual inspection	Daily	Contractor	PMU

Source: JST

Table 7-16 Environmental Monitoring during Operation Stage

No.	Environmental Indicator	Parameters/ Units	Means of Monitoring	Frequency	Implementing Organization	Responsible Organization
1	Water Quality at Coal Stockyard	Turbidity, pH, BOD, etc.	Monitoring by tool	Once in a month	Outsourced Contractor	PQA
2	Noise Level	Monitor the (dB) caused traffics	Monitoring by tool	Once in a year	Outsourced Contractor	PQA
3	Working conditions and Accident	Number of accident in terms of transportation basis	Data collection from traffic police	Once in a month	Outsourced Contractor	PQA

Source: JST

7.3 Land Acquisition and Resettlement

7.3.1 Necessity of Land Acquisition and Resettlement

This section provides information on Pakistani laws and regulations on land acquisition and resettlement and the requirements of the International Finance Corporation's (IFC) Policy on Involuntary Resettlement.

The conveyor belt passes through the right of way belong to PQA, in principle. When it passes a private land or affect a different ownership structure, there may be arisen a resettlement activity. The resettlement policy framework has prepared to cope with such a land or structure.

7.3.2 Legal Framework on Land Acquisition and Resettlement

The Project's resettlement will be regulated by different bodies of Pakistani law for matters relating to land acquisition relative to the Project requiring the application of the right of eminent domain, particularly the following: (i) Land Acquisition Act of 1894 (amended)

covering land acquisition against a fair compensation and complete rehabilitation of affected households/communities; (ii) Easements Act of 1882 (amended) for consideration of the long-standing customary rights of local communities on natural and man-developed resources such as water, land and vegetation, especially the grazing areas; and (iii) Katchi Abadis Act of 1987 for consideration of the non-titled people for compensation and rehabilitation at the Project's expense.

The Land Acquisition Act, 1894 (LAA) with its successive amendments is the main law regulating land acquisition for public and company purposes. The LAA has been variously interpreted by local governments, and some provinces have augmented the LAA by issuing provincial legislations. The LAA and its Implementing Rules require that following an impacts assessment/valuation effort, land and crops are compensated in cash at market rate to titled landowners and registered land tenants/ users, respectively.

Based on LAA, only legal owners and tenants registered with the district's Land Revenue Department, or those possessing formal lease agreements, are eligible for compensation or livelihood support. The rights of the non-titled are, however, addressed under the Easements Act, 1882 and The Katchi Abadis Act, 1987, which recognize the customary rights and the non-titled persons' rights to receive cash compensation and rehabilitation in the form of replacement plots, provision of basic public facilities, and assistance for livelihood restoration.

The LAA does not automatically mandate for specific rehabilitation/ assistance provisions benefiting the poor, vulnerable groups, or severely affected persons (APs); nor does it automatically provides for rehabilitation of income/ livelihood losses or resettlement costs. However, there are exceptions to these rules, as the law is broadly interpreted at provincial level depending on the operational requirements, specific local needs, and socioeconomic circumstances. Recourse is often taken to ad hoc arrangements based on negotiations between a specific executing agency (EA) and the project-affected persons (PAPs). The Project will make optimal use of such recourses. In addition, the provisions in IFC Policy on Involuntary Resettlement will also be applied to this Project's resettlement-related activities.

7.3.3 Gaps between IFC Policy and Related Ordinances in Pakistan

The LAA, 1894 constitutes the main legal framework that regulates land acquisition for public purpose. The LAA, 1894 and its regulation for implementation mandate that only title holders and legal owners of the property/land are compensated as follows:

- Land and crops are compensated in cash at market rate
- Registered land tenants/users are compensated in cash at market rate

The LAA, 1894 mandates that land valuation is to be based on the latest 3 to 5 years average registered land sale rates, although, in several recent cases, the median rate over the past 1 year, or even the current rates, have been applied. Due to widespread land under-valuation by the Revenue Department, current market rates are now frequently applied with an added 15% Compulsory Acquisition Surcharge as per provision of the law.

The following Table 7-17 presents the gaps between LAA 1894 and IFC Policy.

In principle, Pakistani Law and IFC Policy adhere not only to the objective of affected households (AH) compensation, but also to that of AH rehabilitation. However, Pakistani Law is unclear on how rehabilitation is to be achieved and in practice the provision of rehabilitation is left to ad hoc arrangements of local governments and project proponents. To clarify these issues and reconcile gaps between Pakistani Laws and IFC Policy, PQA will

comply with this Policy Framework prepared for the project, ensuring compensation at replacement cost for all items affected, relocation and resettlement of AHs, provision of basic public facilities, and subsidies or allowances for AHs, suffering business or other livelihood losses.

Table 7-17 Comparison of Pakistan LAA and IFC Policy

No.	IFC Policy	Pakistan LAA, 1894
1.	Lack of title should not be an excuse for denying compensation.	Land compensation only for titled landowners or holders of customary rights.
2.	Crop compensation is to be provided irrespectively from the registration status of the affected farmer.	Crop losses compensation provided only to registered landowners and lease/sharecrop tenants (Non-registered are often deprived).
3.	Tree losses are compensated according to market rates based on productive age or wood volume depending on tree type.	Tree losses are compensated on the basis of officially fixed rates by the Forest and Agricultural/Horticulture departments.
4.	Land valuation to be based on current replacement value.	Land valuation based on the median registered land transfer rate over the previous 1 year before the notification of Section 6.
5.	Valuation of built-up structures is based on current market value/cost of new construction of the structure, with no deduction for depreciation. APs can take the salvage material free of cost.	Valuation of structures based on official rates, with depreciation deducted from gross value of the structure.
6.	Complaints and grievances are resolved informally through community participation in the grievance redress committees (GRCs), local governments, NGO and/or local-level community based organizations	Land Acquisition Collector (LAC) is the only prelitigation final authority to decide disputes and address complaints regarding quantification and assessment of compensation for the affected lands and other assets
7.	Information related to quantification and costing of land, structures and other assets, entitlements, and amounts of compensation and financial assistance are to be disclosed to the affected persons prior to project appraisal.	The decisions regarding land acquisition and the amounts of compensations to be paid are published in the official Gazette and notified in convenient places so that the people affected get aware of the same.
8.	JICA Guidelines requires rehabilitation for lost income and special AP expenses during the relocation process.	No provision for income/livelihood rehabilitation measure, allowances for severely affected PAPs and vulnerable groups, or resettlement expenses

Source: JST

7.3.4 Eligibility Policy and Entitlement Matrix

The project operations will have to be carried out based on the exercise of the right of eminent domain under LAA, and will therefore trigger the application of the IFC Policy on Involuntary Resettlement. Impacts reparation under the Project will be carried out based on the compensation eligibility and entitlements framework, to be prepared under the IFC Policy on Involuntary Resettlement, the main theme of which is “just replacement of the lost assets and livelihoods, so that the pre-project standard of living of the affected people is maintained, and none of them becomes worse off as a result of land acquisition for project in question”.

To identify the eligibility, the cut-off date will be declared when census is conducted. Persons who encroach in the area after the cut-off date are not entitled to compensation or any other form of resettlement assistance.

Table 7-18 Entitlement Matrix

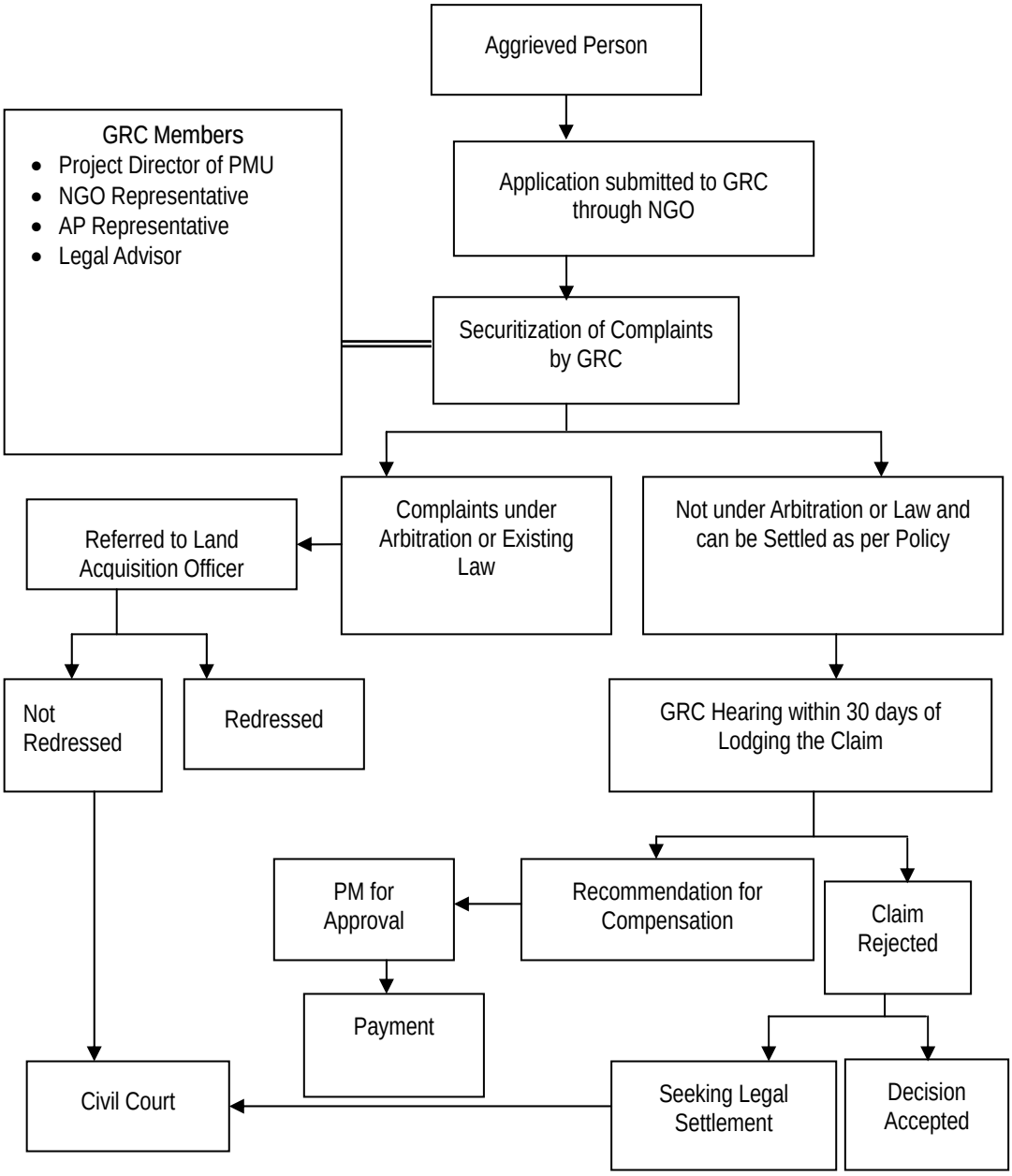
Asset	Specification	Affected People	Compensation Entitlements
Permanent Impact on Arable Land	All land losses independently from impact severity	Farmer/ titleholder	Cash compensation for affected land at replacement cost based on market value plus a 15% compulsory land acquisition surcharge and free of taxes, registration, and transfer costs.
		Leaseholder/ tenant *(registered or not)*	Cash equivalent to market value of gross yield of affected land for the remaining lease years (up to a maximum of 3 years).
		Sharecroppers *(registered or not)*	Cash compensation equal to market value of lost harvest to be shared with landowner based on the sharecropping contract.
		Agricultural workers losing contracts	Cash indemnity corresponding to their salary (including portions in kind) for the remaining part of the contract.
		Squatters	1 rehabilitation allowance equal to net market value of 1 harvest in addition to standard crop compensation for land use loss.
	Additional provisions for severe impacts (More than 10% of land loss)	Farmer/ titleholder Leaseholder	1 severe impact allowance equal to net income from 1 year harvest (winter and summer crop) additional to standard crop compensation.
		Sharecroppers *(registered or not)*	1 severe impact allowance equal to market value of share of harvest lost (additional to standard crop compensation).
		Squatters	1 severe impact allowance equal to net value of harvest of the affected land for one year (inclusive of winter and summer crop and additional to standard crop compensation).
Residential/ Commercial Land		Titleholder	Cash compensation for affected land at full replacement cost, free of taxes, registration, and transfer costs.
		Renter/ leaseholder	Three months allowance.
		Squatters	Accommodation in a government resettlement area or self-relocation allowance: a) provision of a plot property in public resettlement area; b) provision of a plot leased in a public resettlement area; and c) provision of a loss of land use space covering one year of livelihood.
Building and Structures		All APs (including squatters)	Cash compensation at replacement rates for affected structure and other fixed assets free of salvageable materials, depreciation and transaction costs. In case of partial impacts, full cash assistance to restore remaining structure.
Crops	Crops affected	All APs (also squatters)	Crop compensation in cash at full market rate for one year harvest
Loss of Business		All APs	Business owner: (i) Cash compensation

			equal to six months income, if loss is permanent; (ii) cash compensation for the business interruption period up to six months, if loss is temporary. Worker/employees: Indemnity for lost wages up to six months.
Relocation	Transport/Transition livelihood costs	All APs so affected (including squatters)	Provision of a relocation allowance of (Rs.20,000) covering transport costs (Rs.5,000) and a livelihood allowance of Rs.15,000 covering livelihood costs.
Communal Assets			Rehabilitation/substitution of the affected structures/ utilities.
Vulnerable AP		AP under poverty line	One special allowance of Rs.6,500 Employment priority in project-related jobs.

Source: JST

7.3.5 Grievance Redress Mechanism

The Project should set-up a Project Level Grievance Redress Committee (GRC), to be constituted of the representatives from the district government, affected community/ groups and a local third-party (NGO), to resolve the minor disputes and complaints informally, in an effective and timely manner, and to avoid the often lengthy and costly litigation processes.

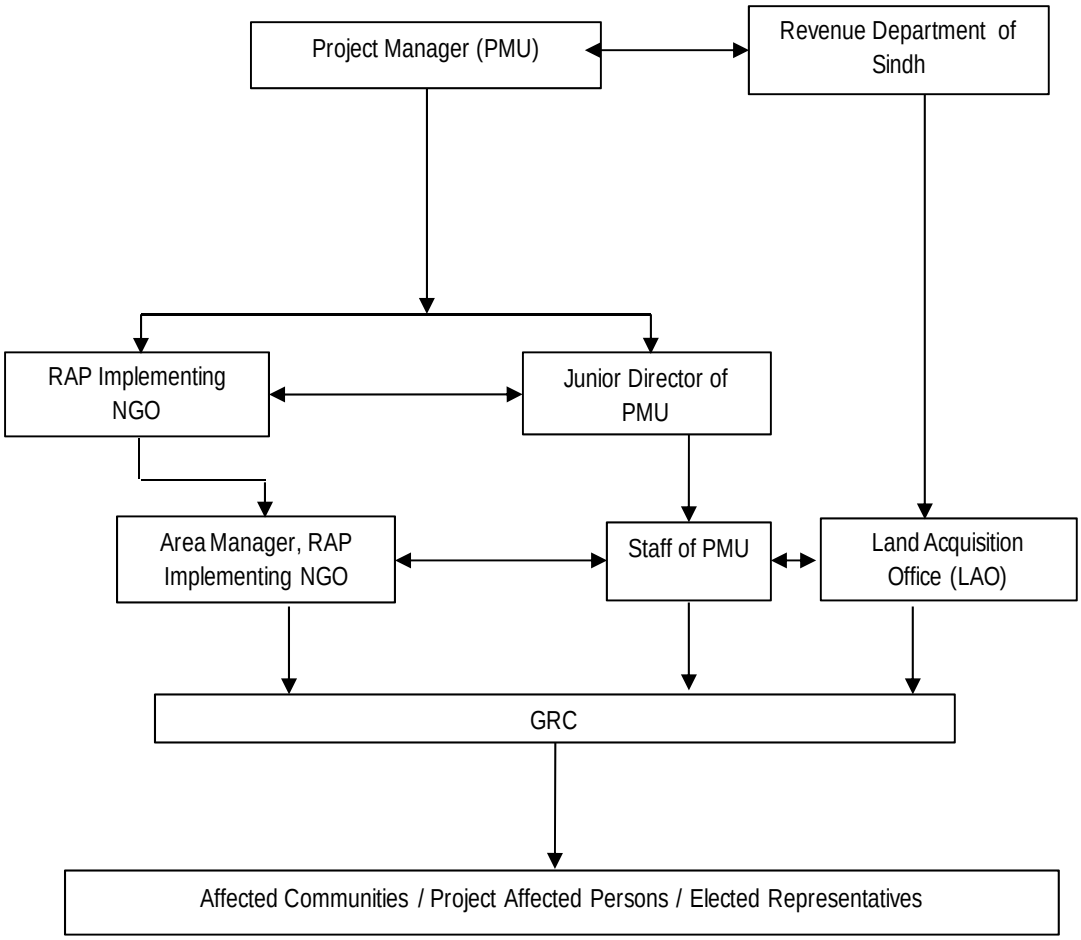


Source: JST

Figure 7-10 Grievance Redress Mechanism

7.3.6 Implementation Organization

The Project will be conducted under the supervision of the project management unit (PMU) and managed relative to the resettlement action plan (RAP). The proposed implementation organization is presented in Figure 7-11.



Source: JST

Figure 7-11 Implementation Organization of Resettlement Plan

7.3.7 Monitoring and Evaluation (M&E)

RAP implementation monitoring will be done both internally and externally to provide feedback to PPA and to assess the effectiveness. Evaluation of the resettlement activities will be performed during and after implementation of the RAP to assess whether the resettlement objectives were appropriate and whether they were met, specifically, whether livelihoods and living standards have been restored or enhanced. The evaluation will also assess resettlement efficiency, effectiveness, impact and sustainability, drawing lessons as a guide to future resettlement planning.

(1) Internal Monitoring

Internal monitoring will be undertaken by the PMU. The PMU will gather information on RAP implementation covering relevant activities as per schedule. Internal monitoring reports on RAP implementation will be included in the quarterly Project Progress Report (PPR). The report will contain: (i) accomplishment to date, (ii) objectives attained and not attained during the period, (iii) challenges encountered, and (iv) targets for the next quarter. Furthermore, internal monitoring would be carried out every half year during the operation stage for at least two years. Table 7-19 shows the potential monitoring indicators which will be reported. Also, Table 7-20 shows the format for RAP implementation monitoring which will be filled quarterly.

Table 7-19 Format for RAP Implementation Monitoring

Component	Total (unit)	Completed (unit)	Cumulative Achievement Total (unit)	Progress During Reporting Month (%)		Status & Remarks
				Target (%)	Achievement (%)	
Resettlement Preparation						
Distribution of Brochures						
Identification of APs/CBEs						
Issuance of ID Cards						
Consultation Meetings						
Payment of Compensation						
Compensation for Land						
Compensation for Tree/Crop/Fish						
Residential/ Commercial Structure						
Payment for Rent/Leaseholder						
Shifting/Relocation Costs						
Social Development Activities						
Grant for Loss of Wages						
Loss of Business Grant						
Business Restoration Grant						
Payment for Indirect Impact						
Restoration and Rehabilitation of Livelihood						

Source: JST

Table 7-20 Monitoring Indicators

Monitoring Issues	Monitoring Indicators
Budget and Timeframe	Have all land acquisition and resettlement staff been appointed and mobilized for field and office work on schedule? Have capacity building and training activities been completed on schedule? Are resettlement implementation activities being achieved against agreed implementation plan? Are funds for resettlement being allocated to resettlement agencies on time? Have resettlement offices received the scheduled funds? Have funds been disbursed according to RAP? Has all land been acquired and occupied in time for project implementation?
Delivery of AP Entitlements	Have all APs received entitlements according to numbers and categories of loss set out in the entitlement matrix? How many affected households received their land titles? How many affected households relocated and built their new structure on the new location?

Monitoring Issues	Monitoring Indicators
	Are income and livelihood restoration activities being implemented as planned? Have affected businesses received entitlements? Have the APs losing their eroded land received proper compensation? Have the squatters, encroachers of PQA or government land, displaced due to the project, been compensated? Have the community structures been compensated and rebuilt on the new site?
Consultation, Grievances and Special Issues	Have resettlement information brochures/leaflets been prepared and distributed? Have consultations taken place as scheduled including meetings, groups, community activities? Have any APs used the grievance redress procedures? What were the outcomes? Have conflicts been resolved?
Benefit Monitoring	What changes have occurred in patterns of occupation compared with the pre-project situation? What changes have occurred in income and expenditure patterns compared with the pre-project situation? Have APs income kept pace with these changes? What changes have occurred for vulnerable groups?

Source: JST

(2) External Monitoring

The PQA will engage individuals/firms to conduct a one-time social impact evaluation, at least six months following the completion of resettlement. It will use appropriate investigative and analytical techniques in assessing the post-project socio-economic conditions of the APs in relation to the baseline socio-economic data generated before undertaking of the resettlement implementation.

The evaluation will describe any outstanding future issues that are required to bring the resettlement into compliance with the IFC Policy on Involuntary Resettlement and Government Policy, and further mitigation measures needed to meet the needs of any APs or families perceiving themselves to be worse off as the result of resettlement. It will include lessons learned from the evaluation that may be useful in developing future policies on involuntary resettlement of APs in Pakistan.

For information, Appendix-4: TOR for External Monitoring Consultant is attached separately.

7.3.8 Local Stakeholder Meeting

As part of the EIA process, consultations were undertaken with communities and institutions that may have interest in the proposed project or may be affected by it.

The consultation meetings were held from January 28 to 29, February 8 and February 24 to 25, 2016 with the stakeholders.

The meetings progressed in the following manner, and summary of the consultation meetings is indicated in Table 7-21.

- An overview of the Project description was provided;
- Briefly described the EIA process that was undertaken for the Project and presented the structure of the EIA report to facilitate understanding of the report;

- Concerns were recorded, queries were addressed.

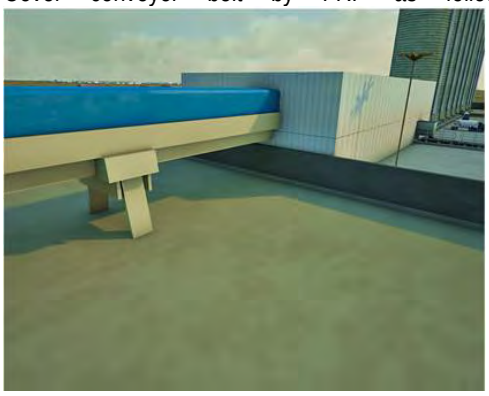
Table 7-21 Summary of Consultation Meeting

Aspect	Concerns
Coal unloading at PIBT	The fishermen community had their concerns regarding the ships that will bring the coal to the port as the ships may pollute the sea. The ships sometimes have the problem of oil spillage that is harmful for the marine life. There is also the problem of blackwater which is actually the waste from toilets and medical facilities that contain harmful bacteria which will also damage the marine life.
Employment opportunities	Demand of employment in both skilled and unskilled labor. The employment rate in the area is very low and any sort of work will be gladly welcomed. There will be protests if labor is hired from other areas.
Transportation of coal	Coal transportation on the conveyor belt may cause hindrance to the overloaded trucks of green grass that move around the area. The conveyor belt may disrupt the smooth flow of the trucks

Source: JST

On the other hand, four letters were sent among the stakeholders mentioning their concerns on the construction of the conveyor belt. Their concerns and proposed countermeasures are summarized as follows.

Table 7-22 Summary of Dissenting Opinions

Concern	Proposed Countermeasures
Coal dust will have effect on quality and product performance. Coal dust will made an air-filtration and an cleaning extra expensive. Conveyor belt will cause traffic problems and accidents. Coal dust will make working conditions of factory workers.	1. Cover conveyor belt by FRP as following reference.  2. Sprinker will be provided at Coal Stockyard. 3. Dust net will be provided at Coal Stockyard.

Source: JST

The issues are not settled yet, as the project proponent PQA is required to procceed the stakeholder meeting with the related firms.

The letter from the stakeholders is attached in Appendix-5.

Chapter 8 Project Cost Estimate

This chapter is divided into two parts, namely, initial cost in Stage 1, and operation and maintenance cost including additional investments in Stage 2. Chapter 5 explains that Stage 1 will be planned to meet coal handling capacity of 10 mtpa for railway transport and Stage 2 will be to meet 20 mtpa for railway transport.

8.1 Initial Cost in Stage 1

8.1.1 Civil Works Cost for Conveyor Belt and Coal Stockyard

Spread foundation and piling for conveyor belt and for coal loading facilities are necessary. As mentioned in Section 3.5.2, piling work is required for approximately 400 m from PIBT towards the north due to the soft soil layer around the seaside area. Other piling work is also estimated at the coal loading facilities. In the other area, spread foundation can be applied. Latest procurement costs of concrete, formwork, and steel work are applied for cost estimation.

The cost of dust suppression net is required in order not to spread the coal dust outside the coal loading terminal.

8.1.2 Mechanical and Electrical Cost for Conveyor Belt and Coal Stockyard

Two main conveyor belt systems with lengths of 1.5 km and 3.0 km shall be installed from PIBT to the coal stockyard. Eight additional small conveyor belts shall be installed within the coal loading terminal as mentioned in Section 4.4.

One stacker-reclaimer, one stacker, one reclaimer, and sprinkler systems shall be installed in the coal stockyard, and surge bin, hoppergate, weight bin, extinguishing facilities, air compressor, and level meter are required for the coal loading system.

Spare parts for conveyor belt, idler, electrical controller, consumables for reclaimer, and stacker consumables are also estimated.

8.1.3 Loading Track Cost for Railway

It is assumed that two new loop loading tracks will be constructed in the initial stage. Total track length will be 5.7 km with eight sets of turnout and one scissors crossing. Construction cost of new track is estimated based on the cost estimate shown in the “Revised PC-1 for Coal Transportation by Rail to Jamshoro Power Plant” and “PC-1 for Dualization and Rehabilitation of Track between Port Qasim and Bin Qasim Stations”.

Walls shall be installed along the boundary of the north, south, and east sides. Building for railway operation control is assumed in the cost of railway loop line. These costs are estimated based on the “PC-1 for the Provision of Coal Conveying System from PIBT to Railway Network at Port Qasim”.

It is assumed that interlocking equipment, point machine, track circuit, color light signal, UPS, battery, power control, maintenance equipment, spares, and installation and commissioning works are included as a signaling system. Telecommunication system shall also be installed. Signal and telecommunication cost is estimated based on similar latest project cost.

8.1.4 Summary of Initial Cost Estimate in Stage 1

The initial cost in Phase 1 is summarized in Table 8-1 below. Land acquisition cost is given by the "PC-1 for the Provision of Coal Conveying System from PIBT to Railway Network at Port Qasim". Physical contingency is assumed to be 5% of the project cost. 25 % of all loading track cost is estimated for PR as overhead.

Table 8-1 Estimated Initial Cost in Stage 1

Confidential

Source: JST

8.2 Operation and Maintenance Costs

The estimated operation and maintenance cost of the conveyor belt system is shown in Table 8-2.

Table 8-2 Estimated Annual Operation and Maintenance Cost for 20 Years

Confidential

Source: JST

Fixed cost and variable cost are explained in Sections 8.2.2 and 8.2.3 below.

8.2.1 Additional Investment in Stage 2

One additional surge bin and conveyor belt from stockyard to additional surge bin will be installed as a third loading system. Related facilities and civil works will be required for construction.

Additional two loop lines and 12 turnouts will be provided in Stage 2 along the new loop line of Stage 1. The additional cost in Stage 2 is summarized in Table 8-3.

Table 8-3 Estimated Additional Investment in Stage 2

Confidential

Source: JST

8.2.2 Fixed Cost for Operation and Maintenance

Salaries and wages are based on the “PC-1 for the Provision of Coal Conveying System from PIBT to Railway Network at Port Qasim”. Monthly electrical charge refers to the K-Electrical tariff. Maintenance cost for infrastructure and mechanical equipment is estimated at 2% of the initial cost for each.

Table 8-4 Estimated Fixed Operation and Maintenance Cost

Confidential

Source: JST

8.2.3 Variable Cost for Operation and Maintenance

Energy consumption of the whole system is 5,180 kW. Estimated total electric power consumption is 37,606,800 kWh annually. Working hours is estimated as 22 hours in a day and 330 days in a year. Unit cost refers to the K-Electrical tariff. Estimated variable operation and maintenance cost is summarized in Table 8-5.

Table 8-5 Estimated Variable Operation and Maintenance Cost

Confidential

Source: JST

8.2.4 Overhaul Cost for Operation and Maintenance

The cost for overhaul is relatively high because it is assumed that conveyor belt will be replaced every ten years and it costs 40% of the total equipment cost. Roller also needs to be replaced every five years and it costs 30% of the initial cost of total equipment cost.

Chapter 9 Implementation Schedule

9.1 Assumptions

The implementation schedule of the construction of connectivity facilities between the coal handling terminal around Port Qasim and Railways in Pakistan is prepared based on the following assumptions:

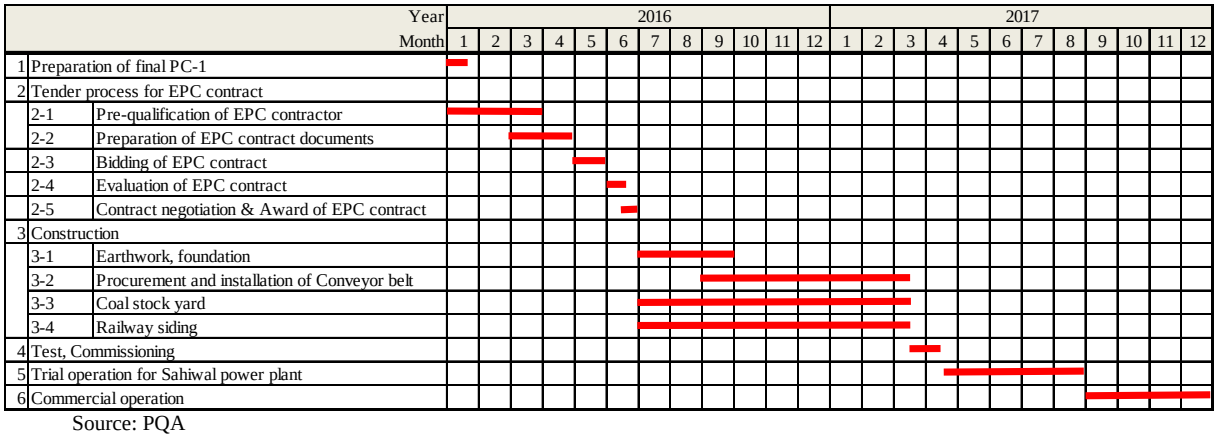
- Construction of PIBT Phase 1 will be completed by December 2016.
- Construction of an additional track between Bin Qasim and Port Qasim will be completed by the end of June 2016 by PR.
- Commercial operation of Sahiwal Coal Fired Thermal Power Plant will be commenced from September 2017.

9.2 Implementation Schedule

PQA, as the Executing Agency, has announced the request for EOI for tender on December 18, 2015 and 11 contractors have submitted EOI on January 18, 2016. PQA is preparing the prequalification documents as of 3rd June 2016.

According to PQA, the construction shall be started from July 1, 2016 and completed by the 17th March 2017 in order to meet the requirements of Sahiwal Power Plant Project. Considering the time for procurement and manufacturing of conveyor belt system, and construction on site, it will be very challenging to achieve the target schedule. The following table indicates the original implementation schedule to meet the PQA's target as of the bigining of March 2016.

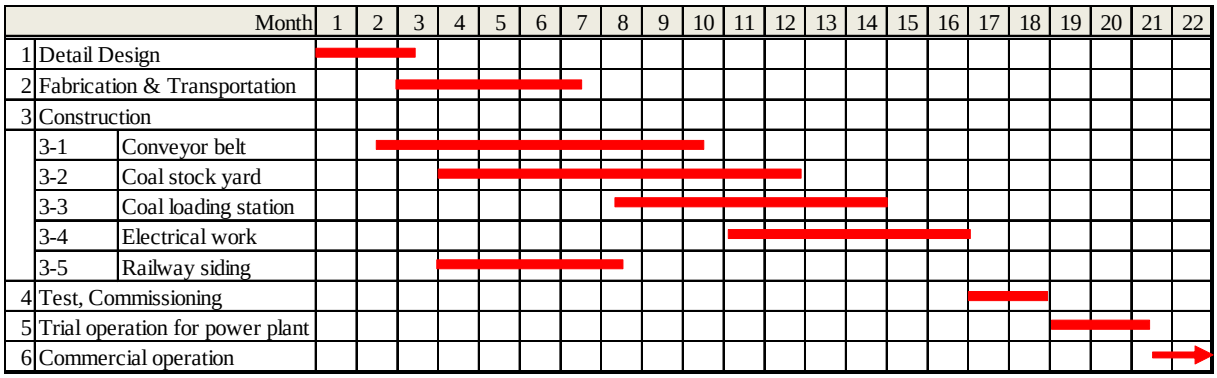
It has already delayed in two months from the original schedule. PQA doesn't have any idea when prequalification is done according to PQA.



Source: PQA

Figure 9-1 Implementation Schedule

Considering the size and contents of the construction, it is recommendable to give 18 months for the construction period as shown in Figure 9-2. In case when the construction is delayed, coal transportation using Marginal Wharf shall be considered as the tentative solution.



Source: JST

Figure 9-2 Recommended Construction Schedule

9.3 Role and Responsibility of Coal Transportation

Coal transportation from PIBT to the railway requires involvement of various organizations and agencies as follows:

9.3.1 PIBT

An Implementation Agreement has been signed between PQA and PIBT on November 6, 2010 to build country's first dedicated dirty bulk cargo handling facility. The terminal was originally expected to be operational within three years. However, the target completion has been modified to the end of 2016.

PIBT is responsible for the unloading of coal from coal ships at the PIBT wharf, transporting of unloaded coal by conveyor belt system, stocking the coal at their stockyard when required, and transporting of coal to PQA's conveyor belt system.

9.3.2 PQA

PQA is responsible for the construction and operation of coal transportation system between PIBT and coal trains, including conveyor belt systems between PIBT and the stockyards at the coal loading terminal, and between stockyards and coal loading bins including weigh bins above the coal loading tracks. Provision and operation of stacker and reclaimer are also under the responsibility of PQA. Coal loading operations on trains are also under PQA's responsibility.

PQA shall be responsible for the mitigation of environmental problems which will be created mainly by coal dust. Conveyor belt system which runs at the center of the industrial zone of PQA from west to east direction shall be covered by FRP roof and side covers. Dust prevention net shall be installed around the coal stockyards. Water sprinkler shall be provided to avoid scattering of coal dust.

PQA shall also be responsible to organize operation and maintenance structure.and workshop including spare parts and maintenance equipment. Skilled staff and workers shall be recruited during the construction. Provision of operation and maintenance manuals and staff training for various facilities shall be included in the requirements of construction contract.

9.3.3 PR

PR is responsible for the construction of double track between Bin Qasim Station and Port Qasim Station and the track within the coal loading terminal. PR shall be responsible for coal train operation from/to and within the coal loading terminal.

Chapter 10 Financial Analysis

10.1 Objectives and Methodology of the Financial Analysis[10]

Financial analysis is conducted to evaluate the profitability of the Project from the viewpoint of the implementing organization. To obtain the financial internal rate of return (FIRR) and the financial net present value (FNPV), the net benefit of the Project is calculated considering 1) the benefits, i.e., incremental revenue of tariff from the Project, and 2) the cost based on the market price.

Financial cost excludes price contingencies, interest during construction (IDC), and other financial charges from the project cost. FIRR and FNPV are calculated based on the cash flow before interest payments and depreciation.

The cash flow of the Project is prepared to calculate FIRR and FNPV. The FIRR is calculated based on the following formula. The FIRR is equal to the cut off rate that results in zero value of FNPV. For the calculation of the FNPV, a predetermined cut off rate is used.

$$\sum_{t=1}^{n} \left\{ (B-C)_t \div (1+r)^t \right\} = 0$$

Where, C=cost, B=Benefit, t=*t*th year (1, 2, 3…n), n=project life, r=internal rate of return

For the calculation of both FIRR and FNPV, two cases, namely, "with project" and "without project", are normally compared to determine the net incremental benefit and cost. The opportunity cost for implementing the Project is not taken into account in this analysis as there is no assumed significant foregone benefit due to the Project.

10.2 Assumptions

This section lists and describes the major assumptions that are used for calculating FIRR and FNPV based on the findings in the study.

10.2.1 Project Life, Salvage Value, and Base Price

The Project is assumed to have a useful economic life of 20 years after the completion of construction.[11] At the end of the economic life, the Project is assumed to have no salvage value. Benefits and costs are expressed in terms of 2016 constant prices in Pakistan Rupees.

10.2.2 Physical Contingency and Price Escalation

Physical contingency is defined as the monetary value of additional resources that may be needed beyond the base cost to complete the Project. It is estimated as a percentage of the base cost (EPC cost plus price escalation). In the analysis, the physical contingency is assumed to be 5% of the base cost.

Price escalation allows for any fluctuation in the foreign exchange and commodity price, after the time of the cost estimate. Price escalations are assumed at 1.8% and 5.9% for

[10] Economic analysis is not conducted in the report, as it is hard to quantify the economic benefit of the Project and MoPS has agreed with this arrangement.

[11] The assumption of project life (20 years) follows that of "*PC1: Provision of Coal Conveying System from PIBT to Railway Network at Port Qasim*" (14th January 2016) prepared by the Ministry of Ports and Shipping and Port Qasim Authority.

foreign cost and local cost portion, respectively.

The cost of price escalation is estimated to be zero in the financial cost due to the uncertainty of price fluctuations in the future and the assumption on the application of 2016 constant prices.

10.2.3 Cut Off Rate

The cut off rate is used for calculating the FNPV and as a deciding factor whether the Project is viable from the viewpoint of the implementing organization.

In principle, the cut off rate adopted in the financial analysis is calculated based on the concept of opportunity cost of capital. The initial cost, which includes the EPC cost, is planned to be financed through a grant from the Government of Pakistan under the Public Sector Development Programme (PSDP).[12] The Project does not take a loan from the government or financial institutions. Although the nominal cost of finance through the grant of the government is zero, the interest rate of the national bond, which is 6.28%,[13] is used as the opportunity cost of capital and for calculating the FNPV.

10.2.4 Operation and Maintenance Cost

The operation and maintenance (O&M) cost of the Project consists of 1) fixed O&M cost, 2) variable O&M cost, and 3) overhead cost.

Table 10-1 O&M Cost

Confidential

Source: JST
Note: Variable O&M cost is at the maximum volume of coal transportation (20.3 million ton) and changes according to the volume of transportation.

Furthermore, the overhaul cost is assumed to be incurred regularly as follows. The overhaul cost is not explicitly included in the cost stream in PC-1.

Table 10-2 Overhaul Cost

Confidential

Source: JST

10.2.5 Tariff

Tariff of coal transportation under the Project is not determined yet at the time of writing this report. The tariff is tentatively decided at the level that makes the FNPV slightly more than zero, which is Rs.253.7/ton.

[12] According to a newspaper article (The Express Tribune, "*Not in sync: Govt clears 19 projects as austerity takes a back seat*", February 12, 2016), the Central Development Working Group (CDWG), which is responsible for clearing the proposed development projects, approved the Project. Following the approval of CDWG, the Executive Committee of the National Economic Council (Ecnec) has approved the Project (Dawn, "*Ecnec approves five projects worth Rs.85.15bn*", March 9, 2016).

[13] Domestic Markets & Monetary Management Department, State Bank of Pakistan, "Result of Auction of Government of Pakistan Market Treasury Bills". The yield of the 12-month treasury bill was 6.2758% on February 4, 2016.

The assumption on the level of tariff in this report is different from that of PC-1, which assumes Rs.335.71/ton. The significant difference in the tariff level reflects the difference in the assumption of the demand on coal transportation between this report and PC-1, which is explained in the following section.[14]

10.2.6 Demand of Coal Transportation

The financial analysis shall be conducted based on the forecast on the demand of coal transportation, as described in Chapter 2.

Table 10-3 Demand of Coal Transportation

Year of Operation	Coal (Million Ton)
Year 1	1.8
Year 2	4.3
Year 3	8.6
Year 4	15.6
Year 5	18.5
Year 6	19.7
Year 7-20	20.3

Source: JST

The assumption on the demand of coal transportation in this report is different from that of PC-1, which assumes that the demand will reach 4 million ton in Year 1-3, 6 million ton in Year 4-10, and 8 million ton in Year 11-20.

10.2.7 Difference in the Assumptions between the Study and PC-1

Major differences in the assumptions between this study and PC-1 are shown in Table 10-4 below. There is a significant difference in the level of tariff, reflecting the difference in the forecast on the maximum volume of coal transportation.

Table 10-4 Major Difference in the Assumptions

Confidential

Source: JST
Note: The annual O&M cost is at the time of maximum volume of coal transportation, 20.3 million ton for the Study and 8 million ton for PC-1.
Note: Overhaul cost of belt conveyor is scheduled to be spent every ten years, while that of roller every five years.
Note: Project cost includes the cost of Stage 1 only.

10.3 Financial Analysis

10.3.1 Financial Cost

The financial cost is derived from the project cost, which is indicated in the estimation of project costs. Financial cost consists of 1) initial investment cost and 2) O&M cost.

[14] Tariff for the coal transportation of 1-20 million ton/year is tentatively calculated to check the impact on the tariff level of the volume of coal transportation. See Table 10-14 for more detail.

Project cost includes engineering, procurement and construction cost, tax, land acquisition, and physical and price contingencies. On the other hand, financial cost is used to estimate the performance of the Project from the viewpoint of the implementing organization, and excludes price escalation as explained in 10.2.2.

Table 10-5 Financial Cost of the Project upon Completion of Construction (Unit: Rs. in millions)

Confidential

Source: JST
Note: See Table 10-9 for more details of the financial cost.

In addition, there is an additional investment (Rs.1,020 million) in the third year of operation.[15]

10.3.2 Financial Benefit

Financial benefit is identified and quantified in this section. The benefit is derived from the incremental revenue from the coal transportation system, which will be achieved through the implementation of the Project.

The financial performance of the Project is evaluated from the viewpoint of the implementing organization (i.e., Port Qasim Authority and the company that operates the coal transportation system under the outsourcing contract).

The benefit is calculated until the end of the project life (20 years). For financial analysis, the benefit of incremental revenue can be calculated in a particular year, by multiplying the volume of coal transported with the tariff.

Revenue = Volume of coal transportation (ton) x Tariff (Rs./ton)

Table 10-6 Forecast of Revenue

Year of Operation	Coal Transported (million ton)	Tariff (Rs./ton)	Revenue (million Rs.)
Year 1	1.8	253.7	453
Year 2	4.3	253.7	1,078
Year 3	8.6	253.7	2,170
Year 4	15.6	253.7	3,944
Year 5	18.5	253.7	4,683
Year 6	19.7	253.7	4,988
Year 7-20	20.3	253.7	5,140

Source: JST

As it is assumed that there will be no forgone benefit from agricultural or other products that used to be produced in the land where the coal transportation facility will be located, which results in no opportunity cost, the gross revenue is equal to what is calculated based on the above formula.

[15] See 8.2.1 for more detail of additional investment cost.

10.3.3 Financial Internal Rate of Return and Net Present Value

The FIRR and FNPV are calculated and presented in this section based on the assumptions, costs, and benefits described so far.

Benefits and costs are compiled and calculated considering the 2016 prices in order to obtain the FIRR. Moreover, the cut off rate (i.e., 6.28%) is used as the discount rate for calculating the FNPV.

Table 10-7 FIRR and FNPV

	FIRR	FNPV (Rs. in million)	FNPV (US$ in million)
Earning before tax basis	6.29%	22	0.2
Earning after tax basis	2.54%	(4,630)	(44)

Source: JST

Note: See Table 10-10 for more details of calculation of FIRR and FNPV.

Note: Earning after tax is calculated based on the forecast of the financial statement of the Project. See Table 10-11, 10-12, and 10-13 for more detail.

As the tariff is determined based on the forecast of the demand for coal transportation to make the FNPV slightly positive, the FNPV results in a small positive value in the case of earning before tax basis.

On the other hand, the FNPV becomes negative in the case of earning after tax basis. This is due to the fact that the tariff is decided at the level that makes the FNPV on the earning before tax basis slightly larger than zero. However, the implementation of the Project can be justified if the corporate tax is treated as the return on equity (i.e., the government revenue).

Sensitivity analysis is conducted for the financial analysis as the actual condition may be different from those assumed for the base case. In the sensitivity analysis, the following changes in the assumptions are considered: 1) tariff decreases (-10%), 2) initial investment cost increases (+20%), and 3) demand decreases (-10%).

Table 10-8 Sensitivity Analysis for FIRR and FNPV (Earning before tax basis)

Case	Benefit	Cost	FIRR (%)	FNPV (Rs. in million)	FNPV (US$ in million)
Base case	No change	No change	6.29%	22	0.2
Tariff decreases (-10%)	-10%	No change	3.45%	(4,286)	(41)
Initial investment cost increases (+20%)	No change	+20%	4.60%	(3,087)	(29)
Demand decreases (-10%)	No change	No change	3.45%	(4,286)	(41)

Source: JST

As shown in the above table, the change in the assumptions (tariff decreases, cost increases, and demand decreases) turns the FNPV into negative value.

Change in the assumptions significantly influences the net present value. Therefore, several countermeasures should be taken to avoid or reduce such negative impacts on the financial performance of the Project. For example, an automatic mechanism can be introduced in the tariff system in order to adjust the level of the tariff to quickly reflect changes in the level of variable cost (e.g., electricity cost). In addition, the revenue is significantly influenced by the actual volume of coal transportation. Therefore, there should be a room for negotiation with the operator of the power plant, which utilizes the Project, for the adjustment of the tariff if the actual volume of coal transportation is significantly different from the forecast.

Table 10-9 Project Cost & Financial Cost

Confidential

Source: JST

Table 10-10 FIRR and FNPV

Confidential

Before tax basis		After tax basis	
FIRR=	6.29%	FIRR=	2.54%
FNPV=	22 Mill Rs.	FNPV=	(4,630) Mill Rs.

Source: JST
Note: Corporate tax (35%) is applied to calculate the net profit after tax basis. See Table 10-11 for more detail of the process of calculating coporate tax.

Table 10-11 Profit and Loss Statement

Confidential

Source: JST

Table 10-12 Balance Sheet

2. Balancesheet	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Cash & equivalent	0	183	605	1,456	4,300	7,993	2,233	6,232	10,473	13,934	17,346	8,167	12,546	16,593	20,447	24,217	18,341	22,834	27,075	31,194	35,281
Receivables	0	38	90	181	329	390	416	428	428	428	428	428	428	428	428	428	428	428	428	428	428
Other current assets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fixed asset (building)	1,274	1,092	936	802	687	589	505	433	371	318	272	233	200	171	147	126	108	92	79	68	58
Fixed asset (equipment)	13,009	8,664	5,770	4,771	3,177	2,116	10,881	7,247	4,826	3,214	2,141	13,812	9,199	6,126	4,080	2,717	11,282	7,514	5,004	3,333	2,220
Fixed asset (land)	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Other fixed asset	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total asset	**16,783**	**12,182**	**9,694**	**9,076**	**10,557**	**13,286**	**15,898**	**16,405**	**18,300**	**20,187**	**22,541**	**24,480**	**24,426**	**25,514**	**27,393**	**29,842**	**32,130**	**33,010**	**34,841**	**37,354**	**40,368**
Payables	0	80	93	114	150	164	170	173	173	173	173	173	173	173	173	173	173	173	173	173	173
Other current liability	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan	0	200	180	160	140	120	100	80	60	40	20	0	0	0	0	0	0	0	0	0	0
Other fixed liability	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital	16,783	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358	16,358
Accumulated profit	0	(4,576)	(6,936)	(7,555)	(6,089)	(3,355)	(729)	(204)	1,710	3,617	5,992	7,951	7,896	8,984	10,863	13,312	15,600	16,480	18,311	20,824	23,838
Liabilities & shareholder's equity	**16,783**	**12,182**	**9,694**	**9,076**	**10,557**	**13,286**	**15,898**	**16,405**	**18,300**	**20,187**	**22,541**	**24,480**	**24,426**	**25,514**	**27,393**	**29,842**	**32,130**	**33,010**	**34,841**	**37,354**	**40,368**

Source: JST

Table 10-13 Cash Flow Statement

3. Cash flow statement	Year 1 2016	Year 2 2017	Year 3 2018	Year 4 2019	Year 5 2020	Year 6 2021	Year 7 2022	Year 8 2023	Year 9 2024	Year 10 2025	Year 11 2026	Year 12 2027	Year 13 2028	Year 14 2029	Year 15 2030	Year 16 2031	Year 17 2032	Year 18 2033	Year 19 2034	Year 20 2035	Year 21 2036
Balance at beginning of year	0	0	183	605	1,456	4,300	7,993	2,233	6,232	10,473	13,934	17,346	8,167	12,546	16,593	20,447	24,217	18,341	22,834	27,075	31,194
A) Operational cash flow																					
Net profit	0	(4,576)	(2,481)	(619)	1,466	2,735	2,626	525	1,915	1,907	2,374	1,959	(54)	1,088	1,879	2,450	2,287	880	1,832	2,512	3,015
Change in working capital	0	42	(40)	(70)	(112)	(47)	(19)	(10)	0	0	0	0	0	0	0	0	0	0	0	0	0
Depreciation	0	4,527	3,050	2,061	1,708	1,160	791	3,707	2,482	1,665	1,119	754	4,647	3,101	2,071	1,384	926	3,784	2,523	1,683	1,123
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B) Investment cash flow																					
Fixed asset (building)	(1,274)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fixed asset (equipment)	(13,009)	0	0	(928)	0	0	(9,472)	0	0	0	0	(12,386)	0	0	0	0	(9,472)	0	0	0	0
Fixed asset (land)	(2,500)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C) Financial cash flow																					
Capital	16,783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loan	0	200	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	(20)	0	0	0	0	0	0	0	0	0
Balance at end of year	0	183	605	1,456	4,300	7,993	2,233	6,232	10,473	13,934	17,346	8,167	12,546	16,593	20,447	24,217	18,341	22,834	27,075	31,194	35,281

Source: JST

Table 10-14 Tariff Level Based on the Volume of Coal Transportation

Coal demand (Mil ton/year)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Tariff (Rs./ton)	3,541.0	1,785.7	1,200.5	908.0	732.5	615.4	531.8	469.1	420.4	381.4	349.5	322.9	300.4	281.1	264.4	249.8	236.9	225.4	215.1	205.9

Source: JST

Note: It is assumed that the volume of coal transportation will be constant from the first year of operation until the end of the operation. Therefore, the tariff level of 20 mil. ton in the above table is different from that in the case of IRR calculation (20 mil. ton/year) due to the different assumption of the volume of coal transportation.

Note: Tariff is calculated to make the financial net present value nearly zero.

Chapter 11 Conclusion and Recommendations

11.1 General

- Although the area is not finalized, the JICA Study Team (JST) considers that the land within the Pakistan Steel Mill (PSM) premises can be utilized for the construction of the coal loading terminal. JST has prepared a basic plan of the coal conveyance system and coal loading terminal in the 150 acre area as informed by PSM.

11.2 Coal Fired Thermal Power Plant Projects and Demand Forecast of Imported Coal

- According to JST's demand forecast, the Pakistan International Bulk Terminal (PIBT) shall have coal handling capacity of 28 million tons per annum (mtpa) in the future. JST confirmed that the maximum bulk handling capacity (28 mtpa) will be achievable if two units of unloader are added at the PIBT's berth. When more than 28 mtpa capacity is required, additional berth with unloader shall be constructed next to the existing berth.

- According to JST's demand forecast, 20.26 million tons of coal shall be transported by the planned conveyor belt system to the new coal loading station. This volume can be transported by a conveyor belt system having a capacity of 2,700 t/hr. However, the National Engineering Services of Pakistan (NESPAK) has planned a conveyor belt system with a capacity of 3,600 t/hr considering direct connection of conveyor belt system from PIBT. If such operation is required, the capacity of the conveyor shall be same as that of PIBT. Thus, JST has also planned to use a system having 3,600 t/hr.

11.3 Coal Transportation Plan

- There are three potential coal unloading terminals in Port Qasim Authority (PQA), namely: PIBT, Marginal Wharf, and Iron Ore and Coal Berth (IOCB). PIBT is planned to have a capacity of 20 mtpa in the future. The marginal wharf is planned to have a capacity of 4 mtpa. IOCB had been used to handle 3 mtpa for PSM. However, due to ongoing privatization process, coal handling facility at IOCB cannot be counted upon at present.

- Potential coal handling capacity of PIBT and marginal wharf were examined by JST. According to the analysis, PIBT's capacity can be expanded up to 28 mtpa if two unloaders are added at PIBT berth and the capacity of navigation channel is expanded. Planned capacity of 4 mtpa at the marginal wharf was confirmed by the analysis of JST.

- There are various combinations of coal transportation routes from (Coal Unloading Terminal) – (Transportation Method) – (Coal Loading Railway Station). Among these, the combination of (PIBT)-(Conveyor Belt)-(New Station) was evaluated as the best option.

- Geological and topographical conditions of the selected route and coal loading terminal are generally good. Pile foundation will be required at the seaside area only. Spread foundation can be adopted at the hillside area. No consolidation settlement may occur at the planned coal stockyard area.

11.4 Coal Handling Plan

- Outline of JST's coal handling plan is similar to that of NESPAK's recommendation. However, track layout, train operation route, and number of coal loading facilities are totally different. NESPAK's track layout will be applicable for the coal transportation to Sahiwal Power Plant. However, modification of the layout will be required when more coal trains need to be operated. Required number of coal loading facilities shall be examined carefully, considering redundancy of the system and train operation schedule.

- JST recommended installing two sets of coal loading system for Phase 1 with 10 mtpa of coal, and additional one set (three sets in total) for Phase 2 to handle 20 mtpa.

11.5 Coal Transportation by Railway

- In order to transport 20.26 million tons of coal per year by train, 31 coal trains shall be dispatched from the coal loading station. When additional track between Bin Qasim and the new coal loading station is constructed, the line capacity of the section will be 102 trains. Therefore, there are enough rooms for container and other freight trains.

- JST estimated the cycle time of 121 min. for coal loading operation starting from the coal train departing from Bin Qasim Station, then moving to the coal loading station, and finally moving to Pakistan Railway (PR) main line at Bin Qasim Station after coal loading operation. Thus, at least three sets of coal loading facilities will be required in Phase 2 to dispatch 31 coal trains in a day.

11.6 Railway Signal and Telecommunication

- Since the section between Bin Qasim Station and Port Qasim Station is a single track and the number of trains running at this section is very small at present, no signaling equipment is installed at this line. Line clear paper ticket is given to the driver who enters into the section.

- In order to accommodate the increase of coal trains when new station is constructed between Bin Qasim Station and Port Qasim Station, PR is constructing additional track at this section. In addition to the double track, there will be multiple coal loading tracks within the coal loading terminal. For efficient train operation, computer-based interlocking system, including electric point machines, track circuit equipment, and color light signals shall be installed.

11.7 Environmental and Social Considerations

- The environmental regulation in Pakistan classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule-I listed projects that may not have significant environmental impacts and therefore they require an initial environmental examination (IEE). Schedule-II listed projects with potentially significant environmental impacts that require the preparation of an environmental impact assessment (EIA).

- The proposed "Connectivity Facilities between Coal Handling Terminal around Port Qasim and Railways in Pakistan" Project is included in Schedule-II which is related to railway transportation. It requires proponents to prepare terms of reference for the environmental assessment reports.

- In accordance with the EIA survey results, various impacts during pre-construction, construction, and operation stages are summarized in Appendix 6: EIA Report.

11.8 Project Cost Estimates

- Project cost was estimated in two parts; the first part is the initial cost in Phase 1, and the second part covers the operation and maintenance (O&M) cost and additional investment in Phase 2.

- Initial cost in Phase 1 is estimated at Rs.16,358 million composed of 1) civil work, 2) mechanical and electrical work, 3) installation of mechanical and electrical equipment, 4) track work including signal and telecommunication work, and control office building, and 5) others, including price escalation, physical contingency, tax and administration cost.

- Annual O&M cost is estimated at Rs.1,030 million when no overhaul is carried out. When overhaul is carried out, the annual O&M cost will be Rs.11,000 million approximately.

- Additional investment in Phase 2 is estimated at Rs.983 million composed of 1) civil work, 2) mechanical and electrical work, 3) installation of mechanical and electrical equipment, 4) track work, and 5) others, including price escalation, physical contingency, tax and administration cost.

11.9 Implementation Schedule

- Implementation schedule of the construction of connectivity facilities between PIBT and the new railway station including coal loading facility was prepared based on the following assumptions:

  - ✓ Construction of PIBT Phase 1 will be completed by December 2016.

  - ✓ Construction of double track between Bin Qasim and Port Qasim will be completed by the end of June 2016 by PR.

  - ✓ Commercial operation of Sahiwal Coal Fired Power Plant will commence from September 2017.

- It seems very challenging to achieve a construction schedule of 12 months from July 1, 2016. However, this construction schedule is decided by the Government of Pakistan and thus JST has also followed the same schedule.

11.10 Financial Analysis

- Based on the project cost estimate (Rs.16,783 ,million), the financial internal rate of return (FIRR) and financial net present value (FNPV) are calculated. As the project is assumed to be financed through a grant from the Government of Pakistan, the rate of the Treasury bill (6.28%) is regarded as the opportunity cost of capital and used as the discount rate to calculate the NPV in the financial analysis. Project life is assumed to be 20 years, which is the same assumption as in NESPAK's study. The conveyor belt system can be utilized for more than 20 years if properly maintained.
  - FIRR: 6.29%
  - FNPV: Rs.22 million