Environmental Impact Assessment (Final)

Project Number: 51274-001
October 2017

THA: Bangkok Mass Rapid Transit (Yellow Line) (Part 3 of 6)

Prepared by The Mass Rapid Transit Authority of Thailand.

3.7 The Forcasting of Ridership

3.7.1 Methodology

The forcasting of ridership for the Yellow Line Project can be done by taking the following four steps:

1) Reviewing the previous studies focusing on the forcasting of passengers by applying Strategic Model ,

2) Studying some exogenous data including economic circumstances, society, land use, and popution in areas in order to improve the commuters' data and anticipate the potential passenger volume,

3) Improving ridership forcasting methods for the Yellow Line Project that connects Latprao – Samrong based on he previous studies,

4) Summarising the studies about the Yellow Line ridership in order to get adequate information for the future implementation.

3.7.2 Assumptions of Ridership

Fundamental information

- Rail transit system's master plan for Bangkok and its perimeter as shown in **Figure 3.7-1**

forcasting

The anticipatin can be done every ten year: 2019, 2029, 2039 and 2049.The total duration of forcasting is 30 years.There are four cases of analysis

- First, the fare is calculated by the distance, no interchange charge for the Skytrain unter MRTA
- Second, the fare is 20 baht for the whole trip, no interchange charge for all Skytrain,
- Third, the fare is 20 baht for the whole trip, no interchange charge for all except the Blue Line Skytrain and the link to Suvarnabhumi airport,
- Fourth, 4 the fare is 20 baht with interchange charges for all route.

The details of fare assumption are as follows:

Distance-based system fare is calculated by the fare 13 + 2X which means the initial fare is 13 baht and the rider is charged 2 more baht/km (First station fare is 15 baht) increasing to the rate of 2.5% by MRT Assessment Standardisation

Twenty baht fare means the fare is 20 baht (the fare is 15 บาท for the first station) which will be increased 5 baht every four year

The results of forcasting

The data of ridership for Yellow Line Sky Train: Latphrao – Samrong is as follows:

- The passenger volume during rush hours (people – trip/hour)
- The highest number of passengers (people – trip/hour)
- The passenger volume Transfer (people – trip/hour)

Table 3.7 - 1 Mass Rapid Transit Master Plan in Bangkok Metropolitan Region

MRT Project	Operation year	Responsible Agencies
1. The Dark Red Line Mass Transit System Project (Thammasat University's Rangsit campus - Maha Chai)	After 2019	SRT
2. The Light Red Line Mass Transit System Project (Salaya - Hua Mak)	After 2019	SRT
3. The Airport Rail Link (ARL) Project (Don Mueang Airport - Suvarnabhumi Airport)		SRT
– Suvarnabhumi Airport – Phaya Thai section	Operation	
– Phaya Thai – Don Mueang Airport section	After 2019	
4. The Dark Green Line Project (Lam Lukka – Samut Prakan – Bang Poo)		
– Mo Chit – Saphan Mai – Khu Khot section	2018	MRTA
– Khu Khot – Lam Lukka section	After 2019	
– Bearing – Samut Prakan section	2018	
– Samut Prakan – Bang Poo section	After 2019	
5. The Light Green Line Project (Yod Se – Bang Wa)	Operation	BMA
6. The MRT Blue Line Project (Bang Sue – Hua Lamphong – Tha Phra - Phutthamonthon Sai 4)		MRTA
– Bang Sue – Hua Lamphong section (The MRT Chaloem Ratchamongkhon Line)	Operation	
– Hua Lamphong – Bang Khae section	2017	
– Bang Khae – Phutthamonthon Sai 4 section	After 2019	
– Bang Sue – Tha Phra section.	2017	
7. The MRT Purple Line Project (Bang Yai – Bang Sue)		MRTA
– Bang Yai – Bang Sue section	2019	
– Bang Sue – Rat Burana section	2019	
8. The Orange Line Project (Taling Chan – Min Buri)	2019	MRTA
9. The Pink Line Project (Khae Rai – Min Buri)	2017	MRTA
10. The Yellow Line Project (Lat Phrao – Samrong)	2019	MRTA

Remark : 1. The MRT Purple Line Project (Bang Yai – Bang Sue) will be operated in end of 2015.
2. The Orange Line Project (Taling Chan – Min Buri) will be full operated in beginning of 2019 but Thailand Cultural Center – Min Buri section will be operated in end of 2018.

3.7.3 The Appropriateness of the Stretegic Model

To anticipate the ridership, eBUM, a Strategic Model, is appropriate for Sketch Planning or Strategic Planning because it can compare commuting condition and transportation in the study areas for “there is ”or “there isn’t ” effect for project that might have effect on commuting condition , transportation, and the area .The results should be mainly used for comparison among projects.

However, if the model is improved for more detailed information in any specific project, it can be implemented. For Yellow Line Sky Train: Latphrao – Samrong , the model is adjusted in the following :

1) Trip Ends calculation for the areas under the Yellow Line’s service because the information about population and employment was changed.

2) The Line is called Yellow Line Sky Train instead of being called dark or light Yellow Line. The commuting time is shorter because there aren’t any interchanges. The whole Skytrain system is adjusted according to the previous Prime Minister Yingluck Chinnawatra’s plan for 10 Skytrain lines development, Yellow Line Sky Train is the last line so the network is quite perfect.

3) Trip Distribution Model is applied for the calculation of commuting in new areas.The model calculates many new data in the new public transportation and numbers of Trip Ends.The results of "Time tables in the sub areas" are calculated for new modes of travelling. The results show that there is an increase in modes of transportation since commuting duration is shorter.

4) Having conducted Public Transport Assignment which study the demand for all modes of public transportation or running timetables, the team can categorise two types of passengers:

- Passengers commuting between stations or Line Loading in a round- trip travelling
- Passengers Boarding and Alighting at each station in a round- trip travelling

However, the study for some more groups of passengers such as those who are transiting at the Interchange needs to be done to get informatin on numbers of trips between the Lines. The Link between the Lines that have direct link can be set as One - Way Link that connects both directions. Public Transport Assignment is shown in **Table 3.7 - 2 and Table 3.7 - 9**

Table 3.7 - 2 3.7 - 2 and Table 3.7 - 2 3.7 - 3 show the ridership forcasting at station for the Yellow Line Project in 2019 and 2049 in Distance-Base Fare system.It is anticipated that in 2019 there will be 250, 000 passengers/day and in 2049 there will be 530, 000 passengers/day .

Table ที่ 3.7 - 4 and Table 3.7 - 5 show the anticipation of ridership in 20 baht fare system. It is anticipated that in 2019 there will be300, 000 passengers/day and in 2049 there will be an increase in population in the areas due to the migration to Bangkok.

Table 3.7 - 6 and Table 3.7 - 7 show the anticipation of ridership in 20 baht fare system without interchange charges except the Blue Line Skytrain and the link to Suvarnabhumi . It is anticipated that in 2019 and there will be 270, 000 passengers/day 2049 there will be 560, 000 passengers/day.

Table 3.7 - 8 and Table 3.7 - 9 show the anticipation of ridership in 20 baht with interchange charges for all route fare system . It is anticipated that in 2019 there will be 260, 000 passengers/day and there will be 540, 000 passengers/day.

At interchange station: Ratchada, Bang Kapi, Lam Sali and Sri Iam, there will be the highest nembers of passengers.The second most passengers will be at stations that link to shopping malls such as Chokchai 4 and Suan Luang Ro 9 station.

Table 3.7 - 2 The passenger demand forecast at 23 stations in 2019 in case of Distance-Base Fare and Free All MRTA Transfer

[illegible] ปี พ.ศ. 2562

กรณีที่ 1 : คิดค่าโดยอัตราตามระยะทาง ไม่มีค่าปรับแก้ไขการ เวลาระบบรถไฟฟ้าที่อยู่ในความรับผิดชอบของ รฟม

		Daily Trips (เที่ยวคน/วัน)						Peak Hour (เที่ยวคน/ชม.)						Total		Station		Transfer	
		ขาออก - ขาเข้า			ขาเข้า - ขาออก			ขาออก - ขาเข้า			ขาเข้า - ขาออก								
Item	Name	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	[illegible]	39,603	0	39,603	0	45,781	0	4,439	0	4,439	0	5,144	0	85,384	45,781	46,021	5,368	39,379	41,413
2	[illegible]	1,111	2,700	38,012	3,181	1,159	45,781	182	876	4,225	535	216	5,144	4,292	3,859	1,110	3,809		
3	[illegible]	4,413	14,355	27,767	18,291	4,289	43,756	1,635	1,179	4,361	5,623	805	8,664	22,703	18,925	21,702	19,925		
4	[illegible] 71	958	431	27,677	718	521	31,731	183	151	4,718	157	111	5,438	1,256	951	1,256	951		
5	[illegible] 63	1,059	3,805	25,569	5,311	1,150	31,537	624	405	4,662	1,005	178	5,362	7,010	5,165	7,010	5,165		
6	[illegible]	3,493	4,130	24,569	4,376	3,978	31,935	787	921	5,075	830	986	4,906	7,869	7,058	7,869	7,058		
7	[illegible] 101	3,305	4,365	23,815	5,326	5,230	31,931	757	872	5,158	616	905	4,857	8,629	7,570	8,629	7,570		
8	[illegible]	8,183	5,130	24,949	5,506	6,287	31,930	1,299	872	5,766	640	704	4,125	11,732	10,417	11,732	10,417		
9	[illegible]	20,253	8,240	37,744	8,240	21,716	37,744	6,897	2,814	8,847	1,968	5,877	8,847	34,545	30,146	6,257	6,256	28,289	24,291
10	[illegible]	1,863	2,792	21,819	2,586	1,627	37,892	627	326	9,110	651	196	8,270	1,451	4,650	1,451	4,650		
11	[illegible]	15,947	14,906	22,860	12,781	17,518	37,306	1,949	3,790	7,298	1,680	3,984	7,815	28,727	32,424	22,305	23,072	6,424	9,417
12	[illegible]	707	2,805	20,057	3,418	533	41,814	382	964	6,617	637	196	8,018	3,175	3,548	3,175	3,548		
13	[illegible]	1,215	1,891	20,029	1,367	858	39,891	268	388	6,758	417	247	8,510	2,569	2,616	2,569	2,616		
14	[illegible] 38	1,702	2,886	20,929	4,291	1,139	39,464	510	0	6,986	1,085	0	8,440	5,394	3,667	5,394	3,667		
15	[illegible] 39	2,943	6,543	20,404	5,748	2,656	39,356	747	874	6,859	1,454	551	7,975	8,760	9,097	8,760	9,097		
16	[illegible]	218	1,911	20,208	836	227	37,972	69	269	6,759	310	79	8,172	1,148	1,678	1,148	1,678		
17	[illegible]	1,965	12,386	24,069	12,337	1,451	37,986	419	1,526	5,379	1,628	314	8,992	14,302	13,836	14,302	13,836		
18	[illegible]	365	1,441	24,158	2,416	434	39,478	301	148	5,526	804	174	8,430	3,856	1,974	3,856	1,974		
19	[illegible]	1,582	3,979	21,819	2,597	2,087	39,557	719	492	5,749	486	993	8,305	1,206	6,573	1,230	6,573		
20	[illegible]	1,267	3,415	19,105	3,356	517	40,347	489	165	5,775	472	21	8,961	5,165	3,756	5,193	3,756		
21	[illegible]	7,923	4,756	21,975	4,773	7,233	39,408	2,597	547	7,815	1,159	586	8,454	12,296	11,961	12,296	11,961		
22	[illegible]	82	366	21,777	366	0	39,997	93	0	7,815	637	75	8,493	261	366	261	366		
23	[illegible]	0	21,772	0	18,586	0	18,586	0	7,815	0	2,629	0	2,629	18,586	21,772	5,638	9,168	12,680	15,311
		124,499	124,499		123,465	123,465		24,742	24,742		24,072	24,072		247,674	247,674	165,022		82,652	

ที่มา : [illegible] โดยบริษัท เอ็ยาย เอ็นจีเนียริ่ง คอนซัลแตนซี่ จำกัด, 25[illegible]

Table 3.7 - 3 The passenger demand forecast at 23 stations in 2049 in case of Distance-Base Fare and Free All MRTA Transfer

การคาดการณ์ปริมาณผู้โดยสาร ปี พ.ศ. 2592

กรณีที่ 1 : อัตค่าโดยสารตามระยะทางไม่มีค่าเปลี่ยนสีทาง เฉพาะระบบรถไฟฟ้าที่อยู่ในความรับผิดชอบของ รฟม. กรณีที่ 1 : อัตค่าโดยสารตามระยะทาง (สำโรง-ร้องกา)

		Daily Trips (คน-เที่ยว/วัน)						Peak Hour (คน-เที่ยว/ชม.)						Total		Station		Transfer	
		ร้องกา - สำโรง			สำโรง - ร้องกา			ร้องกา - สำโรง			สำโรง - ร้องกา								
Item	Name	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	ร้องกา	30,542	0	30,542	0	53,825	0	3,357	0	3,357	0	5,916	0	30,882	53,825	3,483	5,916	27,399	47,909
2	สายลวด	2,142	4,425	28,259	5,008	2,395	59,825	271	797	3,834	355	388	15,695	7,151	6,820	7,151	6,820		
3	โรงพิมพ์ 4	5,160	24,284	47,265	21,687	5,165	59,911	2,363	7,994	8,654	6,393	1,679	19,196	41,044	36,309	41,044	36,309		
4	ถนนรัชดา 7	1,197	957	28,207	1,087	1,355	33,736	281	252	6,721	323	119	8,795	2,791	2,313	2,791	2,313		
5	ถนนรัชดา 10	3,827	2,236	30,798	4,881	3,192	33,250	494	1,040	6,175	1,110	364	9,579	10,486	11,370	10,486	11,370		
6	บางโขง	7,155	7,512	30,441	8,003	8,428	58,894	1,196	1,020	8,543	1,215	1,419	8,977	15,158	15,940	15,158	15,940		
7	ถนนรัชดา 101	6,819	7,931	29,329	7,816	5,365	61,117	1,193	1,019	8,516	1,307	1,232	8,981	14,635	13,297	14,635	13,297		
8	แยกลาดปี	14,248	10,410	33,392	10,647	11,817	53,947	2,362	1,024	9,570	1,156	1,819	8,570	25,094	22,292	25,094	22,292		
9	ลำสาลี	33,705	17,443	102,354	17,369	54,379	54,936	12,584	4,521	17,893	4,928	14,697	9,241	51,073	71,913	13,860	19,634	67,614	68,209
10	ศรีนครินทร์	4,518	5,980	101,892	3,027	1,703	51,638	801	973	17,051	1,149	614	20,112	9,496	8,587	9,496	8,587		
11	ศรีนครินทร์ 38	35,634	34,016	103,763	29,039	58,128	51,616	5,163	7,480	19,870	5,911	7,636	19,647	50,216	73,249	51,053	36,514	3,410	2,324
12	หัวหมาก	5,667	6,432	97,387	4,950	2,160	100,465	406	1,005	14,471	1,373	444	21,435	6,617	6,586	6,617	6,586		
13	หัวหมาก	5,508	7,907	95,593	5,455	1,335	97,607	417	814	14,574	1,363	821	20,779	6,587	6,192	6,587	6,192		
14	ศรีนครินทร์ 46	8,618	5,836	94,212	7,934	2,240	93,902	668	-	19,944	2,435	82	28,679	16,552	8,076	16,552	8,076		
15	ถนนรัชดา 53	6,180	14,459	85,932	14,168	5,928	90,283	1,178	1,886	14,537	2,205	886	18,726	20,348	20,387	20,348	20,387		
16	หัวหมาก	535	7,551	83,916	8,670	358	97,607	166	753	14,429	378	158	17,557	9,205	9,743	9,061	9,743		
17	ศรีวิชัย	6,298	26,240	36,305	31,041	2,353	99,711	4,453	2,729	19,157	4,200	780	19,210	35,239	31,124	35,239	31,124		
18	ลาดพร้าว	806	3,136	57,575	2,527	764	52,254	301	285	15,228	317	155	10,890	3,333	3,900	3,333	3,900		
19	ศรีนครินทร์	4,678	10,039	52,743	7,480	7,365	50,430	1,394	1,087	16,671	1,147	997	10,418	12,133	17,394	12,133	17,394		
20	ศรีวาริน	3,287	6,799	48,756	10,500	1,359	50,115	2,253	1,230	17,692	2,272	310	10,235	13,787	10,128	13,787	10,128		
21	ลำสาลี	15,151	9,272	60,343	9,386	12,763	70,975	1,757	963	21,559	1,371	819	8,053	22,650	22,363	22,650	22,363		
22	พัฒนา	309	306	76,745	543	3	44,376	98	0	28,617	217	157	7,108	740	306	741	306		
23	สำโรง	0	50,745	0	44,632	0	44,632	0	24,977	0	7,103	0	7,103	44,632	50,745	29,681	14,959	29,751	35,492
		268,688	268,688		283,884	283,884		53,378	53,378		50,614	50,614		532,572	532,572	358,478		173,094	

ที่มา : ผลประมวลผลการ วิเคราะห์ ระดับ เส้นทางวิ่ง ของบริษัทที่ปรึกษา, 2557

Table 3.7 - 4 The passenger demand forecast at 23 stations in 2019 in case of Flat Fare

การคาดการณ์ปริมาณผู้โดยสาร ปี พ.ศ. 2562

กรณีที่ 2 : กำหนดอัตราค่าโดยสาร 20 บาทตลอดสายทาง

		Daily Trips (เที่ยวคน/วัน)						Peak Hour (เที่ยวคน/ชั่วโมง)						Total		Station		Transfer	
		ขึ้นลา - ล่าโรง			ล่าโรง - ขึ้นลา			ขึ้นลา - ล่าโรง			ล่าโรง - ขึ้นลา								
Item	Station	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	[illegible]	48,703	0	48,703	0	54,589	0	7,332	0	8,332	0	0	0	48,703	54,589	4,589	4,334	44,021	50,189
2	[illegible]	1,245	3,046	46,902	3,460	1,335	54,645	259	456	8,102	623	10,730	0	4,707	4,317	4,707	4,317		
3	[illegible]	9,361	14,861	38,381	19,673	6,927	32,291	2,758	1,173	9,328	3,759	285	10,106	23,266	21,308	23,266	21,308		
4	[illegible] 71	569	939	38,221	863	699	32,315	257	180	9,376	219	1,016	9,315	1,562	1,255	1,562	1,256		
5	[illegible] 85	1,913	3,930	36,536	5,311	1,775	41,936	499	276	9,398	1,493	91	7,715	7,222	5,705	7,222	5,226		
6	[illegible]	3,902	6,455	34,382	5,287	3,677	38,246	1,063	937	9,705	1,281	232	8,701	9,189	10,132	9,189	10,132		
7	[illegible] 101	4,139	5,090	33,190	4,969	5,970	36,988	984	741	9,948	1,063	828	8,976	9,157	9,060	9,157	9,060		
8	[illegible]	7,853	5,540	34,958	5,143	5,157	36,959	1,937	736	7,947	483	921	5,132	12,996	11,853	12,996	11,853		
9	[illegible]	28,120	10,580	57,350	9,883	24,866	45,376	5,368	3,221	10,572	2,367	1,036	5,240	38,300	35,446	6,347	6,573	31,953	28,874
10	[illegible]	2,273	5,239	51,350	3,455	2,185	38,339	655	595	10,348	909	6,813	3,216	5,315	5,424	5,315	5,424		
11	[illegible]	15,209	17,896	51,367	13,012	16,716	48,307	2,279	1,557	8,367	2,851	219	8,477	31,317	33,743	23,305	21,717	8,012	12,023
12	[illegible]	1,235	3,034	48,448	3,243	1,030	50,211	262	699	8,370	811	3,230	6,975	4,465	4,064	4,465	4,034		
13	[illegible]	1,132	3,004	46,576	3,443	872	50,233	241	330	7,821	503	347	8,531	3,575	2,876	3,575	2,876		
14	[illegible] 26	2,113	4,072	46,540	2,476	1,476	49,760	503	0	9,581	1,272	213	8,241	7,315	5,548	7,315	5,618		
15	[illegible]	3,563	7,021	45,177	5,973	5,506	45,030	863	1,091	9,377	1,353	76	8,190	13,561	13,527	13,537	10,527		
16	[illegible]	262	1,324	42,115	1,171	290	41,557	150	299	8,248	289	530	8,072	1,453	1,613	1,432	1,613		
17	[illegible]	2,107	16,215	30,310	15,127	1,439	44,376	659	1,733	7,201	2,407	51	7,107	17,233	14,752	17,235	14,752		
18	[illegible]	393	1,437	30,366	1,667	545	29,248	425	197	7,436	673	329	4,461	2,388	2,388	2,388	2,388		
19	[illegible]	2,313	4,073	28,606	3,617	3,319	28,260	489	686	7,702	406	156	4,732	5,192	7,303	5,192	7,303		
20	[illegible]	707	1,670	27,367	1,282	591	27,027	341	682	7,701	795	650	5,382	1,953	1,953	1,938	1,938		
21	[illegible]	9,179	5,625	27,201	5,757	7,707	21,390	2,721	632	8,790	1,204	17	4,936	13,927	13,332	13,927	13,332		
22	[illegible]	83	105	27,182	207	0	21,519	33	0	8,806	105	549	3,362	348	105	348	105		
23	[illegible]	1	27,182	0	21,677	0	21,677	1	8,830	0	3,361	13	3,362	21,677	27,182	6,387	7,172	15,605	20,010
		145,202	145,202		145,052	145,052		28,732	28,732		27,674	27,674		290,254	290,254	168,362		101,692	

ที่มา : ผลวิเคราะห์โดยบริษัท เอเชีย อินเตอร์นีชั่นแนล คอนซัลแต้นส์ จำกัด, 2557

Table 3.7 - 5 The passenger demand forecast at 23 stations in 2049 in case of Flat Fare

		Daily Trips (เที่ยว/วัน)						Peak Hour (เที่ยว/ชม.)						Total		Station		Transfer	
		ขาออก			ขาเข้า			ขาออก			ขาเข้า								
Item	Station	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	[illegible]	91,571	0	91,571	0	99,279	0	9,729	0	9,729	0	17,425	0	91,571	99,279	8,875	8,889	82,696	90,390
2	[illegible]	2,329	4,798	89,102	5,269	2,515	99,279	511	782	9,278	1,065	431	17,425	7,515	7,109	7,515	7,109		
3	[illegible] 2	13,220	28,849	73,473	36,932	12,974	99,236	3,305	2,488	13,057	8,929	2,136	16,85	44,054	41,782	44,054	41,782		
4	[illegible] 7	1,535	1,201	73,773	1,350	1,136	76,366	337	288	13,126	379	174	12,018	3,193	2,640	3,193	2,640		
5	[illegible] 02	4,137	7,462	70,448	8,363	3,888	76,173	647	766	8,909	1,151	631	11,818	12,960	11,430	12,960	11,430		
6	[illegible]	3,097	10,933	67,843	8,959	7,721	72,450	1,488	1,403	8,981	1,804	1,555	11,218	18,945	18,655	18,945	18,655		
7	[illegible] 101	7,980	8,231	68,994	8,209	7,787	71,513	1,401	1,273	10,322	1,340	1,394	11,268	18,189	18,419	18,189	18,419		
8	[illegible]	16,560	10,862	73,353	11,706	14,173	68,846	2,090	868	11,427	1,601	1,884	11,008	28,113	24,693	28,113	24,693		
9	[illegible]	53,230	39,879	120,207	19,113	59,288	73,738	13,108	4,772	18,864	4,132	11,264	11,892	87,307	70,941	13,554	12,480	73,753	58,461
10	[illegible]	3,039	5,805	118,313	5,509	2,980	126,215	1,096	822	20,116	1,279	983	22,82	10,647	10,869	10,647	10,869		
11	[illegible]	41,215	20,745	118,515	36,913	12,971	112,726	6,842	6,338	17,567	3,660	5,386	22,091	77,655	62,952	72,555	77,605	5,173	5,347
12	[illegible]	2,316	6,635	115,523	5,301	2,780	119,024	502	1,985	18,273	1,204	641	20,600	8,219	8,364	8,219	8,094		
13	[illegible]	1,530	3,279	114,042	3,363	1,222	116,665	470	511	18,233	1,178	418	20,137	5,473	4,284	5,473	4,284		
14	[illegible] 38	3,593	6,079	110,743	8,963	2,571	113,219	769	3	18,969	1,684	148	22,074	12,466	8,649	12,466	8,469		
15	[illegible]	8,995	15,868	107,273	15,751	8,873	106,905	1,324	1,003	18,321	2,287	873	20,070	22,746	22,637	22,746	22,637		
16	[illegible]	421	2,586	105,389	2,365	426	98,078	260	292	18,433	438	126	19,468	2,786	2,788	2,786	2,788		
17	[illegible]	4,736	31,828	79,292	35,227	2,878	99,235	5,533	1,013	17,953	7,252	738	19,02	38,963	34,307	18,809	34,501		
18	[illegible]	1,019	1,807	72,283	2,365	1,052	84,240	336	272	15,027	387	156	12,728	3,357	3,041	3,357	3,041		
19	[illegible]	5,892	10,404	67,541	8,309	7,046	62,737	1,731	1,262	19,518	1,465	905	12,286	15,472	17,750	15,472	17,750		
20	[illegible]	1,826	15,810	58,023	13,777	1,254	69,244	3,556	1,088	22,409	2,966	91	11,728	14,872	14,897	14,872	14,897		
21	[illegible]	14,075	11,217	50,063	11,479	13,936	46,750	4,620	1,131	22,961	2,142	732	8,044	25,553	24,339	25,553	24,536		
22	[illegible]	213	218	50,058	347	0	50,548	22	3	22,964	231	181	7,494	560	398	560	398		
23	[illegible]	0	50,058	0	50,058	0	50,058	0	22,964	0	7,361	0	7,361	50,058	50,058	50,058	50,058	39,304	47,850
		302,248	302,248		298,439	298,439		57,838	57,838		54,715	54,715		598,677	598,677	463,261		135,415	

ที่มา : ผลการวิเคราะห์ โดยบริษัท [illegible] จำกัด, 2557

Table 3.7 - 6 The passenger demand forecast at 23 stations in 2019 in case of 20 Baht Flat Fare and Free Transfer except Blue line and ARL

การคาดการณ์ปริมาณผู้โดยสาร ปี พ.ศ. 2562

กรณีที่ 3 : ค่าโดยสาร 20 บาทตลอดสาย ไม่มีค่าเปลี่ยนสาย ยกเว้นสายสีน้ำเงิน และรถไฟสายแอร์พอร์ตเรลลิงก์

		Daily Trips (เที่ยว/วัน)						Peak Hour (เที่ยว/ชม.)						Total		Station		Transfer	
		รัชดา - ลำโพ			ลำโพ - รัชดา			รัชดา - ลำโพ			ลำโพ - รัชดา								
Item	Station	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	รัชดา	39,047	0	39,047	0	46,807	0	4,051	0	4,051	0	5,257	0	39,047	46,807	5,374	5,756	33,672	41,611
2	[illegible]	1,913	1,551	39,409	2,115	1,313	48,009	297	251	4,096	267	213	5,037	3,868	3,195	3,856	3,183		
3	ไอทีสี่ 4	7,525	12,589	34,096	8,703	7,263	45,536	1,251	954	5,952	1,108	972	7,896	21,228	19,625	21,228	19,625		
4	รามคำแหง 71	993	640	34,257	882	792	29,087	253	208	5,950	147	91	5,793	1,471	1,439	1,471	1,439		
5	[illegible]	1,013	2,075	33,051	4,092	1,740	31,214	836	286	6,550	1,317	197	6,913	5,107	4,203	5,087	4,214		
6	มหาวิทยาลัยรามคำแหง	5,811	5,222	35,288	4,522	5,358	30,286	1,066	770	6,649	859	743	6,877	8,331	8,580	8,331	8,580		
7	รามคำแหง 10	4,363	4,235	35,203	4,407	4,127	35,303	1,011	653	7,234	725	715	6,780	8,770	8,421	8,770	8,421		
8	มหาวิทยาลัยรามคำแหง	7,513	5,091	34,789	5,175	6,358	33,101	1,392	691	7,955	843	928	6,890	13,022	11,450	13,022	11,450		
9	เอกมัย	30,798	11,196	54,389	10,782	28,223	36,214	6,306	2,788	12,674	2,678	7,494	4,675	41,582	39,206	6,108	5,045	35,474	34,184
10	[illegible]	1,864	2,581	53,672	3,287	1,864	53,245	457	484	12,647	484	722	10,937	5,164	5,175	5,084	5,175		
11	วัดธาตุทอง	15,244	17,557	50,982	14,308	15,554	52,127	1,909	2,676	8,859	2,224	3,154	9,827	32,212	32,691	22,499	22,865	7,713	9,826
12	กลิ่นชื่น	1,165	3,257	48,900	3,047	1,364	52,583	240	903	9,280	537	382	10,737	4,212	4,321	4,212	4,321		
13	หัวลำโพง	1,117	2,071	47,946	1,918	974	50,710	222	412	9,136	58	311	10,462	3,052	2,919	3,052	2,919		
14	สถานีรถไฟฟ้าที่ 39	2,283	3,537	46,649	4,748	1,427	49,842	917	[illegible]	8,729	1,560	28	10,194	6,829	4,794	6,829	4,794		
15	[illegible]	5,304	7,867	42,086	7,368	5,323	49,315	829	1,099	8,452	1,122	697	9,842	10,455	10,295	10,455	10,295		
16	ทองหล่อ	293	1,186	45,085	1,185	247	42,573	122	287	8,237	547	105	8,111	1,420	1,415	1,420	1,415		
17	[illegible]	1,863	12,551	36,737	10,208	1,443	41,837	424	2,886	6,650	2,458	437	7,868	19,559	14,081	19,559	14,081		
18	พร้อมพงษ์	977	1,375	36,012	1,429	905	26,725	356	198	7,014	547	264	5,570	2,302	1,981	2,302	1,981		
19	ทองหล่อ	1,745	4,454	27,254	3,826	2,773	35,708	749	647	7,116	747	85	4,627	5,674	7,227	5,674	7,227		
20	พร้อมพงษ์	267	5,070	22,951	1,798	302	24,835	299	629	5,786	513	24	4,891	5,069	5,372	5,069	5,372		
21	ศูนย์การค้า	6,822	8,649	22,074	6,811	6,423	20,394	1,205	762	5,226	1,678	542	4,272	12,635	13,074	12,635	13,074		
22	[illegible]	27	480	22,221	502	0	20,719	0	0	5,226	200	197	3,119	480	480	480	480		
23	สามย่าน	0	22,221	0	19,175	0	19,175	0	5,226	0	3,119	0	3,119	19,175	22,221	7,454	7,917	11,721	14,721
		134,292	134,292		135,999	135,999		26,734	26,734		26,483	26,483		270,192	270,192	191,301		99,891	

ที่มา : ผลการวิเคราะห์ โครงการ ศึกษาและพัฒนาระบบขนส่งมวลชนกรุงเทพและปริมณฑล, 2557

Table 3.7 - 7 The passenger demand forecast at 23 stations in 2049 in case of 20 Baht Flat Fare and Free Transfer except Blue line and ARL

		Daily Trips (คน-เที่ยว/วัน)						Peak Hour (คน-เที่ยว/ชม.)						Total		Station		Transfer	
		ร้องกา - ต้นโพธิ์			ต้นโพธิ์ - ร้องกา			ร้องกา - ต้นโพธิ์			ต้นโพธิ์ - ร้องกา								
Item	Station	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	ร้องกา	93,911	0	93,911	0	89,587	0	5,755	0	5,755	0	5,069	0	93,911	93,891	19,262	19,226	68,079	70,069
2	ภาการ	2,470	3,241	78,370	1,239	2,365	90,894	373	702	5,456	670	489	15,096	6,360	5,606	6,360	5,606		
3	โชคชัย 4	13,431	23,275	88,755	28,270	13,467	99,050	5,301	2,189	8,739	8,231	2,269	14,636	41,701	39,532	41,701	39,532		
4	ลาดพร้าว 71	1,550	1,240	87,059	1,492	1,763	74,237	382	906	8,615	530	183	13,496	3,311	2,719	3,311	2,719		
5	ลาดพร้าว 83	4,508	5,880	85,558	6,195	3,959	74,225	522	730	8,644	1,031	304	13,568	10,703	9,847	13,703	9,847		
6	ลาดพร้าว	7,092	9,812	83,838	8,038	7,497	80,989	1,478	1,255	8,838	1,474	1,471	8,919	15,071	17,110	15,071	17,110		
7	ลาดพร้าว 101	7,585	5,745	84,027	7,579	7,793	80,476	1,411	977	10,300	1,303	1,357	8,916	15,364	13,102	15,364	13,090		
8	ลาดพร้าว	15,904	9,549	89,380	11,009	13,014	88,004	2,067	990	11,467	1,403	1,780	8,941	26,913	22,563	26,913	22,563		
9	แยกรัชดา	63,040	21,218	117,827	20,219	61,161	71,328	12,905	3,097	18,276	1,131	10,809	12,320	83,259	82,379	12,971	11,436	70,288	70,943
10	ห้วยขวาง	7,616	9,210	116,733	9,670	4,767	112,271	982	821	18,695	1,605	510	21,686	10,219	13,457	10,219	13,457		
11	พระราม 9	55,595	57,708	114,360	36,541	57,283	111,126	6,183	7,893	17,186	8,536	7,389	23,684	68,795	74,538	64,319	69,130	4,477	5,208
12	รัชดาภิเษก	2,259	3,840	139,990	5,489	2,757	114,015	466	1,751	19,090	1,065	393	22,467	7,729	9,606	7,729	9,606		
13	ศูนย์ฯ	1,558	3,096	138,453	3,095	1,223	112,132	456	517	19,029	1,028	307	22,096	4,341	4,322	4,341	4,322		
14	เพชรบุรีตัดใหม่	3,468	3,500	138,419	5,467	2,305	110,749	787	0	19,586	1,444	140	21,977	11,343	9,414	11,343	9,414		
15	ราชปรารภ	9,958	11,372	97,805	10,127	9,833	101,313	1,297	1,725	10,998	2,068	1,174	23,279	22,116	22,207	22,116	22,231		
16	พัฒนา	298	1,962	96,120	1,838	384	98,016	189	283	10,079	536	193	13,405	2,260	2,347	2,260	2,347		
17	พัฒนา	1,938	60,673	39,387	35,279	2,909	91,592	4,869	3,065	18,099	7,071	922	13,170	59,368	63,582	59,368	39,681		
18	ห้วยขวาง	643	1,810	86,592	3,515	958	92,222	310	284	17,040	579	208	12,120	3,459	2,774	3,459	2,774		
19	พหลฯ	4,674	10,402	82,862	9,834	6,739	90,582	1,617	1,268	17,388	1,340	1,169	11,747	14,508	17,141	14,509	17,141		
20	พหลฯ	1,465	13,825	90,213	13,602	1,767	92,080	2,781	1,257	18,819	2,554	884	11,986	14,477	15,582	14,477	15,582		
21	พหลฯ	12,778	11,768	92,843	11,795	12,207	75,706	1,153	1,762	21,772	2,102	890	8,717	24,581	23,975	24,581	23,975		
22	ลาดพร้าว	97	797	51,739	889	0	76,316	39	0	21,791	340	314	7,410	986	797	986	731		
23	สำโรง	0	51,139	0	75,450	0	75,450	0	21,791	0	7,534	0	7,534	65,989	51,139	19,387	19,836	28,086	33,731
		281,294	281,294		281,872	281,872		54,454	54,454		53,418	53,418		562,988	562,988	383,194		179,773	

ที่มา : การประมาณการโดยที่ปรึกษา (ฉบับร่าง เดือนมิถุนายน 2557 กรมพัฒนาที่ดิน กระทรวงเกษตรและสหกรณ์)

Table 3.7 - 8 The passenger demand forecast at 23 stations in 2019 in case of 20 Baht Fare and No Free Transfer

การคาดการณ์ปริมาณผู้โดยสาร ปี พ.ศ. 2562

กรณีที่ 4 อัตราค่าโดยสาร 20 บาท ตลอดสายไม่คิดค่าโดยสารข้ามสาย

		Daily Trips (เที่ยว/วัน)						Peak Hour (เที่ยว/ชม.)						Total		Station		Transfer	
		รัชดา-ลาดพร้าว			ลาดพร้าว - รัชดา			รัชดา - ลาดพร้าว			ลาดพร้าว - รัชดา								
Item	Station	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Line Load	Boarding	Alighting	Boarding	Alighting	Boarding	Alighting
1	รัชดา	40,770	0	40,770	0	47,090	0	4,019	0	4,019	0	5,511	0	40,770	47,090	5,293	5,565	35,805	41,490
2	ห้วยขวาง	1,981	1,850	39,756	2,434	1,916	47,608	272	251	4,120	294	238	5,011	3,915	3,766	3,915	3,766		
3	โชคชัย 4	4,958	12,043	34,181	13,018	5,536	55,090	2,429	1,011	5,539	3,323	840	8,492	21,027	19,840	21,027	19,840		
4	ลาดพร้าว 71	710	692	34,329	692	740	35,760	223	178	5,571	101	82	5,903	1,402	1,432	1,402	1,432		
5	ลาดพร้าว 83	1,949	2,553	33,637	4,782	1,770	38,824	770	251	6,094	1,252	291	5,887	6,831	4,325	6,831	4,325		
6	ลาดพร้าว	3,570	5,202	31,840	7,636	3,696	39,836	857	497	6,146	992	606	6,026	8,166	8,538	8,166	8,538		
7	ลาดพร้าว 101	3,980	4,475	31,253	4,584	3,855	34,965	918	673	6,392	938	850	4,724	8,444	8,127	8,444	8,127		
8	[illegible]	9,667	9,248	32,772	9,845	5,779	35,898	1,126	646	6,871	727	644	4,946	12,379	10,890	12,379	10,890		
9	มหาดไทย	24,959	3,821	43,030	8,135	21,470	34,034	5,353	2,511	9,754	1,471	5,221	4,689	30,134	30,091	6,259	5,590	26,875	24,501
10	ศรีวรา	2,016	3,131	42,024	2,514	2,016	47,309	477	350	9,881	758	220	5,820	4,890	5,127	4,890	5,127		
11	พัฒนาการ	15,427	13,807	47,654	14,040	15,652	46,571	3,030	3,759	9,356	1,302	3,210	9,307	25,477	21,756	21,703	21,756	7,909	10,322
12	[illegible]	1,142	2,827	46,969	2,530	1,012	48,383	277	612	7,624	565	374	5,686	3,672	3,839	3,672	3,839		
13	ศรีนุช	1,116	1,827	46,034	1,602	679	48,925	255	364	7,595	473	320	5,424	2,779	2,506	2,779	2,506		
14	[illegible]	2,157	4,210	43,981	4,541	1,486	48,147	637	0	8,232	1,003	20	6,251	6,748	6,046	6,748	6,046		
15	[illegible]	2,470	8,072	42,585	8,672	2,560	42,959	844	1,064	7,631	1,483	821	7,980	10,349	10,252	10,349	10,252		
16	ศรีอุดม	1,236	1,738	42,084	1,125	248	39,460	193	281	7,845	327	108	7,978	1,367	1,383	1,367	1,383		
17	ศรีอโนชา	3,052	12,373	28,723	15,168	1,490	36,371	455	1,868	6,534	2,453	446	7,135	17,150	14,413	17,150	14,413		
18	[illegible]	667	1,325	28,065	1,515	673	34,853	164	191	6,507	192	212	5,130	2,258	1,998	2,258	1,998		
19	ศรีนครินทร์	1,768	4,265	25,568	3,800	2,920	25,901	777	614	6,821	891	728	4,521	5,565	7,185	5,565	7,185		
20	[illegible]	1,764	4,914	22,418	4,435	532	29,804	814	619	6,815	572	95	4,953	4,771	5,708	4,771	5,708		
21	[illegible]	7,087	6,292	21,606	6,471	5,757	18,370	2,027	714	6,228	1,558	821	4,026	12,358	13,213	13,358	13,213		
22	[illegible]	28	472	21,174	486	0	19,158	0	0	6,978	182	774	3,931	513	472	513	472		
23	สำโรง	0	21,514	0	19,971	0	19,971	0	6,223	0	5,082	0	5,082	19,971	21,514	7,253	7,338	11,453	14,176
		127,851	127,851		129,100	129,100		35,019	35,019		24,982	24,982		256,951	256,951	170,943		81,008	

ที่มา : บริษัท ระยะทาง โดย ที่ปรึกษา เอเชีย เซ็นเตอร์ จำกัด, 2557

Table 3.7 - 9 The passenger demand forecast at 23 stations in 2049 in case of 20 Baht Fare and No Free Transfer

ปริมาณผู้โดยสารที่สถานีผู้โดยสาร ปี พ.ศ.2592

กรณีที่ 4 อัตราค่าโดยสาร 20 บาท ค่าแรกเปลี่ยนเส้นทางทุกเส้นทาง

Item	Station	Daily Trips (คน-เที่ยว/วัน) รัชดา-สำโรง Boarding	Alighting	Line Load	สำโรง-รัชดา Boarding	Alighting	Line Load	Peak Hour (คน-เที่ยว/ชม.) รัชดา-สำโรง Boarding	Alighting	Line Load	สำโรง-รัชดา Boarding	Alighting	Line Load
1	รัชดา	90,130	-	80,730	-	90,825	-	8,364	-	8,364	-	10,025	-
2	ภาวนา	2,417	3,545	78,056	4,220	2,520	90,605	549	747	8,166	953	416	10,053
3	โชคชัย 4	17,550	23,708	68,456	28,501	13,905	88,904	3,117	2,511	9,012	3,505	1,891	10,380
4	ลาดพร้าว 71	1,400	1,105	66,750	1,512	1,441	73,424	346	756	9,014	330	180	10,344
5	ลาดพร้าว 83	4,135	5,756	65,129	3,249	3,654	73,357	641	788	8,867	1,137	388	10,049
6	มหาดไทย	2,325	3,100	67,346	8,077	7,674	68,801	1,276	1,201	8,798	1,581	1,201	10,181
7	ลาดพร้าว 101	7,530	7,066	62,410	7,731	7,270	67,509	1,515	1,051	9,057	1,551	1,286	9,873
8	บางกะปิ	15,213	13,006	67,535	13,049	12,975	67,004	1,604	987	10,014	1,529	1,737	9,775
9	แยกลำสาลี	59,455	13,130	108,800	17,232	62,236	68,960	11,406	4,216	17,184	3,687	12,480	9,373
10	ศรีกรีฑา	4,267	5,620	107,720	5,035	4,551	104,064	950	632	17,512	1,275	513	19,775
11	หัวหมาก	35,582	33,985	108,159	37,441	37,105	103,191	3,495	2,297	15,724	3,091	1,985	19,815
12	กลันตัน	2,264	3,236	104,228	5,151	2,735	106,654	831	1,646	14,879	898	729	20,974
13	ศรีนุช	1,302	7,545	107,470	2,810	1,240	100,217	408	496	14,791	961	342	20,104
14	ศรีนครินทร์ 38	3,492	5,732	105,987	5,890	2,696	104,660	630	-	15,381	1,430	154	20,260
15	สวนหลวง ร.9	7,152	15,104	93,474	14,901	3,074	98,205	1,531	182	16,000	1,308	1,245	19,014
16	ศรีอุดม	308	1,915	96,059	1,601	336	96,859	196	276	11,930	378	151	18,269
17	ศรีเอี่ยม	4,121	52,137	34,940	34,536	2,939	36,440	5,182	3,716	16,329	3,855	971	16,049
18	ศรีลาซาล	348	1,580	64,092	9,462	631	56,140	360	252	16,366	140	291	11,365
19	ศรีแบริ่ง	4,388	12,371	38,450	3,490	8,796	36,329	1,620	1,227	16,349	1,284	1,239	11,055
20	ศรีด่าน	1,409	13,536	46,464	13,129	1,705	43,676	2,104	1,531	18,604	2,771	151	10,980
21	ศรีเทพา	3,160	13,657	47,682	11,396	12,307	42,403	4,211	1,114	21,720	2,118	803	8,378
22	ทิพวัล	90	506	48,174	546		40,054	20		21,750	520	312	7,212
23	สำโรง	-	13,171	-	12,606	-	42,606	-	21,750	-	2,254	-	7,201
		270,945	270,945		272,342	272,342		53,195	53,195		51,991	51,991	

Item	Station	Total Boarding	Total Alighting	Station Boarding	Station Alighting	Transfer Boarding	Transfer Alighting
1	รัชดา	90,130	90,825	9,341	9,563	70,789	80,262
2	ภาวนา	6,351	3,262	6,351	3,563		
3	โชคชัย 4	41,447	29,291	41,447	29,291		
4	ลาดพร้าว 71	2,864	2,610	2,384	2,610		
5	ลาดพร้าว 83	16,364	9,708	16,364	9,703		
6	มหาดไทย	15,404	17,443	15,404	17,433		
7	ลาดพร้าว 101	16,255	15,244	16,255	15,244		
8	บางกะปิ	26,308	23,061	26,308	23,061		
9	แยกลำสาลี	76,707	70,125	15,125	12,301	69,582	57,825
10	ศรีกรีฑา	10,328	10,271	10,328	10,371		
11	หัวหมาก	66,378	61,265	65,891	58,105	4,483	5,163
12	กลันตัน	7,415	9,218	7,415	9,218		
13	ศรีนุช	4,370	4,175	4,370	4,175		
14	ศรีนครินทร์ 38	11,362	8,287	11,362	8,287		
15	สวนหลวง ร.9	21,862	22,038	21,862	22,350		
16	ศรีอุดม	2,202	2,207	2,202	2,209		
17	ศรีเอี่ยม	36,328	33,248	36,329	33,248		
18	ศรีลาซาล	3,412	2,745	3,412	2,741		
19	ศรีแบริ่ง	14,173	17,240	14,179	17,240		
20	ศรีด่าน	14,171	14,907	14,171	14,907		
21	ศรีเทพา	24,321	23,111	24,321	23,111		
22	ทิพวัล	344	506	344	504		
23	สำโรง	42,309	48,171	16,383	10,864	20,798	32,109
		543,287	543,288	377,856		165,831	

ที่มา : รายงานการศึกษาโครงการ โดย บริษัท เอเชีย เอ็นจิเนียริ่ง คอนซัลแตนท์ จำกัด, 2557

3.8 M&E Works System and Train Operation

3.8.1 M&E Works System

M&E works system are a major components in the mass transit system to serve the passengers transportation and to safely and quickly control the train operation to comply with the defined schedule, as well as the overall efficiency of the train operation system. The details of the electric railway system can be described as follows:

1) Power Distribution System

1.1) Power supply for propulsion of the Metropolitan Rapid Transit Yellow LineProject is track beam with a direct current (DC) 1,500 V. The propulsion and standby power of the electric railway system must be received adequate energy to respond to the demand of sufficient number of substations, and to be ensured that energy flows steadily and consistently high quality for the Traction Power Sub-station (TPS). The required major equipment are as follows:

a) 24 kV Switchgear;
b) 24 kV/1160~1158V 3-phase Traction Transformer Rectifier;
c) 1,500V DC High Speed Circuit Breakers;
d) 1,500V DC Isolators;
e) 24kV Switchgear Panel;
f) 1,500V DC Lightning Arresters;
g) Frame/Earth Leakage Relay;
h) Track Earthing Panel

1.2) The selected power system for monorail train is DC 1,500 Volt supplying from the power rails. The advantage is that there is no additional distance of Head Room Clearance and no effect when running under the railroad intersection bridge. Installation of the power rails shall be installed sideways on both sides of the track beam along the length of elevated rail, including the stabling yard and the Depot. The design and installation must be coordinated closely with the manufacturer relating the distance and the height of the power rails to be compatibility installed with the position of the collector shoes from the car body. Electric and power rails will directly receive electric voltage of (+) DC 1,500 Volt from the Traction Power Sub-station (TPS) in order to supply power to propelled devices such as motors, air conditioning, lighting in the rail, etc. It will receive power of (+) DC 1,500 Volt, passes through the collector shoes, then flows back through the Negative Contact Rail to Negative Bus (-), and is complete at TPS as shown in **Figure 3.8.1 - 1**

1.3) The Traction Power Sub-station (TPS) is a station that controls the power supply for the rail propulsion system through the power rails. The primary location of the TPS is determined to be inside the power supply room of the passenger station at Concourse floor and will receive electric voltage of AC 24 kV from Bulk Supply Sub – station (BSS) and then convert to DC 1,500 Volt to supply to the power rails.

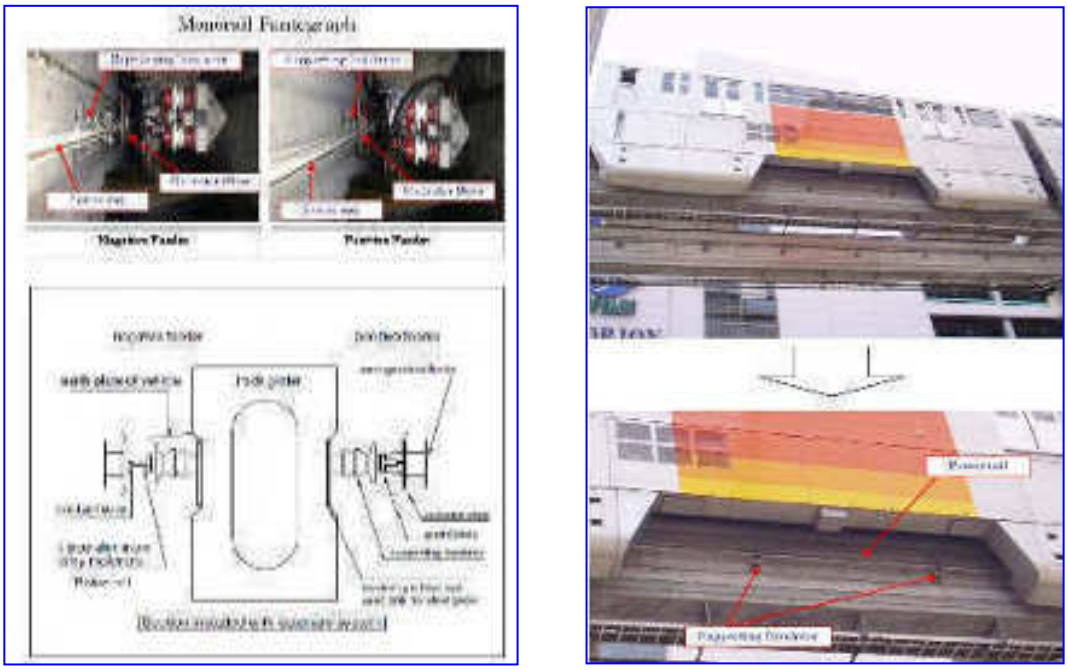


Figure 3.8.1 - 1 Power Rails

2) Supervisory Control and Data Acquisition System (SCADA) at each station and the Depot will detect each type of equipment, which have to be monitored or controlled. It will be connected to device attached to the cable control and monitoring by remote terminal unit (RTU). The data is sent to the central operation control center via electric railway backbone data transmission network which is over fiber optic cable transmission or open transmission network. Therefore, the controller in the central operation control center will be able to monitor and control the operation of the equipment and tools from a distance. The types of control are as follows:

2.1) Manual Control: The controller in the central operation control center can switch on and off all switches in the TPS or passenger station for a certain purpose such as for maintenance, etc.

2.2) Automatic Control: Power supply networks can be automatically connected to each other within two seconds, such as the case of the power failures or short circuit etc. This means that the rail operation is not interrupted by the connecting circuit switching, which is controlled by the SCADA.

2.3) Monitoring of RTU can continually compile information for the operation status of the escalator or toll gate at the station and send to the central operation control center. If there are any problem with the equipment or tools, there will be an audible signal to the control center. The controller in the central operation control center will respond immediately and inform the maintenance staff according to the defined procedures.

3) The telecommunication systems shall consist of, as follows:

3.1) Digital Radio Communication System for communicating among operator.

3.2) Telephone System for communicating among operator.

3.3) Closed Circuit Television System (CCTV) for checking the security of station, platform, etc., and controlling can be seen from the operation control center and station.

3.4) Master Clock System for time synchronizing at all stations and operation control center to control the departure -arrival of station according to the schedule.

3.5) Passenger Information System (PIS)

3.6) Public Addressing System(PAS)

3.7) Passenger Information Display System (PIDS)

3.8) Backbone Transmission Network (BTN)

4) Signaling system shall consist of, as fellows:

Signaling system has to be the versatile operations model in response to the train operation in case of degraded operations and the state of emergency

The signaling system shall include Electronic Interlocking and Automatic Train Control System (ATC) and must have the function of Automatic Train Operation (ATO), Automatic Train Protection (ATP), Automatic Train Regulation (ATR). Data signals are transmitted from the runway to the train and the display monitor in the operator room on the train.

The wayside light signal and signs (at specified area for parking spot) must have throughout the runway and must be covered in case of degraded operations. When the Automatic Train Protection (ATP)has experienced failure, the electric railway and vehicles without an ATP must be controlled or regulated by train controller, under the principle of "Drive on sight", speed limit at 25 km / hr. (RM1) and 35 km / hr. (RM2).

The wayside light signal will be displayed in two colors and must have throughout the runway, including the railroad switch. In the route that there is no railroad switch, the virtual signal must have as the starting signal. The virtual signal is only in a logic of electronic interlocking system. But there are no real positions on sites, therefore, the signal label must be installed for the electric railway and vehicles without an ATP or ATP failure, running through this label with RM model operations must receive prior approval by the train controller.

The installed speed limit signal on the route is no longer needed due to the service route has no speed limits under 35 kilometers per hour (RM2). The speed limit signals are still needed for temporary speed limits at below 35 kilometres per hour. In the stabling yard, the train controller is responsible for the propelling of every train to comply with the installed lights and other signals.

The automatic train supervision will monitor the position of all trains running on the route, and will define routing and running profile, departure time from the rail station, according to the electric railway timetable, and will also be the information for effective assessment and applying in terms of statistics.

4.1) Driverless Operation

Signaling system must be installed by the system which has the driverless operation for both on the rail routes and in the Depot. The driverless operation will eliminate intervention by the train conductor and failure of the person which may occur in service during normal operations.

However, passengers will feel more comfortable when the train is controlled by the train controller and the train conductor, respectively, and especially for routes in tunnel and elevated rail. So at least there must be service staff on a train to be an informant, advise and take care passengers during normal operations. The service staff on the train must communicate to the Operation Control Center, and must be trained to operate the train with the temporarily control

panel in case of a degraded operations. For emergency, the train operation staff will be ready to immediately operate in the train, including assisting in the evacuation from the electric railway.

4.2) Types of Electric Railway Propulsion

The normal train operation shall be applied, as follows:

- Automatic Train Operation (ATO)
- Semi-Automatic Train Operation (SM)
- Restricted Manual 1 (RM)
- Low speed operation (WM)

The train controller is responsible for the safety of the train propulsion. So he/she shall be able to intervene to manually drive the train at any time.

The propelled electric railway on main routes or on the entrance of the stabling yard, typically will propel by ATO or SM. ATO in every train operation is completely automated. Except for closing the door and pressing to start the train propelling shall be done by the train controller.

The train controllers should drive with SM under the ATP at least one cycle of route per month to ensure that their driving skills still maintain the standards. The train crew controller must coordinate with the rail operations controller to practice driving in the SM and to make recommendations related to the train controller.

- Automatic Train Operation (ATO)

ATO controls the train during driving to the next station. The initial run will accelerate speed according to the speed profile, with a top speed of 80 km/hr The train controller will press the button to close the door, wait until the doors is completely closed and the train starts to move by the ATO, by pressing 'ATO start'.

Automatic Train Protection (ATP) shall prevent the train from moving, if the door is not completely closed. ATO shall control train operation after pressing the start button. The propelling power adjustment and braking shall be operated in order to park directly at the parking spot in the next station. When it is completely parked at the station, the door will be opened automatically.

Automatic Train Regulation (ATR) shall be collaborated to adjust running time according to the defined speed profile and parking time at the station, in order to maintain the timetable or to compensate for the delay running time from the reserved running time.

- Semi-Automatic Train Operation (SM)

Semi-Automatic Train Operation (SM) is a form of propelling under the security control by ATP, and non ATO. The train controller shall control the speeding and braking by accelerator and ATP brake (Driving / braking lever).

- Restricted Manual 1

Restricted Manual 1 (RM 1) is a normal propelling model in the stabling yard. RM1 and ATP shall control speed not exceeding 25 km /hr., and prevent sliding backwards. In the event of an overload propelling of the speed limit, ATP shall command to emergency brake.

Under RM1, the system shall not control the compliance with lights, parking spot, runway boundaries, and speed below 25 km/ hr

Train operators are responsible for operating to comply with light signals, and controlling the train speed to be able to park under the scope of vision. The train controllers must stop the train, if there is anything obstructing the runway, or upon receiving of stopping signal label, or stopping train hand signal.

RM1 will change the model when the train forced steering is changed to the forward mode in the stabling yard, or to change the model to RM1 after emergency braking.

When the train reaches boundaries between the stabling yard and main routes, the train is able to change the model from ATO to RM1, without parking the train by pressing the button RM1, and run at speeds under 25 km / hr RM1. It is also available to propel the train under degraded operations.

- Restricted Manual 2

Restricted Manual 2 (RM 2) is a model used when the ATP on train has experienced failure, the rail operating controller shall approve the train controller to change the train operation to RM 2. The train controller is responsible for propelling at a maximum speed limit of 35 km / hr

When the train speed exceeds the maximum speed limit, the system will intercept the train propelling, resulted in reduced speed. If the train speed is still increasing; such as running down the ramp, the propelling control unit shall command to break electric railway in order to speed train back in the speed limit.

Under RM 2, the system shall not control the compliance with lights, parking spot, runway boundaries, and speed below 35 km / hr

Restricted Manual 2 (RM 2) is a model used when ATP in the train has experienced failure and under degraded operations- the passengers do not allow on the train, except in certain circumstances, as described in the degraded operations.

- Low Speed Operation

Low Speed Operation (WM): The train top speed shall not more than 3 km / hour, and is the typical model for the following activities:

- Moving the train through the train washing plant.
- Train coupling
- Bring the train in and out of the Depot

5) Service Vehicles

The normal service vehicles will not install the ATP system on train, due to the unstable system of detecting and displaying train position. The operating procedure for service vehicles must be presented in the operating manual of CCR and the train conductor. This manual will be including; terms of communication, operating route, coordinates, speed limit, route closing, limiting the maximum speed at 35 km / hr, and controlled by a speed control unit on vehicle services.

3.8.2 Train Operation Plan

The defining of normal train operation plan is to be the principle and scope of work relating to the operating procedures manual of electric railway. The normal train operation model covers the operation of the system that is based on the design, and also include the management of delayed train -delays caused by passengers; an inadequate number of staff and train; other faults; the

intruder; or person is not allowed to enter the area, and cancelled flights service due to possibility of overcrowded passenger, etc.

Traffic operator must have the capacity and capability to ensure a high level of safety train operation. The employee must strictly comply with the train operating procedures manual, according to the train operation plan and regulation (Rule Book).

Estimation of transport is the basis for planning relating to, route model of transport and installing transport equipment.

1) Passenger Volume per Day (times/day)

Passenger volume per day is presented as the number of passengers per direction per day (PPDD), and forecasted for fare collection in two cases (by distance, and 20 baht throughout the line). The period of consideration is four times in every ten years.

Distance-Base Fare Distance	Passenger per Day per Direction (PPDD)			
Station / Year	2019	2029	2039	2049
Ratchada – Samrong	124,409	168,345	219,757	268,688
Samrong – Ratchada	123,465	168,583	214,654	263,884

20 Baht Flat Fare	Passenger per Day per Direction (PPDD)			
Station / Year	2019	2029	2039	2049
Ratchada – Samrong	145,202	190,672	243,095	302,248
Samrong – Ratchada	145,052	187,803	238,621	296,429

2) Peak Hour Traffic Demand

Peak hour traffic demand is presented as the number of passengers per direction per day (PPDD), which determines the capacity of the train to be prepared for a time when passenger transport demand is highest. The volume of passengers during rush hour is classified by fare collection in two cases. (by distance, and 20 baht throughout the line). The period of consideration is four times in every ten years.

Distance-Base Fare Distance	Passenger per Day per Direction (PPDD)			
Station / Year	2019	2029	2039	2049
Ratchada – Samrong	9,140	12,451	17,440	21,617
Samrong – Ratchada	9,019	12,039	16,421	21,045

20 Baht Flat Fare	Passenger per Day per Direction (PPDD)			
Station / Year	2019	2029	2039	2049
Ratchada – Samrong	10,946	14,459	19,652	23,924
Samrong – Ratchada	10,729	14,369	19,238	23,800

3) Train Capacity

The required capacity of the train for the demand during the peak hour can be formatted in the manner of less train but with more capacity, or more train but with less capacity. Eventually the appropriate capacity for providing service is the same. The only difference is headway, or at different frequencies.

During the system lifetime, both passenger volume per day and peak hour traffic demand are likely to rise continuously into two or three times from the first phase. Therefore, the system supply must take into consideration the increase of passengers in this format as well.

Monorail Train supplier can supply in various types; number of cars, short or long, narrow or wide. These types are reflected in a variety of train capacities; of 4 passenger cars; 6 passenger cars and 7 passenger cars of various manufacturers as shown in following details:

MRT Supplier	Passenger capacity[1/] (person)		
	4 car per train	6 car per train	7 car per train
Scomi	480	720	840
Bombardier	502	768	896
Hitachi	716	1,090	1,277

Remark : [1/] base on passenger capacity 6 person/m^2

The four passenger cars per train of Scomi and Bombardier shall exceed the capacity on 2039. The four passenger cars per train of Hitachi is closed to exceed the capacity. So from the year 2039 onwards, all trains have to have seven passenger cars per train for Scomi and Bombardier or six passenger cars per train for Hitachi.

4) Requirement of Rolling Stocks

The number of passengers per direction per day, running time per round, and train capacity are the basis information for calculating the number of required rolling stock for the service. The following factors must be taken into account.

- All three manufactures are likely to offer selling of the rolling stock
- There are four periods for procurement (year).
- The passenger capacity is 6 people for square meter.
- 2 formats of collection (by route distance and 20 baht/route)

The following information represents the number of electric railway, which provides the number of rolling stocks, the number of passenger cars. Details of the calculations are shown in **Appendix 3 A.**

SCOMI	Distance-Base Fare Distance				20 Baht Flat Fare			
Year	2019	2029	2039	2049	2019	2029	2039	2049
Passenger capacity 6 person/m^2	7 – car train				7 – car train			
Number of train	18	24	34	43	22	29	39	47
Number of cabin car	126	168	238	301	154	203	273	329

Bombardier	Distance-Base Fare Distance				20 Baht Flat Fare			
Year	2019	2029	2039	2019	2029	2039	2019	2029
Passenger capacity 6 person/m^2	7 – car train				7 – car train			
Number of train	17	23	32	40	20	27	37	44
Number of cabin car	119	161	224	280	140	189	259	308

Hitachi	Distance-Base Fare Distance				20 Baht Flat Fare			
Year	2019	2029	2039	2019	2029	2039	2019	2029
Passenger capacity 6 person/m^2	6 – car train				6 – car train			
Number of train	15	19	27	33	17	22	30	36
Number of cabin car	90	114	162	198	102	132	180	216

Summary

The rolling stock capacity of the seven passenger cars per train of Scomi, Bombardier, and six passenger cars per train of Hitachi are sufficient to serve until the year 2049. The service model is sufficient during peak hours at the frequency of every two minutes. This specification also can serve fare collection in both cases, by distance, and 20 baht throughout the line. It could be applied the 2029 data in considering the procurement of the train at the initial phase of the project.

3.8.3 Depot Operations Plan

The Depot must be provided the layout plan in a manner that can be expanded in the future as the increasing number of the train. In the stabling yard must be provided the space for monorail of 6 passenger cars by Hitachi, of 7 passenger cars by Scomi and Bombardier which have the similarity of length and capacity.

The Depot operations plan shall consist of description of bringing trains into service and withdrawal from the service, including movement of the train in the Depot; in the stabling yard; in the train washing plant, and for inspection, maintenance and repair.

The train operating activities would have to be considered as follows:

- Preparing the train
- Running in-out of the train from the main runway
- Moving away to rotate movement of the train between the Depot and the stabling yard
- Moving of service vehicles in the Depot and in-out of main runway
- Washing and cleaning of the train
- Running train in test guideway and in-out test guideway

Electric railway must run in to the Depot by self-propelling force. If this train is not able to run by its propelling force, it will not be towed by another normal electric railway. But it must be towed by the particular electric railway used especially for towing.

Electric railway and service vehicles which run in the Depot must be controlled by train controller. However, maintenance staff who is trained and certified in train controlling as well as the train controller can control the train to run inside the Depot.

Train operation in the Depot must be controlled by the Depot controller at the operation control center. Except for running train in the workshop, the Depot controller and the train controller will communicate via train radio or mobile radio.

The movement of train between the Depot and main runway, the movement of train within the Depot, are the movement to rotate the train. The train controller shall move the train by seeing signals for bringing train in -out of the workshop, including back and forth train operation. The

movement of train will be subject to the restrictions of the workshop for the purpose of inspection, maintenance or repair, which will be part of the work and will not have back and forth train operation.

Permissible speed for running a train in the Depot is defined as not exceeding 25 km / hr The area to the speed limit is as fellows:

- Main workshop 3 km./hr.
- Permanent way workshop 3 km./hr.
- Train Washing plant 3 km./hr. during washing
- Test Guideway 80 km./hr. with Automatic Train Protection system (ATP)

1) Running train between main runway and the Depot

The rail operator controller in the Depot and the train controller in the main runway, they must reach a consensus on in-out train operation between main runway and the Depot. The delivery responsibilities from the Depot area to the main runway area, and vice versa, the signal area with showing the delivery point must be determined prior to bringing the train out of the Depot. The train controller must abide by the train operation manual for the train controller. After the train has already run through the divided boundaries of delivering area from the Depot to the main runway, the screen of automatic train protection system (ATC) in the train cockpit will be displayed "ready to use", and the automatic train operation system (ATO) will be lit up. The train controller must press the ATO button to command the train to change to automatic train operation (ATO) mode. If the train has experienced failure on the automatic train protection system (ATP), that train will not be allowed to run over the main runway.

When the train will run back from the main runway into the Depot, the train controller will operate the train by ATO system or SM mode, before approaches to the delivery area. The train controller may change in to RM mode by without stopping the train at the delivering area, when the light signal allows the train to go. Otherwise, the train controller would have forced the train to stop. When the train enters the delivery area, the train will run at a speed of 25 km / hr The train controller will drive and brake by switching to restricted manual (RM). By pressing RM button, the train radio system will automatically switch from main runway radio to users in the Depot. The train controller will ask the Depot controller that whether or not there are any train or a vehicle that will run into the Depot. Train cannot encroach the delivery area of the ATO or SM as described in degraded operation.

2) Running train within the Depot

The restricted manual (RM) must be applied for running train within the Depot. The restricted manual is shown by light colored on the wayside /symbol /installed label. The Depot controller defines routing and gives approval to the train controller to move the train according to the defined objectives. The communication between the train controller and the Depot controller are via the train radio system.

3) Running train in-out the maintenance workshop

When entering the main workshop, the train will be in front of the workshop. The maintenance staff must ensure that it is safe to allow the train into the workshop, then inform the

train controller to take the train into the workshop by using hand signals. The certified maintenance staffs will oversee the movement of trains under the restrictions of the workshop. The train controller will deliver train to the maintenance staffs, when the train is parked in specified spots. The train moves into the main workshop, it will be moved with the same mode of operation in the train washing plant (WM), and moving to the signal or specified area under the restrictions of the workshop. The movement of train further from this point is controlled by the Depot controller.

4) Running of Track Maintenance Car

Running of all track maintenance cars will run on main runway, which will be controlled by the rail operating controller in the central operation center. However, running of these cars usually run during maintenance hours. In case of emergency, the track maintenance cars and the service vehicles may have to run in the main runway during the commuter service hours with special permission from the Chief Controller.

5) Train Maintenance

The maintenance staffs must inform the rail operating controller in the Depot in advance about the maintenance plan. The rail operating controller in the Depot will properly determine the train to serve the passengers. If the train needs repairing that are outside the schedule of maintenance plan, the Depot controller and the maintenance controller will manage as required.

6) Preparing the train and removing of coupled train

It will take 20 minute for train coupling of six passenger cars and 10 minutes for removing it. Preparing a train is required to determine the readiness of the train in operation and technical matters. For train maintenance, the coupled train will have to be removed, and the system will be disconnected prior to being maintenance. The service vehicles are required to have the air conditioning system during parking. Using the air conditioning system must be used at a minimum usage to reduce energy consumption.

3.9 Depot

3.9.1 The design concept of the Depot

The design concept of the Depot and stabling yard building block is the use of natural light and ventilation. The building is a wider range and very high, so the ventilation and natural light comes from the roof. The Operation Control Centre (OCC) is used to control the entire operation. Therefore, it must take into account the safety, needs to be controlled and limited access. Meanwhile the main control room is the room where people are very interested in visiting. Therefore, the visiting room must be prepared for visiting can be done without interfering with the staff.

3.9.2 Traffic management in the Depot area

1) Traffic conditions surrounding the Depot area

The Depot is located at the Sri Iam interchange, Srinagarindra road, with six traffic lanes. In 2008, the traffic volume on Srinagarindra Road during the morning rush hour (7:00 to 8:00 pm), the volume was 7,277 cars and evening rush hours (17:00 to 18:00 hrs.), the volume was 6,587 cars. The expected number of cars coming to use Depot area are about 250 cars / day. This will affect Srinagarindra Road during morning and evening rush hour, and have no impact on traffic, comparing to the capacity of

the number of obtained traffic lanes on Srinagarindra Road. Within the Depot area, there is reinforced concrete road- two-way traffic with the width of 18 meters of the entrance, exit connecting to road - two traffic lanes with the width of 14 meters traffic lanes, and the width of 2 meters sidewalks on both side.

2) The traffic management within the Depot area by road and the entrance -exit from the Depot area are provided a two-way traffics (**Figure 3.9.2 - 1**). The road in the project is divided into three parts: the road in the office building area and the operation control center area, the roads in the workshop area and the stabling yard, and service road around the Depot.

2.1) Traffic management in the office building area and the operation control center area: It found that the office building area and the operation control center area are located deep in the Depot area. The employee parking lot is specifically prepared, adjacent to the office building area and the operation control center area.

2.2) Traffic management in maintenance workshop area and the stabling yard: Accessing to the area, the vehicles have to run up to the ramp in front of the checkpoint. The buildings will be connected by the road on Platform. The building needed the service roads for accessing of forklift and truck, including Underfloor Wheel Lathe Plant, Wheel Diagnostic Facility, Dangerous Goods Building, Garbage Storage Building, Train Washing Plant, Heavy and Light Maintenance Workshop, Materials Storage Plant, Permanent Way Workshop Building และ Substation Building. The local road has a width ranging from 6-15 meters. The road is mainly used as equipment and machinery transportation, such as trains, power systems, etc., in the first period before the train operation and when there is additional procurement for equipment and machinery.

2.3) Service Roads around the Depot is intended to secure the area around the Depot and to link Administration Building, Operation Control Center, Dormitory Building and Driver Office Building together. It is on the same or close to the level of the road outside the Depot. Both of the service roads are designed for fire engine accessibility to all buildings.

3.9.3 Lay Out Plan and Compositions of the Depot

Lay out plan of the Depot at Si Iam Interchange is shown in **Figure 3.9.3 - 1** and detailed layout plan of Depot compositions is shown in **Figure 3.9.3 - 2**. There is necessary composition of the Depot buildings of 14 building as follows:

1) Main workshop Building includes heavy and light maintenance workshop - materials storage room and bogie repair in heavy maintenance workshop; tyre replacement and paint shop in main workshop, and offices. There is also the backup space to expand the additional train repair service in the future. The scenery of main workshop is shown in **Figure 3.9 - 3.** The lay out plan of main workshop is shown in **Figure 3.9 - 4**, and the interior of main workshop is shown in **Figure 3.9 - 5.** The main composition of main workshop is as follows:

1.1) Light Maintenance Workshop: The light maintenance activities include the preparation of the train for further service such as monitoring of washing windshield water, checking of lubricants etc.; and the routine treatment to maintain the availability of train to work (Routine Function Control) such as inspection, internal and external cleaning, minor repairs; removing and replacing of installed equipment on rail roof such as air conditioning, etc. There are also elevated area for working on the roof (roof working platform).

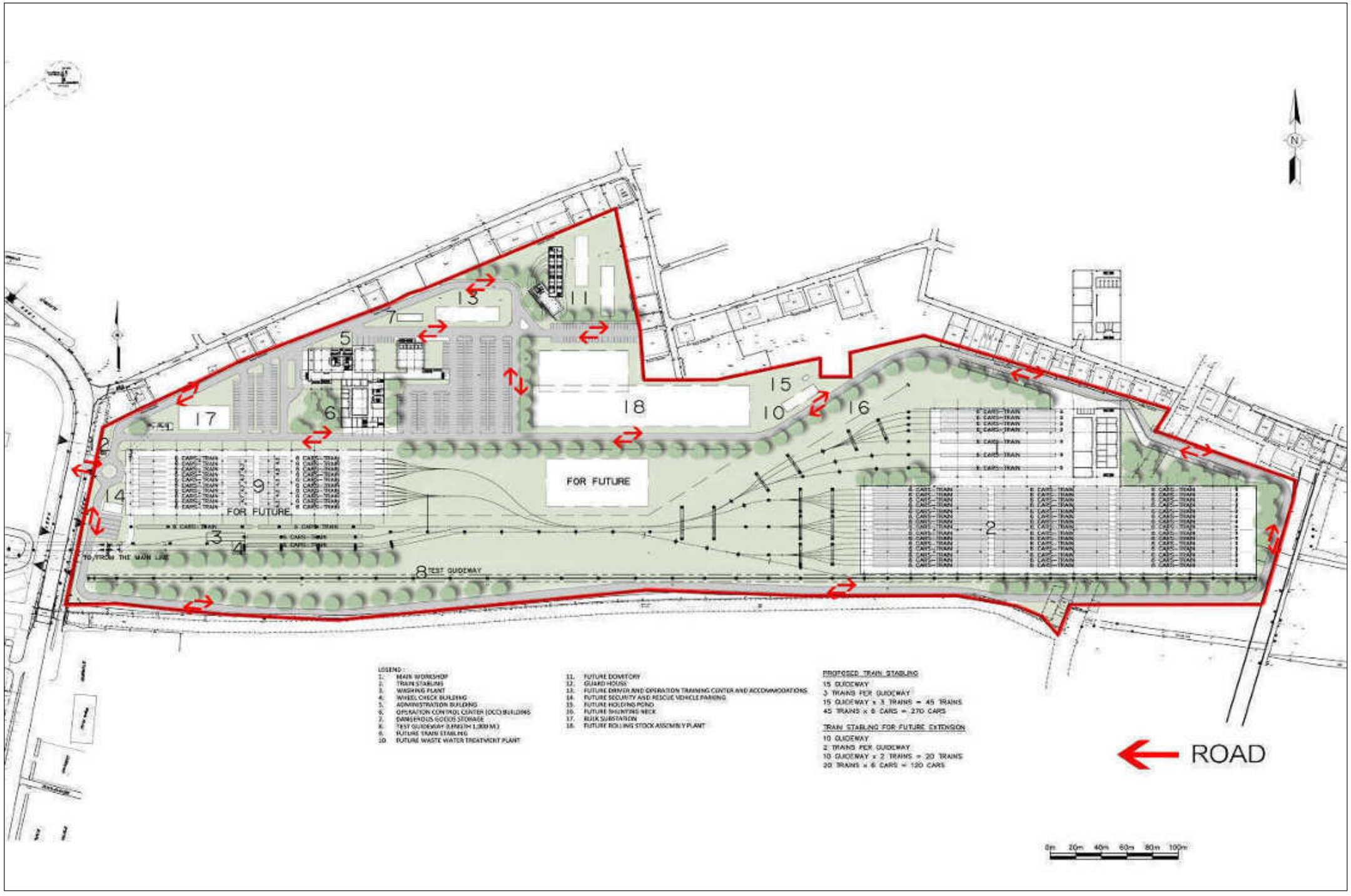


Figure 3.9.2 - 1 Lay out plan of the road around depot area.

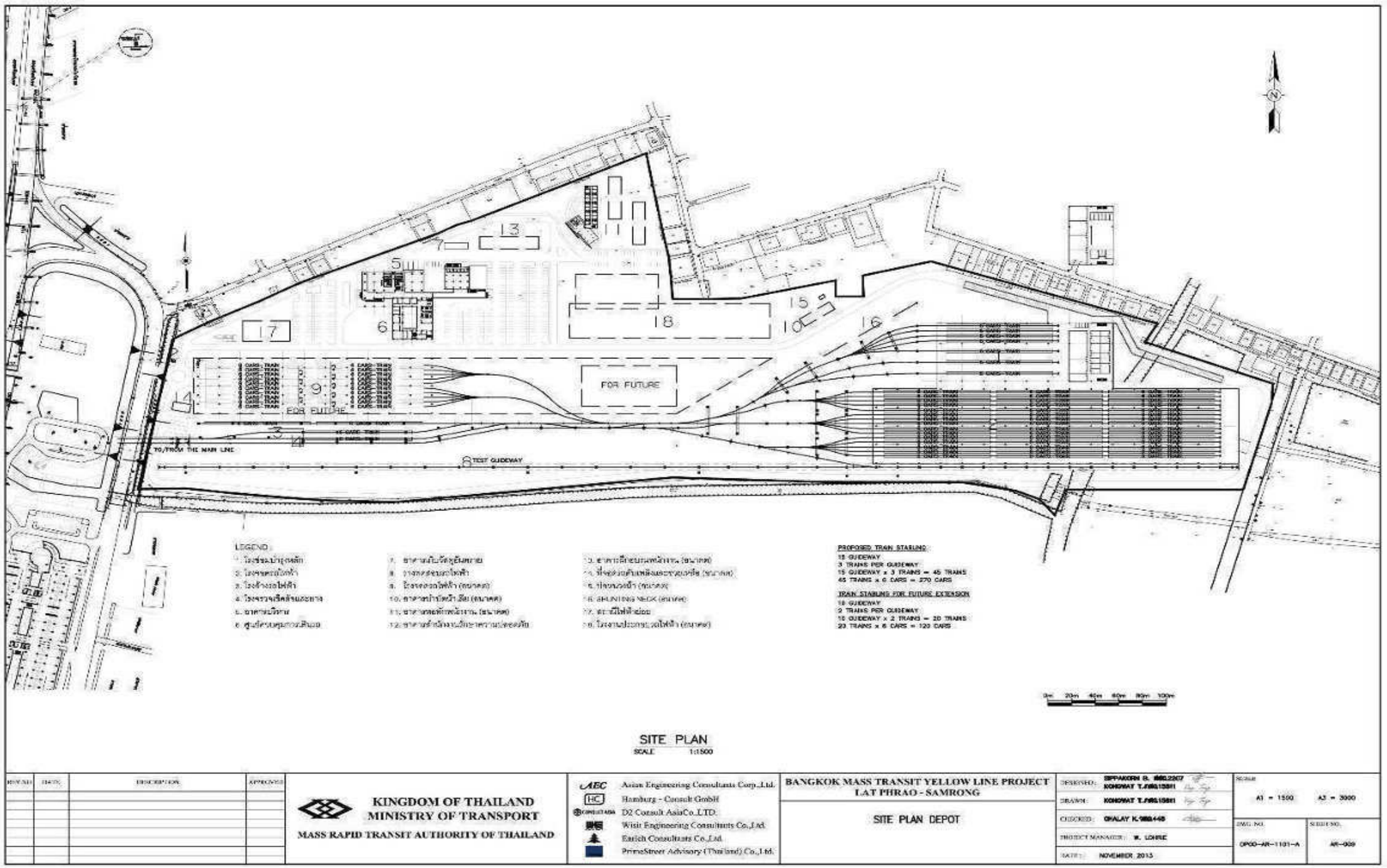


Figure 3.9.3 - 1 Lay out plan of the Depot at Si Iam Interchange.

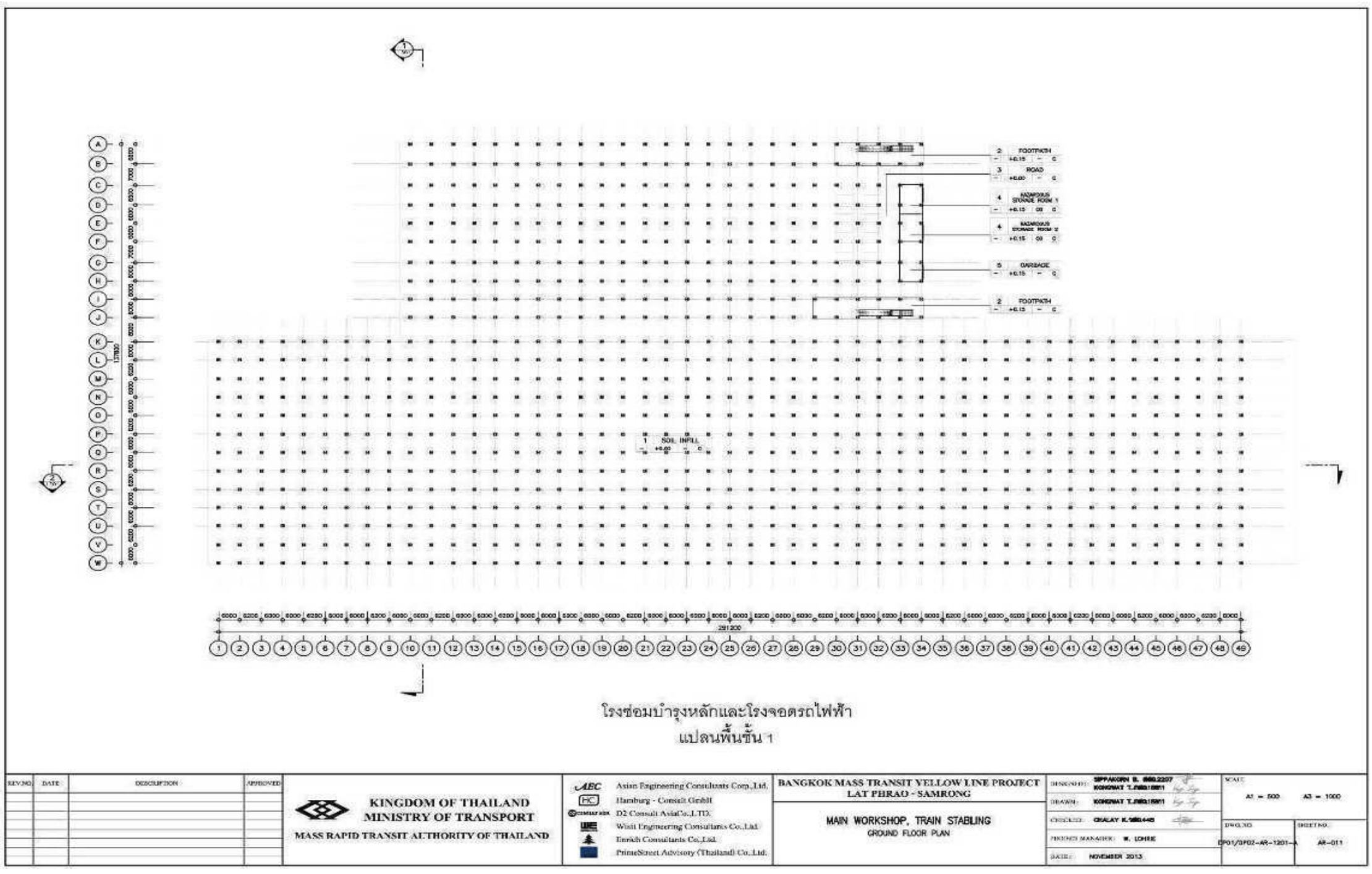


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (1/16)

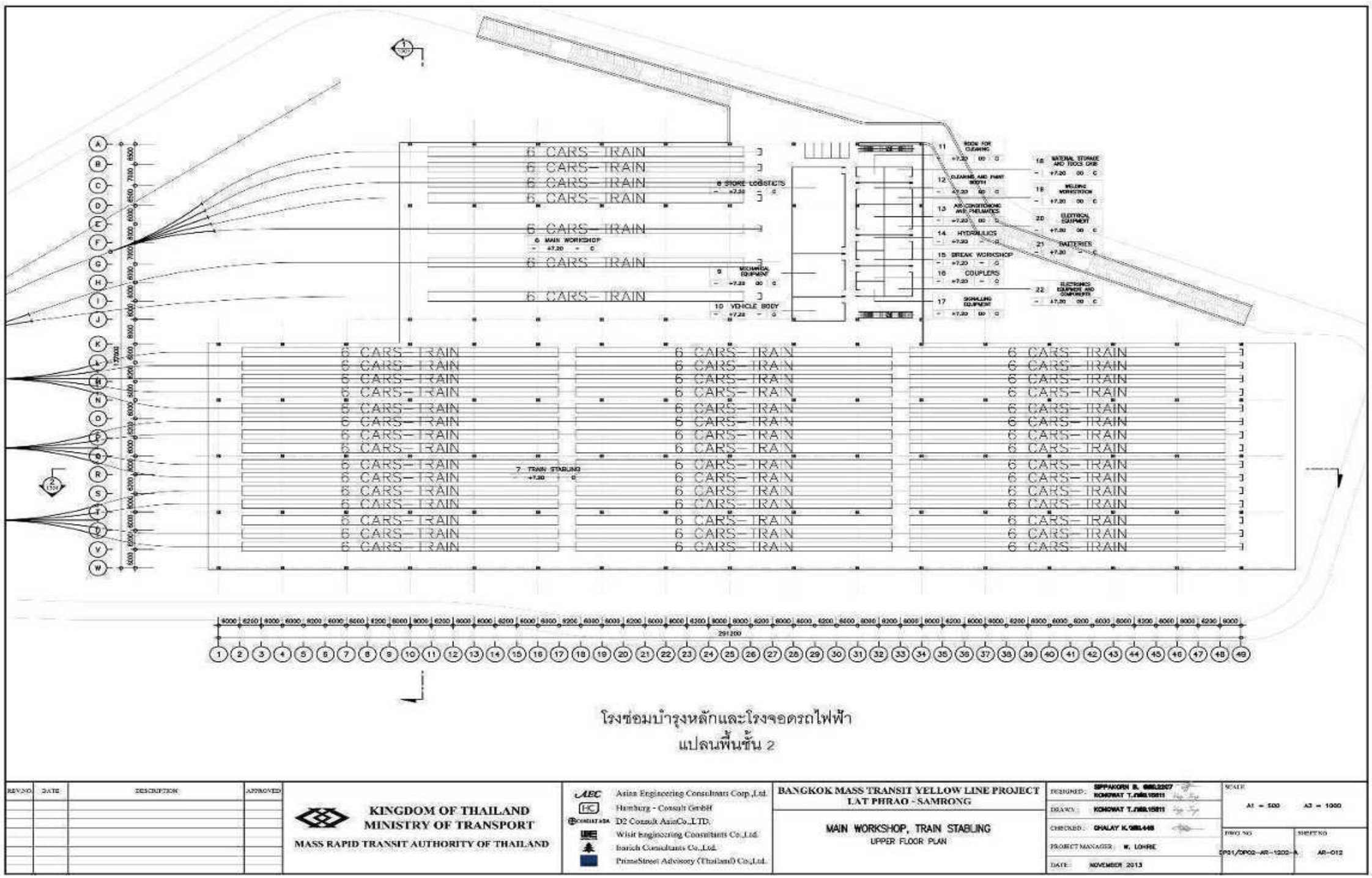


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (2/16)

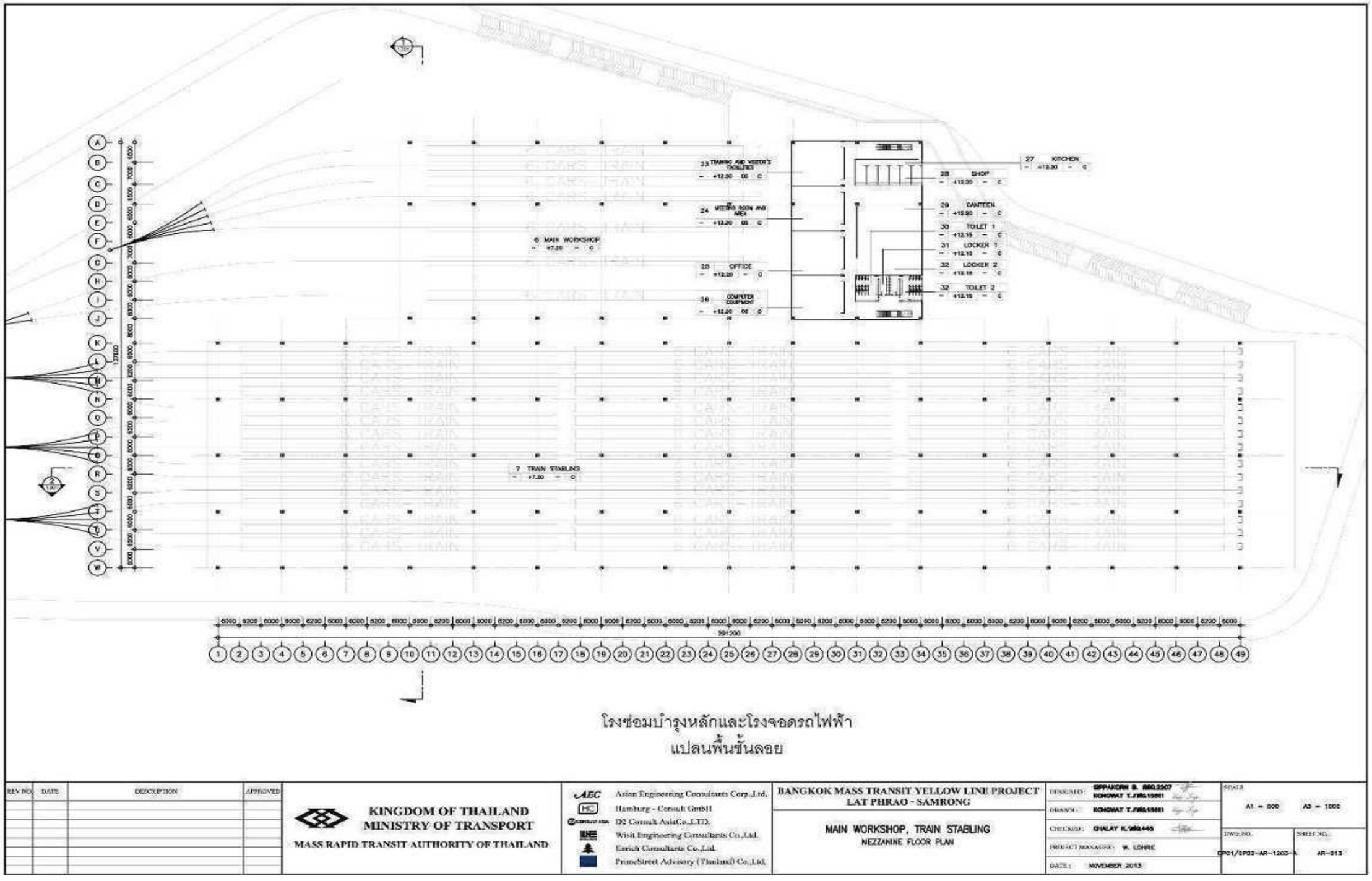


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (3/16)

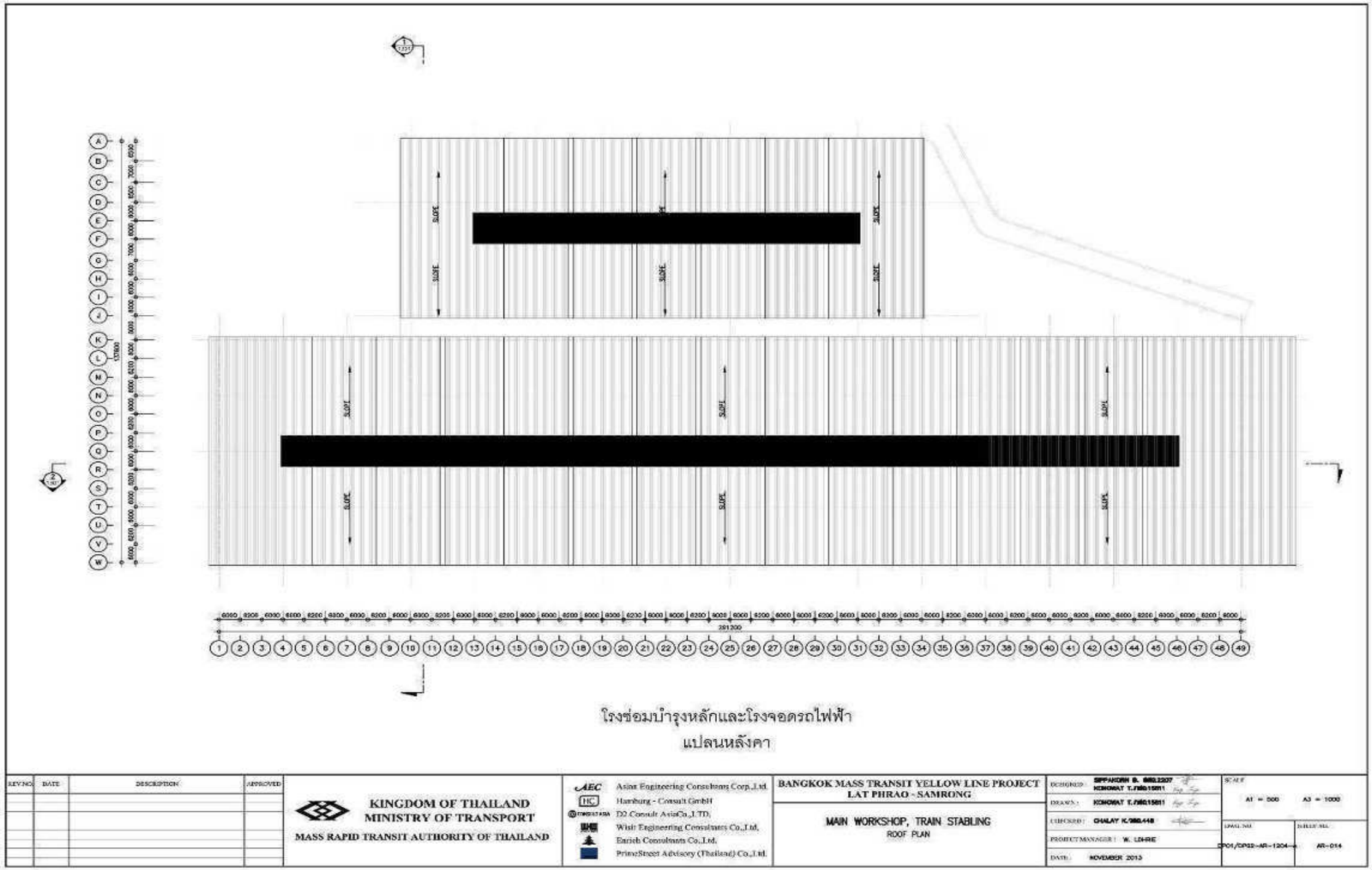


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (4/16)

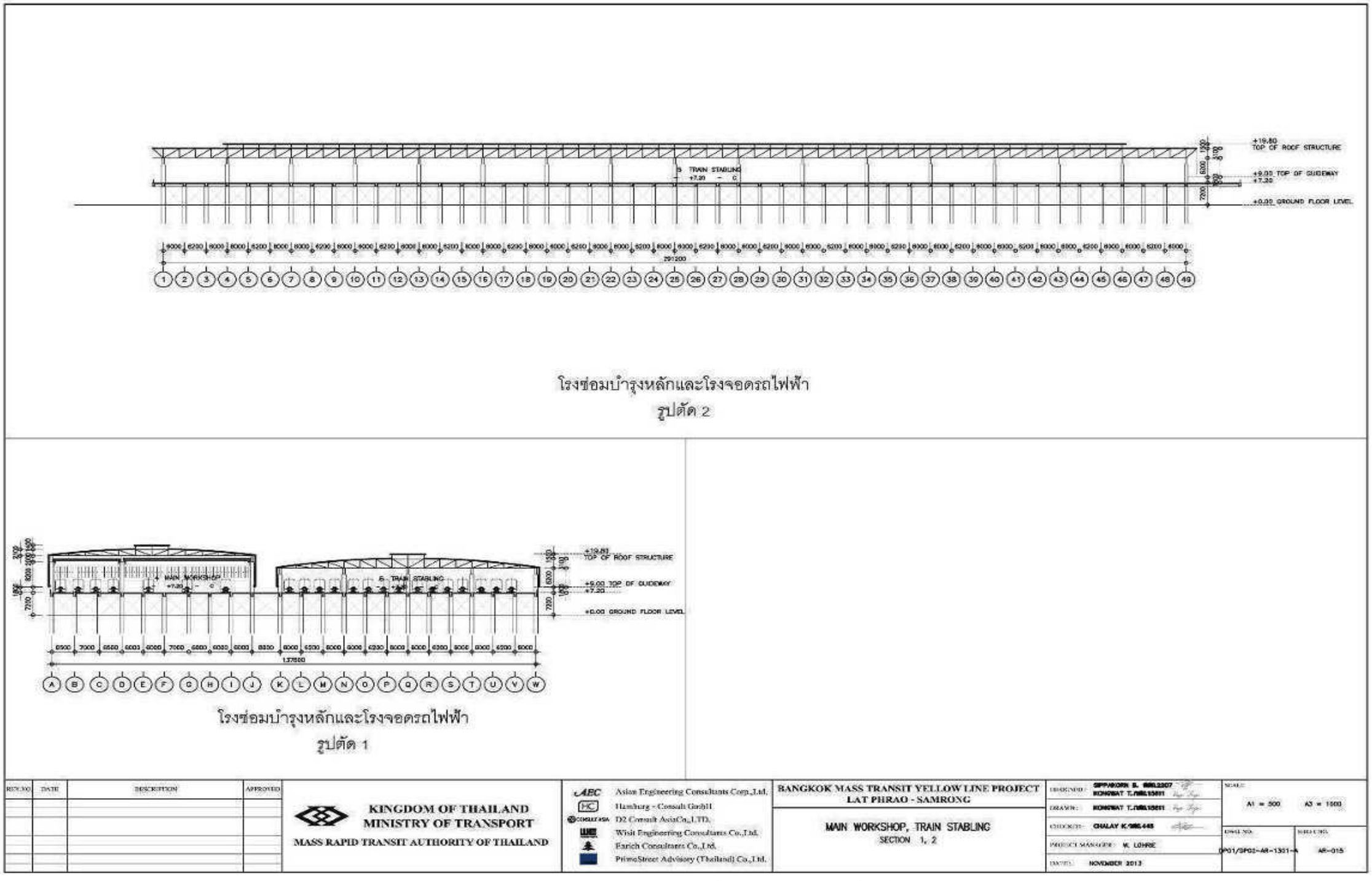
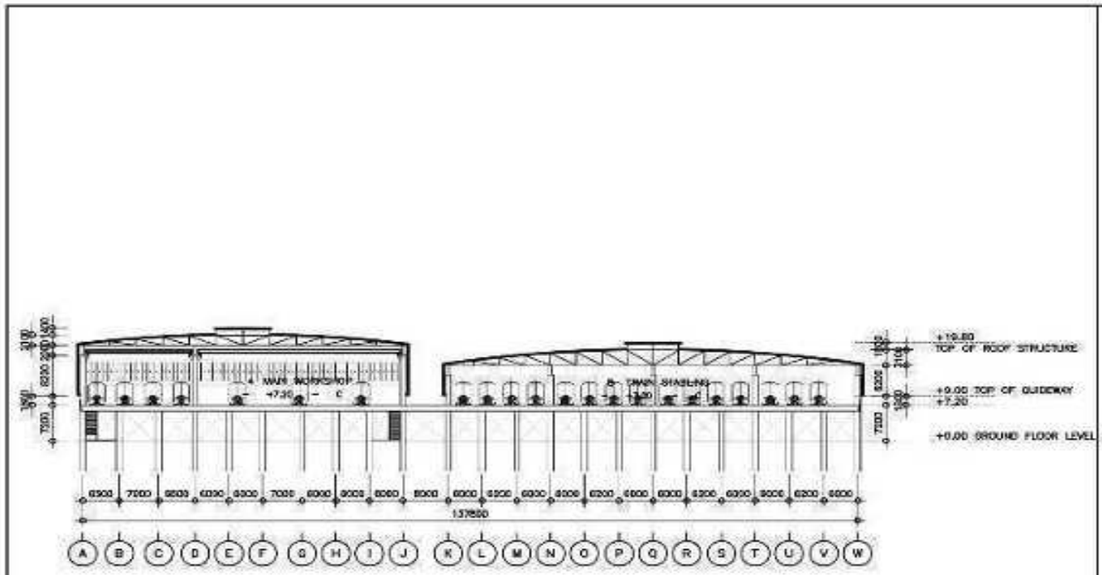
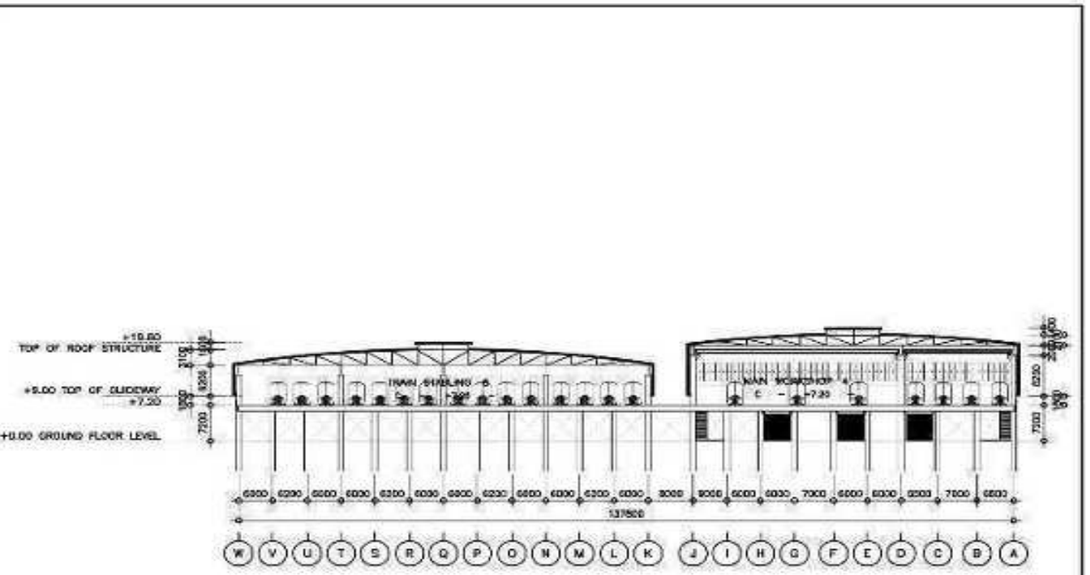


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (5/16)



โรงซ่อมบำรุงหลักและโรงจอดรถไฟฟ้า
รูปด้าน 2



โรงซ่อมบำรุงหลักและโรงจอดรถไฟฟ้า
รูปด้าน 3

REVISION	DATE	DESCRIPTION	APPROVED

KINGDOM OF THAILAND
MINISTRY OF TRANSPORT
MASS RAPID TRANSIT AUTHORITY OF THAILAND

AEC Asian Engineering Consultants Corp.,Ltd.
HC Hamburg - Consult GmbH
D2A D2 Consult AsiaCo.,LTD.
WE Wiest Engineering Consultants Co.,Ltd.
Bonich Consultants Co.,Ltd.
PrimeStreet Advisory (Thailand) Co.,Ltd.

BANGKOK MASS TRANSIT YELLOW LINE PROJECT
LAT PHRAO - SAMRONG

MAIN WORKSHOP, TRAIN STABLING
SECTION 2, 3

DESIGNED: SIPPAKORN B.
DRAWN: KONGNAT T.
CHECKED: CHALAY K.
PROJECT MANAGER: W. LOHRE
DATE: NOVEMBER 2013

SCALE: A1 = 500 A3 = 1000
DWG NO.: DP01/DP02-AR-1303-A
SHEET NO.: AR-017

Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (6/16)

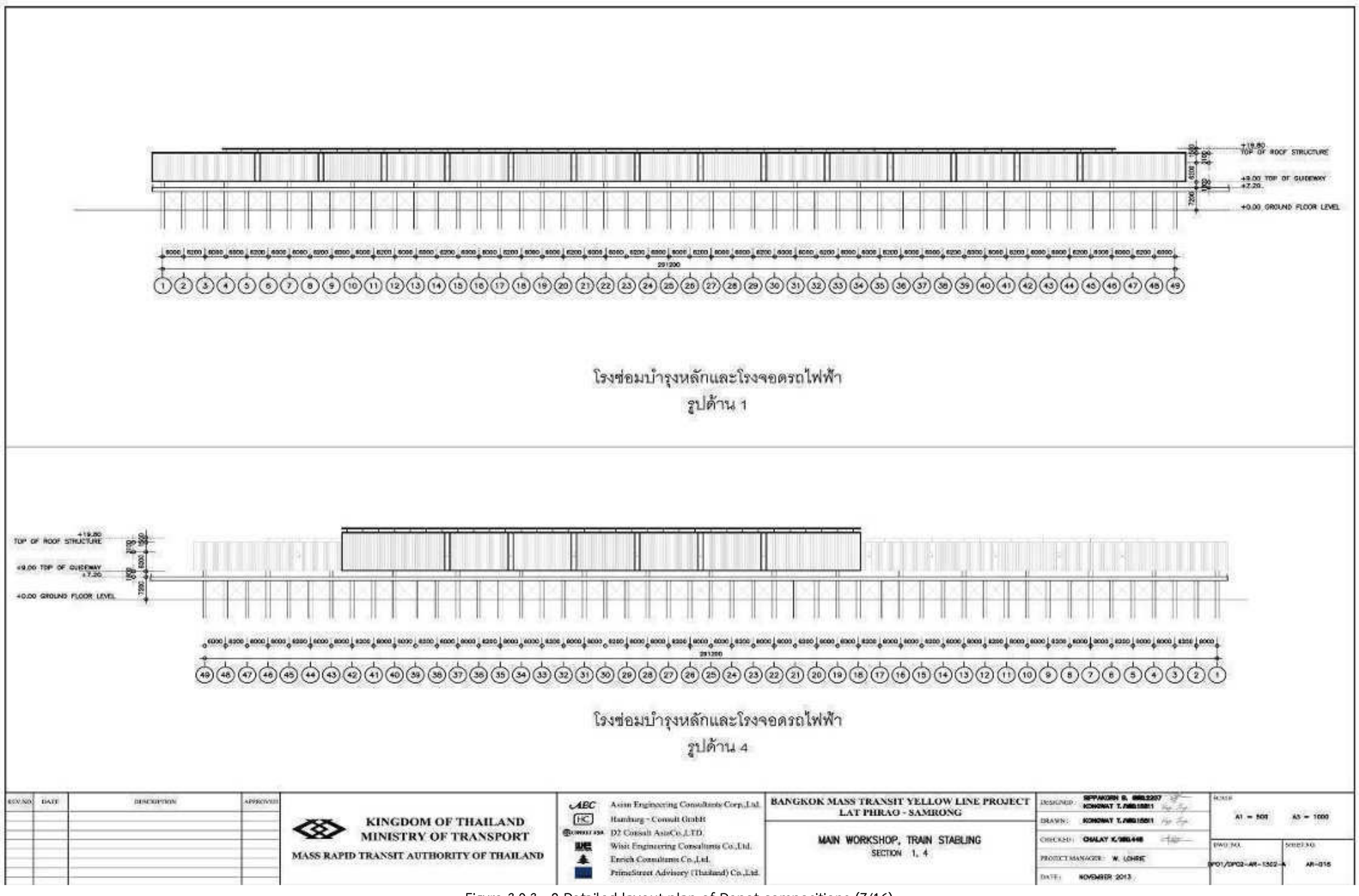


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (7/16)

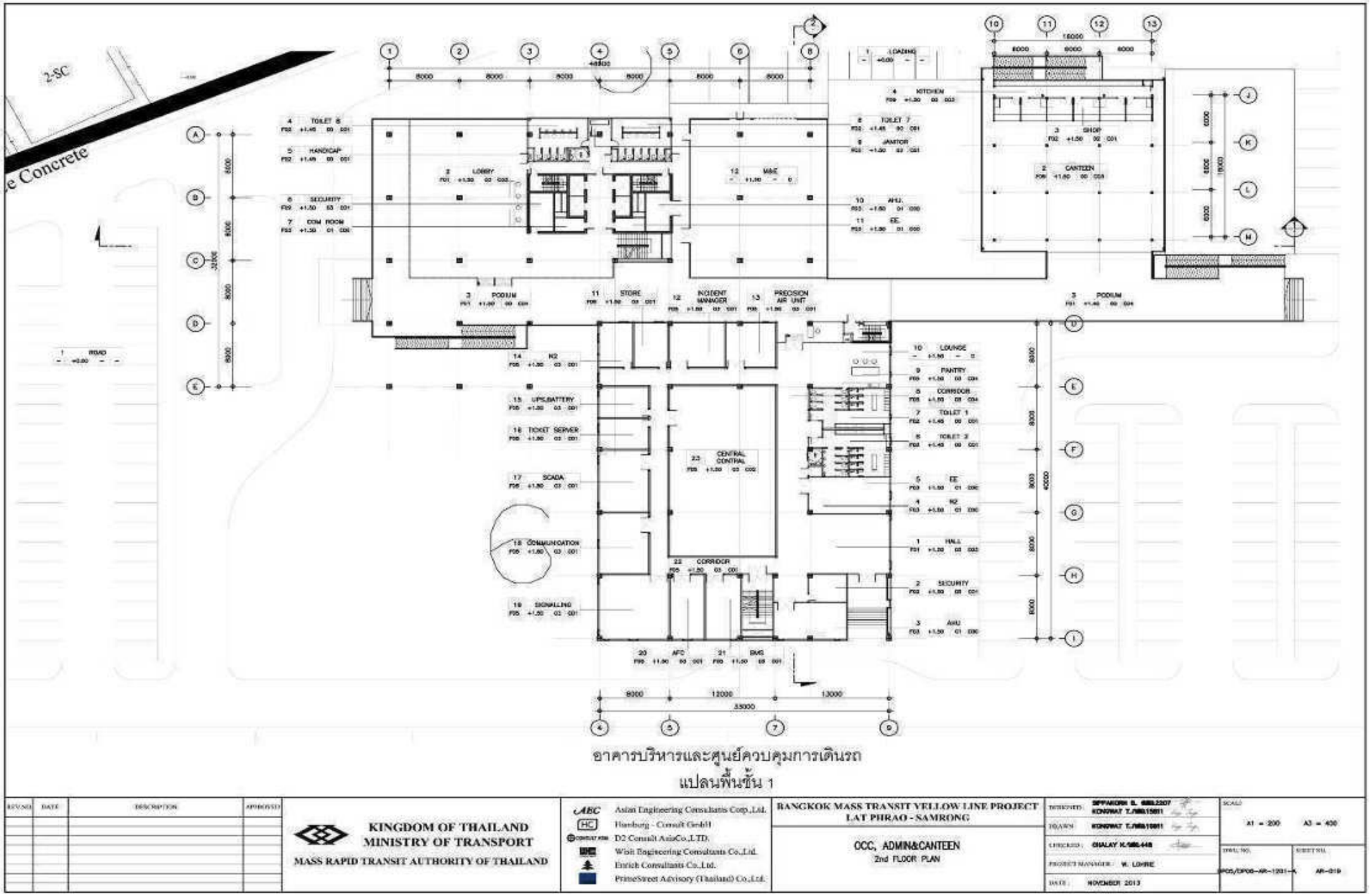


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (8/16)

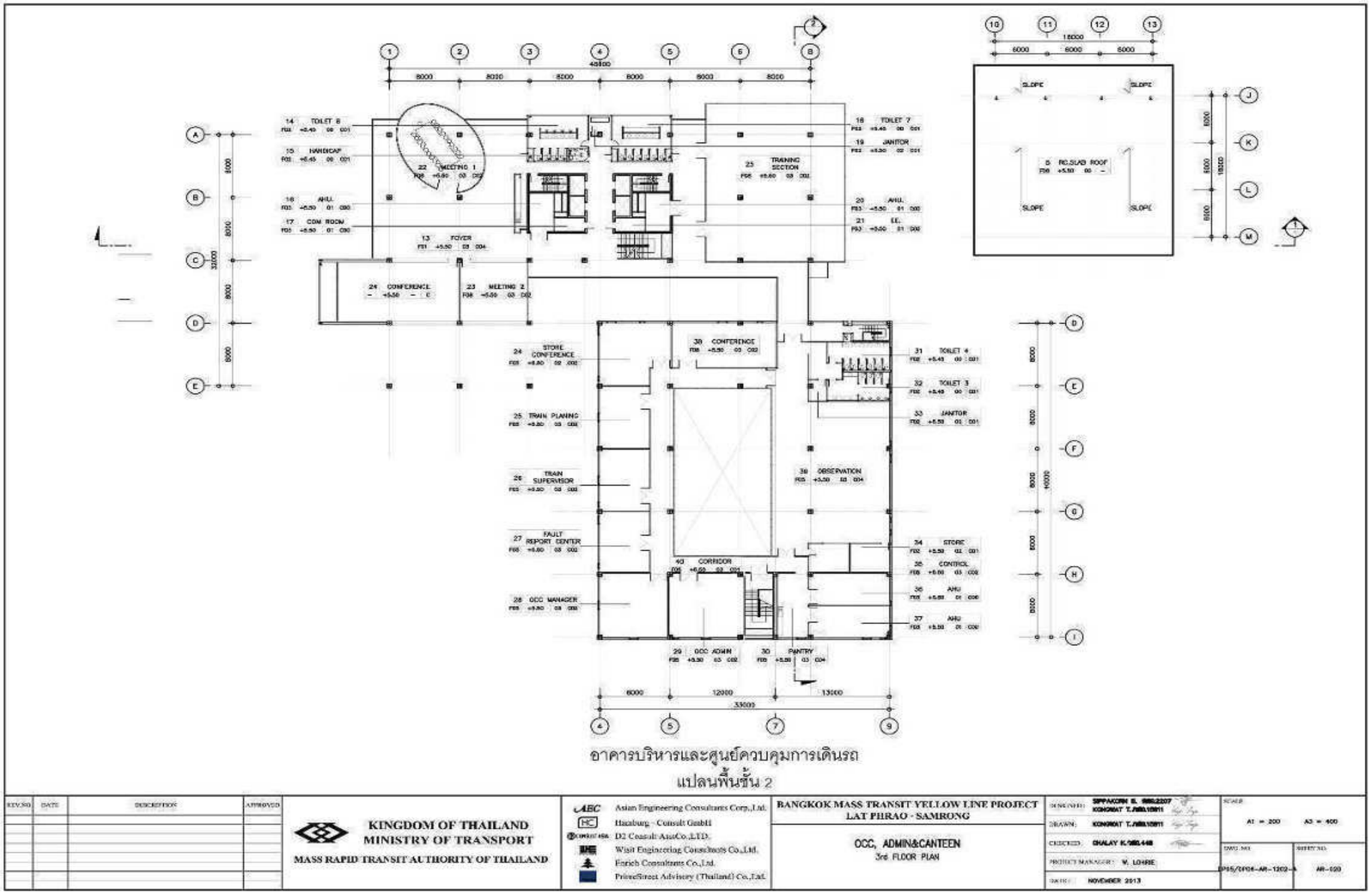


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (9/16)

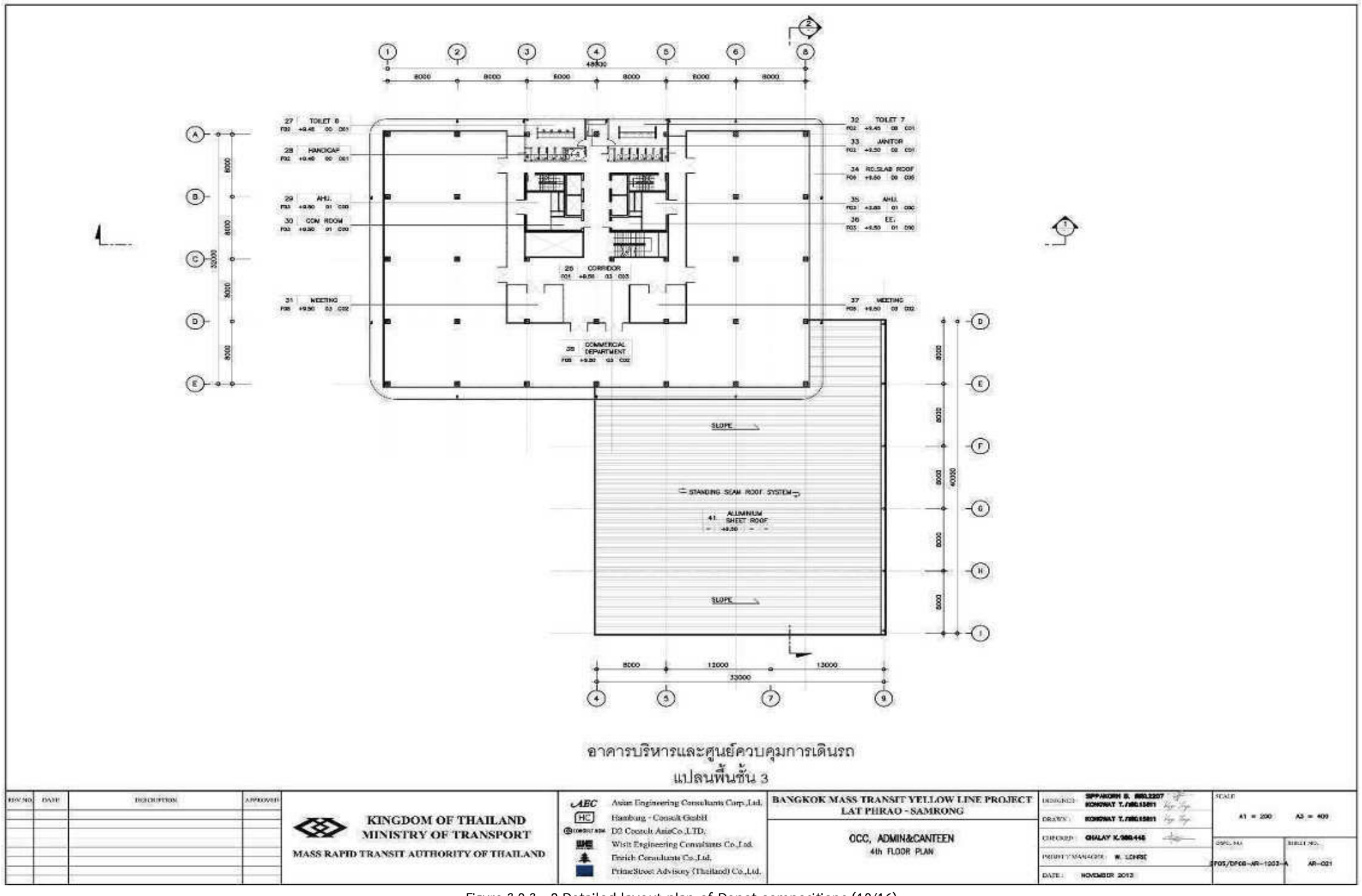


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (10/16)

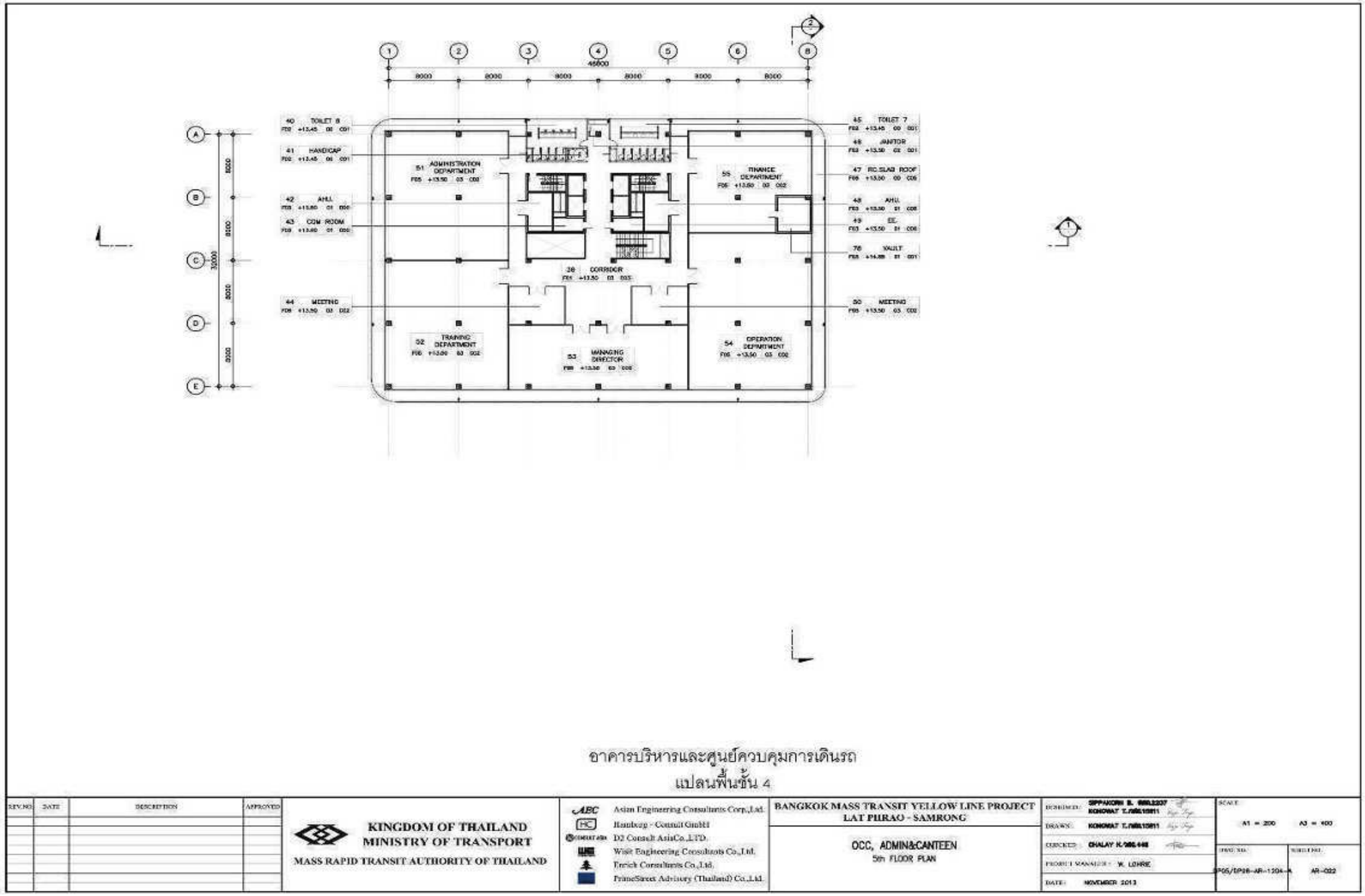


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (11/16)

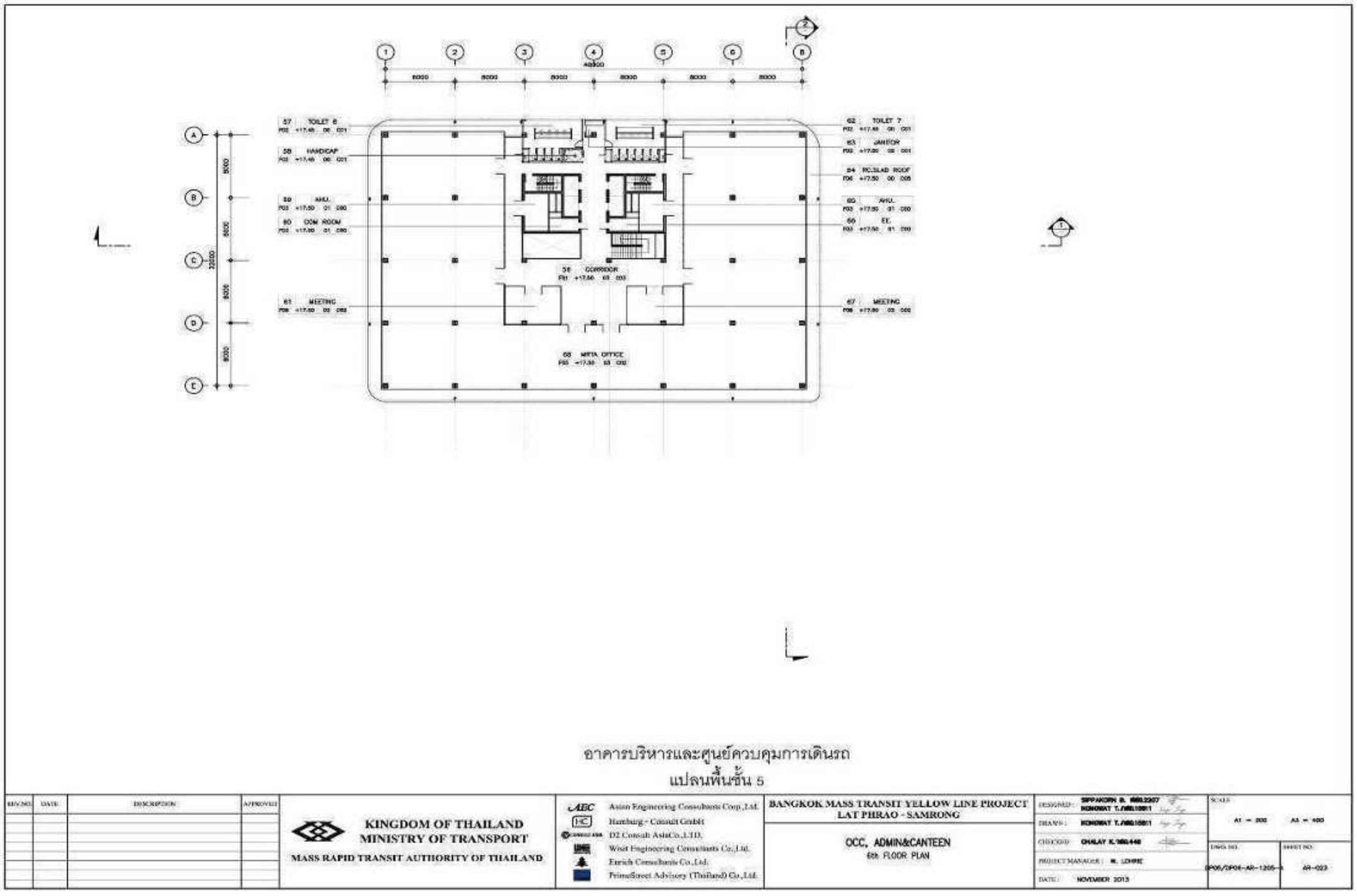


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (12/16)

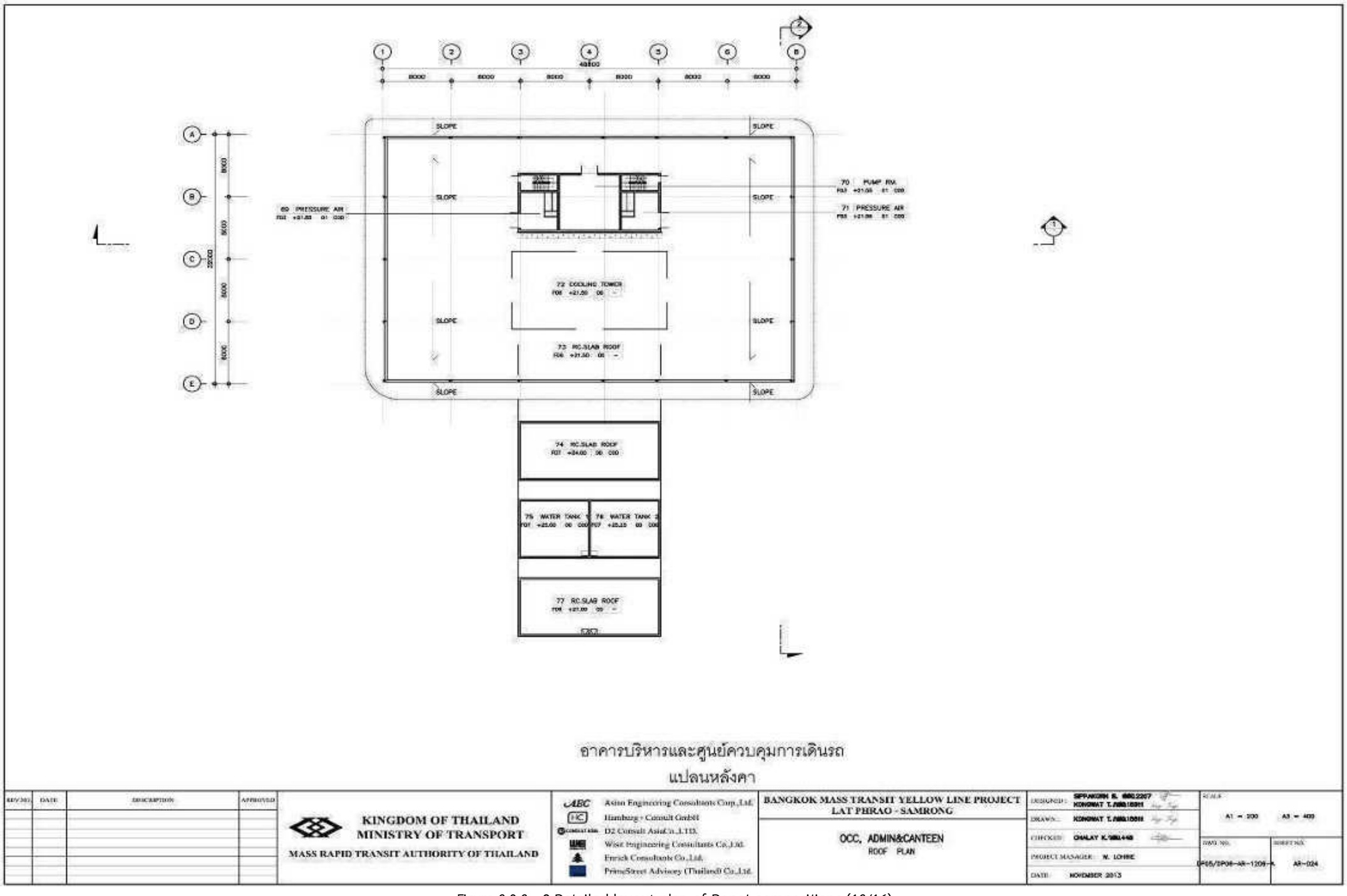


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (13/16)

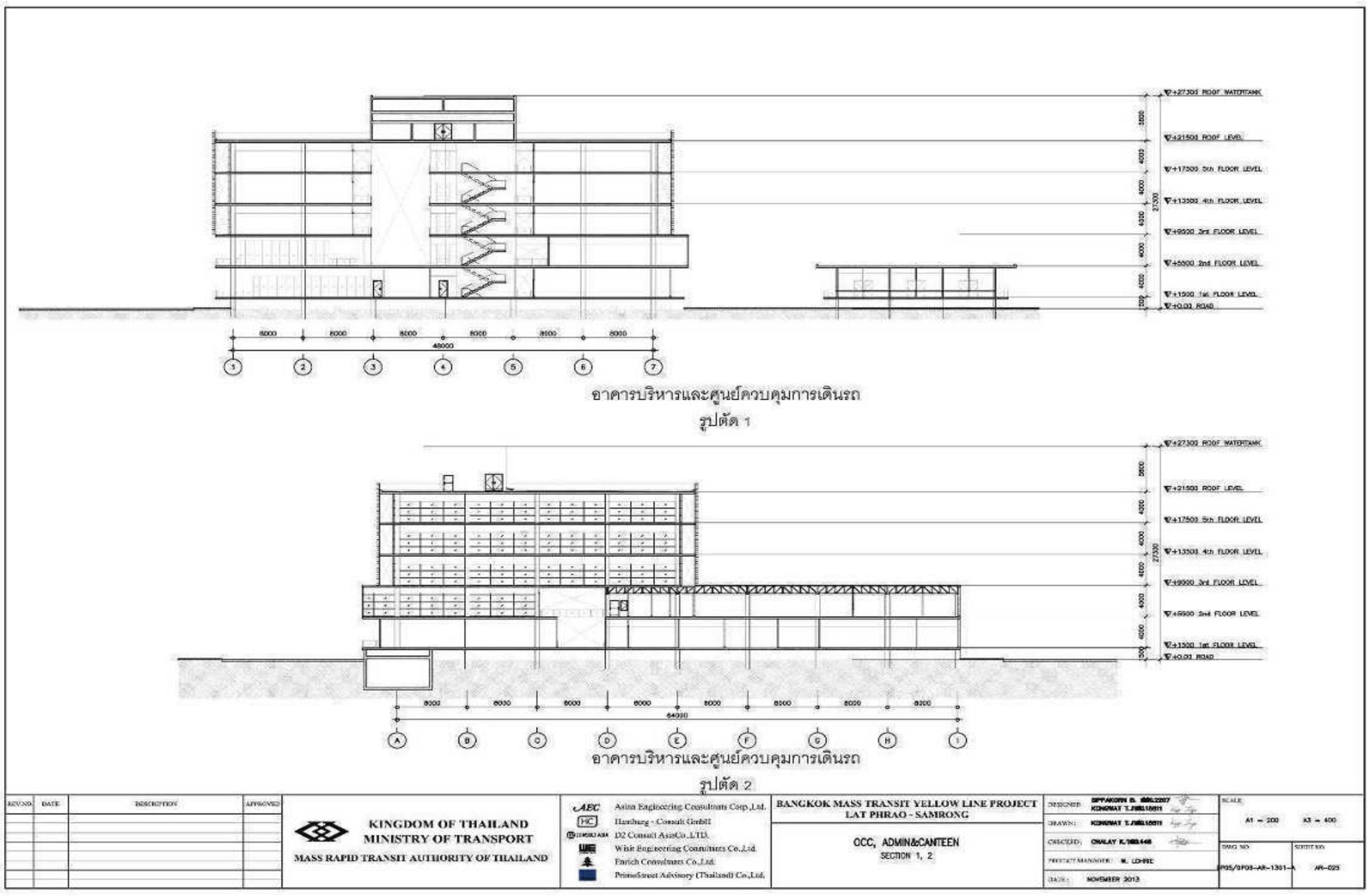
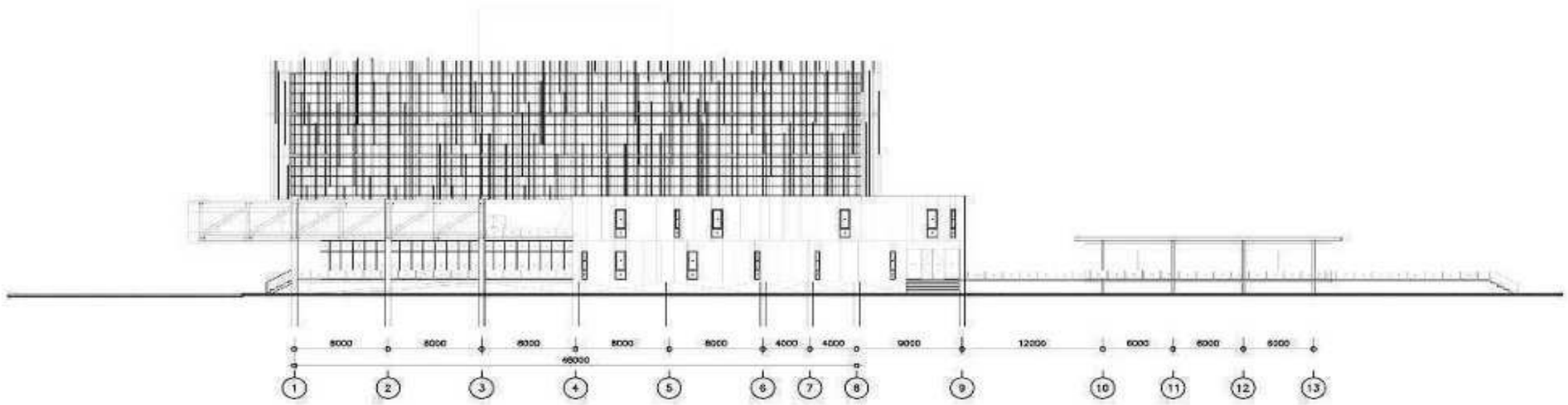
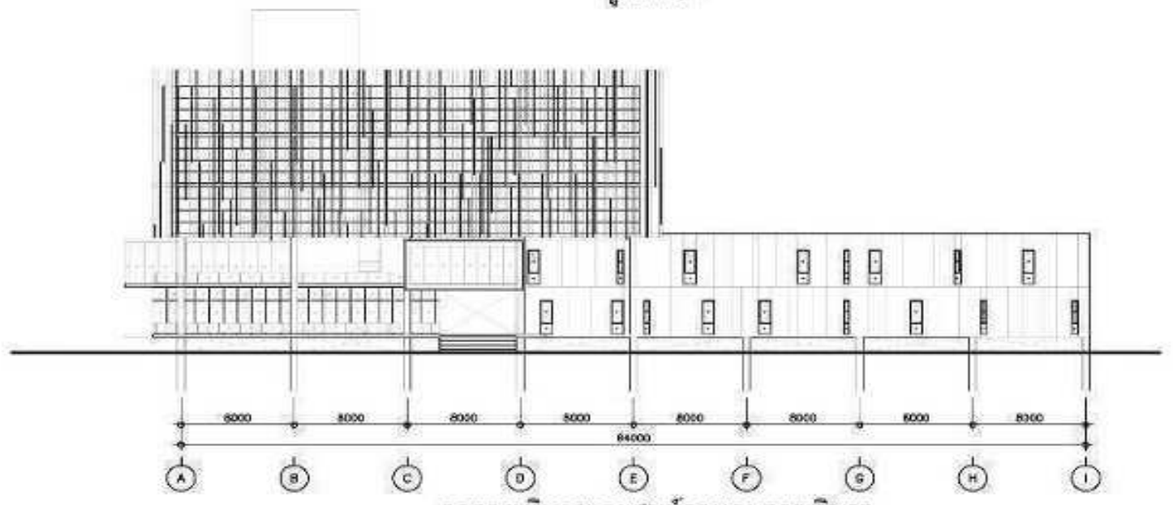


Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (14/16)



อาคารบริหารและศูนย์ควบคุมการเดินรถ
รูปด้าน 1



อาคารบริหารและศูนย์ควบคุมการเดินรถ
รูปด้าน 2

REV NO.	DATE	DESCRIPTION	APPROVED

KINGDOM OF THAILAND
MINISTRY OF TRANSPORT
MASS RAPID TRANSIT AUTHORITY OF THAILAND

Asian Engineering Consultants Corp.,Ltd.
Hamburg - Consult GmbH
D2 Consult AsiaCo.,LTD.
Wisit Engineering Consultants Co.,Ltd.
Enrich Consultants Co.,Ltd.
PrimeStreet Advisory (Thailand) Co.,Ltd.

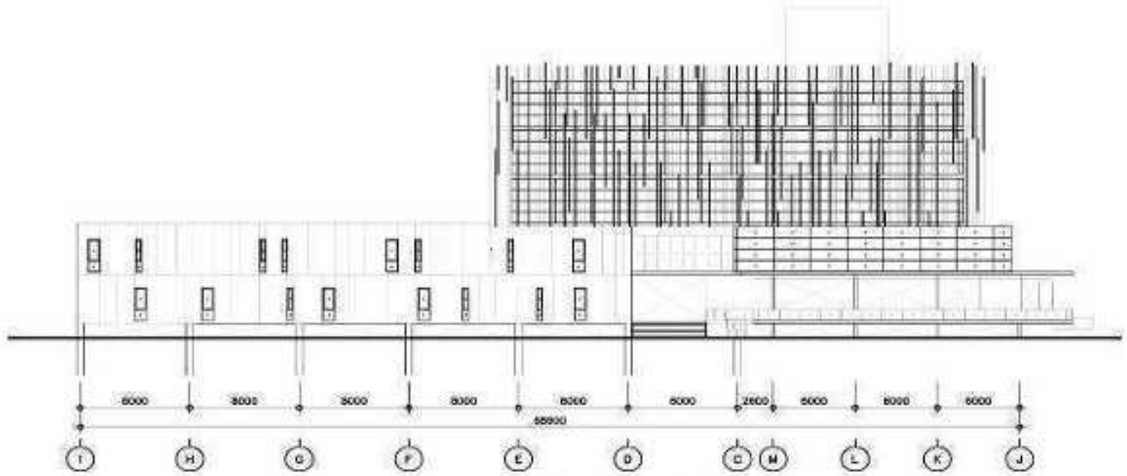
BANGKOK MASS TRANSIT YELLOW LINE PROJECT
LAT PHRAO - SAMRONG

OCC, ADMIN&CANTEEN
ELEVATION 1, 2

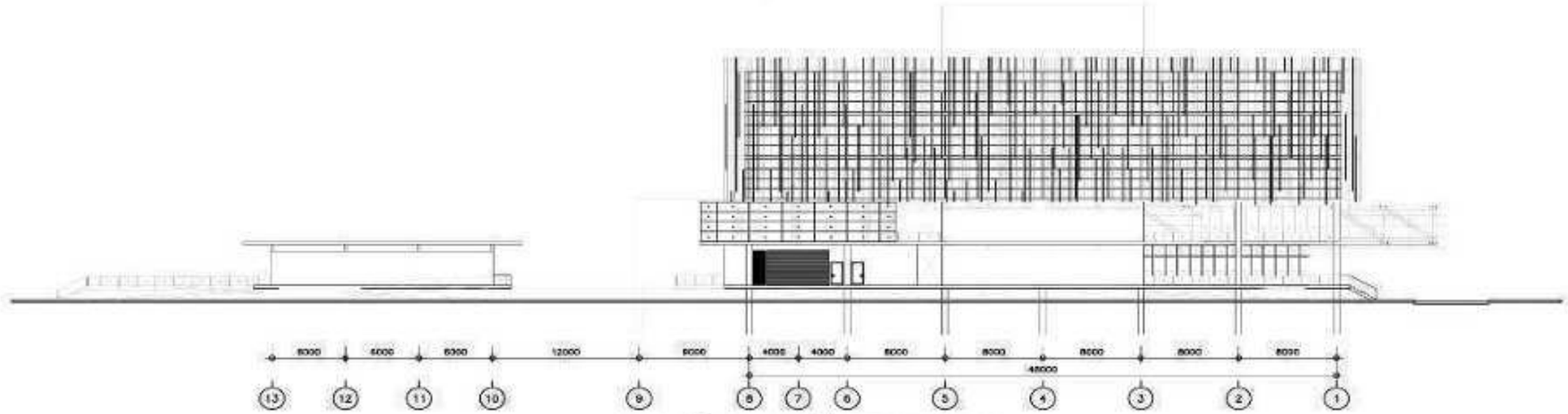
DESIGNED: SIPPAKORN B.
KONGRAT T.
DRAWN: KONGRAT T.
CHECKED: CHALAY K.
PROJECT MANAGER: W. LOHSE
DATE: NOVEMBER 2013

SCALE: A1 = 200 A3 = 400
DWG NO.: DPOS/DP36-AR-1302-A
SHEET NO.: AR-025

Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (15/16)



อาคารบริหารและศูนย์ควบคุมการเดินรถ
รูปด้าน 3



อาคารบริหารและศูนย์ควบคุมการเดินรถ
รูปด้าน 4

REV.NO.	DATE	DESCRIPTION	APPROVED

KINGDOM OF THAILAND
MINISTRY OF TRANSPORT
MASS RAPID TRANSIT AUTHORITY OF THAILAND

AEC Asian Engineering Consultants Corp.,Ltd.
HC Hamburg - Consult GmbH
D2 Consult AsiaCo.,LTD.
WE Wisit Engineering Consultants Co.,Ltd.
Enrich Consultants Co.,Ltd.
PrinceStreet Advisory (Thailand) Co.,Ltd.

BANGKOK MASS TRANSIT YELLOW LINE PROJECT
LAT PHRAO - SAMRONG

OCC, ADMIN&CANTEEN
ELEVATION 3, 4

DESIGNED : SIPPAKORN B.
DRAWN : KONGWAT T.
CHECKED : CHALAY B.
PROJECT MANAGER : W. LOHRE
DATE : NOVEMBER 2013

SCALE : A1 = 200 A3 = 400
DRAWING NO. : DP05/DP06-AR-1303-A
SHEET NO. : AR-027

Figure 3.9.3 - 2 Detailed layout plan of Depot compositions (16/16)

Figure 3.9.3 - 3 The Scenery of Main Workshop

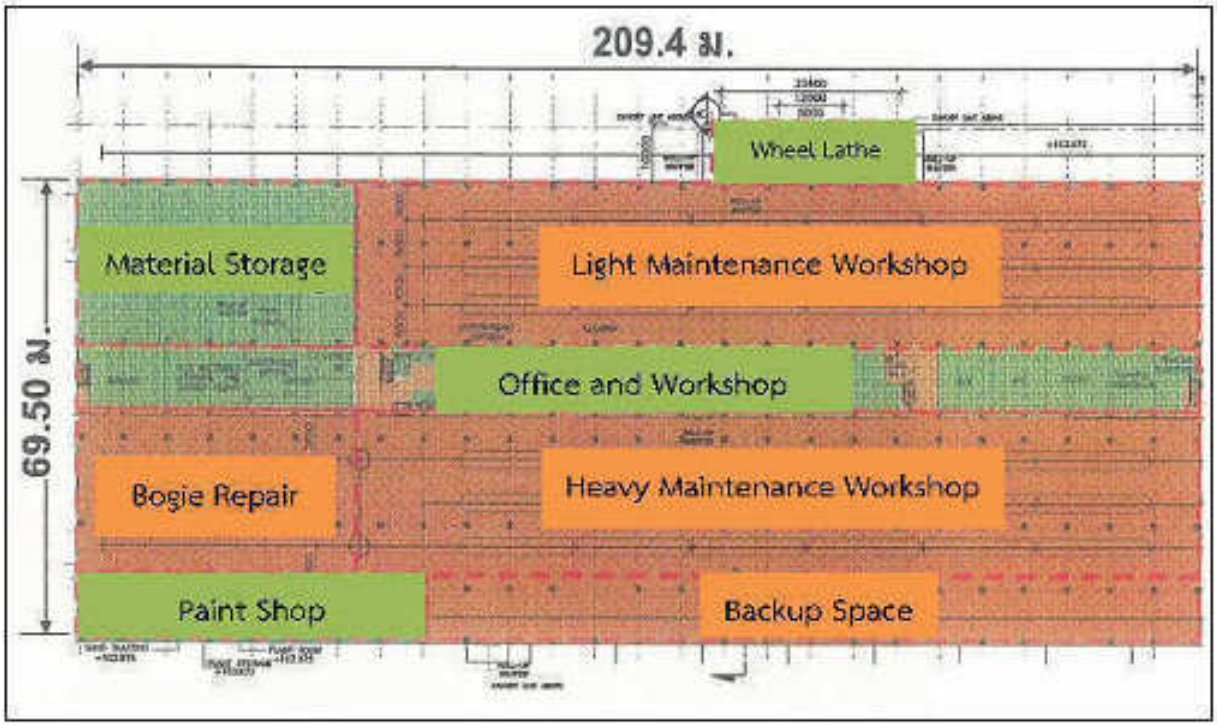


Figure 3.9.3 - 4 The lay out plan of main workshop

Figure 3.9.3 - 5 the Interior of Main Workshop

1.2) Heavy Maintenance Workshop: The general heavy maintenance activities include major overhaul, bogie exchange or repair, heavy repairs (replacing heavy parts from underground), regular maintenance, replacement of parts (batteries, compressor, electronic), body repair, tire changing tires, and painting.

1.3) Offices and Maintenance Workshops: such as training rooms, meeting rooms, brake repair room, and door – window repair room, etc.

A) Repair rooms are designed to be located on the ground floor, between the light and heavy maintenance workshop because of their relatively unclean compared to the office area on the upper floor.

B) Engineering management office and maintenance office are separate office and are between the light and heavy maintenance workshop in order to closely oversee both workshops.

C) Repair rolling stock on the ground floor and second floor of the main workshop. There are windows in foremen office for clearly overseeing the activities within the light and heavy maintenance workshop. The ground floor also has a bathroom, locker and a small living room for maintenance staffs.

D) The light and heavy maintenance workshop are designed to be located together in order to use space more efficiently, including work benches, tool boxes, shelves for replacement parts and material, test and measuring devices. The provided equipment must be able to use in compliance with the provided electric railway. As well as space nearby bogie repair are provided to operate on brake systems, electric motors and gears, current collectors, auxiliary batteries, main switches, electric and electro-mechanic (as door mechanism, compressors, signaling, etc.), electronic equipment as vehicle control, radio, passenger information, glass and interior decoration, etc.

1.4) Material storage room is for storing spare parts for train maintenance by the Pallet Storage System. There are two types of forklift truck, including Electric Powered Forklift Truck and Reach Truck.

1.5) Bogie repair facility is for lifting bogie out of car body. The bogie drop is applied to separate the bogie of monorail system to hold with the main track beam and the beam can rotate up or down. Engineering specification of the bogie repair facility of monorail system is shown in **Figure 3.9.3 - 6.**

1.6) Wheel diagnostics and tyre replacement facility: After the train has started operating services for a certain time, the tyre condition will start to wear and tear due to friction between the wheels and tires. It is necessary to construct the wheel diagnostic facility to check the condition of the tires periodically over time, or by the specified distance according to the maintenance schedule by the tyre manufacturer. The wheel diagnostic and tyre replacement tool is shown in **Figure 3.9.3 - 7** and internal condition of the wheel diagnostics and tyre replacement facility is shown in **Figure 3.9.3 - 8.**

1.7) Paint Shop: The electric railway need to be painted from time to time. due to accidental and environment. These can be summarized as follows:

A) Paint shop in the Depot is prepared for the care and maintenance of color of car body which has been painted since the manufacturing from the train manufacturer in abroad. The most applications are to stick the sign sticker on both sides of train. The paint shop is designed to be dust free and can conveniently and effectively operate. A new paint to the car body will be performed when the train had an accident to the color of the car body, which is a very rare occurrence, or based on lifetime of colors must be repainted in every 10-15 years.

B) Paint shop is a room with a closed system that eliminating pollutants from colour used, and without affecting the other areas. The colors used are water - based color or other types, with low pollution according to the technical specification of the train manufacturer. As well as waste from the painting process will be separately collected in separate containers, and will be eliminated with the hazardous waste by the hazardous solid waste disposal agency.

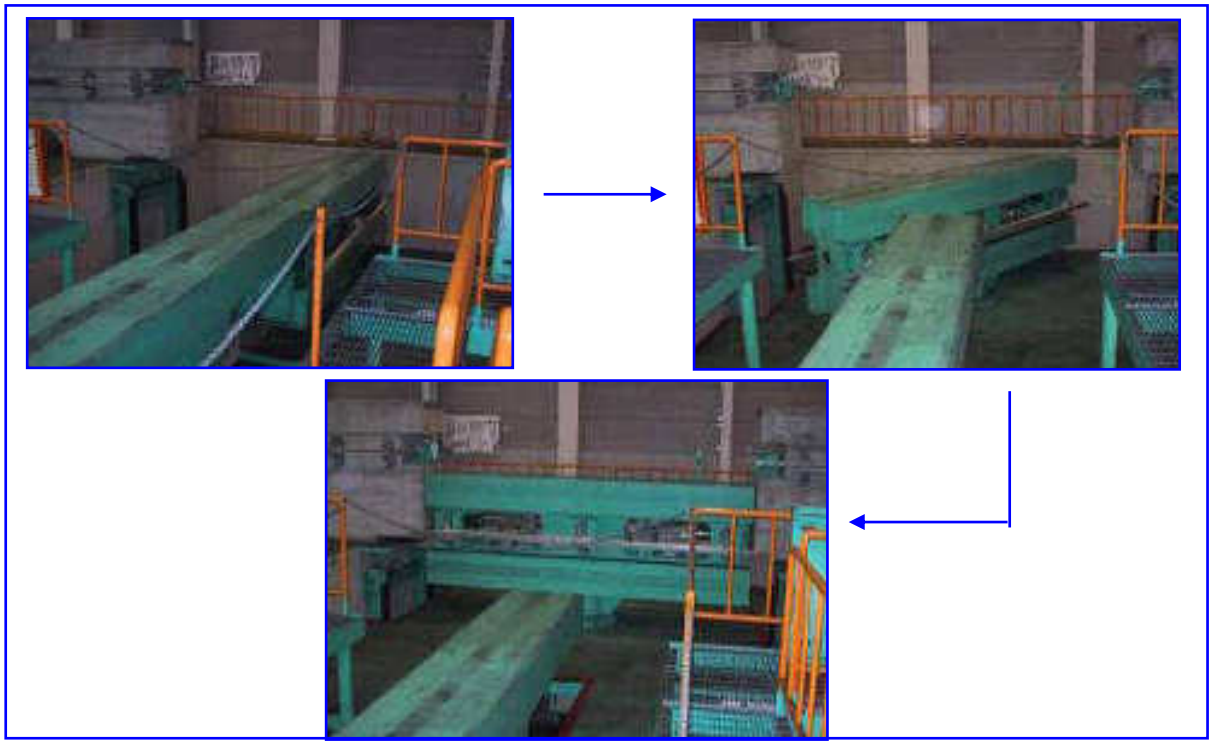


Figure 3.9.3 - 6 Engineering Specification of the Bogie Repair Facility of Monorail System

Figure 3.9.3 - 7 The Wheel Diagnostic and Tyre Replacement tools

Figure 3.9.3 - 8 Internal Condition of the Wheel Diagnostics and Tyre Replacement Facility

2) Administration Building and Operation Control Center consist of meeting room, living room, electrical control room, strong room, transformer room, chiller and pump room, battery room, UPS room, low voltage room, central traffic control, SCADA, gas bottling room, etc. Operation Control Center (OCC) is the central control and monitoring the operation of the entire train system, during and after providing services to the public. The staff can control systems as follows:

2.1) To control the train operation according to the regular schedule, and to respond to unusual situations and emergencies in order to reach high efficiency and safety of train operation.

2.2) To control the operation of support systems such as power system and ventilation systems, etc.

2.3) To control communications system with both staff and the passenger.

3) Other Buildings

3.1) Permanent way workshop building is near the main workshop, intended to keep the rails and the third rails. It is also used as maintenance, parking and fueling for service vehicles. Scenery and lay out plan of the permanent way workshop building is shown in **Figure 3.9.3 - 9**. Inside the permanent way workshop building, there are tools and equipment for track switching, switch and frog point and which is enough space for welding. There is also an outside storage material area with no roof covering. Moreover, the repair workshop and storage material area with roof covering is intended to keep rails, third rails, frog point and diverter. By the other side of repair workshop, there are rail repair workshop, rails work storage, signaling storage and associated offices.

Figure 3.9.3 - 9 Permanent way workshop building

The review of the structures of repair workshop in switch section in general revealed that there are merger switching of, two, three, four or five routes, which can be included into one route, inside the repair workshop of Monorail system. The following examples are shown in **Figure 3.9.3 - 10** and **Figure 3.9.3 - 11.**

3.2) Stabling Yard Building is for parking the train and cleaning inside of the car body, therefore, there are the train cleaner room at each end of the Stabling Yard for convenience of cleaning. The scenery of Stabling Yard is shown in **Figure 3.9.3 - 12.** The lay out and cross-section of Stabling Yard is shown in **Figure 3.9.3 - 13.** It has a capacity of 18x 6 cars per train (18x6 - Car Trains), equivalent to 108 rolling stocks of Monorail.

3.3) Test track shelter is located at both ends of testing rails for the test team to get up and down, with the roof covering to prevent the test team and test equipment from the rain.

3.4) Train washing plant is shown in **Figure 3.9.3 - 14**. There is a roof over the train. The external of car body is cleaned in the train washing plant. The rails with a length of about 150 meters is in the back of train washing machine, which is sufficient for the train with 6 cars / trains. The train will gradually move into the building and slowly being cleaned, front, side, top, roof and back. Train washing machine is automation. The train can in – out of building by itself- propelling. The water from washing is stored in used water tanks and are recycled by the oil and mud extraction system.

3.5) Substation building is responsible for power supply to train systems by receiving the electricity from the Metropolitan Electricity Authority. There is also a standby diesel generator to supply the backup power in the event of a power supply failure, as shown in **Figure 3.9.3 - 15**.

3.6) Dangerous goods building is intended to temporarily keep the oil, grease and chemicals for deposal later. The storage materials area may be designed by using the Pallet Racking System with roof covering. The building is designed for forklift and truck driving in - out easily and safely.

3.7) Garbage storage building: The garbage from cleaning inside the train, plant, office, including the dust from streets and sidewalks, scraps from train lathing machine, residues from maintenance workshop and waste from septic tanks, will be stored in temporary garbage storage building for picking up by garbage gathering truck later. The building is designed to easily accessible of garbage gathering truck from the road, and there are hand washing sinks on the side of the building.

3.8) Dormitory building is provided for drivers, train controllers, maintenance staffs, etc.to use for temporary resting prior to their shift. Each room has a bathroom. Number of rooms and bathrooms are calculated from the number of employees at each shift. The number of employees are used to calculate the number of rooms, including driver, OCC staffs, train staff supervisors, yard supervisors, vehicle maintenance staff, etc. It is not necessary to provide accommodation for these staffs, including station controllers, ticket inspectors, building maintenance staffs, training documents staffs, administration staffs, marketing staffs, finance staffs and human resources staffs.

3.9) Driver office building is located close to the Stabling Yard, so that after the driver has already been assigned to work, the driver can easily walk to the train.

a) Driver office building consists of signing & receiving job assignment room, time scheduling and assistant office, inspector office, locker room, driver message board, driver supervisor

room, meeting room and driver room. The total required area is of approximately 182.50 square meters.

Figure 3.9.3 - 10 Osaka Monorail Depot where has switching of, three, four or five routes

Figure 3.9.3 - 11 KL Monorail Depot where has switching of four routes

Figure 3.9.3 - 12 The Scenery of Stabling Yard

Figure 3.9.3 - 13 Stabling Yard

Figure 3.9.3 - 14 Train Washing Plant

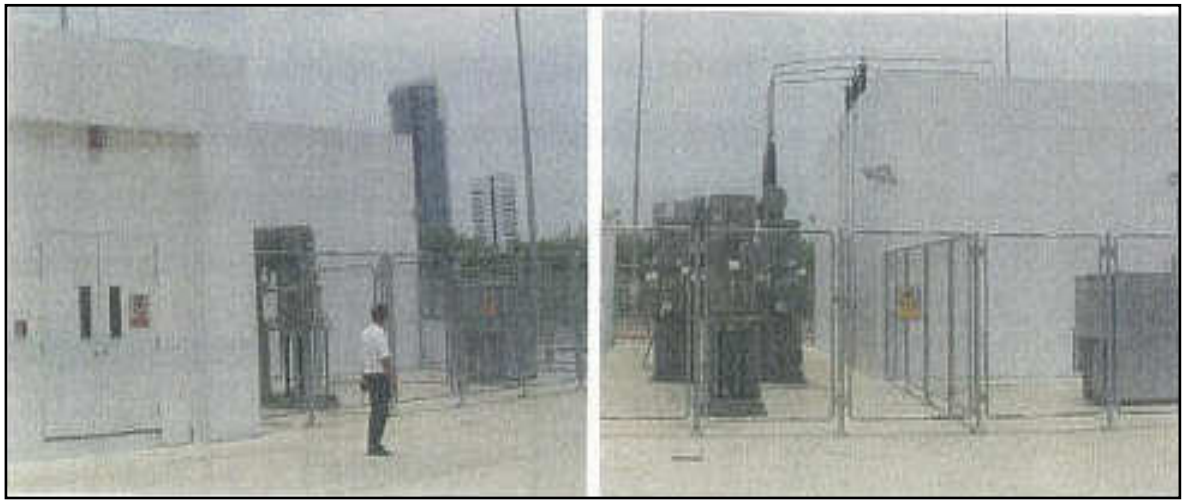


Figure 3.9.3 - 15 Example of Substation Building

b) Driver's School includes trainer room, training room, dressing room and a driving simulator room, etc.

c) Cafeteria will be constructed within the same building of the driver office building in order to save space. It consists of kitchen, cleaning room, private room, cold storage room and the dining room.

3.10) Guardhouse building is located at the entrance – exit of the Depot. It is the checkpoint for those who come into contact. The other entrance – exit can be monitored by CCTV inside the Depot.

3.9.4 The Green Space and Landscape Development in the Depot

The guideline of environmental development in the Depot has considered providing green space and landscaping to be consistent with the layout and the environment surrounding the project area, including space for outdoor use and the panoramic views for creating a better environment. The issues to be considered are as fellows:

1) The maintenance should be easy and convenient to manage. Reducing the water usage for watering plants by selecting species that are durable. The maintenance and cleanliness should be easy such as using grass planting block, hard surface with planting space and thoroughly security.

2) The use of space in the Depot public areas, in front of the building and the surrounding buildings, has considered the area to be landscaped with the ease of care, and is linked to the surrounding space. The example of importance of creating environments are as fellows:

2.1) To create a pleasant landscaped

2.2) To be a space for security, maintenance, building administrative.

2.3) To be used as a buffer zone with the outside areas of the project

2.4) To integrate the indoors and outdoors activities.

2.5) To use of the space in traffic, parking, and maintenance of the building.

3) Landscape development, creating scenery and a great view will create a shady area. The perennial plant will create an aesthetics and obscured the unpleasant landscape.

4) The environmental development reduces the heat, dust, the reflection of light in the area, and also create an aesthetics and pleasant landscape.

5) The landscape development of the Depot office has considered the rectangular coordinate system, by the maintenance building in the center. The landscape development on the side of the Depot office will focus on easy maintenance and beautiful decorative landscaping in public spaces surrounding the building.

5.1) The landscape development of the Depot has considered to leave blank space of the surrounding area as a buffer area that is adjacent to the community. The perennial plants obscure the view from the outside, creating a shady atmosphere to the area and as the background view of the area. It should use plants that are durable, have the high bush to obstruct view, no defoliation and very easy to maintain. And also the plants of different sizes depending on the area should be used, such as White Cheesewood, Lamdman, Mast Tree, and Pong Pong etc.

5.2) The landscape development of office building area has considered building a patio area with a colorful façade, planting sparse perennial plants to reduce the size of the building. And create a shady atmosphere with large perennials that can be planted in the area around the building, on the roadside, and the project fence or space surrounding the building. The ground cover shrub with easy trimming and durable will be used to create the tidiness of the area. And space without much occupying should use a textured stone and cement blocks to grow grass in order to easily maintain, and without feeling too stiff

5.3) Using the appropriate plants: In the front of the Depot has considered using tall perennials tall, such as Cork Tree, Areca nut, MacArthur Palm, etc. The planted trees around the building and nearby will be White Cheesewood, Silver Trumpet, Lamdman and Pong Pong which are

durable and have the oval canopy clustering. They can reduce the feeling of the height of the building very well.

3.9.5 Depot staffs and Drivers

Depot staffs and drivers are summarized in **Table 3.9.5 - 1.**

Table 3.9.5 - 1 Deport staff and monorail train driver

Item	Number of Staff (person)
1. Number of fulltime staffs at Head Office building	
1.1 Operation Control Center staffs are calculated by Manager Operations staffs, Operations Planning/Timetables staffs and Operations Control staffs	43
1.2 Administration staffs are calculated by Training and Documentation staffs, Business Administration staff, Personal Affairs staff, Office Cleaning staffs	80
1.3 Depot staffs (work at Platform) such as Main Workshop Building, Permanent Way Workshop Building are calculated by Maintenance Managers, Engineers, Quality and Safety Team, RST Maintenance Supervisors, Vehicle Light Maintenance staffs, Main Repair staffs, Civil Works Maintenance staffs, Building Services Staffs, Infrastructure Managers	187
1.4 Staffs at other buildings and Monorail driver work at Train Driver Office	100
Total fulltime staffs (1.1 - 1.4)	410
2. Number of temporary staff at Dormitory	
2.1 Train drivers work 3 shift/day during 4:00 AM.– midnight	
2.2 Operation Control Center staffs work 3 shifts (5 persons/day/ shift)	160
2.3 Operation staffs / Train Staff Supervisors work 3 shifts (3 persons/day	
2.4 Yard Supervisor works 3 shift (1 persons/day/shift)	
2.5 Engineering and Maintenance staffs (total staffs of 12 room/unit)	
Total temporary staffs (2.1 – 2.5)	160
Total	**570**

3.9.6 Drinking and Consuming Water Management

The source of drinking and consuming water in the Depot is from the Metropolitan Waterworks Authority, by receiving water from main water pipe from Srinagarindra Road and connecting the water pipe to supply to an underground reserve water tank with the capacity of up to 700 cubic meters. Then it will be pumped to the various buildings within the Depot. The preliminary assessment of water use for activities within the Depot is concluded that the demand for water up to 110.25 cubic meters / day, and classified by activities as fellows:

- Drinking and Consuming Water

1) Administrative Building and Operation Control Center

1.1) The maximum number of employees working in the Operation Control Center are up to 43 person. The rate of water use is 70 liters / person / day (Design Manual of Drainage System for Wastewater and Rainwater, Engineering Institute of Thailand, 2006). The amount of water use is 43x70 = 3,010 liters / day, or equivalent to 3.01 cubic meters / day.

1.2) The maximum number of employees working in the Administrative Building are up to 80 persons. The rate of water use is 70 litters / person / day (Design Manual of Drainage System for Wastewater and Rainwater, Engineering Institute of Thailand, 2006). The amount of water use is 80x70 = 5,600 litters / day, or equivalent to 5.6 cubic meters / day.

1.3) The maximum number of employees working in platform of the Depot is up to 187 persons. The rate of water use is 70 liters / person / day (Design Manual of Drainage System for Wastewater and Rainwater, Engineering Institute of Thailand, 2006). The amount of water use is 187x70 = 13,090 liters / day, or equivalent to 13.09 cubic meters / day

1.4) The maximum number of employees working in other buildings and the drivers working in Driver Office Building is up to 100 persons. The rate of water use is 70 liters / person / day (Design Manual of Drainage System for Wastewater and Rainwater, Engineering Institute of Thailand, 2006). The amount of water use is 100x70 = 7,000 liters / day, or equivalent to 7.0 cubic meters / day.

2) Dormitory: The maximum number of employees using service in dormitory is up to 160 persons. The rate of water usage is 200 liters / person / day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of water use is 160x/200 = 32,000 liters / day, or equivalent to 32.0 cubic meters / day.

3) Cafeteria: The maximum number of employees using service in cafeteria under Driver Office Building is up to 510 persons. The rate of water usage is 50 liters / person / day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of water use is 510x/50 = 25,000 liters / day, or equivalent to 25.50 cubic meters / day.

4) Train Washing Plant: The maximum number of provided train (2046) is up to 23 rolling stocks. The rate of water use is 1.045 cubic meter / rolling stock / day (According to the Bangkok Mass Transit System: Extension: 2000). The amount of water use is 23x1.045 = 24.05 cubic meter / day.

- Water used for fire extinguishing: The project has a reserved water for fire extinguishing in the underground storage tank of 340 cubic meters, which can be used to extinguish fire for about

one hour and a water delivery system with minimum pressure at the sprinkler head on the line not less than 0.45 MPa gauge.

Thus, the total amount of water use for drinking - consuming and water use to extinguish the fire are totally of 670.75 cu.m. The underground reserve water tank is designed to have a capacity of 700 cubic meters, so it is sufficient for use.

3.9.7 Wastewater Collection and Treatment System

1) Depot

Wastewater from the Depot includes wastewater from administrative building, operation control center, dormitory building and train washing plant. The total volume of wastewater is 80 percent of the amount of water use (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The waste water is classified in two types, including the wastewater caused by the activities of the employees in the building and the wastewater from train washing and maintenance. The volume of wastewater causing from activities within the Depot is 110.25x0.80 = 88.2 cubic meters / day and as classified by type of building is shown in **Table 3.9.7 - 1.**

Table 3.9.7 - 1 Wastewater from Depot activities

Buildings	Water use demand (m^3/day)	Wastewater demand (m^3/day)
1. Administration building and Operation Control Center	28.70	23.03
2. Dormitory	32.00	25.60
3. Canteen	25.50	20.40
4. Train Washing Plant	24.05	19.24
Total	110.25	88.27

The selected model and procedures for managing wastewater within the Depot is a small wastewater treatment system (Onsite Treatment Plant), with septic, anaerobic filter and contact aeration process, followed by retention. The wastewater volume causing from activities within the building will be collected directly into the sewage system. The wastewater volume from the cafeteria, train maintenance and train washing will flow through oil interceptor to separate the fat prior to draining into the compact onsite treatment unit. The quality of treated wastewater shall comply with the Notification of the Ministry of Natural Resources and Environment. "Prescribing of standards of wastewater discharging from some types and sizes of building", dated November 7, 2005 in the Government Gazette, Vol. 122, Part 125 dated December 29, 2005. The wastewater clarifier is designed with a size of at least 1 day holding prior to draining water into the public space. The wastewater clarifier for the Depot is installed at the main workshop and for stabling yard installed at the 1^{st} floor, for Operation Control Center and administrative building installed at the 1^{st} floor, as shown in **Figure 3.9.7 - 2** to **Figure 3.9.7 2 - 3.**

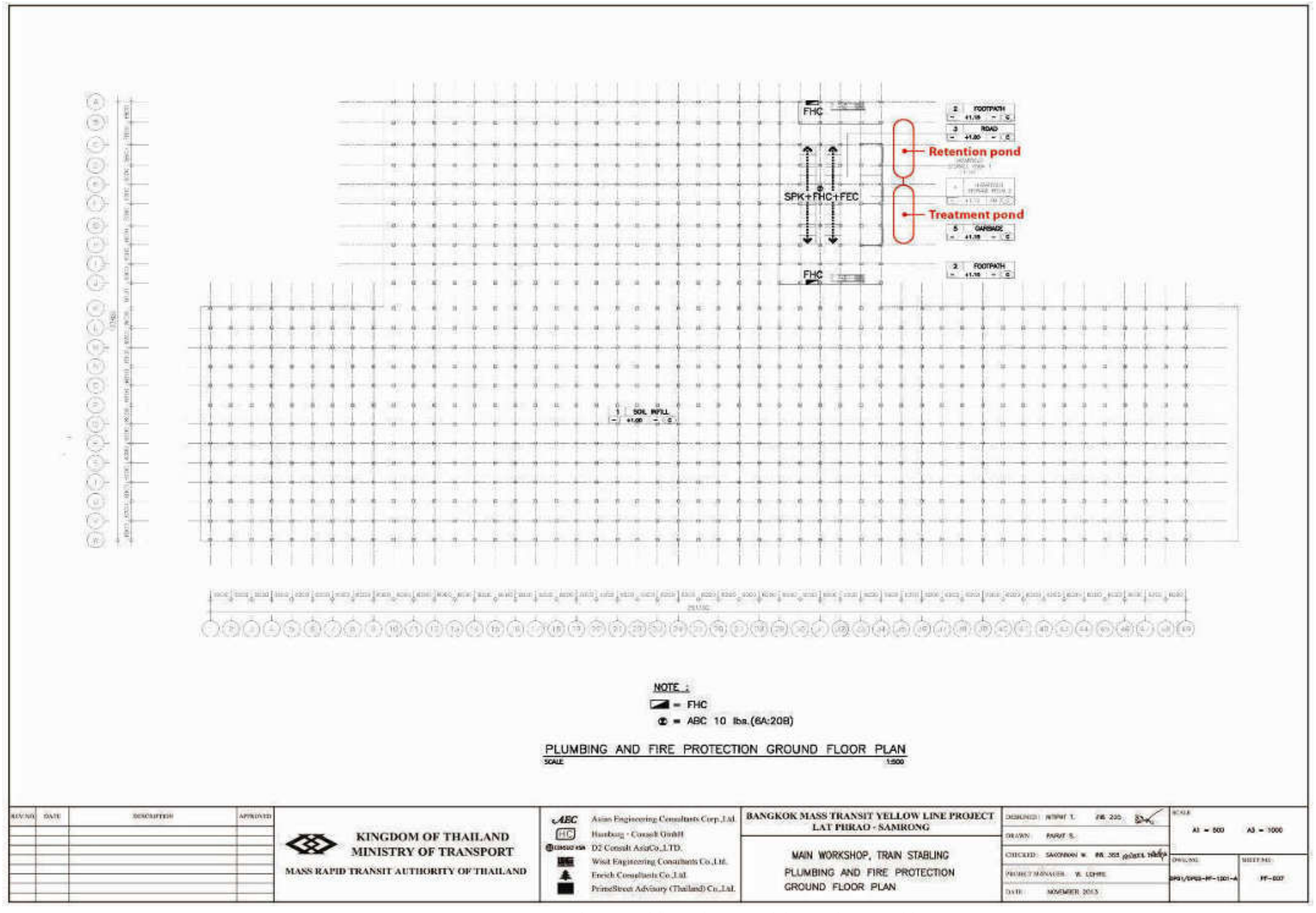


Figure 3.9.7 - 2 Retention pond at ground floor of Main Workshop and Train Stabling

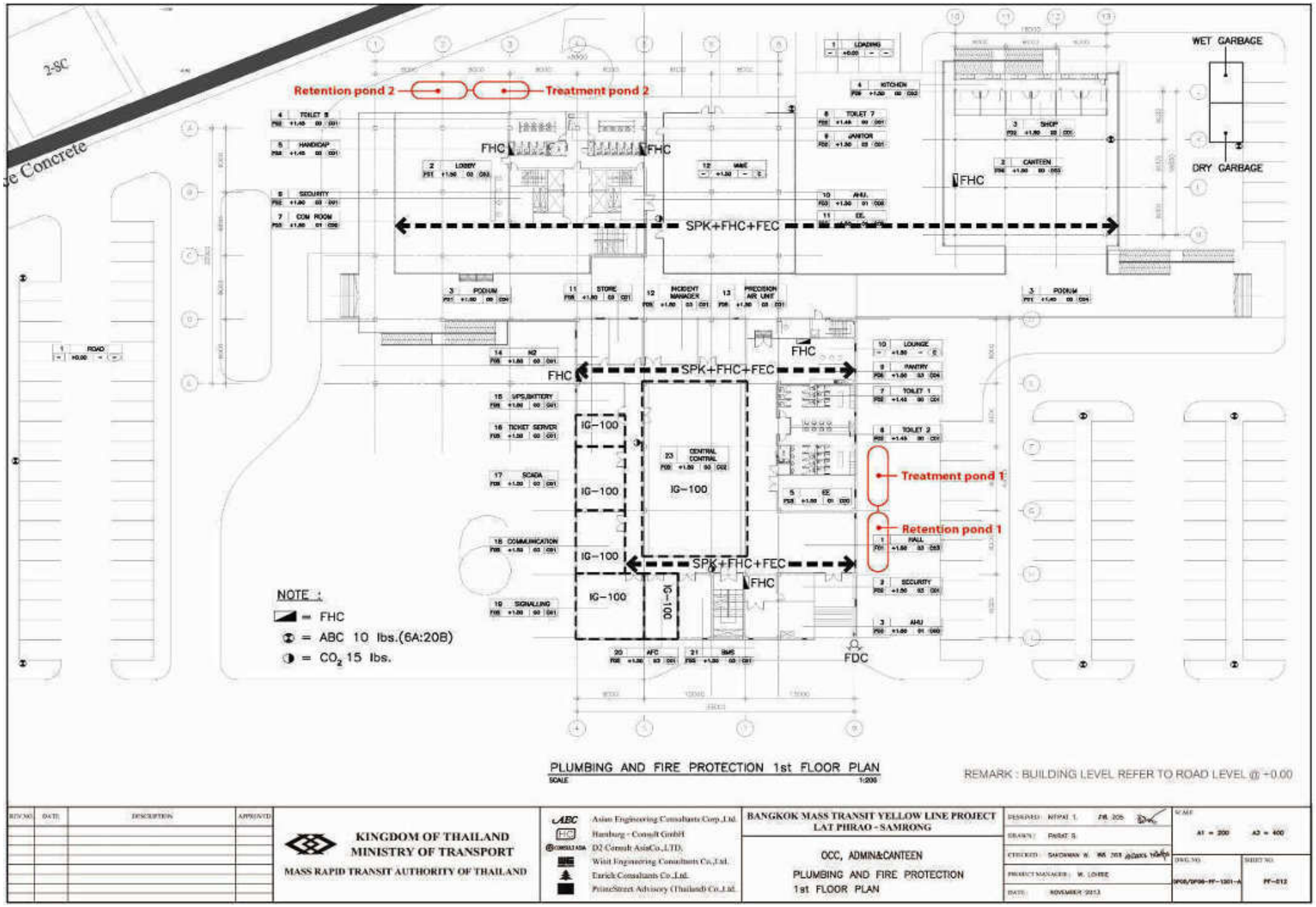


Figure 3.9.7 - 3 Retention pond at 1st floor of Administration building and Operation Control Center

2) Park and Ride Buildings

Park and Ride Building is located at the East side of the Srinagarindra interchange, crossing Bang Na - Trat Road. It is a seven-story building with parking for about 2,800 cars. The project will consider the number of water users from the train customers who park their cars at park and ride building. Since the project has not yet been established, so it was compared with the nine-story park and ride building at Lat Phrao station of the Bangkok Mass Rapid Transit Authority of Thailand (MRTA) for supporting service users of Metro (BEM). It found that the maximum number of Metro service users who parked at park and ride buildings were 41,655 cars / month, representing 1,388 cars / day in 2013. When comparing the capacity building of the park and ride buildings of the project at 2,800 cars which is accounted for 49.57 percent of the capacity of such buildings.

The project reserved for the provision of security at 60.0 percent of capacity building of the park and ride buildings, which equals to 1,680 cars / day. It is used for calculating the amount of water use and volume of wastewater from park and ride buildings. The details are as follows:

- The number of vehicles using the service each day = 1680 cars.
- Average passenger = 2
- The amount of water used per person = 30 liters.

So the total of service users are 3,360 persons / day. The amount of water use was 100.8 cubic meters per day. Thus, the volume of wastewater are 80.64 cubic meters per day. (80 percent of the total water used demand.

For rainwater, the drainage gutters will be provided around the park and ride buildings and discharged into the public sewer. The water retention pond is not provided in that building area. For wastewater treatment, the following system will be provided: 4 septic tanks (with a total capacity of at least 100.8 cubic meters / day) for wastewater from the building, along with 4 of wastewater treatment tanks, which will have a capacity equal to precast wastewater treatment tanks of the project. It will then be collected and discharged into the public sewer.

3.9.8 Garbage and Hazardous Waste Management

The estimation of garbage from the Depot is classified in to two types, general garbage and hazardous waste. The amount of garbage produced in the Depot is about 3.24 cubic meters / day. It is classified by activities in the building as follows:

1) Administration Building and Operation Control Center

1.1) The maximum number of employee working in Operation Control Center is up to 43 persons. The amount of garbage produced by one person is 3 liters/person/day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of garbage is 43x3 = 129 liters/day, equivalent to 0.129 cubic meters/day.

1.2) The maximum number of employee working in administrative building is up to 80 persons. The amount of garbage produced by one person is 3 liters/person/day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of garbage is 80x3 = 240 liters/day, equivalent to 0.24 cubic meters/day.

1.3) The maximum number of employee working in platform of the Depot is up to 187 persons. The amount of garbage produced by one person is 3 liters / person / day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of garbage is 187x3 = 561 liters / day, equivalent to 0.561 cubic meters / day.

1.4) The maximum number of employee working in other buildings and driver the driver working in Driver Office Building is up to 100 persons. The amount of garbage produced by one person is 3 liters / person / day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of garbage is 100x3 = 300 liters / day, equivalent to 0.30 cubic meters / day.

2) The maximum number of employees using service in dormitory is up to 160 persons. The amount of garbage produced by one person is 3 liters / person / day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of garbage is 160x3 = 480 liters / day, equivalent to 0.48 cubic meters / day.

3) The maximum number of employees using service in cafeteria under Driver Office Building is up to 510 persons. The amount of garbage produced by one person is 3 liters /person/day (Guidelines for the preparation of the environmental impact assessment for residential, community service and resort, Office of the Natural Resources and Environmental Policy and Planning, 1999). The amount of garbage is 150x3 = 1,530 liters / day, equivalent to 1.53 cubic meters / day.

The garbage gathering from each building of the Depot are operated by providing the garbage bin capacity 240 liters with the closed lid trash cans (dry waste, wet waste, hazardous waste) and distributing them on various buildings within the Depot as a group of seven bin, total of 22 groups. The placement of garbage bin to accommodate ease of using, collecting and transporting garbage are considered. Moreover, the employee shall be designated to bring garbage to store at Garbage Storage Building in order to wait for collecting from the responsible authority (such as Bang Na District Office, Bangkok), to further bring the garbage to garbage disposal sites outside the Depot area. The Garbage Storage Building is designed with enough space to accommodate the garbage produced from the Depot at least three days (capacity of 151.59 cubic meters. The hazardous waste shall be gathered and stored at Dangerous Goods Building to wait for delivery to dispose by the hazardous waste disposal authorities such as Samaedum Industrial Waste Disposal Center, Bangkhunthien, Bangkok. Garbage retention area in each building of the Depot and Park and Ride Building are shown in **Appendix 3B.**

3.9.9 Hazardous Waste Management at Dangerous Goods Building of the Depot

The detailed hazardous waste management in the Depot are as follows:

1) Types of hazardous waste in the Depot consist of :
   - Electric railway rubber tires include load tire and balancing tire
   - Flammable or combustible substances

   The detailed hazardous waste are as follows:

   1.1 Electric railway rubber tires

Number of stored Rubber Tyres in the maintenance workshop are as follows:

- 100 of load tyres
- 150 of balance tyres

Measurement of protection for Monorail Rubber Tyres storing

- The rubber tyre storage room is separated from the storage of flammable material.
- The fire extinguishers are inside the rubber tyre storage room.
- The worn - out rubber tyre must be gradually taken out of the maintenance workshop.

1.2 Flammable or combustible substances may cause a fire and several injuries. It found that flammable or combustible substances will volatile in the form of gas mixed with oxygen and ready to fire with sparkle. These flammable or combustible substances include solvents for cleaning oil, lubricants, coolants, hydraulic oil, rubber products, etc.

A) The volume of stored flammable or combustible substances for use within the maintenance workshop will only be stored in sufficient quantities to use each week. Because it is easy to purchase in the market, to have flammable substances in limited quantities, and to have high security usage. The volume of stored flammable or combustible substances are as follows:

- solvents for cleaning oil 2 tanks (400litres)
- lubricants 2 tanks (400liters)
- grease 1 tanks (200liters)
- hydraulic oil 3 tanks (600liters)
- coolants 500 litres

B) Entering the human body: Entering of toxic materials into the human body in small amounts can cause damages, such as tissue damage, cancer mutations, cancer. The important path of toxic materials entering the body are four parts, as follows:

- To breathe in is the most common and dangerous.
- Ingestion by eating - drinking through the digestive tract.
- Absorption through the skin into the bloodstream.
- Injecting enter the body, which are very rare.

2) The storage of hazardous waste, and monitoring.

2.1 The storage of hazardous waste

The hazardous waste will be stored at Dangerous Goods Building, which was constructed separately for security reasons. The position of Dangerous Goods Building in the Depot area is shown in **Figure 3.9.9 - 1**.

2.2 Safety Conditions Survey and Monitoring

The normal safety conditions survey and monitoring is crucial to ensure the safety of the workplace and to avoid risks that could cause injury or illness.

A) The safety conditions survey aiming at monitoring the environment in the workplace to identify hazards will be conducted by the safety committee within the Depot on a regular basis each week.

B) The quality assessment of the security plan aiming at the better performance in controlling hazards will be conducted by the safety committee to secure continuous improvement.

2.3 Preparation flammable or combustible substances checklist are as follows:

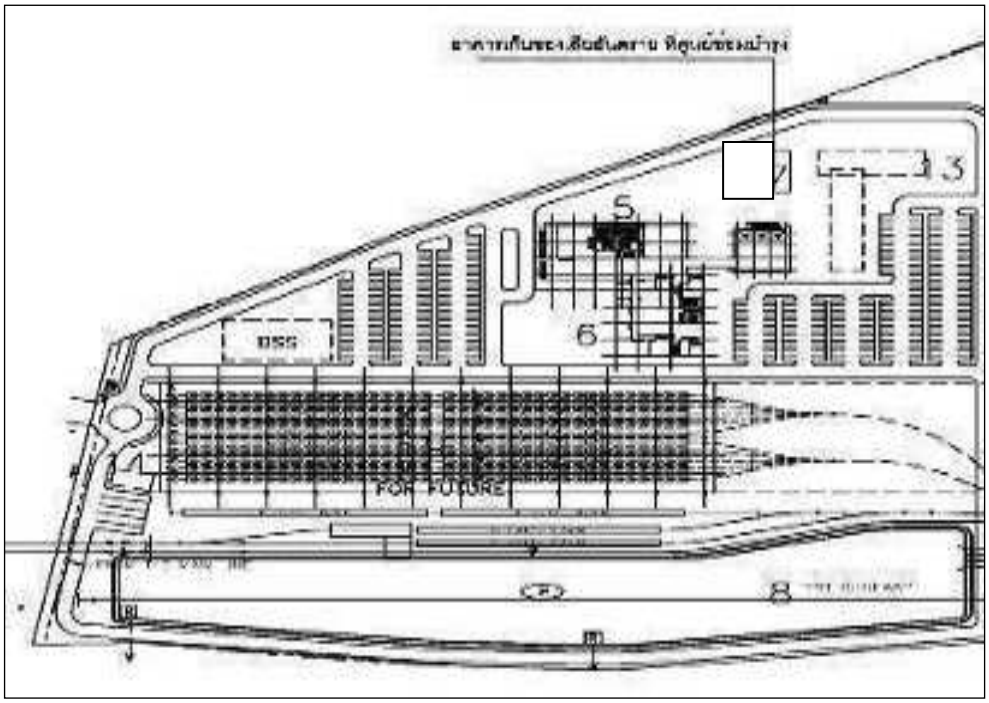


Figure 3.9.9 - 1 The position of Dangerous Goods Building in the Depot area

A) Is the flammable scrap material still stored in protection or not? If yes, is it removed from the environment or not?

B) Is the suitable container used for reducing the flammability risk for storage of flammable or combustible materials or not?

C) Is the container of flammable or combustible approved to use for the storage of flammable substances or not?

D) Is the lid or closing - opening tube of used flammable substance tank completely closed?

E) Are all of unused flammable substance tanks completely closed all the time or not.?

F) Are pile of unused flammable substances tanks grounded to remove static electricity or not?

G) Is the lighting in the flammable liquid storage room installed the explosion proof light bulb or not?

H) Do the flammable liquid storage room have the mechanical ventilation or natural air ventilation or not?

I) Is the storage, handling and use compliance with safety of liquefied petroleum storage or not?

J) Are all of the used flammable liquid and the remaining waste correctly stored in a fireproof flammable liquid container until bringing them out of the Depot or not?

K) Is the fire extinguisher available for immediate use and installed in the designated place or not?

L) Are fire extinguishers in everywhere free from obstructions or barriers in the deployment or not?

M) Are the signs prohibiting smoking area clearly installed in the storage and using area of flammable substances or not?

N) Are the spilled flammable substances eliminated in a timely manner or not?

3.9.10 Management of Wastewater Contaminated with Chemicals Used in Train Washing

The details of management of waste water contaminated with chemicals used in train wash are as follows:

1) Train Wash

The efficiency of water used in train wash must be performed on a daily basis since it is an activity that uses large amounts of water. Conservation and recycled, renewable, reusable are a process to reduce wastewater, reduce environmental impact. Which is the international potential measures to conserve water that can be implemented.

1.1 The train washing process are as follows:

- process of injecting water to wet before washing with automatic sprinklers
- process of injecting water mixed with shampoo detergent
- process of spraying to clean on the bottom of the rail body with high pressure nozzles, brushes, and the high pressure sprayer from the side and the bottom of the train.
- first wash with high pressure water
- Liquid wax injection or coating rail body to be neat and clean
- final cleaning with low pressure water
- drying with the blowing wind
- Wipe dry with hands.

1.2 Measures / water conservation techniques in train washing

- Installation of the sprinkler system by using the small nozzle instead of the big nozzle will make the water pressure low while maintaining the well ability of cleaning.
- Check Position of nozzles to fit regularly. If nozzles are tilted in the wrong position, the train washing will be unclean.
- Check and repair all water leak
- Replace brass or plastic nozzle, which is quickly being eroded with stainless steel or ceramic nozzle instead, which is resistant to hard use.
- Providing reuse waste water system, or waste water tanks for watering plants. (It is needed to ensure that plants are able to withstand the above water quality).
- Growing plants which is resistant to train washing water in the landscape architecture gardening.
- Regular maintenance of nozzle according to maintenance regulations, especially the nozzle used for train washing regularly in order to ensure the most efficient use of water.

2) Measures to manage wastewater from the train washing

The soft water and reverse osmosis (RO) should be used, due to the hardness of the water causes the required amount of shampoo or detergent in large quantities resulting of the environment damages. The use of soft water for train washing very well reduces the environmental problems caused by train washing wastewater. As well as, it is ease of wash-down rail body in the final stages of cleaning. The amount of train washing wastewater as soft water mixed with shampoo

will drain into reverse osmosis (RO) equipment. The water flowing through RO can be reused such as for watering plants, fire extinguisher, general washing. (Do not reuse for drinking).

Measures to choose environmentally friendly cleaning agent

- Free Phosphate
- Free Petrochemical ingredients
- Free Artificial Fragrance
- Non - GMO - Enzyme

3.9.11 Drainage System and Flood Prevention

The Depot of the MRT Yellow Line project is located near the Si Iam interchange. The project condition of waterway in the area before the construction and the drainage system after the construction, shall be consistent and do not affect the existing drainage system of the Department of Drainage and Sewerage, Bangkok Metropolitan Administration (BMA). The system must be adequate and appropriate. According to the review of the flood protection system of the other electric railway projects in Bangkok, it found that the maximum water level in the design of the Depot of the other electric railway projects is +2.50 m.MSL. It is the flood record in the past 200 years, which this water level is applied for protection of various critical equipment of the project.

1) The waterway condition in the project area: The Depot of the MRT Yellow Line project is located on the East of the Si Iam interchange, with the adjacent area, and is on the North of Bang Na – Trat road alignment, behind Parkland Village, as shown in **Figure 3.9.11 - 1**. The main waterway in the area is Klet canal in the East - West line, paralleling to the south side of the project area, and Bang Na canal in the North – South line, cutting through the project area in the Eastern part.

Figure 3.9.11 - 1 Location of The MRT Yellow Line Project (Lat Phrao – Samrong Section) Depot

2) The drainage system of the Depot area

The construction site of Depot of the MRT Yellow Line project is located on the East of the Si Iam interchange, along the Klet canal in Bangkok area. There are some parts slightly crossing Klong Wat canal (branch of Bang Na canal) in Samut Prakan Province. Klong Wat canal and Bang Na canal is the borderline of Bangkok and Samut Prakan Province, therefore the new diversion of the waterway of Klong Wat canal / Bang Na canal will have to be done, to go along the side of the Depot area, and then come back to further link with the existing waterway.

Klet canal and Bang Na canal is in charge of the Department of Drainage and Sewerage, BMA, and the main drainage line of Flood Protection and Mitigation for the eastern Bangkok. In any action relating to the waterway of Bangkok, there are restrictions that prevent waterway obstacles. If the waterway is changed or improved, the size of waterway must be the same size or wider size of the original in order to avoid squeezing of waterway which will cause a back water on upstream.

According to the data from the survey of Flood Protection and Mitigation for the eastern Bangkok, it revealed the original waterway size of Klong Wat canal / Bang Na canal, by using the waterway section profile of Bang Na canal which is the nearest to the project area. A plan showing the survey location, and the waterway section profiles are shown in **Figure 3.9.11 - 2.**

From selected waterway section profile of Bang Na canal was converted to the form of standard waterway to monitor the flow rate through the considered cross sectional area, as shown in **Figure 3.9.11 - 3.** The coefficient of soil canal and slope value of the flattest water area are set. The level of water retention is partly estimated for certain level.

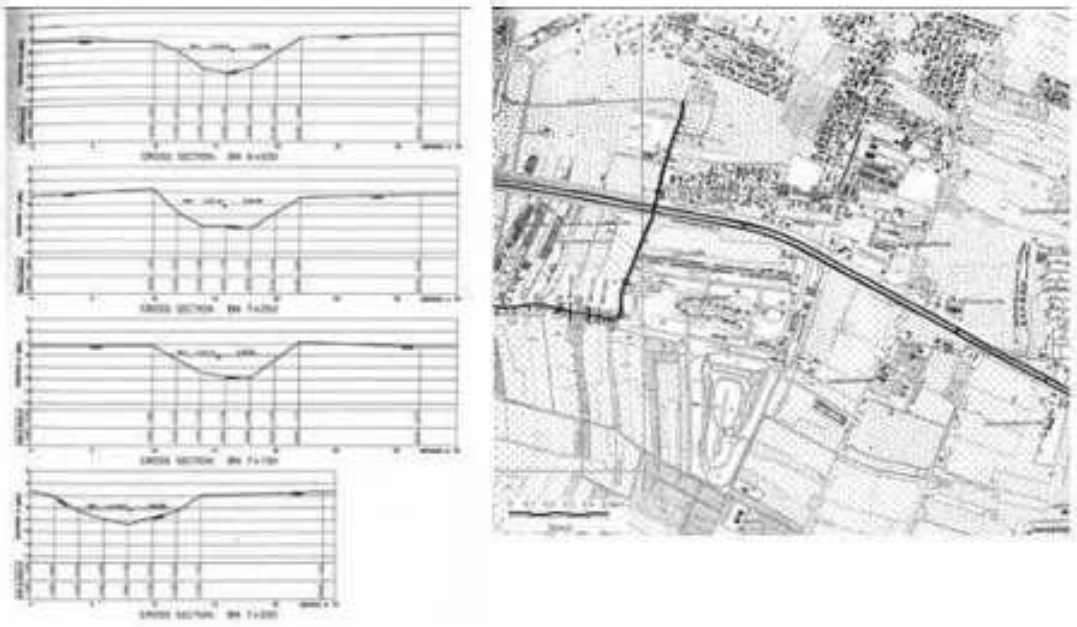


Figure 3.9.11 - 2 Location of Survey Location and Waterway Cross Section

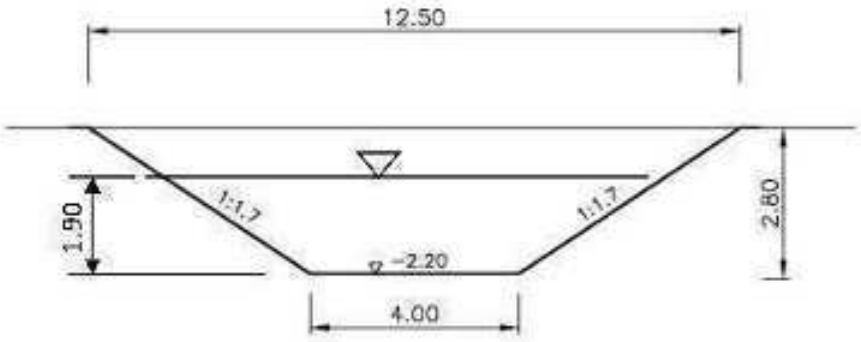


Figure 3.9.11 - 3 The Previous of Natural Khlong (Canal)

The calculation of the flow properties will consider property of the flow by characteristics of the open water along the gravity of the world, by using the Manning formula as follows:

$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

where Q = flow rate (m^3/s)

n = Manning's roughness coefficient

= 0.015 for concrete surface

= 0.025 for general soil

A = cross sectional of flow area (m^2)

R = hydraulic radius (m.)

= A / P

P = wetted parameter (m.)

S = channel slop (m/m)

- The calculation of pre-development of project (original soil canal)

n = 0.025

A = (4.00+1.7x1.90) x 1.90

= 13.737 m2

P = 4.00+2x1.90x(1+1.7^2)$^{1/2}$

= 11.50 m.

R = 13.737 / 11.50

= 1.195 m.

S = 0.00036

formula instead value; $Q = \frac{1}{n} A R^{2/3} S^{1/2}$

$$= \frac{1}{0.025} \times 13.737 \times (1.195)^{2/3} \times (0.0036)^{1/2}$$

= 11.694 m3/s

- The calculation of after-development of project (concrete lined canal)

n = 0.015

A = (4.00+1.7x1.90) x 1.90

= 13.737 m2

P = $4.00+2x1.90x(1+1.7^2)^{1/2}$

= 11.50 m.

R = 13.737 / 11.50

= 1.195 m.

S = 0.00036

formula insteo value: $Q = \frac{1}{n} AR^{2/3} S^{1/2}$

$= \frac{1}{0.015} \times 13.737 \times (1.195)^{2/3} \times (0.0036)^{1/2}$

= 19.490 m3/s

The original condition of soil canal, and the defined specification revealed that the origina. cana. can drain approximately 11 m / sec. The original value of waterway section profile will be applied for the specification of the diverted canal. Therefore, the coefficient of the canal will be changed. Water will flow better. It found that the new lined canal can receive water about 20 m^3/s, which is more, as shown in **Figure 3.9.11 - 4.**

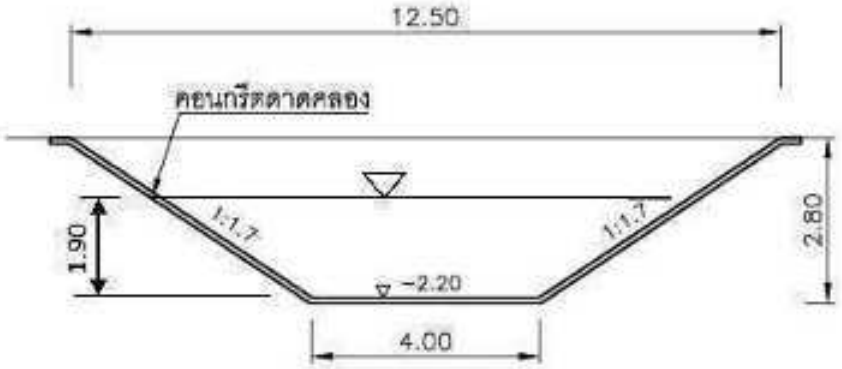


Figure 3.9.11 - 4 Cross Section of New Linning Khlong (Canal)

When waterway is changed from the original line to the side of building area until the end, then it will converge with the original waterway. However, the connecting of the waterway upstream and downstream of the diverted cana. will be properly considered later.

3) The rain water drainage system of the Depot, near Si Iam Station (Y - 17), with the area of 122 rai, is designed by considering of topography, nature of slope areas, and nearby water retention

area, without obstructing the flow of existing waterway, and to drain rain water into the clarifier of 22,800 cubic meters prior to discharging into public canal (Klet Canal).

The rate of rain water drainage and the amount of required water storage of the project area can be calculated as follows:

3.1) The rate of drainage before - after the project development.

Guidelines for calculation and design of the rainwater drainage project will use data from the Table of amount of rainfall and the rainfall rate of Bangkok. The flow rate for the pipe or conduit and clarifier for design is the peak runoff, caused from the amount of return period rainfall of 5 years and 10 years respectively. The calculation is based on the Rational Method as follows

Calculation of rain water runoff in the area:

$Q = 0.278\ CIA$

where Q = the volume of overland flow draining off the land (m3/s)

C = runoff coefficient

I = rainfall rate (mm/hr)

A = area of drainage basin (km^2)

The rainfall rate will use the data from the Table of amount of rainfall and the rainfall rate of Bangkok, as shown in **Table 3.9.11 - 1.**

Table 3.9.11 - 1 Rainfall (mm.), Rainfall Intensities (mm./hr) and Return Period of Rainfall in Bangkok.

Return Period (Year)	Period								
	5 นาที	10 นาที	15 นาที	30 นาที	1 ชม.	2 ชม.	6 ชม.	12 ชม.	24 ชม.
2	11.3	20.2	25.0	42.5	58.7	72.4	85.8	90.0	93.6
	(135.5)	(121.1)	(99.8)	(84.9)	(58.7)	(36.2)	(14.3)	(7.5)	(3.9)
5	14.1	24.3	31.7	54.3	76.0	95.0	114.0	120.0	122.4
	(168.9)	(152.0)	(126.7)	(108.6)	(76.0)	(47.5)	(19.0)	(10.0)	(5.1)
7	14.9	26.9	33.7	58.0	81.5	102.2	123.0	129.6	134.4
	(178.3)	(161.4)	(134.9)	(115.9)	(81.5)	(51.1)	(20.5)	(10.8)	(5.6)
10	15.7	28.4	35.7	61.5	86.8	109.2	132.0	139.2	144.0
	(188.3)	(170.2)	(142.7)	(122.9)	(86.8)	(54.6)	(22.0)	(11.6)	(6.0)
12	17.1	31.0	39.2	67.9	96.5	122.4	149.4	157.2	163.2
	(204.9)	(185.9)	(156.9)	(135.7)	(96.5)	(61.2)	(24.9)	(13.1)	(6.8)

Remark : ( ) Rainfall Intensities, mm./hr

$T_C = (0.87\ L^3/H)^{0.385}$

where T_C = time of concentration from the area of the designed drainage building to the edged line of the drainage retention area, (hour).

L = maximum flow length along the waterway and water flow from the area of the designed drainage building to the edged line of the drainage retention area, (km.)

H = the average difference in elevation (according to topography) between) the area of the designed drainage building and the most farthest of the drainage retention area (m)

3.2) The calculation of the amount of required water storage in the Depot area:

Surface Runoff Coefficient (C) before the project development

The area before development is wilderness area, thus C = 0.30

Surface Runoff Coefficient (C) after the project development

The area is about 194,400 square meters. The area can be divided into various sections according to the surface area and utilization, as fellows:

1) Set up C = 0.70 to 0.95 by the project C = 0.90.

Buildings and internal roads area = 71 380 sq.m.

= 36.72% of project area

2) Set up C = 0.30

Space Area = 123,020 sq.m.

= 63.28% of project area

Time setting for water retention is 3 hours

Table 3.9.11 - 2 and **Table 3.9.11 - 3** shown the rate of runoff and amount of retention water, before and after the project development.

Before project development. A = 194,400 m^2

C = 0.30

Table 3.9.11 - 2 Runoff Rate and Runoff Volume before Project Development

Time (min)	I (mm/hr)	Runoff Rate (m^3/s)	Remain Runoff Demand (m^3)	Cumulative Runoff Demand (m^3)
15	142.7	2.314	2,082	2,082
30	122.9	1.993	1,793	3,876
60	86.8	1.407	2,533	6,409
120	54.6	0.885	3,187	9,595
180	46.4	0.752	2,708	12,304

After project development. A = 194,400 m^2

C = 0.50

Table 3.9.11 - 3 Runoff Rate and Runoff Demand after Project Development

Time (min)	I (mm/hr)	Runoff Rate (m^3/s)	Remain Runoff Demand (m^3)	Cumulative Runoff Demand (m^3)
15	142.7	4.013	3,611	3,611
30	122.9	3.456	3,110	6,722
60	86.8	2.441	4,393	11,115
120	54.6	1.535	5,527	16,642
180	46.4	1.305	4,697	21,339

The results of drainage rate calculation in the Depot area, before and after the project development can be evaluated for the amount of rainwater storage, as follows:

the amount of required water storage = $(Q_{after} - Q_{before})$

= 21,339 - 12,304

= 9,035 m^3

Thus, minimum size of the water retention pond at the Depot area for supporting the rain retention at three-hour is 9, 035 cubic meters.

The calculation list for conduit design in the drainage area of the Depot are shown in **Table 3.9.11 - 4.**

The direction of drainage flow to the water retention pond, and the section profile of the water retention pond at the Depot area is shown in **Figure 3.9.11 - 5**

According to the above assessment, it found that the retention water pond, which must be provided for 3 hours of water retention before draining the rain water to Klong Kled canal must have a total capacity of 21,339 cubic meters. The project must provide two retention water ponds. The minimum size of the retention water pond P1 has a capacity of 21,476 cubic meters and a minimum size of retention water pond P2 has a capacity of 9 037 cubic meters. By installing Submersible Centrifugal Pump, which is suitable for use with high pumping rates, but low total dynamic head. The pump is installed under water with a motor together with pump. Installation location is shown in **Figure 3.9.11 - 5**, as follows.

- Area P1, installing Submersible Centrifugal Pump, Size 0.15 cubic meters / second, for 3 sets, 2 sets for use, and 1 set for backup

- Area P2, installing Submersible Centrifugal Pump, Size 0.15 cubic meters / second, for / sets, 1 set for use, and 1 set for backup

They can accommodate all the amount of required water storage, making the drainage after the project development does not exceed the rate of drainage before the project development, so the impact on drainage conditions of Klong Kled Canal and surrounding areas will be on the low level. However, drainaging of rainwater from the water retention pond, the water will be pumped by using a small pump that does not affect the changing of drainage rate in Klong Kled Canal. The flow rate will be controlled to be equal to the rate before the project. The details of the operation are as follows:

After the rain stopped falling, the water is pumped out of the rain water retention pond to Klong Kled Canal, which the current condition of Klong Kled Canal that runs through the project area has an average width of approximately 10 meters. The distance of canal through the project area has a length of about 800 meters (a canal surface area of 8,000 square meters). If the project is to drain the difference amount of retention rain water, by volume of 9,035 cubic meters from the rain water retention pond within one day (20 hour), it must be pumped out 451.75 cubic meters / hour, or 0.13 cubic meters / second. It does not exceed capacity of Klong Kled Canal to accommodate. Since the drainage rate is lower than the drainage rate of rain water runoff through the area before the project. In practice, prior to pumping the water out of the project area, the water level in Klong Kled Canal must be checked every time, by monitoring the water level from the bank level of canal space to the water surface, which is calculated as follows.

Table 3.9.11 – 4 The calculation list for conduit design in the drainage area of the Depot.

Name of drains	Type of drains			Catchment area (km²)	Length (m)	Ground Level (m MSL)	Height of drain (m)	Slope	Run-off Coefficient (C)	C	Time of concentration (min)	Return Period (Year)	Rainfall Intensity (mm/hr)	K	Sub area Catchment Area (km²)	Area (Ha)	Area in (Hectare)	Speed in Drains (m/s)	Velocity in drains (m/s)	Water depth at outlet (m)	Water depth condition	Remark
1	1.0x0.8	1.0	0.8000	0.0341	28	909.5	2.00	0.0029	0.90	0.81	4.1	5	85	0.9	0.0341	0.0341	0.0341	3.5	3.82	0.72	OK	0.0341
2	1.0x0.8	1.0	0.8000	0.0468	22	909.5	2.00	0.0029	0.90	0.81	3.9	5	85	0.9	0.0468	0.0468	0.0468	4.2	4.59	0.83	OK	0.0468
12	1.0x0.8	1.0	0.8000	0.0249	28	909.5	2.00	0.0029	0.684	0.62	3.0	5	85	0.9	0.0249	0.0249	0.0249	2.8	3.05	0.54	OK	0.0249
14	1.0x0.8	1.0	0.8000	0.0228	45	909.5	2.00	0.0029	0.684	0.62	4.5	5	85	0.9	0.0228	0.0228	0.0228	2.5	2.79	0.49	OK	0.0228
13	1.0x0.8	1.0	0.8000	0.0364	152	909.5	2.00	0.0029	0.684	0.62	8.6	5	85	0.9	0.0364	0.0364	0.0364	3.0	3.34	0.59	OK	0.0364
16	1.0x0.8	1.0	0.8000	0.0455	152	909.5	2.00	0.0029	0.684	0.62	8.6	5	85	0.9	0.0455	0.0455	0.0455	3.3	3.68	0.65	OK	0.0455
23	1.0x0.8	1.0	0.8000	0.0910	217	909.5	2.00	0.0029	0.684	0.62	9.3	5	85	0.9	0.0910	0.0910	0.0910	3.5	3.82	0.72	OK	0.0910

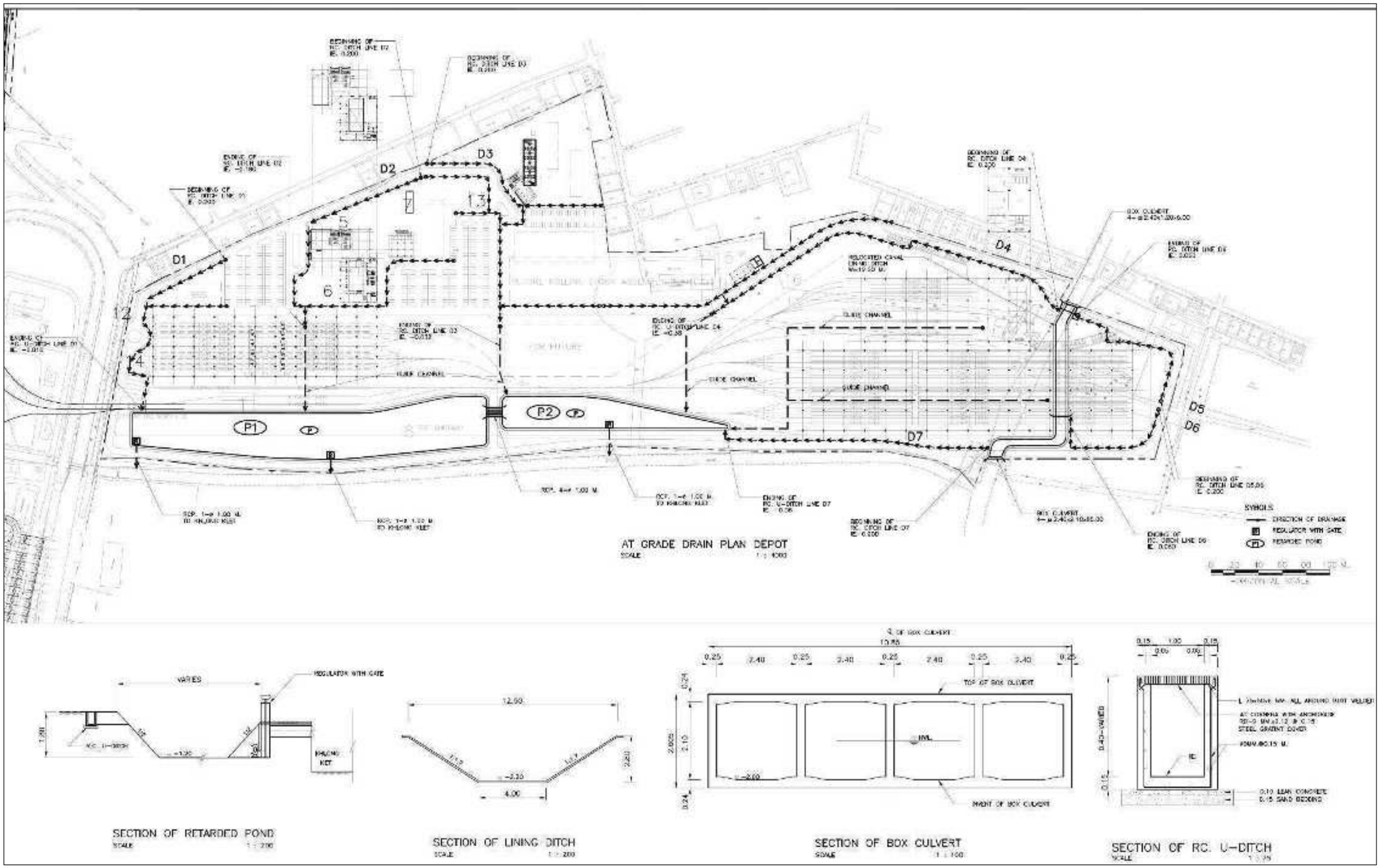


Figure 3.9.11 - 5 The direction of drainage flow to the water retention pond, and the section profile of the water retention pond at the Depot area.

The bank level of canal space to the water surface = The volume of pumping out in one hour / surface area.

= 451.75/8,000 meters

= 0.06 meters

Thus, prior to pumping out water from the rain water retention pond, the project will need for checking the water level in Klet Canal, and while pumping, the water level must be less than 0.06 meters. From these assessments, the measures in pumping out the retained rainwater after the rain stop falling from the rain water retention pond has been considered by the project, as follows:

- The project will pump rainwater from the rain water retention pond and drain it to the Klet Canal after the rain stop falling.

- The project must need prior checking the water level in Klet Canal. If the water level in the canal is lower than 0.50 meters of canal bank, the water will be discharged by pumping. If the water level in the canal is height at 0.10 meters from the canal bank, it will wait for the water level to lower before pumping it out. Therefore, it does not affect the drainage and flooding outside the project surrounding area.

3.9.12 The Security and Fire Protection.

3.9.12.1 The Security and Fire Protection System in the Depot and Park and Ride Buildings

The security and fire protection system in the Depot (at Si Iam Interchange) are as follows:

1) Since the Depot is the central control operation and maintenance center for the train, therefore, the security measures are strict rules. However, the security staffs will strictly inspect within the Depot, and the closed-circuit television (CCTV) will be installed around the fence of the Depot, on the platform and under platform for intrusion prevention, including the installation of adequate lighting for the security. The employee badge must be checked, if the employees who work in the service building and the operation control center will pass the guard at the entrance – exit of Srinagarindra Road. Employees who want to go to dormitory can use roads within the Depot or drivers want to go to the driver office building or employees work on the platform, if they enter the building, they must always inform and show the employee badge to the security staffs on duty in the building. The security around the Depot area can be monitored by CCTV and by motorcycle riding of the security staffs to service roads around the Depot.

2) The prevention of to property damaged from fire in the Depot, the protection systems and fire alarms are provided as follows:

2.1) Standpipe and Hose

2.2) Automatic Sprinkler System

2.3) Clean Agent Suppression System

2.4) Portable Fire Extinguisher

The details of the fire protection system of the Depot and Park and Ride Buildings are shown in **Appendix 3B.**

3.9.12.2 The Security and Fire Protection System around the Electric Train

The design focuses on the protection of personal safety. Since it is a project with a lot of the people travelling. The designer will use the international standard NFPA 12, 14 and the EIT. The

system includes a wet-type pipe, by providing the Class III hose within a radius of easy reach of approximately 30 meters, and designing of Light Hazard automatic water sprinkler by the characteristics of the area designated by the size of controlled area. Also in the area or control rooms such as engine compartment, transformers room, which need the protection of the property and equipment, it is designed to install special fire extinguishing agent system with FM200.

The design standard for monitoring and fire incident reporting system are NFPA 12, 14 and EIT. It is an addressable in order to report the fire incident at first glance before it turns to quickly fire and to be life threatening and property damage with regard to protection area, installation of alarm area, signaling. It is also report further the fire incident to the operation control center.

3.9.12.3 The Accident Prevention Plan and Disaster Response Plan in case of emergency

1) The protecting of mass transit railway against terrorism and serious crime are as follows:

1.1 Preparation of a comprehensive security plan

- There are plans in each level of the alarm, along with the security measures in advance.
- There is an emergency response plan and regular security drill plan as appropriate.
- There are coordination with local authorities and relevant authorities.
- Plans are reviewed regularly in line with the security situation at that time.

1.2 Brainstorming in threat analysis

- Brainstorming with the security agencies and national security agencies.
- Analyzing patterns of crime in the transit system.

1.3 Design general station and the station of departure - arrival (TERMINAL)

- Designing to meet international safety standards for transit systems.
- Use difficult flammable materials and when there is ignition, it does not cause toxic fumes or crackling fire.
- The station is designed for open space, and no hidden corners.
- The Station is designed for better visibility and safety staffs can easily observe the various events.
- There is no out of sight area or hidden objects area.
- There is sufficient emergency exits to evacuate passengers in case of an emergency.
- There is a clearly defined migration path.
- There is adequate lighting.
- There is CCTV recording system covering all the station areas.
- The station is designed to be easy to administer and well-maintained.
- The transparent trash can should be provided, and garbage should be frequently collected from the trash can.

1.4 Rolling stock design

- The rolling stock design must be complied with the safety standards of the international transit system.
- Use difficult flammable materials and when there is ignition, it does not cause toxic fumes or crackling fire
- The passenger seats should be designed with no space to secretly bring hidden object by out of sight of people.
- The CCTV should be installed inside the train.

1.5 The barriers or physical protections should be provided.

- For parking and structure protection.
- For the Depot
- For important facilities such as the power substation
- For the rail runway track
- for track switch
- For the signaling control boxes

1.6 Detection of entrance-exit for intrusion prevention

- Headquarter and Operation Control Center
- Power substation
- Power supply for HVAC air condition system
- Depot
- Entrance-Exit of railway station
- Check point In-Out with CCTV

1.7 The use of closed circuit television should cover the entire area. The camera records are high quality color images, even at night which can send information directly to the police station in the following areas.

- Station
- Public Phone and Ticket Box Purchasing Area
- Station Entrance
- Car Park Area
- Controlling Door for In-Out
- Inside the trains

2) Alarms and anti-sabotage measures.

Alert Levels

<u>The First level</u>

- Updating day-to-day action plan to be higher security.
- New Normal day-to-day operations

<u>The Second level</u>

- Informing passengers and staffs to follow strict safety measures.
- Heightened Security Awareness

The Third level

- There is reliable news that there may be the threat or attacking on public transportation. (Need to continuingly assess the latest situation).
- A Credible threat of an attack on Mass Transit System

The Fourth level

- There is the confirmed threat of attack against the Mass Transit System

An Example of an Action Plan for the First Alert Level

1) There are drill activities for security and alert plan.
2) Do not disclose information to those who do not have a need to know.
3) The strictest security measures need to be applied to the operation control center and the Depot.
4) The planned measures and security system must be tested.

An Example of an Action Plan for the Second Alert Level

1) The thorough security check in transit systems must be performed, as a part of daily work. The passenger should be advocated to observe the suspect or unknown then inform the security authorities.
2) The suspicious matters inside every train should be thoroughly and regularly investigated.
3) There are coordination with national security to request support to secure event that may potentially occur in the third alert level.

An Example of an Action Plan for the Third Alert Level

1) There is reliable information about the threat of sabotage and attacks on Mass Transit System.
2) The safety measures should be maintained together with the national security agencies. such measure should be remained for a week, until it is confident that such threat has been stopped.
3) The transport of hazardous materials that transit through the electric rail route should be strictly controlled, such as cooking gas trucks, oil trucks, hazardous chemical trucks. If it is necessary to transport, the monitoring of transportation is required for the total safety
4) The monitoring of effectiveness and duration of operations for anti-sabotage to Mass Transit System should be continuously assessed.

An Example of an Action Plan for the Fourth Alert Level

1) There are the confirmed threat of attack against the Mass Transit System.
2) Announcement of control area for security situation (Part of the route, along the route, entire network, or notification area)
3) Announcement of the fourth alert level is not less than 72 hours.
4) The risk of sabotage should be continuously assessed.
5) If it is necessary, the train operation should be shut down and provide the attack preventing.

In case of train stopping or fire broking out on the route before reaching the station, the passenger evacuation would not do, while the train is in between two stations. Except in an

emergency case which passengers need to be off the train, since there will be dangerous, if passengers still on the train. The case of the train stopping on the route before reaching the station, if it does not cause any harm to the passengers on the train, such as losing of power for propulsion and cannot move the train, etc. The control center will send the rescue train for assistance by pulling or dragging the disable train to the nearest and safest station.

The passenger evacuation from the disable train while the train is in between two stations, it can be operated only upon receiving approval from the Traffic Controller only. And whenever it is necessary to evacuate the passengers off the train, the evacuation must be peacefully control. This could take the designed walkway or other proper methods. The evacuation procedure is as follows.

1) Traffic Controller must be agreed with the driver and station master of the station which the passenger will be evacuated to. All of them must have common understanding that the passenger will be evacuated to the specified station.

2) Traffic Controller will coordinate with the Power Controller to cut electricity for propelling the disable train in the route section which that disable train had stopped.

3) Traffic Controller shall inform the station master relating to the specified station which the passengers will be evacuated to. Then the station master will instruct the station staffs to go to the disable train to navigate and peacefully control the passenger evacuation back to the station back.

4) When all the passengers are evacuated from the disable train and already away from the runway. The Traffic Controller will inform the station master to send staffs back into the problemed route section to verify that the route is free of passengers and the runway is without any obstacles.

5) Once the route has been confirmed to be safe from obstructions and traffic controller will allow the maintenance staffs or the emergency responders to go to the disable train in order to start working on solutions, or may send another train to pull or push the disable train to further return to the Depot.

In case of the disable train cannot get power, such as the occurring of total black out, it will take power from Diesel Generator or Wayside Storage Battery. The disable train can be moved to the nearest station, for the passengers to get out of the train by train, which depends on the capacity of existing energy reserves. By such method, the passengers are needless to get out of the disable train by walking on the emergency walkway or the available maintenance track. But if it can supply power to the disable train, the rescue train approach for Push-Pull Operation, will be a normal method.

3.10 Total Investment of the Project and the Estimated Cost

Total Investment of MRT Yellow Line Project : Lat Phrao - Samrong Section is classified in to 2 phase as follows:

1) Construction Phase consists of land acquisition cost, total construction cost, rolling stocks procurement cost, consultant fee and provisional sum.

2) Operation Phase consists of additional rolling stock procurement cost, major maintenance & rolling stock refurbishment cost and operation & maintenance cost.

3.10.1 Cost Estimation

1) Investment Cost at Construction Phase consists of:

(1.1) Land Acquisition Cost

Land acquisition cost includes land compensation according to appraisal value of the Treasury Department 2012 -2045, and the replacement of buildings according to appraisal value of the Valuers Association of Thailand, 2012.

(1.2) Construction Cost

The MRT Yellow Line Project : Lat Phrao - Samrong Section is a project of the government. Therefore, the estimation of project construction cost will mainly calculate based on the construction middle price calculation of the Comptroller General's Department, the Ministry of Finance. And the price information from other projects which the nature of work is similar to The MRT Yellow Line, both completed construction and under construction are appropriately used. It has considered together the procedures & construction methods, conditions, environment, and limitations, etc. that affect the construction cost of the project. The estimation cost of construction of the railway system works based on the data of overseas projects that are similar. The construction costs are classified according to the type of works into the two parts, as fellows:

- Civil Works consists of main work as follows:
  - General Preparation Cost
  - Design Cost
  - Track Structure Cost, excluding Guideway Beam
  - Construction costs of 23 Station Buildings, which can accommodate monorail system of 7-8 cars / train (including the reservation for the future of each manufacturer for 1 car / train), including structural, architectural, mechanical and electrical systems of the stations.
  - The relocation of utilities e.g. plumbing relocation
  - Road and Drainage System
  - Construct Cost of the Depot and the stabling yard include structural, architectural, mechanical & electrical systems of the buildings.
  - Elevator and Escalator Cost
- Railway system works consist of main work as follows:
  - Rolling Stocks procurement are estimated by the consultants based on monorail passenger car at 59 million baht/ car (excluding VAT).
  - Signaling and Communication System cost includes ATP and Interlocking, Signal cable, ATS/OCC, ATO, Train Radio System, Backbone Fiber Cable, Cable Rack, Information Display; and other system e.g. CCTV, Public Announcement (PA), and Weather Observer, etc.
  - Power System cost includes Substation, Station Electric Room Equipment, Depot Electric Room Equipment, Power Distribution Cable, Traction Power Cable, and SCADA, etc.
  - Automatic Fare Collection System (AFC) cost includes AFC at station and public, Ticket Vending Machine, etc.
  - Control Access Security Systems cost include access control equipment and other related equipment.
  - Platform Screen Door cost

- Depot equipments cost includes maintenance equipments, inspection and maintenance cars, etc.
- Construction cost of Guideway Beam and Tack Switch
- Construction cost of Operation Control Center

(1.3) Consultant Fee consists of 1) The Project Management Consultant (PMC) is accounted for 1.5 percent of the total estimated construction cost ; (2) Civil Works management consultant is accounted for 2.5 percent of the estimated Civil Works cost; and (3) Railway system management consultant is accounted for 2.5 percent of the estimated railway system cost.

(1.4) Provisional Sum consists of reserved fund and the price adjustment are accounted for 15 percent of the total estimated construction cost.

The investment cost at construction phase is shown in **Table 3.10.1 - 1**.

2) The investment Cost in Operation Phase consists of:

(2.1) Investment cost for additional rolling stock

Investment cost for additional rolling stock is on the assumption that the procurement of additional rolling stock is at every 10 years and at cost of 59 million baht / passenger car (excluding VAT, Rate of the year 2018), which is the average estimated cost by the consultants.

(2.2) Investment cost for major maintenance & rolling stock refurbishment

Investment cost for major maintenance & rolling stock refurbishment are based on the terms of MRT Assessment Standardization, with the assumption that rolling stock will be received the major maintenance & rolling stock refurbishment after 15 years of service and it is accounted for 33 percent of the rolling stock original purchasing cost.

The estimated investment cost as shown in **Table 3.10.1 - 2** is an estimation of the fare collection by distance without the transfer free for the MRTA system (Free MRTA Transfer). The detailed investment information for supplying the additional rolling stock and for major maintenance & rolling stock refurbishment during the 40 years of services in other cases are presented in *the study reviews the feasibility of the project. (the final issue, August 2014).*

(2.3) Investment Cost for Operating and Maintenance (O&M Cost)

The estimation of train operation management cost is the operating fee and maintenance cost (O&M), consisting of 2 types of costs as follows:

- Fixed Cost is the cost used in administration, including the service which is not dependent on number of passengers, consisting of maintenance for civil works cost, staff cost; management staffs; station staffs, and utilities costs for administration & the stations, etc.
- Variable Cost is the cost used in services which is vary depending on the number of passengers and the railway operating guideline, consisting of maintenance for M & E cost, drivers staff cost, utilities costs for train operation (Energy Train), other direct / indirect cost and contingency cost, etc.

Table 3.10.1 - 1 Investment Cost during Construction Phase

Item	Cost (million Baht)	* Addition cost for BMA (million Baht)	Total cost (million Baht)
1. Property Compensation and Land Ownership Management Work	**6,013**	**-**	**6,013**
1.1 Land ownership cost for project route	4,533	-	4,533
1.2 Land ownership cost for Depot	1,460	-	1,460
1.3 Property survey cost	20	-	20
2. Construction cost	**38,905**	**2,083**	**40,988**
2.1 Civil work			
2.1.1 Elevated Guide Way Structures and Station Work	**14,642**	**2,083**	**16,725**
• General preparation work	892	-	892
• Design work	203	26	229
• Elevated guide way structure work	2,118	-	2,118
• Road and drainage work	890	1,498	2,388
• Station work and Bridge connect to other MRT project	8,579	-	8,579
• Public utilities relocation work	1,960	559	2,519
2.1.2 Depot and Park & Ride work	**3,276**	**-**	**3,276**
• Design work	57	-	57
• Depot work	1,918	-	1,918
• Park & Ride work	1,301	-	1,301
2.1.3 Elevator and escalator work	**1,258**	**-**	**1,258**
Total of civil work cost	**19,176**	**2,083**	**21,259**
2.2 Electric train system work			
2.2.1 System work	**12,552**	**-**	**12,552**
• General Requirements	246	-	246
• Signaling and Communication	4,077	-	4,077
• Power Supply and Distribution	3,049	-	3,049
• Platform Screen Door	492	-	492
• Depot Equipment	642	-	642
• Maintenance Vehicle	1,268	-	1,268
• Guide way Beam + Track Switch	2,778	-	2,778
2.2.2 Automatic ticket system work	**738**	**-**	**738**
2.2.3 purchase electric train work	**6,439**	**-**	**6,439**
Total electric train construction cost	**19,729**	**-**	**19,729**
3. Project consultancy cost	**1,479**	**-**	**1,479**
3.1 PMC cost	615	-	615
3.2 CSC for civil work cost	532	-	532
3.3 CSC for electric train construction cost	332	-	332
4. Provisional Sum	**5,657**	**507**	**6,164**
4.1 Contingency	1,945	104	2,049
4.2 Price escalation	3,712	403	4,115
Grand Total	**52,054**	**2,590**	**54,644**

Remark : 1) * construction cost including some structures of BMA
2) total cost included VAT 7%
3) Total cost is not include foundation work of future project at Depot and Park & Ride Buildings

Table 3.10.1 - 2 Investment Cost Forecast for Additional Rolling Stock, Refurbishment of Rolling Stock and Replacement of M&E Equipments

Cost (Million Baht)	Operation Year / Calendar Year (A.D.)							
	Y 11 2029	Y 15 2033	Y 21 2039	Y 25 2043	Y 30 2048	Y 31 2049	Y 35 2053	Total
1) Additional Rolling Stock	1,951	0	4,994	0	0	4,795	0	11,740
2) Refurbishment of Rolling Stock	0	3,417	0	1,350	4,949	0	4,425	14,141
3) Replacement of M&E Equipment	0	13,419	0	0	19,434	0	0	32,853
Total add on Capital Cost	**1,951**	**16,836**	**4,994**	**1,350**	**24,383**	**4,795**	**4,425**	**58,734**

3.10.2 Conclusion of Project Investment Cost

1) Investment Cost at Construction Phase is totally of 54,644 million baht, consisting of:

(2.1) Land acquisition cost 6,013 million baht

(2.2) Construction cost 40,988 million baht

Consisting of (1) Civil work 21,259 million baht, and (2) Railway system (including rolling stock) 19,729 million baht

(2.3) Project consultant fee 1,479 million baht

Consisting of (1) Project management consultant (PMC) 615 million baht, and (2) Civil work construction management cost 532 million baht, (3) Railway system construction management cost 332 million baht

(2.4) Provisional sum 6,164 million baht

2) Investment Cost at Operation Phase

Investment cost at operation phase during 40 years of services will be based on the analysis of the fare structure. Details are shown in *the study reviews the feasibility of the project. (The final issue, August 2014).*

3.11 Implementation Plan

The implementation plan for the MRT Yellow Line Project : Lat Phrao-Samrong Section is shown in **Figure 3.11 - 1.**

3.12 The facilities for the elderly and disabled

MRT Yellow Line: Lat Phrao-Sam Rong Section is designed to accommodate the disabled people. and seniors to have access to facilities, including lifts, ramps and bathroom facilities in the various stations, as well as disabled parking and disabled toilets at the park and ride building. The disabled person is eligible for the fare exemption for travelling by the Monorail system. The disabled person is classified in to five categories as follows:

- Visual impaired
- Hearing or interpretive impaired
- Physical or movement disability
- Mental or behavioral disability
- Intellectual or learning disability

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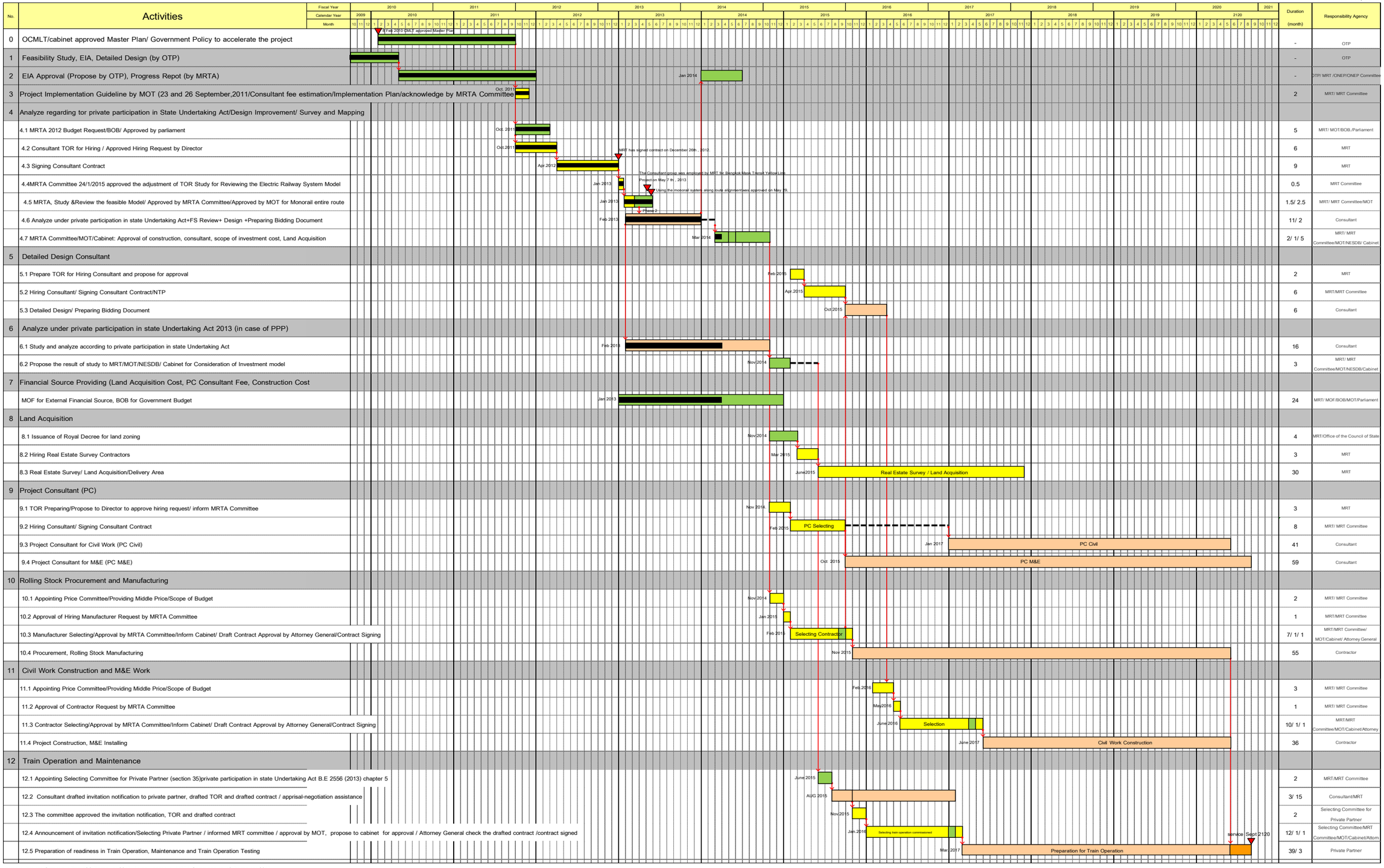
No.	Activities	Duration (month)	Responsibility Agency
0	OCMLT/cabinet approved Master Plan/ Government Policy to accelerate the project	-	OTP
1	Feasibility Study, EIA, Detailed Design (by OTP)	-	OTP
2	EIA Approval (Propose by OTP), Progress Repot (by MRTA)	-	OTP/ MRT /ONEP/ONEP Committee
3	Project Implementation Guideline by MOT (23 and 26 September,2011/Consultant fee estimation/Implementation Plan/acknowledge by MRTA Committee	2	MRT/ MRT Committee
4	Analyze regarding tor private participation in State Undertaking Act/Design Improvement/ Survey and Mapping		
	4.1 MRTA 2012 Budget Request/BOB/ Approved by parliament	5	MRT/ MOT/BOB,/Parliament
	4.2 Consultant TOR for Hiring / Approved Hiring Request by Director	6	MRT
	4.3 Signing Consultant Contract	9	MRT
	4.4MRTA Committee 24/1/2015 approved the adjustment of TOR Study for Reviewing the Electric Railway System Model	0.5	MRT Committee
	4.5 MRTA, Study &Review the feasible Model/ Approved by MRTA Committee/Approved by MOT for Monorail entire route	1.5/ 2.5	MRT/ MRT Committee/MOT
	4.6 Analyze under private participation in state Undertaking Act+FS Review+ Design +Preparing Bidding Document	11/ 2	Consultant
	4.7 MRTA Committee/MOT/Cabinet: Approval of construction, consultant, scope of investment cost, Land Acquisition	2/ 1/ 5	MRT/ MRT Committee/MOT/NESDB/ Cabinet
5	Detailed Design Consultant		
	5.1 Prepare TOR for Hiring Consultant and propose for approval	2	MRT
	5.2 Hiring Consultant/ Signing Consultant Contract/NTP	6	MRT/MRT Committee
	5.3 Detailed Design/ Preparing Bidding Document	6	Consultant
6	Analyze under private participation in state Undertaking Act 2013 (in case of PPP)		
	6.1 Study and analyze according to private participation in state Undertaking Act	16	Consultant
	6.2 Propose the result of study to MRT/MOT/NESDB/ Cabinet for Consideration of Investment model	3	MRT/ MRT Committee/MOT/NESDB/Cabinet
7	Financial Source Providing (Land Acquisition Cost, PC Consultant Fee, Construction Cost		
	MOF for External Financial Source, BOB for Government Budget	24	MRT/ MOF/BOB/MOT/Parliament
8	Land Acquisition		
	8.1 Issuance of Royal Decree for land zoning	4	MRT/Office of the Council of State
	8.2 Hiring Real Estate Survey Contractors	3	MRT
	8.3 Real Estate Survey/ Land Acquisition/Delivery Area	30	MRT
9	Project Consultant (PC)		
	9.1 TOR Preparing/Propose to Director to approve hiring request/ inform MRTA Committee	3	MRT
	9.2 Hiring Consultant/ Signing Consultant Contract	8	MRT/ MRT Committee
	9.3 Project Consultant for Civil Work (PC Civil)	41	Consultant
	9.4 Project Consultant for M&E (PC M&E)	59	Consultant
10	Rolling Stock Procurement and Manufacturing		
	10.1 Appointing Price Committee/Providing Middle Price/Scope of Budget	2	MRT/ MRT Committee
	10.2 Approval of Hiring Manufacturer Request by MRTA Committee	1	MRT/MRT Committee
	10.3 Manufacturer Selecting/Approval by MRTA Committee/Inform Cabinet/ Draft Contract Approval by Attorney General/Contract Signing	7/ 1/ 1	MRT/MRT Committee/ MOT/Cabinet/ Attorney General
	10.4 Procurement, Rolling Stock Manufacturing	55	Contractor
11	Civil Work Construction and M&E Work		
	11.1 Appointing Price Committee/Providing Middle Price/Scope of Budget	3	MRT/ MRT Committee
	11.2 Approval of Contractor Request by MRTA Committee	1	MRT/ MRT Committee
	11.3 Contractor Selecting/Approval by MRTA Committee/Inform Cabinet/ Draft Contract Approval by Attorney General/Contract Signing	10/ 1/ 1	MRT/MRT Committee/MOT/Cabinet/Attorney
	11.4 Project Construction, M&E Installing	36	Contractor
12	Train Operation and Maintenance		
	12.1 Appointing Selecting Committee for Private Partner (section 35)private participation in state Undertaking Act B.E 2556 (2013) chapter 5	2	MRT/MRT Committee
	12.2 Consultant drafted invitation notification to private partner, drafted TOR and drafted contract / apprisal-negotiation assistance	3/ 15	Consultant/MRT
	12.3 The committee approved the invitation notification, TOR and drafted contract	2	Selecting Committee for Private Partner
	12.4 Announcement of invitation notification/Selecting Private Partner / informed MRT committee / approval by MOT, propose to cabinet for approval / Attorney General check the drafted contract /contract signed	12/ 1/ 1	Selecting Committee/MRT Committee/MOT/Cabinet/Attorn
	12.5 Preparation of readiness in Train Operation, Maintenance and Train Operation Testing	39/ 3	Private Partner



Remark: Revised from Work Plan of 6 December 2015, Acknowledged by MRTA Committee on 19 December 2015

Figure 3.11 – 1 Implementation Plan of MRT Yellow Line Project : Lat Phrao - Samrong Section (Monorail system entire route,, Civil Work and M&E Work, PSC, Train operation commissioned by private, PPP Model)

Universal Design for Mass Transit System for the use of all groups of people in the social is an environmental design. Especially the design for the electric railway, as a major Mass Transit Transportation system must design places and objects in providing travel for everyone to be equal to the general public, including the elderly, disabled and disadvantaged people who have limitations on the use or access to services of Mass Transit Transportation. The example for the design of electric train facilities for the disabled are as follows:

1. The picture shows the public telephone with regard to the usage of users with different heights by automatically adjust the position to up and down the height of the user.
2. The picture shows the public telephone with regard to the use of the disabled, wheelchair users and the elderly, as well as the general public.

Figure 3.12 - 1 Example of Public Telephone Designed within MRT Station

3. The picture shows the ATM with regard to the usage of person disabilities who use wheelchairs by leaving space at the bottom for easy wheelchairs access to the machine.
4. The ramp design for wheelchairs and the elderly.

Figure 3.12 - 2 Example of Ramp Designed for Wheelchairs and Elderly

5. The Toilet design for the disabled, elderly, pregnant women to easy use and understand for everyone, such as installing of handrails in bathroom, bathrooms for wheelchair users. At least in the public toilet should provide facilities for pregnant women, those with a child or baby car by installing ease of use diaper changing in the room.

Figure 3.12 - 3 Example of Toilet Designed for the Disabled, Elderly and Pregnant Women

6. The walkway design for the visual impaired person should provide the walkway with the different contact surface in order to assist disabled people to know the safe route- which area is the intersection of walkway. The ramp at the walkway curb should be provided for the convenience of the disabled with wheelchair. Including the slaps with the different contact surface should be installed in such area.

The design and installing slabs for the visual impaired person, connecting to the public services surrounding the train station should assist the visual impaired person to be able to travel safely and continuously.

Figure 3.12 - 4 Example of Pathway Designed for the Blind

7. The elevators should design for all types of disabilities, by adding the switch, press up-down for the disabled with wheelchairs, or slabs navigation for visually impaired with the switch with Braille.

Figure 3.12 - 5 Example of Elevator Designed for the Disabled

8. The designing of up – down stairs to the station

- There is the assisting tool to go up the stairs for the disabled with wheelchairs (Stair Lift)- when presses the button the slab is spread out to underlie the wheelchairs and move up to the top floor automatically

- The staircase is designed to be less height of each step and mounted with the colour stripes in order to see each step easier.

- There is the Braille at stairs handrail to inform the number of steps for the visual impaired person.

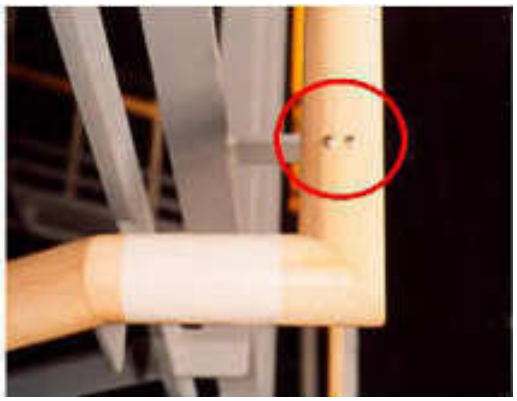


Figure 3.12 - 6 Example of MRT stairs design for the blind

9. The entrance-exit station design

There is at least one entrance-exit channel at train station for the wheelchairs or baby car can easily pass.

Figure 3.12 - 7 Example of Entrance and Exit at station

10. The designed seat in the train should specify the zoning areas for the Disabled, Elderly, Pregnant women, by clearly divided into yellow zones

Figure 3.12 - 8 Example of Facilities Designed within the Monorail Train

In addition, the design and service for the five types of disabled, requiring for Monorail Train service shall receive services and facilitates by station staffs as follows:

1. Visual impaired person

- All stations are designed, installed elevator for disabled. Inside the elevator has provided Braille for the visual impaired person.
- The landing of the stairs is designed with knotty floor for visual impaired person to know that the area is at different level.
- The staffs will assist the disabled by letting the disabled holding staff arm in order to be the navigator for the disabled.
- The area with different level may affect the safety of the disabled such as ramps, floor level, escalators, the staffs will alert the visual impaired person to know first of all times for safety.
- The staffs will facilitate the in-out station of the visual impaired person by passing through the special door
- The staffs will facilitate the disabled at the platform and to get in the train
- The staffs at the origin station will inform the staffs at the destination station to ensure the safety of disabled from leaving the train to leave the station

2. Hearing or interpretive impaired person

- The disabled cannot use spoken language to communicate, therefore, it is necessary to arrange a media briefing how to obtain the services documents such as booklets, brochures, maps or photos, etc.

- The disabled cannot hear the announcement of the station staff such as the departure time, delay departure, changing platform, accident; therefore, it needs to declare by using the marquee or special equipment, such as the LCD installed to display a map of traveling and to inform the passengers of the current place of the train. When the train arrive at the station, it will be announced by voice to inform the passengers.

- The staffs will communicate with the disabled by writing message on the paper to inquire the desired destination station.

- The staffs will facilitate the in-out station of the disabled by passing through the special door.

- The hearing or interpretive impaired person in the train cannot hear the announcement of the next station which is going to stop. So they do not know where the train will stop and whether it is their desired destination station or not. Especially at night, the hearing impaired person cannot see the place, or they are never known the place before, therefore, it needs to announce by the marquee on the train, which will inform the going to stop station.

- The rotation lights are installed in the station for the disabled, in case of emergency. Therefore, the disabled will be informed the state of emergency and the evacuation.

3. Physical or movement disabled person

- There are ramp up – down for disabled with wheelchair and elevators at all stations.

- The street level elevator will be closed at all stations. The label with contact details of request for using the elevator is installed in front of the elevator. If passengers want to use the elevator, they have to contact the staffs station.

- The staffs will facilitate the in-out station of the disabled by passing through the passenger elevator

- The staffs will facilitate the in-out station of the disabled by passing through the special door.

- The staffs will facilitate the passenger at the platform and to get in the train, and lock the wheelchair.

- The staff at the origin station will inform the staff at the destination station to ensure the safety of disabled from leaving the train to leave the station.

4. Mental or behavioral disabled person

- The mental or behavioral disabled person must be accompanied by relatives or caretaker. The staffs will facilitate the in-out station of the disabled by passing through the special door.

The MRT Yellow Line Project : Lat Phrao-Samrong Section has designed facilities for the elderly and disabled according to the details prescribed by Ministerial Regulations, “Prescribed facilities in the building for the disabled or handicapped and the elderly, 2009 (published in the Government Gazette, Volume 52, dated July 2, 2548) as shown in **Appendix 3C**.