4. Evaluation of the Current Facilities and Services

4.1. *Runway*

4.1.1. *Runway Length*

4.1.1.1. Small Jet and Turboprop Aircraft

The required runway length for the aircraft operated at VTE is calculated based on the data from the airlines. The required runway length for takeoff operations is applied because it generally requires a longer runway than landing operations. The conditions of the calculation are shown in Table 4.1 and Table 4.2.

Table 4.1 Temperature and Elevation of VTE

	Value	Source
Temperature	36.8℃	AIP
Elevation	170.7m	AIP

Table 4.2 Target Small Jet and Turboprop Aircraft and Maximum Takeoff Weight

Target aircraft	MTOW	Source
ATR72-500	22,000 kg	ATR72-500 Performance Data (January 1997)
A320	78,000 kg	Aircraft Characteristics Airport and Maintenance Planning (2020)
A737	79,016 kg	737 Airplane Characteristics for Airport Planning (2020)

The required runway length at the maximum takeoff weight (MTOW) was obtained from the charts (Refer to Appendix- 1). Based on the ICAO Design Manual, Part 1, Runway, the runway length is corrected for the runway elevation and reference temperature because the chart is only available at certain numbers of temperature and elevation. For example, the chart of the ATR72-500 reads a temperature of International Standard Atmosphere (ISA) + 15°C, which is 35°C and at sea level elevation. Table 4.3 shows the calculated required runway length for the target aircraft.

Table 4.3 Required Runway Length of Small Jet and Turboprop Aircraft

	Condition in Charts		Required runway length (m)	Correction (m)			Corrected runway length (m)
Aircraft	Temperature	Elevation		Temperature	Elevation	Slope	
ATR72-500	35℃	0 m	1,350	24	54	0	1,428
A320-200	30℃	0 m	2,250	153	90	0	2,493
B737-800	30℃	0 m	2,490	169	99	0	2,758

These calculations show that the existing runway length of 3,000 m is sufficient for takeoff operations and, in turn, for landing operations for small jet and turboprop aircraft at MTOW.

4.1.1.2. Large Jet Aircraft

Unlike small jets and turboprop aircraft, a typical large jet requires more than a 3,000 m runway for takeoff with MTOW. The B747-400, the B777-200, and the B787-10 are selected as typical large jet aircraft in order to verify the adequacy of the current runway length.

The maximum ranges of each aircraft at the runway length of 3,000 m is calculated to verify if the 3,000-m long runway is adequate for current and future operation. The takeoff weight for a 3,000-m long runway is calculated and from the takeoff weight, the range of the aircraft is further calculated.

The 3,000-m long runway is converted to the runway length at the temperature on the chart and the elevation of VTE. As the temperature of the available charts different, so the converted runway length is different. Table 4.4 shows the converted runway length for charts in each aircraft.

Table 4.4 Converted Runway Length

	Condition in Chart		Correction (m)			Converted runway length (m)
Aircraft	Temperature	Elevation	Temperature	Elevation	Slope	
B747-400	33.3℃	0m	132	110	0	2,750
B777-200	30℃	0m	191	108	0	2,700
B787-9	30℃	0m	191	108	0	2,700
B787-10	30℃	0m	191	108	0	2,700

Takeoff weight and range are calculated from the chart as shown in Table 4.5.

Table 4.5 Takeoff Weight and Range (Max Payload)

Aircraft	Runway length (m)	Takeoff Weight (kg)	Range (NM)	Range (km)
B747-400	2,750	360,500	4,450	8,241
B777-200	2,700	276,000	4,450	8,241
B787-9	2,700	243,000	4,400	8,153
B787-10	2,700	238,000	2,900	5,371

The payload of this calculation assumes 95 kg per passenger based on a guideline in the Aircraft Characteristics for Airport and Maintenance Planning published by Airbus.

This calculation was assumed to be operated with a full passenger load and a full cargo. Because the OEW was not published for the B787-10, the weight requirements were set for the B747-400 and B777-200.

Table 4.6 Calculation Conditions (Max Payload)

	B747 -400	B777 -200	B787 -9	B787 -10	Source
Number of seats	400	375	406	440	Airplane Characteristics for Airport Plannnig(2020)
Passenger weight (kg/person)	95	95	95	95	AIRCRAFT CHARACTERISTICS AIRPORT AND MAINTENANCE PLANNING (Airbus A350)
Brake-Release gross weight (kg) for takeoff 3,000m runway	360,500	276,000	243,000	238,000	Airplane Characteristics for Airport Plannnig(2020)
Max Zero fuel weight (kg)	246,076	195,000	181,436	192,776	Airplane Characteristics for Airport Plannnig(2020)
Fuel (kg)	114,424	81,000	61,564	45,224	
Operating empty weight (kg)	179,015	138,100	128,850	135,500	Airplane Characteristics for Airport Plannnig(2020)
Payload (full pax, full cargo)	67,061	56,900	52,586	57,276	
Passenger (kg)	38,000	35,625	38,570	41,800	
Cargo (kg)	29,061	21,275	14,016	15,476	

Normally, the aircraft will not be operated at Max Payload and because the payload is reduced, the operable range is extended. In addition to the Max Payload case, the range is calculated for full-passenger and half-cargo assumptions from the chart as shown in Table 4.7.

Table 4.7 Takeoff Weight and Range (full passenger, half cargo)

Aircraft	Runway length (m)	Takeoff Weight (kg)	Range (NM)	Range (km)
B747-400	2,750	360,500	5,300	9,821
B777-200	2,700	276,000	5,300	9,821
B787-9	2,700	243,000	5,050	9,358
B787-10	2,700	238,000	3,700	6,856

Table 4.8 shows distance between VTE and selected airports around the world.

Table 4.8 Distance to Cities in the World from Vientiane

City	Distance (NM)	Distance (km)
London (LHR)	5,038	9,330
Paris (CDG)	4,981	9,225
Sydney	4,168	7,719
Istanbul	3,982	73,74
Dubai	2,661	4,298
Narita	2,271	4,206
Incheon	1,715	3,177
Beijing	1,509	2,795

Large jets can reach Europe with weight restriction and Australia without weight restriction. A medium jet can reach Dubai, Japan, and Korea. Based on this analysis, the current runway length of 3,000 m is adequate.

4.1.2. *Runway Capacity*

4.1.2.1. Mode of Operation and Runway Usage

The runway usage ratio of Vientiane International Airport is shown in Table 4.9. Landings from the northwest of the airport account for 90% and takeoffs to the northwest of the airport account for 80% of the total operation. One reason for this pattern is to avoid aircraft noise over Vientiane City; another is to avoid aircraft flying to the Thailand border at the southside of the airport along the Mekong River. This type of operation is called a Preferential Runway System (PRS).

Table 4.9 Runway Usage

Arrival		Departure	
RWY31	10%	RWY31	80%
RWY13	90%	RWY13	20%
Total	100%	Total	100%

4.1.2.2. Peak Traffic

(1) Busy Month Analysis

Traffic data for 2019 was used to analyze peak characteristics of the airport because the operational performance in 2020 was influenced by COVID-19 and is not reflective of the past trend.

According to the 2019 schedule, December was the busiest month of the year. Therefore, in the following sections, we analyzed the flight schedules for scheduled flights (see Figure 4.1) and flight log data for nonscheduled flights in December 2019.

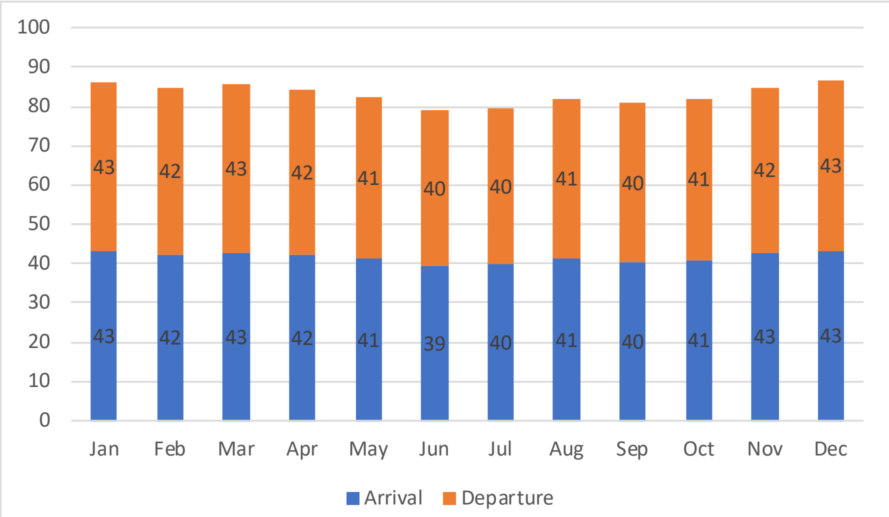


Figure 4.1 Average Daily Aircraft Movements by Month (Scheduled Flights Only)

(2) Busy Day Analysis

The busy day was December 19, 2019. This day was selected based on the IATA definition of "busy day," which is the second busiest day in an average week during the peak month. The number of hourly movements by departure and arrival and by scheduled and nonscheduled flights are shown in Figure 4.2 and Figure 4.3. There were 108 flights per day. Among these flights, 80 percent were scheduled flights and 20 percent were nonscheduled flights.

Busy hour of departure flight was 9:00 AM to 10:00 AM and there were seven departures; busy hour of arrival flight was 12:00 PM to 1:00 PM, and there were nine arrivals.

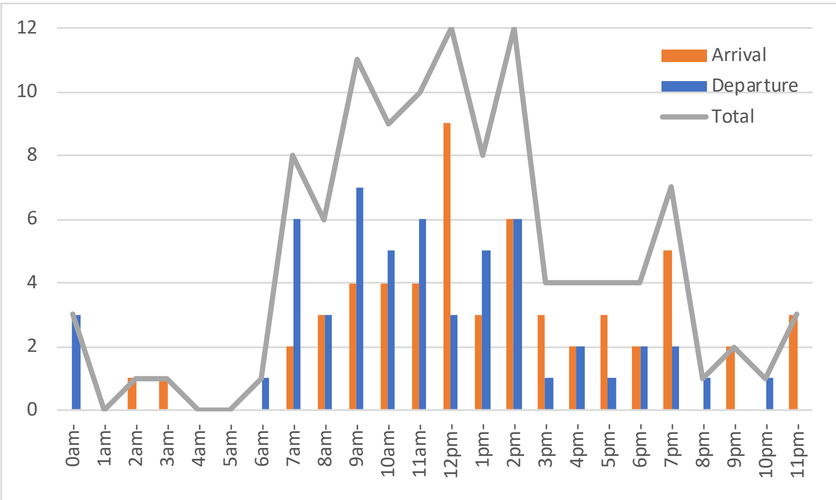


Figure 4.2 Aircraft Movements of Arrival and Departure

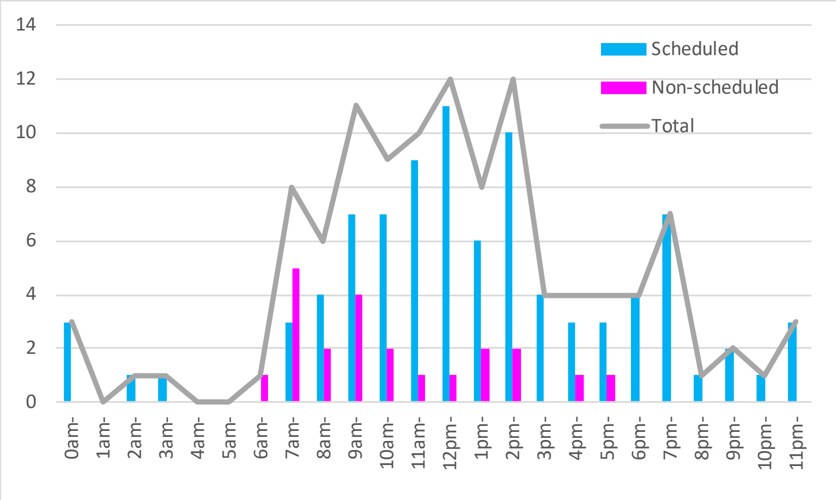


Figure 4.3 Aircraft Movements of Scheduled and Nonscheduled Flights

(3) Peak Hour Analysis

Figure 4.4and Figure 4.5 show the number of hourly movements, categorized into scheduled and nonscheduled flights, respectively. Scheduled flights were operated from 7:00 AM to 3:00 PM. The peak hour for scheduled flights was 12:00 PM, and there were eleven operations during the peak hour.

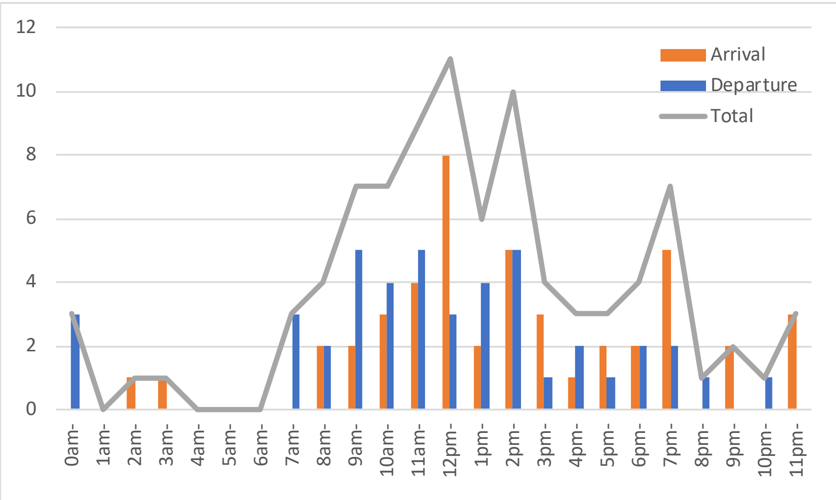


Figure 4.4 Aircraft Movements of Scheduled Flights

Nonscheduled flights were operated from 6:00 AM to 5:00 PM. The peak hour for nonscheduled flights was in 7:00 AM, and there were five operations.

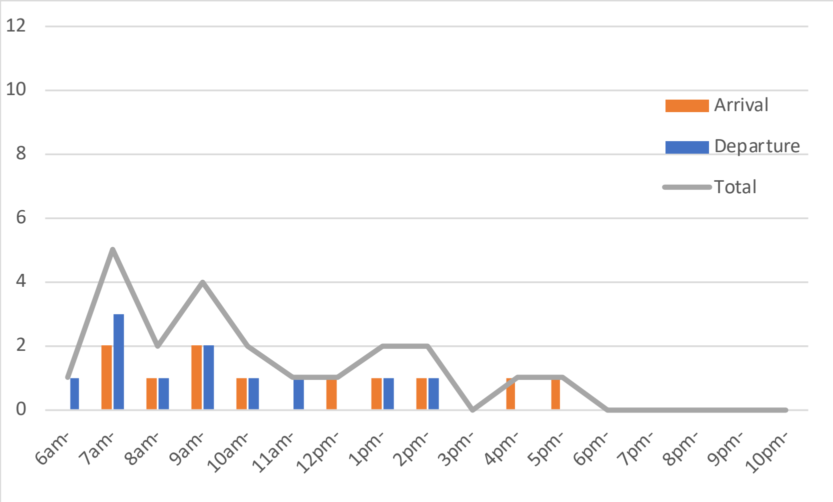


Figure 4.5 Aircraft Movements of Nonscheduled Flights

4.1.2.3. Fleet Mix

Jet aircraft account for about 60% of scheduled flights (colored blue) and turboprop aircraft about 40% (colored green). The most popular aircraft in service are the A320, the ATR-72, and the MA-60.

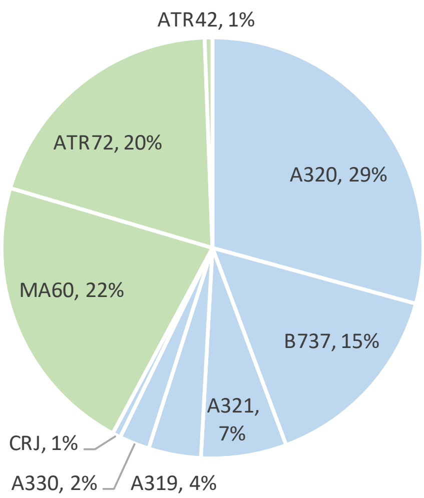


Figure 4.6 Aircraft Type of Scheduled Flights

Turboprop aircraft and helicopters accounted for about 40% of nonscheduled flights, while jet aircraft and fighter jets account for a total of 20% in the nonscheduled flights. The most popular aircraft in operation are the MI17, the C208, the L410, and the Y130.

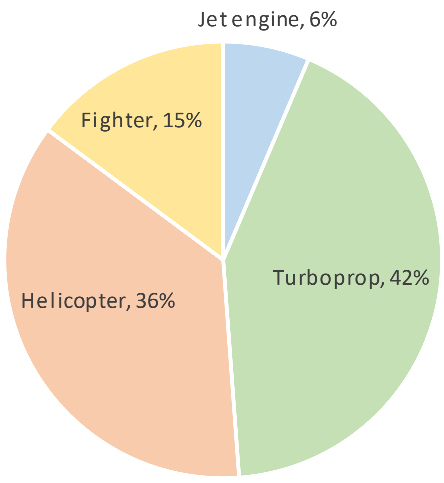


Figure 4.7 Aircraft Type of Nonscheduled Flights

4.1.2.4. Runway Occupancy Time

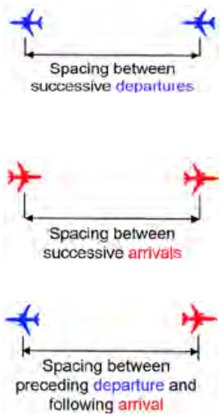
The runway occupancy time of departing aircraft was measured from the time of the start of the takeoff run to when the runway clears. The runway occupancy time of arriving aircraft was measured from the time of entering the runway threshold to vacating the runway through taxiways. As shown in Table 4.10, the average runway occupancy time for departing aircraft was 31 seconds and that for arriving aircraft was 73 seconds.

Table 4.10 Runway Occupancy Time

	RWY	Average Runway Occupancy Time	Aircraft
Departure	31	31 seconds	A320, B738, ATR72
Arrival	13	73 seconds	A320, ATR72, MA-60

4.1.2.5. ATC Procedure

The control spacing for the Preferential Runway System (PRS) operations at the current airport is shown in Figure 4.8. When there is a successive of departures, the interval is 5 NM or 8 NM. In the case of successive arrivals, the interval is 8 NM. When the arrival aircraft follows the departure aircraft, more separation is required and the interval is 15 NM.



		Following departure	
	Aircraft type	Jet	Turboprop
Preceding departure	Jet	5 NM	8 NM
	Turboprop	8 NM	5 NM

		Following arrival	
	Aircraft type	Jet	Turboprop
Preceding arrival	Jet	8 NM	8 NM
	Turboprop	8 NM	8 NM

		Following arrival	
	Aircraft type	Jet	Turboprop
Preceding departure	Jet	15 NM	15 NM
	Turboprop	15 NM	15 NM

Figure 4.8 Current Operation Separation

4.1.2.6. Ratio of Arrivals and Departures during Peak Hour

The arrival ratio is 40~60% during busy traffic hours.

4.1.2.7. Existing Runway Capacity Calculation

Based on the fleet mix of the demand forcast, 65% of the fleet is jets and 35% is turboprop aircraft. Therefore, the combination of preceding aircraft and following aircraft is shown in Table 4.11.

Table 4.11 Probability of Occurrence of Aircraft Combinations

Preceding aircraft	Following aircraft	Probability of Occurrence
Jet	Jet	65% x 65% = 42.5%
Jet	Turboprop	65% x 35% = 22.75%
Turboprop	Jet	35% x 65% = 22.75%
Turboprop	Turboprop	35% x 35% = 12.25%

The landing and takeoff ratio is assumed to be 50%, because there was no significant difference in the number of landings and takeoffs during peak hours. The final approach segment speed of final approach fix (FAF) to runway threshold is 130 kts and the approach segment (Initial Approach Fix (IAF) to FAF) is 180 kts. The takeoff speed of the takeoff straight segment is about 6 NM, and the takeoff speed is 210 kt.

(1) Successive departures

Table 4.12 shows the separations between preceding aircraft and following aircraft used in the calculation.

Table 4.12 Aircraft Separation of Aircraft Combination

Preceding aircraft	Following aircraft	Separation
Jet	Jet	5NM
Jet	Turboprop	8NM
Turboprop	Jet	8NM
Turboprop	Turboprop	5NM

Since the separation is different for jets and turboprop aircraft, the average separation is calculated based on the separation and the probability of occurrence of aircraft combinations as shown in Table 4.13.

Table 4.13 Separation of Successive Departure

Preceding aircraft	Following aircraft	Probability of Occurrence (a)	Separation (b)	(a) x (b)
Jet	Jet	42.25%	5NM	2.11NM
Jet	Turboprop	22.75%	8NM	1.82 NM
Turboprop	Jet	22.75%	8NM	1.82 NM
Turboprop	Turboprop	12.25%	5NM	0.61 NM
Total (Average Separation)				6.36 NM

When flying 6.36 NM at a flight speed of 210 kt, the flight time is 109 seconds (6.36 NM/210 kt = 109 seconds). Therefore, the runway capacity for successive departures is 32 movements per hour (3,600 seconds/109 seconds = 33 movements per hour).

(2) Successive arrivals

Spearation of successive arrivals is 8 NM regardless of aircraft type. The flight time for a flight of 8 NM at a speed of 180 kt is160 seconds (8 NM/180 kt = 160 seconds). Therefore, the runway capacity for successive arrivals is 22 movements per hour (3600 seconds/160 seconds = 22 movements per hour).

(3) Alternating arrivals and departures

Figure 4.9 shows the operational situation during alternating departure and arrival operations. The preceding departing aircraft is cleared for takeoff when the following arriving aircraft is at least 15 NM away from the airport. Therefore, the time required to handle one departing aircraft and one arriving aircraft is the sum of flight time of 15 NM flight of the arriving aircraft and the runway occupancy time of the arriving aircraft.

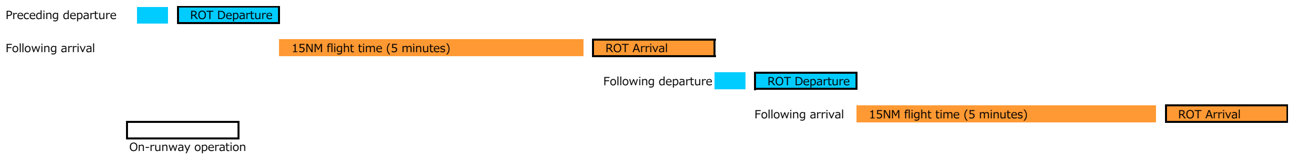


Figure 4.9 Operational Status of Alternating Arrivals and Departures

The flight time for a 15 NM flight at a flight speed of 180 kt is 300 seconds (15 NM/180 kt = 300 seconds).

The runway occupancy time for the arriving aircraft is 73 seconds. For the departing aircraft it is 31 seconds based on the observations. From the start of the takeoff run after the landing aicraft vacated the runway, 15 seconds is added for departing aircraft. Therefore, the time required for each landing and takeoff cycle is 419 seconds (300 seconds + 73 seconds + 15 seconds + 31 seconds = 419 seconds).

From the above calculation, the runway capacity is 16 movements per hour (3,600 seconds/419 seconds × 2 = 16 movements per hour).

(4) Runway capacity in the current operation

Assuming a landing ratio of 50% (the same number of arrivals and departures) and a combination of successive departures (25% of the total), successive arrivals (25% of the total), and alternating departures and arrivals (50% of the total), the runway capacity can be calculated as 21 movements per hour (see Table 4.14).

Table 4.14 Existing Runway Capacity

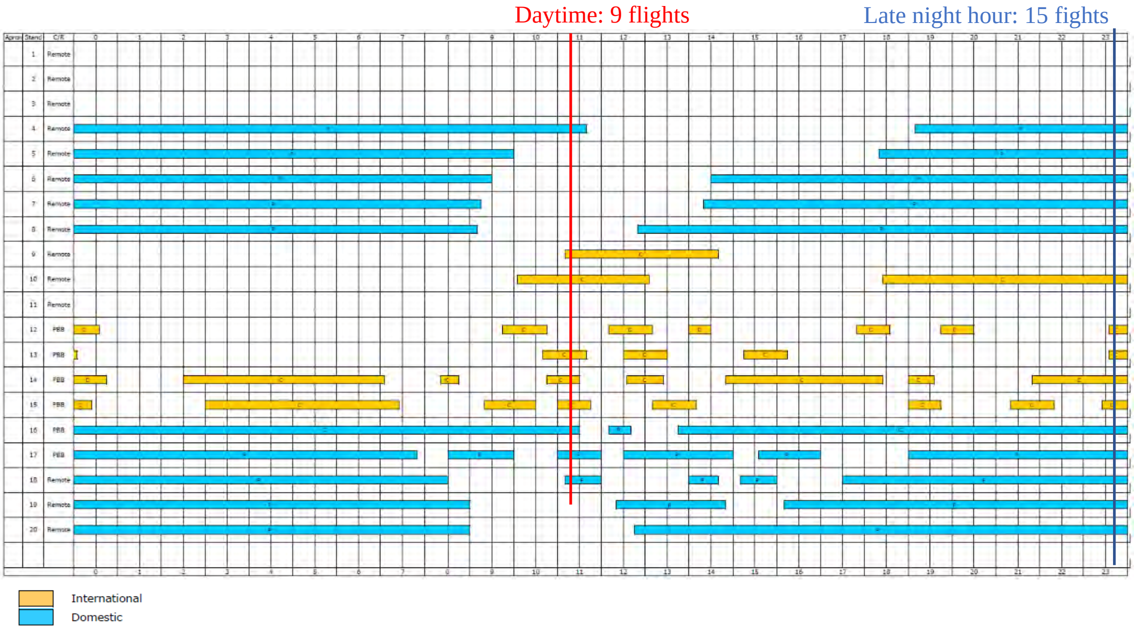
Operation	Combination (a)	Runway Capacity (b)	(a) x (b)
Successive Departure	25%	33	8
Successive Arrival	25%	22	5
Alternating Departures and Arrivals	50%	16	8
Total			21

According to the air traffic demand forecasts, busy hour aircraft movement will be 21 in year 2035, so the runway capacity under current operation will be insufficient in year 2035.

4.2. *Aprons Capacity*

4.2.1. *Current Demand*

Usage of the aircraft parking stands was evaluated based on the OAG timetable. The date of December 19, 2019, was used. During daytime, 9 flights used the apron at the same time. Among these flights, 5 were international flights, and 4 were domestic flights. During the late night, 15 flights used the apron at the same time. Among these, 5 were international flights and 10 were domestic flights. See Figure 4.10.



Source OAG

Figure 4.10 Gate Allocation Chart (19 December 2019)

With the expansion of the apron in 2013, the total number of parking positions is 20 spots, and it is adequate for the current operation.

As mentioned in Chapter 2, there are a total of six PBBs at Vientiane International Airport. Four of them are for international flights, and two are for domestic flights as shown in Table 4.15.

Table 4.15 Number of Aircraft during Peak Time and PBBs

	aircraft size	Number of aircraft		PBBs
		Daytime peak	Night peak	
INT	Prop	5	5	4
	C	0	0	
DOM	Prop	3	9	2
	C	1	1	

Most of the aircraft in service on domestic routes are turboprops; therefore, the quantity of PBBs is considered reasonable. On international flights, there are five aircraft staying during peak hours, two of which are staying longer than the others. It might be possible to increase the utilization rate of PBBs by towing the aircraft with long-stay times to the remote apron. Based on the assumption of improvement in operations, the current quantity of PBBs is considered to be reasonable.

4.2.2. *Future Demand*

4.2.2.1. Parking Spots

Future requirements for parking stands were calculated based on the results of the air traffic demand forecast. Aircraft movements in the future is shown in Table 4.16and Table 4.17.

Table 4.16 Future International Aircraft Movements

	2025	2030	2035	2040	2045	2050
Large Jet	1	1	2	2	2	2
Small Jet	7	9	11	14	17	21
Turboprop	1	1	2	2	2	2

Table 4.17 Future Domestic Aircraft Movements

	2025	2030	2035	2040	2045	2050
Small Jet	2	3	3	3	4	4
Turboprop	5	7	8	10	12	13

The number of aircraft parking spots required is calculated from the following formula.

(Number of parking spots by category) = (Peak hour movements) × 1/2 × (Spot occupancy time in minutes/60) × (contingency)

For the contingency, we used the general value of 1.2. The value is to take into account the longer parking time in case of bad weather or arrival/departure adjustments.

The actual results of stay time for international flights on December 14, 2019, are listed in Table 4.18. There is a variation in stay time.

Table 4.18 Stay Time of International Flight

Carrier Code	Country	Specific Aircraft Code	Mainline/Low Cost	Arrival time	Departure time	Stay time
QV	LAO	320	M	03:00	07:25	4:25
AK	MYS	320	L	08:20	08:45	0:25
3U	CHN	320	M	09:20	10:30	1:10
MU	CHN	737	M	09:45	10:45	1:00
QV	LAO	320	M	10:05	13:05	3:00
WE	THA	320	M	10:40	11:40	1:00
VN	VNM	321	M	10:45	11:30	0:45
PG	THA	319	M	11:00	11:45	0:45
MU	CHN	737	M	12:10	13:10	1:00
BX	KOR	321	L	12:30	13:30	1:00
WE	THA	32S	M	12:35	13:25	0:50
FD	THA	320	L	14:00	14:30	0:30
MU	CHN	738	M	15:15	16:15	1:00
QV	LAO	320	M	16:00	18:25	2:25
QV	LAO	320	M	17:50	18:35	0:45
PG	THA	319	M	18:50	19:35	0:45
VN	VNM	321	M	19:00	19:45	0:45
TG	THA	330	M	19:45	20:30	0:45
TW	KOR	737	L	21:20	22:20	1:00

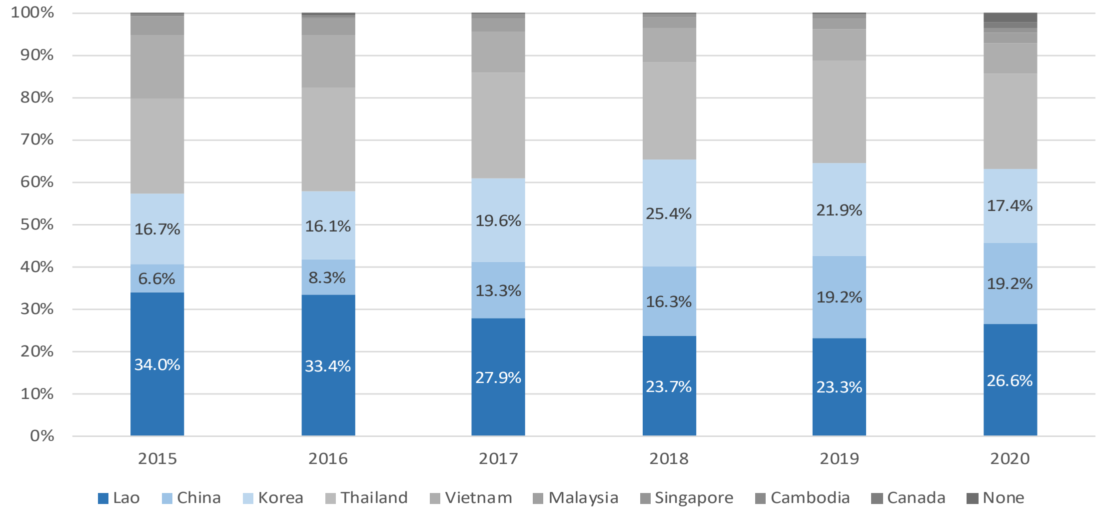
The average stay time by country of airline is different as shown in Table 4.19.

Table 4.19 Average Stay Time by Country of Airlines

Nationality	Average Stay Time
China	1:02
Korea	1:00
Lao PDR	2:38
Malaysia	0:25
Thailand	0:45
Vietnam	0:45

The average stay time of airlines from China and Korea was about one hour. From Thailand and Malaysia it was 45 minutes. The stay time of airlines in Lao was long. Most of the aircraft used by airlines from China, Korea, Malaysia and Thailand were small jet aircraft, such as A320 and B737 series.

Figure 4.11 shows the ratio of nationalities of passengers in Vientiane International Airport for the last six years. The total ratio of Lao PDR, China, and Korea was about 65%.



Source : L-JATS

Figure 4.11 Ratio of Passenger Nationalities at VTE

It is assumed that among the small jets, 65% of the small jets are from Korea and China and their stay time is 60 minutes and another 35% of small jets is from neighboring countries, and their stay time is 45 minutes. Table 4.20 below shows adopted stand occupancy time of international flights. The time interval between flights was assumed to be 30 minutes for international flights.

Table 4.20 Spot Occupancy Time of International Flights

Aircraft Type	Stand occupancy time (min)
Large Jet	60 + 30 = **90** min
Small Jet	60 + 30 = **90** min (65%) 45 + 30 = **75** min (35%)
Turbo Prop	30 + 30 = **60** min

The actual stay time for domestic flights on the days with the highest number of flights in 2019 (December 14, 2019) are shown in Table 4.21, and the average stay time was 46 minutes.

Table 4.21 Average Stay Time of Domestic Flight

Carrier Code	Country	Specific Aircraft Code	Mainline/Low Cost	Arrival time	Departure time	Stay time
QV	LAO	AT7	M	08:30	09:10	0:40
QV	LAO	AT7	M	10:35	11:40	1:05
LK	LAO	MA6	L	11:10	12:00	0:50
QV	LAO	AT7	M	12:10	12:40	0:30
QV	LAO	AT7	M	14:00	14:40	0:40
LK	LAO	MA6	L	14:20	14:50	0:30
LK	LAO	MA6	L	14:30	15:00	0:30
QV	LAO	AT7	M	15:10	16:00	0:50
QV	LAO	AT7	M	15:35	17:00	1:25
					Average	**0:46**

The spot occupancy time in Table 4.20 is applied for domestic flights. The time interval between flights was assumed to be 15 minutes for domestic flights.

Table 4.22 Spot Occupancy Time for Domestic Flights

Aircraft Type	Stand occupancy time (min)
Small Jet	45 + 15 = **60** min
Turbo Prop	30 + 15 = 45 min

It is necessary to consider time for unexpected aircraft delays and time adjustments for meteorological reasons, and the value of 1.2 is used for planning in general. The calculated number of required spots is shown in Table 4.23 and Table 4.24.

Table 4.23 Number of Required International Stands

	2025	2030	2035	2040	2045	2050
Large Jet	2	2	2	2	2	2
Small Jet	7	9	11	12	16	19
Turboprop	0	0	2	2	2	2
Total	9	11	15	16	20	23

Table 4.24 Number of Required Domestic Spots

	2025	2030	2035	2040	2045	2050
Small Jet	2	2	3	3	3	3
Turboprop	3	4	4	5	6	7
Total	5	6	7	8	9	10

Because there are 20 stands, the current facility will meet the demand up to 2030 without modification. Considering the extra stands and the cargo stands, it is possible that there will be a shortage of stands in 2035 (see Table 4.25).

Table 4.25 Number of Required Spots

	2025	2030	2035	2040	2045	2050
International	9	11	15	16	20	23
Domestic	5	6	7	8	9	10
Extra stands	2	2	3	3	3	4
Other stands	4	1	-	-	-	-
Total	20	20	25	27	32	37

It is possible to increase the number of parking positions by modifying the stands for Code-E aircraft to Code-C aircraft to meet the demand. In addition, the depth of the existing apron is 130 meters to accommodate B747-400 aircraft.

4.2.2.1. Depth of the Existing apron

The existing apron depth is 130 m to accommodate B744 as the target aircraft. As shown in the figure below, the separation from the apron taxiway to the parked aircraft is 47.5 m.

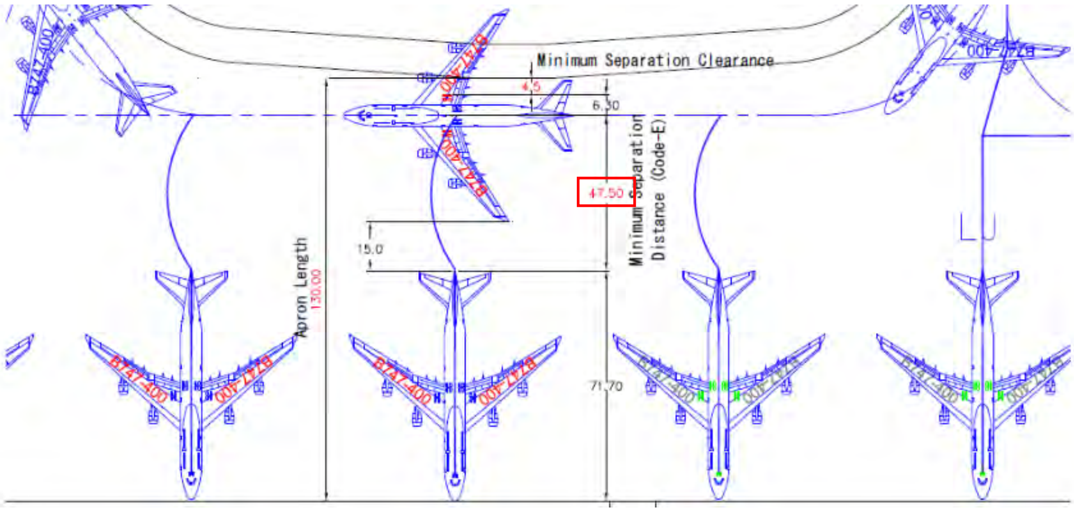


Figure 4.12 Existing Apron Depth for B747-400

Applying the current standard of 43.5 m separation between the centerline of the apron taxiway and the parked aircraft, the depth of the apron is sufficient to accommodate a B777-300ER.

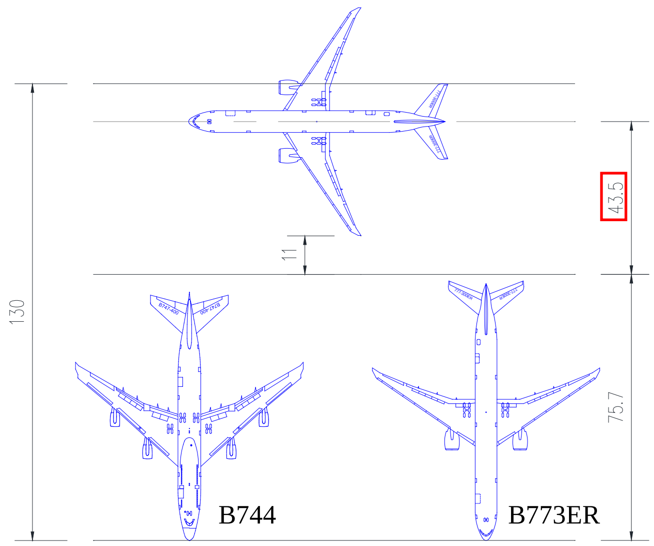


Figure 4.13 Existing Apron Depth for B777-300ER

4.3. ***Pavement Conditions***

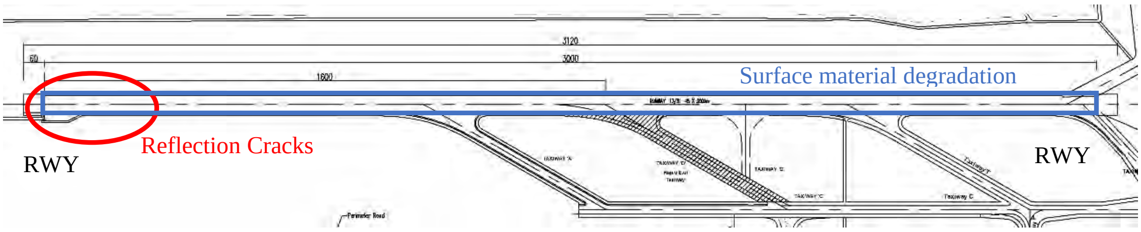
4.3.1. *Pavement Conditions of Runway*

A field survey was conducted by the study team on August 25, 2021. A visual inspection of the pavement surface to check for deterioration and damages was conducted.

As shown in Figure 4.14, there were a few cracks on the runway. On the Runway Threshold 13 area, there were cracks in the transverse direction at regular intervals. Because the cracks occurred at regular intervals, the study team considers that these to be reflection cracks caused by the concrete pavement under the asphalt surface as shown in Figure 4.15. The severity of the cracks are rated medium as the crack width is about 20 mm (see Figure 4.16).

There were no other significant cracks, so it is assumed that the cracks are not caused by structural fatigue, and the existing pavement structure is considered to be sufficiently strong.

The surface material has deteriorated throughout the entire runway. The asphalt binder was decreasing, and some of the aggregate was exposed. The reason for the deterioration is presumed to be aging because the surface was overlaid in 2006, which was 15 years ago.



Source : AS BUILT DRAWING

Figure 4.14 Pavement Conditions of Runway

Figure 4.15 Example of Reflection Cracks on Runway

Figure 4.16 Close View of Crack on Runway

4.3.2. *Pavement Conditions of Taxiways*

The field survey of the taxiway was conducted on the same day as the runway. Similar to the runway, the pavement surface was visually inspected.

On taxiways A, B, C, F, G, and T, the concrete pavement was used as the roadbed, and cracks that appeared on surface are reflection cracks (see Figure 4.17 and Figure 4.18). Structural fatigue damage crack were found in Taxiway B and T.

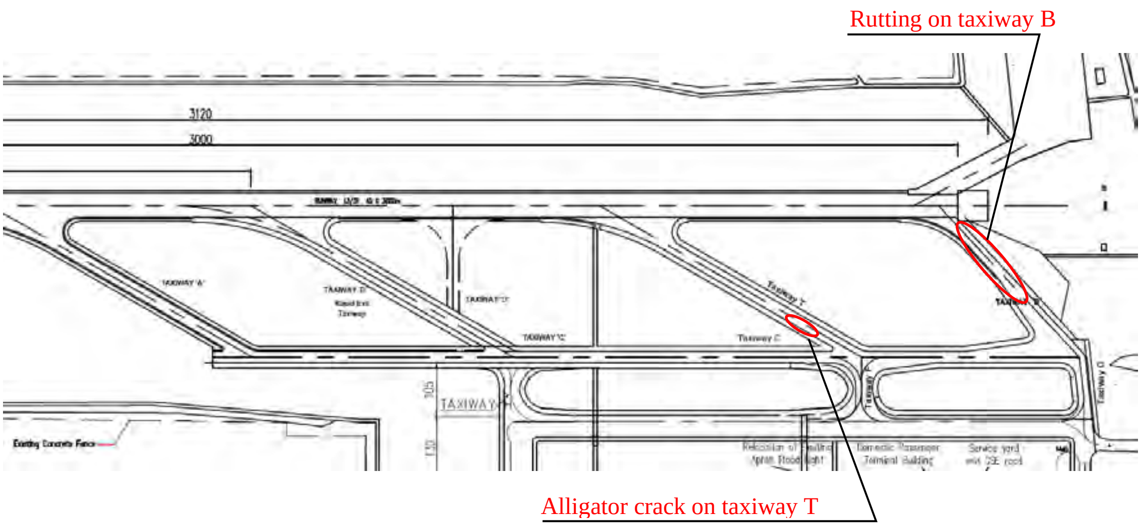


Figure 4.17 Location of Taxiway Damage

On Taxiway B (Figure 4.19), rutting on the asphalt surface was found. The maximum depth of the rutting was about 3 cm, and the severity is rated high.

On Taxiway T, alligator cracks were observed. The damage appears at a location approximately 4 meters from the centerline of the taxiway where the main gear of the Code C aircraft runs. Because the cracks are found in this place only, there is a possibility that the roadbed does not have enough bearing capacity at this location. The severity of the crack is rated medium. See Figure 4.20.

In addition to the above damage, the binder of the asphalt pavement was reduced, and the aggregate was exposed in all the taxiways except Taxiway D. In other words, the material of the pavement surface has deteriorated as shown in Figure 4.21.

Figure 4.18 Reflection Cracks on Taxiway

Figure 4.19 Rutting of Taxiway B

Figure 4.20 Alligator Cracks on Taxiway T

Figure 4.21 Pavement Surface Condition of Taxiways

4.3.3. *Pavement Conditions of Aprons*

The field survey of the apron was conducted on the same day as the survey of the runway and taxiway. Similar to the runway and taxiways, the pavement surface was visually checked.

Cracks were observed on the apron in front of the international terminal building in Apron 1A. Linear cracks on the concrete pavement close to the terminal building were observed. Most of the cracks observed were in the second concrete slab from the edge of the pavement. See Figure 4.22 and Figure 4.23.

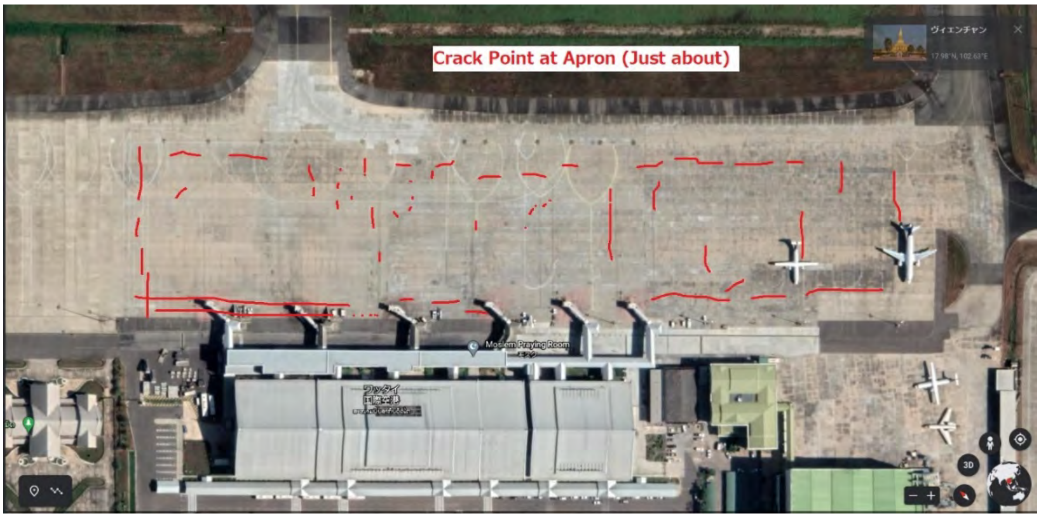


Figure 4.22 Location of Cracks in International Apron

Figure 4.23 Apron Cracks in front of the International Passenger Terminal

The concrete slab at the edge of the pavement, and the second concrete slab are tethered. It is presumed that the crack was caused by the concentration of stress during repeated expansion and contraction.

In the No.14 spot of the international apron, cracks were found at the position where the main gear of the aircraft runs. It is thought that the damage is due to fatigue accumulated by the repeated action of the added weight of the aircraft (Figure 4.24).

Figure 4.24 Cracks in Main Gear Position

4.4. ***Passenger Terminal Facilities***

4.4.1. *International Passenger Terminal Building*

Based on peak- hour air passengers and aircraft movements from the demand forecast, the study team evaluated the size of the existing terminal facility. The required size in the future is calculated based on the formulas such as IATA's Airport Development Reference Manual.

4.4.1.1. Departure Lobby

Current area of the departure lobby in the international passenger terminal building is 630 m^2. In 2019 (before the COVID-19 pandemic), the required area for the departure lobby had already exceeded the existing area. The small area is due to the insufficient depth of the original building.

Table 4.26 Facility Requirements of Departure Lobby in IPTB

No.	Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
	Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
1	**Departure Lobby**	A									FR	
	Ratio of well-wisher per passenger	α		0.3	0.3	0.3	0.3	0.3	0.3	0.3		
	Occupancy time (minutes)	t		25	25	25	25	25	25	25		
	Required area per person (m2)	a		2.3	2.3	2.3	2.3	2.3	2.3	2.3		ADRM 9th Table F9.3 w/carts
	A = PHP*(1.0+α)*t/60*a		630.0	592.7	636.0	840.3	1,034.7	1,275.7	1,505.6	1,777.8		

:Within the area of existing facilities

:Over 85% of the area/ number of existing facilities

:Exceeding the area of existing facilities

FR : VTE Expansion Project Preparatory Survey Final Report

4.4.1.2. Check-in Area

There are 33 check-in counters in the check-in area. According to the facility requirements calculation of check-in counters, 35 counters will be required by 2035. According to Table 4.27, the total check-in counter will reach its capacity by 2035.

Table 4.27 Facility Requirements of the Check-in Area in IPTB

No.		Definition	Acronym	Measured Value	Values							Reference	Note
					2019	2025	2030	2035	2040	2045	2050		
		Number of peak hour originating passengers (one way)	PHP		476	504	668	823	1,017	1,201	1,420		
2		**Check-in**											
	a	Check-in Lobby	A									FR	
		Ratio of well-wisher per passenger	α		0	0	0	0	0	0	0		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.0	2.0	2.0	2.0	2.0	2.0	2.0		ADRM 9th Table F9.2
		A = PHP*(1.0+α)*t/60*a		804.0	396.4	419.6	556.3	685.8	847.5	1,000.8	1,183.3		
	b	Check-in Counters	N									ADRM 8th 1.6.5.4	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t1		2.3	2.3	2.3	2.3	2.0	2.0	2.0		
		N = [(PHP+b)t1/60]*1.1		33	21	22	29	35	38	45	53		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
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4.4.1.3. Departure Passport Control

According to the interviews, the departure passport control area was congested even before the COVID-19 pandemic. The cause is not only the shortage of counters but also the shortage of immigration staff during peak hours. On the other hand, the JICA TC Team assumes the required number of passport control counters will exceed the number of existing counters by 2035. Since this area is difficult to expand due to the surrounding walls, other mesures to increase the passenger handling capacity are needed to be considered. (Table 4.28).

Table 4.28 Facility Requirements of Departure Passport Control in IPTB

No.		Definition	Acronym	Measured Value	Values							Reference	Note
					2019	2025	2030	2035	2040	2045	2050		
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
3		**Departure Passport Control**											
	a	Departure Passport Control Counter	N									ADRM 8th 1.6.5.5	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t2		1.0	1.0	1.0	1.0	1.0	1.0	1.0		FR
		N = [(PHP+b)t2/60]*1.1		13	9	10	13	16	19	23	27		
	b	Departure Passport Control Area	A									FR	
		Inspection booth width	C1		1.425	1.425	1.425	1.425	1.425	1.425	1.425		Measured width
		Passenger width 0.7m on booth sides	C2		1.4	1.4	1.4	1.4	1.4	1.4	1.4		
		Number of Inspection booth	X1		9	10	13	16	19	23	27		
		Wheel-chair and Crew passege width	C3		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Inspection Booth depth	D		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Queue Space	L		9.0	9.0	9.0	9.0	9.0	9.0	9.0		
		A = [(C1+C2)*X1+C3]*(D+L)		380	228.8	254.3	330.5	406.8	483.1	584.8	686.5		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
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4.4.1.4. Security Check Point

In the security area, the inspection of the departing passenger is currently carried out by two x-ray inspection machines and one Full Body Scanner. There was a long queue at the peak time before the COVID-19 pandemic. The JICA TC team estimates that three x-ray machines will be needed by 2028, and it is required to improve the situation earlier (Table 4.29).

Table 4.29 Facility Requirements of Security Check Point in IPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
4	a	**Security Check**	N									ADRM 8th 1.6.5.6	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		N = (PHP+b)/300		2	2	2	3	3	4	5	5		

:Within the area of existing facilities
:Over 85% of the area/ number of existing facilities
:Exceeding the area of existing facilities
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4.4.1.5. Departure Lounge

The departure lounge is designed with a required area of 1,391 m^2 for a target year of 2028, according to the Preparatory Survey Report in the Vientiane Airport Expansion Project. However, after handover of the building, due to setting up a Duty-Free Shop, etc., the space of the lounge became smaller than designed and is currently 1,300 m^2.

The existing departure lounge of 1,300 m^2 can accommodate a peak hour crowd of 488. Considering the processing capacity until 2035, the departure area of is required more than 2300 m^2.

Table 4.30 Facility Requirements of Departure Lounge in IPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
5		**Departure Lounge**	A									ADRM 9th F9.10.4	
		Seating Space per person (m2)	A1		*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*		*assumptions*
		Seat Capacity Rate	a		*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*		*assumptions*
		Space for Standing person (m2)	A2		*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*		*assumptions*
		Standing Capacity Rate	b		0.2	0.2	0.2	0.2	0.2	0.2	0.2		1-a
		Passenger Staying Time (minutes)	t		50	50	50	50	50	50	50		
		Rate of Associated Space	C		2.00	2.00	2.00	2.00	2.00	2.00	2.00		Table F9.5
		(wicket, queue and pass ways etc.)											
		A= PHP*(A1*a+A2*b)*t/60*C		1,300	1,268.6	1,361.3	1,798.7	2,214.7	2,730.7	3,222.7	3,805.3		

:Within the area of existing facilities
:Over 85% of the area/ number of existing facilities
:Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.1.6. Arrival Passport Control

In 2030, the required number of passport control counters will be the same as the number of existing counters. However, it is difficult to expand the area. See Table 4.31.

Table 4.31 Facility Requirements of Arrival Passport Control in IPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
6		**Arrival Passport Control**	N									ADRM 10th 3.4.13.2	
		Approximate Number of Arrival Passport Control Desks	PCi										
		Peak 30-minute Factor (in% of PHP)	PK		70%	70%	70%	70%	70%	70%	70%		
		Process Time per Passenger at Arrival Passport Control (in seconds)	PT		72	72	72	72	72	72	72		
		Maximum Queuing Time (in minutes)	MQT		10	10	10	10	10	10	10		
		N = (PHP*PK(PT/60))/(30+MQT)		15	10	11	15	18	22	26	30		

:Within the area of existing facilities (2019, 2025)
:Over 85% of the area/ number of existing facilities (2030)
:Exceeding the area of existing facilities (2035–2050)
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.1.7. Baggage Claim Area

There are two baggage carousels for wide body aircraft and one baggage carousel for narrow body aircraft. By 2040, the required number of baggage carousels will exceed the existing number (refer to No. 7a and 7b in Table 4.32). However, if a carousel with a long belt for a wide-body aircraft is used simultaneously with multiple narrow-body aircrafts, it will be possible to operate with the existing number of carousels until 2045 (refer to No. 7c in).

Table 4.32 Facility Requirements of Baggage Claim Area in IPTB

No.		Definition	Acronym	Measured Value	Values							Reference	Note
					2019	2025	2030	2035	2040	2045	2050		
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
7		**Baggage Claim**											
	a	Baggage Carousel -Wide body	BC_{WB}									FR	
		Number of flights (one way)	PHF_W		1	1	1	1	1	1	1		
		Device occupancy time per flight based on design aircraft of A330 (minutes)	t		30	30	30	30	30	30	30		
		$BC_{WB} = PHF_W$*t/60		2	1	1	1	1	1	1	1		
	b	Baggage Carousel - Narrow body	BC_{NB}									FR	
		Number of flights (one way)	PHF_N		2	5	6	8	9	11	13		
		Device occupancy time per flight based on design aircraft of B737 (minutes)	t		20	20	20	20	20	20	20		
		$BC_{NB} = PHF_N$*t/60		1	1	2	2	3	3	4	5		
	c	Number of Baggage Carousel converted to Narrow Body	BC									Original	
		$BC = BC_{WB}+BC_{NB}/1.5$		3	2	3	3	3	3	4	5		
	d	Area of Baggae Claim (m2)	A									ADRM 10th 3.4.13.3	
		Area of a carousel for wide body aircraft	AC_{WB}										
		Carousel width (m)	CW		*6*	*6*	*6*	*6*	*6*	*6*	*6*		
		Side buffer to allow passenger movement around the reclaim belt (total meters. allowing for both sides)	SB		*5*	*5*	*5*	*5*	*5*	*5*	*5*		
		Carousel frontage for passenger lIne up (in meters) = PAXWB*SP*PR*RR	CL_{WB}		62.5	62.5	62.5	62.5	62.5	62.5	62.5		
		Number of passengers in the design aircraft (wide body)	PAX_{WB}		294	294	294	294	294	294	294		
		Claim frontage per passenger (m)	SP		0.85	0.85	0.85	0.85	0.85	0.85	0.85		
		Ratio of passengers collecting bags	PR		50%	50%	50%	50%	50%	50%	50%		
		Recirculation rate	RR		50%	50%	50%	50%	50%	50%	50%		
		End buffer to allow passenger movement around the reclaim belt (total meters. allowing for both sides)	EB		10	10	10	10	10	10	10		
		$AC_{WB} = (CW+SB)*((CL_{WB}/2)+EB)$			453.6	453.6	453.6	453.6	453.6	453.6	453.6		
		Area of a carousel for narrow body aircraft	AC_{NB}										
		Carousel width (m)	CW		*6*	*6*	*6*	*6*	*6*	*6*	*6*		
		Side buffer to allow passenger movement around the reclaim belt (total meters. allowing for both sides)	SB		*5*	*5*	*5*	*5*	*5*	*5*	*5*		
		Carousel frontage for passenger lIne up (in meters) = PAXWB*SP*PR*RR	CL_{NB}		24.4	31.9	32.3	31.5	31.9	32.2	32.5		
		Number of passengers in the design aircraft (wide body)	PAX_{NB}		115	150	152	148	150	151	153		
		Claim frontage per passenger (m)	SP		0.85	0.85	0.85	0.85	0.85	0.85	0.85		
		Ratio of passengers collecting bags	PR		50%	50%	50%	50%	50%	50%	50%		
		Recirculation rate	RR		50%	50%	50%	50%	50%	50%	50%		
		End buffer to allow passenger movement around the reclaim belt (total meters. allowing for both sides)	EB		10	10	10	10	10	10	10		
		$AC_{NB} = (CW+SB)*((CL_{NB}/2)+EB)$			244.4	285.3	287.4	283.0	285.3	287.0	288.6		
		Area of Baggae Claim (m2)											
		Baggage Claim - Wide body	BC_{WB}		1	1	1	1	1	1	1		
		Area of a carousel for wide body aircraft	AC_{WB}		453.6	453.6	453.6	453.6	453.6	453.6	453.6		
		Baggage Claim - Narrow body	BC_{NB}		1	2	2	3	3	4	5		
		Area of a carousel for narrow body aircraft	AC_{NB}		244.4	285.3	287.4	283.0	285.3	287.0	288.6		
		$A = BC_{NB}*AC_{NB}+BC_{WB}*AC_{WB}$		1,190	698.0	1024.2	1028.5	1,302.5	1,309.6	1,601.5	1,896.5		

(light blue)	:Within the area of existing facilities
(yellow)	:Over 85% of the area/ number of existing facilities
(pink)	:Exceeding the area of existing facilities
FR	: VTE Expansion Project Preparatory Survey Final Report

4.4.1.8. Arrival Customs

There are seven customs lanes. The required number of customs lanes will be 7 in 2030 (see Table 4.31). However, it is difficult to expand the area.

Table 4.33 Facility Requirements of Arrival Customs in IPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
8		**Arrival Customs**											
	a	Queuing area	A									ADRM 8th 1.6.5.15	
		Proportion of passengers to be customs checked	f		100%	100%	100%	100%	100%	100%	100%		
		A = 0.25PHP*f*1.1		145	130.8	140.4	185.5	228.4	281.6	332.3	392.4		
	b	Arrival Customs Lane	N									ADRM 8th 1.6.5.16	
		Proportion of passengers to be customs checked	f		30%	30%	30%	30%	30%	30%	30%		FR
		Average processing time per passenger (minutes)	t4		2.0	2.0	2.0	2.0	2.0	2.0	2.0		FR
		N = PHPft4/60		7	5	6	7	9	11	13	15		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.1.9. Arrival Lobby

The required area of the arrival lobby will exceed the existing area by 2030. See Table 4.34.

Table 4.34 Facility Requirements of Arrival Lobby in IPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
9		**Arrival Lobby Waiting Area (excluding Concessions)**	A									ADRM 8th 1.6.5.17	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Number of visitors per passenger	o		1	1	1	1	1	1	1		
		A = 0.375(PHP+b+2PHPo)*1.1		793	588.7	631.7	834.7	1,027.7	1,267.2	1,495.5	1,765.9		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.1.10. Summary

The calculations of the major facilities requirement in the International Passenger Terminal Building are summarized in Table 4.35. The calculation shows that most of facilities in the International Passenger Terminal Building will be less than the demand requires in 2030 or 2035.

Table 4.35 Facility Size and Area Calculation (International Passenger Terminal Building)

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		476	511	675	831	1,024	1,209	1,427		
		Number of peak hour wide body aircraft (one way)	PHF_W		1	1	1	1	1	1	1		
		Number of peak hour narrow body aircraft (one way)	PHF_N		2	5	6	8	9	11	13		
1		**Departure Lobby**	A									FR	
		Ratio of well-wisher per passenger	α		0.3	0.3	0.3	0.3	0.3	0.3	0.3		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.3	2.3	2.3	2.3	2.3	2.3	2.3		ADRM 9th Table F9.3 w/carts
		A = PHP*(1.0+α)*t/60*a		630.0	592.7	636.0	840.3	1,034.7	1,275.7	1,505.6	1,777.8		
2		**Check-in**											
	a	Check-in Lobby	A									FR	
		Ratio of well-wisher per passenger	α		0	0	0	0	0	0	0		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.0	2.0	2.0	2.0	2.0	2.0	2.0		ADRM 9th Table F9.2
		A = PHP*(1.0+α)*t/60*a		804.0	396.4	425.4	562.1	692.1	853.3	1,007.1	1,189.2		
	b	Check-in Counters	N									ADRM 8th 1.6.5.4	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t1		2.3	2.3	2.3	2.3	2.3	2.3	2.3		
		N = [(PHP+b)t1/60]*1.1		33	21	22	29	36	44	51	61		
3		**Departure Passport Control**											
	a	Departure Passport Control Counter	N									ADRM 8th 1.6.5.5	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t2		1.0	1.0	1.0	1.0	1.0	1.0	1.0		FR
		N = [(PHP+b)t2/60]*1.1		13	9	10	13	16	19	23	27		
	b	Departure Passport Control Area	A									FR	
		Inspection booth width	C1		1.425	1.425	1.425	1.425	1.425	1.425	1.425		Measured width
		Passenger width 0.7m on booth sides	C2		1.4	1.4	1.4	1.4	1.4	1.4	1.4		
		Number of Inspection booth	X1		9	10	13	16	19	23	27		
		Wheel-chair and Crew passege width	C3		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Inspection Booth depth	D		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Queue Space	L		9.0	9.0	9.0	9.0	9.0	9.0	9.0		
		A = [(C1+C2)*X1+C3]*(D+L)		380	228.8	254.3	330.5	406.8	483.1	584.8	686.5		
4	a	**Security Check**	N									ADRM 8th 1.6.5.6	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		N = (PHP+b)/300		2	2	2	3	3	4	5	5		
5		**Departure Lounge**	A									ADRM 9th F9.10.4	
		Seating Space per person (m2)	A1		*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*		*assumptions*
		Seat Capacity Rate	a		*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*		*assumptions*
		Space for Standing person (m2)	A2		*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*		*assumptions*
		Standing Capacity Rate	b		0.2	0.2	0.2	0.2	0.2	0.2	0.2		1-a
		Passenger Staying Time (minutes)	t		50	50	50	50	50	50	50		
		Rate of Associated Space	C		2.00	2.00	2.00	2.00	2.00	2.00	2.00		Table F9.5
		(wicket, queue and pass ways etc.)											
		A= PHP*(A1*a+A2*b)*t/60*C		1,300	1,268.6	1,361.3	1,798.7	2,214.7	2,730.7	3,222.7	3,805.3		
6		**Arrival Passport Control**	N									ADRM 10th 3.4.13.2	
		Approximate Number of Arrival Passport Control Desks	PCi										
		Peak 30-minute Factor (in% of PHP)	PK		70%	70%	70%	70%	70%	70%	70%		
		Process Time per Passenger at Arrival Passport Control (in seconds)	PT		72	72	72	72	72	72	72		
		Maximum Queuing Time (in minutes)	MQT		10	10	10	10	10	10	10		
		N = (PHP*PK(PT/60))/(30+MQT)		15	10	11	15	18	22	26	30		
7		**Baggage Claim**											
	a	Baggage Carousel -Wide body	BC_{WB}									FR	
		Number of flights (one way)	PHF_W		1	1	1	1	1	1	1		
		Device occupancy time per flight based on design aircraft of A330 (minutes)	t		30	30	30	30	30	30	30		
		$BC_{WB} = PHF_W*t/60$		2	1	1	1	1	1	1	1		
	b	Baggage Carousel - Narrow body	BC_{NB}									FR	
		Number of flights (one way)	PHF_N		2	5	6	8	9	11	13		
		Device occupancy time per flight based on design aircraft of B737 (minutes)	t		20	20	20	20	20	20	20		
		$BC_{NB} = PHF_N*t/60$		1	1	2	2	3	3	4	5		
	c	Number of Baggage Carousel converted to Narrow Body	BC									Original	
		$BC = BC_{WB}+BC_{NB}/1.5$		3	2	3	3	3	3	4	5		
	d	Area of Baggae Claim (m2)											
		Baggage Claim - Wide body	BC_{WB}		1	1	1	1	1	1	1		
		Area of a carousel for wide body aircraft	AC_{WB}		453.6	453.6	453.6	453.6	453.6	453.6	453.6		
		Baggage Claim - Narrow body	BC_{NB}		1	2	2	3	3	4	5		
		Area of a carousel for narrow body aircraft	AC_{NB}		244.4	285.3	287.4	283.0	285.3	287.0	288.6		
		$A = BC_{NB}*AC_{NB}+BC_{WB}*AC_{WB}$		1,190	698.0	1024.2	1028.5	1,302.5	1,309.6	1,601.5	1,896.5		

(light blue)	:Within the area of existing facilities
(yellow)	:Over 85% of the area/ number of existing facilities
(pink)	:Exceeding the area of existing facilities
FR	: VTE Expansion Project Preparatory Survey Final Report

Table 4.36 shows an overview of the facility scale of the existing IPTB. According to the report of the expansion project, the planned year is 2028, the design capacity of the IPTB is 2.3 million passenger per year, and the design peak hour passenger capacity is 677. Some areas, such as the departure lobby, security checkpoint, and departure lounge, have already exceeded capacity as of 2019. Check-in counters, the departure passport control area, the arrival passport area, and baggage claims in other areas are also expected to run short between 2030 and 2035.

Table 4.36 Capacity vs. Demand of IPTB

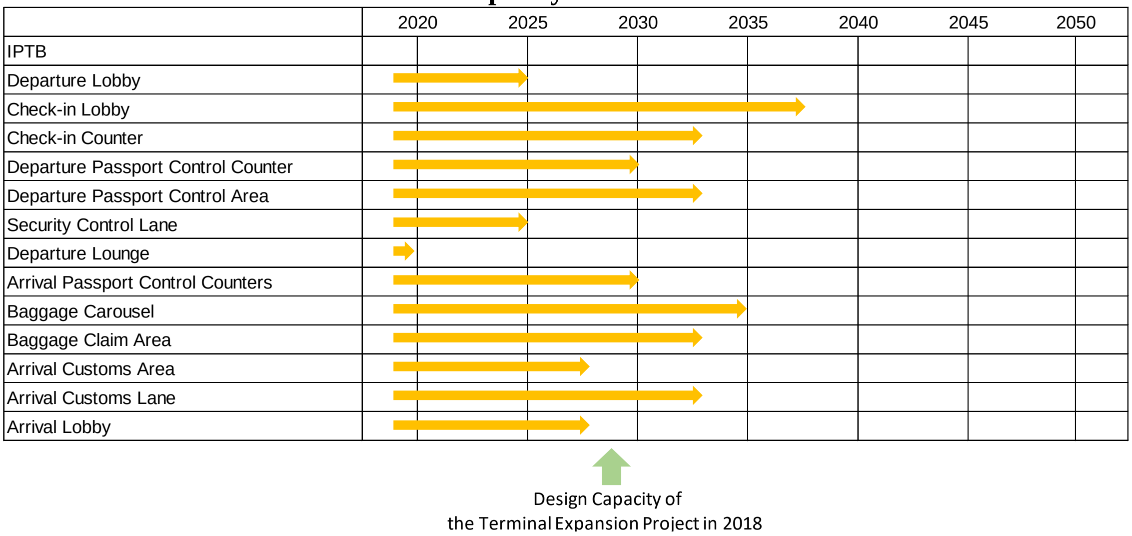


Figure 4.25 illustrates the Comparison between the Actual Capacity and the Design Capacity of the Expansion Project. Although the design of the existing IPTB is targeted for 677 peak-hour passengers, security check lanes, departure lounges, and check-in counters are not designed to meet the design capacity.

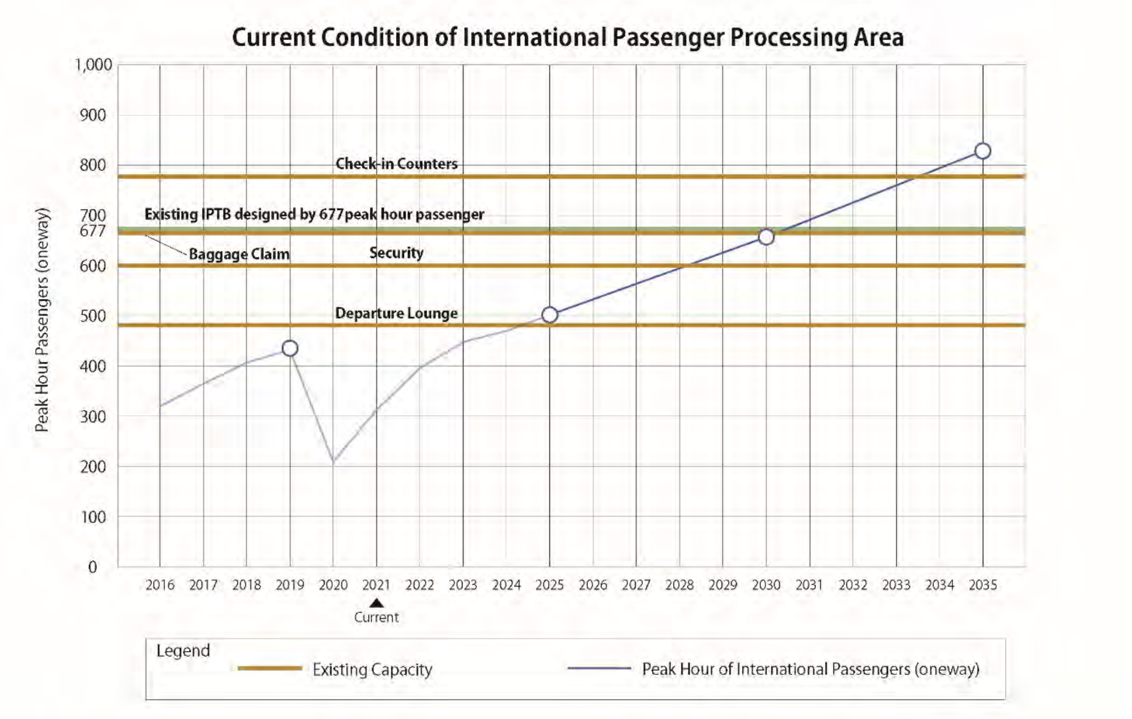


Figure 4.25 Comparison between the Actual Capacity and the Design Capacity of the Expansion Project

If the capacity of these areas, security check lanes, and departure lounges are expanded, the IPTB can be used without congestion after 2030.

For example, if the number of security lanes are increased to three lanes, it can handle 900 peak-hour passengers, and the facility can be used without difficulties after 2035 as shown in Figure 4.26.

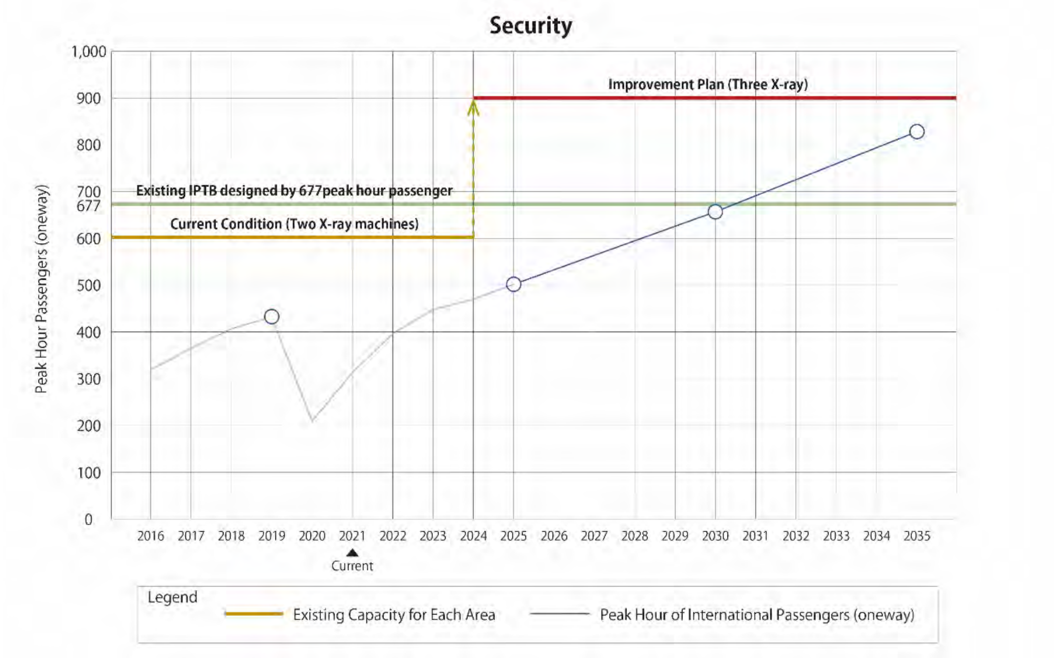


Figure 4.26 Improvement of Security Lanes

In the case of the departure lounge, if the area can be expanded to 2,450 m^2 from its current 1,300 m^2, it can handle 919 peak-hour passengers, and the facility will not be saturated until 2035.

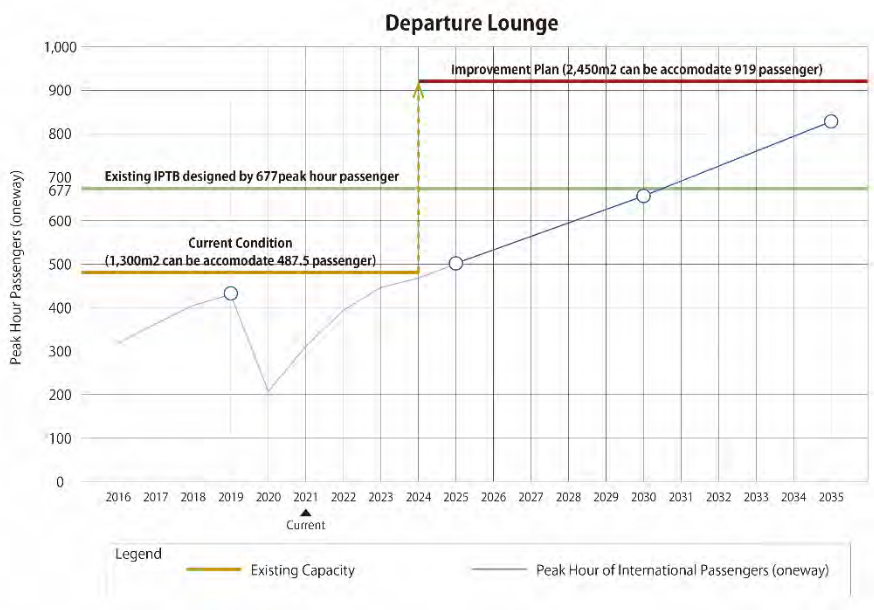
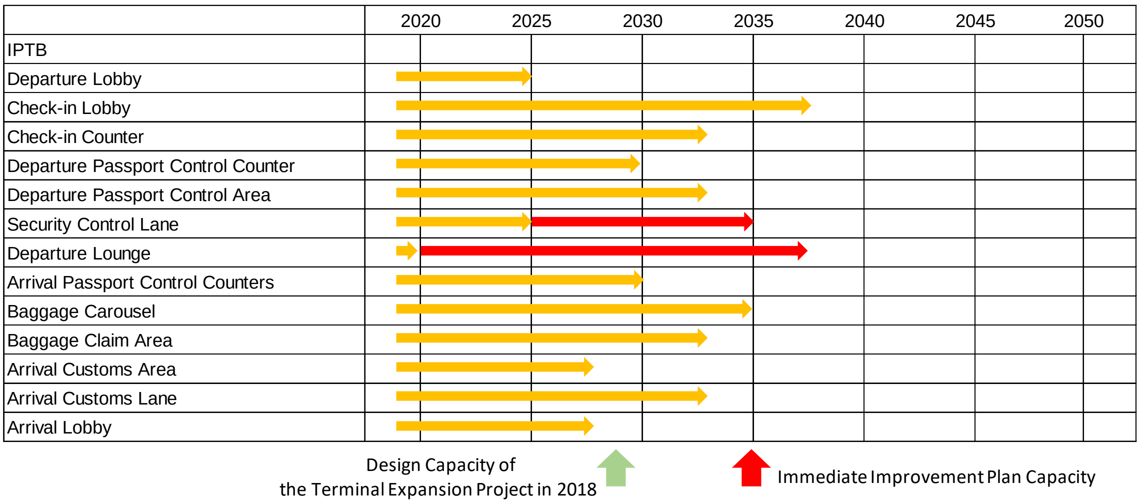


Figure 4.27 Improvement of Departure Lounge

If those improvements are made, the IPTB can be used within its capacity by 2035 as shown in Table 4.37.

Table 4.37 Capacity vs. Demand of IPTB after Improvements



However, it is difficult to increase the capacity of other areas such as the check-in lobby and the baggage claim. In this regard, major capacity expansion will be necessary by 2035.

4.4.2. *Domestic Passenger Terminal Building*

4.4.2.1. Departure Lobby

The area of the existing departure lobby is 310 m^2. In 2025, the required area of the departure lobby will be almost the same as the area of the existing one (See Table 4.38).

Table 4.38 Facility Requirements of Departure Lobby in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
1		**Departure Lobby**	A									FR	
		Ratio of well-wisher per passenger	α		0.5	0.5	0.5	0.5	0.5	0.5	0.5		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.3	2.3	2.3	2.3	2.3	2.3	2.3		ADRM 9th Table F9.3 w/carts
		A = PHP*(1.0+α)*t/60*a		310.0	266.3	288.9	377.3	462.2	562.1	672.0	745.3		

:Within the area of existing facilities
:Over 85% of the area/ number of existing facilities
:Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.2.2. Check-in Area

There are 14 check-in counters. The required number of check-in counters in 2040 will be the same as exists now.

Table 4.39 Facility Requirements of Check-in Area in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
2		**Check-in**											
	a	Check-in Lobby	A									FR	
		Ratio of well-wisher per passenger	α		0	0	0	0	0	0	0		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.0	2.0	2.0	2.0	2.0	2.0	2.0		ADRM 9th Table F9.2
		A = PHP*(1.0+α)*t/60*a		280.0	154.4	167.5	218.8	267.9	325.8	389.6	432.1		
	b	Check-in Counters	N									ADRM 8th 1.6.5.4	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t1		2.5	2.0	2.0	2.0	2.0	2.0	2.0		
		N = [(PHP+b)t1/60]*1.1		14	9	8	10	12	15	18	20		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.2.3. Departure Immigration Area

There are 6 counters in the departure immigration area. In 2035, the required number of counters will be 6 , and in 2040, 7 counters will be required, according to Table 4.40. The existing area for departure immigration is 140 m^2 and by 2035, the area will be congested.

Table 4.40 Facility Requirements of Departure Immigration in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
3		**Passport Control - Departure**	N										
	a	Departure Passport Control Counter	N									ADRM 8th 1.6.5.5	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t2		0.6	0.6	0.6	0.6	0.6	0.6	0.6		FR
		N = [(PHP+b)t2/60]*1.1		6	3	3	3	4	5	6	6		
	b	Departure Passport Control Area	A									FR	
		Inspection booth width	C1		1.425	1.425	1.425	1.425	1.425	1.425	1.425		Measured width
		Passenger width 0.7m on booth sides	C2		1.4	1.4	1.4	1.4	1.4	1.4	1.4		
		Number of Inspection booth	X1		3	3	3	4	5	6	6		
		Wheel-chair and Crew passege width	C3		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Inspection Booth depth	D		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Queue Space	L		9.0	9.0	9.0	9.0	9.0	9.0	9.0		
		A = [(C1+C2)*X1+C3]*(D+L)		140	76.3	76.3	76.3	101.7	127.1	152.6	152.6		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

4.4.2.4. Security Check Point

Table 4.39 shows that in 2030, the required number of security inspection lanes will exceed the existing number.

Table 4.41 Facility Requirements of Security Check Point in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
4	a	**Security Check**	N									ADRM 8th 1.6.5.6	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		N = (PHP+b)/300		1	1	1	1	2	2	2	2		

(light blue)	:Within the area of existing facilities
(yellow)	:Over 85% of the area/ number of existing facilities
(pink)	:Exceeding the area of existing facilities
FR	: VTE Expansion Project Preparatory Survey Final Report

4.4.2.5. Departure Lounge

In 2035, the required area of the departure lounge will be almost the same as the existing area, as shown in Table 4.42.

Table 4.42 Facility Requirements of Departure Lounge in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
5		**Departure Lounge**	A									ADRM 9th F9.10.4	
		Seating Space per person (m2)	A1		*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*		*assumptions*
		Seat Capacity Rate	a		*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*		*assumptions*
		Space for Standing person (m2)	A2		*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*		*assumptions*
		Standing Capacity Rate	b		0.2	0.2	0.2	0.2	0.2	0.2	0.2		1-a
		Passenger Staying Time (minutes)	t		30	30	30	30	30	30	30		
		Rate of Associated Space	C		2.00	2.00	2.00	2.00	2.00	2.00	2.00		Table F9.5(?)
		(wicket, queue and pass ways etc.)											
		A= PHP*(A1*a+A2*b)*t/60*C		540	296.4	321.6	420.0	514.4	625.6	748.0	829.6		

(light blue)	:Within the area of existing facilities
(yellow)	:Over 85% of the area/ number of existing facilities
(pink)	:Exceeding the area of existing facilities
FR	: VTE Expansion Project Preparatory Survey Final Report

4.4.2.6. Baggage Claim

There is only one baggage carousel in the area. The required number of baggage carousels in 2019 was the same, and an additional carousel will be required by 2025.

Table 4.43 Facility Requirements of Baggage Claim Area in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
6		**Baggage Claim**											
	a	Baggage Carousel - Narrow body	BC_{NB}									FR	
		Number of flights (one way)	PHF_N		3	4	5	6	7	8	9		
		Device occupancy time per flight based on design aircraft of B737 (minutes)	t		20	20	20	20	20	20	20		
		$BC_{NB} = PHF_N*t/60$		1	1	2	2	2	3	3	3		
	b	Area of Baggae Claim (m2)											
		Baggage Claim - Wide body	BC_{WB}										
		Area of a carousel for wide body aircraft	AC_{WB}										
		Baggage Claim - Narrow body	BC_{NB}		185	201	263	322	391	468	519		
		Area of a carousel for narrow body aircraft	AC_{NB}		1.0	2.0	2.0	2.0	3.0	3.0	3.0		
		$A = BC_{NB}*AC_{NB}+BC_{WB}*AC_{WB}$		457	185.3	402.0	525.0	643.0	1,173.0	1,402.5	1,555.5		

(light blue)	:Within the area of existing facilities
(yellow)	:Over 85% of the area/ number of existing facilities
(pink)	:Exceeding the area of existing facilities
FR	: VTE Expansion Project Preparatory Survey Final Report

4.4.2.7. Arrival Lobby

In 2040, the required arrival lobby area will be almost the same as the existing area according to Table 4.44.

Table 4.44 Facility Requirements of Arrival Lobby in DPTB

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
7		**Arrival Lobby Waiting Area (excluding Concessions)**	A									ADRM 8th 1.6.5.17	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Number of visitors per passenger	o		1	1	1	1	1	1	1		
		A = 0.375(PHP+b+2PHPo)*1.1		363	152.8	165.8	216.6	265.2	322.6	385.7	427.8		

(light blue)	:Within the area of existing facilities
(yellow)	:Over 85% of the area/ number of existing facilities
(pink)	:Exceeding the area of existing facilities
FR	: VTE Expansion Project Preparatory Survey Final Report

4.4.2.8. Summary

The calculations regarding the major facility and the area in the Domestic Passenger Terminal Building are shown in Table 4.45. The calculation shows that most of facilities in the Domestic Passenger Terminal Building will be less than demand requires in 2035 and 2040.

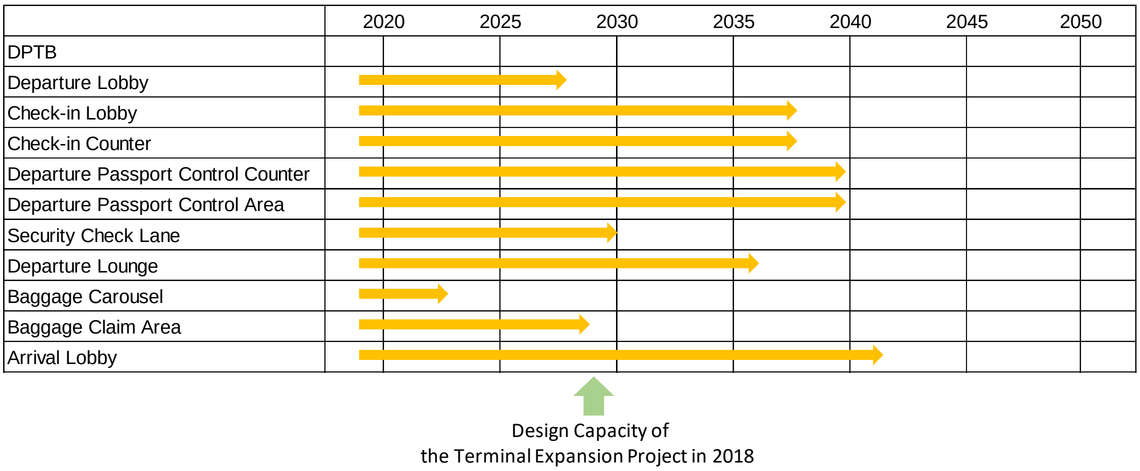
Table 4.45 Facility Size and Area Calculation (Domestic Passenger Terminal Building)

No.		Definition	Acronym	Measured Value	Values 2019	2025	2030	2035	2040	2045	2050	Reference	Note
		Number of peak hour originating passengers (one way)	PHP		185	201	263	322	391	468	519		
		Number of peak hour wide body aircraft (one way)	PHF_W		0	0	0	0	0	0	0		
		Number of peak hour narrow body aircraft (one way)	PHF_N		3	4	5	6	7	8	9		
1		**Departure Lobby**	A									FR	
		Ratio of well-wisher per passenger	α		0.5	0.5	0.5	0.5	0.5	0.5	0.5		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.3	2.3	2.3	2.3	2.3	2.3	2.3		ADRM 9th Table F9.3 w/carts
		A = PHP*(1.0+α)*t/60*a		310.0	266.3	288.9	377.3	462.2	562.1	672.0	745.3		
2		**Check-in**											
	a	Check-in Lobby	A									FR	
		Ratio of well-wisher per passenger	α		0	0	0	0	0	0	0		
		Occupancy time (minutes)	t		25	25	25	25	25	25	25		
		Required area per person (m2)	a		2.0	2.0	2.0	2.0	2.0	2.0	2.0		ADRM 9th Table F9.2
		A = PHP*(1.0+α)*t/60*a		280.0	154.4	167.5	218.8	267.9	325.8	389.6	432.1		
	b	Check-in Counters	N									ADRM 8th 1.6.5.4	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t1		2.5	2.0	2.0	2.0	2.0	2.0	2.0		
		N = [(PHP+b)t1/60]*1.1		14	9	8	10	12	15	18	20		
3		**Passport Control - Departure**	N										
	a	Departure Passport Control Counter	N									ADRM 8th 1.6.5.5	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Average processing time per passenger (minutes)	t2		0.6	0.6	0.6	0.6	0.6	0.6	0.6		FR
		N = [(PHP+b)t2/60]*1.1		6	3	3	3	4	5	6	6		
	b	Departure Passport Control Area	A									FR	
		Inspection booth width	C1		1.425	1.425	1.425	1.425	1.425	1.425	1.425		Measured width
		Passenger width 0.7m on booth sides	C2		1.4	1.4	1.4	1.4	1.4	1.4	1.4		
		Number of Inspection booth	X1		3	3	3	4	5	6	6		
		Wheel-chair and Crew passege width	C3		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Inspection Booth depth	D		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
		Queue Space	L		9.0	9.0	9.0	9.0	9.0	9.0	9.0		
		A = [(C1+C2)*X1+C3]*(D+L)		140	76.3	76.3	76.3	101.7	127.1	152.6	152.6		
5		**Departure Lounge**	A									ADRM 9th F9.10.4	
		Seating Space per person (m2)	A1		*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*		*assumptions*
		Seat Capacity Rate	a		*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*		*assumptions*
		Space for Standing person (m2)	A2		*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*	*1.2*		*assumptions*
		Standing Capacity Rate	b		0.2	0.2	0.2	0.2	0.2	0.2	0.2		1-a
		Passenger Staying Time (minutes)	t		30	30	30	30	30	30	30		
		Rate of Associated Space	C		2.00	2.00	2.00	2.00	2.00	2.00	2.00		Table F9.5(?)
		(wicket, queue and pass ways etc.)											
		A= PHP*(A1*a+A2*b)*t/60*C		540	296.4	321.6	420.0	514.4	625.6	748.0	829.6		
6		**Baggage Claim**											
	a	Baggage Carousel - Narrow body	BC_{NB}									FR	
		Number of flights (one way)	PHF_N		3	4	5	6	7	8	9		
		Device occupancy time per flight based on design aircraft of B737 (minutes)	t		20	20	20	20	20	20	20		
		$BC_{NB} = PHF_N*t/60$		1	1	2	2	2	3	3	3		
	b	Area of Baggae Claim (m2)											
		Baggage Claim - Wide body	BC_{WB}										
		Area of a carousel for wide body aircraft	AC_{WB}										
		Baggage Claim - Narrow body	BC_{NB}		185	201	263	322	391	468	519		
		Area of a carousel for narrow body aircraft	AC_{NB}		1.0	2.0	2.0	2.0	3.0	3.0	3.0		
		$A = BC_{NB}*AC_{NB}+BC_{WB}*AC_{WB}$		457	185.3	402.0	525.0	643.0	1,173.0	1,402.5	1,555.5		
7		**Arrival Lobby Waiting Area (excluding Concessions)**	A									ADRM 8th 1.6.5.17	
		Number of transfer passenger not processed airside	b		0	0	0	0	0	0	0		
		Number of visitors per passenger	o		1	1	1	1	1	1	1		
		A = 0.375(PHP+b+2PHPo)*1.1		363	152.8	165.8	216.6	265.2	322.6	385.7	427.8		

(light blue) :Within the area of existing facilities
(yellow) :Over 85% of the area/ number of existing facilities
(pink) :Exceeding the area of existing facilities
FR : VTE Expansion Project Preparatory Survey Final Report

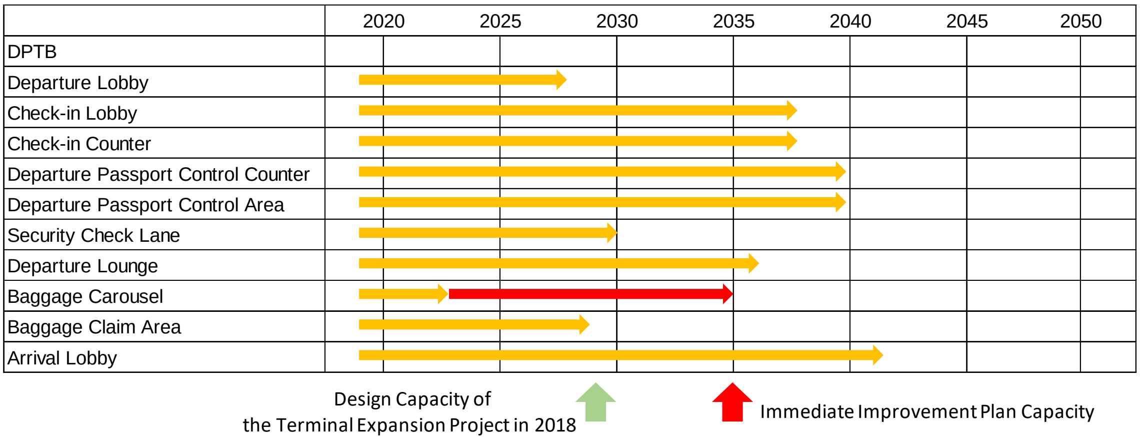
The results of the capacity demand analysis of the DPTB are shown in Table 4.46. According to the previous design report, the design capacity is 586 thousand passengers per annum and design peak hour passenger is 227 per hour. This design capacity will be reached by 2035. Some of the facilities and areas such as the departure lobby, the security check lane, and the baggage carousel will not meet capacity in 2035.

Table 4.46 Capacity vs. Demand of DPTB



If one more baggage carousel is added, the capacity of the baggage carousel will meet the demand of 2040. See Table 4.47.

Table 4.47 Capacity vs. Demand of DPTB after Improvement



4.5. *Ground Support Equipment Workshop*

There is no maintenance workshop for large-sized GSE in the airport. Maintenance workshops are needed to be able to use the equipment for a long time.

4.6. *Cargo Terminal Facilities*

Future handling of the volume of cargo is predicted as shown in Table 4.48.

Table 4.48 Results of Air Cargo Forecast

	2019	2025	2030	2035	2040	2045	2050
International Air Cargo (ton)	3,514	4,900	6,500	8,100	10,100	12,000	14,300
Domestic Air Cargo (ton)	689	1,100	1,600	2,200	2,800	3,500	4,300

In accordance with IATA ADRM 10th, the required area for Cargo terminal for Low Automation level of 5 tons per square meters is applied for the calculation. The existing cargo terminals include a 3,250 m^2 international cargo building, a 840 m^2 Lao Airlines cargo building, and a 216 m^2 Lao Skyway cargo building. In terms of the area of the existing international and domestic cargo, the area of Lao Airlines Cargo is divided into the international area and the domestic area because Lao Airlines handles both international and domestic cargo. Therefore, the total area of the existing international cargo is 3,670 m^2, which is the sum of the international cargo terminal and half of Lao Airlines cargo terminal. The total area of the existing domestic cargo is 636 m^2, which is the sum of half of Lao Airlines cargo terminal and Lao Skyway cargo terminal.

Table 4.49 Required Cargo Terminal Size

	Current Area	2019	2025	2030	2035	2040	2045	2050
Required area of the International Air Cargo (m^2)	3,670	703	980	1,300	1,620	2,020	2,400	2,860
Required area of the Domestic Air Cargo (m^2)	636	138	220	320	440	560	700	860

According to Table 4.49, it is considered that the area required for cargo handling in the future will be sufficient.

4.7. *Rescue and Fire-Fighting Facilities*

4.7.1. *Fire Station*

The air compressor for the firefighter’s breathing tank at the fire station is out of order, and there is a problem with the air charge.

4.7.2. *Training Space for Fire-Fighters*

The venue and facility for personnel-training corresponding to aviation accidents and aircraft fires is currently limited.

4.7.3. *Water Supply in Case of Emergency*

The water supply pipe from town is very small, so it takes a long time to supply the water to the fire-fighting vehicles. This will be a major obstacle in the case of a fire at the airport. A water tank is also required.

4.7.4. *Maintenance Workshop for Fire-Fighting Vehicle*

Two bays have been expanded due to the increase of the number of vehicles, but there is no space for vehicle maintenance.

4.7.5. *Fire-Fighting Vehicles*

Two of the vehicles procured in 2018 are not in use due to a failure of the summation box for automatic control in the center of the vehicle. There is not enough facility for fire vehicle maintenance. The lack of an air compressor for large-sized vehicles is causing major maintenance problems.

4.8. ***Control Tower***

Visibility analysis is conducted with an FAA Air Traffic Control Visibility Analysis Tool. This tool analyses Object Discrimination Analysis and Line of Sight Angle of Incidence Analysis. The input values for calculation are distance between the control tower to the key point, observer eye height, ground elevation of the control tower, and ground elevation of the key point. Object discrimination analysis provides detection, recognition, and identification of the object at the key point. In this case, a vehicle, a Dodge Caravan at the runway threshold is used. Figure 4.28 shows the location of the control tower and the distance between the control tower and Runway Thresholds 13 and 31. The elevation of the Runway 31 Threshold is 169.99 m (557.72 feet) and that of the Runway13 Threshold is 171.31 m (562.03 feet). The ground height of the control tower is 169.50 m (556.10 feet). Because Runway Threshold 13 is farther than Runway Threshold 31, the Runway Threshold 13 is used as the key point for the calculation.

Figure 4.28 Location of the Control Tower and Runway Thresholds

The result shows that object discrimination passes the threshold value but the line of sight angle fails. The threshold of the line of sight angle is 0.8 degree but the current line of sight from the control tower eye height to the Runway 13 Threshold is 0.68 degree. The required eye height for 0.8 degree is 36.6 m while the current eye height is 31.2 m. This is because when the control tower was designed in 1995, the criteria of line of sight angle was 35 minutes (0.58 degree).

4.9. *Airport Access*

4.9.1. *Curb Side Road*

Based on the timetable data published by OAG, the JICA TC team estimated the number of users during the current peak hours and evaluated the scale of the facility. The conditions for calculating the number of passengers during the peak hours are as follows.

Table 4.50 Peak Hour Aircraft Seats and Load Factor

Date to be caluculated - 2019/12/19	Available Seats	Load Factor (DOM)	Load Factor (INT)
A319	120	-	64.3%
A320	142	50%	64.3%
A321	203	-	64.3%
A330	299	-	64.3%
B737	140	-	64.3%
B738	189	-	64.3%
AT72	72	60%	-
MA60	60	60%	-

The number of peak hour passengers estimated based on the OAG timetable data and the above conditions is shown in Table 4.51. The JICA TC team used data from December 19, 2019, the day with the highest number of flights for the entire year for our estimates.

Table 4.51 Estimated Peak-Hour Passengers (2019/12/19)

		Peak hour passenger	Time
Departure	DOM	206	9:05-10:04
	INT	403	12:35-13:34
	Total	489	11:05-12:04
Arrival	DOM	198	11:55-12:54
	INT	400	18:50-19:49
	Total	510	11:55-12:54
Departure &Arrival	DOM	320	11:55-12:54
	INT	611	10:35-11:34
	Total	**801**	10:45-11:44

The number of passengers by means of transportation was estimated based on the total number of arriving and departing passengers (801) for domestic and international flights.

In making the calculations, the sharing ratio for each mode of transportation used in the demand forecast was applied. The share used in the calculations was 6% for motorcycles, 5% for tuk-tuks, 3% for taxies, 7% for buses, and 79% for private cars.

The required length of the curbside was calculated based on the number of users per 5 minutes and the required space by traffic mode. Required space by traffic modes was 3 meters for motorcycles, 4 meters for tuk tuks, 5 meters for taxies and private cars, and 15 meters for buses.

If all private cars were to use the curbside, the required length would be 269 m, which is almost equal to the length available for taxies, buses, and private cars.

It is not reasonable to presume that all private cars will use the curbside. In fact there are a certain number of cars that use the parking lot. Therefore, the required length is expected to be less than the current level. The current size is a reasonable facility size for the current number of users.

Table 4.52 Estimated Curb Side Length

		Ratio	Peak hour passenger	Trafic number	5-minutes average	Required length
Total		100%	801	-	-	-
	Motorcycles	6%	49	49	5	15
	Tuktuks	5%	41	41	4	16
	Taxis	3%	25	25	3	15
	Buses	7%	53	6	1	15
	Private Cars	79%	633	633	53	265
					Total required length	**326**

4.9.2. *Car park*

The required parking spaces was calculated based on peak hour passengers estimated from OAG timetable data and the number of parking spaces used per passenger.

The number of parking spaces used per passenger was assumed to be 0.6 spaces for international flights and 0.8 spaces for domestic flights, as indicated in the survey reports of previous years.

It is considered that the parking lot size is sufficient for the current demand.

Table 4.53 Number of Required Car Park

Number of parking per passenger(INT)	0.6 stand/passenger
Number of parking per passenger(DOM)	0.8 stand/passenger

		2019
Busy hour passenger		801
	International	611
	Domestic	190
Required number of parking		**519**
	International	367
	Domestic	152
Number of parking		**874**
	Existing	874
	Expansions	0

4.10. *Airfield Lighting Systems*

4.10.1. *Runway Lights*

Runway lights were installed in 1997. However, the lighting fixtures are in good condition with minor repairs, and spare parts are available in the market.

4.10.2. *Apron Edge Lights and Taxiway Lights*

Half of the apron edge lights and the taxiway lights were replaced after 2011, but the rest of the lights were installed in 1997. However, the products and spare parts are available in the market.

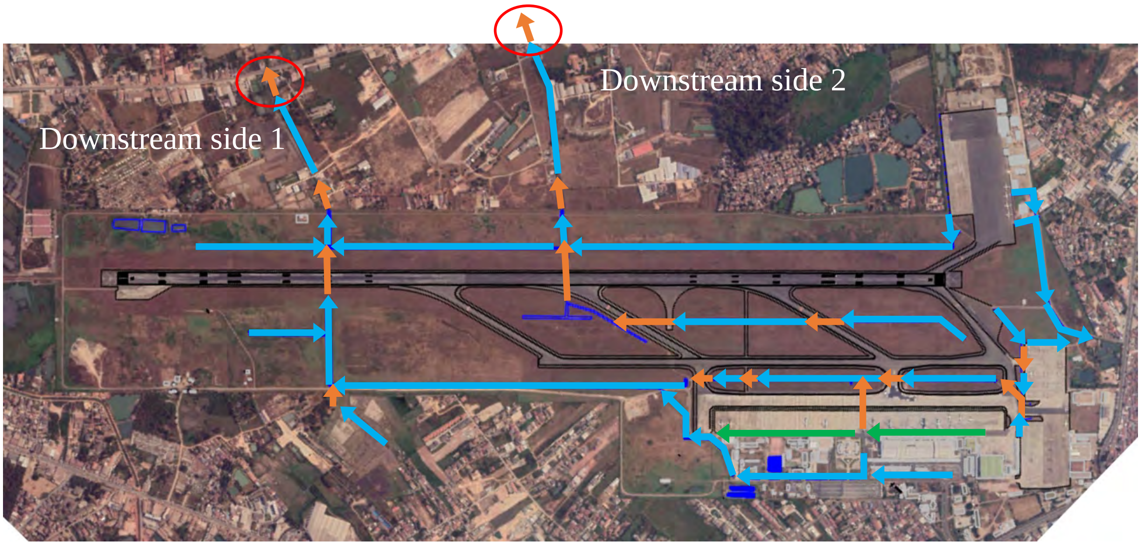
4.10.3. *Power Cable for Airfield Lighting*

The power cables for the airfield lighting system were installed in 1997 and aged 25 years. These cables from the powerhouse to hand-holes in the apron are installed in the pipe. However, the wires between the handholes in the apron and the lighting are direct installations without piping underground. Mice sometimes damage the power cable without pipe protection. Also, it is not easy to find the damaged portion to fix it.

4.11. *Drainage System*

The paved area in the airport has not increased since the apron expansion. Existing facilities carry out drainage of rainwater outside the airport.

According to the information received from the local authorities, the GSE road is often flooded during heavy rains, but the flooding seems to dissipate as soon as the rainfall decreases. When expanding the facility in the future, it will be necessary to identify the location of the flooding and the facility that causes it.



Legend : ←Open Channel ←Culvert ←Grating

Figure 4.29 Drainage Surveyed Area

As shown in Figure 4.30, on the downstream side 1, the drainage system from the airport is treated in an underground facility that crosses under the road, where stagnant water is generated. There is no problem because the rainwater drainage from the airport has not led to flooding in the surrounding area.

Figure 4.30 Downstream Side 1

On the downstream side 2 shown in Figure 4.31, concrete pavement and a restaurant have been constructed on top of the box culvert where the storm water drainage from the airport flows. As with downstream 1, this is not considered a problem as it has not caused flooding in the surrounding area.

Figure 4.31 Downstream Side 2

Both downstream 1 and 2 have one thing in common: the box culvert used for drainage is above the living area, so it will not be easy to increase the flow rate by expansion.

Figure 4.32 shows the catchment area for open channels between the culvert nearest to the airport and the culvert surveyed here, where residential development has progressed in recent years.

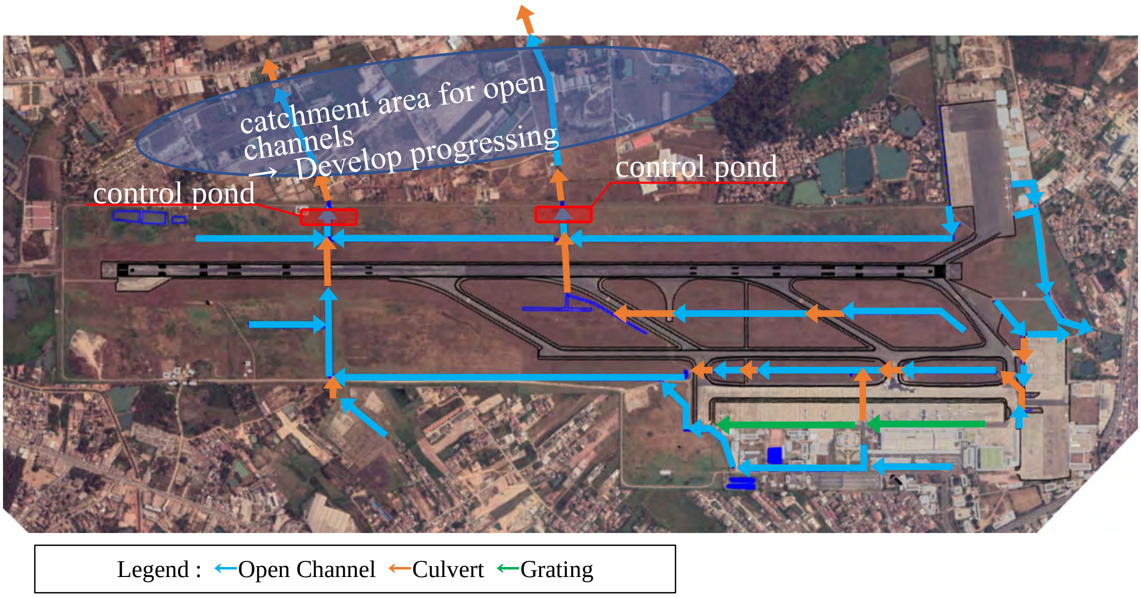
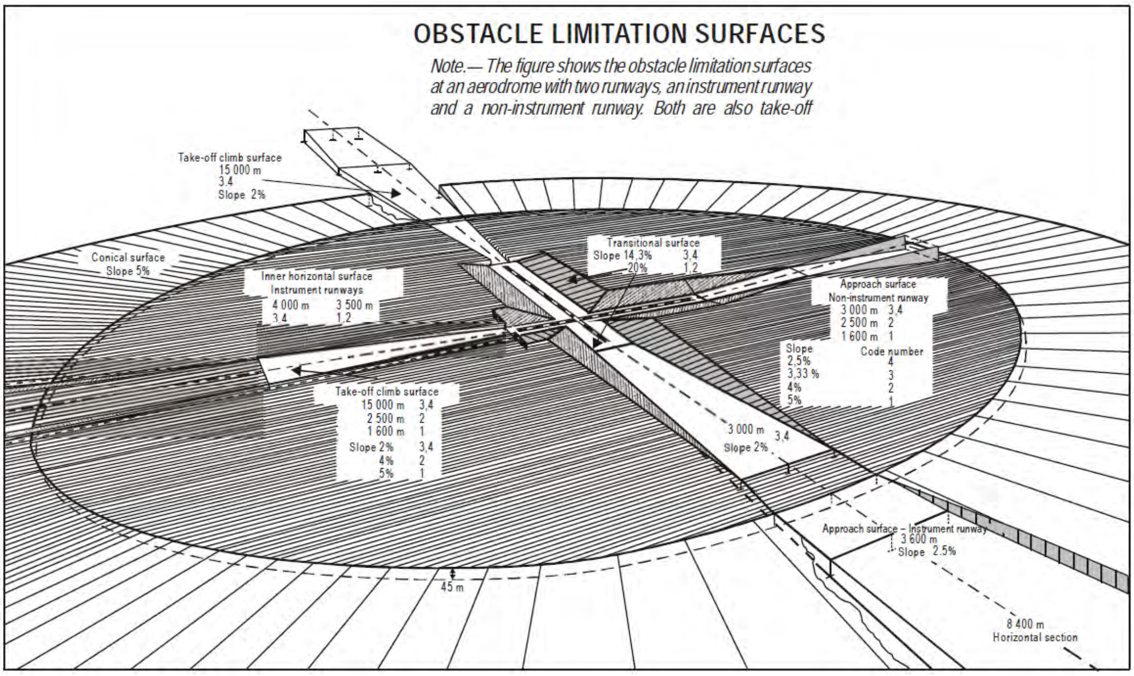


Figure 4.32 Catchment Area of Open Channels

4.12. ***Obstacle Limitation Surfaces***

4.12.1. *General*

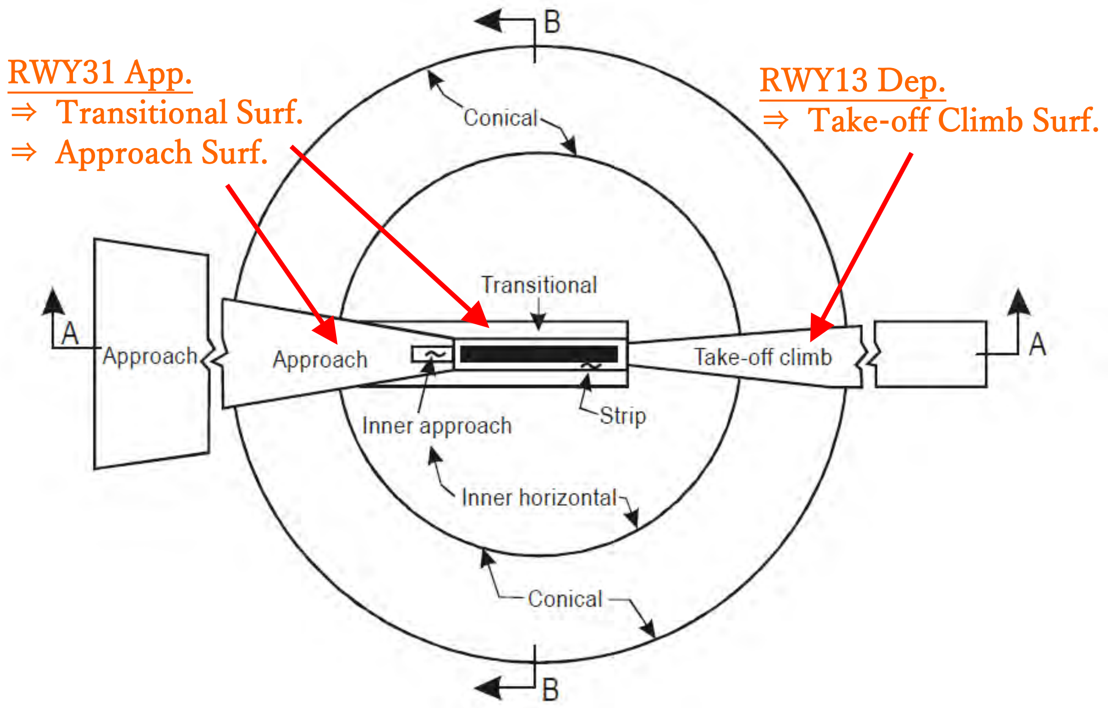
Obstacle Limitation Surfaces (OLS) is assessed as the basic aerodrome set-up for airspace development with IFPs in order to assure the use of Runway 31 before exploring the possibility of a specifical setup airspace utilization, route structure, and specific IFPs, such as Standard Instrument Departure (SID) and Instrument Landing System (ILS) Approach. Figure 4.33 shows the conceptual shape of OLS for an aerodrome.



Source: Annex 14 Vol.1 Attachment B

Figure 4.33 Obstacle Limitation Surfaces (Conceptual View)

Figure 4.34 shows the plan view of OLS, which is defined in ICAO Annex 14. From this figure, it is clear that securing Obstacle Limitation Surfaces (OLS), in particular an approach surface, transitional surfaces, and a takeoff climbing surface, are mandatory to develop the operations on RWY31. The priority should be to set those 3 surfaces for this assessment. Other surfaces, such as inner horizontal surface, should also be secured, but it can be treated less critically considering the nature of the aircraft operations and aerodrome set-up at VTE.



Source: Annex 14 Vol.1

Figure 4.34 Obstacle Limitation Surfaces (Plan view)

Table 4.54 and Table 4.55 are the summary of dimensions and slopes of OLS for approach runways and takeoff runways, respectively. The runway at VTE is categorized for Code number 4.

Table 4.54 Dimensions and Slopes of OLS - Approach Runways

	RUNWAY CLASSIFICATION									
	Non-instrument Code number				Non-precision approach Code number			Precision approach category I Code number		Precision approach category II or III Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
APPROACH										
Length of inner edge	60 m	80 m	150 m	150 m	140 m	280 m	280 m	140 m	280 m	280 m
Distance from threshold	30 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m	60 m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1 600 m	2 500 m	3 000 m	3 000 m	2 500 m	3 000 m	3 000 m	3 000 m	3 000 m	3 000 m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	—	—	—	—	—	3 600 m[b]	3 600 m[b]	12 000 m	3 600 m[b]	3 600 m[b]
Slope	—	—	—	—	—	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	—	—	—	—	—	8 400 m[b]	8 400 m[b]	—	8 400 m[b]	8 400 m[b]
Total length	—	—	—	—	—	15 000 m	15 000 m	15 000 m	15 000 m	15 000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%

Source: Annex 14 Vol.1

Table 4.55 Dimensions and Slopes of OLS of Takeoff Runway

Surface and dimensions[a] (1)	Code number 1 (2)	Code number 2 (3)	Code number 3 or 4 (4)
TAKE-OFF CLIMB			
Length of inner edge	60 m	80 m	180 m
Distance from runway end[b]	30 m	60 m	60 m
Divergence (each side)	10%	10%	12.5%
Final width	380 m	580 m	1 200 m 1 800 m[c]
Length	1 600 m	2 500 m	15 000 m
Slope	5%	4%	2%[d]

a. All dimensions are measured horizontally unless specified otherwise.
b. The take-off climb surface starts at the end of the clearway if the clearway length exceeds the specified distance.
c. 1 800 m when the intended track includes changes of heading greater than 15° for operations conducted in IMC, VMC by night.
d. See 4.2.24 and 4.2.26.

Source: Annex 14 Vol.1

There are three noticeable differences between approach runway and takeoff runway:

1) OLS for Takeoff is narrower in width,

2) OLS for Takeoff does not have transitional surfaces at either side, and

3) OLS for Takeoff does not start at the runway end but at the end of the clearway.

The first and second differences are clearly advantageous for a takeoff runway while the third difference is not advantageous for a takeoff runway. However, it could be equalized if the length of clearway is shortened below 60 m from the current 150 m with certain evaluations and discussions among related parties. Such evaluations are discussed later in this section.

4.12.2. *OLS and Obstacle Assessment for VTE*

Figure 4.35 and Figure 4.36 show the OLS of VTE for the approach runway and the takeoff runway, respectively, at Runway 31 end. Three different surfaces are found in the figure for approach runway, namely, 1) a non-instrument runway (green dotted line), 2) an instrument runway with the current ICAO standard value of 280-m long inner edge (blue solid line) and 3) an instrument runway with the previous ICAO standard value of 300 m for the inner edge (red solid line). According to the current AIP in Lao PDR, the length of the inner edge, which is equal to the width of the runway strip, is 300 m, but it is confirmed with a counterpart team from DCA that Lao PDR will change the applied standard from 300 m to 280 m in accordance with the change in Annex 14 for future development.

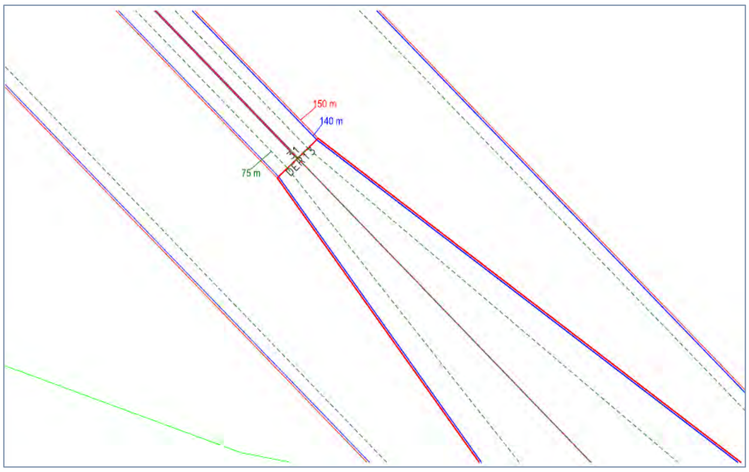


Figure 4.35 OLS for Approach Runway for Runway31 Approach

There are two different surfaces for a takeoff runway. One is a current clearway of 150 m and the other is a shortened clearway to 60 m, which is expectedly implemented by the time for the introduction of instrument departure from Runway 13. This change is already agreed with its DCA counterpart through the discussions.

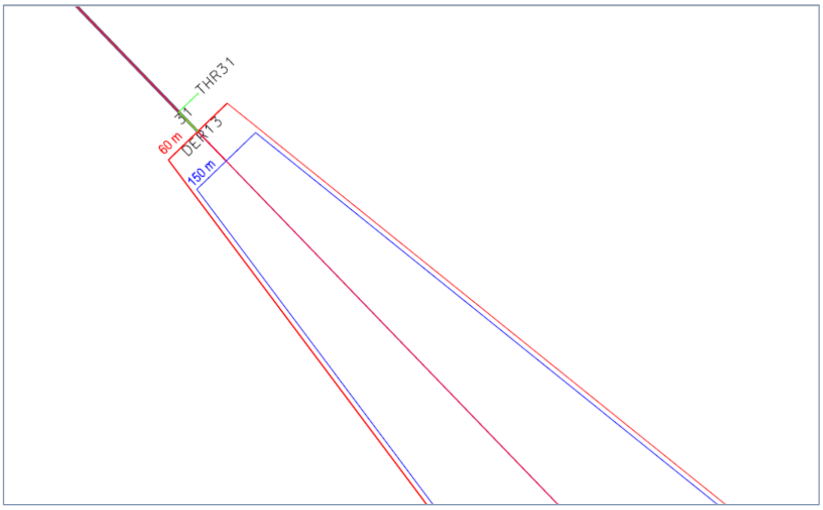


Figure 4.36 OLS for Takeoff Runway for Runway 13 Departure

Figure 4.37 to Figure 4.39 and Table 4.56 to Table 4.58 are the results of obstacle assessment for these surfaces for the approach runway. Some obstacles are already penetrating the concerned surfaces even for the current non-instrument runway set-up, which would be a big issue even for the current Visual Meteorological Condition (VMC) based operations. Further, in the case of the instrument runway set-up for the future operations, there are more penetrating obstacles: the number of penetrating obstacles increases from 2 for non-instrument runway to 8 (3 of 11 seems to be measured at a different point of the same obstacle) for instrument runway (both for non-precision or precision). It should be noted that some discrepancy of obstacle data was found during the site survey. Therefore, remeasurements of obstacles are requested to AOL through DCA and LANS, and the assessment result will be updated later.

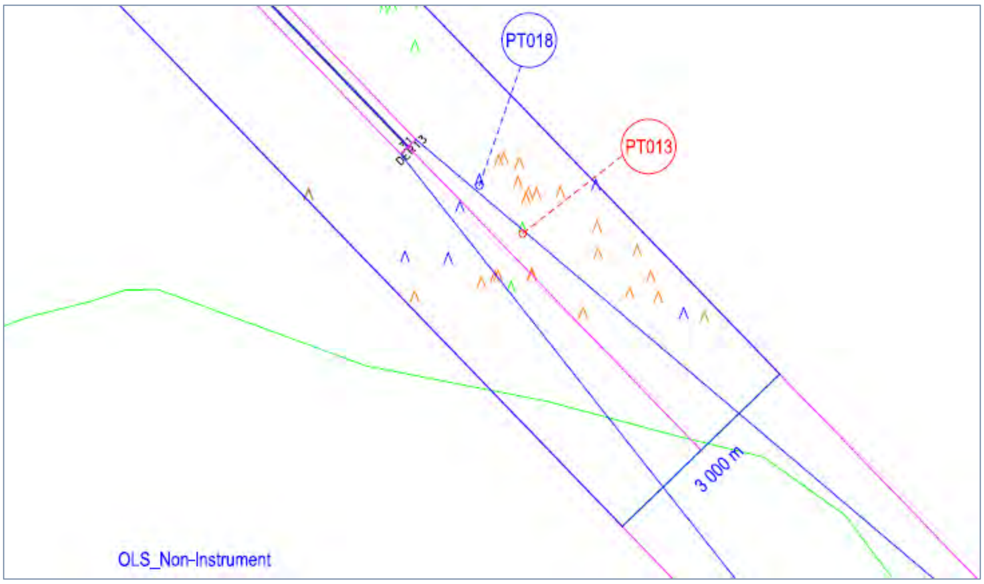


Figure 4.37 OLS Assessment Results: (1) Non-instrument Approach Runway

Table 4.56 OLS Assessment Results: (1) Non-instrument Approach Runway

Approach Surface Slope **2.5** %

No	Obstacle Name	Latitude	Longitude	Alt.(m)	Dist. (m)	Surface Alt. (m)	Penet. (m)
1	VLVT_25112020_PT013_TREE	17°58' 22.2529" N	102°34' 52.8428" E	197.16	1005.09	196.22725	0.93275
2	T_VLVT_30 03 2018_14_TREE	17°58' 08.7100" N	102°34' 50.2500" E	198.5	1247.17	202.27925	-3.77925
3	VLVT_25112020_PT071_BUILDING	17°58' 02.9543" N	102°35' 07.6743" E	207.06	1733.98	214.4495	-7.3895
4	VLVT_25112020_PT038_BUILDING	17°58' 11.7573" N	102°34' 55.2282" E	196.95	1283.78	203.1945	-6.2445
5	VLVT_25112020_PT021_BUILDING	17°58' 26.9445" N	102°34' 37.7035" E	182.8	588.88	185.822	-3.022

Transitional Surface Length of inner edge **150** m

No	Obstacle Name	Latitude	Longitude	Altitude(m)	Distance to the App edge (m)	Distance to Starting point of 60m (m)	Position	elevation (m)	Surface Alt. (m)	Penet. (m)	Note
1	VLVT_25112020_PT018_ANTENNA	17°58' 33.1766" N	102°34' 42.3005" E	198.89	41.14	548.02	along app surface	184.80	190.68	8.21	
1	VLVT_25112020_PT004_BUILDING	17°58' 30.2874" N	102°34' 54.1434" E	216.85	195.22	856.55	along app surface	192.51	220.43	-3.58	ARMANY Hotel
2	17082021 VLVT_PT005_BUILDING	17°58' 29.0970" N	102°34' 53.5740" E	213.98	156.12	870.75	along app surface	192.87	215.19	-1.21	ARMANY Hotel
3	VLVT_02_ARMANY Hotel	17°58' 30.2000" N	102°34' 56.1000" E	214	229.98	889.01	along app surface	193.33	226.21	-12.21	
4	VLVT_25112020_PT229_BUILDING	17°58' 38.3129" N	102°34' 48.1118" E	214.3	273.01	556.26	along app surface	185.01	224.05	-9.75	ATHENS Hotel
5	VLVT_89_ATHENS Hotel	17°58' 37.7000" N	102°34' 46.9000" E	210	235.58	544.54	along app surface	184.71	218.40	-8.40	

The planned change of OLS in shape with inner edge length of approach surface from 300 m to 280 m will ease the penetrating situation of obstacles to some extent, but it is found that the number of penetrating obstacles does not change: 6 for approach surface and 5 for transitional surfaces. While the differences are shown in the amount of penetration in transitional surfaces, which is approximately 1.4 m, as the result, the improvement is limited.

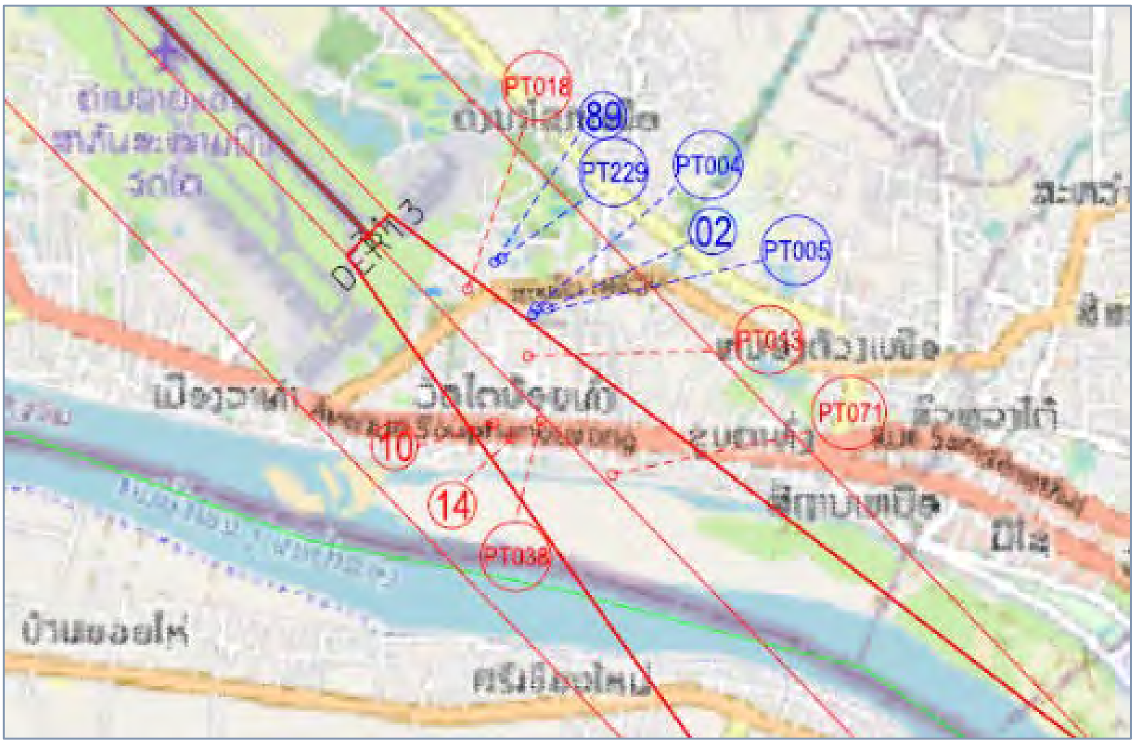


Figure 4.38 OLS Assessment Results: (2) Instrument Approach Runway (300 m)

Table 4.57 OLS Assessment Results: (2) Instrument Approach Runway (300 m)

Approach Surface Slope 2 %

No	Obstacle Name	Latitude	Longitude	Alt.(m)	Dist. (m)	Surface Alt. (m)	Penet. (m)
1	VLVT_25112020_PT018_ANTENNA	17°58' 33.1766" N	102°34' 42.3005" E	198.89	548.02	182.0604	16.8296
2	T_VLVT_30 03 2018_10_BUILDING	17°58' 11.2000" N	102°34' 47.1000" E	200.2	1127.51	193.6502	6.5498
3	VLVT_25112020_PT013_TREE	17°58' 22.2529" N	102°34' 52.8428" E	197.16	1005.09	191.2018	5.9582
4	T_VLVT_30 03 2018_14_TREE	17°58' 08.7100" N	102°34' 50.2500" E	198.5	1247.17	196.0434	2.4566
5	VLVT_25112020_PT071_BUILDING	17°58' 02.9543" N	102°35' 07.6743" E	207.06	1733.98	205.7796	1.2804
6	VLVT_25112020_PT038_BUILDING	17°58' 11.7573" N	102°34' 55.2282" E	196.95	1283.78	196.7756	0.1744
7	VLVT_25112020_PT021_BUILDING	17°58' 26.9445" N	102°34' 37.7035" E	182.8	588.88	182.8776	-0.0776

Transitional Surface Length of inner edge 300 m

No	Obstacle Name	Latitude	Longitude	Altitude(m)	Distance to the App edge (m)	Distance to Starting point of 60m (m)	Position	elevation (m)	Surface Alt. (m)	Penet. (m)	Note
1	VLVT_25112020_PT004_BUILDING	17°58' 30.2874" N	102°34' 54.1434" E	216.85	76.78	856.55	along app surface	188.231	199.21054	17.63946	(Confirm with
2	17082021 VLVT_PT005_BUILDING	17°58' 29.0970" N	102°34' 53.5740" E	213.98	36.96	870.75	along app surface	188.515	193.80028	20.17972	(Confirm with
3	VLVT_02_ARMANY Hotel	17°58' 30.2000" N	102°34' 56.1000" E	214	109.38	889.01	along app surface	188.8802	204.52154	9.47846	
4	VLVT_25112020_PT229_BUILDING	17°58' 38.3129" N	102°34' 48.1118" E	214.3	169.8	556.26	along app surface	182.2252	206.5066	7.7934	ATHENS Hotel
5	VLVT_89_ATHENS Hotel	17°58' 37.7000" N	102°34' 46.9000" E	210	132.97	544.54	along app surface	181.9908	201.00551	8.99449	
6	VLVT_25112020_PT052_BUILDING	17°58' 11.4835" N	102°35' 23.8415" E	215.72	135.6	1882.70	along app surface	208.754	228.1448	-12.4248	
7	17082021 VLVT_PT053_BUILDING	17°58' 06.7980" N	102°35' 25.6850" E	211.89	51.47	2023.25	along app surface	211.565	218.92521	-7.03521	

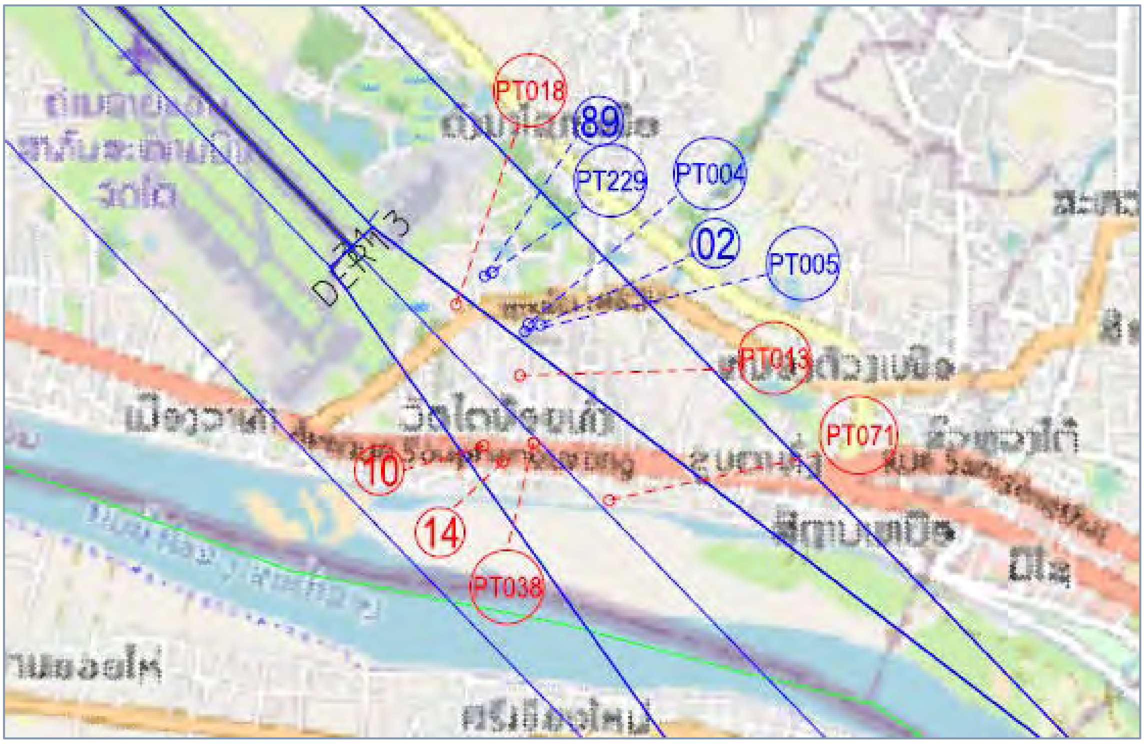


Figure 4.39 OLS Assessment Results: (3) Instrument Approach Runway (280 m)

Table 4.58 OLS Assessment Results: (3) Instrument Approach Runway (280 m)

Approach Surface Slope 2 %

No	Obstacle Name	Latitude	Longitude	Alt.(m)	Dist. (m)	Surface Alt. (m)	Penet. (m)
1	VLVT_25112020_PT018_ANTENNA	17°58' 33.1766" N	102°34' 42.3005" E	198.89	548.02	182.0604	16.8296
2	T_VLVT_30 03 2018_10_BUILDING	17°58' 11.2000" N	102°34' 47.1000" E	200.2	1127.51	193.6502	6.5498
3	VLVT_25112020_PT013_TREE	17°58' 22.2529" N	102°34' 52.8428" E	197.16	1005.09	191.2018	5.9582
4	T_VLVT_30 03 2018_14_TREE	17°58' 08.7100" N	102°34' 50.2500" E	198.5	1247.17	196.0434	2.4566
5	VLVT_25112020_PT071_BUILDING	17°58' 02.9543" N	102°35' 07.6743" E	207.06	1733.98	205.7796	1.2804
6	VLVT_25112020_PT038_BUILDING	17°58' 11.7573" N	102°34' 55.2282" E	196.95	1283.78	196.7756	0.1744
7	VLVT_25112020_PT021_BUILDING	17°58' 26.9445" N	102°34' 37.7035" E	182.8	588.88	182.8776	-0.0776

Transitional Surface Length of inner edge **280** **m**

No	Obstacle Name	Latitude	Longitude	Altitude(m)	Distance to the App edge (m)	Distance to Starting point of 60m (m)	Position	elevation (m)	Surface Alt. (m)	Penet. (m)	Note
1	VLVT_25112020_PT004_BUILDING	17°58' 30.2874" N	102°34' 54.1434" E	216.85	86.78	856.55	along app surface	188.231	200.64054	16.20946	ARMANY Hotel
2	17082021 VLVT_PT005_BUILDING	17°58' 29.0970" N	102°34' 53.5740" E	213.98	46.96	870.75	along app surface	188.515	195.23028	18.74972	ARMANY Hotel
3	VLVT_02_ARMANY Hotel	17°58' 30.2000" N	102°34' 56.1000" E	214	119.38	889.01	along app surface	188.8802	205.95154	8.04846	
4	VLVT_25112020_PT229_BUILDING	17°58' 38.3129" N	102°34' 48.1118" E	214.3	179.8	556.26	along app surface	182.2252	207.9366	6.3634	ATHENS Hotel
5	VLVT_89_ATHENS Hotel	17°58' 37.7000" N	102°34' 46.9000" E	210	142.97	544.54	along app surface	181.9908	202.43551	7.56449	
6	VLVT_25112020_PT052_BUILDING	17°58' 11.4835" N	102°35' 23.8415" E	215.72	145.6	1882.70	along app surface	208.754	229.5748	-13.8548	
7	17082021 VLVT_PT053_BUILDING	17°58' 06.7980" N	102°35' 25.6850" E	211.89	61.47	2023.25	along app surface	211.565	220.35521	-8.46521	

Unlike the approach runway for Runway 31, the shape of the takeoff climb surface does not change as shown in Figure 4.40 because the non-instrument/instrument situation does not basically affect the aircraft operation. This in turn means that the current obstacle situation is expected to be applied for the future operation.

The obstacle situation is the same as the approach runway case: some obstacles are already penetrating the concerned surface even for the current VMC-based operation. Figure 4.40 and Table 4.59 show the results of obstacle assessment for the takeoff runway from Runway 13. There are 6 penetrating obstacles already for the takeoff climb surface, and this would be a quite critical issue even now and could be more problematic at the time of the introduction of IFP operations.

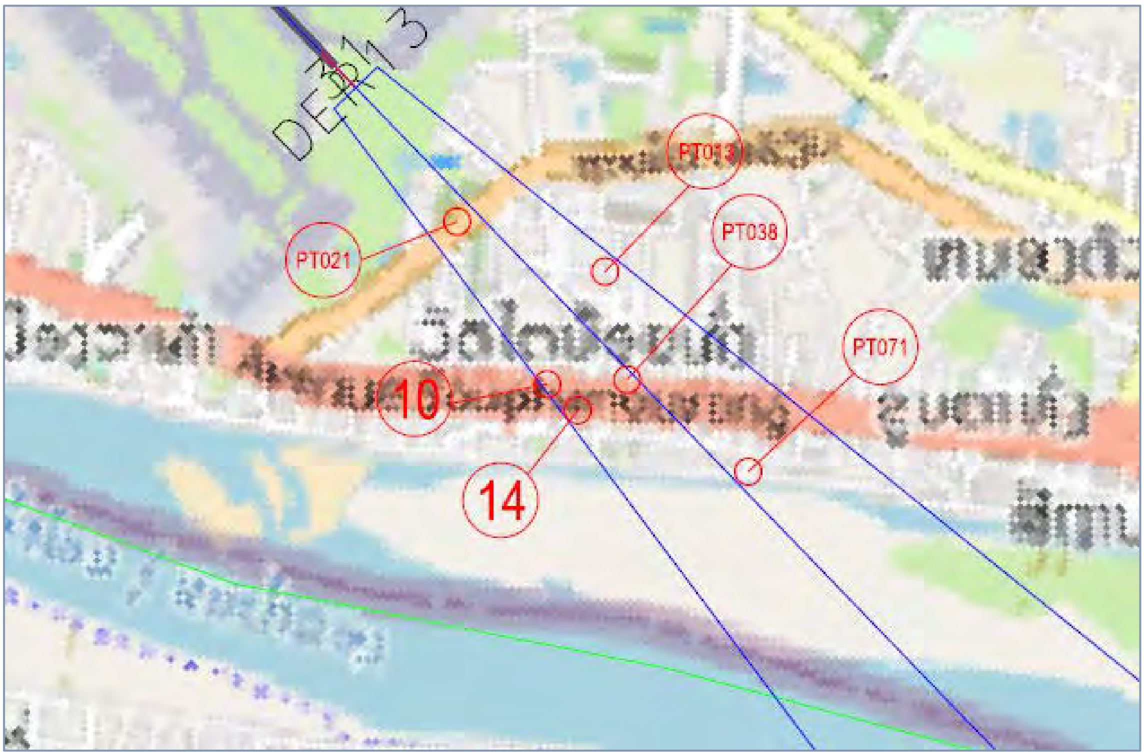


Figure 4.40 OLS Assessment Results: (4) Takeoff runway (Clearway of 150 m)

Table 4.59 OLS Assessment Results: (4) Takeoff runway (Clearway of 150 m)

Take-Off Climb surface distance from RWY end **150** **m**

No	Obstacle Name	Latitude	Longitude	Alt.(m)	Dist. (m)	Surface Alt. (m)	Penet. (m)
1	T_VLVT_30 03 2018_10_BUILDING	17°58' 11.2000" N	102°34' 47.1000" E	200.2	1037.51	191.8502	8.3498
2	T_VLVT_30 03 2018_14_TREE	17°58' 08.7100" N	102°34' 50.2500" E	198.5	1157.17	194.2434	4.2566
4	12082021_PT013_TREE	17°58' 22.2529" N	102°34' 52.8428" E	197.16	915.09	189.4018	7.7582
5	12082021_PT071_BUILDING	17°58' 02.9543" N	102°35' 07.6743" E	207.06	1643.98	203.9796	3.0804
6	12082021_PT038_BUILDING	17°58' 11.7573" N	102°34' 55.2282" E	196.95	1193.78	194.9756	1.9744
7	12082021_PT021_BUILDING	17°58' 26.9445" N	102°34' 37.7035" E	182.8	498.88	181.0776	1.7224

With the above assessment results, some discussions were made with DCA/LANS in order to ease the situation in accordance with the current operational set-up at VTE as well as international standards. Then, it was agreed that the clearway length that defines the start of the takeoff climb surface would be decreased from 150 m to 60 m. This change certainly eases the obstacle penetrating situation as the number of penetrating obstacles would decrease from 6 to 5 and as the magnitude of penetration would become less as shown in Figure 4.41 and Table 4.60, the obstacle assessment result with 60-m long clearway. However, it would not be possible to make the runway free from obstacles for takeoff.

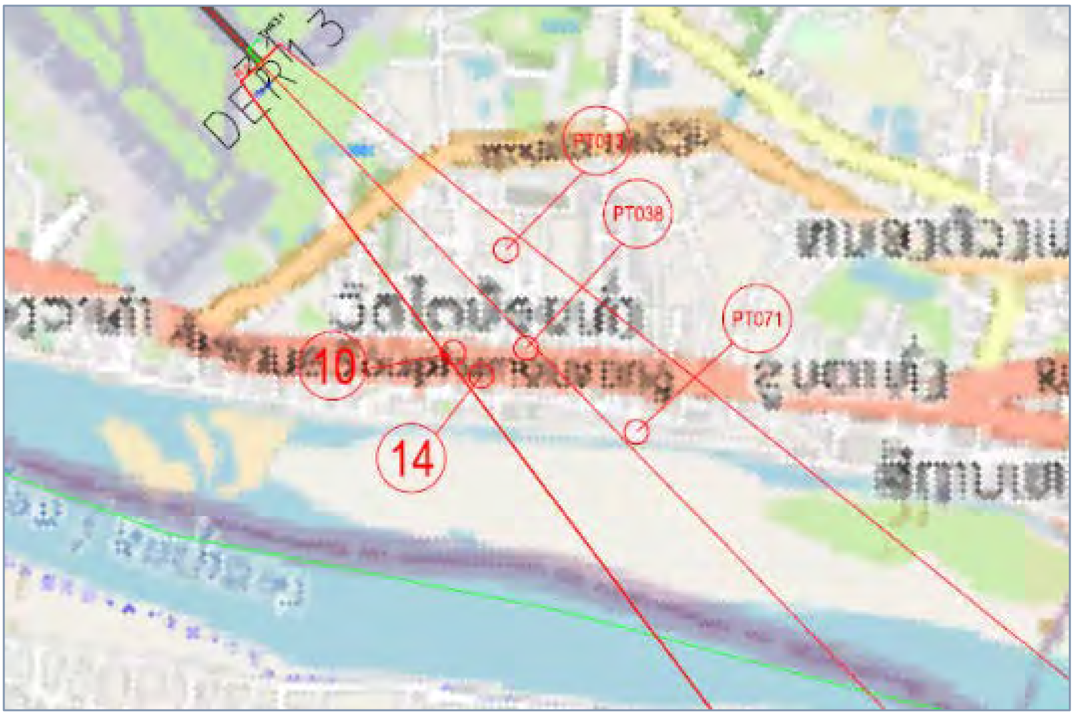


Figure 4.41 OLS Assessment Results: (5) Takeoff Runway (Clearway of 60 m)

Table 4.60 OLS Assessment Results: (5) Takeoff Runway (Clearway of 60 m)

Take-Off Climb surface distance from RWY end 60 m

No	Obstacle Name	Latitude	Longitude	Alt.(m)	Dist. (m)	Surface Alt. (m)	Penet. (m)
1	T_VLVT_30 03 2018_10_BUILDING	17°58' 11.2000" N	102°34' 47.1000" E	200.2	1127.51	193.6502	6.5498
2	T_VLVT_30 03 2018_14_TREE	17°58' 08.7100" N	102°34' 50.2500" E	198.5	1247.17	196.0434	2.4566
3	12082021_PT013_TREE	17°58' 22.2529" N	102°34' 52.8428" E	197.16	1005.09	191.2018	5.9582
4	12082021_PT071_BUILDING	17°58' 02.9543" N	102°35' 07.6743" E	207.06	1733.98	205.7796	1.2804
5	12082021_PT038_BUILDING	17°58' 11.7573" N	102°34' 55.2282" E	196.95	1283.78	196.7756	0.1744

The obstacle assessment results regarding primary surfaces of OLS shown in above Figures and Tables clearly shows that the obstacle situation is quite critical even for current aircraft operations, and it could be more critical with expected IFP operations. Introduction of an appropriate obstacle control/management scheme is required as soon as practically possible.

In addition to the primarily concerned surfaces such as the approach surface, the transitional surface, and the takeoff-climb surface, the obstacle assessment is made for inner horizontal and conical surfaces. Figure 4.42and Figure 4.43 show the whole area and the Runway 31 side of the inner horizontal and conical surfaces with the locations of penetrating obstacles circled in red (Areas of inner horizontal and conical surfaces are inside and outside track-shaped lines). Figure 4.43 and Table 4.61 summarize the total of 29 penetrating obstacles with 6 obstacles in the city area, which are colored in the table. Table 4.62 shows the list of 6 penetrating obstacles to conical surfaces. This situation further shows the necessity of obstacle control/management scheme.

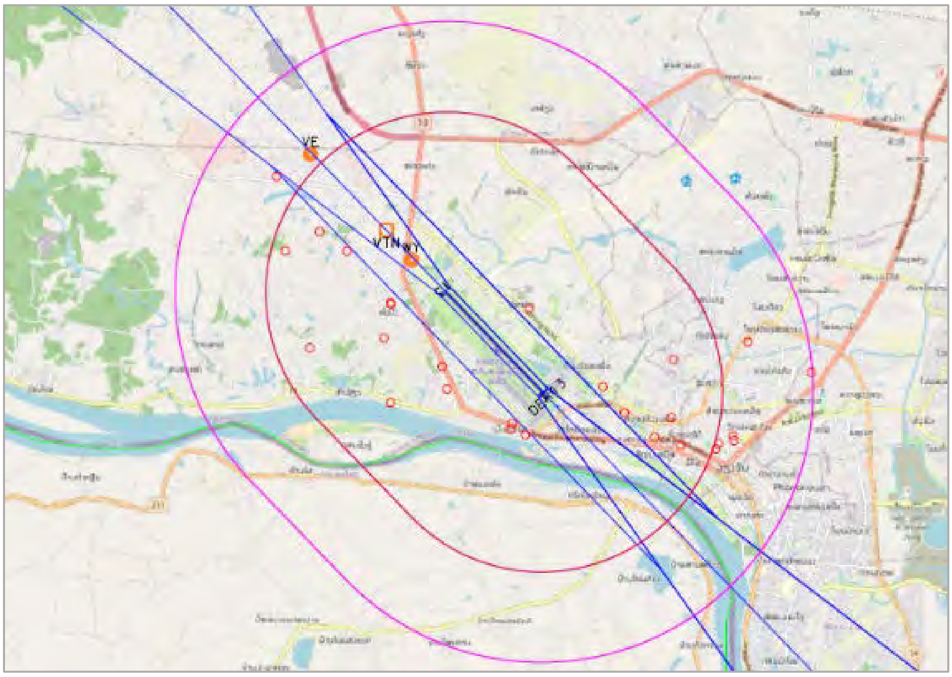


Figure 4.42 OLS Assessment Results: (6a) Inner Horizontal and Conical Surfaces (Whole area)

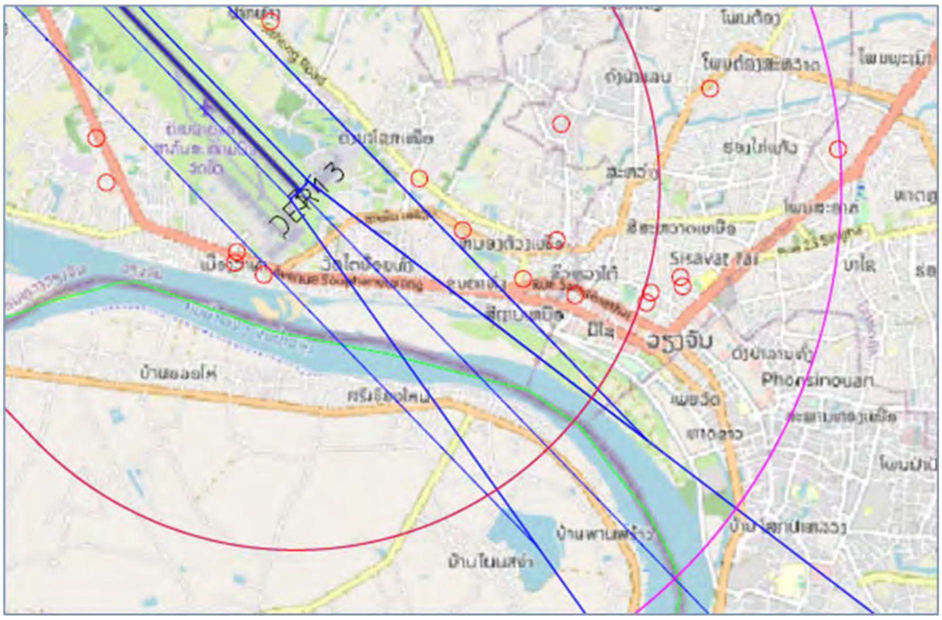


Figure 4.43 OLS Assessment Results: (6b) Inner Horizontal and Conical Surfaces (RWY31 end)

Table 4.61 OLS Assessment Results: (6a) Inner Horizontal Surface (Whole area)

No	Obstacle Name	Latitude	Longitude	Alt.(m)	**Penet. (m)**	Note
1	T_VLVT_30 03 2018_13_ANTENNA	17°58' 19.6200" N	102°34' 01.9900" E	244.3	28.20	
2	T_VLVT_11 05 2018_86_ANTENNA	18°01' 24.3000" N	102°31' 46.2000" E	243.4	27.30	
3	T_VLVT_02 05 2018_44_POST	17°58' 33.4000" N	102°32' 30.5000" E	239	22.90	
4	VLVT_25112020_PT216_ANTENNA	18°00' 21.4064" N	102°31' 10.0760" E	236.211	20.11	
5	VLVT_25112020_PT102_ANTENNA	18°01' 24.4103" N	102°31' 46.4888" E	236	19.90	
6	VLVT_25112020_PT217_ANTENNA	18°00' 35.5990" N	102°31' 35.7515" E	235.111	19.01	
7	T_VLVT_02 05 2018_47_ANTENNA	17°59' 45.1300" N	102°32' 29.4500" E	234.9	18.80	
8	VLVT_25112020_PT157_ANTENNA	17°59' 44.0702" N	102°32' 29.8969" E	230.027	13.93	
9	VLVT_25112020_PT055_BUILDING	17°58' 11.2817" N	102°35' 49.0436" E	227.56	11.46	City Area
10	VLVT_25112020_PT228_BUILDING	17°58' 46.7550" N	102°35' 09.7380" E	226.3	10.20	City Area
11	T_VLVT_11 05 2018_81_BUILDING	17°58' 05.7000" N	102°36' 08.5000" E	222.3	6.20	City Area
12	VLVT_25112020_PT188_BUILDING	17°58' 25.3329" N	102°36' 01.4230" E	222.11	6.01	City Area
13	T_VLVT_30 03 2018_12_BUILDING	17°58' 11.5800" N	102°34' 12.1600" E	222	5.90	
14	T_VLVT_10 05 2018_76_TREE	17°59' 12.6000" N	102°34' 18.8000" E	220.37	4.27	
15	T_VLVT_08 05 2018_54_ANTENNA	17°58' 59.7200" N	102°33' 08.9500" E	220.3	4.20	
16	VLVT_25112020_PT214_ANTENNA	17°59' 19.7450" N	102°32' 24.9538" E	220.234	4.13	
17	VLVT_25112020_PT218_ANTENNA	18°00' 21.8071" N	102°31' 56.4452" E	220.05	3.95	
18	T_VLVT_08 05 2018_50_BUILDING	17°58' 43.8000" N	102°33' 12.9000" E	219.7	3.60	
19	17082021 VLVT_PT115_BUILDING (S	17°58' 15.7500" N	102°34' 01.2530" E	219.4	3.30	
20	VLVT_25112020_PT202_BUILDING	17°58' 33.2529" N	102°32' 30.3921" E	219.393	3.29	
21	T_VLVT_05 04 2018_27_BUILDING	17°59' 06.9300" N	102°36' 02.5200" E	218.8	2.70	City Area
22	VLVT_25112020_PT210_ANTENNA	17°59' 11.9304" N	102°31' 29.4433" E	217.203	1.10	
23	T_VLVT_10 05 2018_77_TREE	17°59' 16.7000" N	102°34' 18.4000" E	217.02	0.92	
24	T_VLVT_10 05 2018_68_ANTENNA	17°59' 42.1800" N	102°34' 13.4200" E	217	0.90	
25	VLVT_25112020_PT230_BUILDING	17°58' 17.4153" N	102°35' 20.4875" E	217	0.90	
26	VLVT_25112020_PT191_BUILDING	17°58' 28.4460" N	102°35' 26.2206" E	216.881	0.78	City Area
27	VLVT_25112020_PT004_BUILDING	17°58' 30.2874" N	102°34' 54.1434" E	216.85	0.75	
28	T_VLVT_30 03 2018_8_BUILDING	17°58' 15.8000" N	102°34' 02.5000" E	216.5	0.40	
29	VLVT_25112020_PT116_BUILDING	17°58' 11.2726" N	102°34' 12.2826" E	216.12	0.02	

Table 4.62 OLS Assessment Results : (6b) Conical Surface (RWY31 side)

No	**Obstacle Name**	**Latitude**	**Longitude**	**Alt.(m)**	**OLS Alt. (m)**	**Penet. (m)**
1	T_VLVT_11 05 2018_80_ANTENNA	17°58' 03.3500" N	102°36' 35.2100" E	291.00	219.26	71.74
2	VLVT_25112020_PT099_ANTENNA	18°01' 14.7141" N	102°31' 02.7740" E	287.12	244.17	42.95
3	T_VLVT_11 05 2018_78_ANTENNA	17°58' 09.2000" N	102°36' 48.6000" E	255.00	235.80	19.20
4	T_VLVT_11 05 2018_79_ANTENNA	17°58' 12.7000" N	102°36' 47.8000" E	252.50	233.43	19.07
5	T_VLVT_30 04 2018_40_ANTENNA	17°58' 59.1000" N	102°37' 46.0500" E	316.00	314.98	1.02
6	VLVT_25112020_PT181_ANTENNA	17°59' 20.2336" N	102°36' 57.9456" E	251.02	250.19	0.83

Further, the area of conical surface will be extended some 2 km closer to the city center where some main governmental offices, such as the Presidential Palace and Ministry of National Defense. While those facilities/buildings are not critical obstacles for VTE, this situation also shows the concern of OLS as a whole.

Remeasurements of obstacles are requested to AOL through DCA and LANS, and these measurements are ongoing. The assessment results mentioned above may change with the updated obstacle data but there is no guarantee that the situation will ease. Further, according to AOL, there are 72 applications for new buildings/towers undergoing the approval process for the concerned governmental organization. The construction approval can be obtained from two different governmental agencies, but there is no close involvement with civil aviation related organizations such as AOL, which makes coordination on this matter difficult.

4.13. *Airspace and ATC Capacity*

4.13.1. *Airspace*

Figure 4.44 and Table 4.63 show traffic proportions on routes connecting from/to VTE from September to November 2019 based on the traffic data from the ATC section, LANS. It is assumed that the proportion shown in the figure will stay almost the same for the period of immediate to long-term development, and this situation is taken into account for the development of a IFP route structure.

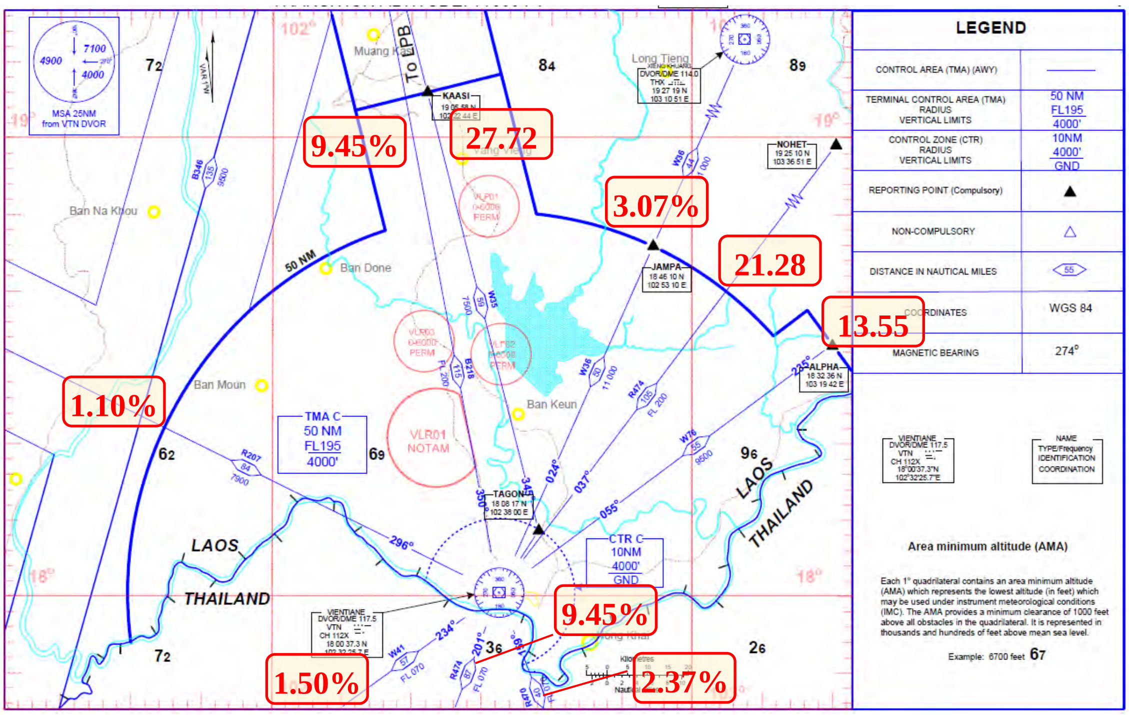


Figure 4.44 Traffic Proportion on En-routes at VTE (Sept. to Nov. 2019)

Table 4.63 Traffic Proportion on Enroutes at VTE (Sep. to Nov. 2019)

Average Traffic Percentage in 3 Months of September-October & November 2019								
No.	Route Name	Direction	September	October	November	Total %	Average %	Note
1	R470	UDN	2.27	2.37	2.46	7.10	2.37	
2	R474	CMP	19.17	20.04	20.65	59.86	19.95	
3	R474	NOHET	22.36	20.54	20.93	63.83	21.28	
4	R207	ANBOK	1.14	1.19	0.98	3.31	1.10	
5	B218	LOY	1.59	1.53	1.39	4.51	1.50	
6	B218	LPB	9.66	9.52	9.18	28.36	9.45	
7	R335	IDOTA	1.89	1.91	1.23	5.04	1.68	
8	W35	TAGON	26.37	28.68	28.10	83.16	27.72	
9	W36	THX	4.47	2.29	2.46	9.22	3.07	
10	W76	ALPHA	11.06	11.93	12.62	35.61	11.87	
	Non-Schedule	Non-Direction		564	145	137	188	FGTH
	Non-Schedule	Traffic Circuit		800	200	200	266.67	FGTH

The current IFPs presented in Section 2.6 Airspace are capable of handling the expected increase in traffic, and those IFPs including their route structure continue to be so as they will be renewed every five years to accommodate the upcoming changes in accordance with the requirement of ICAO PANS-OPS. Lao PDR, both DCA and LANS, has maintained capable IFP designers who have been trained through a JICA Project called "EMCA ("The Project for the Capacity Development for Transition to the New CNS/ATM Systems in Cambodia, Lao PDR, and Vietnam")," which was implemented from 2011 to 2016. Through this technical cooperation project those IFP designers would continue to be capable of managing the IFPs as long as appropriate recurrent training should be given to them and sufficient facilities, including automated flight procedure design tool (PANADES, which was introduced to Lao PDR under JICA Grant aid in 2014) be updated to accommodate changes and updates of ICAO standards.

4.13.2. *ATC Capability*

Regarding the ATC staff of LANS, a sufficient level of training was given to their ATC officers at the time of the survey (in September 2021). In particular, there are periodical and recurrent training sessions that utilize simulators for tower, approach, and ACC (Figure 4.45). However, due to a lack of funding, some data set-ups have not been updated. For instance, the taxiway system on the tower simulator is not identical to the real locations.

As shown in Table 4.64, a sufficient level of training has been provided up to now, but there is an expectation that more training be conducted that aims for shorter separations to handle more traffic, in particular between departing aircraft from RWY31 and arriving aircraft to RWY13 as well as for accommodating different operation modes such as with IFR departure from RWY13 and IFR approach to RWY31. Appropriate and timely training should be provided in accordance with the implementation program of new operation modes.

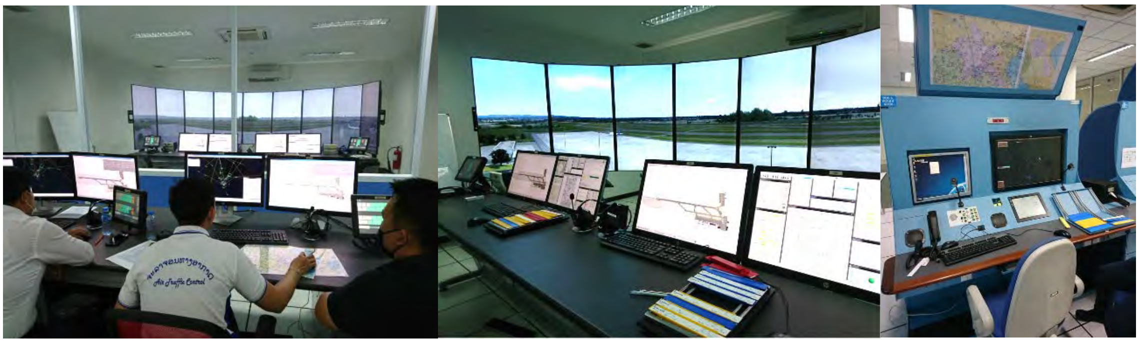


Figure 4.45 Simulator for ATC Training: Tower/APP (left, middle) and ACC (right)

Table 4.64 ATC Annual Training Relating to VTE in 2021

Topics	Duration	Participants
1. Vientiane/Wattay International Airport		
Approach and Aerodrome Procedural Control · Approach Control Procedural Theory · Air Traffic Management · Data Display · IFR and VFR Operations · Unusual and Emergency Situations · Separation Standards · ICAO Doc 4444	**Theory:** 5 days/group **Practice:** 5 days/group	49
Approach Surveillance · Approach Radar Control Theory · Radar Theory · Vectoring & Sequencing Skills · Air Traffic Management · Data Display · IFR and VFR Operations · Unusual and Emergency Situations · ICAO Doc 4444	**Theory:** 5 days/group **Practice:** 5 days/group	49
PBN Training for ATC · To provide the training for Air Traffic Controllers to understand ICAO's Strategic Objectives and Priorities in Air Navigation, facilitate of PBN implementation through the improvement of understanding on PBN and its benefits; · To understand the importance of air traffic controllers' role in successful PBN implementation, · To understand how to apply PBN procedures to actual ATC operations to improve efficiency, capacity and safety of operations.	5 days	19
2. Vientiane/ACC		
Area Procedural Control · Area Procedural Control Theory · Separation Standards · Air Traffic Management · Data Display · Unusual and Emergency Situations · ICAO Doc 4444	**Theory:** 5 days/group **Practice:** 5 days/group	75
Area Surveillance · Area Control Theory · Radar Theory · Vectoring Skills · Air Traffic Management · Data Display · Unusual and Emergency Situations · ICAO Doc 4444	**Theory:** 5 days/group **Practice:** 5 days/group	75

5. Immediate Improvement Needs at Vientiane International Airport

5.1. *General*

In Chapter 4 of this report, the capacity of the existing facilities is compared with current and future demand. The rehabilitation and capacity improvements are required to meet the current and future demand. The immediate improvement plan focuses on resolving the current capacity issue and rehabilitation of facilities that need urgent measures.

The following facilities need to be developed to ease congestion and improve service to the passengers.

- International Passenger Terminal Building
- Domestic Passenger Terminal Building
- Access Road

The following facilities need immediate rehabilitation for safe aircraft operation.

- Taxiways
- Apron
- Airfield Lighting Systems

Details of immediate improvement plans for each facility are explained below.

5.2. *International Passenger Terminal Building*

5.2.1. *Expansion of the Departure Lounge*

The Departure Lounge in the international passenger terminal building is 1,200 ㎡ and will run out of space if many passengers recover after the COVID-19 pandemic. Therefore, the JICA TC Team proposes a plan to create a new departure lounge space between the departure concourse and the main building shown in Figure 5.1.

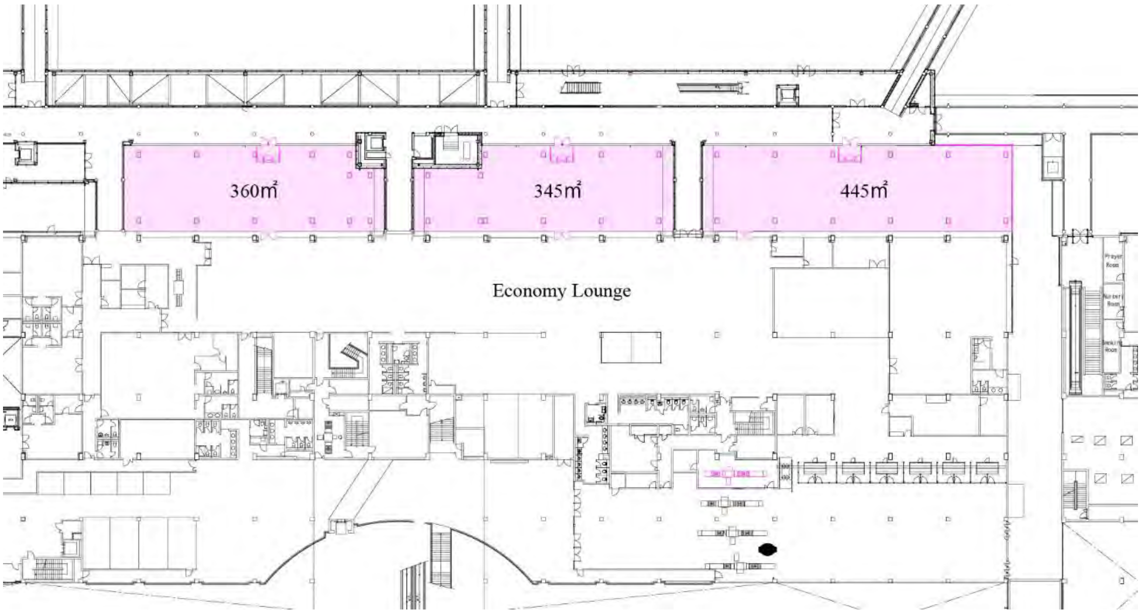


Figure 5.1 Improvement Plan of Departure Lounge in International Passenger Terminal

By expanding this space, 1,150 m2 will be newly added, and the lounge space will be 2,350 ㎡.

The JICA TC team assumes that the area will be filled by 2035.

Figure 5.2 Space between the Departure Concourse and the Main Building

5.3. *Domestic Passenger Terminal Building*

5.3.1. *Additional Baggage Claim Belt*

Before COVID-19, congestions were observed at the baggage claim area in the domestic passenger terminal building. There is a baggage claim belt, but sometimes more than two flights arrive simultaneously in the domestic flights. To solve the congestion, the JICA TC Team proposes to install a new baggage belt. Since there is enough space to install the other belt, installing the equipment is not difficult, as shown in Figure 5.3.

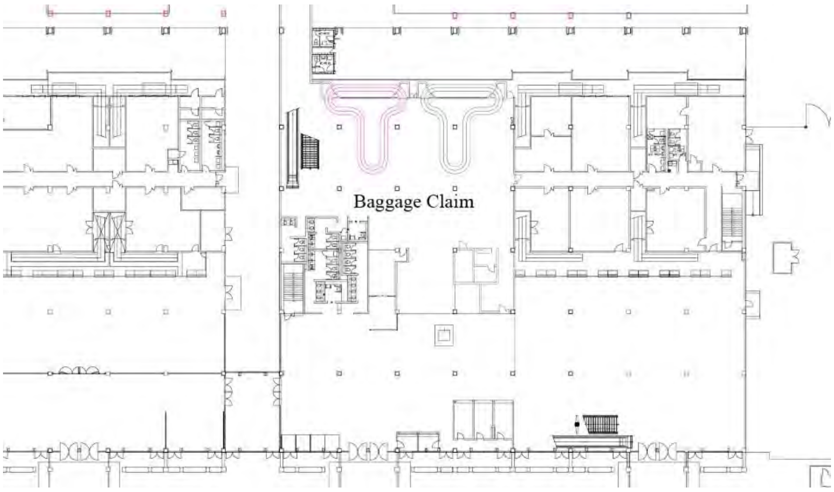


Figure 5.3 Additional Baggage Claim Belt in Domestic Passenger Terminal Building

5.4. *Maintenance Workshop*

As explained in other parts of this report, there is no space to carry out maintenance and repair work for GSE in the airport. GSE workshop is necessary to maintain the GSE in good condition and use them for a long time. Figure 5.9 shows the candidate sites for the maintenance workshop.

Alternative A is between the international passenger terminal building and the VVIP. Alternative B is the western side of the control tower, Alternative C is a grass area between the fire station and the AOL office, and Alternative D is the west side of the military fuel farm.

Figure 1 Candidate Sites for Maintenance Workshop

Alternative A is convenient as it is close to the apron and GSE parking area. However, this area is a future expansion area of the passenger terminal building, so adopting Alternative A will be a problem.

Alternative B is next to the apron and has a good location. There is a plan to develop this area by a private company. And the private company reclaimed from a pond, but there has been no development works for a long time. The private company leased the area, and it is necessary to cancel the lease to use the site for the maintenance workshop.

Alternative C is next to the fire station and close to the security access gate to the apron. This area is on the landside. There is enough space to construct the maintenance, but AOL plans to utilize the site for future office space.

Alternative D is the property of the military. It is necessary to obtain the land from the military.

There are alternative locations for the new maintenance workshop. However, it is not possible to decide on the area as several stakeholders utilize the alternative sites. The JICA TC team recommend DCA start a discussion with stakeholders to determine the location of the new maintenance workshop.

5.5. *Expansion of the Access Road*

During the busy time, the traffic volume on the airport roads increases and causes congestions from the main road to the airport terminal area.

The JICA TC Team planned to add a lane in the entry part of the access road from the intersection of national road 13 to the terminal area, with the lane assignment shown in the figure below.

This lane widening will enable smooth travel from the national road to the terminal area and is expected to reduce traffic congestion on the entry lane. In addition, the exit lane will be widened to three lanes for smooth traffic flow since the volume of traffic flowing into the airport will increase with the increase of routes in the entry lane.

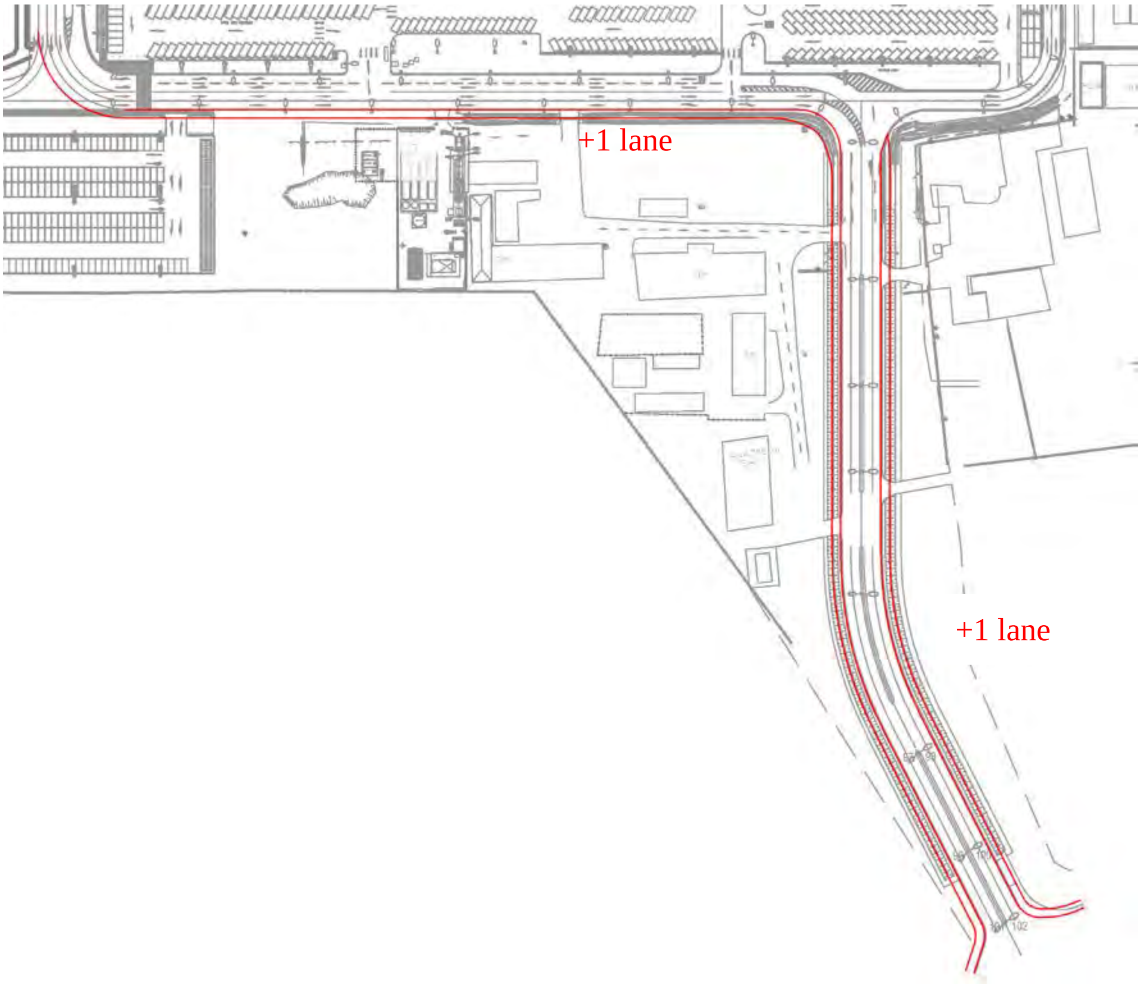


Figure 5.4 Access Road Expansion Plan

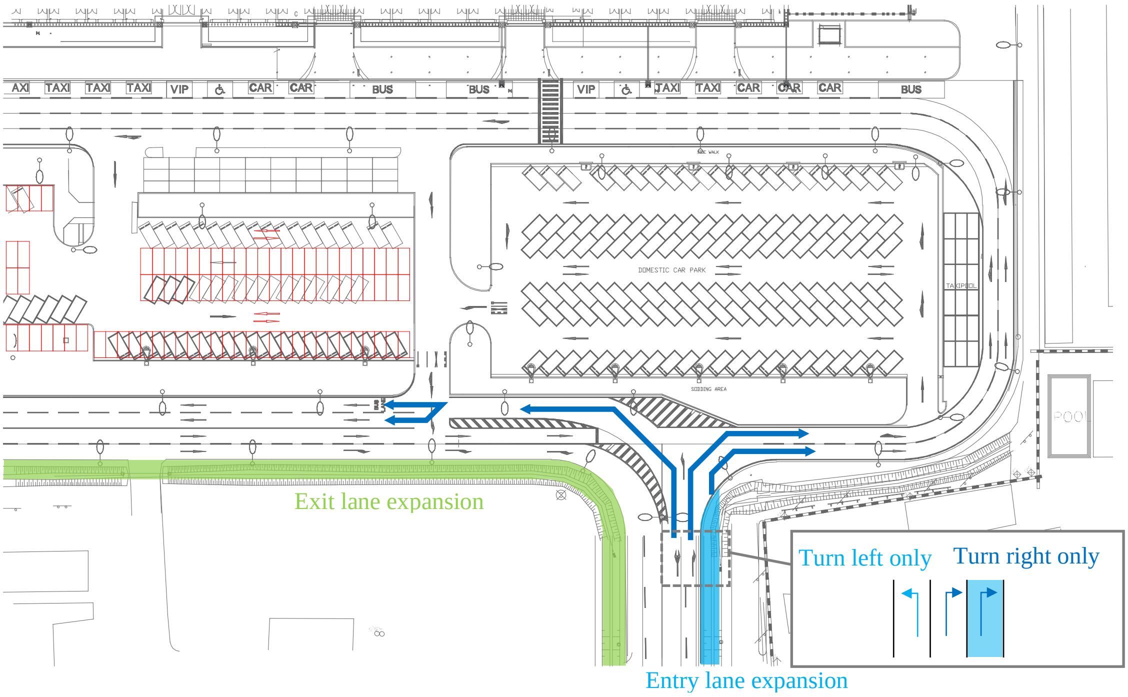


Figure 5.5 Access Road Expansion Plan Detail

5.6. *Rehabilitation of Taxiways*

The priority of rehabilitation of taxiways are Taxiways B and Taxiway T. As described in "4.3.2 Pavement Conditions of Taxiways" of this report, rutting is observed on Taxiway B, and Alligator cracks exist on Taxiway T. The area of rutting and cracks should be repaired to avoid further damage to the pavement and overlay of the entire area is planned. The overlay area of Taxiway B is 13,242 $m^{2,}$ and that of Taxiway T is 15,972 m^2. The current PCN of Taxiway B and Taxiway T is PCN 62 F/B/W/T. Considering current operating aircraft and movements, the pavement strength may be sufficient so that planned overlay work is scarifying the surface and replacing it with new hot mix surface asphalt pavement.

Further study on pavement, such as some cores cut sampling in several locations, may be required to confirm the thickness and structural strength of the pavement because there had been overlaying works on these pavements in the past. The actual thickness may be different. Additional soil investigation on the subgrade level will not be required as the CBR of the subgrade in most of the airport area is 5%.

Detail implementation plan for rehabilitation is required as these taxiways are heavily used by landing and takeoff aircraft in the airport. Also, the taxiway connects the runway, and nighttime work will be needed when the rehabilitation is conducted near the runway. Also, coordination with relative organizations such as airlines, air traffic service providers, airport operators, etc., is important to implement the project smoothly.

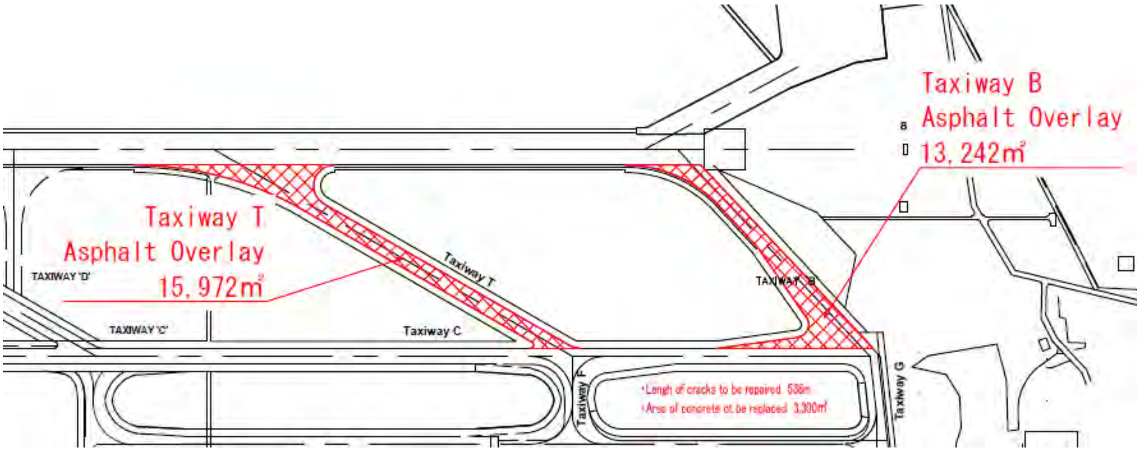
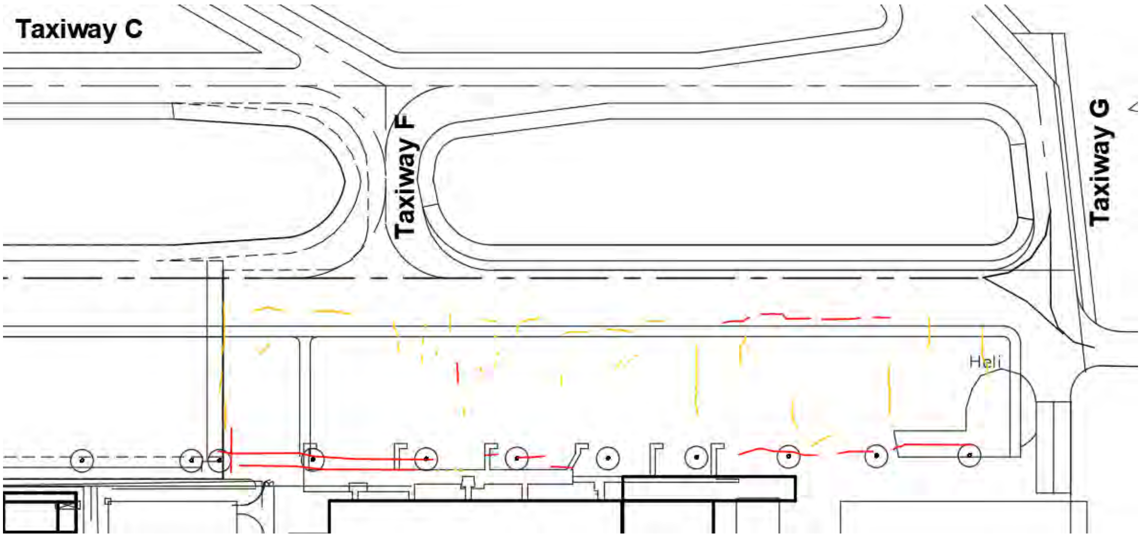


Figure 5.6 Rehabilitation of Taxiway B and Taxiway T

5.7. *Rehabilitation of Aprons*

The size of the apron pavement cracks is large and in a wide area. It was reported that water went into the cracks. These cracks are severe and require the replacement of the whole slab as the cracks penetrate the entire thickness of the pavement. The cracks appear on the edge line and the second line of slabs. Replacement of these slabs with a new concrete slab is recommended. In addition to the edge, cracks on the No. 14 spot should be replaced because the distress shows it is structural damage.



—: Cracks considered desirable to be repaired
—: Cracks that should be considered for observation and maintenance.

Figure 5.7 Sketch of the location of cracks in the apron

As same as the rehabilitation of the taxiway, some destructive inspections on the apron concrete slab will be required because some parts of the concrete are very old, and several rehabilitation works have been carried out. It is necessary to confirm the pavement thickness and structure as it may be different from the record.

5.8. *Rehabilitation of Air Field Lighting System*

5.8.1. *Replacement of Lightings*

The taxiway lights in Taxiway B and Taxiway T were installed in 1997. It is good to replace these taxiway lights with a new LED type lighting system and pavement rehabilitation.

5.8.2. *Replacement of Power Cable*

The power cable around the taxiways are old and buried without pipe. It is necessary to replace all power cables in this area. In addition to the wires for Taxiway B and Taxiway T, the replacement of lines to PAPI close to the Runway 13 Threshold is planned because there are common cable routes with the taxiway light cables.

5.8.3. *Constant Current Regulator (CCR) System*

Some of the CCRs are old, and no spare parts are available. These CCRs should be replaced due to age and instability.

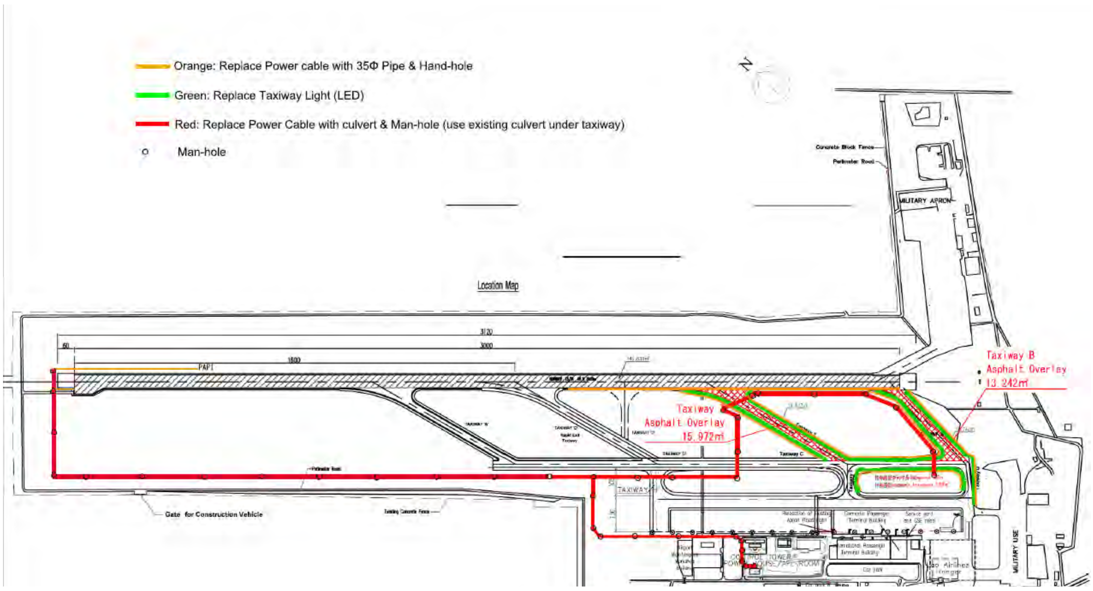


Figure 5.8 Rehabilitation of Airfield Lighting System in Immediate Improvement Plan

5.9. *Cost Estimate*

Project cost of the immediate improvement plan is estimated as shown in Table 5.1. The exchange rate used in the estimate is TTM rate in December 2021:

USD1.00=JPY115.02, USD1.00=LAK11,205, and LAK1.00=JPY0.010265

Table 5.1 Cost Estimate of Immediate Improvement Plan

Items	Cost (Million Kip)	Cost (Million Yen)
Renovation of International Passenger Terminal Building	68,780	706
Renovation of Domestic passenger Terminal Building	1,790	18
Expansion of Access Road	1,960	20
Rehabilitation of Taxiway B and T	5,800	60
Rehabilitation of Aprons	6,110	63
Air Field Lighting System	58,220	598
Overhead and indirect cost	47,570	488
Total construction cost	190,240	1,953
Contingency	19,970	205
Consultant fee	19,020	195
Total Project Cost	229,240	2,353

6. Long-term Improvement Plan of Vientiane International Airport

6.1. *Alternatives to Enhance Runway Capacity*

6.1.1. *Runway Capacity Enhancement*

6.1.1.1. Background

The existing runway capacity has limitations as described in this report in 4.1.2 Runway Capacity. Two alternatives to increase the runway, one is to construct a new runway, and another is to increase the capacity of the existing runway, are studied and explained below.

6.1.2. *Alternatives: New Runway*

A proposal to construct a new runway to enhance the runway capacity was conducted. The primary issue concerning the existing runway is that the departure airspace to the southside is close to the Thailand border. The current Obstacle Assessment Surface (OAS) is shown in Figure 6.1. The southeast side of the OAS is inside the Thailand border.

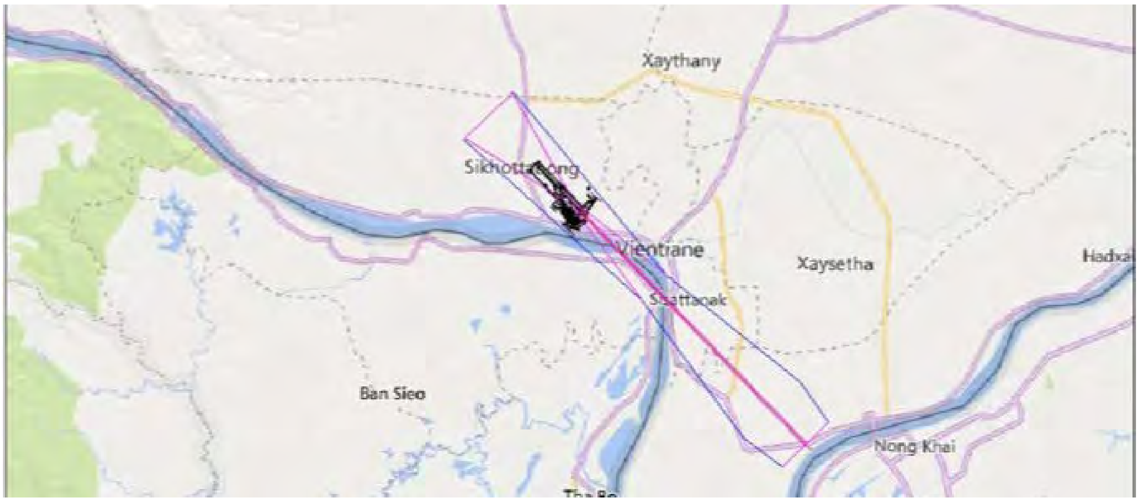


Figure 6.1 The Existing OAS

If the runway orientation is kept as is, it is necessary to move the runway for OAS to avoid the Thailand border. In this case, it is necessary to move the runway 16,500 m to the northwest as shown in Figure 6.2.

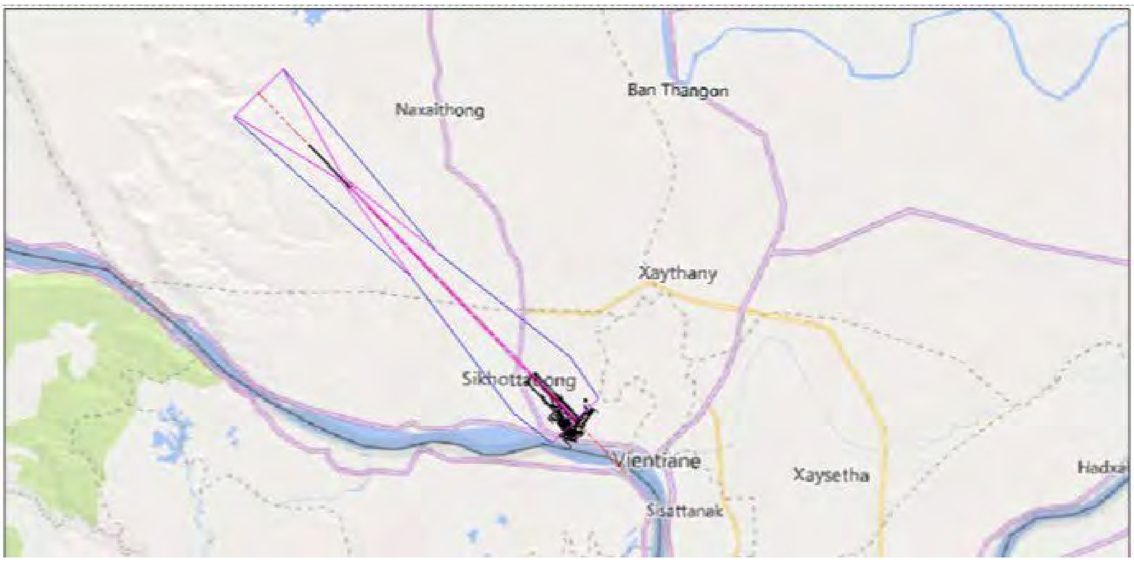


Figure 6.2 The Plan to Move the Runway to the Northwest

In case of keeping the runway direction and moving the runway to parallel to the existing runway, it is necessary to move the runway 1,500 m to the northeast, as shown in Figure 6.3.

These alternatives are not realistic because the new runway is too far from the existing airport.

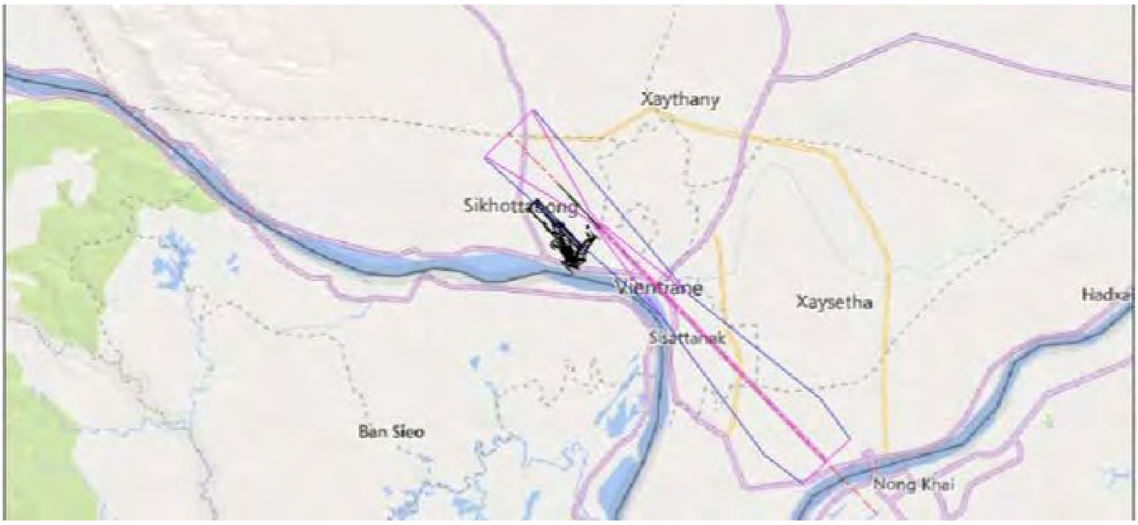


Figure 6.3 The Plan to Move the Runway to the Northeast

Another alternative is to rotate the runway while keeping Runway Threshold 13, as shown in Figure 6.4. In this case, it would be necessary to offset the runway 12 degrees to avoid the Thailand border.

Figure 6.4 The Plan to Fix the Runway 13 Threshold and Offset It 12 Degrees

This case is further developed, as shown in Figure 6.5. To operate the runway, it is necessary to construct several connecting taxiways and obtain the land at the north side of the airport.

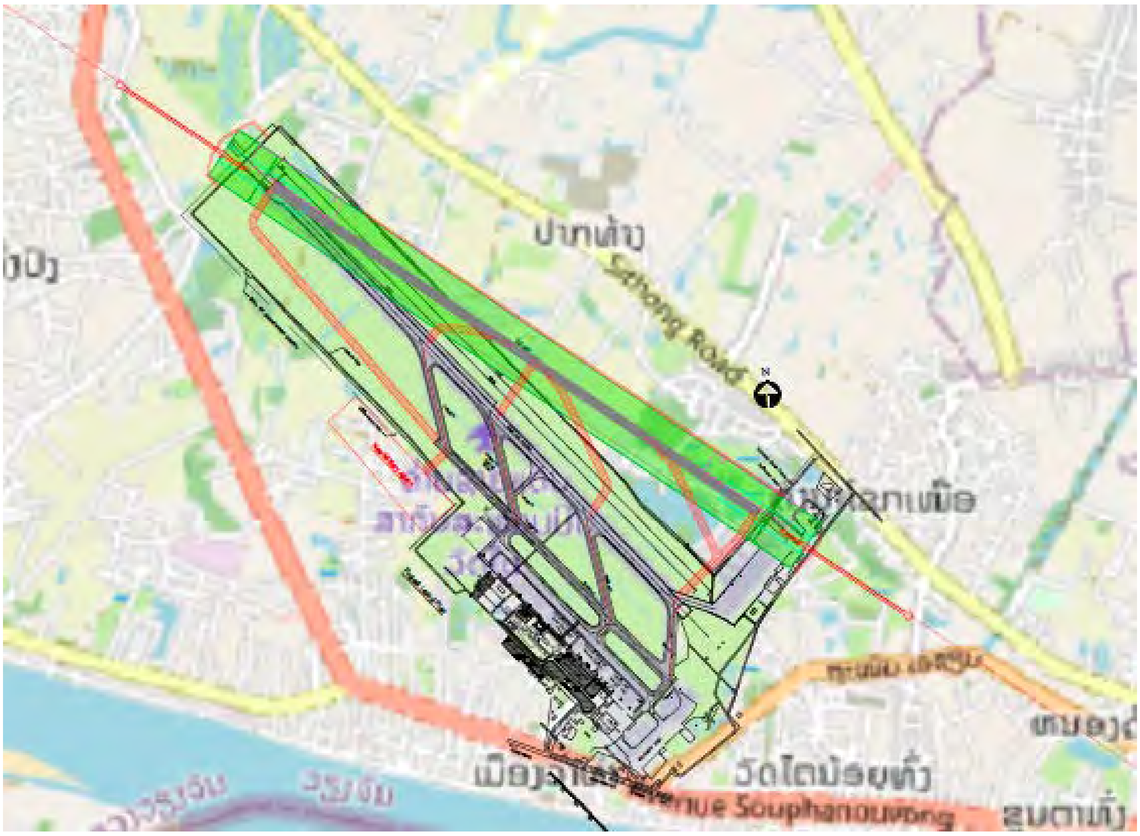


Figure 6.5 Alternative Plan to Develop the New Runway on the North Side

6.1.2.1. Analysis of Environmental and Social Impacts

(1) Outline of the subject under consideration

As one of the measures to enhance the future arrival and departure processing capacity of Vientiane International Airport, the construction of a second runway is being considered. Figure 6.6 shows the scope of the two tentative proposals. It should be noted that the purpose of this section is to examine the future feasibility of the expansion proposal only, and the expansion of the airport area is not a prescribed decision.

Figure 6.6 Proposed Second Runway and Rotation Plans

The land use map of the proposed expansion area is shown in Figure 6.7. The Vientiane International Airport is built in the wetland area behind the Mekong River and drains to the northeast in the opposite direction of the Mekong River. Because of its proximity to the center of Vientiane, there is intense development pressure around the airport. In recent years extensive commercial facilities and hotels have opened one after another. There are residential buildings, temples, cemeteries, warehouses, etc., within the proposed expansion area, and the remaining wetlands are used for aquaculture ponds.

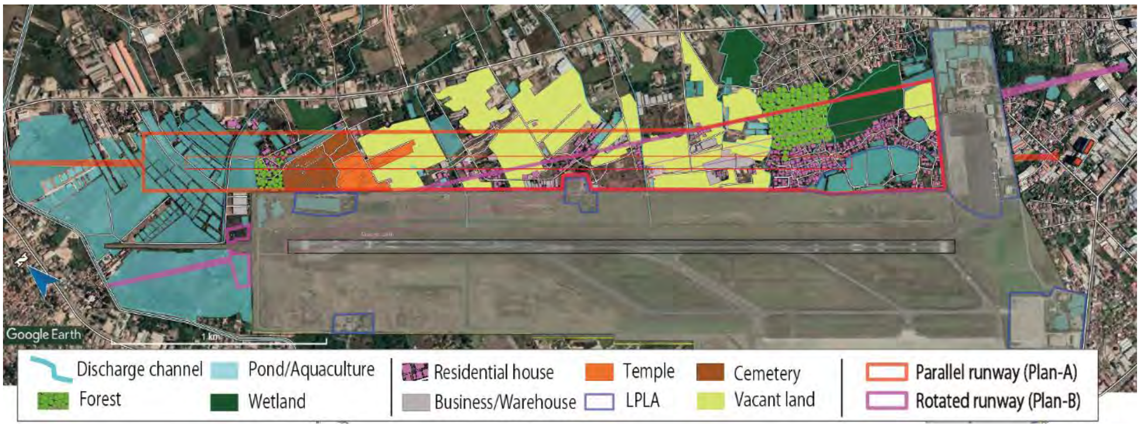


Figure 6.7 Land Use Map near the Proposed Area

(2) Land acquisition and resettlement

The areas to be acquired for land acquisition, excluding government land, are shown in Figure 6.8. In the figure, A1 and A2 are the areas to be expanded when the second runway plan is implemented, and B1, B2, and B3 are the areas to be expanded when the rotation plan is implemented. In addition to the expansion area, the main facilities of the current Air Force (LPLAAF) base will need to be relocated within the airport site when either Proposal A or Proposal B is implemented.

Figure 6.8 Parcels to be Expanded in the Comparison Plan

1) Land acquisition area and number of residents relocated

The land area required for the implementation of Plan-A and Plan-B and the approximate area of each land use type were estimated based on the results of aerial photo-reading and field survey (Table 6.1). The number of residents to be relocated is a rough estimate obtained by multiplying the number of houses by the average number of households in the urban area of Vientiane Province, which is 5.0 (Source: Results of Population and Housing Census, 2015, World Bank).

Table 6.1 Estimated Land Acquisition Area and Number of Residents Being Subject to Relocation

Object being interfered	Plan-A	Plan-B
Total land acquisition area (ha)	124.3	75.7
Aquaculture ponds (ha)	34.7	12.3
Forest land (ha)	5.0	5.0
Cemetery (ha)	5.8	0
Temple (ha)	4.2	0
Others (ha)	72.1	58.4
Number of houses to be relocated	373	316
Number of residents to be relocated	1, 865	1, 580
Number of offices/warehouses to be relocated	26	11

Housing within the relocation target areas (Plan-A and Plan-B)

Location of the house (left photo)

Establishments located within the relocation target area (Plan-A and Plan-B)

Location of the office (left photo)

2) Estimating the amount of compensation

In this section, compensation cost is estimated by grasping the site size, the number of units and offices, and the site area of residential and business properties and multiplying them by the market value of comparable properties (unit price/m^2). The process of the estimation is shown in Appendix- 2, and the materials of the properties referred to are attached in Appendix- 3. It is a general practice to use the official price for land acquisition in public works in Laos, but in JICA's cooperative projects, it is a prerequisite to acquiring land at the market price. The required land acquisition area and the price multiplied by the market price of similar sites are shown in Table 6.2**.**

Table 6.2 Estimation of Compensation Amount

Compensation Coverage types	Estimated compensation (mil. USD)	
	Plan-A	Plan-B
Involuntary Resettlement	63	54
Business/warehouse resettlement	27	18
Others	210	116
Total	**301**	**188**

3) Other major relocation

The following is a summary of the impacts that cannot be converted into the amount of compensation shown in Table 6.2 above.

- Temples (to be relocated when Plan-A is implemented)

Name: Vieng Thong Buddhist Temple

Location: Dong Na Thong Village, Sikhottabong District

Area: Approximately 4.2 hectares

Summary: Vieng Thong Temple was built by the villagers of Doen Na Thong when the village was formed. A large-scaled annex building, which is currently under construction, is also being built by the villagers' donation. The Lao people are generally devout Buddhists, as are the *Lao Roam* people who make up the majority in the Vientiane area. The residents of the area are also Buddhists, and their way of thinking, behavior, and life are deeply rooted in Buddhist teachings. The local people have great respect for the monks and make offerings to the monks in order to gain virtue. Temples, on the other hand, are not just places of worship but play an important role in various occasions in the lives of the residents and are positioned as important facilities that are inseparable from the lives of the surrounding residents. For example, temples are the meeting place of the local community and function as a central place for many annual events, weddings, funerals, ceremonies, and providing a place for children to play and study.

Main gate of Vieng Thong Temple

Temple annex (under construction)

- Cemetery (to be relocated when Plan-A is implemented)

Name: Paa Saa Chin Cemetery

Location: Dong Na Thong Village, Sikhottabong District

Area: Approximately 5.8 hectares

Summary: It was established in 1986. Today, the number of tombs has reached 5,000, and it is managed by the Lao Chinese Association.

Ritual hall in the cemetery

A section of the cemetery

- Sacred forest land (to be relocated when both Proposals A and B are implemented)

Name: Pa Saksid

Location: Pak Thang Village, Sikhottabong District

Area: Approximately 7.4 hectares (required acquisition area is 5.0 hectares)

Description: A forest protected by the local community in village of Paktan in the higher ground near the airport. Unlike the value of forests in Western countries, the significance of forests in Laos is based on the traditional belief of animism, and it is believed that spirits (called "Phi" by the Lao Roam tribe, who make up the majority in the Vientiane airport area) are omnipresent in the natural world, including forests. The people have great respect and awe for these spirits, and cutting down trees in this forest is strictly prohibited.


Inside the Sacred Forest (Pa Saksid)

(3) Aircraft noise impact

The impact range of the maximum noise value of each proposal is shown in Figure 6.9 and Figure 6.10. In this section, the 85dB LAmax noise curve (3000 nmi Mission) of the A330-300, the largest aircraft used for scheduled flights at Vientiane International Airport, is used to compare the current situation and the impact range of each proposal as a method to understand the noise impact of each proposal effectively. It is estimated that the greatest noise impact in the surrounding area will occur when this aircraft is closest to the airport at night.

The given conditions for the estimation of the scope of influence above are as follows.

- Takeoffs and landings are assumed to occur in both directions.
- For both the second runway proposal (Plan-A) and the runway rotation (Plan-B), the area to be acquired was excluded from the noise impacted area.
- In measuring the noise impact area of Plan-A, the impact area of the new second runway was calculated after adding the impact area of the current runway since the existing runway will continue to be operated.
- On the other hand, since the current runway will not be used during the operation of Plan-B, the area of influence of the existing runway was excluded.

Figure 6.9 Predicted Noise Area (at maximum) for Plan-A

Figure 6.10 Predicted Noise Area (at maximum) for Plan-B

he maximum instantaneous noise (85 dBA) impact area for Plan-A is the largest at 215 hectares, 76 hectares more than the current 139 hectares (Figure 6.11). The area affected by Plan-A and Plan-B includes the shopping area along Sithong Road and the area north of Asean Road, which consists of a Buddhist temple and high-rise hotels.

Since the noise value used for comparison here is the instantaneous maximum value (LAmax) of the largest aircraft and not the cumulative average value (equivalent noise level: LAeq), it does not mean that the noise standard is immediately exceeded even if it is within the influence of the above noise prediction. In addition, it is expected that the 85dBA curve for the latest medium-sized aircraft (such as the B787) will be almost within the airfield site.

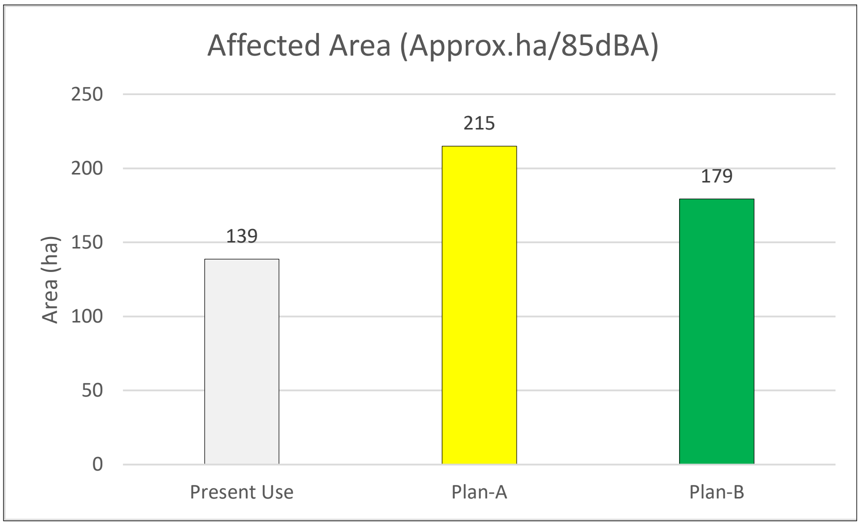


Figure 6.11 Comparison of the Scope of Impact of Each Proposal

(4) Impacts on the urban development

1) Extent and altitude to be secured

Figure 6.12 shows the impact area when the restricted surface required by the Civil Aeronautics Rule is applied to Vientiane International Airport. The minimum height to be secured as the restricted surface is 0 m, which is the same as the ground elevation on the side closest to the runway, and the height of the restricted surface on the farthest side is 60 m above the runway elevation, which is the hypothetical slope connecting between the point of the 0 m and the 60 m in a straight line. Therefore, the height of buildings in this area must be restricted in order to secure the restricted surface in the regulation. Since the current runway will be in service at the same time as the second runway (Plan-A), the area circled in white and yellow will be the height-restricted area, while the runway rotation (Plan-B) will only be in the area circled in green.

2) Obstructing buildings

Vientiane International Airport is located adjacent to the center of the capital city of Vientiane, and there is a strong demand for high-rise buildings and other structures to be constructed in the future. However, when implementing Plan-A and Plan-B, it will be necessary to establish construction ordinances that require height restrictions for new structures and incorporate them into city planning. In addition, in areas where height restrictions are required, land prices are expected to fall, economic opportunities will be lost, and compensation for forced changes in construction plans may be required. In fact, some high-rise buildings have already been constructed above the restricted surface limit, and these need to be removed. The locations of the obstacles that exceed the restricted surface limit are shown in Figure 6.13**.**

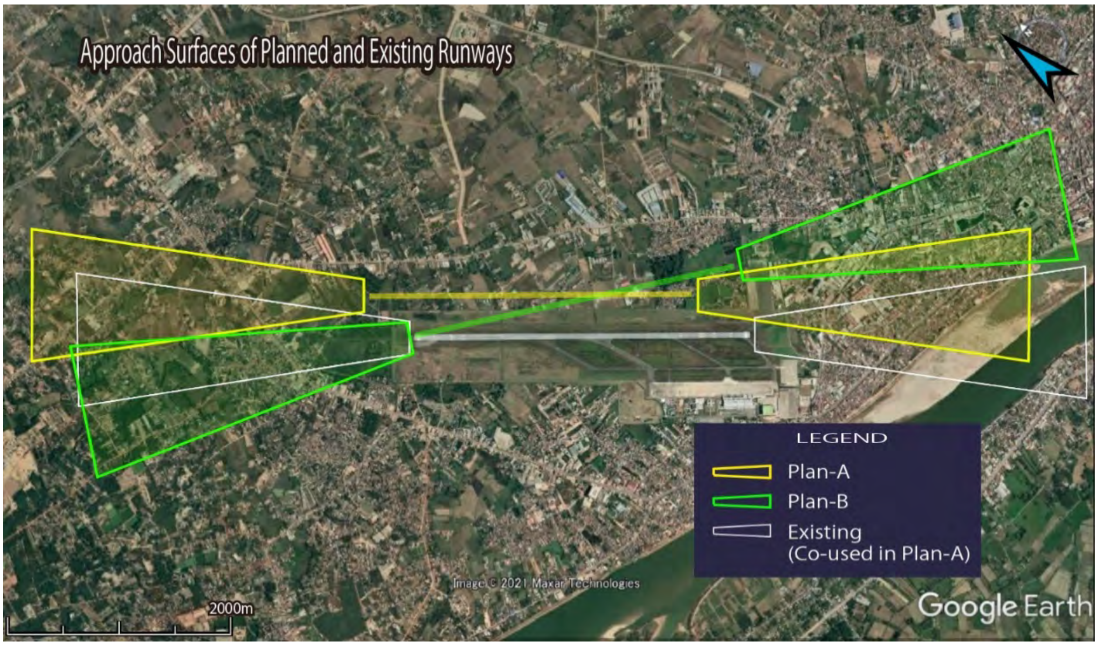


Figure 6.12 Affected-areas of each Plan by the Obstacle Limitation Surfaces

Figure 6.13 Buildings that may exceed OLS when new runways are introduced

The list of each building is shown in Table 6.3.

Table 6.3 List of structures that may be obstacles to entry

Obstructing structures	Restricted surface height near the building in question (m)	Applicable plan	
		Plan-A	Plan-B
1. Athens Hotel (1)	21.4 m	✓	Not applicable
2. Athens Hotel (2)	21.7 m	✓	Not applicable
3. Xang Jen Shopping Mall	27.6 m	✓	Not applicable
4. Jiangxi International Hotel	23.4 m	✓	Not applicable
5. Grand Szechuan Hotel	25.3 m	✓	Not applicable
6. Hunan Hotel	19.8 m	Not applicable	✓

The exterior of the buildings that exceed the aircraft approach plane are shown below: No. 3 is a large shopping center, and the others are large foreign-affiliated hotels, many of which have opened in recent years.

[Buildings that may exceed the surface limit of Plan-A

1. Athens Hotel (1) (foreground)
2. Athens Hotel (2)

3. Xang Jieng Shopping Mall

3. Jiangxi International Hotel

4. Grand Szechuan Hotel

[Buildings that may exceed the surface limit of Plan-B

6. Hunan Hotel

(5) Environmental and social impact assessment of each proposal

1) Second runway proposal (Plan-A)

A) Resettlement and land acquisition

The estimated number of residents to be relocated is about 1,800 to 2,000, the number of houses to be relocated is about 370, and the business buildings/warehouses to be relocated is 26. The land acquisition area is 125 hectares, and the compensation amount is estimated to be about 300 million USD. Since the airfield is located near the center of the capital, the cost of reacquisition based on the market price will be extremely high. The relocation cost does not include the cost of relocating the Air Force facilities, which must be accounted for separately; it is necessary to construct the facilities from the ground up.

In addition, there are many other significant social losses that are difficult to convert into monetary value, such as the local residents' temple, a large cemetery, the sacred forest, etc. It is presumed that obtaining consent from local residents for the proposed expansion will be a significant challenge.

Furthermore, the Lao Construction Law (Chapter 6, Prohibitions, Article 59, General Prohibitions) prohibits the development of cultural heritage areas as well as military sites, so theoretical justification for the proposed expansion of the airfield is required.

B) Airfield noise

It was predicted that the area around the airport site on the northeast and southeast sides of the second runway would experience instantaneous exceedances of 85 dBA when the largest aircraft takes off.

C) Impact on urban development

At present, development is proceeding rapidly in the southeast side of the airport, near the center of Vientiane, and it is confirmed that there are more than six hotels and other buildings that exceed the OLS. Considering that the removal of these buildings and the establishment of new restricted airspace in the center of Vientiane will have a significant impact on the development plans of the capital city, the issue of height obstruction is being a critical issue in moving forward with Plan-A.

D) Other key issues

The main facilities of the Air Force need to be relocated. The Vientiane Air Force Base is a key facility for the national defense of Laos, so negotiations with the Lao People’s Army are essential. In addition, many of the relocated residents are the Air Force personnel, and it is inevitable that the relocation site will be farther from their current residences.

2) Runway rotation plan (Plan-B)

A) Resettlement and land acquisition

The estimated number of residents to be relocated is about 1,600, about 250 less than in Plan-A. The number of houses to be relocated is about 320, also about 50 fewer than in Plan-A. The number of business establishments to be relocated is eleven. The land acquisition area is 75 hectares, and the amount of compensation to the private sector is estimated to be about 188 million USD. In addition, although temples and cemeteries will not be relocated, it is expected that it will be difficult to obtain the consent of the local residents for the proposed expansion because a large part of the sacred forest will be converted to airfield land. Since the Air Force base will be divided by a runway, a large-scale relocation of the airfield will be necessary to implement Plan-B.

B) Airfield Noise

It was predicted that a portion of the 85 dBA would be instantaneously exceeded when large aircraft takes off near the airport property boundary on the northeast and southeast sides.

C) Impacts on the urban development

We have confirmed that there is a large hotel that exceeds OLS. The removal of this hotel and the establishment of new restricted airspace will raise a significant issue in the business industries and municipal development plans of the capital. The fact that the Presidential Palace is directly under the path of the proposed project is also an issue that should be taken into consideration when examining the validity of Plan-B.

6.1.3. *Alternatives: Existing Runway*

A study on existing runway capacity enhancement was conducted. Because of the difficulty of operating the existing runway on both sides, keeping the PRS operation was considered in most cases. The runway capacity in case of cancellation of the PRS was also studied. The considered cases are as follows:

CASE 1: This case is a base case (Refer to Section 2.10 of this report).

CASE 2: This case is based on Case 1 and a shortened departure aircraft separation.

CASE 3: This case is based on Case 2 and a shortened arrival aircraft separation.

CASE 4: This case is based on Case 3 and a reduced landing aircraft runway occupancy time.

CASE 5: This case is based on Case 4 and on enabling turboprop aircraft take off from RWY13.

CASE 6: This case is based on the cancellation of PRS operation.

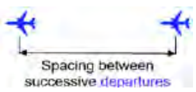
Table 6.4 Study Cases for Runway Capacity Enhancement

Operation	CASE	Setting Contents	Runway Capacity (movements/ hour)	Remarks
PRS	CASE 1	Existing runway capacity	21	See 4.1.2 Runway Capacity
	CASE 2	CASE 1 plus shortened departure separation between preceding jet aircraft and following turboprop aircraft	22	Separation is reduced from 8 NM to 5 NM
	CASE 3	CASE 2 plus shortened arrival separation between preceding aircraft and following aircraft	25	Separation is reduced from 8 NM to 4 NM (Minimum separation is 3 NM)
	CASE 4	CASE 3 plus shortened landing aircraft runway occupancy time	26	Reduce landing aircraft runway occupancy time with enhanced use of Taxiway D
	CASE 5	CASE 4 plus enabling turboprop aircraft taking off from RWY13	30	Allowing turboprop aircraft taking off from RWY13 with the partial extension of the parallel taxiway
Non-PRS	CASE 6	PRS cancellation case	38	Allowing all aircraft taking off from RWY13 with full extension of the parallel taxiway

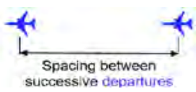
6.1.3.1. CASE 2: Shortened departure separation between jet aircraft and turboprop aircraft

(1) Air traffic control separation

This case assumes a reduction of separation of departures between preceding jet aircraft following turboprop aircraft. It is possible to reduce the break because the flight speed of a preceding jet aircraft is faster than that of the following turboprop aircraft. In this case, the separation is reduced from the current 8 NM to 5 NM. Other breaks between jet and jet and turboprop and turboprop are shown in Figure 6.6.



	Aircraft type	Following departure: Jet	Following departure: Turboprop
Preceding departure	Jet	5 NM	8 NM
	Turboprop	8 NM	5 NM



	Aircraft type	Following departure: Jet	Following departure: Turboprop
Preceding departure	Jet	5 NM	5 NM
	Turboprop	8 NM	5 NM

Figure 6.14 Reduction of Separation for Departure

(2) Runway capacity

The runway capacity of successive departures is calculated by the same method in Section 2.1 as in Table 6.5.

Table 6.5 Separation of Successive Departures in Case 2

Preceding Aircraft	Following Aircraft	Probability of Occurrence (a)	Separation (b)	(a) × (b)
Jet	Jet	42.25%	5 NM	2.11
Jet	Turboprop	22.75%	5 NM	1.14
Turboprop	Jet	22.75%	8 NM	1.82
Turboprop	Turboprop	12.25%	5 NM	0.61
			Total (Average Separation)	5.68

Note*: Based on the demand forecast results, the fleet mix of 65% is jets, and 35% is turboprop aircraft.*

When flying 5.68 NM at a flight speed of 210 kt, the flight time is 97 seconds (5.68 NM/210 kt = 97 seconds). Therefore, the runway capacity for successive departures is 37 movements per hour (3,600 seconds/97 seconds = 37 movements per hour).

Next arrivals are the same as the existing runway, 22 movements per hour. Alternating departures and arrivals are the same as the existing runway, which is16 movements per hour.

Runway capacity in CASE2 is shown in Table 6.6.

Table 6.6 Runway Capacity in Case 2

Operation	**Combination (a)**	**Runway Capacity (b)**	**(a) × (b)**
Successive Departure	25%	37	9
Successive Arrival	25%	22	5
Alternating Departures and Arrivals	50%	16	8
Total			22

6.1.3.2. CASE3: Shortened arrival aircraft separation

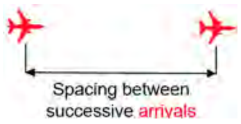
(1) Air traffic control separation

The minimum separation in ICAO Doc4444 PANS-ATM is:

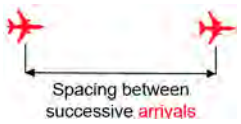
- Successive departures: 2 minutes/See Appendix- 5.
- Successive arrivals: 3 NM: See Appendix- 6.
- In case of arrival aircraft following departure aircraft: Takeoff is at least 5 minutes before arrival aircraft arrives on the runway. See Appendix- 7.

For successive departures, the shortened distance-based control separation is the same as CASE2, which is shorter than the time-based ICAO minimum. Therefore, the current distance-based control separation should be applied to the successive departures.

For successive arrivals, the 3 NM separation between successive arrivals is not applied in most airports in the world. Figure 6.16 Observation of Newark Liberty International Airport shows an observation of Newark Liberty International Airport. Most of the aircraft operated in the airport is small jet aircraft. The dotted yellow line shows the approach path to Runway 22L. The average separation between the small jet was 3.98 NM. In this study, 4 NM is applied in Case 3.



		Following arrival	
	Aircraft type	Jet	Turboprop
Preceding arrival	Jet	8 NM	8 NM
	Turboprop	8 NM	8 NM



		Following arrival	
	Aircraft type	Jet	Turboprop
Preceding arrival	Jet	4 NM	4 NM
	Turboprop	4 NM	4 NM

Figure 6.15 Reduction of Separation for Arrival

For alternating departures and arrivals, the current distance-based separation of 15 NM is the same as the minimum ICAO separation of 5 minutes (15 NM/180 kt = 300 seconds = 5 minutes).

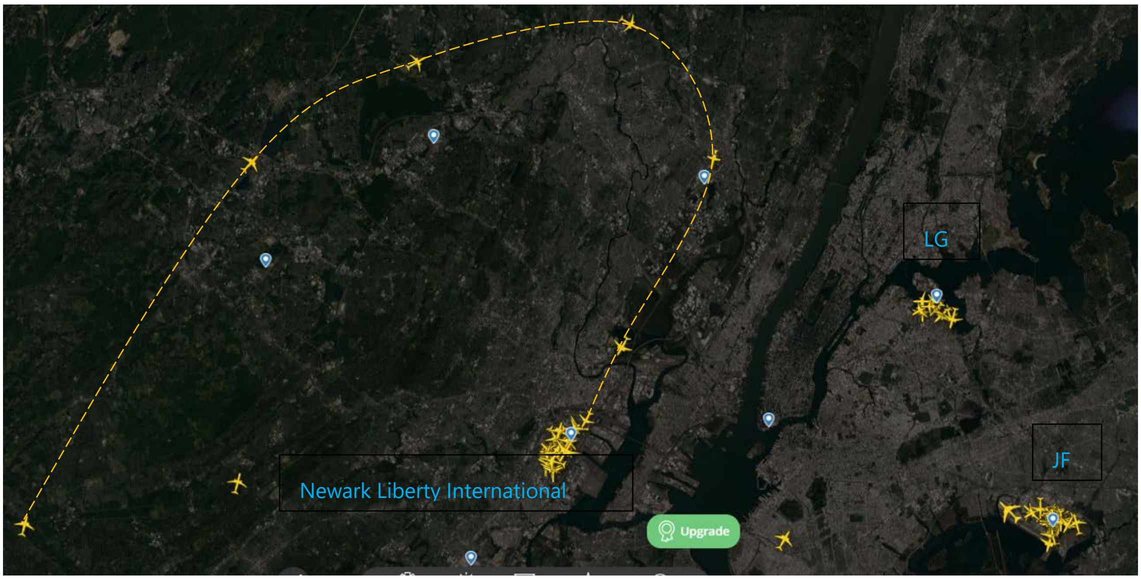


Figure 6.16 Observation of Newark Liberty International Airport

(2) Runway capacity

For successive departures, 37 movements per hour are the same as Case2.

The separation of the successive arrivals is 4 NM regardless of the aircraft type. The flight time for a flight of 4 NM at a speed of 130 kt is 111 seconds (4 NM/130 kt = 111 seconds). Therefore, the runway capacity for successive arrivals is 32 movements per hour (3,600 seconds/111 seconds = 32 movements per hour).

The capacity is the same for alternating departures and arrivals as the current operation, which is 16 movements per hour.

Runway capacity in CASE3 is shown in Table 6.7.

Table 6.7 Runway Capacity in Case 3

Operation	Combination (a)	Runway Capacity (b)	(a) × (b)
Successive Departure	25%	36	9
Successive Arrival	25%	32	8
Alternating Departures and Arrivals	50%	16	8
Total			25

6.1.3.3. CASE 4: Reduced landing aircraft runway occupancy time

(1) Reduction of runway occupancy time

Reduction of runway occupancy time for landing is considered in addition to the separation of Case 3. It is impossible to reduce the runway occupancy time for takeoff because the takeoff run will be the same regardless of the operation. According to IATA ADRM, 50 to 55 seconds of runway occupancy time is recommended. Considering the current taxiway configuration in the airport, it is possible to reduce the landing runway occupancy time to utilize more rapid exit taxiways such as Taxiway D. According to the observation from the control tower, almost all aircraft use Taxiway T for exits and take a long time to exit the runway. In Case 4, a 55-second runway occupancy time for landing is applied.

(2) Runway capacity

The existing runway capacity for successive departures and arrivals, 36 and 32 movements per hour, respectively, were applied.

In Case 1, Case 2, and Case 3, a runway capacity of 16 movements per hour is applied based on the 300 seconds of flight time for arrival aircraft (15 NM/180 kt = 300 seconds), a runway occupancy time for the landing of 73 seconds and 31 seconds for takeoff runway occupancy time was considered. The total time of this circle is 419 seconds (300 seconds + 73 seconds + 15 seconds and 31 seconds), and the runway capacity is 16 movements per hour (3600 seconds/419 seconds × 2 = 16 movements per hour).

The 73 seconds landing time is reduced to 55 seconds in Case 4 so that the total time of this cycle is reduced to 401 seconds (300 seconds + 55 seconds +15 seconds and 31 seconds). The runway capacity is 18 movements per hour (3,600 seconds/401 seconds × 2 = 18 movements per hour).

The runway capacity in Case 4 is shown in Table 6.8.

Table 6.8 Runway Capacity in Case 4

Operation	Combination (a)	Runway Capacity (b)	(a) × (b)
Successive Departure	25%	37	9
Successive Arrival	25%	32	8
Alternating Departures and Arrivals	50%	18	9
Total			26

6.1.3.4. CASE 5: Operation including RWY13 departures in PRS

When the departures and arrivals are in the opposite direction, an extensive interval (5 minutes) is required. To improve runway capacity, it is helpful to eliminate or reduce the number of operations of departures and arrivals in the opposite direction. In Case 5, operations that reduce the number of operations in the opposite direction of departure is studied.

Based on the minimal separation standards of ICAO, the separation between departing aircraft and arriving aircraft in the case of the opposite direction is at least 5 minutes. And the separation in case of the same direction is 3 minutes. One RWY13 takeoff will provide 2 minutes of clearance for alternating departures and arrivals. It means the approximate increase of one slot for departure or arrival.

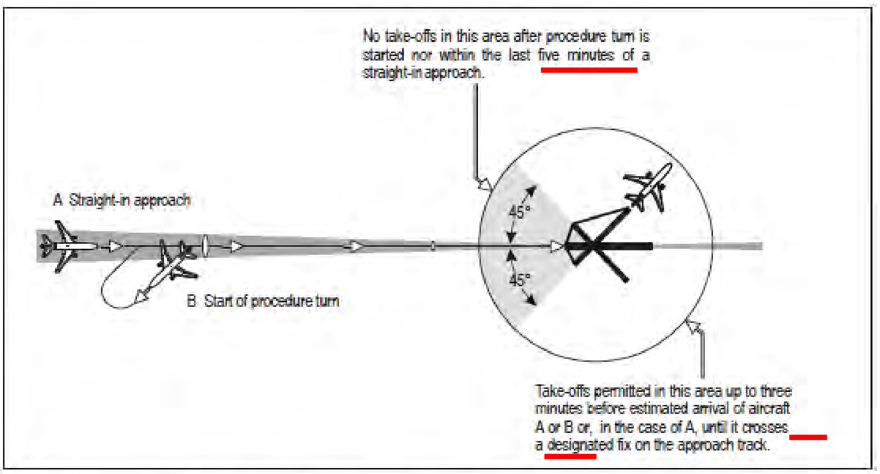


Figure 5-40. Separation of departing aircraft from arriving aircraft (see 5.7.1.1 b) and 5.7.1.2 b))

Source: ICAO PANS-ATM

Figure 6.17 Separation of Departing Aircraft from Arriving Aircraft

(1) Runway capacity

The existing runway capacity for successive departures is applied, which is 37 movements per hour. The same runway capacity for the next arrival, 32 movements per hour, is applied.

In Case 5, runway capacity is applied based on the 3 minutes separation for arrival aircraft. A runway occupancy time for the landing of 55 seconds and 31 seconds for takeoff runway occupancy time was considered. The total time of this cycle is 281 seconds (180 seconds + 55 seconds + 15 seconds + 31 seconds), and the runway capacity is 26 movements per hour (3,600 seconds/281 seconds × 2 = 26 movements per hour).

Runway capacity in Case 5 is shown in Table 6.9.

Table 6.9 Runway Capacity in Case 5

Operation	Combination (a)	Runway Capacity (b)	(a) × (b)
Successive Departure	25%	37	9
Successive Arrival	25%	32	8
Alternating Departures and Arrivals	50%	26	13
Total			30

6.1.3.5. CASE 6: Preferred Runway System cancellation

(1) Air traffic control separation

The minimum separation in ICAO Doc4444 PANS-ATM is applied in Case 6. For successive departures, reduction of separation is used the same as in Case 2. For successive arrivals, a 4 NM separation the same as in Case 3 is applied. For alternating departing and arrival aircraft, 3 NM separation is used (Refer to Appendix- 7).

(2) Runway capacity

For successive departures, a 5.68 NM separation is applied as the same as in Case 2. The runway capacity of the next departures is 37 movements per hour. For successive arrivals, a 4 NM separation, the same as in Case 3, is applied, and the capacity is 32 movements per hour.

Alternating departures and arrivals are different from other cases because the direction of landing and takeoff is the same. After the departure aircraft, a 3 NM separation is applied to the arrival aircraft. The time to fly 3 NM with 130 kt is 83 seconds (3 NM/130 kt × 3,600). A reduced landing occupancy time of 55 seconds is applied the same as in Case 4. For the runway occupancy time of departing aircraft, 31 seconds is applied, the same as in the other cases. The total time for this cycle is 169 seconds, and the capacity of this operation is 42 movements per hour (3,600/169 seconds × 2 = 42).

The runway capacity in Case 6 is shown in Table 6.10.

Table 6.10 Runway Capacity in Case 6

Operation	Combination (a)	Runway Capacity (b)	(a) × (b)
Successive Departure	25%	37	9
Successive Arrival	25%	32	8
Alternating Departures and Arrivals	50%	42	21
Total			38

6.1.3.6. Comparison of runway capacity and demand forecast

Suppose the current operation, i.e., Case 1, is continued. In that case, the existing runway will reach its capacity by between 2035 as compared to the results of the air traffic demand forecast because the estimated ability is 21 movements per hour.

Based on the study results, if the current runway can be used as Case 5, the existing runway can accommodate the demand up to the year 2044. The possibility of Case 5 is further analyzed.

Table 6.11 Runway Capacity and the Demand Forecast

	Runway Capacity (movements per hour)						Demand Forecast
	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Busy Hour Aircraft Movements
2025	21	22	25	26	30	38	14
2030	21	22	25	26	30	38	18
2035	21	22	25	26	30	38	21
2040	21	22	25	26	30	38	26
2045	21	22	25	26	30	38	31
2050	21	22	25	26	30	38	36

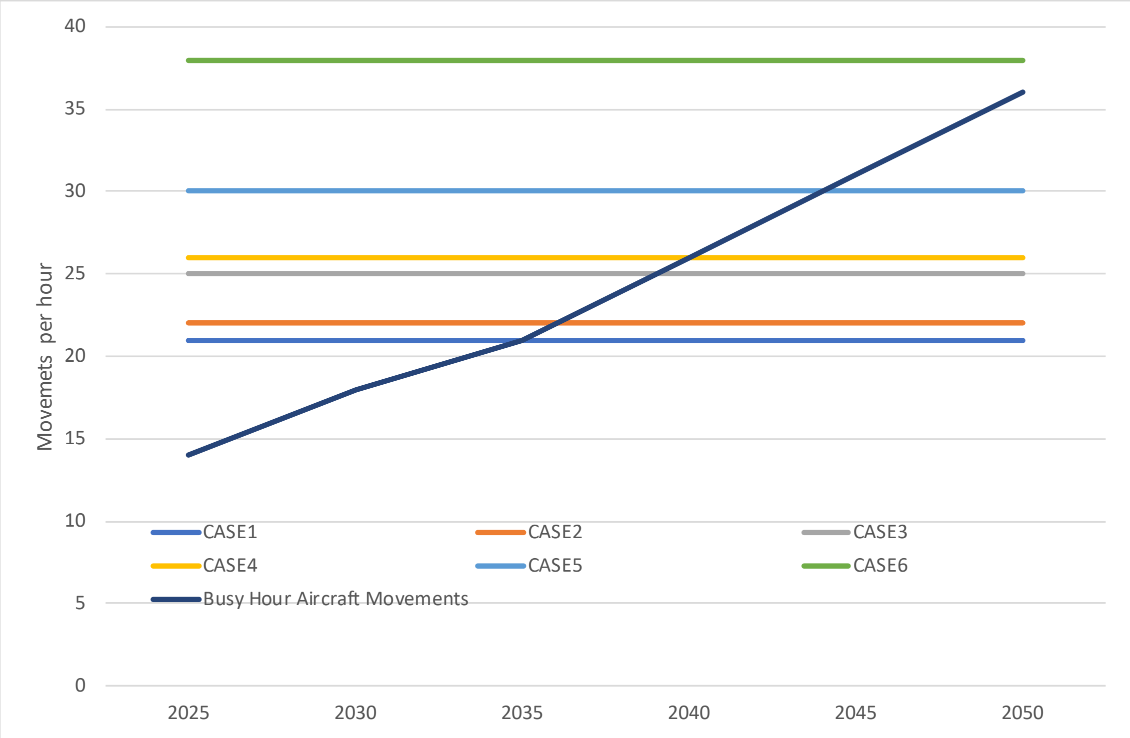


Figure 6.10 Comparison of Runway Capacity and Busy Hour Aircraft Movements

6.2. *Terminal Buildings Layout*

6.2.1. *Background*

As described in 4.4.1 International Passenger Terminal Building in this report, it is necessary to expand the capacity of international and domestic passenger terminal buildings. The expansion should be on a large scale, and the location of new buildings are studied as shown below.

6.2.2. *Alternatives of New Terminal Area*

Four alternatives of new terminal area location are studied.

6.2.2.1. Case 1

Case 1 is to construct a new international passenger terminal building on the western side of the existing international passenger building, where VVIP and cargo terminals are located. The current domestic building will be used as it is, and the existing international passenger building will be converted to the common use of domestic and international passengers. The passenger handling capacity of domestic passengers will be increased by altering the international passenger building to common usage. Additional passenger handling capacity for the international passenger will be beard by the new international passenger building. The existing VVIP building and the cargo terminal building have to be relocated to the western edge of the terminal area. Figure 6.18 shows the layout plan.

The advantage of Case 1 is that the new construction work will be smaller than the other alternatives. And the disadvantage of Case 1 is that the operation of the building will be complicated because there will be two international passenger buildings. The area for departure and domestic passengers will be duplicated because of two buildings.

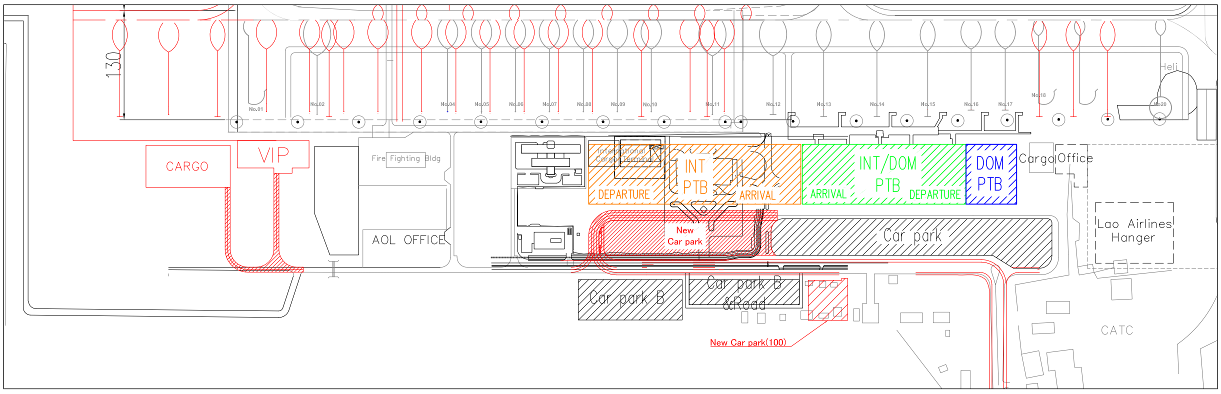


Figure 6.18 Case-1 Improvement Plan of Terminal Area

6.2.2.2. Case 2

Case 2 is to construct a new international passenger terminal building in the open space at the western edge of the terminal area. The existing international and domestic passenger buildings will be converted to dedicated domestic passenger buildings. Figure 6.19 shows the layout plan of Case 2.

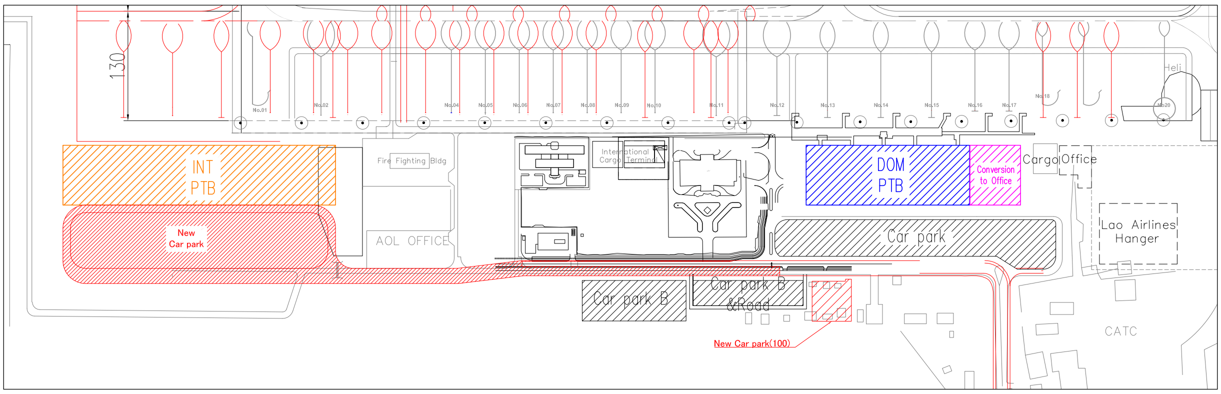


Figure 6.19 Case-2 Improvement Plan of Terminal Area

The advantage of this case is that as the new building will be constructed in the open space, it is not necessary to demolish or relocate other facilities. Also, the effect of the construction of the new international passenger building on the operation of the airport is minimum because converting the existing international passenger building to the domestic building is easy. After completing the new international passenger building, the process can be started immediately. The disadvantage of this case is that transfer between international and domestic flights will be challenging because of the long distance between the new international passenger building and the domestic passenger building. A new road to connect the buildings and operation of terminal transfer bus will be required.

6.2.2.3. Case 3

Case 3 is to construct two new buildings, one is a new domestic passenger building, and another is a new international departure passenger building. The new domestic passenger building is planned at the existing fire station area and the new international departure passenger building at the VVIP and cargo terminal area. The current international passenger building will be converted to an international arrival passenger building, and the existing domestic passenger building will be converted to office space. The layout plan of Case 3 is shown in Figure 6.20.

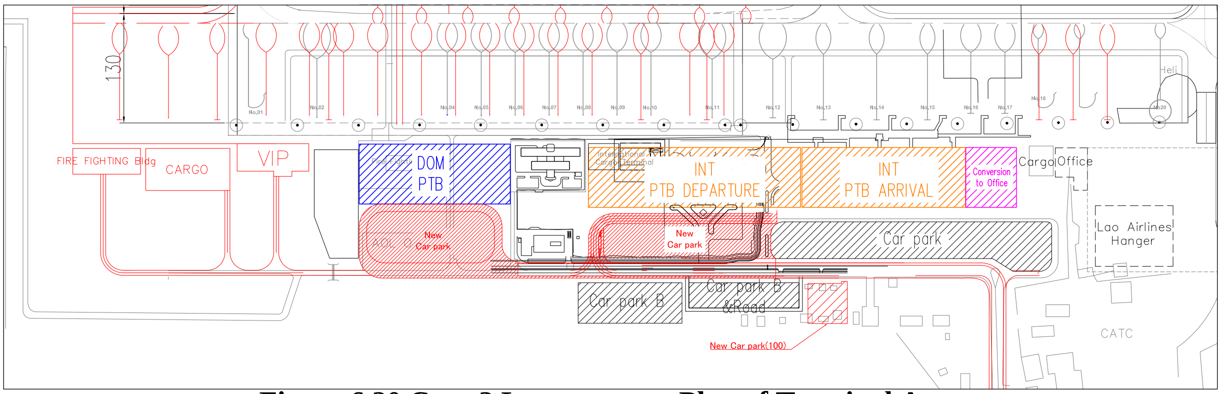


Figure 6.20 Case-3 Improvement Plan of Terminal Area

The advantage of this case is that the passenger handling capacity of international passengers will be significantly improved. Handling passengers will be easier compared to other cases because there will be two separate dedicated buildings, one for international passengers and another for domestic passengers. The disadvantage of this case is that transit between international and domestic flights will be challenging because of the distance between two buildings. Relocation of facilities is also challenging in this case because the fire station, cargo terminal building, and VVIP building should be relocated to the western side of the terminal area to provide a construction site for the new international departure passenger building and the new domestic passenger terminal building.

6.2.2.4. Case 4

Case 4 is to construct a new international departure passenger building in the existing VVIP and cargo terminal buildings. The current international passenger building will be converted to an arrival dedicated facility to handle international and domestic arrival passengers. The existing domestic passenger building will be converted to the departure building for domestic passengers. It is necessary to relocate the existing VVIP terminal building and cargo terminal building to the western side of the terminal area. Figure 6.21 shows the layout plan of Case 4.

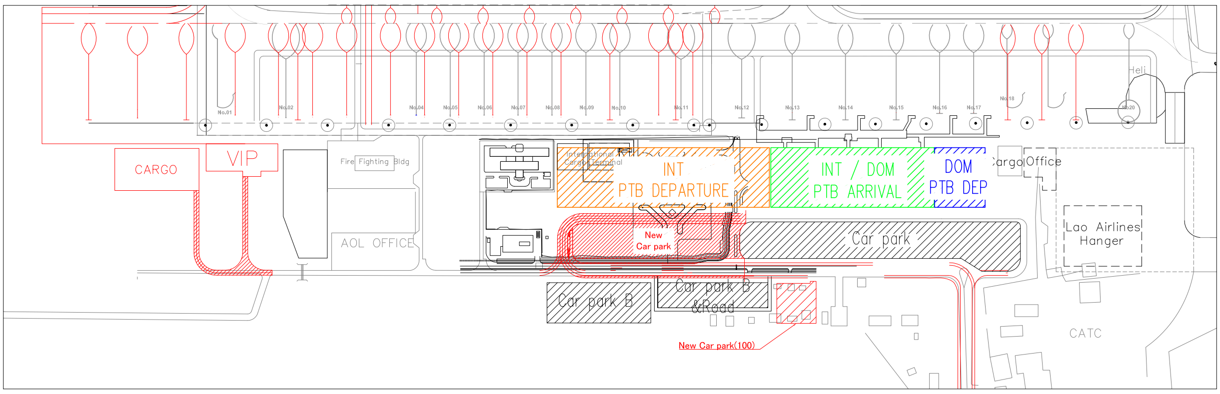


Figure 6.21 Case-4 Improvement Plan of Terminal Area

The advantage of this case is that it is convenient for passengers because the international building and the domestic building is located next to each other. The passenger terminal area is only one, so it is suitable for airlines and handling agents. The disadvantage of this case is the relocation of the VVIP building, and the cargo terminal building will be required. The renovation work of the existing passenger buildings will be challenging while keeping airport operation.

6.2.2.5. Conclusion

The JICA TC team considers Case 4 as the best option among those alternatives because of the convenience of the passengers and operations.

6.2.2.6. Implementation

The first procedure to implement Case 4 is to relocate the existing VVIP building and the cargo terminal building to the western end of the terminal area to secure the construction site for the new Int’l DPTB. After the relocation of these buildings, the latest international departure passenger building will be constructed, and renovation of the existing international passenger building and domestic passenger terminal building will be carried out. It is assumed that the building will be ready for operation by 2035. The implementation plan will be as shown in Figure 6.22.

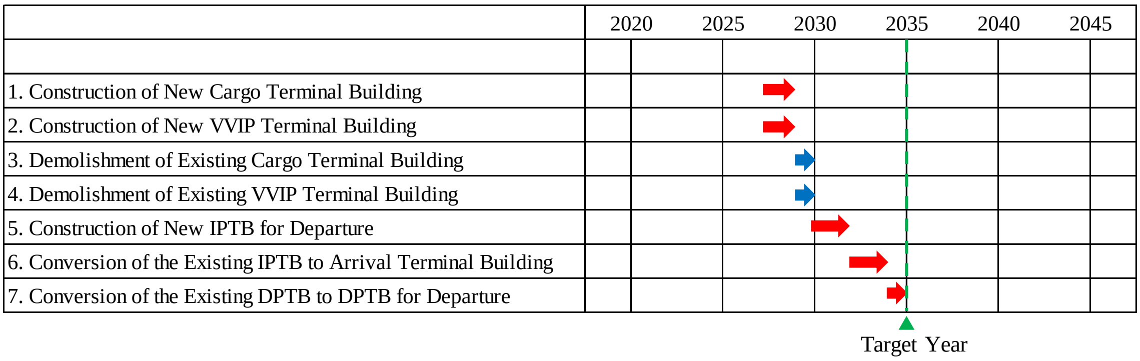


Figure 6.22 Development Timeline for Case 4 Long-Term Plan

6.3. ***Apron Layout***

6.3.1.1. Potential sites for apron expansion

There are three potential sites for apron expansion, as shown in the figure below. Site A is at the western end of the apron, and there is no constraint about the aircraft size. Site B and Site C is between the parallel taxiway C and the apron. Site B is between Taxiway E and Taxiway F, and Site C is between Taxiway F and Taxiway G. Because Site B and Site C are located between the apron and the parallel taxiway, the available parking space is limited, so that size of the aircraft in the sites are limited to turboprop aircraft.

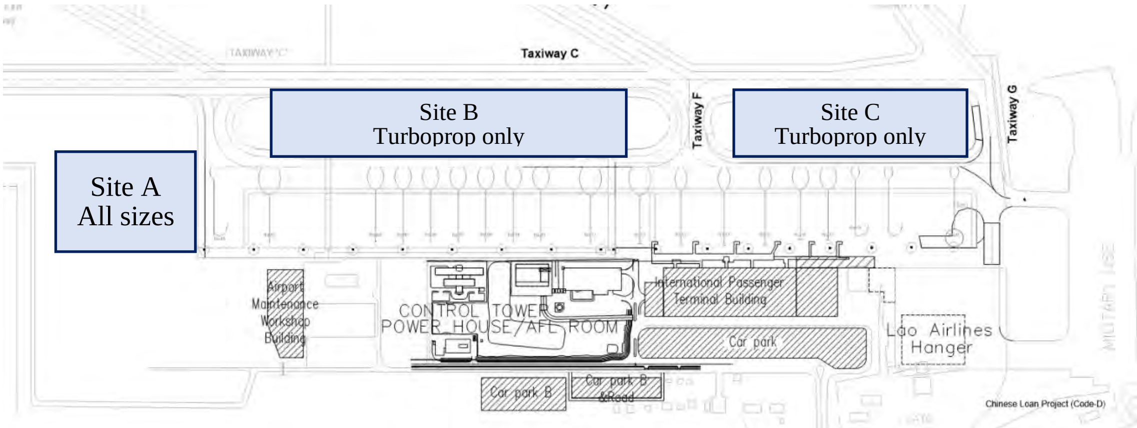


Figure 6.23 Potential sites for apron expansion

6.3.1.2. Study of Site B and Site C

The depth that can be used as an apron in Site B and Site C is about 40 meters. The distance between the center line of the parallel taxiway C and the apron taxiway is 127.5m. As Code E aircraft is operated on those taxiways, the distance between the taxiway center line to the object shou be 43.5m per Annex 14.

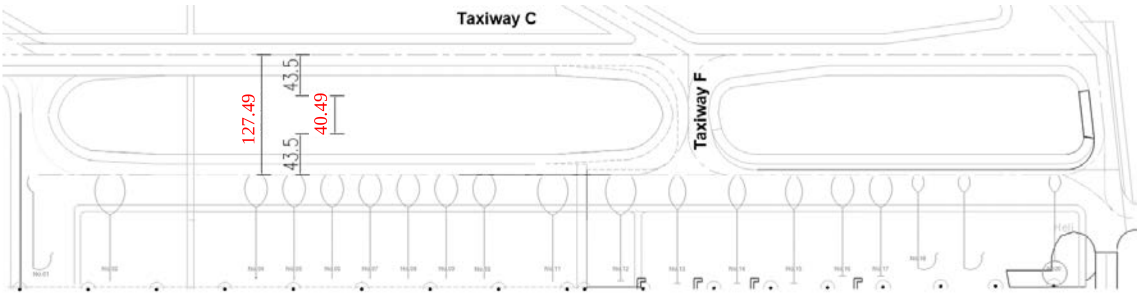


Figure 6.24 Apron depth of site B and C

The ATR72-600 can be parked on the apron with a depth of 40.49 meters. A 5 m is reserved in front of the aircraft for the marshaller to guide, and a 7 m is secured in the plane's rear for the shuttle bus.

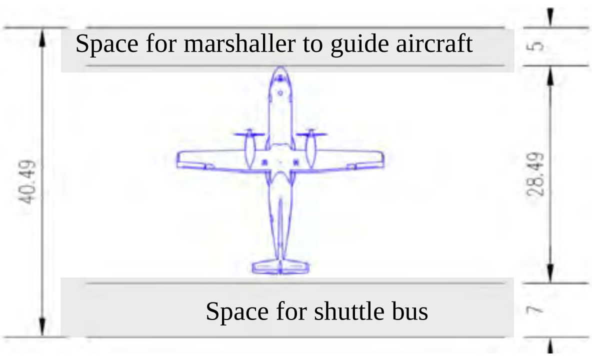


Figure 6.25 Assumptions when parking the ATR72-600

When departing aircraft are lined up on Taxiway C, the plane on the apron should wait for the taxiway to be cleared at Site C, and stand occupancy time may increase. In the case of Site B, the situation to block the taxiway may not occur frequently. At this point, it is better to develop Site B for the expansion area.

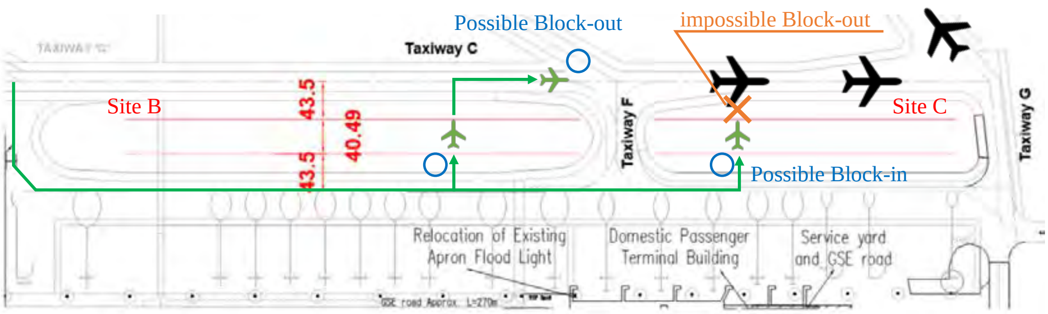


Figure 6.26 Characteristics of the sites

6.3.1.3. Parking Spots Planning Policy

The existing apron parking spots will be reorganized for the new parking position t. However, it is assumed that the position of the stand, which is currently equipped with PBBs, will not be changed. Code E aircraft will be located in front of the International Passenger Terminal Building, where the PBB is used for passenger convenience and ease of airport operation. The spare stands are located far from the passenger terminal building area. Dedicated aprons are provided in front of the VVIP and cargo terminals. The apron for the turboprop aircraft will be constructed at Candidate Site B.

(1) Aircraft size

The small jet and turboprop are Code C aircraft, while the large jet aircraft is Code E, as shown in the table below.

Table 6.12 Code Letter and Wingspan

Code letter	Wingspan	
A	Up to but not including 15 m	
B	15 m up to but not including 24 m	
C	24 m up to but not including 36 m	Small jet Turboprop
D	36 m up to but not including 52 m	
E	52 m up to but not including 65 m	Large jet
F	65 m up to but not including 80 m	

Source: ICAO Annex14

Design aircraft for the large jet is B777-300ER and ATR72 is turboprop aircraft.

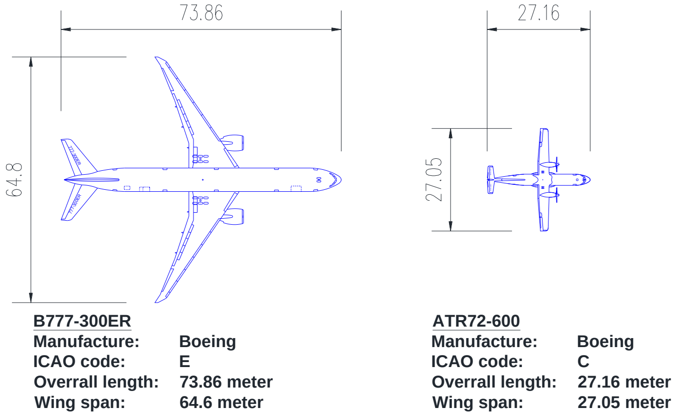
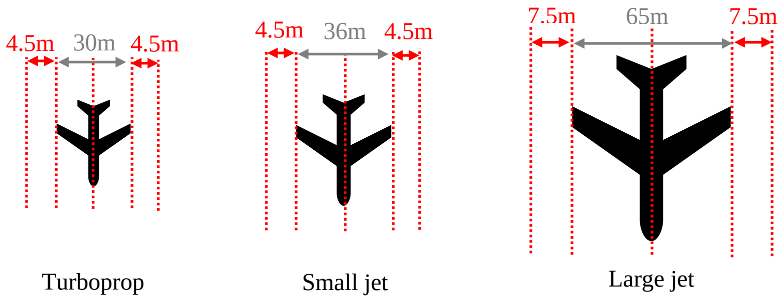


Figure 6.27 Design Aircraft

(2) Separation between aircraft

The separation between aircraft in the apron was planned following the separation distances in ICAO Annex 14. In the apron, 4.5m separation distance is applied between Code C aircraft and objects and 7.5m separation for Code E aircraft.



Code letter	Clearance (m)
A	3.0
B	3.0
C	4.5
D	7.5
E	7.5
F	7.5

Figure 6.28 Clearance Requirements

(3) The separation between apron taxiway centerline and aircraft on the apron

Because the largest aircraft is Code E, the separation distance of Code E, as shown in the table below, is applied between aircraft stand taxi lane center line to object and apron taxiway center line to object.

Table 6.13 Minimum Separation Distances

Annex 14 — Aerodromes *Volume I*

Table 3-1. Taxiway minimum separation distances

Code letter	Distance between taxiway centre line and runway centre line (metres)								Taxiway centre line to taxiway centre line (metres)	Taxiway, other than aircraft stand taxilane, centre line to object (metres)	Aircraft stand taxilane centre line to aircraft stand taxilane centre line (metres)	Aircraft stand taxilane centre line to object (metres)
	Instrument runways Code number				Non-instrument runways Code number							
	1	2	3	4	1	2	3	4				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	77.5	77.5	–	–	37.5	47.5	–	–	23	15.5	19.5	12
B	82	82	152	–	42	52	87	–	32	20	28.5	16.5
C	88	88	158	158	48	58	93	93	44	26	40.5	22.5
D	–	–	166	166	–	–	101	101	63	37	59.5	33.5
E	–	–	172.5	172.5	–	–	107.5	107.5	76	43.5	72.5	40
F	–	–	180	180	–	–	115	115	91	51	87.5	47.5

Note 1.— The separation distances shown in columns (2) to (9) represent ordinary combinations of runways and taxiways. The basis for development of these distances is given in the Aerodrome Design Manual *(Doc 9157), Part 2.*

Note 2.— The distances in columns (2) to (9) do not guarantee sufficient clearance behind a holding aeroplane to permit the passing of another aeroplane on a parallel taxiway. See the Aerodrome Design Manual *(Doc 9157), Part 2.*

6.4. *Long-term Improvement Plan*

6.4.1. *Phasing of Development Plan*

The phased development plan is prepared for a long term improvement plan. Phase 1 is the immediate development plan explained in this report in "5. Immediate Improvement Needs at Vientiane International Airport" in this report. Five-year development plans from 2030 to 2040 are planned. Each plan is prepared considering that the developed facility will not require significant development after five years of completion.

The target year to complete Phase 2 is 2030. The scope of the works in Phase 2 is an expansion of the apron, extension of the parallel taxiway, a new access road from the west side, development of car parks, additional apron flood lights, and additional taxiway lights. Extension of the parallel taxiway is planned in this phase to improve the runway's capacity. A new access road from the western side of the airport is planned.

The target year to complete Phase 3 is 2035. The scope of the works in Phase 3 is constructing the new international departure passenger building and renovation of existing passenger buildings. The alternative study of the development of passenger terminal building is explained in "6.2.2 Alternatives of New Terminal Area".

Target year to complete Phase 4 is 2040. Scope of the works in Phase 4 are expansion of aprons , an extension of the parallel taxiway, renovation of passenger terminal buildings, and rehabilitation of air field lighting system.

The scope of work of each phase is summarized in Table 6.14.

Table 6.14 Scope of Work of Each Phase

Phases	Completion Year	Target Demand Year	Scope of Works
Phase 1 (Immediate Improvement)	2025	2035	International Passenger Terminal Building (Expansion of Departure Lounge) Domestic passenger Terminal Building (Additional Baggage Claim Belt) Expansion of Access Road Rehabilitation of Taxiway B and T Rehabilitation of Aprons Rehabilitation of Air Field Lighting System
Phase 2	2030	2035	Expansion of Aprons Extension of Parallel Taxiway New Access Road from Western Side Additional Car Parks Rehabilitation of Runway Pavement Rehabilitation of Taxiway Pavement Rehabilitation of Air Field Lighting System New Power House
Phase 3	2035	2040	New Cargo Terminal Building New VVIP Building Construction of International Departure Passenger Building Renovation of International Passenger Building Renovation of Domestic Passenger Building
Phase 4	2040	2045	Expansion of Aprons Extension of Parallel Taxiway Renovation of Passenger Terminal Building Rehabilitation of Air Field Lighting System

6.4.2. *Phase 2 Development Plan*

6.4.2.1. Expansion of Apron

As discussed in Chapter 4, the parking spots will be insufficient before 2035. It is necessary to expand the apron to meet future demand. The number of required parking spots in 2035 is shown in Table 6.15.

Table 6.15 Required Apron Parking Spots in 2035

		Existing stands	Required stands in 2035
International		-	15
	Large jet	-	2
	Small Jet	-	11
	Turboprop	-	2
Domestic		-	7
	Small Jet	-	3
	Turboprop	-	4
Total		18	27
	Large jet	4	2
	Small Jet	9	14
	Turboprop	3	6
	Cargo	1	1
	VIP	1	1
	Spare	0	3

A new apron between Taxiway C and the apron is planned to accommodate four turboprop aircraft and expansion of the existing apron to the west side to accommodate a large jet is planned. Apron parking spot marking will be changed to accommodate required aircraft in the current and extended apron, as shown in Figure 6.29.

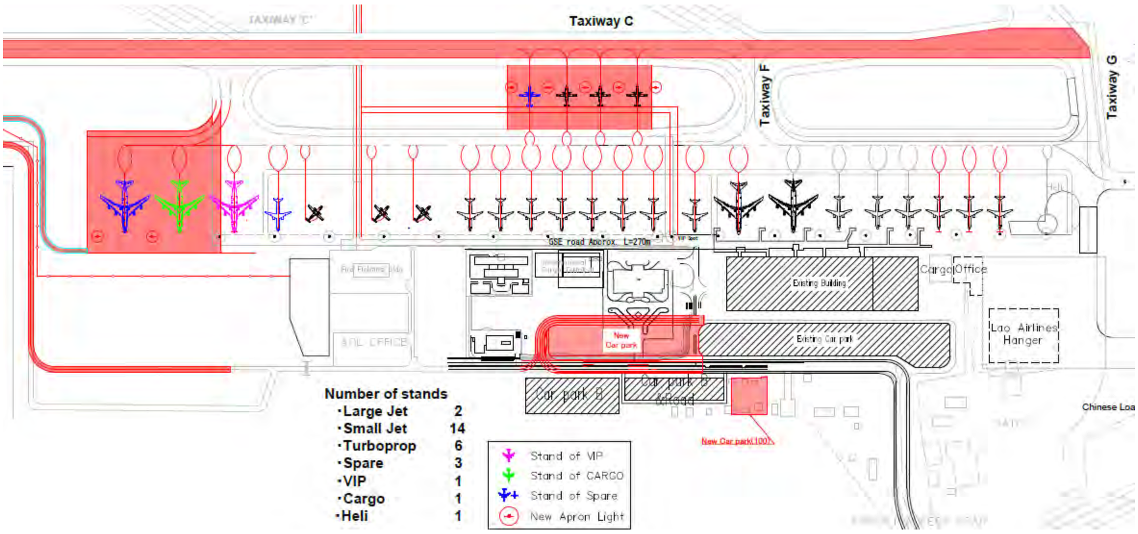


Figure 6.29 Expansion of Apron in Phase 2

6.4.2.2. Extension of Parallel Taxiway

To ensure the runway throughput of Case 5 (Refer to “6.1.3 Alternatives: Existing Runway”), turboprop aircraft must depart from Runway 13, which requires a runway length of 2,000 meters. There is some operation of a small jet to take off from Runway 13. With a 2,000 m length runway, weight restriction for Code C small jet aircraft such as B737 and A320 series is required.

The flight ranges of B737-800 aircraft with a runway length of 2,000 m and 2,500 m are calculated. In the 2,000 m runway, the range with full passenger and full cargo is 741 km, and with full passenger and half, cargo is 1,390 km, as shown in Figure 6.11. In the 2,500 m runway, the range with full passenger and full cargo is 2,872 km, and with full passenger and half, cargo is 3,613 km, as shown in Figure 6.12. The runway length of 2,500m is desirable because it covers all the current routes in service. If a taxiway is connected at a runway length of 2,000 m, there is a possibility that aircraft will travel on the runway to threshold 13 side, make a U-turn, and then take off to the south (So-called "trackback") so that the parallel taxiway will be extended to a point where 2,500m runway length can be secured for takeoff from RWY13.

Table 6.16 Flight Range at Runway 2,000 m and 2,500 m(B738)

	2,000m	2,500m
Number of seats	184	184
Passenger weight (kg/person)	95	95
Brake-Release gross weight (kg) for takeoff 2,000m or 2,500m runway	69,000	75,250
Max Zero fuel weight (kg)	62,732	62,732
Fuel (kg)	6,268	12,518
Operating empty weight (kg)	41,413	41,413
Payload (full pax, full cargo)	21,319	21,319
Passenger (kg)	17,480	17,480
Cargo (kg)	3,839	3,839
Payload (full pax, half cargo)	19,400	19,400
Passenger (kg)	17,480	17,480
Cargo (kg)	1,920	1,920
Operating empty weight + Payload (full pax, full cargo)	62,732	62,732
Available range (Nm)	400	1,550
Available range (km)	741	2,872
Operating empty weight + Payload (full pax, half cargo)	60,813	60,813
Available range (Nm)	750	1,950
Available range (km)	1,390	3,613

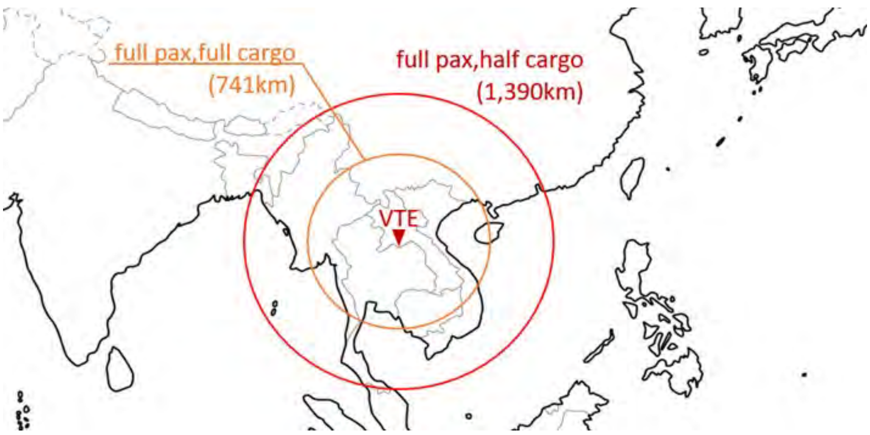


Figure 6.30 Flight Range at runway 2000m(B738)

Figure 6.31 Flight Range at runway 2,500m(B738)

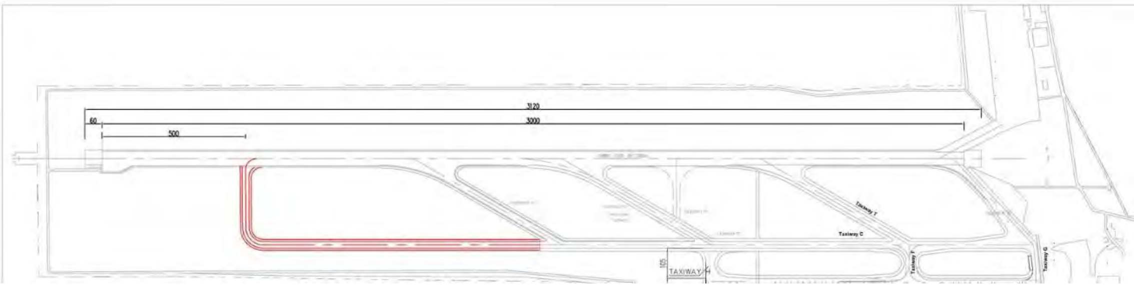


Figure 6.32 Development Plan of Expansion of Parallel Taxiway

6.4.2.3. Rehabilitation of Runway and Taxiway Pavement

The whole area of the runway and taxiways other than Taxiway B, Taxiway T, and Taxiway D were overlaid in 2006, and since that time, there has been no significant rehabilitation works as stated in “4.3.2 Pavement Conditions of Taxiways”, major repair such as overlay will be required by 2030. It is planned to conduct the overlay work in this phase, and at the same time, the air field lighting system on the runway and the taxiway will be replaced.

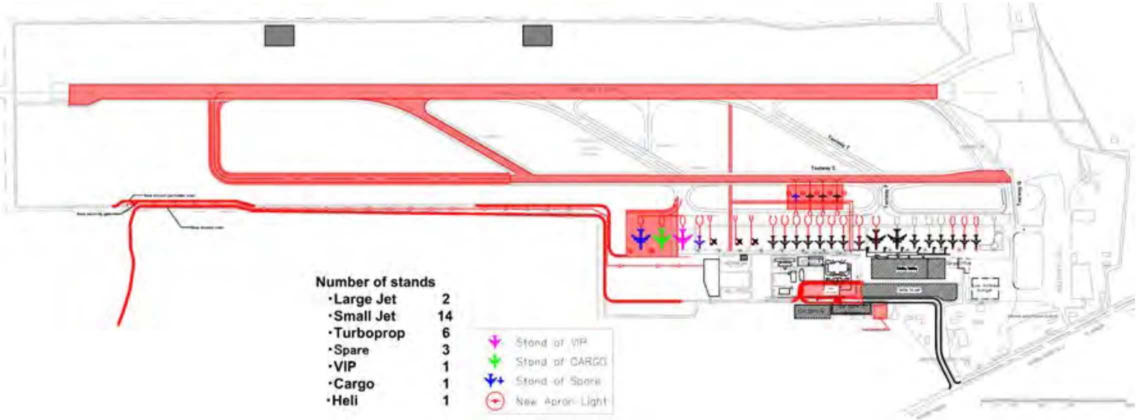


Figure 6.33 Pavement Rehabilitation Plan in Phase 2

6.4.2.4. Air Field Lighting System

Major rehabilitation of air field lighting system is planned. All the runway lights and taxiway lights will be replaced with LED type, and power cables will be replaced with new wires cast in pipes. As the rehabilitation has to be conducted while keeping the existing lighting, a new power house is planned next to the current power house. CCRs for associated lighting will also be replaced. New taxiway edge lights to the extended part of the parallel taxiway and apron floodlight in the new apron are also planned.

The scope of the work is shown below:

- Taxiway edge lights (New and replacement)
- Runway edge lights
- Turn pad lights
- New apron floodlight
- CCRs (Runway A, Runway B, Threshold 13, PAPI 13, PAPI31, Threshold 31, Approach Lights, Taxiway A, and Taxiway B)
- Power cables
- New power house
- Backup generators

The layout plan of air field lighting system rehabilitation is shown in Figure 6.34.

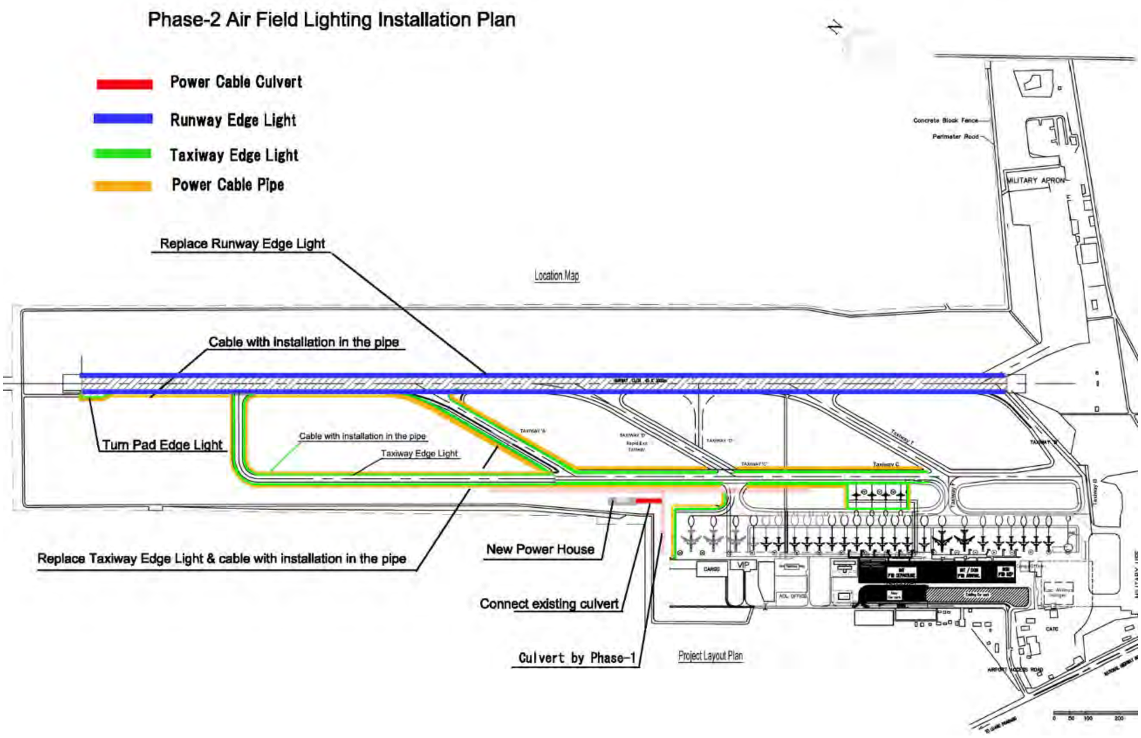


Figure 6.34 Air Field Lighting System Plan in Phase 2

6.4.2.5. New access Road from the West Side

If the traffic volume increases further in the future, other access roads to the airport will be needed. The demand for a new access road from the north side of the airport will increase in the future as the cargo building is planned to be relocated to the western side.

A new access route from national road 13 to the existing gate at the western side of the airport is planned as the access route from the northwest. The way will be connected to the terminal area by utilizing part of the existing airport service road, as shown in Figure 6.35. It is necessary to install new road lighting along the new road. The existing road lights in the terminal area are installed at intervals of 30 meters, and if the same gaps are used, 71 new road lights will need to be installed.

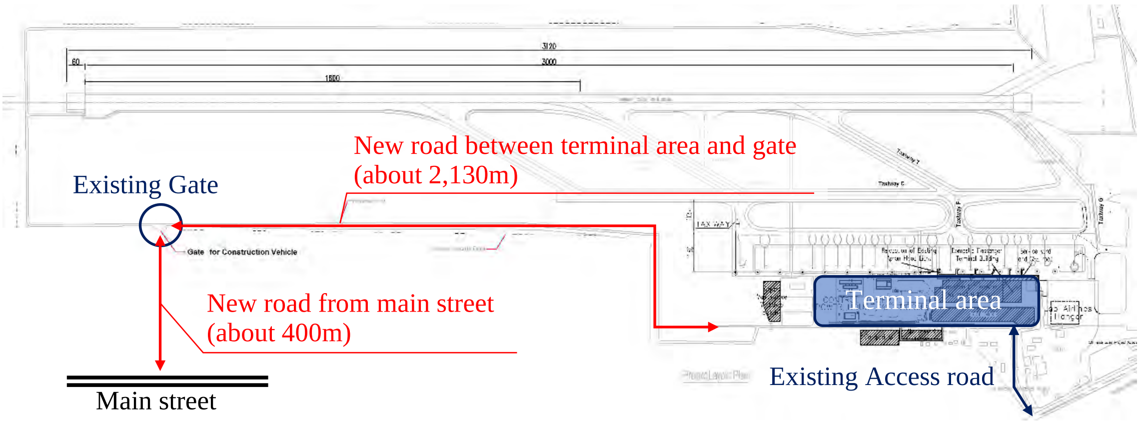


Figure 6.35 Outline of the New Access Road

In this plan, a new access road will be built inside the existing perimeter fence, so a new perimeter fence will need to be made inside the access road to indicate the boundary of the restricted area.

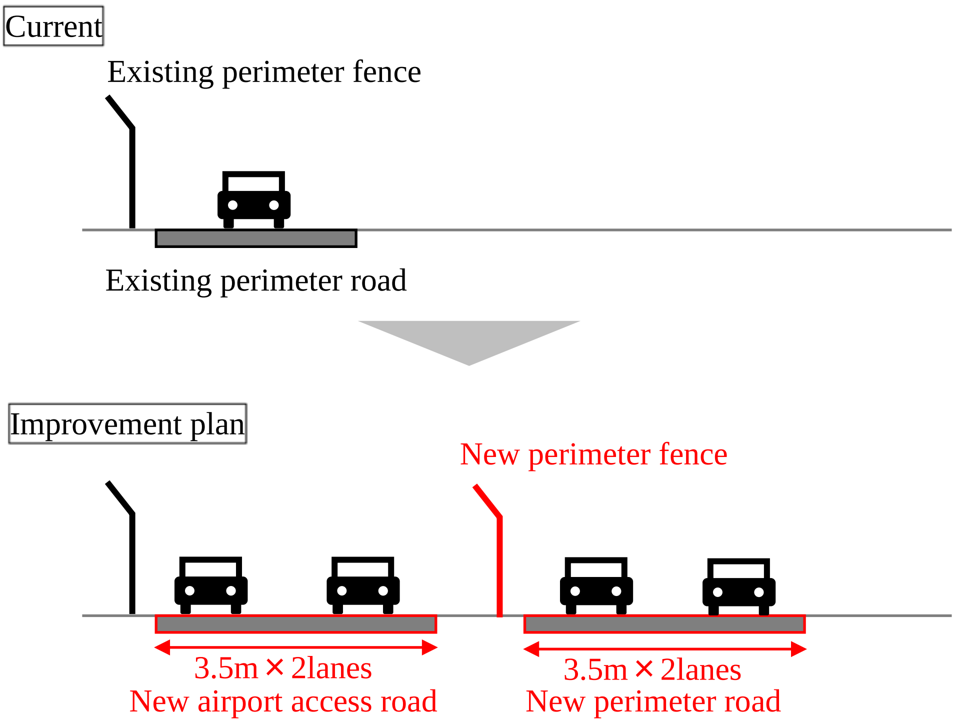


Figure 6.36 Cross-sectional of New access Road

Since the new airport access road has a long straight section and the driving speed may be high, it is recommended to increase the curve radius in consideration of safety. It was decided to plan for a curve radius of 30 m, used for airport roads in Japan.

In the Japanese case, the design speed of a curve radius of 30m is 30km/h. If there is room, it is recommended that the curve radius be further increased to improve safety or take measures to improve safety through road markings. A detailed survey will be required in the implementation stage.

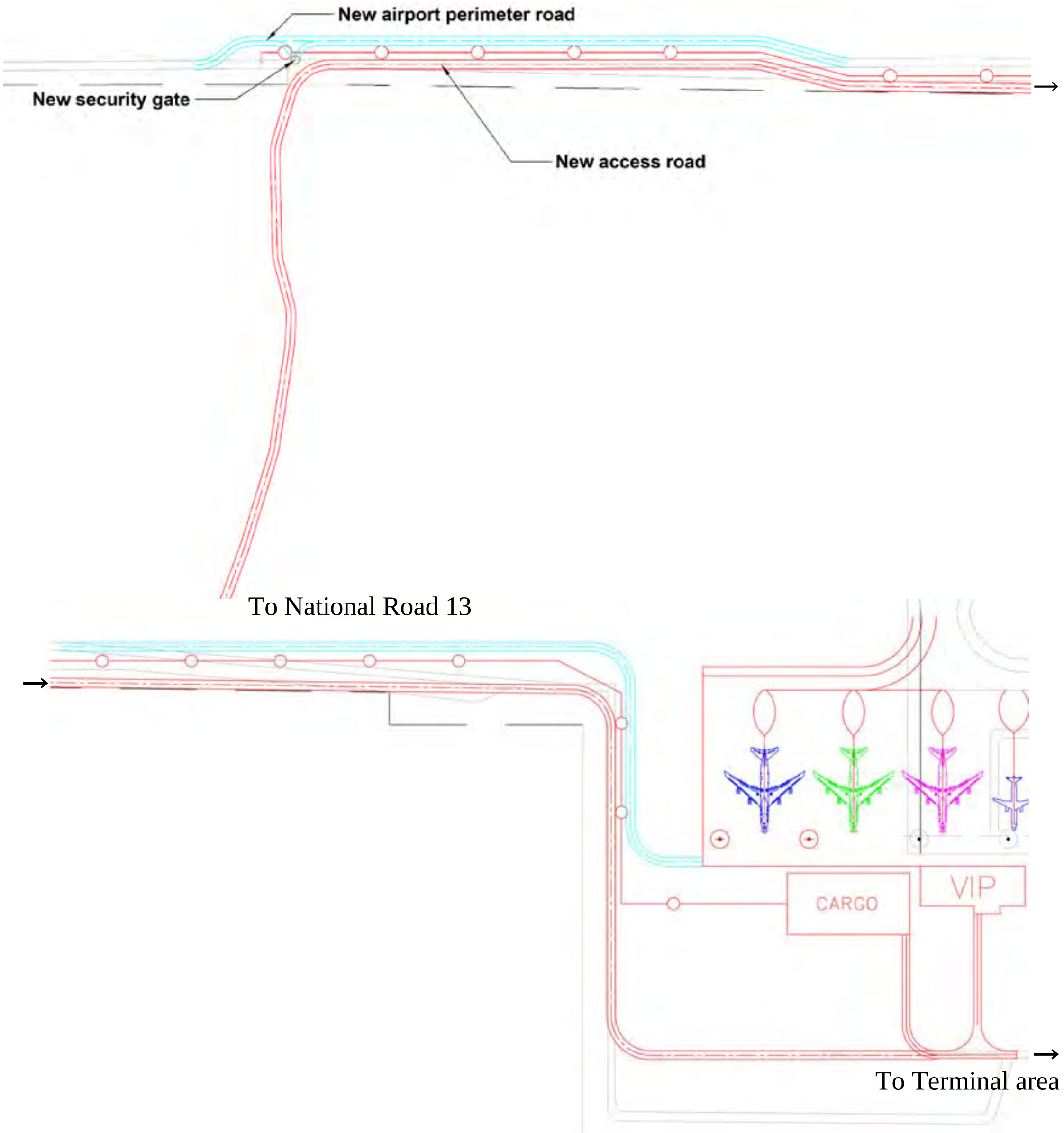


Figure 6.37 Layout of New Access Road

6.4.2.6. Expansion of Car Parks

The size of the parking lot was planned as the same as the existing one, 2.3m wide and 5.1m deep.

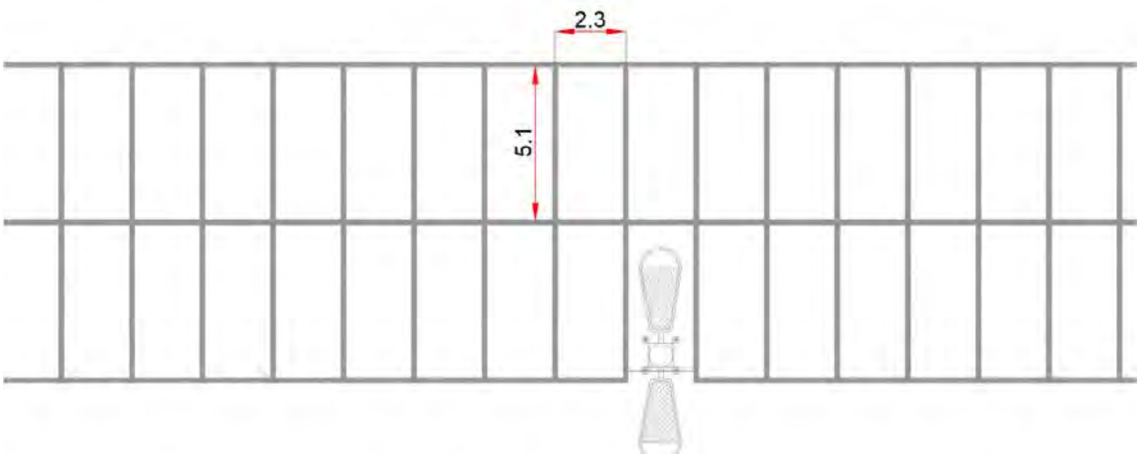


Figure 6.38 Existing Parking Lots Size

A new road is required together with parking lot expansion. The new route is in front of the new IPTB and will have the same lane as the existing one. A total of 493 parking lots is planned, as shown in Figure 6.39.

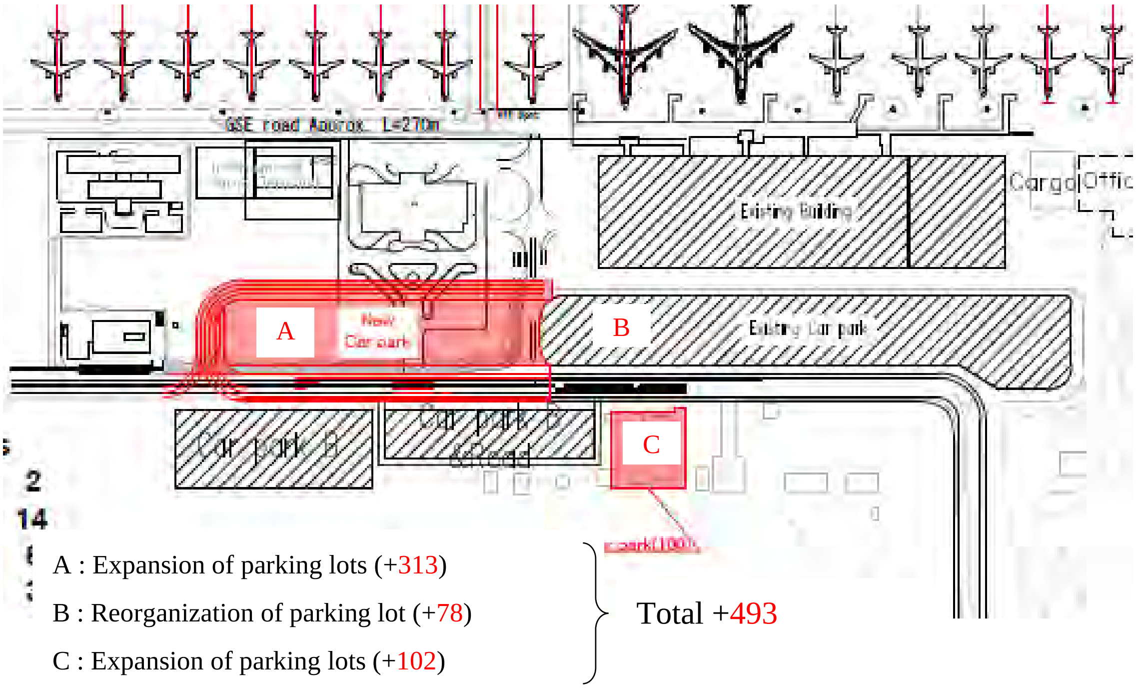


Figure 6.39 Expansion of Parking Lots

6.4.2.7. Cost Estimate

Table 6.17 Cost Estimate of Phase 2 Development Plan

Items	Cost (Million Kip)	Cost (Million Yen)
Expansion of Aprons	43,770	449
Extension of Parallel Taxiway and Rehabilitation of Taxiways	54,710	562
New Access Road from Western Side	20,520	211
Additional Car Parks and Fence	12,310	126
Rehabilitation of Runway Pavement	28,930	297
New Power House	22,310	229
Air Field Lighting System	72,390	743
Overhead and indirect cost	76,970	790
Total construction cost	331,890	3,407
Contingency	34,850	358
Consultant fee	33,190	341
Total Project Cost	399,930	4,105

6.4.3. *Phase 3 Development Plan*

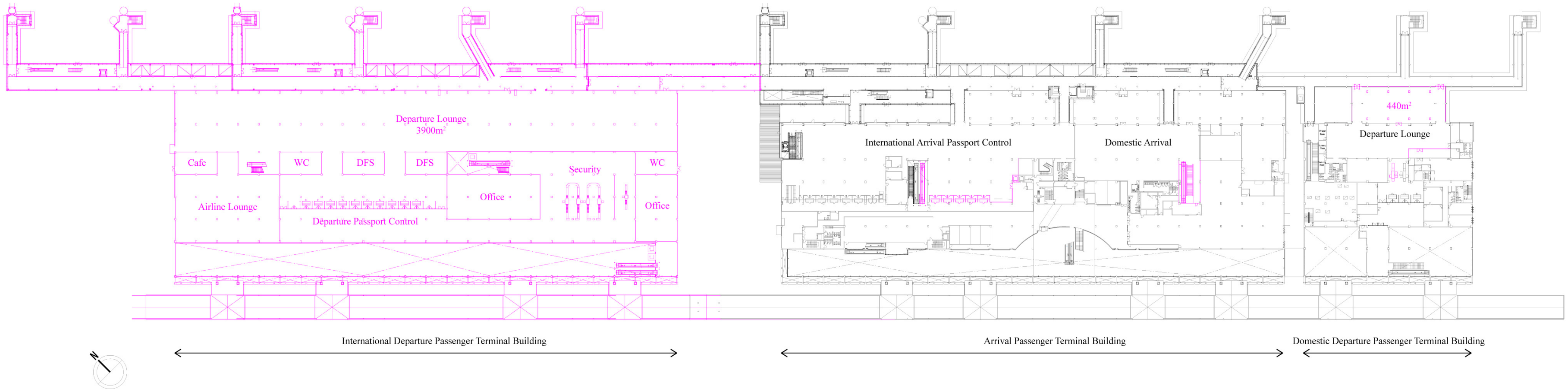
6.4.3.1. New Cargo Terminal Buildings and VVIP Building

Before constructing the new Int’l DPTB, the existing cargo terminal building and VVIP building will be relocated to the open space in the west part of the airport.

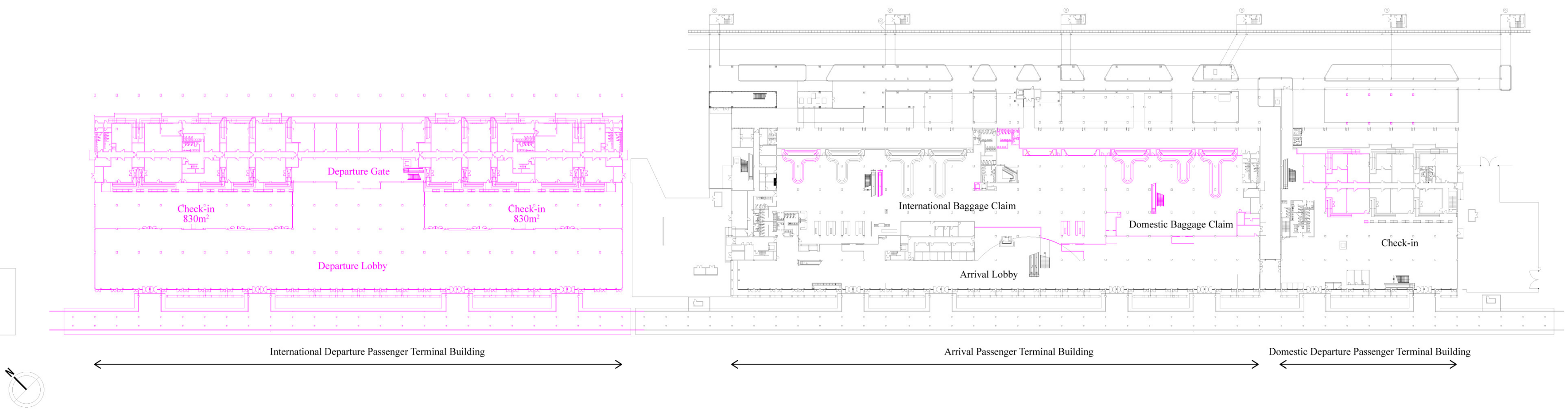
6.4.3.2. Passenger Terminal Buildings

The construction of a new Int’l DPTB is planned. The existing Int’l PTB will be converted to a dedicated arrival passenger terminal for international and domestic passengers. The Dom PTB will be converted to a Dom DPTB. The floor plan of the new Int’l DPTB and the existing passenger terminal is shown in Figure 6.40.

2F



1F



Legend

Phase-3 Renovation

Figure 6.40 Floor Layout of New Passenger Termina Buildings in Phase 3

After the Int'l DPTB is opened, it is possible to renovate the departure section of the existing Int'l PTB to covert to the arrival area of domestic passengers. The current arrival area for the international arrival passengers will be used, and one additional baggage claim belt will be installed in the area. On the 2nd floor, the existing business lounge area for departure passengers will be renovated for arrival immigration. Additional escalators and lifts will be installed in both arrival areas for international and domestic passengers.

The arrival section of the Dom PTB will be converted to the departure area for domestic passengers after opening the renovated international passenger terminal building.

The renovation plan in Phase 3 is shown in Figure 6.41 and Figure 6.42.

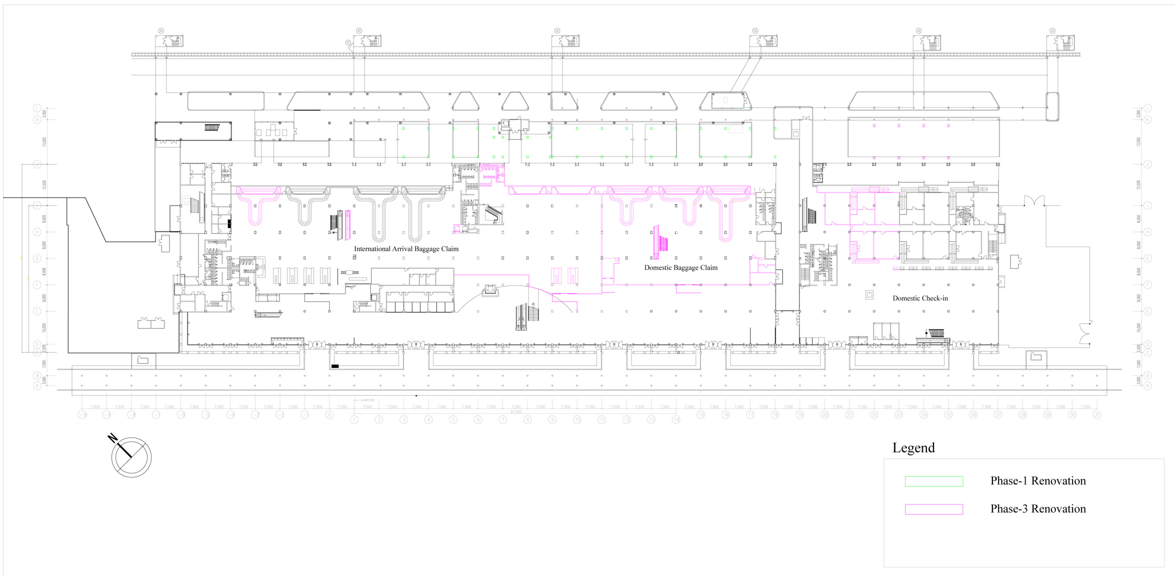


Figure 6.41 Phase-3 Renovation Plan of Passenger Terminal Building (1st Floor)

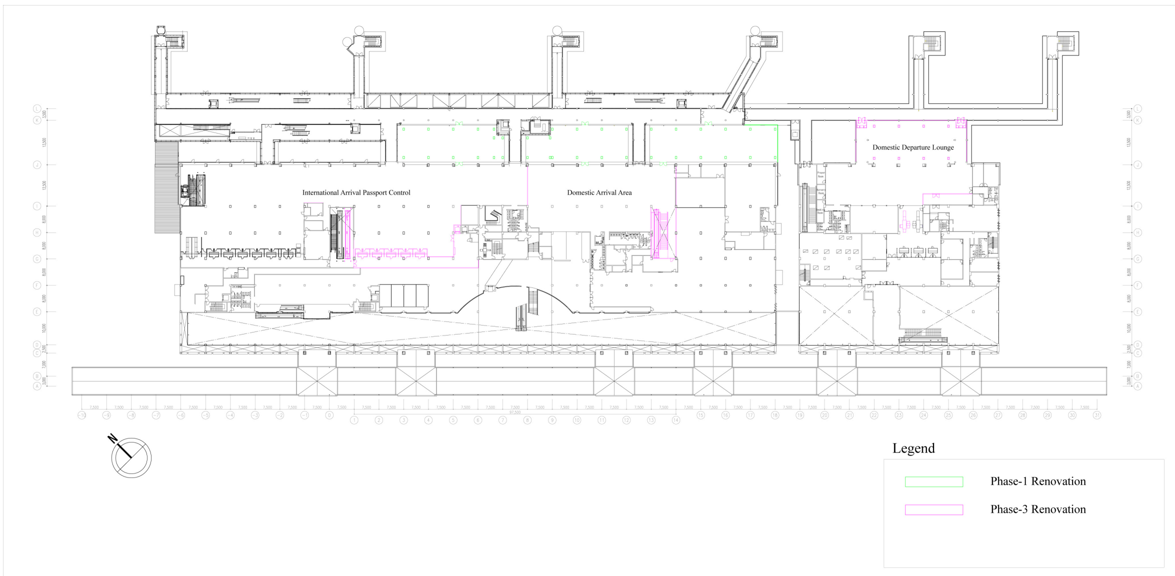


Figure 6.42 Phase-3 Renovation Plan of Passenger Terminal Building (2nd Floor)

6.4.3.3. Special Equipment

The current security X-ray system for screening hold baggage and cabin baggage will be replaced with CT type X-ray equipment in the future. This phase plans the replacement of the existing X-ray system to CT type X-ray equipment.

6.4.3.4. Cost Estimate

Table 6.18 Cost Estimate of Phase 3 Development Plan

Items	Cost (Million Kip)	Cost (Million Yen)
New Cargo Terminal Building	107,700	1,106
New VVIP Building	76,490	785
Construction of Int'l DPTB	943,620	9,686
Renovation of Passenger Buildings	32,050	329
Special Equipment	164,680	1,690
Overhead and indirect cost	314,810	3,232
Total construction cost	1,639,350	16,828
Contingency	172,130	1,767
Consultant fee	163,930	1,683
Total Project Cost	1,975,410	20,278

6.4.4. *Phase 4 Development Plan*

The scope of the Phase 4 development plan is to expand the apron and renovate the passenger terminal buildings.

6.4.4.1. Expansion of Apron

The number of required aircraft spots in 2045 is shown in Table 6.19.

Table 6.19 Number of existing and required stands

		Required stands in 2045
International		20
	Large jet	2
	Small Jet	16
	Turboprop	2
Domestic		9
	Small Jet	3
	Turboprop	6
Total		34
	Large jet	2

	Small Jet	19
	Turboprop	8
	Cargo	1
	VIP	1
	Spare	3

To meet the demand in 2045, the apron between Taxiway C and the existing apron is further extended to the western side. Because all the turboprop aircraft will be parked in the extended area and change of parking configurations in the frontal apron, expansion of the frontal apron to the western side will not be required.

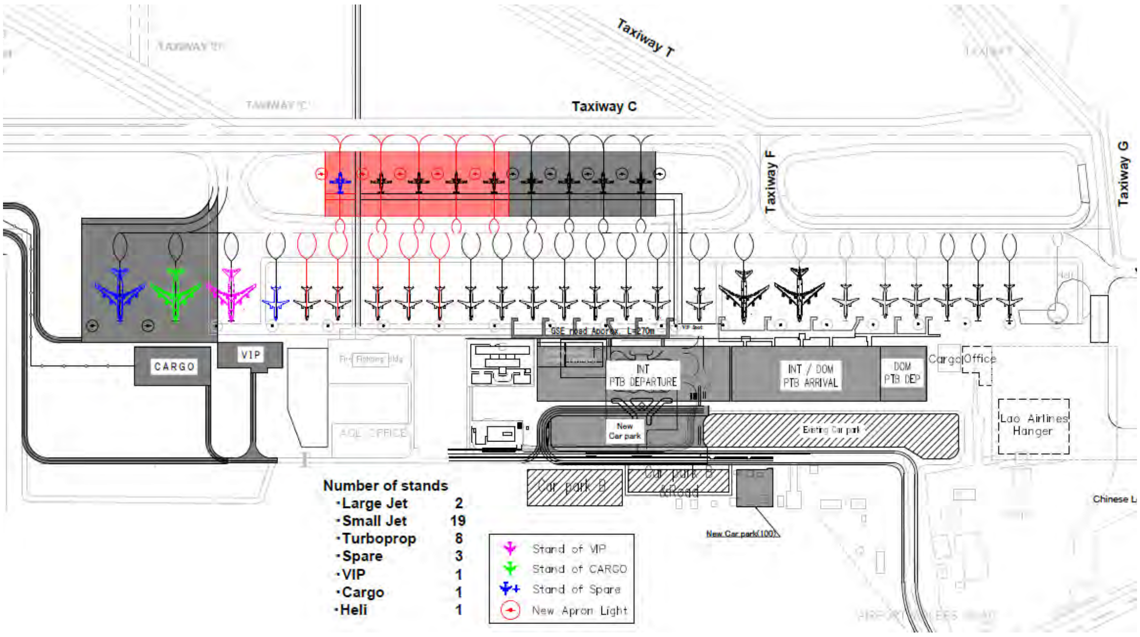


Figure 6.43 Expansion of Apron in Phase 4

6.4.4.2. Extension of Parallel Taxiway

Extension of the parallel taxiway to the Runway Threshold 13 is planned in this phase.

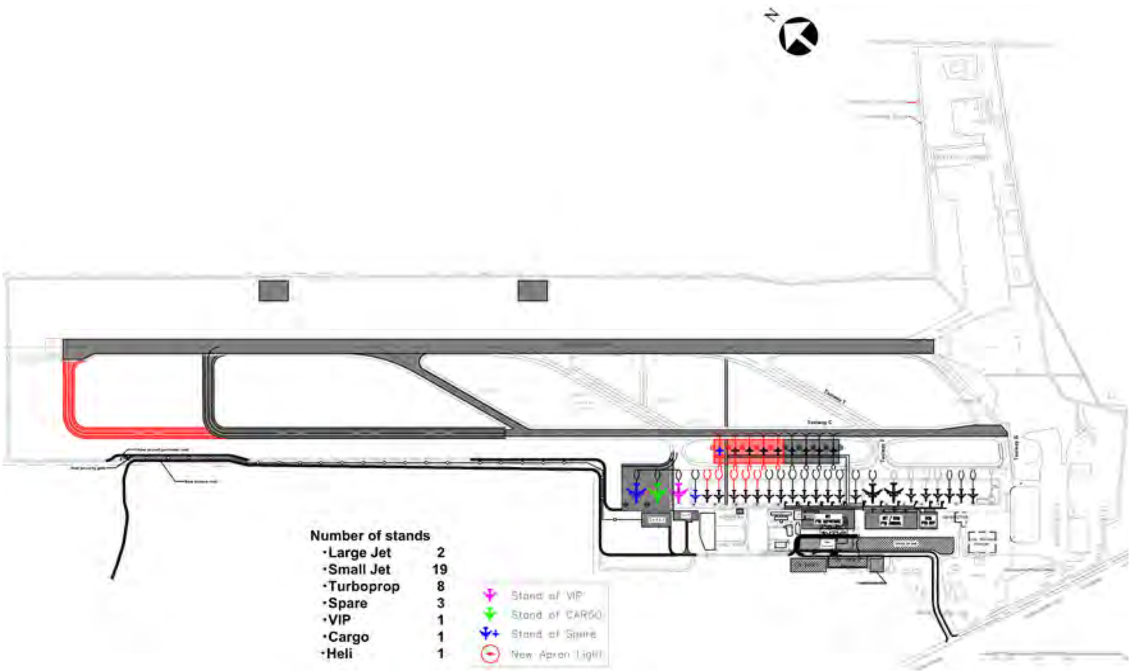


Figure 6.44 Extension of Parallel Taxiway

6.4.4.3. Renovation of Passenger Terminal Buildings

The renovation of the passenger terminal building in this phase will not require major structural expansion. Additional baggage claim belts will be installed in the domestic arrival area on the first floor. Other counters of the international arrival immigration will be installed on the second floor of the arrival building.

The check-in counter in the international departure building and domestic departure building will be added in the same space of the check-in area in both buildings. The security equipment such as for hold baggage and cabin baggage will be replaced with CT type X-ray equipment for domestic and international departure passengers.

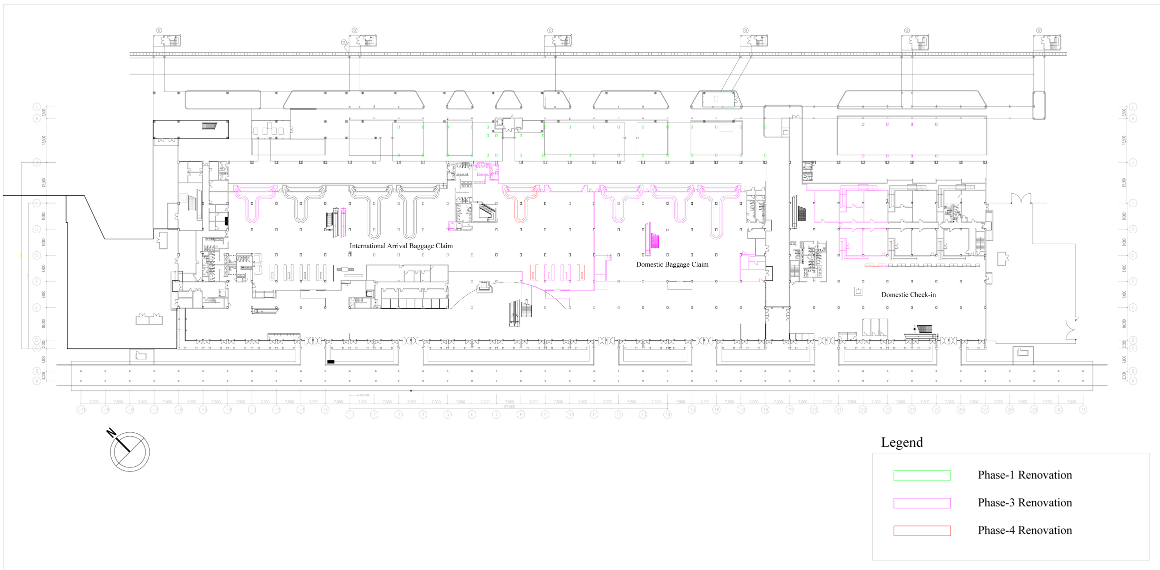


Figure 6.45 Phase-4 Renovation Plan of Passenger Terminal Building (1st Floor)

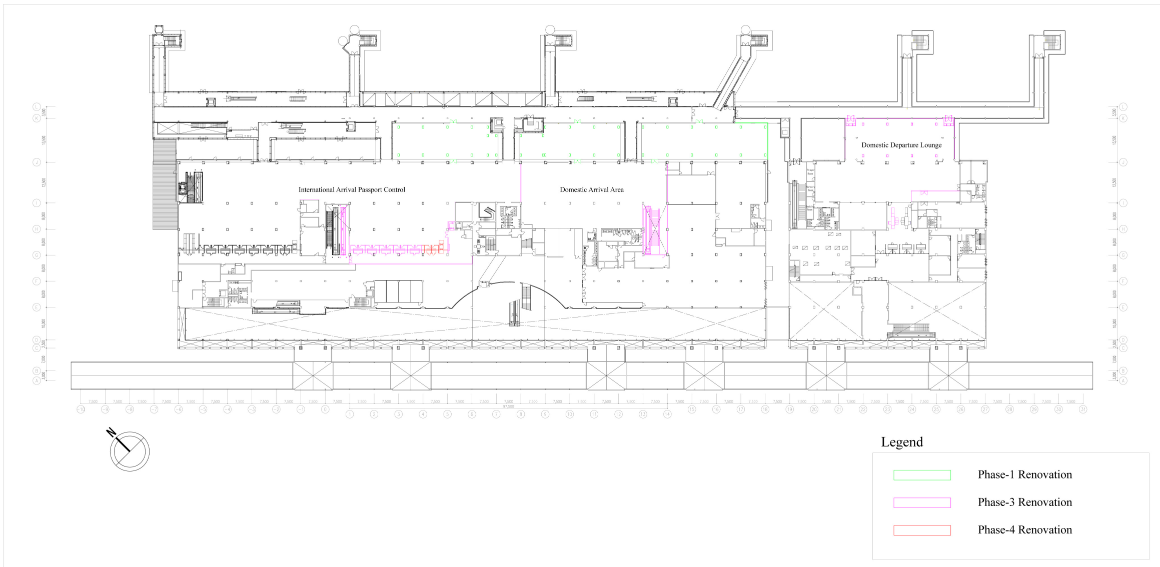


Figure 6.46 Phase-4 Renovation Plan of Passenger Terminal Building (2nd Floor)

6.4.4.4. Installation of New Air Field Lighting System

Because the apron is expanded and the parallel taxiway is extended, installation of new apron floodlights and taxiway edge lights are planned. The PAPI on both sides, threshold lights on both sides, are approach lights for 13 approaches, will be replaced. Stop bars will be installed in all six taxiways. The layout plan of the airfield lighting system rehabilitation is shown in Figure 6.47.

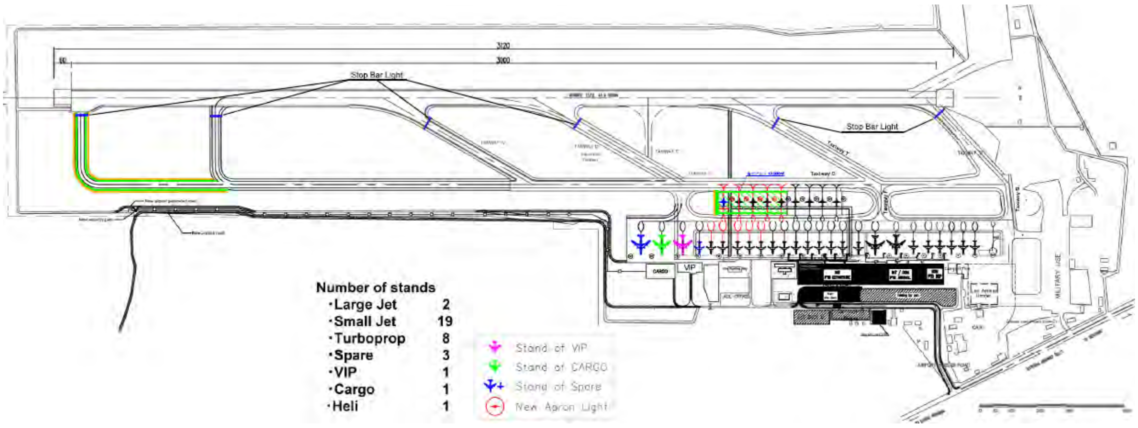


Figure 6.47 Air Field Lighting System in Phase 4

6.4.4.5. Cost Estimate

Table 6.20 Cost Estimate of Phase 4 Development Plan

Items	Cost (Million Kip)	Cost (Million Yen)
Expansion of Aprons	19,650	202
Extension of Parallel Taxiway	31,170	320
Renovation of Int'l DPTB	2,240	23
Renovation of Passenger Arrival Buildings	6,630	68
Special Equipment	73,950	759
Air Field Lighting System	33,800	347
Overhead and indirect cost	40,480	416
Total construction cost	207,920	2,134
Contingency	21,830	224
Consultant fee	20,790	213
Total Project Cost	250,550	2,572

6.5. *Summary*

Figure 6.48 shows the airport layout after completing all phases development plan. After extending the parallel taxiway to the runway 13 threshold side, the runway capacity will be 30 movements per hour. The ability to handle international passengers will be 5.9 million passengers per annum, and that for the domestic passenger will be 1.9 million. Thus, the total handling capacity will be 7.8 million passengers per annum.

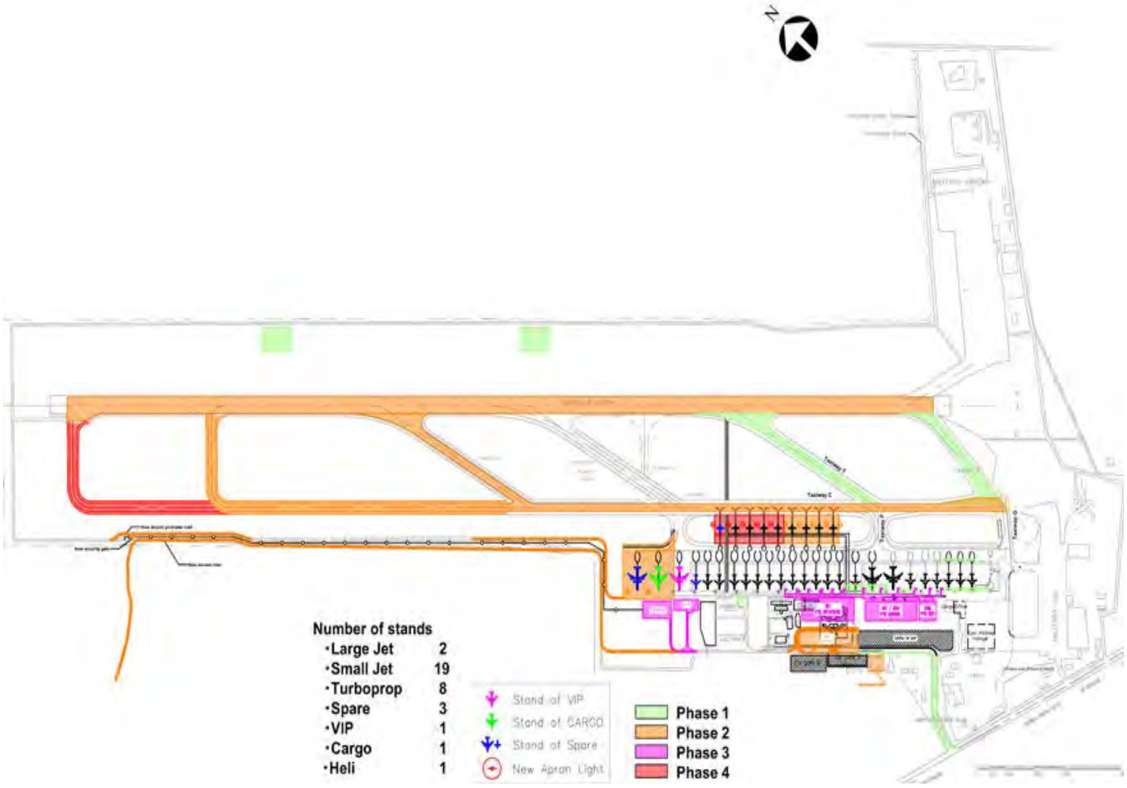


Figure 6.48 Final Airport Layout Plan

To maintain Vientiane International Airport to the capacity of the year 2045, the total investment will be approximately LAK 2,885,130 million (JPY 29,308 million).

Table 6.21 Total Project Cost

Items	Cost (Million Kip)	Cost (Million Yen)
Phase 1	229,240	2,353
Phase 2	399,930	4,105
Phase 3	1,975,410	20,278
Phase 4	250,550	2,572
Total	2,855,130	29,308

6.6. ***Airspace***

6.6.1. *Basic Directions for Airspace Utilization*

The introduction of IFPs for departure from RWY 13 was selected as the prioritized procedures for the improvement of an airspace development plan to accommodate the runway capacity improvement strategy. The introduction of IFPs for approach to RWY31 would require more time from an airspace development point of view due to the following reasons:

1. The obstacle environment to which a management scheme would be implemented will take more time,
2. Limited airspace, in particular within the Thai border, that requires more discussions and coordination with the Thai side, and
3. The nature of aircraft operation that requires longer, straight airspace around the final part of the approach and the lower altitude to stabilize aircraft.

The following directions are applied as the basic development policy of the new departure IFPs from Runway 13 in the airspace southeast of VTE:

1. To avoid Thai airspace as much as possible (both nominal track and protection area),
2. To avoid the city center of Vientiane as much as possible, in particular major important facilities such as the President's Office and the Ministry of Defense,
3. To clear the obstacles concerned,
4. To simplify the route structure,
5. To accommodate future route plans, and
6. To assess the Thai airspace usage in particular that of Udon-Thani TMA, namely SID and STAR.

6.6.2. *Departure from Runway 13*

Taking into account the directions mentioned in Section 6.2.1, the preliminary design of departure IFP (SID) from RWY13 was developed. As the first step of SID development , the initial segment right after takeoff is considered. There are two types of possible path-terminator combinations as follows:

1) CF-TF Combination, and VA-DF-TF Combination

Note: The path terminator is defined as a two-letter code, which defines a specific type of flight path along a segment of a procedure and a specific type of termination of that flight path.

The following figures 6.49and 6.50 show the nominal tracks and the protection area of those two combinations toward the northeast of VTE/within Lao airspace. As for the note of those drawings, solid lines in red, purple, and black are nominal tracks (the most expected centerline of departure track), the outer edge of the primary protection area, and the outer edge of the secondary protection area, respectively.

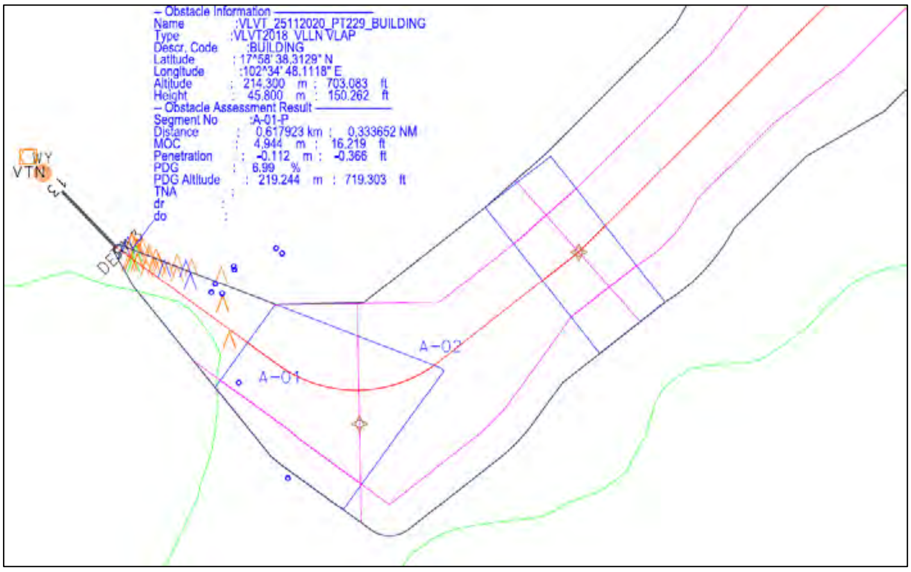


Figure 6.49 SID from Runway 31 with CF-TF Combination

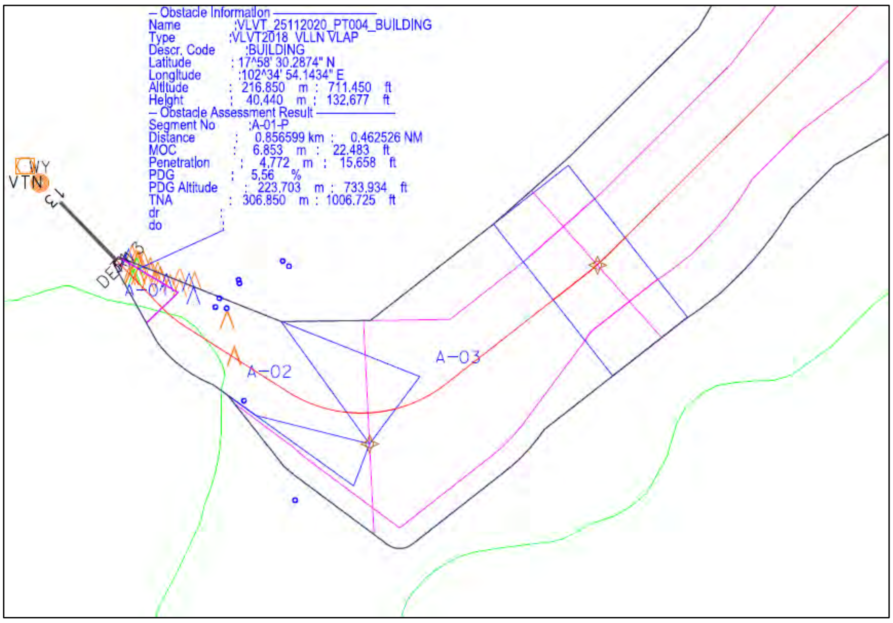


Figure 6.50 SID from Runway 31 with VA-DF-TF Combination

In both cases, the first section is set going out almost straight for approximately 5 NM in order to avoid flying over the city center of Vientiane. At the same time, the appropriate offset is considered to avoid going into Thai airspace as much as possible. In these cases, the expected nominal track is mostly on the Mekong River or around the river shore area in Lao side so that the environmental influence can also be minimized.

The primary difference between the two combinations of "path-terminators," which are used to code the way aircraft flies, in the navigation database, is that CF takes a specified course while VA flies with a heading rather than a specific course. The size of the protection area is almost the same in either case, while there are some noticeable differences between the two SIDs as follows:

CF-TF:	(Advantage)	The flying course is more stable.
		Its nominal track would stay within Lao airspace.
	(Disadvantage)	Required PDG would increase up to 7.0%.
VA-DF-TF:	(Advantage)	Required PDG can be reduced to 5.6%.
		The size of expected protection area is somewhat smaller.
	(Disadvantage)	Its nominal track would go into Thai airspace.

It is difficult to choose one of the two path-terminator combinations for the application to VTE at this design stage. More discussions are required with the concerned parties because it will affect negotiations with Thai CAA.

It should be noted that there is a small private airfield called Khoksa at the east side of Vientiane City with the highest vertical limit of 3,000′ mean sea level as shown in the Figure 6.51 While the draft SIDs can be modified, however, it was also confirmed in the interview with CP from DCA/LANS that the size of the airfield can be modified as appropriate in order to accommodate the expected IFPs within the limited airspace.

Source: AIP Lao PDR

Figure 6.51 Ban Khoksa Airfield at the East Side of Vientiane

6.6.3. *Route Structure with Departure from Runway 13+*

Figure 6.52 shows the current route structure for VTE with PRS operations.

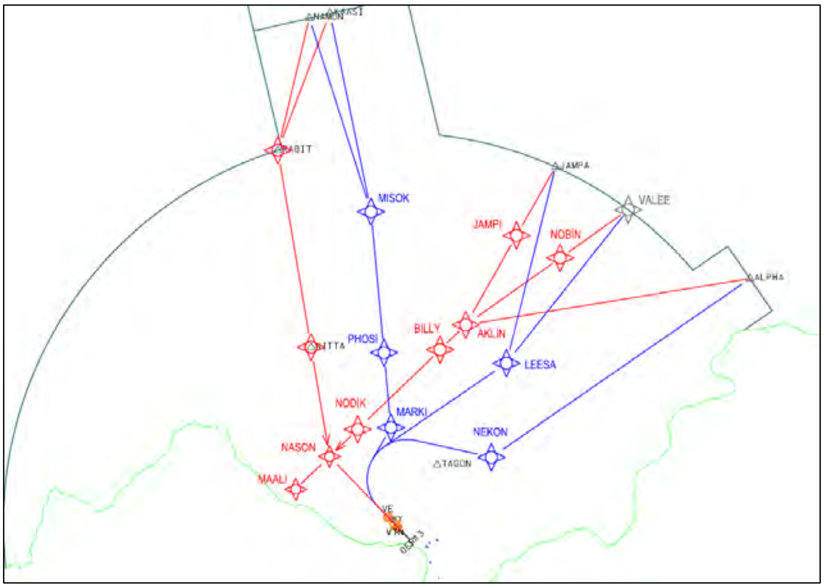


Figure 6.52 Current Route Structure with PRS Operations (North Side Only)

Figure 6.53 shows the modified route structure with SID from Runway 13, considering the necessity of basic directions.

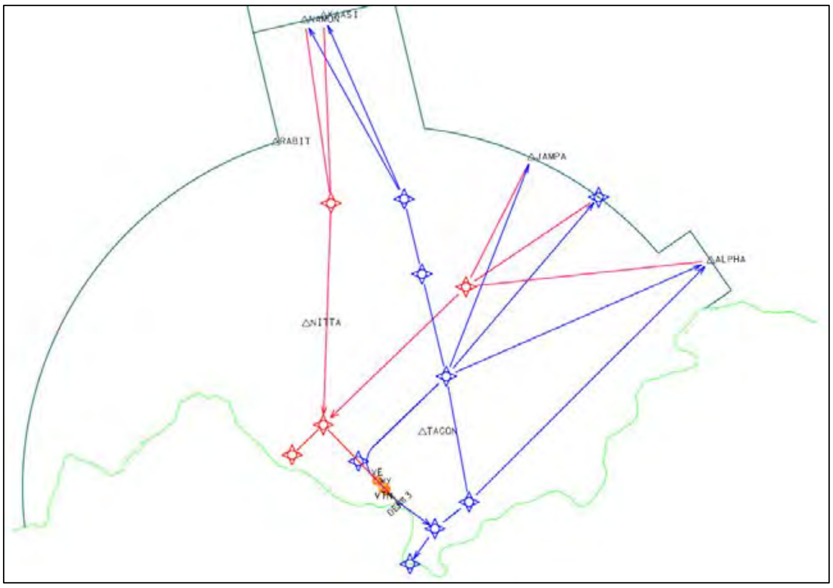


Figure 6.53 Expected Route Structure with SID from Runway 13

The following points were accounted for in the modification of the route structure:

- The expected modifications of TMA along with the enroute structure, in particular the routes between Vientiane and Luang Prabang are considered.

- The route crossings among SIDs and STARs are minimized.
- The connection with the Thai side is set to be from/to the most likely position of WPTs near the border.
- The routes with a fairly small proportion of traffic, namely R207 and B218 to Thailand, both with less than 2.0%, are excluded for the route structure development.

Figure 6.54 provides an additional chart of the (1) expected route structure with SID with Primary Enroute (left) and (2) IFP structure charts with only SIDs from both runway ends (right).

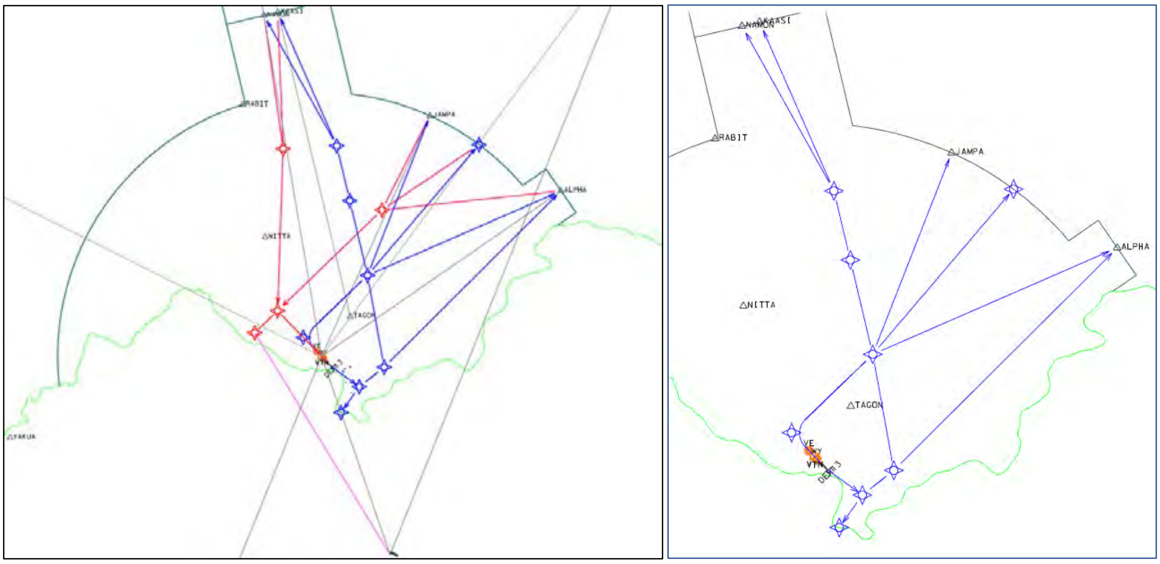


Figure 6.54 Route Structure with Enroute (Left) and Charts with only SID (Right)

The primary design of SID shown in Figure 6.16 and the route structure can be reviewed and revised as necessary. The needs of instrumental flight procedures (IFPs) vary depending on factors such as expected traffic demands, ATC capability, available CNS facilities, applied navigation specifications, and the PBN implementation scheme of the region. It is expected that CP of DCA/LANS can deal with those issues as they are accumulating their experiences through their regular works and this Project.

6.6.4. *ATC Training*

Appropriate ATC training should be provided in accordance with facility development as well as an increase in demand. A special type of training would be necessary to achieve shorter separation between aircraft and to handle a new type of operations with both runway operations with IFPs (PRS cancelled). Appropriate equipment such as tower/approach simulator should be provided with sufficient funding.

7. Financial and Economic Analyses

7.1. *Allocation of Revenues and Costs of Vientiane International Airport*

Four organizations (AOL, LANS, ATS and L-JATS) share costs and revenues of Vientiane International Airport operation as summarized in Table 7.1 and Table 7.2. The present study analyses consolidated accounts of these four organizations.

Table 7.1 Allocation of VTE Costs

	Investment (owned assets)		O&M
	Civil & Architecture	Special Equipment	
AOL	Terminal buildings, runway, taxiway, apron, air field lighting system, powerhouse, firefighting station, fence, airside & landside security office	Most of special equipment installed at international PTB; All special equipment installed at domestic PTB	100% of costs related to aircraft landing/parking
LANS	Control tower	All special equipment including radar and instrument landing system	100% of costs related to air navigation services
ATS	No investment	No investment	100% of costs incurred at domestic PTB
L-JATS	No investment	Some special equipment (x-rays, metal detectors and flight information system) installed at international PTB	100% of costs incurred at international PTB

Note: The Lao Government owns the airport land.
Source: AOL, LANS, ATS and L-JATS

Table 7.2 Allocation of VTE Revenues

	Aeronautical	Non-aeronautical
AOL	8/15 of international PSF; 100% of landing/parking charges	SITA Cute system service; advertisement outside the terminal buildings
LANS	100% of air navigation charges	None
ATS	100% of domestic PSF	100% of non-aeronautical revenues related to domestic flight operation (ground handling, rental space, car parking and advertisement)
L-JATS	7/15 of international PSF	100% of non-aeronautical revenues related to international flight operation (ground handling, rental space, car parking and advertisement)

Source: AOL, LANS, ATS and L-JATS

7.2. ***Financial analysis***

Financial analysis of the proposed development project of Vientiane International Airport is carried out in this section. Based on the assumptions below, cashflow of Incremental Case (difference between With the Project (WP) Case and Without the Project (WOP) Case) is prepared and Financial Internal Rate of Return (FIRR) is calculated to evaluate the financial feasibility of the project.

7.2.1. *Basic Assumptions*

The following are basic assumptions applied to both With the Project (WP) Case and Without the Project (WOP) Case, unless otherwise mentioned.

7.2.1.1. Definition of WP Case and WOP Case

The WP Case and WOP Case are defined as follows.

- WP Case:

The development project proposed by the JICA study will be implemented in order to accommodate both international and domestic traffic demand up to 2045. The traffic handled by the project will remain constant after 2045.

- WOP Case:

The JICA proposed project will NOT be implemented. The airport will meet international and domestic traffic demand up to 2030. The traffic handled by the project will remain constant after 2030.

7.2.1.2. Project Period

The project period is 48 years from 2023 to 2070, including the initial construction period of 2023-2025 and evaluation period of 2026-2070.

7.2.1.3. Reference Year

Since 2019 is the most recent year unaffected by COVID 19, 2019 will be used as the reference year. The data of 2019 will be used as the basis of forecasting.

7.2.1.4. Price Base and Exchange Rates

Prices are shown in Kip. Prices are expressed net of price escalation at the constant price level of December 31 2021.

The real exchange rate, net of price escalation in Laos and the US, is estimated to remain at US$1=LAK 11,205 (TTM rate on December 31, 2021) during the project period.

7.2.1.5. Contingencies

Physical contingency of 10% for investment costs and 5% for consulting fees is included in the total investment costs. Price contingency is not considered.

7.2.1.6. Taxes

Taxes (value added tax (10%), income tax and import duties) are excluded for FIRR calculation.

7.2.2. *Costs*

Project costs are comprised of investment costs and operation and maintenance (O&M) costs.

7.2.2.1. Investment Costs (Initial and Replacement)

Investment costs, including initial and replacement investment, are summarized in Table 7.3. Investments under WOP case includes renovation of runway, taxiway B&T and apron (repairing cracks); replacement of the runway light, taxiway edge light and turn pad light. They are the minimum investment required to maintain the airport operation up to 2070. Such investment costs 129,449 million LAK, or 3.4% of WP Case Investment and will be made in 2028-2030.

Table 7.3 Investment Costs (MN LAK)

	WP Case			WOP Case		
	Initial (Phase I to IV)	Replacement	Total	Initial (2028-2030)	Replacement	Total
Civil Works	550,070	171,092	721,162	77,972	29,455	107,427
Architectural Works	1,931,385	506,993	2,438,378	0	0	0
Consulting Service Fee	251,849	48,030	299,879	7,797	2,946	10,743
Physical Contingency	260,738	50,432	311,170	8,187	3,093	11,280
Total Investment Costs	2,994,043	776,546	3,770,589	93,956	35,493	129,449

Source: JICA TC Team

Replacement investment are estimated to be made based on respective lifetime of assets as shown in Table 7.4. The salvage value of net assets at the completion year (2070) is ignored.

Table 7.4 Expected Durable Life of Invested Assets

Invested Assets	Durable Life
Building works	50 years
Civil works	50 years
Special equipment	15 to 30 years, depending on equipment

Source: JICA TC Team

7.2.2.2. Operation and Maintenance Costs

Operation and maintenance costs are the costs related to personnel, utilities, operation, administration, etc. They are estimated to increase at the rates shown in Table 7.5.

Table 7.5 Estimated Growth Rate of O&M Costs

O&M Costs	Annual Growth Rate
Personnel, Utilities, Administration	1/3 of the relevant air traffic growth rate
Operation	2/3 of the relevant air traffic growth rate

Source: JICA TC Team

Annual O&M costs of 2045-2070 and total O&M costs during the project life are summarized in Table 7.6.

Table 7.6 O&M Costs (MN LAK)

WP Case		WOP Case	
Annual Costs (2045-2070)	Total Costs 2026-2070	Annual Costs (2045-2070)	Total Costs 2026-2070
369,994	15,036,735	243,502	10,871,158

Source: JICA TC Team

7.2.3. *Revenues*

Revenues consist of aeronautical and non-aeronautical revenues. They are estimated to increase in line with the traffic movement as explained below.

7.2.3.1. Passenger Traffic Movement

Annual passenger traffic movement of WP Case and WOP Case are summarized in Table 7.7.

Table 7.7 Forecast of Passenger Traffic Movement

	WP		WOP	
	Intl.	Dom.	Intl.	Dom.
2026	2,086,076	683,835	2,086,076	683,835
2027	2,248,507	736,403	2,248,507	736,403
2028	2,419,871	791,863	2,419,871	791,863
2029	2,600,660	850,372	2,600,660	850,372
2030	2,791,392	912,100	2,791,392	912,100
2031	2,956,029	965,383	2,791,392	912,100
2032	3,128,074	1,021,063	2,791,392	912,100
2033	3,307,861	1,079,248	2,791,392	912,100
2034	3,495,739	1,140,052	2,791,392	912,100
2035	3,692,072	1,203,593	2,791,392	912,100
2036	3,897,239	1,269,992	2,791,392	912,100
2037	4,111,639	1,339,380	2,791,392	912,100
2038	4,335,686	1,411,890	2,791,392	912,100
2039	4,569,816	1,487,662	2,791,392	912,100
2040	4,814,482	1,566,845	2,791,392	912,100
2041	5,013,341	1,631,203	2,791,392	912,100
2042	5,219,160	1,697,813	2,791,392	912,100
2043	5,432,183	1,766,755	2,791,392	912,100
2044	5,652,661	1,838,110	2,791,392	912,100
2045-2070	5,880,856	1,911,962	2,791,392	912,100

Source: JICA TC Team

7.2.3.2. Aeronautical Revenues

Aeronautical revenues such as passenger service fees (PSF), aircraft landing charges and air navigation charges are forecast.

(1) Passenger Service Fees (PSF)

Domestic PSF tariff is LAK 20,000 (since 2013) and international PSF tariff is US$15 (since 2015) at VTE.

PSE revenues are forecast based on the tariff and estimated number of departing passengers.

(2) Landing Charges

Table 7.8 outlines the tariff structure of landing charges at VTE.

Table 7.8 Landing Charges at VTE

Maximum Take-off Weight of Aircraft (Metric Ton)	International Flights (US$)	Domestic Flights (LAK)

Less than 7	28	80,000
7.1 to 20	80	340,000
20.1 to 50	200	840,000
50.1 to 100	400	1,840,000
100.1 to 200	800	3,840,000
200.1 to 300	1,200	5,840,000
Above 300	1,800	7,840,000

Source: DCA

In the analysis, landing charges are estimated annually based on the tariff and estimated number of arriving aircraft by Maximum Take-off Weight of Aircraft (MTOW).

(3) Air Navigation Charges

Present tariff structure of air navigation charges at VTE is summarized in Table 7.9.

Table 7.9 Air Navigation Charges at VTE

Maximum Take-off Weight of Aircraft (Metric Ton)	International Flights (US$)	Domestic Flights (LAK)
Less than 7	50	200,000
7.1 to 20	100	400,000
20.1 to 50	250	1,000,000
50.1 to 100	300	1,500,000
100.1 to 150	400	2,000,000
150.1 to 200	500	2,500,000
200.1 to 250	600	3,000,000
250.1 to 300	700	3,500,000
Above 300	800	4,00,000

Source: DCA

Air navigation charges are forecast based on the tariff and estimated number of landing aircraft by MTOW.

7.2.3.3 Non-aeronautical Revenues

Non-aeronautical revenues include ground handling, concession (rental space), car parking, advertising and utilities.

Non-aeronautical revenues from both international and domestic PTB are estimated to increase at rates shown in Table 7.10.

Table 7.10 Estimated Growth Rate of Non-aeronautical Revenue

Non-aeronautical Revenues	Annual Growth Rate
Ground handling, car parking, SITA Cute system service	1/3 of the respective passenger growth rate
Concession (rental space), advertising, utilities	1/3 of the growth in floor space of respective passenger terminal building

Source: JICA TC Team

7.2.3.4 Collection Rate

The collection rates of landing charges and air navigation charges are estimated at 80% for both domestic and international flights.

As for PSF and non-aeronautical revenues, the analysis applies the same collection rate of 2019 throughout the project life.

7.2.3.5 Results of Revenue Forecast

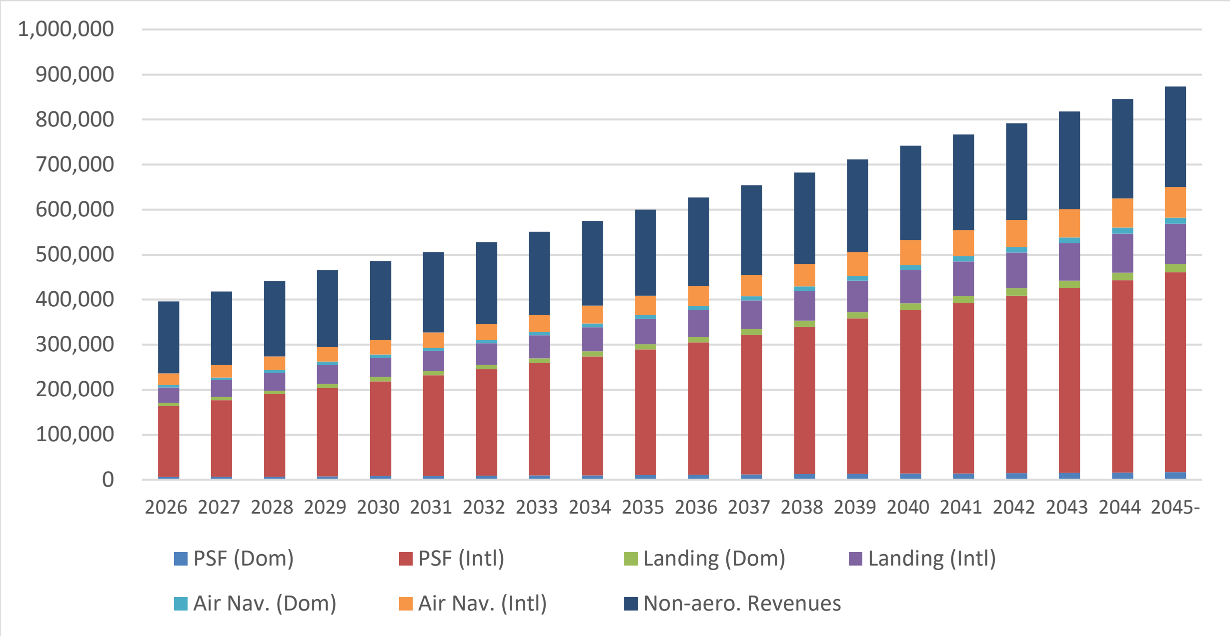
VTE revenues are forecast as summarized in Table 7.11. WP revenues are 80% larger than WOP revenues in 2045 while WP's total revenues are 58.8% larger than WOP's total revenues.

Table 7.11 Revenue Forecast (MN LAK)

	WP Case		WOP Case	
	Annual Revenues (2045-2070)	Total Revenues (2026-2070)	Annual Revenues (2045-2070)	Total Revenues (2026-2070)
I. Aeronautical Revenues				
1. PSF				
Domestic	16,402	627,128	7,824	347,074
International	444,205	16,970,598	210,845	9,351,283
2. Landing Charges				
Domestic	18,155	699,237	9,558	423,983
International	90,154	3,455,303	42,792	1,908,923
3. Air Navigation Charges				
Domestic	13,507	519,907	7,078	313,985
International	67,662	2,593,262	32,116	1,432,679
II. Non-aeronautical Revenues	223,234	9,443,486	174,937	7,833,950
Total Revenues	873,317	34,308,921	485,152	21,611,876

Source: JICA TC Team

Figure 7.1 depicts WP's revenue trend. International PSF is expected to increase most steadily (5.6% CAGR), increasing its share to total revenues from 39.8% in 2026 to 50.9% in 2070. International landing will also increase its share from 8.7% to 10.3% during the same period.



Source: JICA TC Team

Figure 7.1 VTE Revenues under WP Case (MN LAK)

7.2.4. *Financial Evaluation (Financial Internal Rate of Return (FIRR))*

Financial Cashflow of Incremental Case is prepared based on the above assumptions and is presented as Appendix- 8. The Project FIRR is calculated at 5.6%. It is concluded, therefore, that the project will be financially feasible if it is financed at lower cost than 5.6%.

7.3. ***Economic Analysis***

Economic analysis of the proposed development project of VTE is carried out in this section. Based on the assumptions below, economic cashflow of Incremental Case (difference between WP Case and WOP Case) is prepared and Economic Internal Rate of Return (EIRR) is calculated to evaluate net economic impact of implementing the project on the national economy.

7.3.1. *Basic Assumptions*

In addition to relevant assumptions used for the financial analysis, following assumptions are also applied in economic analysis.

7.3.1.1. Conservatism Principle

Economic analysis of costs and benefits is not an exact science. It is rather an approximate value analysis as it is based on the assumption of 'perfect competition.' The present analysis will apply conservative (and not optimistic) assumptions and data where appropriate.

7.3.1.2. Economic Prices

Financial prices are used as economic prices due to following reasons.

(1) Exclusion of Transfer Payment

In principle, economic prices are to exclude transfer payment such as taxes and subsidies. The project, however, does not enjoy any subsidies while prices used in financial analysis are expressed net of taxes (import duties, VAT and income tax).

(2) Opportunity Costs of Land and Unskilled Labors

Financial prices of non-tradable and non-competitive goods and services, if distorted, are to be converted to economic prices. For the present project, land and unskilled labor costs are considered as the only non-tradable and non-competitive goods and services.

The analysis assumes that the land used for the new terminal has no commercial value given its location. As for unskilled labor cost, there is no basic data to estimate the shadow wage rate factor (SWRF) in Laos.

Given above, it is assumed that economic prices are equal to financial prices.

7.3.1.3. Target Economic Internal Rate of Return (EIRR)

EIRR is an efficiency index for the use of scarce capital, indicating the average percentage of returns that can be expected every year to the national economy through the planned investment. Leading development banks, such as the World Bank and the Asian Development Bank, typically apply a real social discount rate in the range of 10 percent to 12 percent when evaluating projects in developing countries.[7]

[7] Zhuang et al., 2007, and Harrison, 2010

The project sets the target EIRR at 12%. That is to say, if the project's EIRR is greater than 12%, the project is considered to bring net benefits to the national economy, or to be economically feasible.

7.3.2. *Economic Costs*

Financial project costs (both investment costs and O&M costs) are used as economic project costs as explained in 7.3.1.2 Economic Prices.

7.3.3. *Economic Benefits*

7.3.3.1. Economic Benefit Items

(1) Quantitative Economic Benefit

Table 7.12 lists the quantitative economic benefit items expected to be generated for the country by implementing the project.

Table 7.12 Quantitative Economic Benefit Items

	Benefits Generated for Incremental Lao Passengers	Benefits Generated by Incremental Foreign Passengers to Laos
Domestic flights	Consumer surplus	(Not relevant)
International flights	Consumer surplus	Spending in Laos (added value)

Source: JICA TC Team

(2) Share of Lao and Foreign Passengers

The share of Lao and foreign national passengers is calculated based on 2019 traffic data of Lao Airlines and is presented in Table 7.13. The same share will be applied throughout the project period.

Table 7.13 Share of Lao and Foreign Passengers at VTE in 2019

	Lao Passengers	Foreign Passengers
Domestic Flights	52.2%	47.8%
International Flights	15.4%	84.6%

Source: Lao Airlines

7.3.3.2. Consumer Surplus

(1) Benefits for Incremental Lao Passengers on Domestic Flights

Passengers are willing to pay for the air fare as they benefit from it one way or another. Net economic benefits (difference between gross benefits and costs) of a passenger are called

'Consumer Surplus'. Consumer Surplus of a passenger is defined by the following formula and assumptions.

Consumer Surplus (Net Economic Benefit) of a Passenger
= (Gross Economic Benefit (Willingness to Pay)) – (Economic Cost)

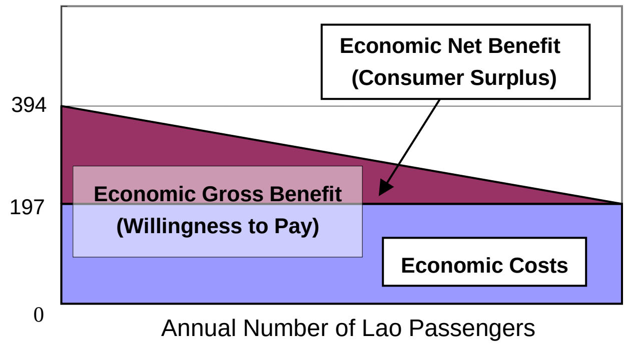
- Gross Economic Benefit, or Willingness to Pay, is defined by the ticket price（inclusive of PSF and insurance costs). It is assumed that the maximum gross benefit of passengers is equal to double the ticket price while the minimum gross benefit is equal to the air ticket price. That is to say, willingness to pay of a passenger is somewhere between the actual ticket price and its double amount. There will be no passengers if the ticket is priced higher than the double amount.
- Gross Economic Benefits are distributed evenly among all passengers.
- Economic Costs are equal to the ticket prices paid by passengers.

Total consumer surplus of Lao passengers on domestic routes in certain year is exemplified by the internal area of the right-angled triangle in Figure 7.2. The average round-trip ticket price is assumed to be US$197 for domestic flights, which is the weighted average round-trip ticket price of typical domestic routes[8]. The ticket price of US$197 on the axis *y* indicates Economic Costs and minimum Gross Economic Benefit while US$394, or the double the ticket price, is the maximum Gross Economic Benefit of passengers. The axis *x* shows the number of Lao passengers on domestic routes in the year.

From above, annual net economic benefits, i.e., consumer surplus, of incremental Lao passengers on domestic flights, is calculated by the following equation.

Annula Net Economic Benfits (Consumer Surplus) of Total Lao Passengers on Domestic Flights) = (US$394-US$197) × (Annual Number of Lao Passengers) × 1/2

[8] Weighted average return ticket of domestic flights (between Vientiane and Luang Prabang (39% of the total), Pakse (16%), Luang Namtha (13%) and Xeing Khouang (10%)) is respectively priced at US$197 (inclusive of taxes and insurance) based on Lao Airlines.



Source: JICA TC Team

Figure 7.2 Consumer Surplus of Lao Passengers on Domestic Flights (US$)

(2) Benefits for Incremental Lao Passengers on International Flights

Consumer surplus, or net economic benefits, of incremental Lao passengers on international flights are calculated by the same way. Economic costs are expressed by round-trip ticket prices, which are assumed to be US$199 for international flights, expressed by the weighted average round-trip ticket price of typical routes[9]. The minimum gross benefit of passengers is equal to the air ticket price (US$199) and the maximum gross benefit is equal to the double amount of the ticket price (US$398).

7.3.3.3. Spending by Incremental Foreign-national Passengers

According to the “Statistical Report on Tourism in Laos 2019” by the Ministry of Information, Culture and Tourism in Laos, foreign travelers spend on average USD244.5 per person per stay (Table 7.14). Assuming a conservative added value rate of 10%[10], a foreign-national arriving passenger per stay would contribute LAK 274,000 to the national economy of Laos.

[9] Weighted average return ticket of international flights (between Vientiane and Bangkok (30.9% of total), Kunming (21.1%), Seoul (18.8%), Hanoi (12.2%) and Phnom Penh (7.1%)) is respectively priced at US$199, inclusive of taxes and insurance, based on Lao Airlines.

[10] Data on value added rate of the industry in Laos is not available. The value-added rate of the food and beverage service/accommodation business sector in Japan is reported to be 34.5% in 2019. (Source: METI, https://www.stat.go.jp/data/kkj/kekka/pdf/2020youyaku2.pdf)

Table 7.14 Foreign Tourists' Spending per Stay in Lao PDR

Nationality	Tourist Arrivals	Spending (USD)
Thailand	1,330,180	207,508,080
Vietnam	894,665	80,519,850
China	852,844	204,682,560
Cambodia	24,254	2,182,860
Myanmar	7,743	696,870
Other Countries	632,297	419,380,596
Total	3,741,983	914,970,816
Average Spending per Tourist per Stay		244.5

Source: Statistical Report on Tourism in Laos 2019 by Ministry of Information, Culture and Tourism in Laos

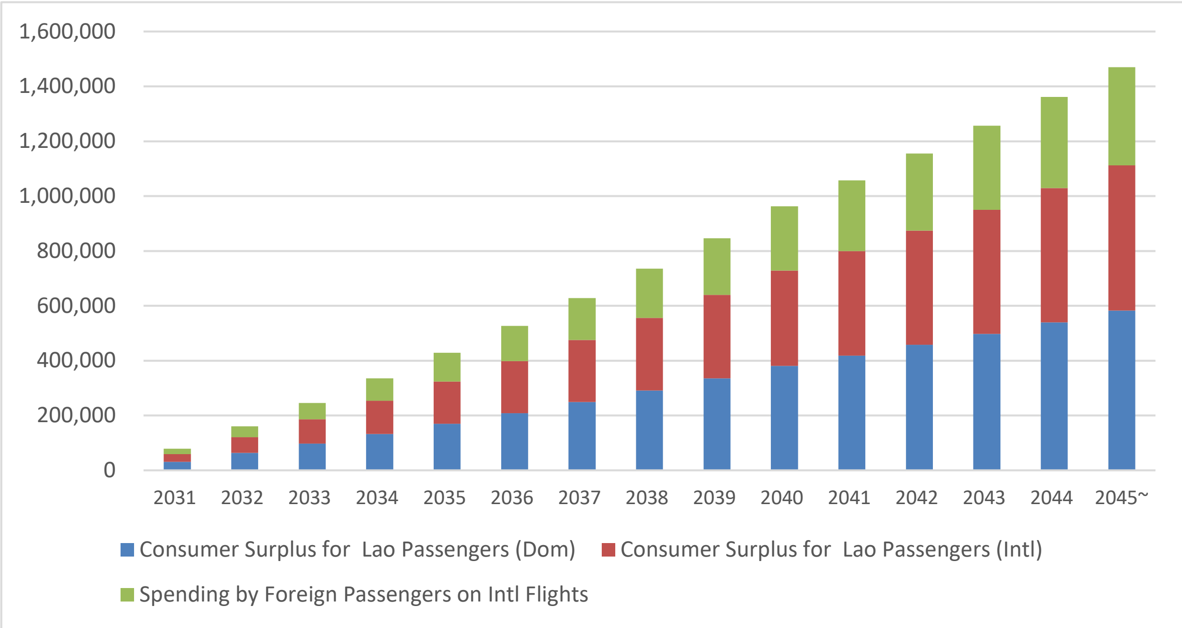
7.3.3.4. Summary of Economic Benefit Amount

Table 7.15 and Figure 7.3 show the project's economic benefits during the project period. The largest item is consumer surplus of incremental Lao passengers on domestic flights, followed by that of incremental Lao passengers on international flights.

Table 7.15 Economic Benefits (MN LAK)

	Annual Amount (2045-2070)	Total Amount (2026-2070)
1. Consumer Surplus for Incremental Lao Passengers		
Domestic Flights	582,248	19,010,684
International Flights	529,682	17,294,382
2. Spending by Incremental Foreign Passengers on International Flights (added value)	358,195	11,695,239
Total	1,470,124	48,000,304

Source: JICA TC Team



Source: JICA TC Team

Figure 7.3 Economic Benefits (MN LAK)

7.3.4. *Economic Evaluation (Economic Internal Rate of Return (EIRR))*

Incremental economic cash flow is prepared on the basis of above assumptions and is presented as Appendix- 9. EIRR is 21.1%, above the target of 12%. Economic net present value (ENPV) of the project is calculated LAK 1,222,895MN LAK at 12% discount rate. It could be concluded that the present project is economically feasible and should be implemented as it is expected to generate sufficient economic benefits to the country.

Appendix- 1 Runway Length Charts

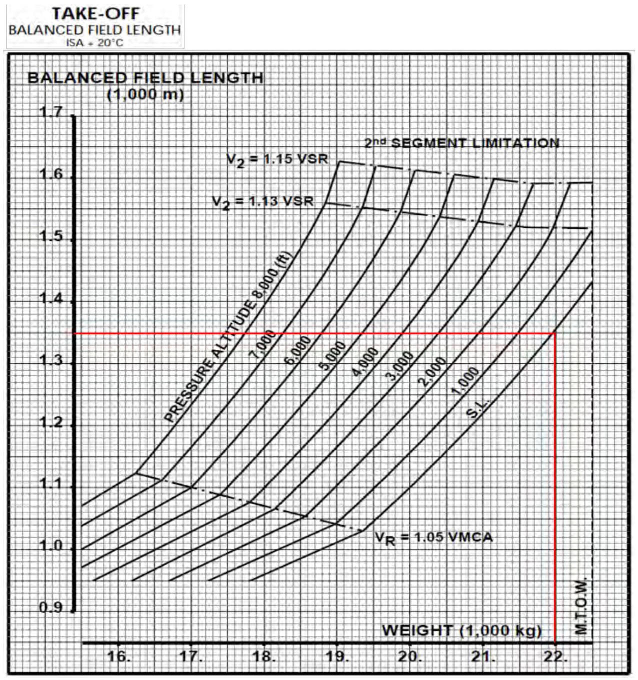


Figure A- 1 Takeoff Runway Length vs. Weight Chart ATR72-500

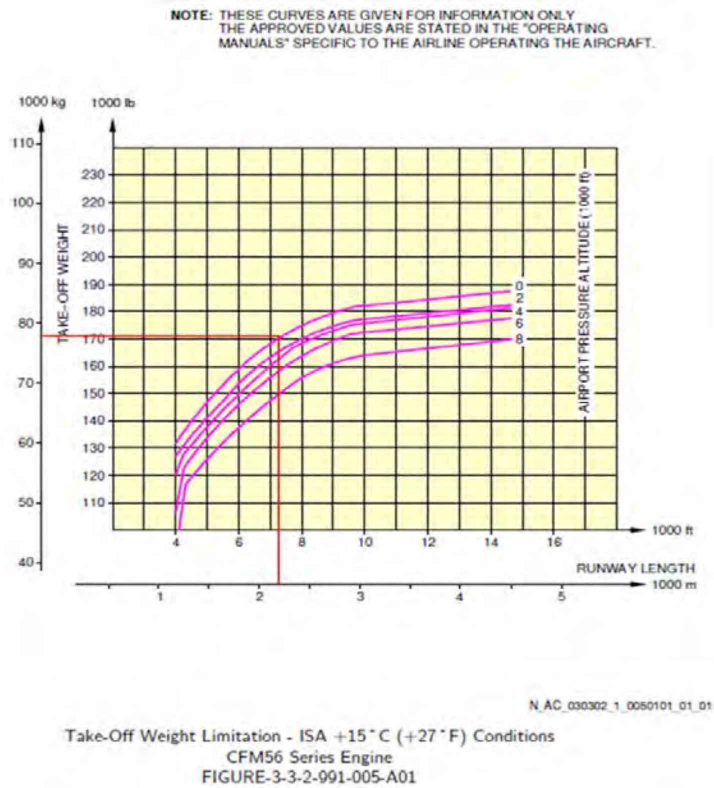


Figure A- 2 Takeoff Runway Length vs. Weight Chart A320-200

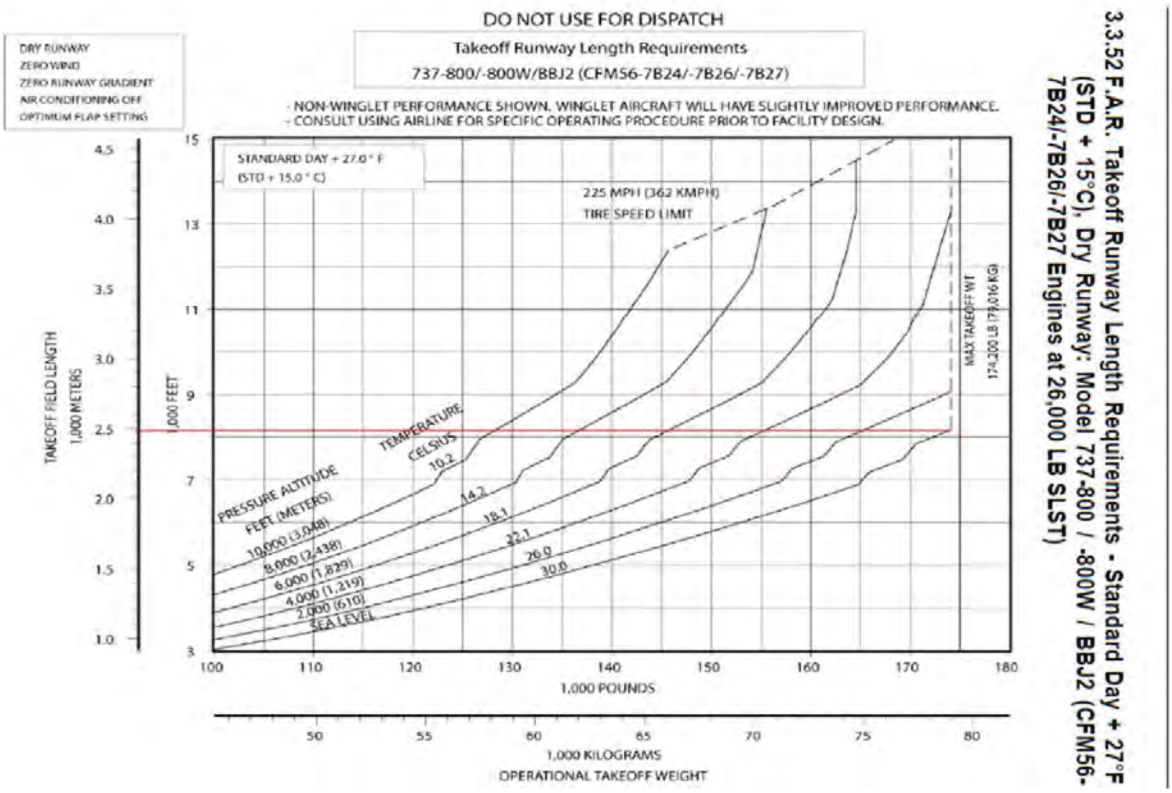


Figure A- 3 Takeoff Runway Length vs. Weight Chart B737

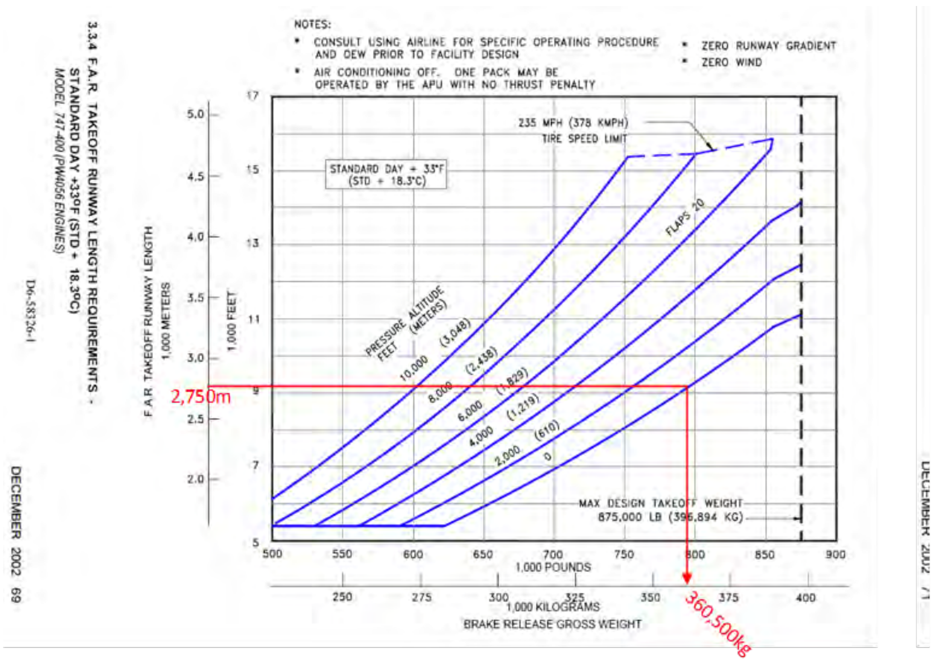


Figure A- 4 Takeoff Runway Length vs. Weight Chart B747-400

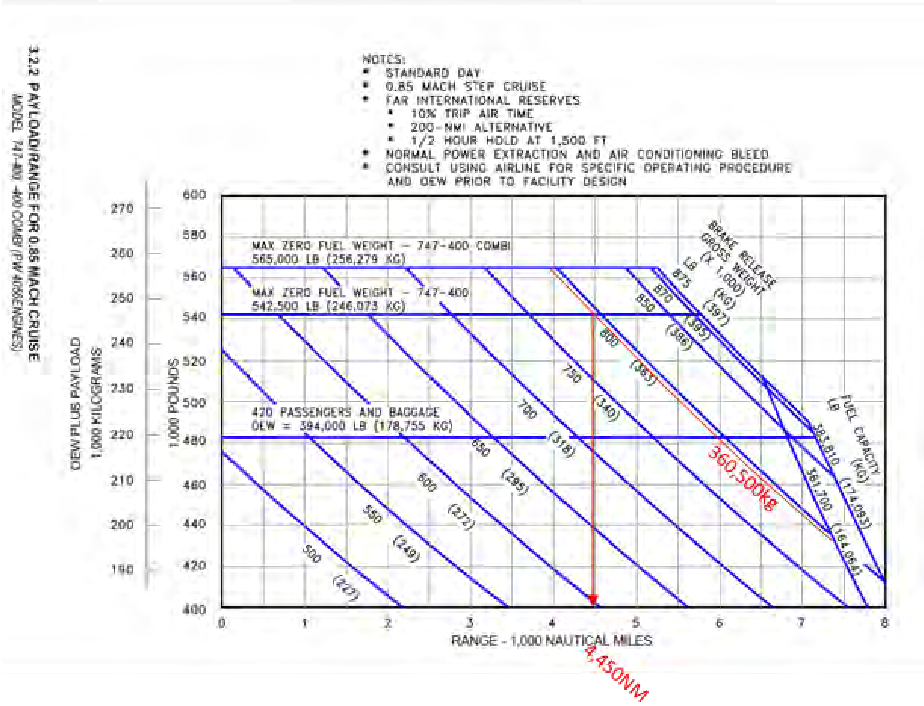


Figure A- 5 Takeoff Weight vs. Range Chart B747-400

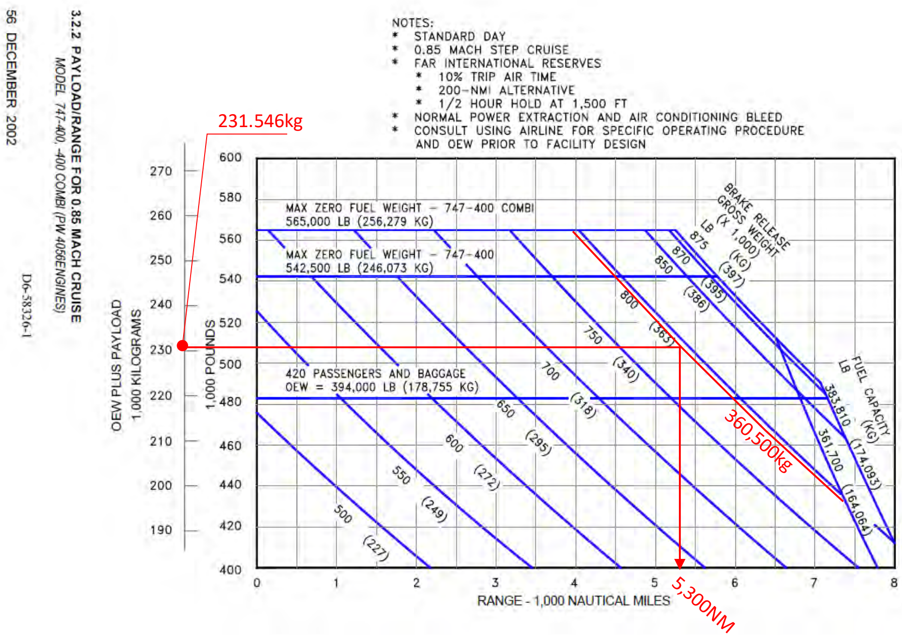


Figure A- 6 Takeoff Weight vs. Range Chart B747-400

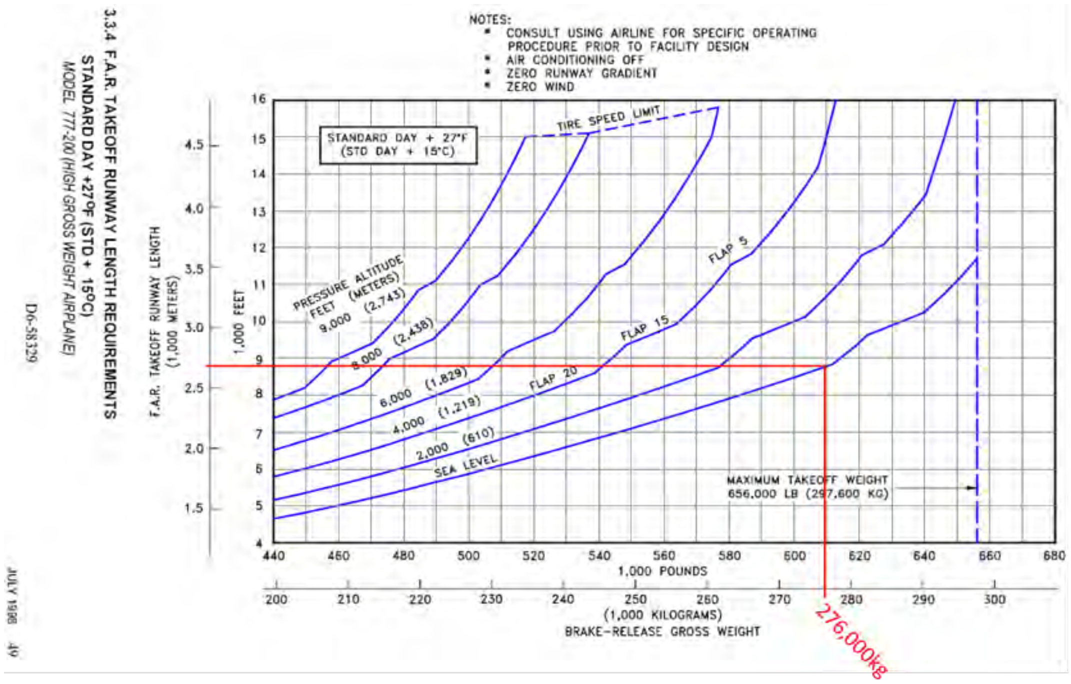


Figure A- 7 Takeoff Runway Length vs. Weight Chart B777-200

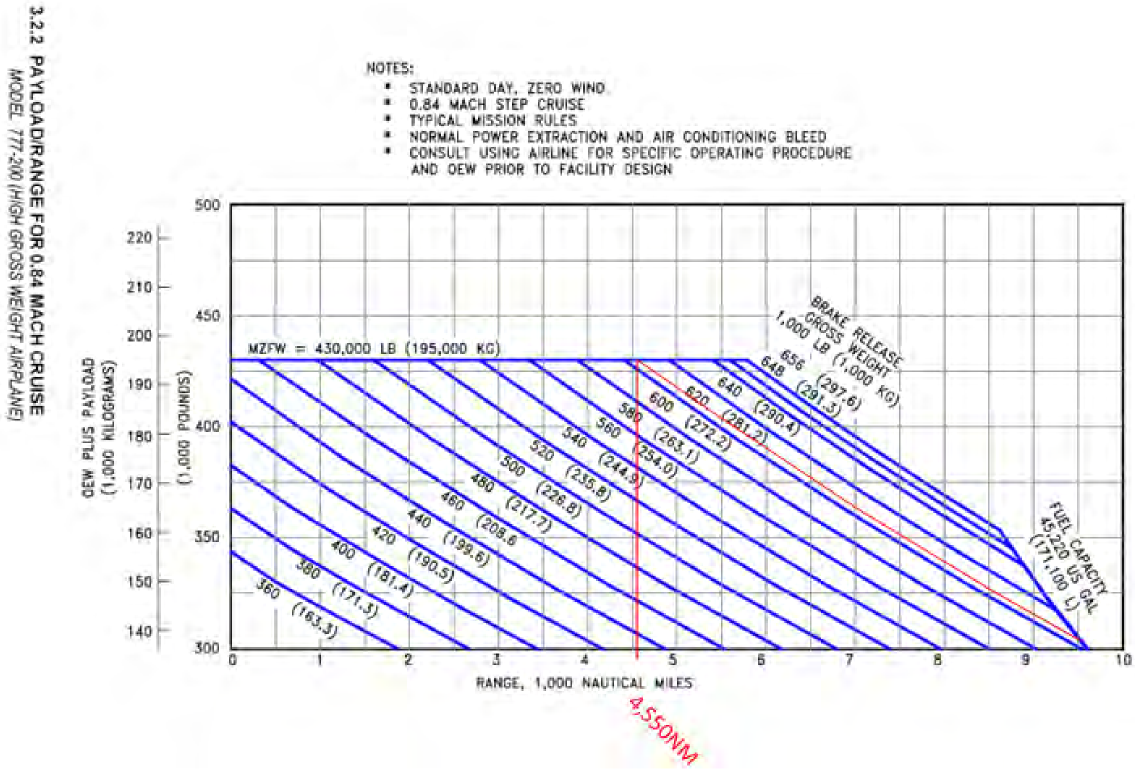


Figure A- 8 Takeoff Weight vs. Range Chart B777-200

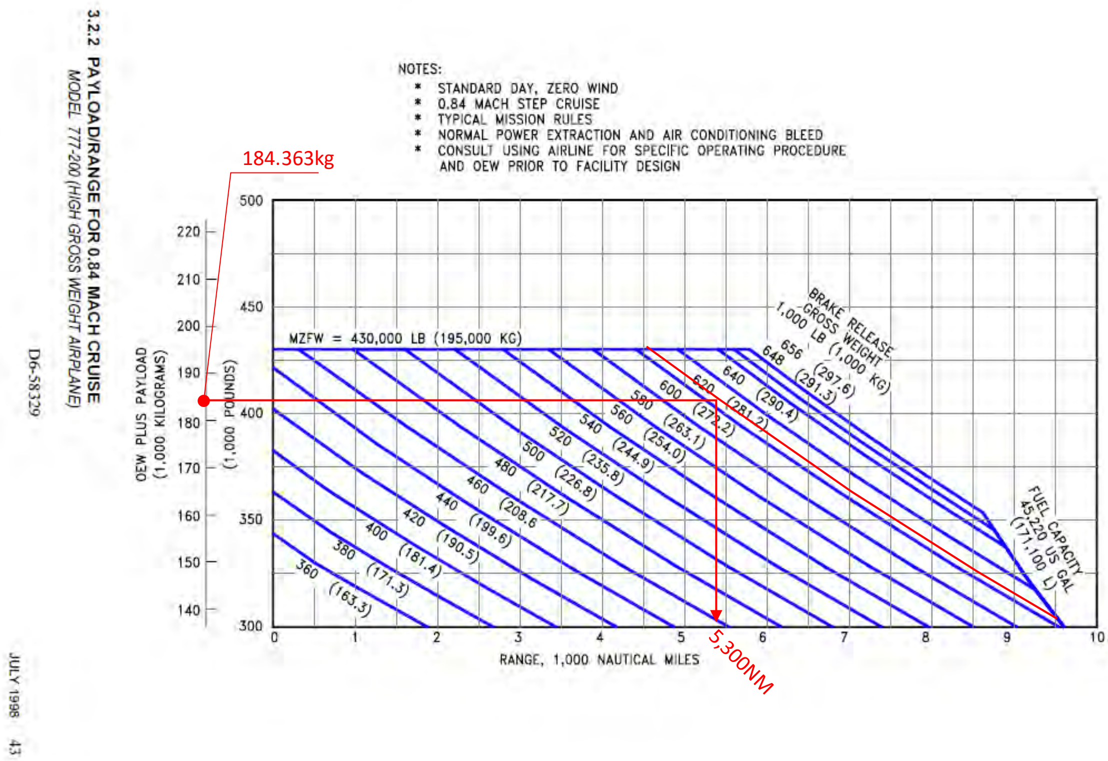


Figure A- 9 Takeoff Weight vs. Range Chart B777-200

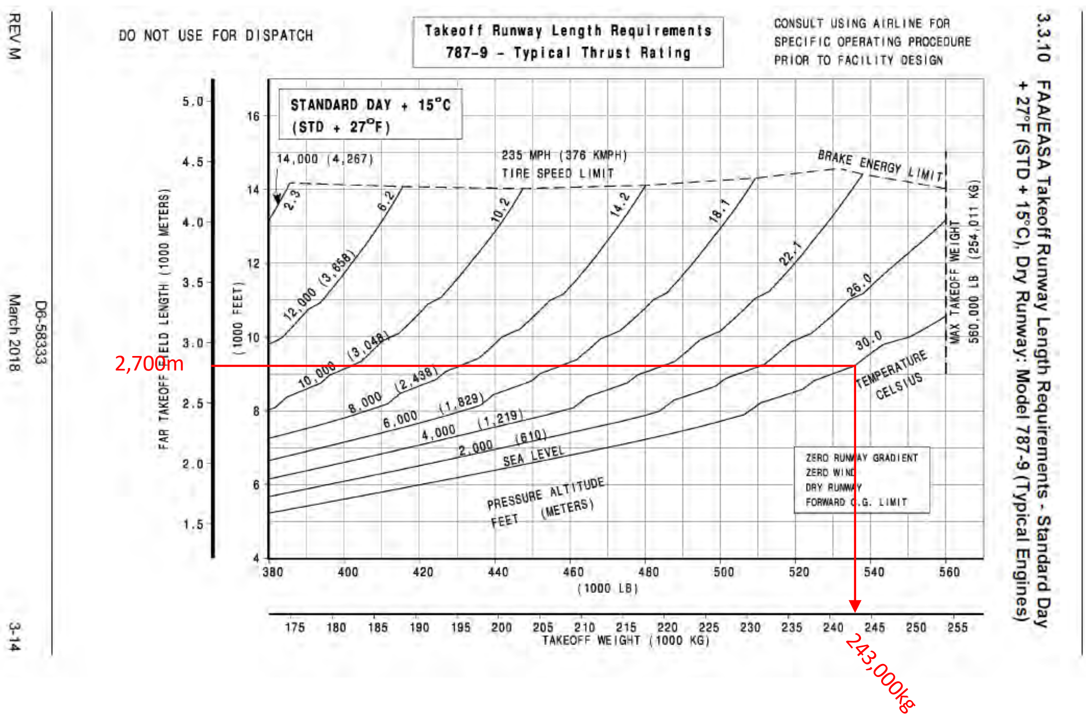


Figure A- 10 Takeoff Runway Length vs. Weight Chart B787-9

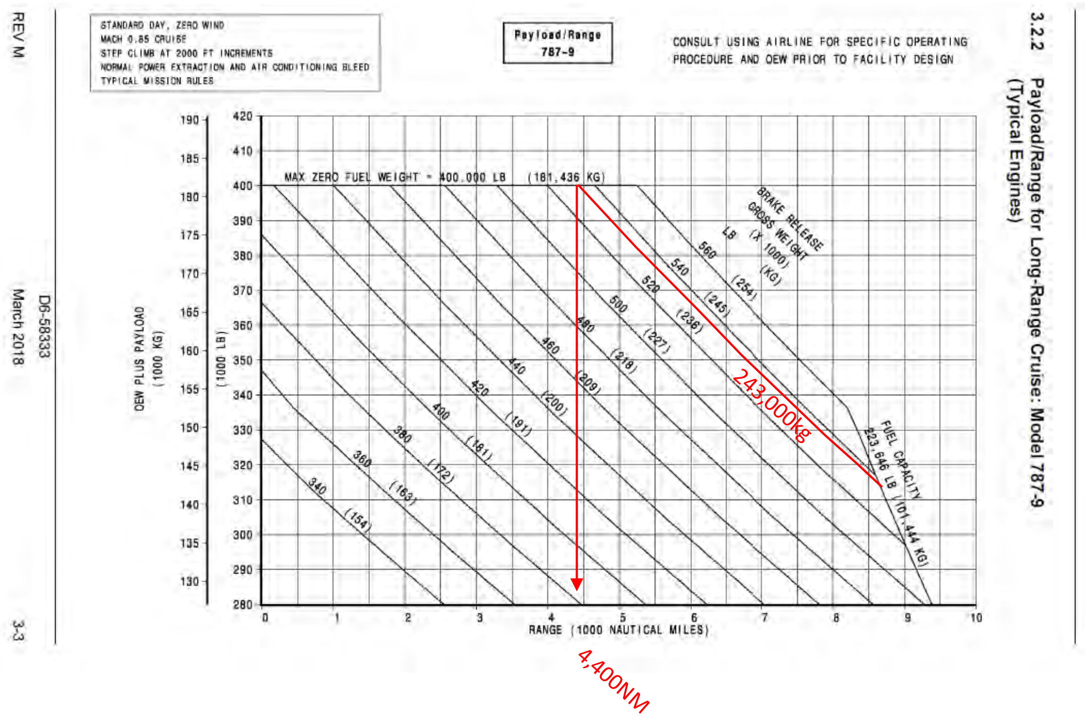


Figure A- 11 Takeoff Weight vs. Range Chart B787-9

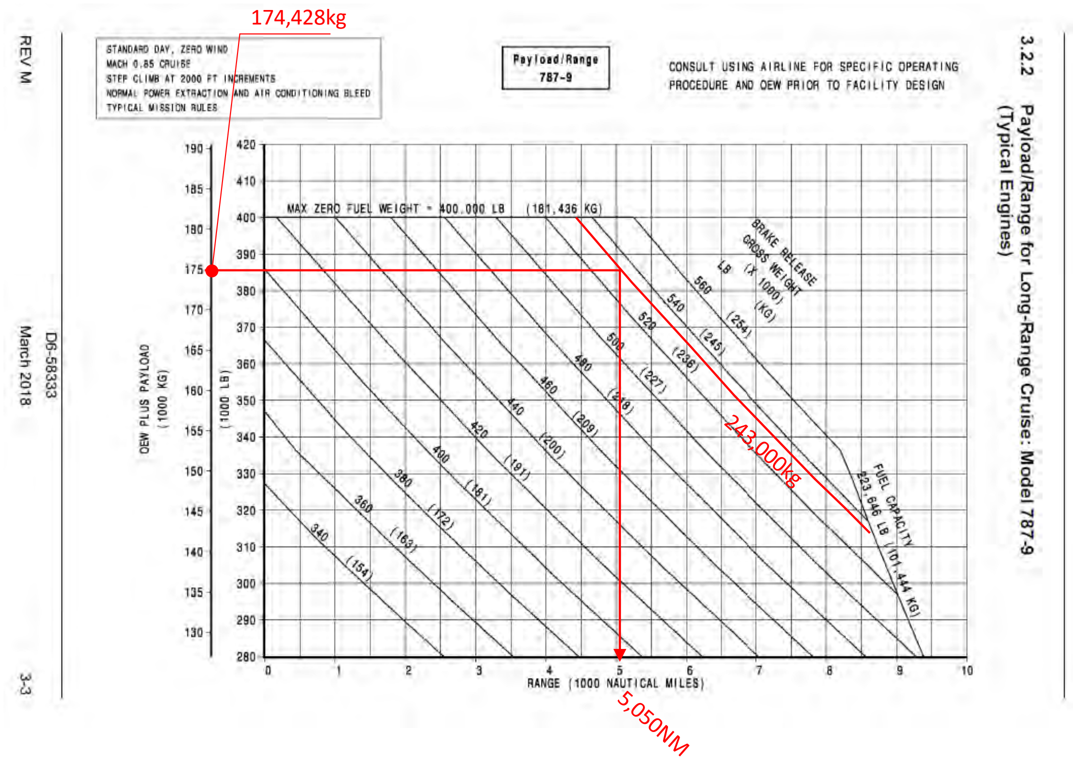


Figure A- 12 Takeoff Weight vs. Range Chart B787-9

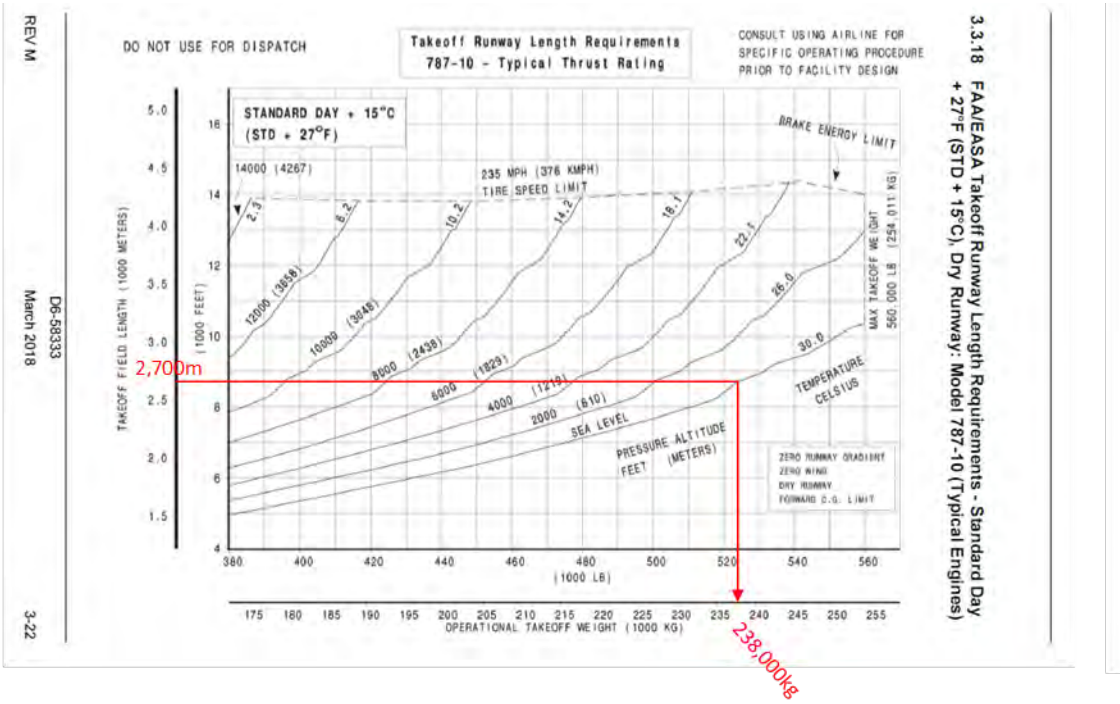


Figure A- 13 Takeoff Runway Length vs. Weight Chart B787-10

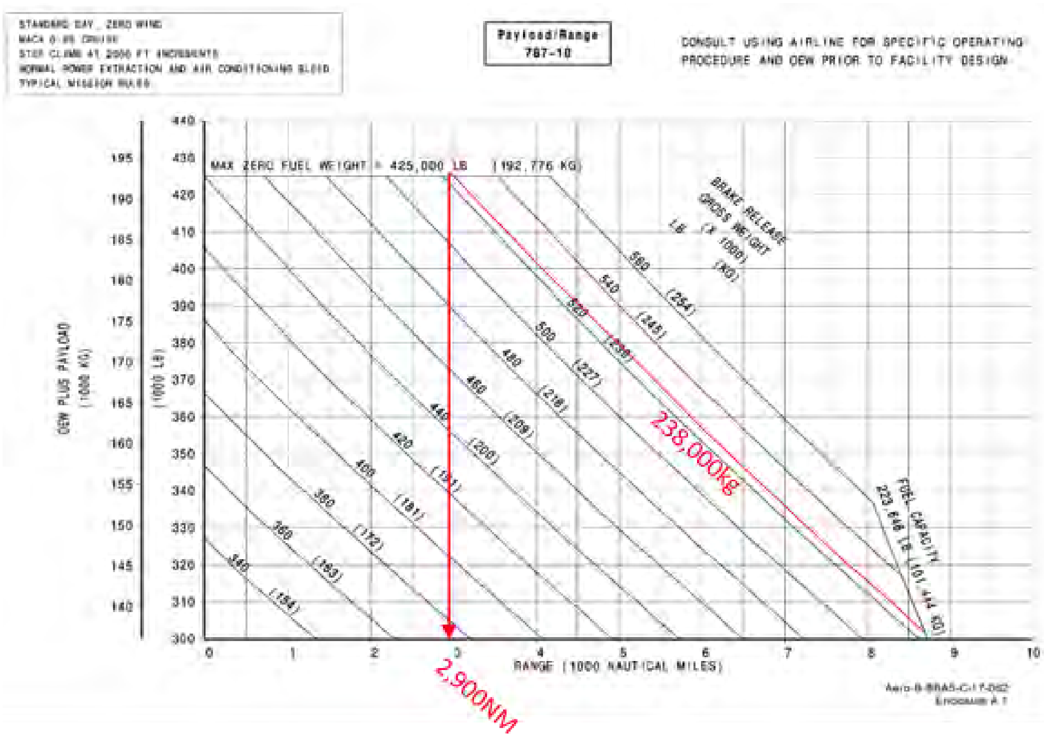


Figure A- 14 Takeoff Weight vs. Range Chart B787-10

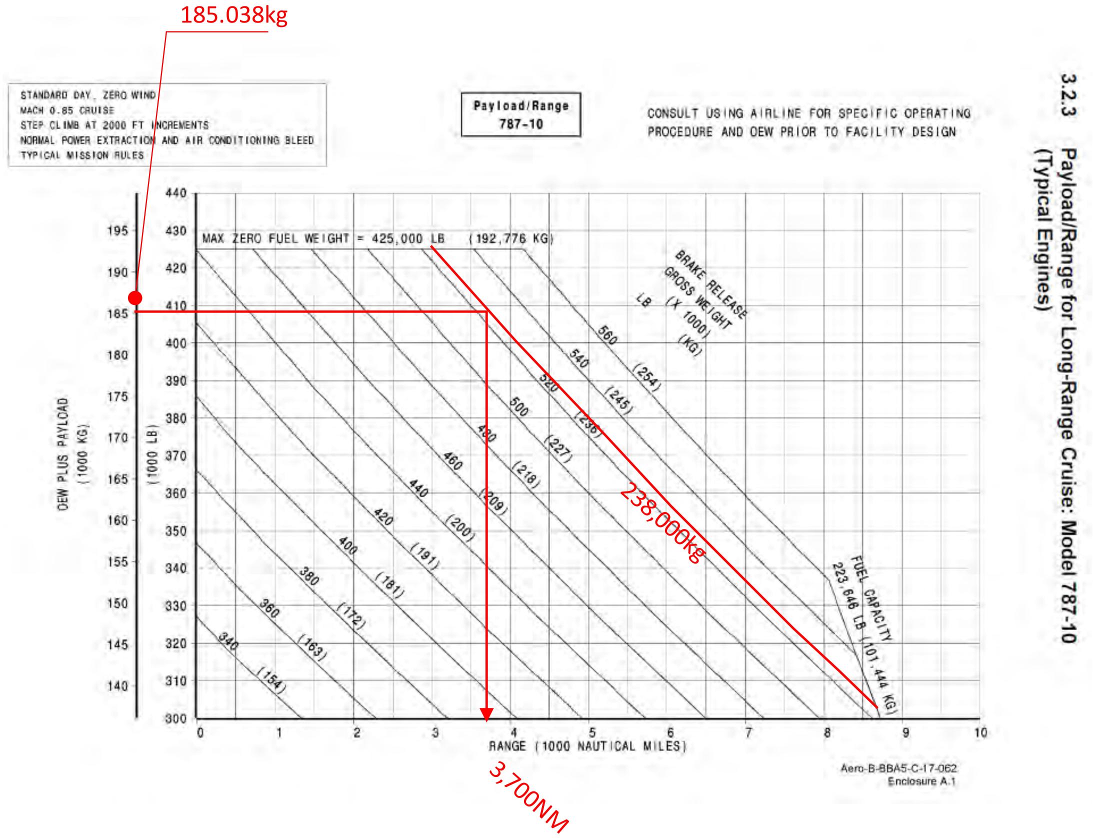


Figure A- 15 Takeoff Weight vs. Range Chart B787-10

Appendix- 2 Estimation of Compensation

1. Samples for calculation of an average house area

Sample houses are chosen in the subject area and the land area of each house is calculated from the aerial photo.

House	Area (m2)
1	495
2	400
3	333
4	275
5	295
6	314
7	316
8	338
9	283
10	600
11	252
12	334
13	233
14	277
15	211
16	270
17	272
18	257
19	241
20	152
21	136
22	218
23	270
24	278
25	320
26	270
27	283
28	274
29	262
Average (m2/house)	291.7

Photo: House samples used for estimation of average area

The number of houses in the subject areas, Plan-A and Plan-B, are counted, and the approximate unit price of the market price in the vicinity area is retrieved from the attached advertisement of real-estate companies.

	Plan-A	Plan-B
No. of houses	373	316
Average (m2/house)	291.7	291.7
Unit Price (USD/m2)	581	581
Total Compensation Cost (USD)	63,212,940	53,553,054

2. Areas of existing Business building/ Warehouse

The approximate compensation cost is obtained by following procedures. First, the size of business buildings and warehouses are measured from the aerial photo, and multiplied by the estimated market unit price.

Business/ Warehouse	Area (m2)		
		Plan-A	Plan-B
1	849	x	—
2	472	x	—
3	780	x	—
4	227	x	—
5	453	x	—
6	1,448	x	—
7	2,372	x	—
8	982	x	x
9	1,548	x	x
10	359	x	x
11	285	x	x
12	1,327	x	x
13	2,761	x	x
14	345	x	x
15	3,175	x	x
16	3,240	x	x
17	3,674	x	x
18	4,124	x	x
19	1,036	x	—
20	254	x	—
21	407	x	—
22	281	x	—
23	928	x	—
24	170	x	—
25	216	x	—
26	178	x	—
Total Area (m2)	31,891	31,891	21,820
Unit price (USD/m2)	847	-	-
Total compensation cost (USD)		27,011,677	18,481,540

Photo: Locations of business buildings and warehouses

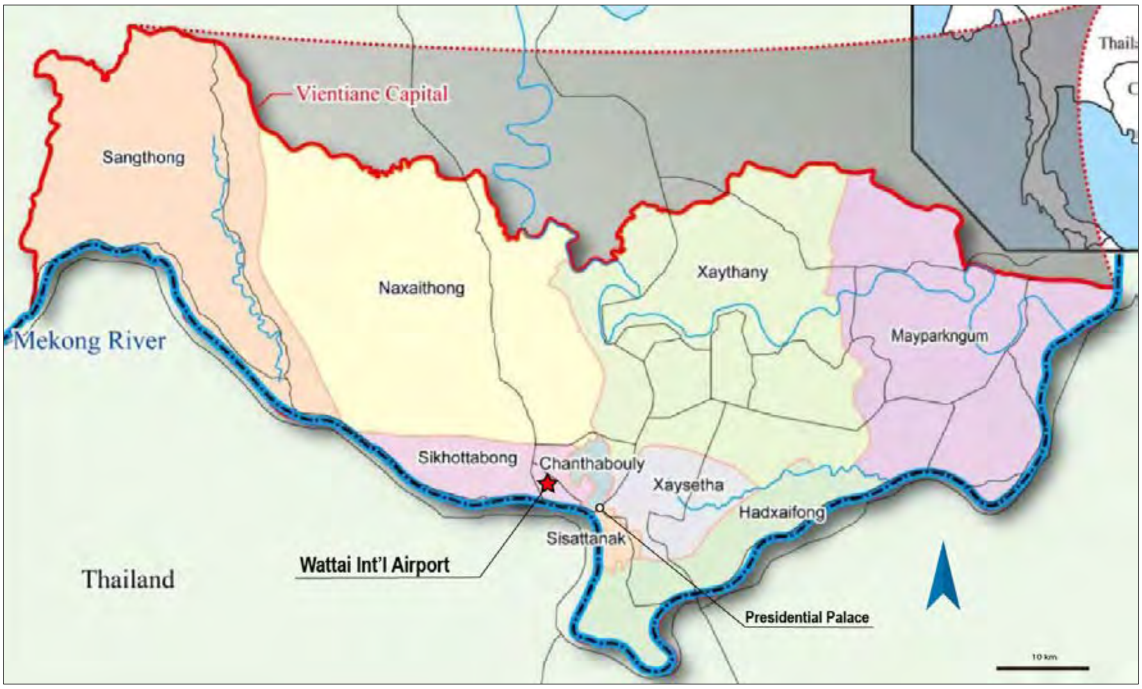
3. Calculation of average unit price

Approximate unit price are estimated from the samples chosen in the vicinity of the airport. District map is shown below.

Type	Sr.	Land Area (m2)	Floor	Bed Room	Toilet	Price (USD)	Unit Price (m2)	District
House	1	216	1	7	5	125,000	579	Chanthabuly
	2		1	2	2	90,000	-	Chanthabuly
	3	618	2	4	6	260,000	421	Chanthabuly
	4	604	1	3	4	450,000	745	Sisattanak
Warehouse	1	2,592	1	-	-	3,010,000	1,161	Xaysetha
	2	3,374	-	-	-	1,800,000	533	Xaysetha
Land	1	1,848	-	-	-	517,440	280	Chanthabuly
	2	7,290	-	-	-	1,093,500	150	Chanthabuly
	3	1,145	-	-	-	126,000	110	Sisattanak

Type	Avg. Unit Price (m2)
House	581
Land	180
Warehouse	847

4. The location of the airport and Districts of Vientiane Prefecture (Capital)



Appendix- 3 Samples Used for Calculation of Market Price

House-1

House for sale It's in the heart of the city. Good location.

https://www.ddohome.com/index.php?menu=property&submenu=view&id=522

216 m² 1 Floor 7 Bedroom 5 Toilet

Viangchan Chanthabuly ສີບຸນເຮືອງ

125,000 usd

House For Sell Posted on 2020-08-06 12:21

Detail

Location: Ban Sibounhuang Chanthaboury District, Vientiane Capital.
It's in the heart of the city. Good location.
**sale 125.000 $
7 Bedroom
5 Toilet
Land size 216 sqm
Area of use 432 sqm

House-2

House for rent / sale It's in the heart of the city. Good location.
https://www.ddohome.com/index.php?menu=property&submenu=view&id=483

N/A 1 Floor 2 Bedroom 2 Toilet

Viangchan Chanthabuly หนองทาเหนือ

2,300 usd

House For Rent Yearly Posted on 2020-07-22 14:33

For Rent 90,000 usd

Detail

House for rent / sale It's in the heart of the city. Good location.
Location: ban nongthanuae Chanthaboury Vientiane Capital
Enter Choi 11 or 13
There is ample parking.
rent 75,000 ิbath /year
sale 90,000 $

House-3

House for sale on the 1st floor 2nd floor mortar is wood
https://www.ddohome.com/index.php?menu=property&submenu=view&id=529

618 m² 2 Floor 4 Bedroom 6 Toilet

Viangchan Chanthabuly ສີສັງວອນ

260,000 usd

House For Sell Posted on 2020-08-07 09:48

Detail

House for sale on the 1st floor 2nd floor mortar is wood
Location: Ban Sisangvone soi 9 chanthabourny District, Vientiane Capital.
Land size 333 sqm
Area of use 200 sqm
4 Bedroom
6 Toilet
There are 5 rooms for rent.
**sale 260.000 $ **

House-4

House for sale, Ban Saphanthong

604 m² 1 Floor 3 Bedroom 4 Toilet

Viangchan Sisattanak ສະພານທອງໃຕ້

450,000 usd

House For Sell Posted on 2020-08-05 10:41

House for sale
Location: Ban saphanthong
Sisadtanark District, Vientiane Capital.
Land size 604 sqm
Area of use 612 sqm
3 Bedroom
4 Toilet
1 basement

**sale 450,000 $ **

Warehouse-1

Sell large storage warehouse with land

https://www.ddohome.com/index.php?menu=property&submenu=view&id=494

2,592 m² 1 Floor

Viangchan Xaysetha โชกน้อย

3,010,000 usd

Warehouse For Sell Posted on 2020-07-28 10:14

Detail

Sell large storage warehouse with land
Location: Ban Sorknoi xaysettha
District, Vientiane Capital.
Route 450 years
100 meters from the main road
Land and warehouse
Land 2592 sqm
Sell 9,500,000 baht

*16km from the Airport

Warehouse-2

https://www.yula.la/en/warehouse-sale-in-xaysetha-vientiane-capital-58456

ID: 4061 - Nice warehouse near main road and Lakeview Golf Course for rent and sale

Location: Xaysetha, Vientiane Capital

Posted On: 30 Nov -0001

The warehouse for rent by concrete road, near Lakeview Golf Course, located in the East of City Center, about 7 Km from Patuxay.

Warehouse not far from BBQ Dome Restaurant and near Keomixay convention hall, located in the East of Vientiane city near National Convention Center and Latsavong Plaza, about 4km from Patuxay. The location is also close to Nongnieng market, shop, BCEL branch, pharmacy, BBQ Dome restaurant, school and etc…

It is also available for sale price 1.800.000$ and total area 3.374 sqm. Price can be negotiated

General Amenities: Business area, Lao communities, Market, Mini mart, Restaurant

- **Exterior Amenities**: Balcony

Land-1

Land for sale

1,848 m2

https://www.ddohome.com/index.php?menu=property&submenu=view&id=615

Viangchan Chanthabuly ຫ້ວຍຫົງ

280 usd

* Close the sale | Land | For Sell | Posted on 2020-09-22 11:34

Land for sale

Location: Ban huayhong chanthabory Vientiane Capita

land 1848 square meters

**sal 280 $ / sqm

150 meters from the main road

Land-2

Land for sale

7,290 m2

https://www.ddohome.com/index.php?menu=property&submenu=view&id=679

Viangchan Chanthabuly ຫ້ວຍຫົງ

1,093,500 usd

Land For Sell Posted on 2020-11-09 16:03

Land-3

Land for sale

https://www.ddohome.com/index.php?menu=property&submenu=view&id=638

1,145 m²

Viangchan Sisattanak ດອນກອຍ

126,000 usd

Land For Sell Posted on 2020-10-08 15:00

Appendix- 4 ICAO Doc 8168 Aircraft Operations

Volume II Construction of Visual and Instrument Flight Procedures Seventh Edition, 2020

Section 4 ARRIVAL AND APPROACH PROCEDURES

Chapter 1 GENERAL CRITERIA FOR APPROACH/ARRIVAL PROCEDURES

Table I-4-1-2. Speeds (IAS) for procedure calculations in knots (kt)

Aircraft category	V_{at}	*Range of speeds for initial approach*	*Range of final approach speeds*	*Max speeds for visual manoeuvring (circling)*	*Max speeds for missed approach*	
					Intermediate	*Final*
A	<91	90/150(110*)	70/100	100	100	110
B	91/120	120/180(140*)	85/130	135	130	150
C	121/140	160/240	115/160	180	160	240
D	141/165	185/250	130/185	205	185	265
E	166/210	185/250	155/230	240	230	275
H	N/A	70/120**	60/90***	N/A	90	90
Cat H (PinS)***	N/A	70/120	60/90	NA	70 or 90	70 or 90

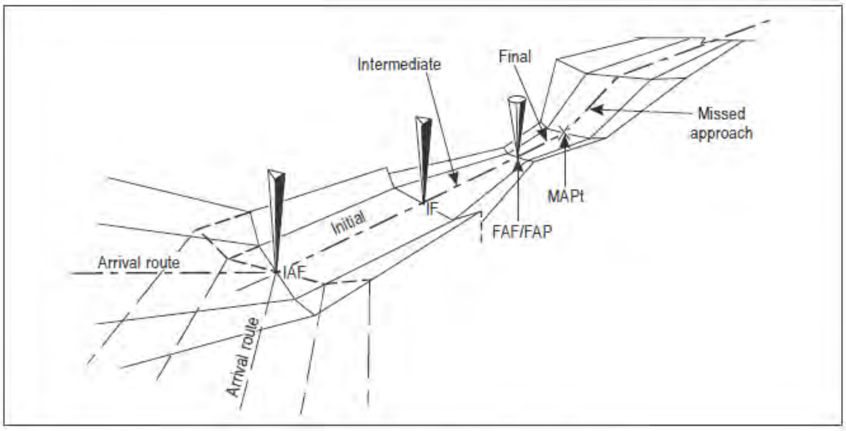


Figure I-4-1-1. Segment of instrument approach

Section 3 DEPARTURE PROCEDURES

Chapter 3 DEPARTURE ROUTES

Table I-3-3-App-1. Average flight path determination
(Distance in km (NM), height in m (ft), bank angle in degrees, speed in km/h (kt) IAS)

Distance from DER	1.9 (1)	3.7 (2)	5.6 (3)	7.4 (4)	9.3 (5)	11.1 (6)	13 (7)	14.8 (8)	16.7 (9)	18.5 (10)	20.4 (11)	22.2 (12)	24.1 (13)
Height above rwy	130 (425)	259 (850)	389 (1 275)	518 (1 700)	648 (2 125)	777 (2 550)	907 (2 976)	1037 (3 401)	1167 (3 827)	1296 (4 252)	1476 (4 677)	1556 (5 103)	1685 (5 528)
Bank angle	15	15	20	20	20	20	20	25	25	25	25	25	25
Speed	356 (192)	370 (200)	387 (209)	404 (218)	424 (229)	441 (238)	452 (244)	459 (248)	467 (252)	472 (255)	478 (258)	483 (261)	487 (263)

Distance from DER	25.9 (14)	27.8 (15)	29.6 (16)	31.5 (17)	33.3 (18)	35.2 (19)	37 (20)	38.9 (21)	40.7 (22)	42.6 (23)	44.4 (24)	46.3 (25)
Height above rwy	1815 (5 953)	1945 (6 379)	2074 (6 804)	2204 (7 229)	2334 (7 655)	2463 (8 080)	2593 (8 505)	2723 (8 931)	2892 (9 356)	2982 (9 781)	3112 (10 207)	3241 (10 632)
Bank angle	25	25	25	25	25	25	25	25	25	25	25	25
Speed	491 (265)	493 (266)	494 (267)	498 (269)	502 (271)	504 (272)	511 (276)	515 (278)	519 (280)	524 (283)	526 (284)	530 (286)

Appendix- 5 ICAO Doc4444 PROCEDURES FOR AIR NAVIGATION SERVICES Air Traffic Management Sixteenth Edition, 2016

Chapter 5 SEPARATION METHODS AND MINIMA

5.6 MINIMUM SEPARATION BETWEEN DEPARTING AIRCRAFT

Note. - The following provisions are complementary to the longitudinal separation minima specified in Section 5.4.2.

5.6.1 One-minute separation is required if aircraft are to fly on tracks diverging by at least 45 degrees immediately after take-off so that lateral separation is provided (see Figure 5-37). This minimum may be reduced when aircraft are using parallel runways or when the procedure in Chapter 6, 6.3.3.1, is adopted for operations on diverging runways which do not cross, provided instructions covering the procedure have been approved by the appropriate ATS authority and lateral separation is effected immediately after take-off.

Note 1. - Wake turbulence categories of aircraft are contained in Chapter 4, Section 4.9.1 and longitudinal separation minima are contained in Section 5.8 and in Chapter 8, Section 8.7.

Note 2. - Detailed characteristics of wake vortices and their effect on aircraft are contained in the Air Traffic Services Planning Manual (Doc 9426), Part II, Section 5.

5.6.2 Two minutes are required between take-offs when the preceding aircraft is 74 km/h (40 kt) or more faster than the following aircraft and both aircraft will follow the same track (see Figure 5-38).

Note. - See Chapter 4, Section 4.6, concerning speed control instructions. Calculations, based on TAS, of speed differentials of aircraft during climb may not be sufficiently accurate in all circumstances for determining if the procedure in 5.6.2 can be applied, in which case calculations based on IAS may be more suitable.

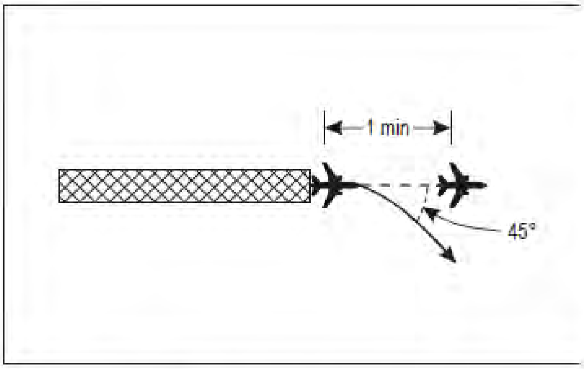


Figure 5-37. One-minute separation between departing aircraft following tracks diverging by at least 45 degrees (see 5.6.1)

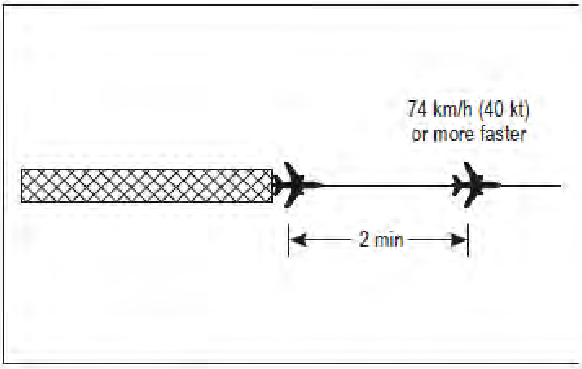


Figure 5-38. Two-minute separation between aircraft following same track (see 5.6.2)

Appendix- 6 ICAO Doc4444 PROCEDURES FOR AIR NAVIGATION SERVICES Air Traffic Management Sixteenth Edition, 2016

Chapter 8 ATS SURVEILLANCE SERVICES

8.7 USE OF ATS SURVEILLANCE SYSTEMS IN THE AIR TRAFFIC CONTROL SERVICE

8.7.3 Separation minima based on ATS surveillance systems

8.7.3.1 Unless otherwise prescribed in accordance with 8.7.3.2, 8.7.3.3 or 8.7.3.4, or Chapter 6 (with respect to independent and dependent parallel approaches), the horizontal separation minimum based on radar and/or ADS-B and/or MLAT systems shall be 9.3 km (5.0 NM).

8.7.3.2 The separation minimum in 8.7.3.1 may, if so prescribed by the appropriate ATS authority, be reduced, but not below:

a) 5.6 km (3.0 NM) when radar and/or ADS-B and/or MLAT systems'capabilities at a given location so permit;

and

b) 4.6 km (2.5 NM) between succeeding aircraft which are established on the same final approach track within 18.5 km (10 NM) of the runway threshold. A reduced separation minimum of 4.6 km (2.5 NM) may be applied, provided:

i) the average runway occupancy time of landing aircraft is proven, by means such as data collection and statistical analysis and methods based on a theoretical model, not to exceed 50 seconds;

ii) braking action is reported as good and runway occupancy times are not adversely affected by runway contaminants such as slush, snow or ice;

iii) an ATS surveillance system with appropriate azimuth and range resolution and an update rate of 5 seconds or less is used in combination with suitable displays;

iv) the aerodrome controller is able to observe, visually or by means of surface movement radar (SMR), MLAT system or a surface movement guidance and control system (SMGCS), the runway-in-use and associated exit and entry taxiways;

v) distance-based wake turbulence separation minima in 8.7.3.4, or as may be prescribed by the appropriate ATS authority (e.g. for specific aircraft types), do not apply;

vi) aircraft approach speeds are closely monitored by the controller and when necessary adjusted so as to ensure that separation is not reduced below the minimum;

vii) aircraft operators and pilots have been made fully aware of the need to exit the runway in an expeditious manner whenever the reduced separation minimum on final approach is applied; and

viii) procedures concerning the application of the reduced minimum are published in AIPs.

Appendix- 7 ICAO Doc4444 PROCEDURES FOR AIR NAVIGATION SERVICES Air Traffic Management Sixteenth Edition, 2016

Chapter 5 SEPARATION METHODS AND MINIMA

5.7 SEPARATION OF DEPARTING AIRCRAFT FROM ARRIVING AIRCRAFT

5.7.1 Except as otherwise prescribed by the appropriate ATS authority, the following separation shall be applied when take-off clearance is based on the position of an arriving aircraft.

5.7.1.1 If an arriving aircraft is making a complete instrument approach, a departing aircraft may take off:

a) in any direction until an arriving aircraft has started its procedure turn or base turn leading to final approach;

b) in a direction which is different by at least 45 degrees from the reciprocal of the direction of approach after the arriving aircraft has started procedure turn or base turn leading to final approach, provided that the take-off will be made at least 3 minutes before the arriving aircraft is estimated to be over the beginning of the instrument runway (see Figure 5-40).

5.7.1.2 If an arriving aircraft is making a straight-in approach, a departing aircraft may take off:

a) in any direction until 5 minutes before the arriving aircraft is estimated to be over the instrument runway;

b) in a direction which is different by at least 45 degrees from the reciprocal of the direction of approach of the arriving aircraft:

1) until 3 minutes before the arriving aircraft is estimated to be over the beginning of the instrument runway (see Figure 5-40); or

2) before the arriving aircraft crosses a designated fix on the approach track; the location of such fix to be determined by the appropriate ATS authority after consultation with the operators.

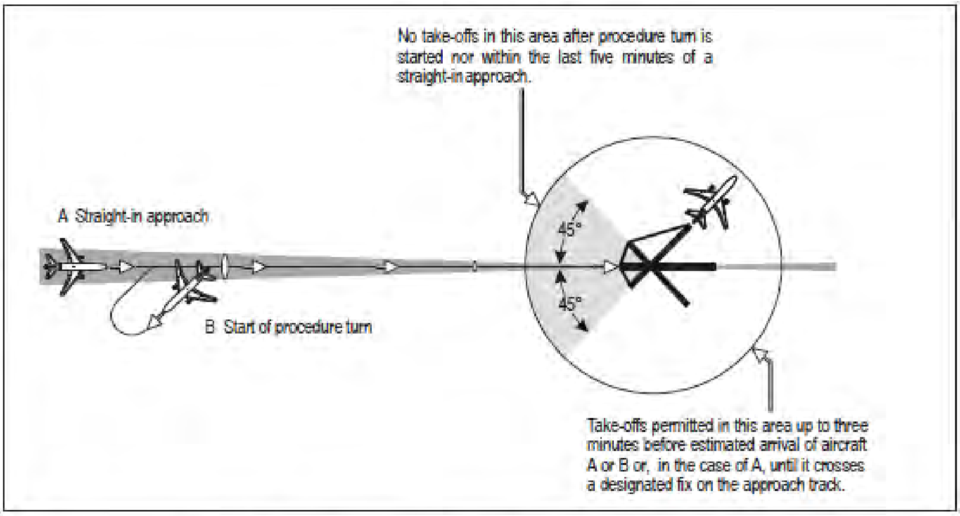


Figure 5-40. Separation of departing aircraft from arriving aircraft (see 5.7.1.1 b) and 5.7.1.2 b))

Appendix- 8 Incremental Financial Cashflow (Million LAK)

APPENDIX 8: INCREMENTAL FINANCIAL CASHFLOW (MN LAK)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Aeronautical Revenues																
Passenger Service Fees																
(Domestic)	0	0	0	0	0	0	0	0	457	935	1,434	1,955	2,501	3,070	3,665	4,287
(International)	0	0	0	0	0	0	0	0	12,436	25,431	39,011	53,202	68,032	83,529	99,724	116,647
Sub-total	0	0	0	0	0	0	0	0	12,893	26,366	40,445	55,158	70,533	86,599	103,389	120,934
Landing Charges, Parking Charges and Lighting charges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	-164	323	832	1,364	1,920	2,252	2,846	3,466
(International)	0	0	0	0	0	0	0	0	2,524	5,161	7,917	10,798	13,807	16,953	20,239	23,674
Sub-total	0	0	0	0	0	0	0	0	2,360	5,485	8,750	12,162	15,728	19,205	23,085	27,140
Air Navigation Charges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	-132	268	687	1,125	1,582	1,893	2,383	2,895
(International)	0	0	0	0	0	0	0	0	1,894	3,874	5,942	8,104	10,363	12,723	15,190	17,768
Sub-total	0	0	0	0	0	0	0	0	1,762	4,142	6,629	9,228	11,945	14,616	17,573	20,663
Total Aeronautical Revenues	0	0	0	0	0	0	0	0	17,015	35,993	55,824	76,548	98,205	120,421	144,047	168,737
Non-aeronautical Revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ground handling service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	32	65	98	131	165	198	232	267
(International)	0	0	0	0	0	0	0	0	2,847	5,711	8,594	11,498	14,424	17,373	20,347	23,346
Sub-total	0	0	0	0	0	0	0	0	2,879	5,776	8,692	11,629	14,588	17,571	20,579	23,613
Concesssions (Airlines)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	0	0	0	0	0	117	117	117
(International)	0	0	0	0	0	0	0	0	45	90	135	180	225	635	683	731
Sub-total	0	0	0	0	0	0	0	0	45	90	135	180	225	752	800	848
Concessions (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	0	0	0	0	0	58	58	58
(International)	0	0	0	0	0	0	0	0	60	121	181	240	300	1,484	1,554	1,624
Sub-total	0	0	0	0	0	0	0	0	60	121	181	240	300	1,542	1,612	1,682
Parking Service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	6	12	18	25	31	37	44	50
(International)	0	0	0	0	0	0	0	0	47	93	140	188	236	284	332	381
Sub-total	0	0	0	0	0	0	0	0	53	106	159	213	267	321	376	432
SITA Cute System Service (International Only)	0	0	0	0	0	0	0	0	38	90	141	192	243	291	341	391
Advertisement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(International)	0	0	0	0	0	0	0	0	27	54	81	108	135	509	539	569
Sub-total	0	0	0	0	0	0	0	0	27	54	81	108	135	509	539	569
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)(including ATS's revevenues from BOTHIP)	0	0	0	0	0	0	0	0	0	0	0	1	1	29	29	29
(International)	0	0	0	0	0	0	0	0	52	104	156	209	262	316	370	424
Sub-total	0	0	0	0	0	0	0	0	52	104	157	210	263	345	399	454
Total Non-Aeronautical Revenues	0	0	0	0	0	0	0	0	3,154	6,340	9,546	12,772	16,021	21,331	24,647	27,989
Total Revenues	0	0	0	0	0	0	0	0	20,169	42,333	65,370	89,320	114,226	141,752	168,694	196,726
Operating Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Personnel, etc.	0	0	0	0	0	0	0	0	4,408	9,049	13,804	18,675	23,668	28,762	34,009	39,391
Insurance	0	0	0	0	0	0	0	0	55	112	170	229	290	352	416	482
Utilities	0	0	0	0	0	0	0	0	269	556	849	1,148	1,454	1,765	2,085	2,413
Training	0	0	0	0	0	0	0	0	10	32	53	75	97	117	140	163
Various Charges of Administration	0	0	0	0	0	0	0	0	457	926	1,407	1,901	2,407	3,048	3,581	4,129
Various Charges of Operation	0	0	0	0	0	0	0	0	1,028	2,547	4,106	5,706	7,347	8,935	10,661	12,434
Others	0	0	0	0	0	0	0	0	877	1,823	2,792	3,784	4,800	5,833	6,900	7,995
Total Operating Expenses	0	0	0	0	0	0	0	0	7,105	15,046	23,181	31,518	40,065	48,812	57,794	67,007
Investement Costs																
Civil Work	0	37,463	64,569	0	0	-25,991	148,107	132,717	0	0	0	0	0	0	0	0
Architecutral Work	0	58,801	34,577	0	0	0	25,188	0	0	238,170	331,705	464,393	727,400	0	0	0
Consulting Service Fee	1,954	10,747	6,839	0	0	1,351	15,177	15,177	44,042	21,140	22,902	35,233	52,850	0	0	4,992
Physical Contingency	98	10,164	10,257	0	0	-2,532	18,088	14,031	2,202	24,874	34,316	48,201	75,383	0	0	250
Total Investment Costs	2,052	117,175	116,241	0	0	-27,171	206,560	161,924	46,244	284,184	388,922	547,827	855,633	0	0	5,241
Total Costs	2,052	117,175	116,241	0	0	-27,171	206,560	161,924	53,349	299,230	412,103	579,345	895,698	48,812	57,794	72,248
Surplus (Deficit)	-2,052	-117,175	-116,241	0	0	27,171	-206,560	-161,924	-33,180	-256,897	-346,734	-490,025	-781,472	92,940	110,900	124,478

	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Aeronautical Revenues																
Passenger Service Fees																
(Domestic)	4,937	5,617	6,169	6,740	7,332	7,944	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577
(International)	134,332	152,812	167,833	183,379	199,470	216,123	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360
Sub-total	139,269	158,429	174,002	190,119	206,801	224,067	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937
Landing Charges, Parking Charges and Lighting charges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	4,114	4,791	5,341	5,911	6,501	7,111	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742
(International)	27,263	31,014	34,063	37,218	40,483	43,863	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362
Sub-total	31,377	35,805	39,404	43,129	46,984	50,974	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104
Air Navigation Charges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	3,431	3,990	4,445	4,915	5,402	5,906	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428
(International)	20,462	23,277	25,565	27,933	30,383	32,920	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546
Sub-total	23,892	27,267	30,009	32,848	35,786	38,827	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974
Total Aeronautical Revenues	194,539	221,501	243,415	266,096	289,571	313,868	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015
Non-aeronautical Revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ground handling service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	301	336	364	391	419	447	476	476	476	476	476	476	476	476	476	476
(International)	26,372	29,427	31,826	34,243	36,678	39,133	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608
Sub-total	26,674	29,763	32,189	34,634	37,097	39,581	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084
Concesssions (Airlines)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
(International)	779	827	865	902	940	977	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015
Sub-total	896	944	981	1,019	1,056	1,094	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131
Concessions (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58
(International)	1,694	1,764	1,819	1,873	1,928	1,982	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037
Sub-total	1,752	1,822	1,877	1,931	1,986	2,040	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095
Parking Service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	57	63	69	74	79	84	90	90	90	90	90	90	90	90	90	90
(International)	431	481	520	560	599	639	680	680	680	680	680	680	680	680	680	680
Sub-total	488	544	589	633	678	724	770	770	770	770	770	770	770	770	770	770
SITA Cute System Service (International Only)	442	491	530	569	608	646	685	685	685	685	685	685	685	685	685	685
Advertisement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(International)	599	629	652	676	699	722	746	746	746	746	746	746	746	746	746	746
Sub-total	599	629	652	676	699	722	746	746	746	746	746	746	746	746	746	746
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)(including ATS's revevenues from BOTHIP)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
(International)	479	535	578	622	666	711	756	756	756	756	756	756	756	756	756	756
Sub-total	509	564	608	652	696	741	786	786	786	786	786	786	786	786	786	786
Total Non-Aeronautical Revenues	31,359	34,758	37,426	40,114	42,821	45,548	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297
Total Revenues	225,897	256,259	280,841	306,210	332,392	359,416	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312
Operating Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Personnel, etc.	44,911	50,575	55,095	59,707	64,414	69,217	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121
Insurance	549	618	673	729	786	844	904	904	904	904	904	904	904	904	904	904
Utilities	2,748	3,092	3,365	3,644	3,927	4,217	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511
Training	185	208	227	245	263	282	300	300	300	300	300	300	300	300	300	300
Various Charges of Administration	4,692	5,269	5,731	6,202	6,683	7,175	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677
Various Charges of Operation	14,255	16,125	17,620	19,146	20,705	22,298	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925
Others	9,118	10,269	11,188	12,126	13,082	14,058	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054
Total Operating Expenses	76,458	86,157	93,898	101,798	109,861	118,091	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492
Investement Costs																
Civil Work	31,289	83,944	0	0	0	0	3,145	0	0	0	0	24,452	0	0	0	0
Architecutral Work	51,152	0	0	0	0	0	0	0	0	0	0	199,608	0	0	0	0
Consulting Service Fee	6,655	4,992	0	0	0	0	314	0	0	0	0	2,628	0	0	0	0
Physical Contingency	8,577	8,644	0	0	0	0	330	0	0	0	0	2,759	0	0	0	0
Total Investment Costs	97,673	97,580	0	0	0	0	3,790	0	0	0	0	229,446	0	0	0	0
Total Costs	174,132	183,736	93,898	101,798	109,861	118,091	130,281	126,492	126,492	126,492	126,492	355,938	126,492	126,492	126,492	126,492
Surplus (Deficit)	51,766	72,523	186,944	204,412	222,531	241,325	257,030	260,820	260,820	260,820	260,820	31,373	260,820	260,820	260,820	260,820

	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
Aeronautical Revenues																
Passenger Service Fees																
(Domestic)	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577	8,577
(International)	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360	233,360
Sub-total	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937	241,937
Landing Charges, Parking Charges and Lighting charges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742	7,742
(International)	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362	47,362
Sub-total	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104	55,104
Air Navigation Charges	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428	6,428
(International)	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546	35,546
Sub-total	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974	41,974
Total Aeronautical Revenues	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015	339,015
Non-aeronautical Revenues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ground handling service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	476	476	476	476	476	476	476	476	476	476	476	476	476	476	476	476
(International)	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608	41,608
Sub-total	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084	42,084
Concesssions (Airlines)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
(International)	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015	1,015
Sub-total	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131	1,131
Concessions (Others)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58	58
(International)	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037	2,037
Sub-total	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095	2,095
Parking Service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
(International)	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680	680
Sub-total	770	770	770	770	770	770	770	770	770	770	770	770	770	770	770	770
SITA Cute System Service (International Only)	685	685	685	685	685	685	685	685	685	685	685	685	685	685	685	685
Advertisement	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(International)	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746
Sub-total	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746	746
Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Domestic)(including ATS's revevenues from BOTHIP)	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
(International)	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756
Sub-total	786	786	786	786	786	786	786	786	786	786	786	786	786	786	786	786
Total Non-Aeronautical Revenues	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297	48,297
Total Revenues	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312	387,312
Operating Expenses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Personnel, etc.	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121	74,121
Insurance	904	904	904	904	904	904	904	904	904	904	904	904	904	904	904	904
Utilities	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511	4,511
Training	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Various Charges of Administration	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677	7,677
Various Charges of Operation	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925	23,925
Others	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054	15,054
Total Operating Expenses	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492
Investement Costs																
Civil Work	43,556	0	0	0	0	14,729	0	0	0	0	55,756	0	0	0	0	0
Architecutral Work	99,719	0	0	0	0	259	0	0	0	0	207,406	0	0	0	0	0
Consulting Service Fee	14,328	0	0	0	0	1,499	0	0	0	0	26,316	0	0	0	0	0
Physical Contingency	15,044	0	0	0	0	1,574	0	0	0	0	27,632	0	0	0	0	0
Total Investment Costs	172,646	0	0	0	0	18,060	0	0	0	0	317,111	0	0	0	0	0
Total Costs	299,138	126,492	126,492	126,492	126,492	144,552	126,492	126,492	126,492	126,492	443,602	126,492	126,492	126,492	126,492	126,492
Surplus (Deficit)	88,173	260,820	260,820	260,820	260,820	242,760	260,820	260,820	260,820	260,820	-56,291	260,820	260,820	260,820	260,820	260,820

FIRR	**5.6%**

Appendix- 9 Incremental Economic Cashflow (Million LAK)

APPENDIX 9: INCREMENTAL ECONOMIC CASHFLOW (MN LAK)

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Economic Benefits																
Consumer Surplus for Incremental Lao Passengers																
Domestic Flights				0	0	0	0	0	31,028	63,452	97,335	132,743	169,744	208,411	248,817	291,041
International Flights				0	0	0	0	0	28,227	57,723	88,548	120,759	154,420	189,595	226,353	264,766
Spending by Incremental Foreign Passengers on International Flights (value added)				0	0	0	0	0	19,088	39,035	59,880	81,663	104,425	128,213	153,070	179,047
Total Economic Benefits				0	0	0	0	0	78,343	160,210	245,762	335,164	428,589	526,218	628,241	734,854
Economic Costs																
O&M Costs	0	0	0	0	0	0	0	0	7,105	15,046	23,181	31,518	40,065	48,812	57,794	67,007
Investment Costs	2,052	117,175	116,241	0	0	-27,171	206,560	161,924	46,244	284,184	388,922	547,827	855,633	0	0	5,241
Total Economic Costs	2,052	117,175	116,241	0	0	-27,171	206,560	161,924	53,349	299,230	412,103	579,345	895,698	48,812	57,794	72,248
Economic Surplus (Deficit)	-2,052	-117,175	-116,241	0	0	27,171	-206,560	-161,924	24,993	-139,020	-166,341	-244,181	-467,108	477,406	570,447	662,606

	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054
Economic Benefits																
Consumer Surplus for Incremental Lao Passengers																
Domestic Flights	335,166	381,276	418,754	457,543	497,690	539,242	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248
International Flights	304,907	346,854	380,948	416,236	452,758	490,558	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682
Spending by Incremental Foreign Passengers on International Flights (value added)	206,192	234,559	257,614	281,477	306,175	331,738	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195
Total Economic Benefits	846,265	962,689	1,057,317	1,155,256	1,256,623	1,361,538	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124
Economic Costs																
O&M Costs	76,458	86,157	93,898	101,798	109,861	118,091	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492
Investment Costs	97,673	97,580	0	0	0	0	3,790	0	0	0	0	229,446	0	0	0	0
Total Economic Costs	174,132	183,736	93,898	101,798	109,861	118,091	130,281	126,492	126,492	126,492	126,492	355,938	126,492	126,492	126,492	126,492
Economic Surplus (Deficit)	672,133	778,953	963,419	1,053,458	1,146,762	1,243,447	1,339,843	1,343,633	1,343,633	1,343,633	1,343,633	1,114,186	1,343,633	1,343,633	1,343,633	1,343,633

	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070
Economic Benefits																
Consumer Surplus for Incremental Lao Passengers																
Domestic Flights	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248	582,248
International Flights	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682	529,682
Spending by Incremental Foreign Passengers on International Flights (value added)	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195	358,195
Total Economic Benefits	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124	1,470,124
Economic Costs																
O&M Costs	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492	126,492
Investment Costs	172,646	0	0	0	0	18,060	0	0	0	0	317,111	0	0	0	0	0
Total Economic Costs	299,138	126,492	126,492	126,492	126,492	144,552	126,492	126,492	126,492	126,492	443,602	126,492	126,492	126,492	126,492	126,492
Economic Surplus (Deficit)	1,170,986	1,343,633	1,343,633	1,343,633	1,343,633	1,325,573	1,343,633	1,343,633	1,343,633	1,343,633	1,026,522	1,343,633	1,343,633	1,343,633	1,343,633	1,343,633

EIRR	**21.1%**
ENPV	**1,222,895**