

**Kingdom of Thailand**  
**Department of Highways**

**Project for Capacity Development on  
Tunnel Project Management  
in Thailand**

**Project Completion Report**

**February 2025**

**Japan International Cooperation Agency**

**CTI Engineering International Co., Ltd.**  
**Oriental Consultants Global Co., Ltd.**  
**Eight-Japan Engineering Consultants Inc.**  
**Central Nippon Expressway Co., Ltd.**  
**Metropolitan Expressway Co., Ltd.**

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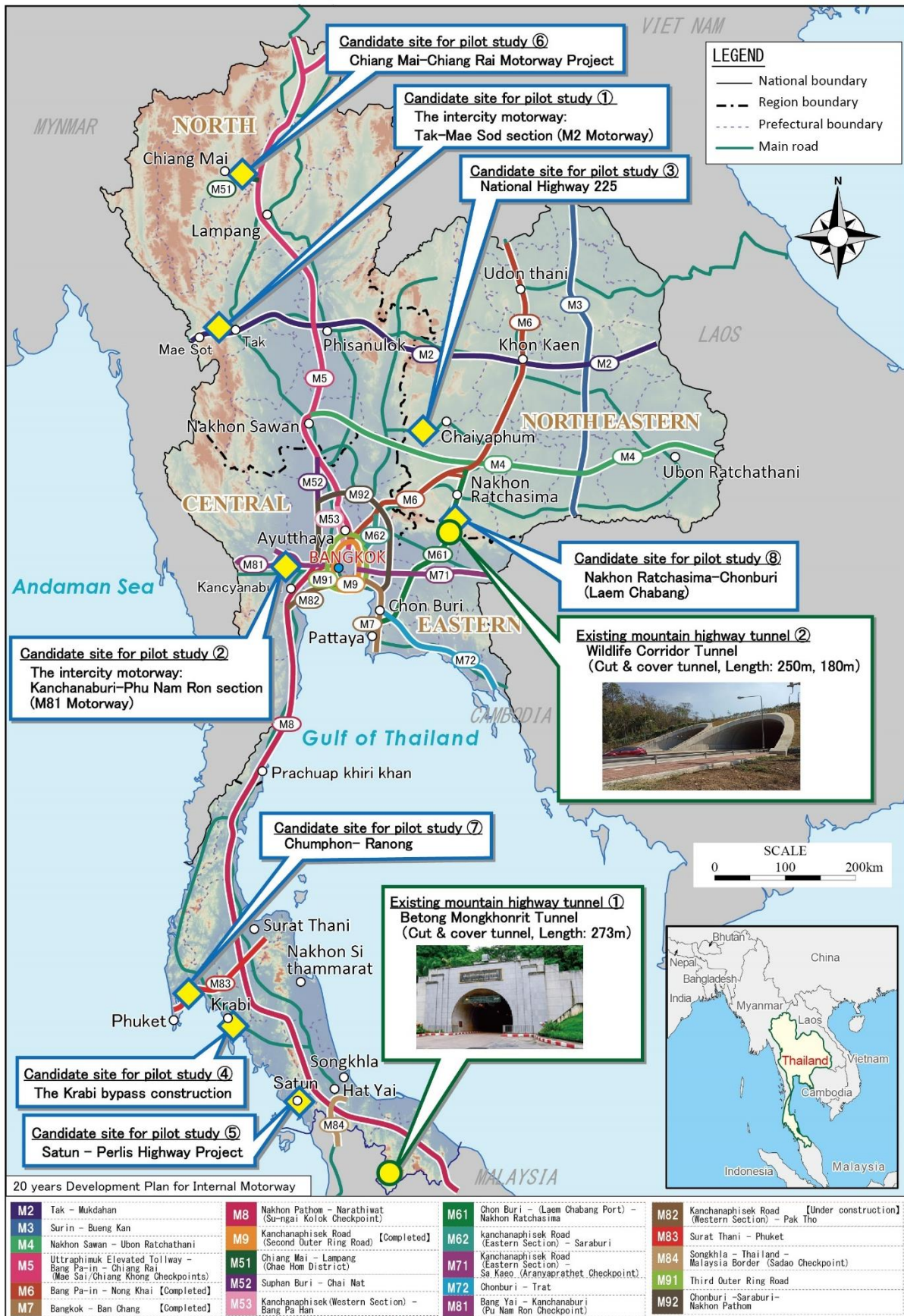
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**【Location Map: Thailand's Road Network and Pilot Study Candidate Sites】**



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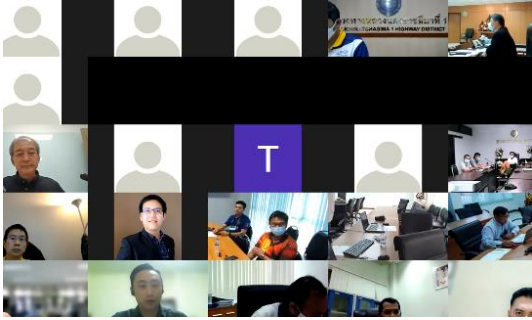

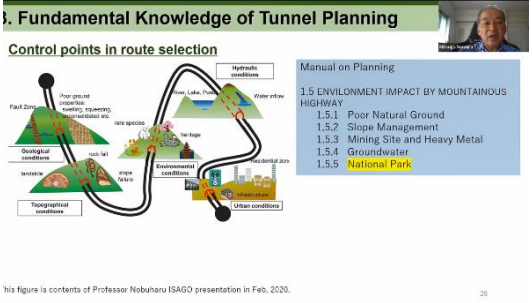
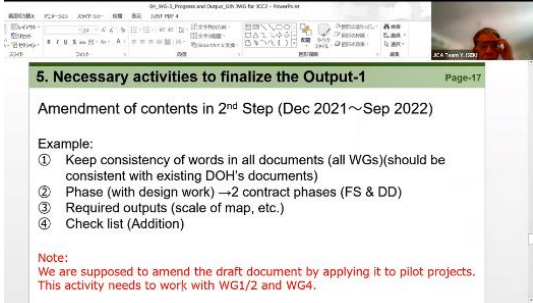
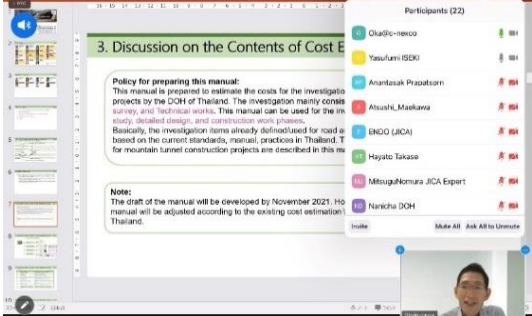



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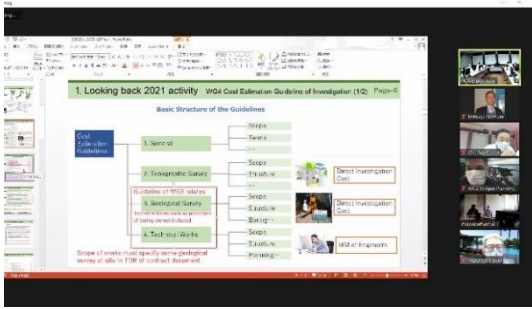
<p><b>【Photo1】 :Information Gathering Meeting with DOH</b></p>	<p><b>【Photo2】 :Baseline Survey (DOH)</b></p>
 <p align="center">(Date:2 March 2021)</p>	 <p align="center">(Date:21 June 2021)</p>
<p><b>【Photo3】 :2<sup>nd</sup> JWG Meeting (Online)</b></p>	<p><b>【Photo4】 :4<sup>th</sup> JWG Meeting</b></p>
 <p align="center">(Date:28 April 2021)</p>	 <p align="center">(Date:16 June 2021)</p>
<p><b>【Photo5】 :Baseline Survey (Local Survey Company)</b></p>	<p><b>【Photo6】 :Baseline Survey (Local Consultant)</b></p>
 <p align="center">(Date:17 June 2021)</p>	 <p align="center">(Date:18 June 2021)</p>
<p><b>【Photo7】 :Baseline Survey (Local Contractor)</b></p>	<p><b>【Photo8】 :1<sup>st</sup> JCC Meeting</b></p>
 <p align="center">(Date:16 June 2021)</p>	 <p align="center">(Date:21 June 2021)</p>

**【Photo Collection (2/7)】**

<p align="center"><b>【Photo9】 :1<sup>st</sup> Lecture of Tunnel Engineering (DOH)</b></p>  <p align="center">(Date:14 July 2021)</p>	<p align="center"><b>【Photo10】 :4<sup>th</sup> WG-1 (Online)</b></p>  <p align="center">(Date:2<sup>nd</sup> December 2021)</p>
<p align="center"><b>【Photo11】 :2<sup>nd</sup> WG-2 (Online)</b></p>  <p align="center">(Date:12 October 2021)</p>	<p align="center"><b>【Photo12】 :9<sup>th</sup> WG-3 (Online)</b></p>  <p align="center">(Date:27 October 2021)</p>
<p align="center"><b>【Photo13】 :4<sup>th</sup> WG-4 (Online)</b></p>  <p align="center">(Date:28 September 2021)</p>	<p align="center"><b>【Photo14】 :2<sup>nd</sup> WG-5 (Online)</b></p>  <p align="center">(Date:8 December 2021)</p>
<p align="center"><b>【Photo15】 :2<sup>nd</sup> JCC Meeting</b></p>  <p align="center">(Date:18 November 2021)</p>	<p align="center"><b>【Photo16】 :1<sup>st</sup> Technical Seminar</b></p>  <p align="center">(Date:19 November 2021)</p>

**【Photo Collection (3/7)】**

**【Photo17】 :12<sup>th</sup> WG-3 (Online)**



(Date:24 February 2022)

**【Photo18】 :5<sup>th</sup> WG-1 (Online)**



(Date:28 February 2022)

**【Photo19】 :Pilot Study (Krabi Bypass)**



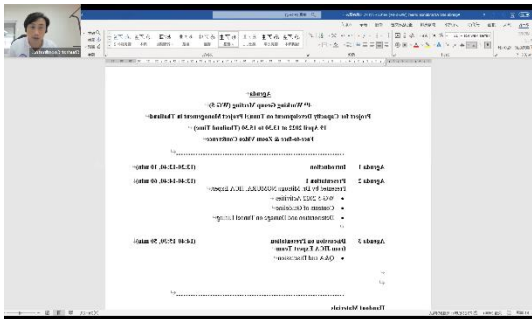
(Date:8 March 2022)

**【Photo20】 :3<sup>rd</sup> JCC Meeting**



(Date:10 March 2022)

**【Photo21】 :4<sup>th</sup> WG-5 (Online)**



(Date:19 April 2022)

**【Photo22】 :Pilot Study (Wild Life Corridor)**



(Date:11 May 2022)

**【Photo23】 :9<sup>th</sup> WG-2 (Online)**



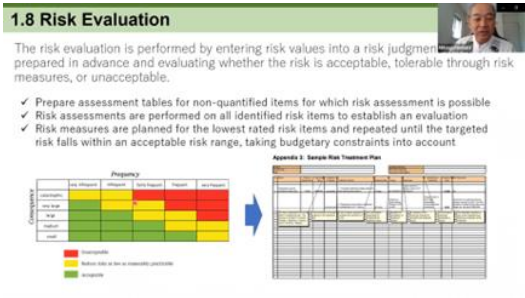







(Date:9 June 2022)

**【Photo24】 :Pilot Study (Tak Mae sod Motorway)**



(Date:22 June 2022)

**【Photo Collection (4/7)】**

<p align="center"><b>【Photo25】 :2<sup>nd</sup> Lecture of Tunnel Engineering</b></p>  <p align="center">(Date:21 July 2022)</p>	<p align="center"><b>【Photo26】 :12<sup>th</sup> WG-4 (Online)</b></p>  <p align="center">(Date:14 September 2022)</p>
<p align="center"><b>【Photo27】 :4<sup>th</sup> JCC Meeting</b></p>	<p align="center"><b>【Photo28】 :2<sup>nd</sup> Technical Seminar</b></p>
 <p align="center">(Date:22 September 2022)</p>	 <p align="center">(Date:27 September 2022)</p>
<p align="center"><b>【Photo29】 :1<sup>st</sup> Japan Training NEXCO CENTRAL Inspection of Yoro Tunnel</b></p>	<p align="center"><b>【Photo30】 :1<sup>st</sup> Japan Training NILIM (Inspection of Tunnel Test Facility of Actual Size)</b></p>
 <p align="center">(Date:21 November 2022)</p>	 <p align="center">(Date:25 November 2022)</p>
<p align="center"><b>【Photo31】 :1<sup>st</sup> Japanese Training Presentation</b></p>	<p align="center"><b>【Photo32】 :16<sup>th</sup> WG-1 (Online)</b></p>
 <p align="center">(Date:28 November 2022)</p>	 <p align="center">(Date:8 February 2023)</p>


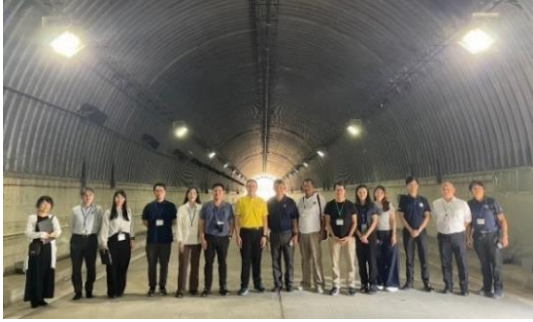






**【Photo Collection (5/7)】**

<p align="center"><b>【Photo33】 :15<sup>th</sup> WG-4 (Online)</b></p>	<p align="center"><b>【Photo34】 :5<sup>th</sup> JCC Meeting</b></p>
 <p align="center">(Date:21 February 2023)</p>	 <p align="center">(Date:22 March 2023)</p>
<p align="center"><b>【Photo35】 :10<sup>th</sup> JWG Meeting (Online)</b></p>	<p align="center"><b>【Photo36】 :2<sup>nd</sup> Japan Training NILIM (Inspection of Tunnel Test Facility of Actual Size)</b></p>
 <p align="center">(Date:10 May 2023)</p>	 <p align="center">(Date:12 May 2023)</p>
<p align="center"><b>【Photo37】 :2<sup>nd</sup> Japan Training VR Experience at FORUM8</b></p>	<p align="center"><b>【Photo38】 :2<sup>nd</sup> Japan Training NEXCO CENTRAL Inspection of Takamatsu Tunnel</b></p>
 <p align="center">(Date:16 May 2023)</p>	 <p align="center">(Date:17 May 2023)</p>
<p align="center"><b>【Photo39】 :20<sup>th</sup> WG-3 (Online)</b></p>	<p align="center"><b>【Photo40】 :19<sup>th</sup> WG-1, 18<sup>th</sup> WG-2 (Online)</b></p>
 <p align="center">(Date:13 June 2023)</p>	 <p align="center">(Date:28 June 2023)</p>

**【Photo Collection (6/7)】**

<p align="center"><b>【Photo41】 :12<sup>th</sup> JWG Meeting (Online)</b></p>	<p align="center"><b>【Photo42】 :6<sup>th</sup> JCC Meeting</b></p>
 <p align="center">(Date:24 August 2023)</p>	 <p align="center">(Date:26 September 2023)</p>
<p align="center"><b>【Photo43】 :3<sup>rd</sup> Technical Seminar</b></p>	<p align="center"><b>【Photo44】 :11<sup>th</sup> WG-5 Wildlife Corridor Tunnel On-Site Training</b></p>
 <p align="center">(Date:29 September 2023)</p>	 <p align="center">(Date:30 November 2023)</p>
<p align="center"><b>【Photo45】 :WG-5 On-Site Training of Tunnel Facilities O&amp;M (Wildlife Corridor Tunnel)</b></p>	<p align="center"><b>【Photo46】 :19<sup>th</sup> JWG Meeting (Online)</b></p>
 <p align="center">(Date: 13 December 2023)</p>	 <p align="center">(Date:20 December 2023)</p>
<p align="center"><b>【Photo47】 :3<sup>rd</sup> Japan Training NEXCO CENTRAL Site visit</b></p>	<p align="center"><b>【Photo48】 : 3<sup>rd</sup> Japan Training Tokyo Metropolitan University lecture</b></p>
 <p align="center">(Date:18 January 2024)</p>	 <p align="center">(Date:19 January 2024)</p>

**【Photo Collection (7/7)】**

<p align="center"><b>【Photo49】 :7<sup>th</sup> JCC Meeting</b></p>  <p align="center">(Date:26 March 2024)</p>	<p align="center"><b>【Photo50】 :4<sup>th</sup> Japan Training NILM Lecture</b></p>  <p align="center">(Date:12 June 2024)</p>
<p align="center"><b>【Photo51】 4<sup>th</sup> Japan Training NEXCO East Shodo Tunnel Site visit</b></p>  <p align="center">(Date:14 June 2024)</p>	<p align="center"><b>【Photo52】 :13<sup>th</sup> WG-5</b></p>  <p align="center">(Date:26 September 2024)</p>
<p align="center"><b>【Photo53】 :8<sup>th</sup> JCC Meeting</b></p>  <p align="center">(Date:18 December 2024)</p>	<p align="center"><b>【Photo54】 : Site survey of Highway 304 Wildlife Corridor Tunnel</b></p>  <p align="center">(Date:19 December 2024)</p>
<p align="center"><b>【Photo55】 :7<sup>th</sup> JICA Technical Advisory Committee</b></p>  <p align="center">(Date:20 December 2024)</p>	<p align="center"><b>【Photo56】 :4<sup>th</sup> Technical Seminar</b></p>  <p align="center">(Date:20 December 2024)</p>

### 【List of Abbreviations】

Abbreviation	Description
D/D	Detailed Design
DAC	Development Assistance Committee
DOH	Department of Highways
EIA	Environmental Impact Assessment
F/S	Feasibility Study
GNI	Gross National Income
GRP	Gross Regional Product
IEE	Initial Environmental Examination
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
JWG	Joint Working Group
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MoNRE	Ministry of Natural Resources and Environment
MOT	Ministry of Transport
MR-Map	Intercity Motorway and Railway Network Development Plan
NEXCO	Nippon Expressway Company Limited
NFPA	National Fire Protection Association
O&M	Operation and Maintenance
ONEP	Office of Natural Resources and Environmental Policy and Planning
PDM	Project Design Matrix
PO	Plan of Operations
R/D	Record of Discussions
RMR	Rock Mechanics Rating
RQD	Rock Quality Designation
TOMIE	Tunnel Operations, Maintenance, Inspection, and Evaluation Manual
TOR	Terms of Reference
WG	Working Group

# **CHAPTER 1 BASIC INFORMATION OF THE PROJECT**

## **1.1 Project Country**

Kingdom of Thailand

## **1.2 Title of the Project**

Project for Capacity Development on Tunnel Project Management in Thailand

## **1.3 Duration of the Project**

December 28, 2020 to February 28, 2025 (4 years 2 months)

## **1.4 Background**

Thailand is classified as a middle-income country with a Gross National Income (GNI) per capita of USD 6,610. However, significant regional economic disparities exist; while the Gross Regional Product (GRP) per capita in the Central Region is THB 280,000 (2017, Thailand National Economic and Social Development Plan 2017–2021), it is only THB 74,000 in the Northeastern Region (2017, Thailand National Economic and Social Development Plan 2017–2021). Bridging the economic gap between Bangkok and rural areas remains a significant development challenge.

In Thailand, roads account for 84% of passenger transport and 88% of freight transport (2017, Office of Transport and Traffic Policy and Planning, Ministry of Transport), underscoring their importance as essential transport infrastructure. While major national highways connecting key cities are well-developed with three or more lanes per side and central medians, mountainous areas in the North and West are often served by single-lane roads with sharp curves and steep gradients, necessitating road improvements for safer and more efficient passenger and freight transport.

Thailand's development policies, including the 12th National Economic and Social Development Plan (2017–2021) and the Department of Highways (DOH)'s Intercity Motorway Development Master Plan (2017–2036), emphasize new road construction and improvements to existing roads. The Master Plan outlines an investment of approximately THB 2 trillion (about JPY 6.5 trillion) to develop a 6,600-kilometer expressway network with controlled access. This plan includes routes that connect major cities in mountainous areas via expressways, incorporating several planned mountainous road tunnels to secure optimal alignments, with some tunnels exceeding 10 kilometers in length.

On the other hand, although Thailand has experience in project management for railway tunnels and waterway tunnels, it lacks experience in mountainous road tunnels, which require large cross-sections and emergency facilities. For the smooth implementation of the planned mountainous road tunnel projects, it is essential to enhance the capabilities in investigation, planning, design, construction management, and maintenance.

Under these circumstances, with the aim of strengthening tunnel project management capabilities, the Thai government requested Japan to implement the "Project for Capacity Development on Tunnel Management in Thailand" (hereafter referred to as "the Project"). In September 2020, JICA and the Ministry of Transport of Thailand (MOT) signed the Record of Discussions (R/D) regarding the implementation of the Project, with the Department of Highways (DOH) designated as the counterpart (C/P) agency for its execution.

**1.5 Overall Goal and Project Purpose**

Overall Goal, Project Purpose and Outputs are shown in Table 1-1.

**Table 1-1 Overall Goal, Project Purpose and Outputs**

Overall Goal	Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	
Project Purpose	A base of management of mountain highway tunnel projects is established in DOH.	
	【Indicator1】	DOH assigns not less than 5 staff members who are in charge of tunnel project. (investigation and design)
	【Indicator2】	At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.
Expected Outputs	【Output 1】	DOH's human resources, institution and scope of works on tunnel project are established.
	【Output 2】	DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.
	【Output 3】	DOH's capacity of investigation on mountain highway tunnels is enhanced.
	【Output 4】	DOH's capacity of design on mountain highway tunnel is enhanced.

**1.6 Implementing Agency**

DOH: Department of Highways

**1.7 Project Implementation Schedule**

The project implementation schedule is shown in Figure 1-1.

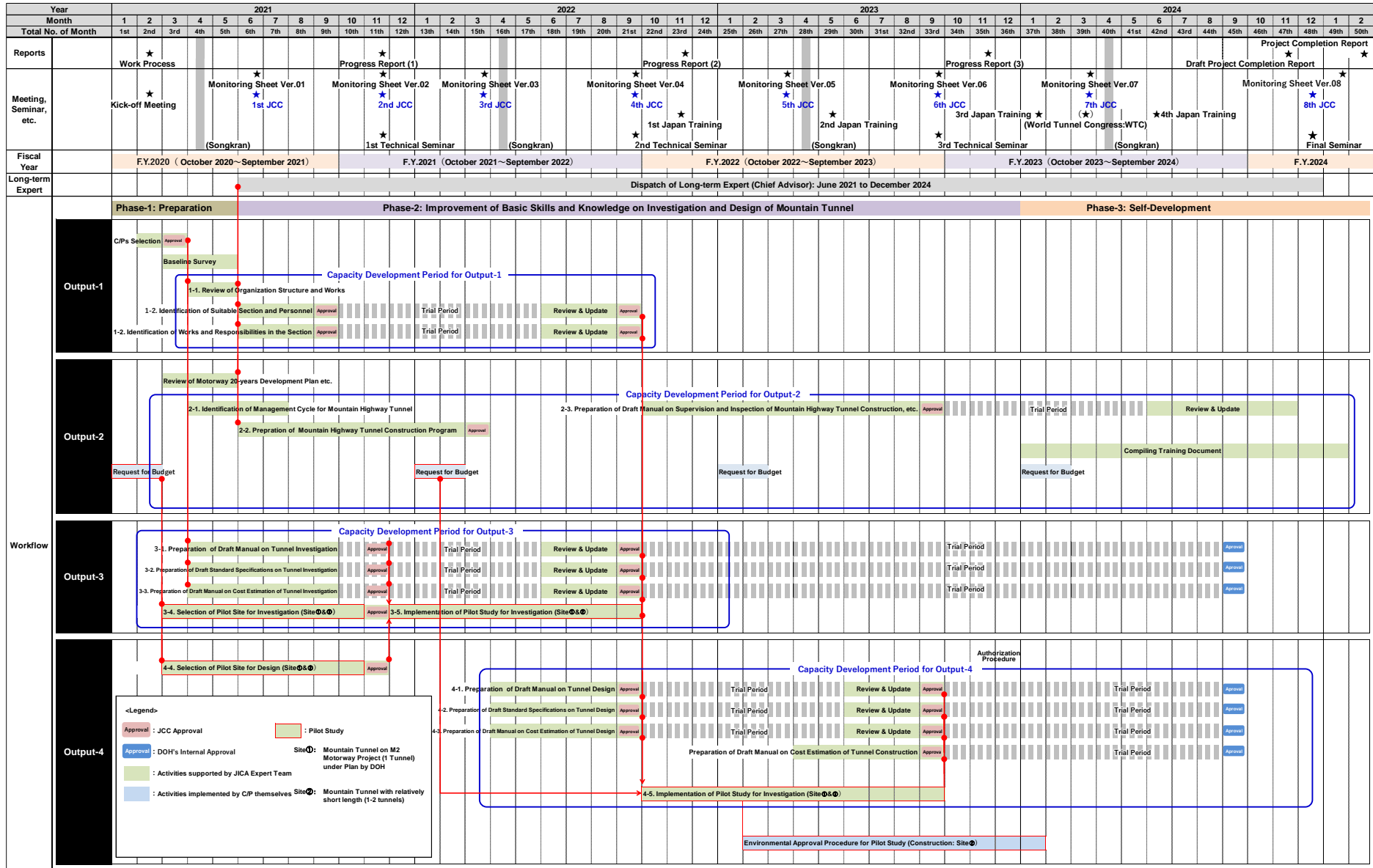


Figure 1-1 Implementation Schedule

## CHAPTER 2 RESULTS OF THE PROJECT

### 2.1 Project Inputs

#### 2.1.1 Input by the Japanese Side

Table 2-1 summarizes Inputs by the Japanese Side. Additionally, the training and seminars conducted in this project the project is shown in Table 2-2.

**Table 2-1 Achievements of Inputs by the Japanese Side**

Inputs	Plan (PDM ver.6.0)	Achievement
Experts	<ol style="list-style-type: none"> <li>1. Long-term Expert</li> <li>2. Short-term Experts               <ol style="list-style-type: none"> <li>1) Team Leader / Mountain Highway Planning</li> <li>2) Deputy Team Leader/Mountain Highway Planning 2</li> <li>3) Tunnel Planning (Location and Structure)</li> <li>4) Tunnel Planning (Environmental and Social Consideration)</li> <li>5) Tunnel Design (Structure)</li> <li>6) Tunnel Design (Facilities)</li> <li>7) Cost Estimation (Investigation, Design, Construction/Civil)</li> <li>8) Cost Estimation (Investigation, Design, Construction/Facilities)</li> <li>9) Construction Plan / Safety Management</li> <li>10) Geological Investigation for Tunnel Planning and Design</li> <li>11) Contract Management (For Investigation and Design)</li> <li>12) Contract Management (For Construction)</li> <li>13) Training Planning</li> <li>14) Project Monitoring / Public Relations</li> </ol> </li> </ol>	<ol style="list-style-type: none"> <li>1. Long-term Expert MM:42.0MM/42.0MM <b><u>Progress:100.0%</u></b></li> <li>2. Short-term Expert MM:110.83/110.83MM <b><u>Progress:100.0%</u></b></li> </ol>
Japan Training	4 times in total	4 times implemented ( <b><u>Progress:100.0%</u></b> )
Seminar/Training	4 times in total	4 times implemented ( <b><u>Progress:100.0%</u></b> )
Equipment	<ol style="list-style-type: none"> <li>1. UC-win/Road Advanced (2 licenses)</li> <li>2. Geomap3D (2 licenses)</li> <li>3. Monitor (2 sets)</li> <li>4. Laptop PC etc. (6 sets)</li> <li>5. AUTODESK Architecture, Engineering &amp; Construction Collection (2 licenses)</li> </ol>	<ol style="list-style-type: none"> <li>1. Procurement completed (April 2021)</li> <li>2. Procurement completed (April 2021)</li> <li>3. Procurement completed (June 2021)</li> <li>4. Procurement completed (June 2022)</li> <li>5. Procurement completed (December 2022, December 2023) <b><u>Progress:100.0%</u></b></li> </ol>

**Table 2-2 Implementation Status of the Training and Seminars**

Training/Seminar		Date	Achievement
Technical Seminar	1 <sup>st</sup>	19 November 2021	<ul style="list-style-type: none"> <li>Project Outline (Japanese Expert)</li> <li>Draft Investigation Manual for Road Tunnels (C/P: DOH)</li> <li>Keynote Speech “Geological Future in Thailand” (Prof. Suttisak Soralump:Kasetsart University,)</li> <li>Presentation on Tunneling Technology in Japan (Japanese Expert)</li> </ul>
	2 <sup>nd</sup>	27 September 2022	<ul style="list-style-type: none"> <li>Investigation Manual for Road Tunnels (C/P: DOH)</li> <li>Draft Design Manual for Road Tunnels (C/P: DOH)</li> <li>Draft Planning Manual for Road Tunnels (C/P: DOH)</li> <li>Presentation on Japanese Technology (Akros Trading (Thailand) Co. Ltd, Nikkari Co. Ltd)</li> <li>Keynote Speech “Experiences from Mountain Tunnel Projects in Thailand” (Prof. Noppadol Phien-wej: Asian Institute of Technology)</li> <li>Keynote Speech “Importance of Investigation for Tunnelling” (Prof. ISAGO Nobuharu: Tokyo Metropolitan University)</li> </ul>
	3 <sup>rd</sup>	29 September 2023	<ul style="list-style-type: none"> <li>Design Manual for Road Tunnels (Civil Works) (C/P: DOH)</li> <li>Planning Manual for Road Tunnels (C/P: DOH)</li> <li>Design Manual for Road Tunnels (Tunnel Facilities) (C/P: DOH)</li> <li>Keynote Speech “On-Site Visualization as a new strategy for infrastructure monitoring” (Dr. AKUTAGAWA Shinichi: Kobe University)</li> <li>Presentation on Japanese Technology (8 Japanese Companies)</li> </ul>
	4 <sup>th</sup>	20 December 2024	<ul style="list-style-type: none"> <li>Keynote Speech “Prospects for Mountain Tunnel Projects in Thailand” (Chair: ISAGO Nobuharu: Tokyo Metropolitan University)</li> <li>Keynote Speech “Introduction to the Japan Tunnelling Association” (Member Yasuhiro Ishikawa: Japan Tunneling Association)</li> <li>Keynote Speech “The Importance of Maintenance and Management of Mountain Tunnels” (Member: Toshio Suzuki: Tunnel Division and Road Research Department, Nippon Expressway Research Institute Company Limited)</li> <li>“Introduction to Potential Future Tunnel Projects in Thailand” (C/P: DOH)</li> <li>Project Completion Report (C/P: DOH)</li> </ul>
Japan Training	1 <sup>st</sup>	High Officials: 20 November 2022 ~26 November 2022 Trainee: 16 November 2022 ~29 November 2022	<ul style="list-style-type: none"> <li>Targeting mainly management personnel and WG leaders, the program includes lectures on facility management and overall project supervision, along with visits to relevant locations. 【3 High Officials, 10 Trainees】</li> </ul>
	2 <sup>nd</sup>	10 May 2023 ~23 May 2023	<ul style="list-style-type: none"> <li>The training primarily consists of practitioners and engineers, aiming to complement the on-site activities of the project's working groups and to enhance knowledge in investigation, design, and planning related to mountainous road tunnels. 【10 Trainees】</li> </ul>
	3 <sup>rd</sup>	10 January 2024	<ul style="list-style-type: none"> <li>The training primarily consists of practitioners and engineers, aiming to complement the on-site activities</li> </ul>

Training/Seminar		Date	Achievement
		~23 January 2024	of the project's working groups and to enhance knowledge in design changes, and cost estimation related to mountainous road tunnels. 【8 Trainees】
	4 <sup>th</sup>	5 June 2024 ~18 June 2024	<ul style="list-style-type: none"> <li>The training primarily consists of practitioners and engineers, aiming to complement the on-site activities of the project's working groups and to enhance knowledge in operations, and maintenance related to mountainous road tunnels. 【12 Trainees】</li> </ul>

### 2.1.2 Input by the Thai Side

Table 2-3 summarizes the Thai inputs. Additionally, the members of the Joint Coordination Committee (JCC) and Working Groupe Activity Themes are shown in Table 2-4 and Table 2-5, respectively.

**Table 2-3 Inputs by the Thai Side (Plan and Actual)**

Inputs	Plan (PDM ver.6.0)	Achievement
Personnel Allocation	<ol style="list-style-type: none"> <li>JCC Chairperson</li> <li>JCC Deputy Chairperson</li> <li>JCC Project Director</li> <li>JCC Project Manager</li> <li>JCC Committee</li> <li>JCC Members (WG1 leader)</li> <li>JCC Members (WG2 leader)</li> <li>JCC Members (WG3 leader)</li> <li>JCC Members (WG4 leader)</li> <li>JCC Members (WG5 leader)</li> <li>Secretary</li> <li>WG Members (71 persons)</li> </ol>	All personnel listed above (a total of 82 members) have been allocated by DOH. <b>(Progress: 100.0%)</b>
Running Expenses	<ol style="list-style-type: none"> <li>Provision of Project Office</li> <li>Project Running Expenses</li> <li>Budget for Pilot Study</li> </ol>	<ol style="list-style-type: none"> <li>Provided</li> <li>Provided</li> <li>Provided</li> </ol>

**Table 2-4 Members of Joint Coordination Committee (JCC)**

In charge	Name	Position
Chairperson	Mr. Sarawut Songsivilai (To 30 September 2024)	Director-General, DOH
	Mr. Apirat Chaiwongnoi (From 1 October 2024)	
Deputy Chairperson	Dr. Montri Dechasakulsom (To February 2023)	Deputy Director-General for Engineering, DOH
	Dr. Piyapong Jiwattanakupaisarn (From March 2023)	
Project Director	Mr. Sittichai Boonsaat	Chief Engineer for Location and Design, DOH
Project Manager	Dr. Danai Ruengsorn (To January 2024)	Director, Bureau of International Highways Cooperation, DOH
	Dr. Tunwin Svasdisant (From February 2024)	
Committee	Dr. Prechaporn Suwatnodom (To August 2022)	Deputy Director, Bureau of International Highways Cooperation, DOH

In charge	Name	Position
	Dr. Prechaporn Suwatnodom (September 2022~January 2024)	
	Dr. Bhanitiz Aursudkij (From February 2024)	

**Table 2-5 Working Groupe Activity Themes and Leaders**

WG	Activity Themes	Leader (Name)
WG-1	Tunnel Investigation and Design	Mr. Wirote Kongkeaw
WG-2	Tunnel Planning	Dr. Puttipan Seraneeprakarn
WG-3	Contract (Tunnel)	Mr. Sawang Buranathananukit
WG-4	Cost Estimation (Tunnel)	Mr. Pornchai Silarom
WG-5	Tunnel Operation and Maintenance	Dr. Tunwin Svasdisant (Till 14 March 2024)
		Dr. Apichai Issariyanukula (From 15 March 2024)

## 2.2 Project Activities

### 2.2.1 JCC and WG

The records of JCC and WG activities are shown in Table 2-6 and Table 2-7.

**Table 2-6 Records of JCC**

JCC	Date	Summary
1 <sup>st</sup>	21 June 2021	<ul style="list-style-type: none"> <li>• Selection of C/Ps</li> <li>• Approval of PDM ver.1.0</li> <li>• Approval of Policy on Selection of Pilot Study Sites</li> <li>• Approval of Selection of Pilot Study Sites</li> </ul>
2 <sup>nd</sup>	18 November 2021	<ul style="list-style-type: none"> <li>• Approval of Retitle of the Manuals</li> <li>• Approval of Draft of newly established section/unit and personnel for Tunnel Projects</li> <li>• Approval of Draft Investigation Manual for Road Tunnels</li> <li>• Approval of Draft Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels [Investigation]</li> <li>• Approval of Draft Guidelines for Cost Estimation of Road Tunnel Projects [Investigation]</li> </ul>
3 <sup>rd</sup>	10 March 2022	<ul style="list-style-type: none"> <li>• Pilot Study (Tunnel Investigation) Report</li> <li>• Approval of PDM ver.2.0</li> </ul>
4 <sup>th</sup>	22 September 2022	<ul style="list-style-type: none"> <li>• Approval of Investigation Manual for Road Tunnels</li> <li>• Approval of Draft Design Manual for Road Tunnels</li> <li>• Approval of Draft Planning Manual for Road Tunnels</li> <li>• Approval of Guidelines for Determination of Scope of Works for Investigation and Design for Road Tunnels (For Investigation)</li> <li>• Approval of Draft Guidelines for Determination of Scope of Work for Investigation and Design for Tunnels (For Design)</li> <li>• Approval of Guidelines for Cost Estimation of Road Tunnel Projects (For Investigation)</li> <li>• Approval of Draft Guidelines for Cost Estimation of Road Tunnel Projects (For Design (Civil))</li> <li>• Approval of PDM ver.3.0</li> </ul>

JCC	Date	Summary
5 <sup>th</sup>	22 March 2023	<ul style="list-style-type: none"> <li>• Approval of Design Manual of Road Tunnels (Tunnel Facilities)</li> <li>• Approval of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Tunnel Facilities)</li> <li>• Report of 1st Japan Training</li> <li>• Approval of PDM ver.4.0</li> </ul>
6 <sup>th</sup>	26 September 2023	<ul style="list-style-type: none"> <li>• Pilot Study (Tunnel design) Report</li> <li>• Approval of Design Manual of Road Tunnels (Civil Works)</li> <li>• Approval of Design Manual of Road Tunnels (Facility)</li> <li>• Approval of Planning Manual of Road Tunnels</li> <li>• Approval of Guidelines for Determination of Scope of Work for Design for Road Tunnels</li> <li>• Approval of Draft Guidelines for Design Change of Road Tunnel Projects</li> <li>• Approval of Guidelines for Cost Estimation of Road Tunnel Projects for Design</li> <li>• Approval of Draft Guidelines for Cost Estimation of Road Tunnel Projects for Construction</li> <li>• Approval of Draft Guidelines for Supervision and Inspection of Road tunnel Construction</li> <li>• Approval of Draft Guidelines for Operation &amp; Maintenance of Road Tunnels</li> <li>• Report of 2nd Japanese Training</li> </ul>
7 <sup>th</sup>	26 March 2024	<ul style="list-style-type: none"> <li>• JICA Technical Advisory Committee Report</li> <li>• Report of 3rd Japanese Training</li> <li>• Approval of PDM ver.5.0</li> </ul>
8 <sup>th</sup>	18 December 2024	<ul style="list-style-type: none"> <li>• Additional Training (Operation and Maintenance) Report</li> <li>• Report of 4th Japanese Training</li> <li>• Approval of PDM ver.6.0</li> <li>• Confirmation of Project Completion</li> </ul>

**Table 2-7 Records of WG Activities**

WG	Date	Summary
WG-1 Investigation & Design	1 <sup>st</sup>	22 June 2021 <u>Kickoff Meeting</u> <ul style="list-style-type: none"> <li>• Overview of Project</li> <li>• Introduction of Working Group (WG) Members</li> <li>• Activity Schedule for WG</li> <li>• Discussion on Manual Preparation and Content</li> </ul>
	2 <sup>nd</sup>	25 August 2021 <u>Preparation of the Investigation Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Overview of Geological Surveys</li> <li>• Geological Characteristics of Thailand</li> </ul>
	3 <sup>rd</sup>	14 October 2021 <u>Preparation of the Investigation Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Objectives and Selection of Investigations by Phase</li> <li>• Outcomes of Investigation Results</li> </ul>
	4 <sup>th</sup>	2 December 2021 <u>Preparation of the Investigation Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Characteristics of Various Rock Types and Geological Structures</li> <li>• Special Ground Conditions</li> </ul>
	5 <sup>th</sup>	28 February 2022 <u>Preparation of the Investigation Manual of Road Tunnels</u> <ul style="list-style-type: none"> <li>• Geological Risks in Tunnel Construction</li> <li>• Case Studies on the Use of BIM and VR Tools in Planning/Design Operations</li> </ul>
	6 <sup>t</sup>	24 March 2022 <u>Preparation of the Design Manual of Road Tunnels (Civil Works) (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on Table of Contents Structure (Part 1)</li> </ul>
	7 <sup>th</sup>	1 April 2022 <u>Preparation of the Design Manual of Road Tunnels (Civil Works) (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on Table of Contents Structure (Part 2)</li> </ul>

WG	Date	Summary
	8 <sup>th</sup> 6 May 2022	<u>Preparation of the Design Manual of Road Tunnels (Civil Works) (Draft)</u> <ul style="list-style-type: none"> <li>· Alignment for Mountain Highway Tunnels</li> <li>· Tunnel Design Methods</li> <li>· Cross-sectional Design</li> </ul>
	9 <sup>th</sup> 8 June 2022	<u>Preparation of the Design Manual of Road Tunnels (Civil Works) (Draft)</u> <ul style="list-style-type: none"> <li>· Ground Classification</li> <li>· Portal Design</li> <li>· Tunnel Support Design</li> <li>· Auxiliary Construction Methods</li> <li>· Excavation Method/Excavation Technique</li> </ul>
	10 <sup>th</sup> 22 June 2022	<u>Preparation of the Design Manual of Road Tunnels (Civil Works) (Draft)</u> <ul style="list-style-type: none"> <li>· Waterproofing/Drainage Works</li> <li>· Paving Inside Tunnel</li> <li>· Other Tunnel Structures</li> </ul>
	11 <sup>th</sup> 27 June 2022	<u>Preparation of the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</u> <ul style="list-style-type: none"> <li>· Design Standards for Tunnel Facilities</li> <li>· Risk Tolerance and Countermeasures</li> <li>· Overview of Tunnel Facilities</li> </ul>
	12 <sup>th</sup> 26 July 2022	<u>Preparation of the Design Manual of Road Tunnels (Civil Works) (Draft)</u> <ul style="list-style-type: none"> <li>· Tunnel Construction Plan</li> </ul>
	13 <sup>th</sup> 1 August 2022	<u>Preparation of the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</u> <ul style="list-style-type: none"> <li>· Emergency Facility Design for Tunnels</li> </ul>
	14 <sup>th</sup> 9 November 2022	<u>Preparation of the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Table of Contents Structure (Part 2)</li> </ul>
	15 <sup>th</sup> 13 December 2022	<u>Preparation of the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</u> <ul style="list-style-type: none"> <li>· Ventilation Equipment Design</li> </ul>
	16 <sup>th</sup> 7 February 2023	<u>Preparation of the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</u> <ul style="list-style-type: none"> <li>· Lighting Equipment Design</li> <li>· Water Spray Systems</li> </ul>
	17 <sup>th</sup> 27 April 2023	<u>Guidelines for Implementing the Pilot Project</u> <ul style="list-style-type: none"> <li>· Guidelines for Pilot Project Using the Design Manual of Road Tunnels (Civil Works) (Draft)</li> <li>· Guidelines for Pilot Project Using the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</li> </ul>
	18 <sup>th</sup> 13 June 2023	<u>Implementation of Pilot Project (Civil Works)-Part1</u> <ul style="list-style-type: none"> <li>· Rock Mass Classification</li> <li>· Preparation of Tunnel Project Cost Estimates and Construction Schedules</li> </ul>
	19 <sup>th</sup> 28 June 2023	<u>Implementation of Pilot Project (Civil Works)-Part2</u> <ul style="list-style-type: none"> <li>· Rock Mass Classification</li> <li>· Preparation of Tunnel Project Cost Estimates and Construction Schedules</li> </ul>
	20 <sup>th</sup> 3 July 2023	<u>Implementation of Pilot Project (Tunnel Facilities)-Part1</u> <ul style="list-style-type: none"> <li>· Emergency Facilities for Tunnels</li> </ul>
	21 <sup>st</sup> 27 July 2023	<u>Implementation of Pilot Project (Tunnel Facilities)-Part2</u> <ul style="list-style-type: none"> <li>· Emergency Facilities for Tunnels</li> </ul>
	22 <sup>nd</sup> 20 May 2024	<u>Observation and Measurement -Part 1</u> <ul style="list-style-type: none"> <li>· Tunnel Measurement – A</li> <li>· Tunnel Measurement – B</li> </ul>
	23 <sup>rd</sup> 27 June 2024	<u>Observation and Measurement -Part 2</u> <ul style="list-style-type: none"> <li>· Tunnel Measurement – A</li> <li>· Tunnel Measurement – B</li> </ul>
	24 <sup>th</sup> 25 September 2024	<u>Geological Risk Management</u> <ul style="list-style-type: none"> <li>· Japanese Case Studies of Tunnel Collapse Incidents</li> <li>· Risk Factors and Countermeasures</li> <li>· Quality Control Testing, Surveying, and Benchmarking</li> </ul>

WG	Date	Summary
WG-2 Planning	1 <sup>st</sup>	8 July 2021 <u>Kickoff Meeting</u> <ul style="list-style-type: none"> <li>• Overview of Project</li> <li>• Introduction of Working Group (WG) Members</li> <li>• Activity Schedule for WG</li> <li>• Discussion on Manual Preparation and Content</li> </ul>
	2 <sup>nd</sup>	21 October 2021 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Introduction to Design Methods for Mountain Highway Tunnels</li> </ul>
	3 <sup>rd</sup>	18 February 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Alignment Planning for Mountain Roads</li> </ul>
	4 <sup>th</sup>	18 March 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on the Table of Contents (Tunnel Planning) (1)</li> </ul>
	5 <sup>th</sup>	23 March 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Environmental and Social Considerations in DOH Projects</li> </ul>
	6 <sup>th</sup>	31 March 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on the Table of Contents (Tunnel Planning) (2)</li> </ul>
	7 <sup>th</sup>	6 May 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Tunnel Cross-Section Planning</li> <li>• Tunnel Alignment Planning</li> <li>• Tunnel Portal Planning</li> </ul>
	8 <sup>th</sup>	17 May 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Environmental and Social Considerations for Mountain Highway Tunnel Projects (1)</li> </ul>
	9 <sup>th</sup>	9 June 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Tunnel Outline Design</li> <li>• Tunnel Construction Plan</li> </ul>
	10 <sup>th</sup>	24 June 2022 <u>Preparation of the Planning Manual of Road Tunnels (Draft)</u> <ul style="list-style-type: none"> <li>• Tunnel Facility Planning</li> <li>• Risk Management</li> <li>• Preliminary Cost Estimation for Tunnels</li> </ul>
	11 <sup>th</sup>	31 August 2022 <u>Preparation of Planning Manual of Road Tunnels (Planning)</u> <ul style="list-style-type: none"> <li>• Preparation of JCC Presentation Materials for the Design Manual (Draft)</li> </ul>
	12 <sup>th</sup>	22 September 2022 <u>Preparation of Planning Manual of Road Tunnels (Planning)</u> <ul style="list-style-type: none"> <li>• Presentation Rehearsal for the Design Manual (Draft)</li> </ul>
	13 <sup>th</sup>	25 October 2023 <u>Preparation of Planning Manual of Road Tunnels (Planning)</u> <ul style="list-style-type: none"> <li>• Environmental and Social Considerations for Mountain Highway Tunnel Projects (2)</li> </ul>
	14 <sup>th</sup>	2 November 2022 <u>Preparation of Planning Manual of Road Tunnels (Planning)</u> <ul style="list-style-type: none"> <li>• Environmental and Social Considerations for Mountain Highway Tunnel Projects (3)</li> </ul>
	15 <sup>th</sup>	9 November 2022 <u>Preparation of Planning Manual of Road Tunnels (Planning)</u> <ul style="list-style-type: none"> <li>• Discussion on Additional Items for Inclusion in the Planning Manual (Draft)</li> </ul>
	16 <sup>th</sup>	7 February 2023 <u>Preparation of the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</u> <ul style="list-style-type: none"> <li>• Lighting Equipment Design</li> <li>• Water Spray Facilities</li> </ul>
	17 <sup>th</sup>	27 April 2023 <u>Implementation Policy for Pilot Project</u> <ul style="list-style-type: none"> <li>• Implementation Policy for Pilot Project Utilizing the Design Manual of Road Tunnels (Civil Works) (Draft)</li> <li>• Implementation Policy for Pilot Project Utilizing the Design Manual of Road Tunnels (Tunnel Facilities) (Draft)</li> </ul>
	18 <sup>th</sup>	13 June 2023 <u>Pilot Project (Civil Works) Implementation (1)</u> <ul style="list-style-type: none"> <li>• Rock Mass Classification</li> <li>• Preparation of Tunnel Project Cost Estimates and Construction Schedules</li> </ul>
	19 <sup>th</sup>	28 June 2023 <u>Pilot Project (Civil Works) Implementation (2)</u> <ul style="list-style-type: none"> <li>• Rock Mass Classification</li> <li>• Preparation of Tunnel Project Cost Estimates and Construction Schedules</li> </ul>

WG	Date	Summary
WG-3 Contract	1 <sup>st</sup>	2 July 2021 <u>Kickoff Meeting</u> <ul style="list-style-type: none"> <li>• Overview of Project</li> <li>• Introduction of Working Group (WG) Members</li> <li>• Activity Schedule for WG</li> <li>• Discussion on Manual Preparation and Content</li> </ul>
	2 <sup>nd</sup>	5 August 2021 <u>Confirmation of Current DOH-Related Matters Required for Preparation of Draft Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Investigation) (Civil Works)</u>
	3 <sup>rd</sup>	18 August 2021 <ul style="list-style-type: none"> <li>• Project Phases and Deliverables</li> <li>• Construction Contract- Related Documents</li> <li>• Examples of Terms of Reference (TOR) for Investigation and Design Work</li> </ul>
	4 <sup>th</sup>	2 September 2021 <ul style="list-style-type: none"> <li>• Collection of Contractual Information within DOH</li> <li>• Discussion on Table of Contents for WG-3 Deliverables</li> <li>• Electronic Bidding Process and Contract Committee</li> </ul>
	5 <sup>th</sup>	14 September 2021 <ul style="list-style-type: none"> <li>• Registration and Ranking of Consultants (Consultant Information Center) and Contractors (Management Division)</li> <li>• Overview of Design Changes and Processes during Construction</li> <li>• Design Changes in Consulting Work</li> <li>• Comparison of Contractual Matters between DOH and Japan</li> <li>• Overview of the Table of Contents for the Draft Guidelines prepared by WG-3</li> </ul>
	6 <sup>th</sup>	29 September 2021 <u>Preparation of Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels</u> <ul style="list-style-type: none"> <li>• Proposal for Document Title Change (Specification → Guideline)</li> <li>• Discussion on the Table of Contents for Technical Assistance Documents (Draft) (Verification of Required and Deliverable Items)</li> </ul>
	7 <sup>th</sup>	6 October 2021 <ul style="list-style-type: none"> <li>• Review of Content for Submission at JCC2</li> <li>• Review of Content for Submission at JCC2</li> </ul>
	8 <sup>th</sup>	14 October 2021 <ul style="list-style-type: none"> <li>• Draft Presentation Material for the 5th JWG</li> <li>• Draft of Output1 to be Approved at the 2nd JCC</li> <li>• Timeline for the 2nd JCC</li> </ul>
	9 <sup>th</sup>	27 October 2021 <ul style="list-style-type: none"> <li>• Progress toward the 2nd JCC</li> <li>• Output of the 6th JWG</li> </ul>
	10 <sup>th</sup>	26 November 2021 <ul style="list-style-type: none"> <li>• Open Discussion for the Next Phase (2021/12–2022/9)</li> <li>• Confirmation of the “Revision Policy” of the Draft</li> <li>• Summary of Today's Discussion and Tentative Approval of 2022 Activities</li> </ul>
	11 <sup>th</sup>	17 December 2021 <ul style="list-style-type: none"> <li>• Meeting Confirmation of November 26, 2021</li> <li>• Proposal of Tentative WG-3 Schedule for 2022</li> <li>• Relationships with WG-1/2/4</li> <li>• Need for Cooperation with WG-1/2/4</li> <li>• Key Points of Consultation and Requests with DOH</li> </ul>
	12 <sup>th</sup>	24 February 2022 <ul style="list-style-type: none"> <li>• Review of 2021 Activities</li> <li>• Planned Activities for WG-3 in 2022</li> <li>• Importance of Mutual Cooperation and Relationships among WG-1 to WG-4</li> <li>• Activity Schedule for WG-3 in 2022</li> </ul>
	13 <sup>th</sup>	17 March 2022 <ul style="list-style-type: none"> <li>• Relationship between Standard Specifications and Special Specifications (Japan)</li> <li>• Examples of Special Specifications (Japan)</li> <li>• Explanation of Pilot Study (Assignment)</li> <li>• Draft Table of Contents for Design (Civil Works) Guidelines</li> </ul>
	14 <sup>th</sup>	26 May 2022 <ul style="list-style-type: none"> <li>• Report on Pilot Study Results (by DOH)</li> <li>• Explanation of Pilot Study (Assignment)</li> <li>• Contents of Design (Civil Works) Guidelines (Explanation of Design Stages, etc.)</li> </ul>

WG		Date	Summary
	15 <sup>th</sup>	20 July 2022	<ul style="list-style-type: none"> <li>Responses to DOH Questions Based on Pilot Study</li> <li>Final Version Based on Pilot Study Results</li> <li>Draft Table of Contents for Design (Tunnel Facilities) Guidelines</li> <li>Revised Schedule for Year-End 2022</li> </ul>
	16 <sup>th</sup>	20 September 2022	<ul style="list-style-type: none"> <li>Guidelines for Developing Draft Guidelines for Design Changes</li> </ul>
	17 <sup>th</sup>	17 February 2023	<ul style="list-style-type: none"> <li>Drafting Approach and Table of Contents for Draft Guidelines for Design Change of Road Tunnel Projects</li> </ul>
	18 <sup>th</sup>	22 February 2023	<ul style="list-style-type: none"> <li>Table of Contents for Draft Guidelines for Design Change of Road Tunnel Projects, Including Case Examples</li> </ul>
	19 <sup>th</sup>	27 April 2023	<ul style="list-style-type: none"> <li>Explanation of Pilot Study Results</li> <li>Description of Content in the Draft Guidelines for Design Change of Road Tunnel Projects, Including Design Change Cases</li> </ul>
	20 <sup>th</sup>	13 June 2023	<ul style="list-style-type: none"> <li>Differences between Draft Guidelines for Design Change of Road Tunnel Projects and Change Procedures within DOH (Verification)</li> </ul>
	21 <sup>st</sup>	27 June 2023	<ul style="list-style-type: none"> <li>Explanation of Pilot Study Results</li> </ul>
	22 <sup>nd</sup>	24 July 2023	<ul style="list-style-type: none"> <li>Details (Text) of the Draft Guidelines for Design Change of Road Tunnel Projects</li> <li>Contract Structure According to FIDIC</li> </ul>
WG-4 Cost Estimation & Construction	1 <sup>st</sup>	24 June 2021	<u>Kickoff Meeting</u> <ul style="list-style-type: none"> <li>Overview of Project</li> <li>Introduction of Working Group (WG) Members</li> <li>Activity Schedule for WG</li> <li>Discussion on Manual Preparation and Content</li> </ul>
	2 <sup>nd</sup>	29 July 2021	<u>Collection of Cost Estimation Information in Thailand</u> <ul style="list-style-type: none"> <li>Q&amp;A Session on Cost Estimation within DOH (Discussion)</li> </ul>
	3 <sup>rd</sup>	31 August 2021	<u>Collection of Cost Estimation Information in Thailand</u> <ul style="list-style-type: none"> <li>Discussion on Objectives/Content of the Draft Guidelines</li> <li>Q&amp;A Session on Cost Estimation within DOH (Discussion)</li> <li>Understanding Current Contract and Cost Estimation Methods in Thailand</li> </ul>
	4 <sup>th</sup>	28 September 2021	<u>Preparation of the Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft)</u> <ul style="list-style-type: none"> <li>Discussion on Table of Contents</li> <li>Discussion on the Proposed New Table of Contents by the JICA Team</li> </ul>
	5 <sup>th</sup>	18 October 2021	<u>Preparation of the Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft)</u> <ul style="list-style-type: none"> <li>Discussion on Guidelines' Content</li> <li>Organization of Content Related to Tunnel Projects (Investigation)</li> </ul>
	6 <sup>th</sup>	9 November 2021	<u>Preparation of the Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft)</u> <ul style="list-style-type: none"> <li>Discussion on Guidelines' Content</li> <li>Organization of Content Related to Tunnel Projects (Investigation)</li> </ul>
	7 <sup>th</sup>	3 March 2022	<u>Preparation of the Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft)</u> <ul style="list-style-type: none"> <li>Discussion on Guidelines' Content</li> <li>Organization of Content Related to Tunnel Projects (Investigation)</li> </ul>
	8 <sup>th</sup>	17 March 2022	<u>Preparation of the Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft)</u> <ul style="list-style-type: none"> <li>Discussion on Guidelines' Content</li> <li>Organization of Content Related to Tunnel Projects (Investigation)</li> </ul>
	9 <sup>th</sup>	2 June 2022	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Investigation and Design (Draft)</u> <ul style="list-style-type: none"> <li>Discussion on Guidelines' Content</li> <li>Organization of Content Related to Tunnel Projects (Investigation and Civil/Facility Design)</li> </ul>

WG	Date	Summary
10 <sup>th</sup>	25 July 2022	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Investigation and Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Investigation and Civil Design)</li> </ul>
11 <sup>th</sup>	25 August 2022	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Investigation and Design (Draft)</u> <ul style="list-style-type: none"> <li>· Finalization of Investigation Guidelines</li> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Investigation and Civil Design)</li> </ul>
12 <sup>th</sup>	14 September 2022	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Facility Design)</li> <li>· Organization of Content Related to Supervision Work</li> </ul>
13 <sup>th</sup>	13 December 2022	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Facility Design)</li> <li>· Organization of Content Related to Supervision Work</li> </ul>
14 <sup>th</sup>	3 February 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Facility Design)</li> </ul> Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction <ul style="list-style-type: none"> <li>· Explanation of Table of Contents Structure</li> </ul>
15 <sup>th</sup>	21 February 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Facility Design)</li> </ul> Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction <ul style="list-style-type: none"> <li>· Explanation of Content in the Guidelines</li> </ul>
16 <sup>th</sup>	8 March 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Guidelines' Content</li> <li>· Organization of Content Related to Tunnel Projects (Civil and Facility Design)</li> <li>· Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction</li> <li>· Explanation of Content in the Guidelines</li> </ul>
17 <sup>th</sup>	2 May 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft)</u> <ul style="list-style-type: none"> <li>· Discussion on Pilot Study Related to the Guidelines</li> <li>· Organization of Content Related to Tunnel Projects (Civil and Facility Design)</li> </ul> Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction <ul style="list-style-type: none"> <li>· Explanation of Key Sections in the Guidelines</li> </ul>

WG	Date	Summary
	18 <sup>th</sup> 14 June 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design and Civil Works (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on Pilot Study Related to the Guidelines</li> <li>• Organization of Content Related to Tunnel Projects (Civil and Facility Design)</li> <li>• Organization of Content Related to Tunnel Projects (Facility Construction)</li> <li>• Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction</li> <li>• Explanation of Key Sections in the Guidelines</li> </ul>
	19 <sup>th</sup> 10 July 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design and Civil Works (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on Pilot Study Related to the Guidelines</li> <li>• Organization of Content Related to Tunnel Projects (Civil and Facility Design)</li> </ul>
	20 <sup>th</sup> 16 August 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Civil Works (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on Guidelines' Content</li> </ul>
	21 <sup>st</sup> 29 August 2023	<u>Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Design and Civil Works (Draft)</u> <ul style="list-style-type: none"> <li>• Discussion on Guidelines' Content</li> <li>• Organization of Content Related to Tunnel Projects (Civil and Facility Design)</li> <li>• Organization of Content Related to Tunnel Projects (Civil and Facility Construction)</li> <li>• Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction</li> <li>• Explanation of Content in the Guidelines</li> </ul>
	22 <sup>nd</sup> 29 April 2024	<u>Training Activities Based on the Guidelines for Cost Estimation of Road Tunnel Projects</u> (Investigation, Civil Works, Tunnel Facilities)
WG-5 Operation & Maintenance	1 <sup>st</sup> 18 August 2021	<u>Kickoff Meeting</u> <ul style="list-style-type: none"> <li>• Overview of Project</li> <li>• Introduction of Working Group (WG) Members</li> <li>• Activity Schedule for WG</li> <li>• Discussion on Manual Preparation and Content</li> </ul>
	2 <sup>nd</sup> 8 December 2021	<ul style="list-style-type: none"> <li>• Overview of Japan's highway maintenance practices and structural inspection methods</li> </ul>
	3 <sup>rd</sup> 21 February 2022	<ul style="list-style-type: none"> <li>• Thailand's Structural Maintenance System and Implementation Status</li> <li>• Current status and implementation of Thailand's structural maintenance system</li> </ul>
	4 <sup>th</sup> 19 April 2022	Preparation of Draft Guidelines for Operation & Maintenance of Road Tunnels <ul style="list-style-type: none"> <li>• Discussion on the Table of Contents and Details of the Guidelines</li> </ul>
	5 <sup>th</sup> 16 August 2022	Preparation of Draft Guidelines for Operation & Maintenance of Road Tunnels <ul style="list-style-type: none"> <li>• The Table of Contents and Details of the Guidelines</li> </ul>
	6 <sup>th</sup> 31 January 2023	<ul style="list-style-type: none"> <li>• The Table of Contents and Details of the Guidelines</li> <li>• Chapter 1 General Overview</li> </ul>
	7 <sup>th</sup> 8 May 2023	<ul style="list-style-type: none"> <li>• Chapter 2 Routine Tunnel Management and Emergency Response</li> </ul>
	8 <sup>th</sup> 20 June 2023	<ul style="list-style-type: none"> <li>• Chapter 3 General Tunnel Maintenance</li> </ul>
	9 <sup>th</sup> 28 August 2023	<ul style="list-style-type: none"> <li>• Chapter 4 Regular Tunnel Inspections</li> </ul>
	10 <sup>th</sup> 1 September 2023	<ul style="list-style-type: none"> <li>• Overall Explanation of Chapters 1–4</li> </ul>
11 <sup>th</sup> 30 November 2023	<ul style="list-style-type: none"> <li>• Field Survey of the 304 Wildlife Corridor Tunnel</li> </ul>	

WG		Date	Summary
	12 <sup>th</sup>	30 May 2024	Preparation of Draft Guidelines for Operation & Maintenance of Road Tunnels <ul style="list-style-type: none"> <li>• Tunnel Management</li> <li>• Case Study of the 304 Wildlife Corridor Tunnel</li> </ul>
	13 <sup>th</sup>	26 September 2024	<ul style="list-style-type: none"> <li>• Routine Management and Regular Equipment Inspection</li> <li>• Emergency Management Procedures for the 304 Wildlife Corridor Tunnel</li> <li>• Cost Estimation for Equipment Design and Maintenance in the 304 Wildlife Corridor Tunnel</li> </ul>

## 2.2.2 Activities for Each Output

Activities are shown in Table 2-8 to Table 2-11.

**Table 2-8 Achievement under Output 1**

Activities	Achievement	Status
<b><u>Activity 1-1</u></b> To review present organization structure and works in DOH	<ul style="list-style-type: none"> <li>• Conducted a baseline survey to analyze the organizational structure of DOH and the responsibilities of each bureau/division.</li> </ul>	Completed
<b><u>Activity 1-2</u></b> To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management	<ul style="list-style-type: none"> <li>• Based on Activity 1-1, reviewed the appropriate level for establishing a new tunnel division.</li> <li>• Allocated personnel in alignment with the responsibilities established under Activity 1-3.</li> </ul>	Completed
<b><u>Activity1-3</u></b> To identify works and responsibilities of the section in charge of mountain highway tunnel project management	<ul style="list-style-type: none"> <li>• Defined the necessary responsibilities for the new tunnel division, taking into account the findings from Activity 1-1.</li> </ul>	Completed

**Table 2-9 Achievement under Output 2**

Activities	Achievement	Status
<b><u>Activity2-1</u></b> To identify management cycle for mountain highway tunnel	<ul style="list-style-type: none"> <li>• Conducted a baseline survey to gather and analyze information on the existing management cycle of DOH's road projects.</li> </ul>	Completed
<b><u>Activity2-2</u></b> To prepare programs of mountain highway tunnel construction as the management cycle	<ul style="list-style-type: none"> <li>• Completed a review of DOH's Intercity Highway Development Plan (20-year plan).</li> <li>• Currently compiling a program for the development of mountain highway tunnels by DOH.</li> </ul>	Completed
<b><u>Activity2-3</u></b> To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle	<ul style="list-style-type: none"> <li>• Drafted the Draft Guidelines for Supervision and Inspection of Road Tunnel Construction, Guidelines for Operation &amp; Maintenance of Road Tunnels (Draft), and Draft Guidelines for Design Change of Road Tunnel Projects (approved at the 6th JCC).</li> <li>• Preparing training materials.</li> </ul>	Completed
<b><u>Activity2-4</u></b> To study environmental issues and measures of mountain highway tunnel project	<ul style="list-style-type: none"> <li>• Conducted a review of DOH's previous Environmental Impact Assessment (EIA) reports.</li> <li>• Delivered a technical lecture on environmental issues and countermeasures for mountain highway tunnel projects (lecture contents are documented in the Planning Manual of Road Tunnels).</li> </ul>	Completed

**Table 2-10 Achievement under Output 3**

Activities	Achievement	Status
<p><b><u>Activity3-1</u></b> To prepare the draft manual on investigation of mountain highway tunnel</p>	<ul style="list-style-type: none"> <li>• Draft Investigation Manual of Road Tunnels completed and approved at the 2nd JCC.</li> <li>• Investigation Manual of Road Tunnels finalized and approved at the 4th JCC.</li> </ul>	Completed
<p><b><u>Activity3-2</u></b> To prepare the draft standard specifications on investigation of mountain highway tunnel</p>	<ul style="list-style-type: none"> <li>• Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Draft) [Investigation Edition] completed and approved at the 2nd JCC.</li> <li>• Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels [Investigation Edition] finalized and approved at the 4th JCC.</li> </ul>	Completed
<p><b><u>Activity3-3</u></b> To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p>	<ul style="list-style-type: none"> <li>• Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft) completed and approved at the 2nd JCC; finalized Guidelines for Cost Estimation of Road Tunnel Projects for Investigation approved at the 4th JCC.</li> </ul>	Completed
<p><b><u>Activity3-4</u></b> To select the pilot study site for mountain highway tunnel investigation</p>	<ul style="list-style-type: none"> <li>• Selection criteria for pilot study sites completed and approved at the 1st JCC.</li> <li>• Three pilot study sites selected and approved at the 1st JCC.</li> </ul>	Completed
<p><b><u>Activity3-5</u></b> To implement the pilot study for mountain highway tunnel investigation</p>	<ul style="list-style-type: none"> <li>• Conducted pilot studies using the Krabi Bypass Construction Project (D/D) and Tak-Mae Sod Project (F/S) results, applying the Draft Investigation Manual of Road Tunnels, Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Draft) [Investigation Edition], and Guidelines for Cost Estimation of Road Tunnel Projects for Investigation (Draft), leading to the finalization of these manuals and guidelines.</li> </ul>	Completed

**Table 2-11 Achievement under Output 4**

Activities	Achievement	Status
<p><b><u>Activity4-1</u></b> To prepare the draft manual on design of mountain highway tunnel</p>	<ul style="list-style-type: none"> <li>• Draft Planning / Design Manual of Road Tunnels completed and approved at the 4th JCC.</li> <li>• Planning / Design Manual of Road Tunnels finalized and approved at the 6th JCC.</li> </ul>	Completed
<p><b><u>Activity4-2</u></b> To prepare the draft standard specifications on design of mountain highway tunnel</p>	<ul style="list-style-type: none"> <li>• Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Draft) [Design Edition] completed and approved at the 4th JCC.</li> <li>• Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels [Design Edition] finalized and approved at the 6th JCC.</li> </ul>	Completed
<p><b><u>Activity4-3</u></b> To prepare the draft manual on cost estimation of mountain highway tunnel design</p>	<ul style="list-style-type: none"> <li>• Guidelines for Cost Estimation of Road Tunnel Projects for Design (Draft) completed and approved at the 4th JCC.</li> <li>• Guidelines for Cost Estimation of Road Tunnel Projects for Design finalized and approved at the 6th JCC.</li> </ul>	Completed
<p><b><u>Activity4-4</u></b> To select the pilot study site for mountain highway tunnel design</p>	<ul style="list-style-type: none"> <li>• Selection criteria for pilot study sites completed and approved at the 1st JCC.</li> <li>• 3 pilot study sites selected and approved at the 1st JCC.</li> </ul>	Completed

Activities	Achievement	Status
<b>Activity4-5</b> To implement the pilot study for mountain highway tunnel design	<ul style="list-style-type: none"> <li>Conducted pilot studies using the Krabi Bypass Construction Project (D/D) and Tak-Mae Sod Project (F/S) as reference projects.</li> </ul>	Completed

## 2.3 Project Output and Achievement of Goal

### 2.3.1 Output 1

The achievement status related to Output 1 is shown in Table 2-12.

**Table 2-12 Achievement Status Related to Output 1**

Output1	DOH's human resources, institution and scope of works on tunnel project are established.
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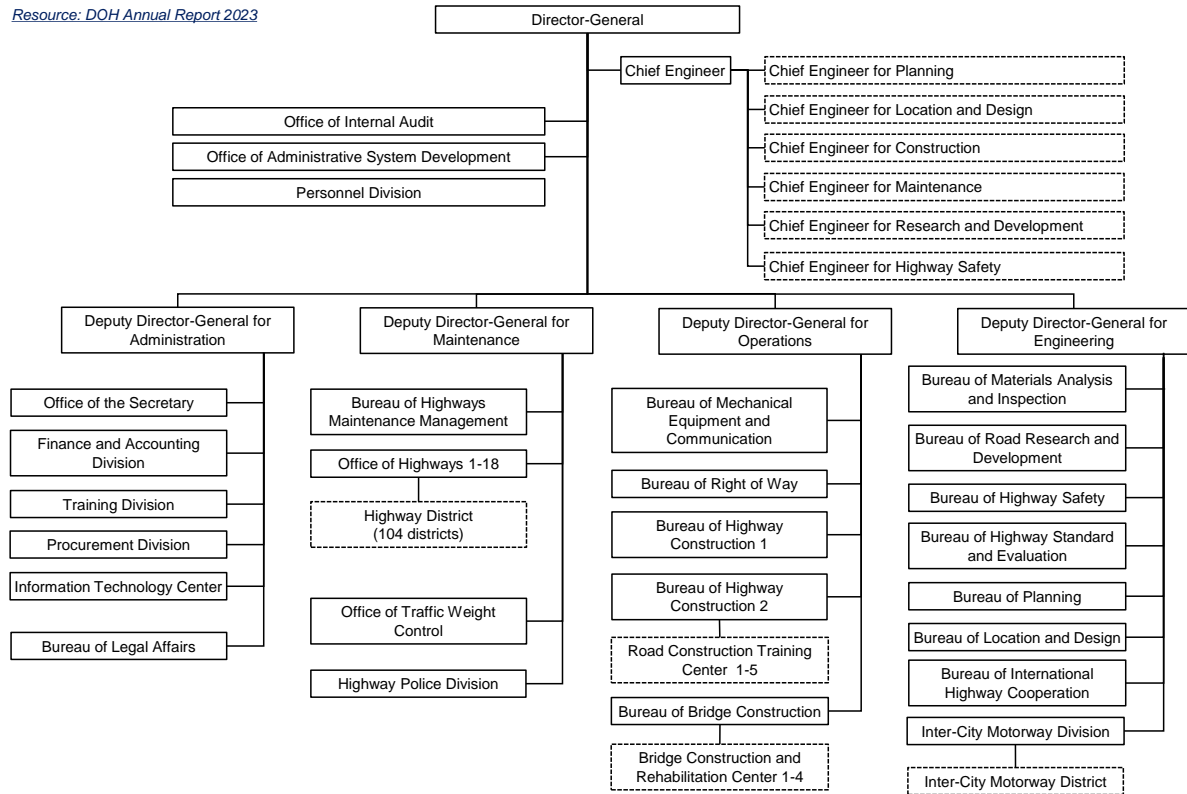
Indicators	Actual Results	Achievement Rate
<b>Indicator1-1</b> Unit or section in charge of tunnel project in DOH is established.	<ul style="list-style-type: none"> <li>To collect and analyze the information on existing organization structure of DOH (30%/30%)</li> <li>To establish a draft unit or section in charge of tunnel project in DOH (70%/70%)</li> </ul>	100%
<b>Indicator 1-2</b> Enough human resources are assigned to the section.	<ul style="list-style-type: none"> <li>To collect and analyze the information on existing human resource of DOH (30%/30%)</li> <li>To assign draft members to the unit or section in charge of tunnel project (70%/70%)</li> </ul>	100%
<b>Indicator 1-3</b> The responsibilities of the section are clarified.	<ul style="list-style-type: none"> <li>To collect and analyze the information on existing responsibilities and works of DOH (30%/30%)</li> <li>To draft the responsibilities and works of the unit or section in charge of tunnel project (70%/70%)</li> </ul>	100%

#### 2.3.1.1 Analysis of DOH Organizational Structure

##### (1) Organizational Structure and Number of Engineers

DOH operates under the Ministry of Transport (MOT) and is responsible for the construction and management of Thailand's national highways and intercity motorways. The organizational structure primarily consists of the Headquarters and Regional Offices. Regional Offices include 18 Regional Offices of Highways, five Road Construction Training Centers, and four Bridge Construction Training Centers, with the Regional Offices overseeing 104 Highway District Offices. The DOH organizational structure is shown in Figure 2-1. It illustrates the hierarchical structure of DOH. The DOH employs a total of 12,541 personnel, comprising 5,834 officials, 1,565 permanent employees, and 5,142 government employees. The highest-ranking position within the DOH is the Director-General, followed by four Deputy Director-Generals and six Chief Engineers. Prior to recent structural reforms, most bureaus and divisions reported directly to the Deputy Director-Generals or Chief Engineers. However, under the new structure, bureaus and divisions no longer report to Chief Engineers and are now directly under the supervision of Deputy Director-Generals. DOH personnel may request internal transfers every six months, subject to position availability. Promotions are typically processed promptly to fill vacancies arising from promotions, relocations, retirements, or resignations.

Resource: DOH Annual Report 2023



Source: Based on DOH Annual Report 2023 (Compiled by JICA Expert Team)

**Figure 2-1 Organizational Structure of DOH**



Source: DOH Annual Report 2023

**Figure 2-2 Number of DOH Staffs**

## (2) Scope of Duties

The scope of duties for each bureau/division within DOH is shown in Table 2-13.

**Table 2-13 The Scope of Duties for Each Bureau/Division**

**Red:** Items with Strong Technical Relevance to the Project

**Blue:** Items Related to Tunnel Project Management

Name of Department	The Scope of Duties
Office of Internal Audit	<ol style="list-style-type: none"> <li>1) Conduct audits on administrative, financial, and accounting matters of the bureau/division.</li> <li>2) Collaborate with or support other relevant departments as assigned.</li> </ol>
Office of Administrative System Development	<ol style="list-style-type: none"> <li>1) Provide recommendations and advice to the Director-General on strategies for bureaucratic development within the department.</li> <li>2) Monitor, evaluate, and prepare reports on bureaucratic development.</li> <li>3) Coordinate with central agencies and other departments on government system bureau/division.</li> <li>4) Collaborate with or support other relevant departments as assigned.</li> </ol>
Personnel Division	<ol style="list-style-type: none"> <li>1) Operate on the organization of work and administration. Department of Human Resources, except for the Department's Human Resource Development</li> <li>2) Take action on strengthening discipline. maintain the moral system and personnel welfare work of the Department</li> <li>3) Working with or supporting the operations of other relevant bureau/division or assigned</li> </ol>
Office of the Secretary	<ol style="list-style-type: none"> <li>1) Handle general administration, documentation, and maintenance of the department's buildings and premises.</li> <li>2) Perform administrative and secretarial tasks for the department.</li> <li>3) Conduct public relations and disseminate information about the department's work.</li> <li>4) Undertake tasks not specifically assigned to other government agencies.</li> <li>5) Collaborate with or support the operations of other relevant bureau/division as assigned.</li> </ol>
Finance and Accounting Division	<ol style="list-style-type: none"> <li>1) Manage financial, accounting, and budgeting matters of the department.</li> <li>2) Collaborate with or support the operations of other relevant bureau/division as assigned.</li> </ol>
Training Division	<ol style="list-style-type: none"> <li>1) Manage human resource development activities for the department.</li> <li>2) Collaborate with or support the operations of other relevant bureau/division as assigned.</li> </ol>
Procurement Division	<ol style="list-style-type: none"> <li>1) <a href="#">Handle procurement activities for the department.</a></li> <li>2) <a href="#">Collaborate with or support the operations of other relevant bureau/division as assigned.</a></li> </ol>
Information Technology Center	<ol style="list-style-type: none"> <li>1) Prepare the department's Information Technology Master Plan and Action Plan, including monitoring and evaluating performance.</li> <li>2) Manage the department's information technology systems.</li> <li>3) Develop computer systems and networks, and provide advice, training, or support on the use of computers and software.</li> <li>4) Collaborate with or support the operations of other relevant bureau/division as assigned.</li> </ol>
Bureau of Legal Affairs	<ol style="list-style-type: none"> <li>1) 1. Handle legal matters related to highway laws and other relevant regulations.</li> <li>2) Manage legal and contractual issues related to civil, criminal, administrative, and other cases under the department's jurisdiction.</li> <li>3) Provide legal advice and disseminate knowledge on relevant laws.</li> <li>4) Study, draft, and develop laws related to the department's responsibilities.</li> <li>5) Collaborate with or support the operations of other relevant bureau/division as assigned.</li> </ol>
Inter-City Motorway Division	<ol style="list-style-type: none"> <li>1) Collect toll fees and <a href="#">manage traffic and safety systems on intercity highways.</a></li> <li>2) Develop and maintain the intercity highway network.</li> </ol>

Name of Department	The Scope of Duties
	3) Oversee concession highway operations. 4) Collaborate with or support the operations of other relevant bureau/division as assigned.
Inter-City Motorway District	1) Plan and manage maintenance, security, and small construction projects on intercity highways. 2) Survey, inspect, and prepare information on material sources, road works, and road conditions. 3) Perform maintenance, security, and small project construction on intercity highways. 4) Maintain and repair vehicles, machinery, and equipment. 5) Engage local communities in reconstruction and maintenance projects. 6) Enforce highway laws as assigned. 7) Issue permits under the Highway Act as assigned. 8) Support and collaborate with provincial and other agencies. 9) Collaborate with or support the operations of other relevant bureau/division as assigned. Coverage: Highway No. 7 (Bangkok - Chonburi - Pattaya) and Highway No. 9 (Bang Pa-in - Bang Phli) Eastern Ring Road.
Bureau of Highways Maintenance Management	1) <a href="#">Develop strategies, work plans, and road maintenance projects.</a> 2) <a href="#">Study and improve road maintenance management and data analysis.</a> 3) <a href="#">Monitor and evaluate road maintenance budgets.</a> 4) Prepare plans and standards for vehicle weight control. 5) Collaborate with or support the operations of other relevant bureau/division as assigned.
Office of Highways 1-18	1) <a href="#">Plan, survey, design, inspect, and analyze highway maintenance, safety, and small project construction.</a> 2) <a href="#">Manage medium-sized construction projects and highway network maintenance.</a> 3) Handle land ownership and legal matters. 4) Operate vehicle weighing checkpoints. 5) Manage and maintain machinery and vehicles. 6) Supervise and monitor highway district operations. 7) Issue permits under highway laws as assigned. 8) Provide technical advice and support to highway districts and other agencies. 9) Collaborate with or support the operations of other relevant bureau/division as assigned.
Highway District (104 districts)	1) <a href="#">Plan highway maintenance, safety, and small project construction.</a> 2) Survey and prepare information on road work materials and conditions. 3) <a href="#">Perform highway maintenance, safety, and small project construction.</a> 4) Maintain and repair vehicles, machinery, and tools. 5) Engage local communities in construction, reconstruction, and maintenance projects. 6) Enforce highway laws as assigned. 7) Issue permits under the Highway Act as assigned. 8) Operate mobile vehicle weighing checkpoints. 9) Support and collaborate with provincial and other agencies. 10) Collaborate with or support the operations of other relevant bureau/division as assigned.
Office of Traffic Weight Control	1) Plan and manage systematic vehicle weight control, including establishing weighing checkpoints. 2) Develop and update vehicle weight control standards and regulations. 3) Monitor and control the budget for weighing checkpoints. 4) Supervise and evaluate vehicle weight control operations across various offices. 5) Serve as a central coordination point for vehicle weighing checkpoints nationwide, and develop proactive policies with other agencies. 6) Perform other tasks as assigned.

Name of Department	The Scope of Duties
Highway Police Division	1) Investigate and act according to the Criminal Procedure Code and other traffic-related laws. 2) Safeguard government property and manage highway usage. 3) <a href="#">Control traffic and pollution according to the law.</a> 4) <a href="#">Provide assistance and ensure the safety of highway users.</a> 5) Educate the public about traffic laws.
Bureau of Mechanical Equipment and Communication	1) Develop and standardize plans for the use and repair of machinery and vehicles of the department. 2) Maintain and repair machinery and vehicles. 3) Manage the department's working capital for mechanical costs. 4) Procure spare parts for machinery and vehicle repairs. 5) Install, repair, and maintain the department's telecommunications systems. 6) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Right of Way	1) <a href="#">Survey and calculate the value of land and properties used in road works.</a> 2) <a href="#">Secure ownership of land and property used in road works.</a> 3) <a href="#">Handle appeals related to compensation for land and property used in road works.</a> 4) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Highway Construction 1	1) <a href="#">Supervise and manage the construction and renovation of large projects.</a> 2) <a href="#">Prepare preliminary appraisals for large-scale construction and renovation projects.</a> 3) <a href="#">Ensure safety and environmental standards during construction and renovation.</a> 4) <a href="#">Study and improve construction and restoration methods for large projects.</a> 5) <a href="#">Provide technical advice on large-scale construction and renovation.</a> 6) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Highway Construction 2	1) <a href="#">Supervise and manage special projects and urgent emergency works.</a> 2) <a href="#">Prepare preliminary appraisals for special and emergency construction works.</a> 3) <a href="#">Ensure safety and environmental standards during special and emergency construction works.</a> 4) Study and improve construction methods for special and emergency projects.
Road Construction Training Center 1-5	1) Responsible for road construction and reconstruction using in-house methods. 2) Provide training in road and mechanical engineering.
Bureau of Bridge Construction	1) <a href="#">Supervise and manage the construction and restoration of bridges.</a> 2) <a href="#">Prepare preliminary appraisals for bridge construction and restoration projects.</a> 3) <a href="#">Ensure safety and environmental standards during bridge construction and restoration.</a> 4) Study and improve construction and restoration methods for bridges. 5) Transfer technology and provide field training to develop departmental personnel and other organizations. 6) Provide technical advice on bridge construction and restoration. 7) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bridge Construction and Rehabilitation Center 1-4	1) Supervise and manage bridge construction, restoration, and maintenance. 2) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Materials Analysis and Inspection	1) Study, develop, and establish specifications for materials and material testing methods. 2) Design and recommend pavement structures and improve the quality of materials used in road works. 3) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Road Research and Development	1) Conduct research and development related to road works. 2) Liaise with domestic and international research institutes. 3) Collaborate with or support the operations of other relevant bureau/division as assigned.

Name of Department	The Scope of Duties
Bureau of Highway Safety	1) Plan, survey, and analyze traffic problems on highways. 2) <a href="#">Develop and establish standards for traffic control signs and signals.</a> 3) Provide technical advice on highway safety operations. 4) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Highway Standard and Evaluation	1) Develop and enforce engineering standards and requirements. 2) Promote and supervise contractor performance standards. 3) Assess the quality of engineering works. 4) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Planning	1) <a href="#">Prepare strategic and action plans for the department.</a> 2) <a href="#">Develop highway network standards.</a> 3) <a href="#">Conduct feasibility studies and project evaluations.</a> 4) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of Location and Design	1) <a href="#">Develop standards and requirements for route and structural design.</a> 2) <a href="#">Conduct surveys and prepare geographic information for highway projects.</a> 3) <a href="#">Study geological suitability for highway construction.</a> 4) <a href="#">Design highways and related structures.</a> 5) Collaborate with or support the operations of other relevant bureau/division as assigned.
Bureau of International Highway Cooperation	1) <a href="#">Develop the domestic highway network to connect with international highways.</a> 2) <a href="#">Coordinate international highway development projects.</a> 3) Manage loan and grant programs, including liaising with funding sources. 4) Collaborate with or support the operations of other relevant bureau/division as assigned.

### (3) Financial Status

The annual budget of DOH is shown in Table 2-14. The budget for the fiscal year 2023 is THB 118.816 billion, accounting for approximately 3.7% of the national budget. The 2024 budget for DOH represents about 2.3 times the amount allocated in the fiscal year 2013. Additionally, the proportion of DOH's budget within the national budget has been trending upward.

**Table 2-14 Annual Budget of DOH**

Year	Budget (Unit: Million THB)		Ratio (b/a)
	National Budget (a)	Budget of DOH (b)	
2024	3,480,000	121,827	3.5%
2023	3,185,000	118,816	3.7%
2022	3,100,000	113,348	3.7%
2021	3,285,962	125,946	3.8%
2020	3,200,000	113,883	3.6%
2019	3,000,000	117,138	3.9%
2018	2,900,000	105,747	3.6%
2017	2,733,000	91,280	3.3%
2016	2,720,000	77,510	2.8%
2015	2,575,000	60,334	2.3%
2014	2,525,000	52,759	2.1%
2013	2,400,000	52,966	2.2%

### **2.3.1.2 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P) in Mountain Road Tunnels**

To assess the capabilities (knowledge, experience, technical skills, expertise, etc.) of DOH personnel (C/P) involved in the project's Working Groups (WG), a baseline survey was conducted through a web-based questionnaire targeting 61 personnel. This survey aimed to provide specificity for the project activities. The overall survey results, as well as the results by each WG, are shown in Table 2-15 to Table 2-20 and Figure 2-3 to Figure 2-7.

**Table 2-15 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P: Member of WG) in Mountain Highway Tunnels [Overall]**

Items		Results
Category 1 (Qualifications)	Educational Background and Qualifications	<ul style="list-style-type: none"> <li>• Among the 61 survey participants (C/P: WG members), 12 hold a Ph.D. in engineering, indicating a high academic background.</li> <li>• With 52 members holding a bachelor's degree, it is assumed that they possess foundational civil engineering knowledge, making this organization highly capable compared to counterparts in other countries. * Breakdown: 52 bachelor's degree holders (including 12 with doctoral degrees), and 9 others.</li> <li>• Approximately 90% of the personnel hold a Professional Engineer qualification in Thailand, demonstrating experience in civil engineering projects.</li> </ul>
	Age Distribution	<ul style="list-style-type: none"> <li>• The majority of WG members are in their 30s to early 40s, indicating that the participants are individuals who will lead DOH in the future.</li> </ul>
	Expertise	<ul style="list-style-type: none"> <li>• 21.3% specialize in project management, while 83.6% are civil engineering specialists.</li> <li>• The high percentage of civil engineering specialists means they generally understand standard civil engineering terminology, allowing WG activities to proceed with minimal disruption.</li> </ul>
	English Skills	<ul style="list-style-type: none"> <li>• Nearly half of the WG members have a Fair level of English skills, suggesting that simple English or Thai should be used in WG activities and workshops.</li> </ul>
Category 2 (Experience & Skills)	Years of Work Experience	<ul style="list-style-type: none"> <li>• WG-1, WG-3, and WG-5 consist of a balanced mix of experience levels.</li> <li>• WG-2 and WG-4 are predominantly composed of members from the same department, with relatively less experience than other WGs.</li> </ul>
	Current Job Responsibilities	<ul style="list-style-type: none"> <li>• Each WG primarily includes members suited to the theme of the respective WG, allowing efficient learning of WG activities.</li> </ul>
	Preferred Frequency of WG Meetings	<ul style="list-style-type: none"> <li>• Around 80% expressed a preference for holding WG meetings once or twice a month.</li> </ul>
Category 3 (Knowledge in Road and Bridge Sector)	Knowledge of Roads and Bridges	<ul style="list-style-type: none"> <li>• WG-1, WG-4, and WG-5 have many members from departments related to their themes, resulting in relatively high levels of knowledge relevant to each WG's focus.</li> <li>• WG-2 has a relatively younger member demographic with limited practical experience, leading to lower overall expertise.</li> <li>• WG-3 has members from a variety of departments, resulting in a wide range of knowledge levels.</li> </ul>
Category 4 (Knowledge in Tunnel Sector)	Knowledge of Mountain Highway Tunnels	<ul style="list-style-type: none"> <li>• All WGs expressed a desire to acquire at least basic-level knowledge in mountain highway tunnel-related fields (investigation, planning, and design). Many comments indicated an interest in learning about environmental impacts, mitigation measures, and evaluations related to tunnel development.</li> </ul>
	Desired Skill Level in Mountain Highway Tunnel Technology	<ul style="list-style-type: none"> <li>• Members have limited knowledge related to mountain highway tunnel projects due to lack of experience in this area.</li> <li>• Members of WG1 and WG2 largely consist of personnel from the Bureau of Location and Design, who are currently involved in the Conceptual Design of the Krabi Bypass Construction project, showcasing high technical expertise in certain areas.</li> </ul>
Category 5 (Requirements)	Expectations and Interests in the Project	<ul style="list-style-type: none"> <li>• Overall, DOH staff exhibit high expectations and interest in this project, with many expressing a desire to join the newly established tunnel division initiated by this project.</li> </ul>

**Table 2-16 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P: Member of WG) in Mountain Highway Tunnels 【WG-1】**

Items		Results
Category 1 (Qualifications)	Educational Background and Qualifications	<ul style="list-style-type: none"> <li>• WG-1 consists of 15 members, primarily young to mid-career professionals in their early 30s to early 40s, including 6 Ph.D. holders in engineering and 7 Senior Professional Engineers, making it the most advanced</li> <li>• The majority of members are affiliated with the Bureau of Location and Design.</li> </ul>
	Age Distribution	
	Expertise	
	English Skills	<ul style="list-style-type: none"> <li>• Approximately half of the WG members have Fair-level English proficiency, suggesting that WG activities and workshops should ideally be conducted in simple English or Thai.</li> </ul>
Category 2 (Experience & Skills)	Years of Work Experience	<ul style="list-style-type: none"> <li>• The group composition is balanced in terms of years of work experience.</li> </ul>
	Current Job Responsibilities	<ul style="list-style-type: none"> <li>• Most members are from the Design Bureau and are involved in survey, testing, design (road, pavement, drainage), and construction management tasks.</li> </ul>
	Preferred Frequency of WG Meetings	<ul style="list-style-type: none"> <li>• More than half of the members expressed a preference for a monthly WG meeting frequency.</li> </ul>
Category 3 (Knowledge in Road and Bridge Sector)	Knowledge of Roads and Bridges	<ul style="list-style-type: none"> <li>• Despite individual differences, the overall scores for road survey, design, and traffic operation and maintenance were 3 or higher.</li> </ul>
Category 4 (Knowledge in Tunnel Sector)	Knowledge of Mountain Highway Tunnels	<ul style="list-style-type: none"> <li>• Although there is no experience with mountain highway tunnel projects, knowledge levels are generally low; however, several members from the Design Bureau are involved in the ongoing Krabi Bypass Construction Project (including mountain highway tunnels), resulting in some higher scores.</li> </ul>
	Desired Skill Level in Mountain Highway Tunnel Technology	<ul style="list-style-type: none"> <li>• Members are keen on acquiring knowledge above the basic level.</li> </ul>
Category 5 (Requirements)	Expectations and Interests in the Project	<ul style="list-style-type: none"> <li>• There is high expectation and interest in this project, particularly among members interested in joining the newly established tunnel department, with many also showing interest in 3D CAD.</li> </ul>

**Table 2-17 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P: Member of WG) in Mountain Highway Tunnels 【WG-2】**

Items		Results
Category 1 (Qualifications)	Educational Background and Qualifications	<ul style="list-style-type: none"> <li>• WG-2 consists of 7 members, including 2 Ph.D. holders in engineering, most of whom are in their late 30s to early 40s</li> <li>• 6 members specialize in civil engineering, and 1 specializes in environmental studies.</li> <li>• The majority of members are affiliated with the Bureau of Planning.</li> </ul>
	Age Distribution	
	Expertise	
	English Skills	<ul style="list-style-type: none"> <li>• Approximately half of the WG members have Fair-level English proficiency, suggesting that WG activities and workshops should ideally be conducted in simple English or Thai.</li> </ul>
Category 2 (Experience & Skills)	Years of Work Experience	<ul style="list-style-type: none"> <li>• Most members are from the same department, with relatively fewer years of experience compared to other WGs.</li> </ul>
	Current Job Responsibilities	<ul style="list-style-type: none"> <li>• Many members belong to the Planning Bureau, engaging in project planning, construction supervision, project evaluation, and EIA/IEE responses, as well as in-house consulting.</li> </ul>
	Preferred Frequency of WG Meetings	<ul style="list-style-type: none"> <li>• About 80% of the members prefer a twice-monthly WG meeting frequency, with no one expressing a preference for weekly meetings.</li> </ul>
Category 3 (Knowledge in Road and Bridge Sector)	Knowledge of Roads and Bridges	<ul style="list-style-type: none"> <li>• Although there are individual differences, the overall scores were low. This may be due to the relatively young age group, limited practical experience, and the fact that upstream activities, such as master planning and feasibility studies, are predominantly outsourced to private consultants.</li> </ul>
Category 4 (Knowledge in Tunnel Sector)	Knowledge of Mountain Highway Tunnels	<ul style="list-style-type: none"> <li>• Members lack experience in mountain highway tunnel projects, and overall knowledge in this area is low. However, some members show high scores due to involvement in the ongoing Krabi Bypass Project.</li> </ul>
	Desired Skill Level in Mountain Highway Tunnel Technology	<ul style="list-style-type: none"> <li>• Members are eager to acquire knowledge above the basic level.</li> </ul>
Category 5 (Requirements)	Expectations and Interests in the Project	<ul style="list-style-type: none"> <li>• There is high interest and expectation toward the project, with many members expressing a desire to join the newly established tunnel department and a significant number showing interest in 3D CAD.</li> </ul>

**Table 2-18 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P: Member of WG) in Mountain Highway Tunnels [WG-3]**

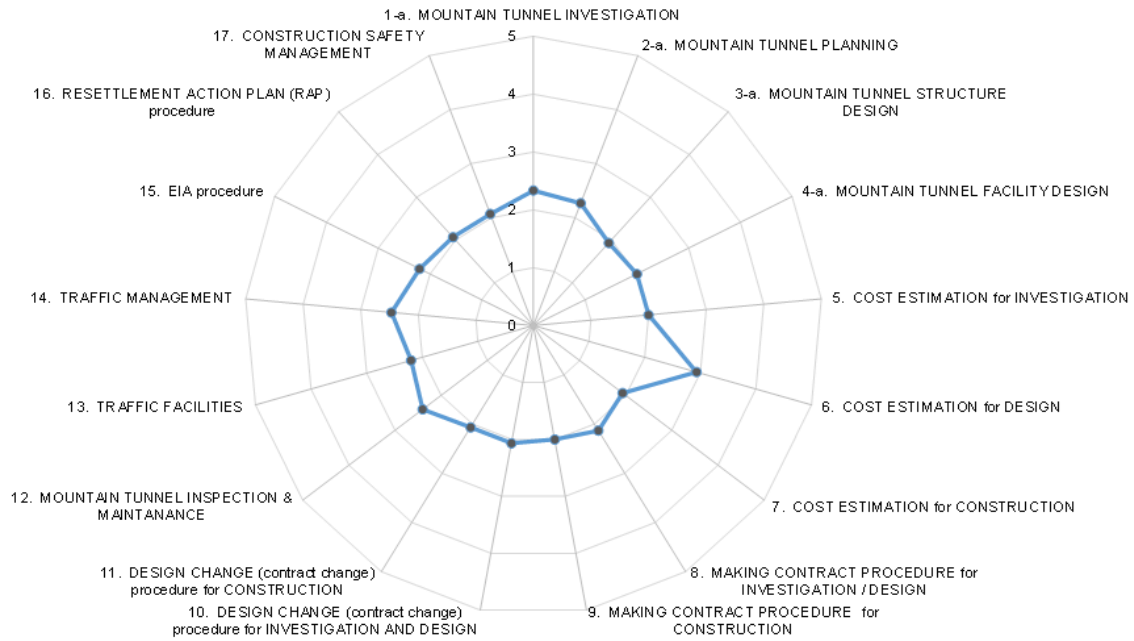
Items		Results
Category 1 (Qualifications)	Educational Background and Qualifications	<ul style="list-style-type: none"> <li>• WG-3 consists of 14 members, including 3 Ph.D. holders in engineering, with a broad age range from the late 20s to early 50s.</li> <li>• 6 members specialize in civil engineering, and 1 specializes in environmental studies.</li> <li>• This WG has the most diverse expertise among all WGs, comprising members from the highest number of different departments.</li> </ul>
	Age Distribution	
	Expertise	
	English Skills	<ul style="list-style-type: none"> <li>• Approximately half of the WG members have Fair-level English proficiency, indicating that WG activities and workshops would benefit from being conducted in simple English or Thai.</li> </ul>
Category 2 (Experience & Skills)	Years of Work Experience	<ul style="list-style-type: none"> <li>• The group has a balanced distribution in terms of years of experience.</li> </ul>
	Current Job Responsibilities	<ul style="list-style-type: none"> <li>• Members of WG-3 are gathered from various departments, with a relatively high number of members responsible for cost estimation, contract documentation, and external negotiations.</li> </ul>
	Preferred Frequency of WG Meetings	<ul style="list-style-type: none"> <li>• The preferred WG meeting frequency is split evenly, with 50% favoring weekly meetings and 50% preferring monthly or twice-monthly meetings.</li> </ul>
Category 3 (Knowledge in Road and Bridge Sector)	Knowledge of Roads and Bridges	<ul style="list-style-type: none"> <li>• Due to the broad age range and diverse departmental representation, there are significant variations in practical experience and individual proficiency.</li> </ul>
Category 4 (Knowledge in Tunnel Sector)	Knowledge of Mountain Highway Tunnels	<ul style="list-style-type: none"> <li>• Members lack experience in mountain highway tunnel projects, and overall related knowledge is low.</li> </ul>
	Desired Skill Level in Mountain Highway Tunnel Technology	<ul style="list-style-type: none"> <li>• Members expect to acquire knowledge beyond the basic level.</li> </ul>
Category 5 (Requirements)	Expectations and Interests in the Project	<ul style="list-style-type: none"> <li>• There is a high level of interest and expectation toward this project, with many members perceiving it as significant for the DOH.</li> </ul>

**Table 2-19 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P: Member of WG) in Mountain Highway Tunnels 【WG-4】**

Items		Results
Category 1 (Qualifications)	Educational Background and Qualifications	<ul style="list-style-type: none"> <li>WG-4 consists of 10 members, with an age range from the late 20s to early 40s. More than half of the members are from the Bridge Construction Bureau.</li> </ul>
	Age Distribution	
	Expertise	
	English Skills	<ul style="list-style-type: none"> <li>About half of the WG members have Fair-level English proficiency, suggesting that WG activities and workshops should be conducted in simple English or Thai.</li> </ul>
Category 2 (Experience & Skills)	Years of Work Experience	<ul style="list-style-type: none"> <li>The majority of members are from the same department, and the group is composed of members with relatively less experience compared to other WGs.</li> </ul>
	Current Job Responsibilities	<ul style="list-style-type: none"> <li>Since most members belong to the Bridge Construction Bureau, many are involved in cost estimation, contract documentation, bidding, and construction supervision.</li> </ul>
	Preferred Frequency of WG Meetings	<ul style="list-style-type: none"> <li>The preferred meeting frequency is once a month for 70% of the members, while 30% prefer twice a month.</li> </ul>
Category 3 (Knowledge in Road and Bridge Sector)	Knowledge of Roads and Bridges	<ul style="list-style-type: none"> <li>Members have a high level of knowledge in cost estimation, contracts, and bridge construction and maintenance due to their departmental affiliation.</li> </ul>
Category 4 (Knowledge in Tunnel Sector)	Knowledge of Mountain Highway Tunnels	<ul style="list-style-type: none"> <li>They lack experience in mountain highway tunnel projects, and their overall knowledge in this area is low.</li> </ul>
	Desired Skill Level in Mountain Highway Tunnel Technology	<ul style="list-style-type: none"> <li>Members expect to acquire knowledge beyond the basic level.</li> </ul>
Category 5 (Requirements)	Expectations and Interests in the Project	<ul style="list-style-type: none"> <li>There is significant interest and expectation toward the project, with many members considering it important for the DOH. Additionally, a considerable number expressed interest in joining the new tunnel department.</li> </ul>

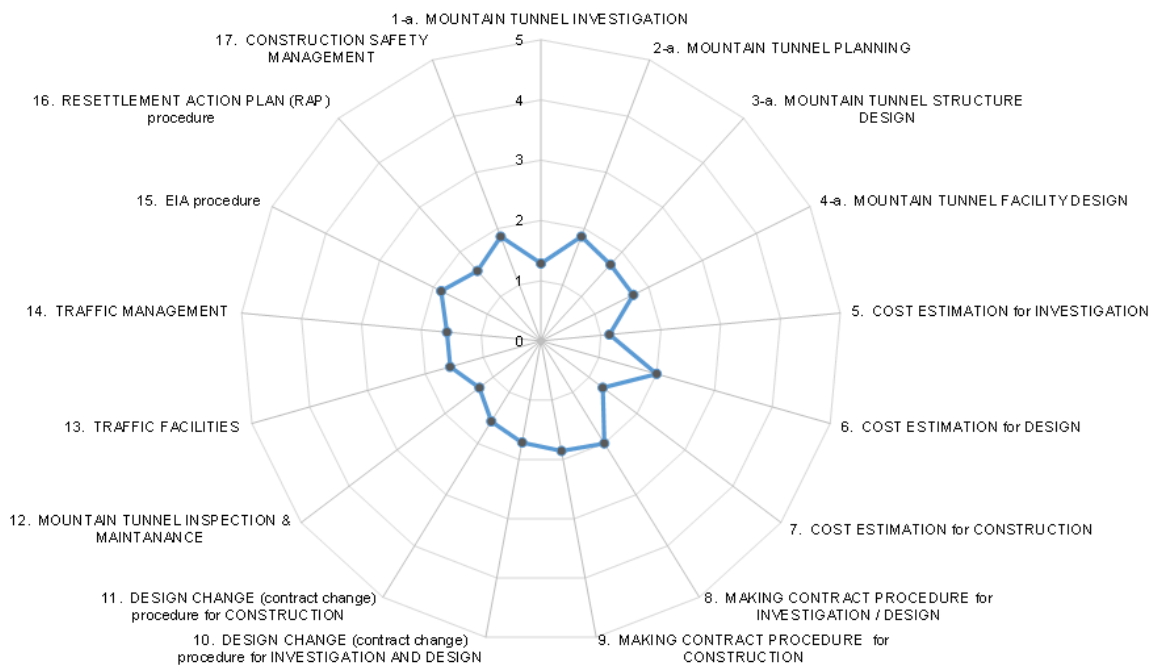
**Table 2-20 Knowledge, Experience, and Technical Skills of DOH Personnel (C/P: Member of WG) in Mountain Highway Tunnels 【WG-5】**

Items		Results
Category 1 (Qualifications)	Educational Background and Qualifications	<ul style="list-style-type: none"> <li>• WG-5 comprises 15 members, including 1 Doctor of Engineering, and the age range spans from the late 20s to early 40s.</li> <li>• Most of the members are affiliated with the Bureau of Maintenance.</li> </ul>
	Age Distribution	
	Expertise	
	English Skills	<ul style="list-style-type: none"> <li>• About half of the WG members have Fair-level English proficiency, indicating that WG activities and workshops should ideally be conducted in simple English or Thai.</li> </ul>
Category 2 (Experience & Skills)	Years of Work Experience	<ul style="list-style-type: none"> <li>• The group has a well-balanced range of work experience.</li> </ul>
	Current Job Responsibilities	<ul style="list-style-type: none"> <li>• Many members are responsible for operations, maintenance, inspections, and facility management due to their affiliation with the Bureau of Maintenance.</li> </ul>
	Preferred Frequency of WG Meetings	<ul style="list-style-type: none"> <li>• The preferred meeting frequency is once a month for more than half of the members, with 30% preferring twice a month.</li> </ul>
Category 3 (Knowledge in Road and Bridge Sector)	Knowledge of Roads and Bridges	<ul style="list-style-type: none"> <li>• While they have a high level of knowledge related to maintenance, they lack experience in mountain highway tunnel projects, and their overall knowledge in this area is low.</li> </ul>
Category 4 (Knowledge in Tunnel Sector)	Knowledge of Mountain Highway Tunnels	<ul style="list-style-type: none"> <li>• While they have a high level of knowledge related to maintenance, they lack experience in mountain highway tunnel projects, and their overall knowledge in this area is low.</li> </ul>
	Desired Skill Level in Mountain Highway Tunnel Technology	<ul style="list-style-type: none"> <li>• They expect to acquire knowledge beyond the basic level.</li> </ul>
Category 5 (Requirements)	Expectations and Interests in the Project	<ul style="list-style-type: none"> <li>• There is significant interest and expectation toward the project, with many members recognizing its importance to the DOH.</li> </ul>



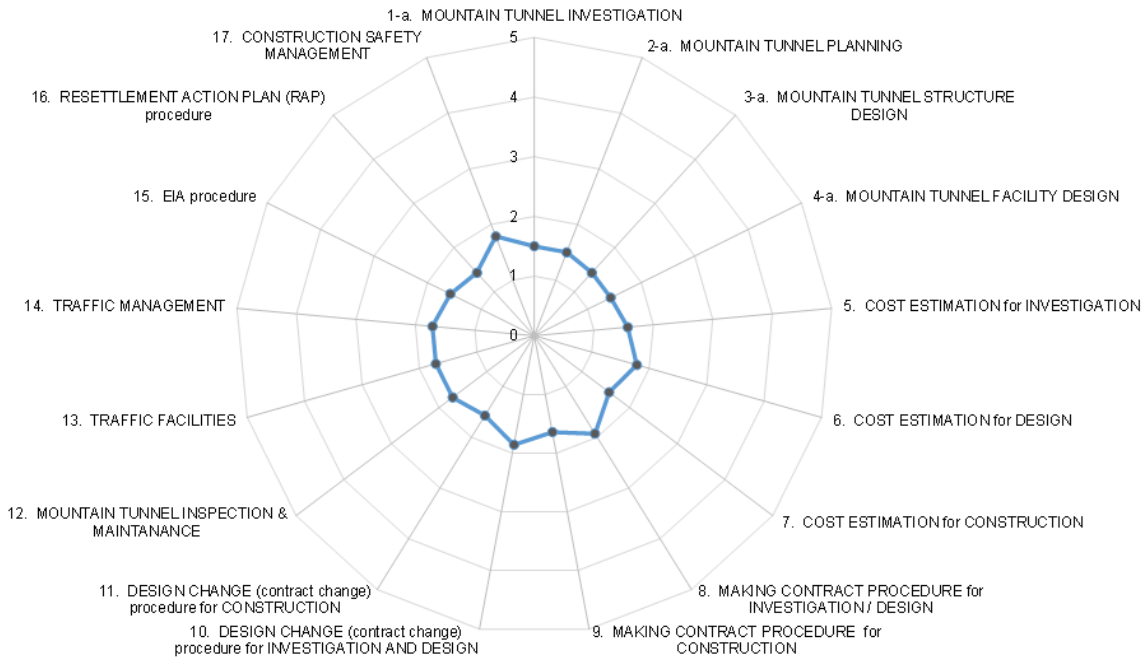
Source: Based on the Web Survey Results (Compiled by JICA Expert Team)

**Figure 2-3 Knowledge Level of DOH Personnel (C/P: WG Members) on Mountain Highway Tunnels [WG-1]**



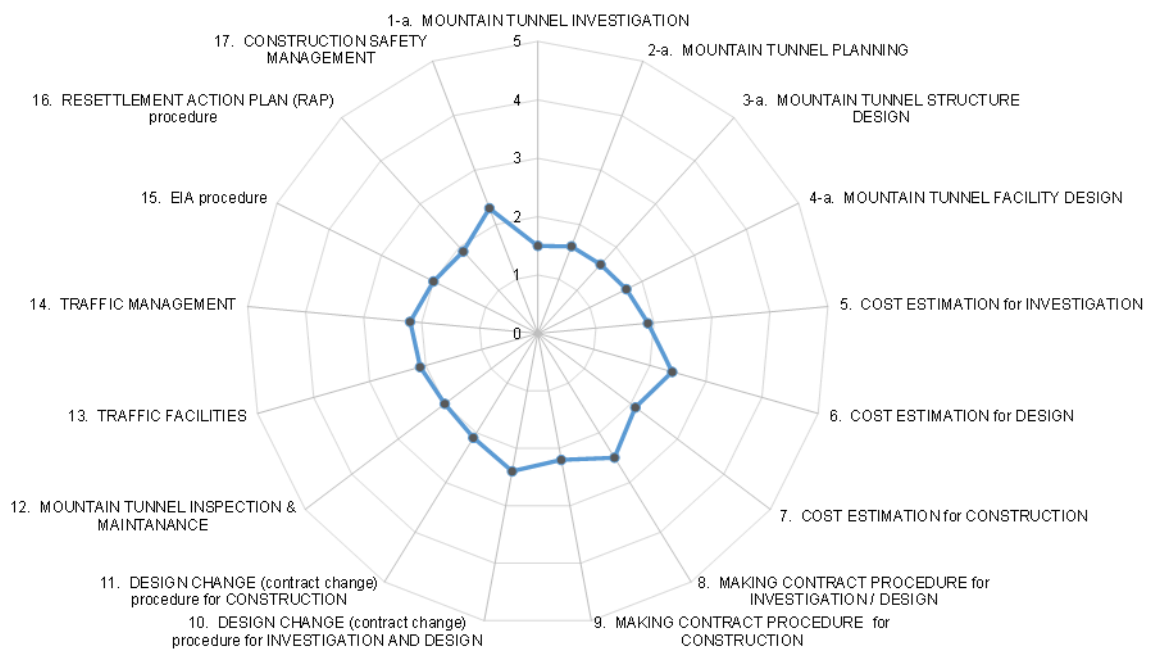
Source: Based On the Web Survey Results (Compiled by JICA Expert Team)

**Figure 2-4 Knowledge Level of DOH Personnel (C/P: WG Members) on Mountain Highway Tunnels [WG-2]**



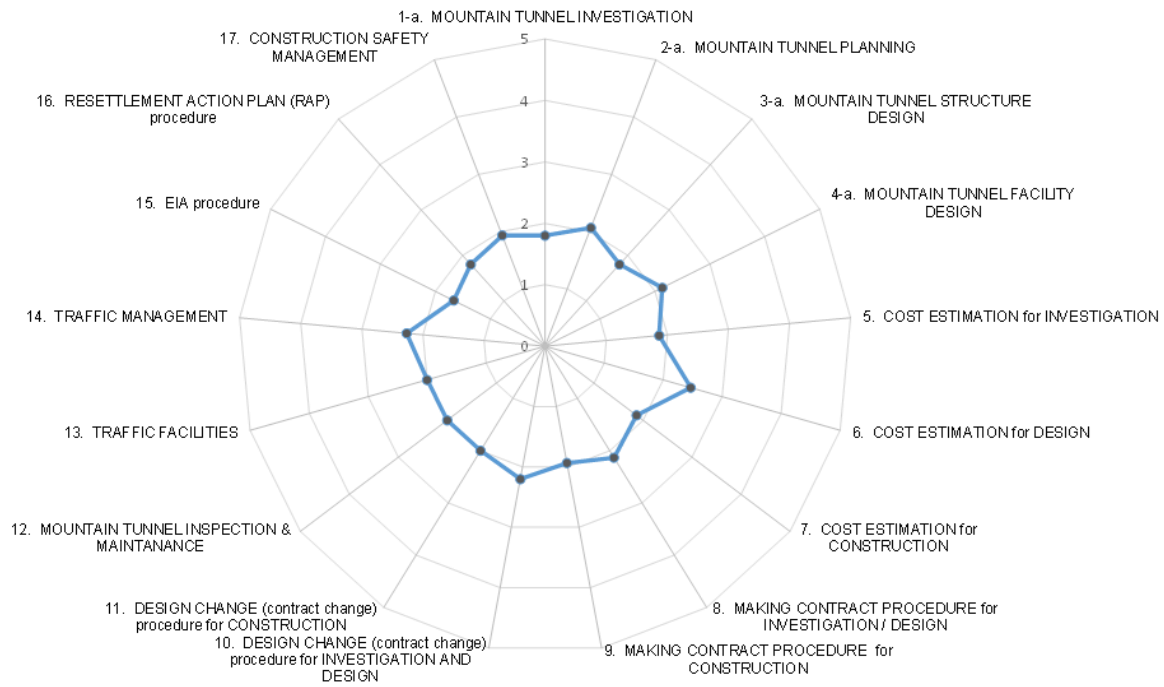
Source: Based on the web survey results (compiled by JICA Expert Team)

**Figure 2-5 Knowledge Level of DOH Personnel (C/P: WG Members) on Mountain Highway Tunnels (WG-3)**



Source: Based On the Web Survey Results (Compiled by JICA Expert Team)

**Figure 2-6 Knowledge Level of DOH Personnel (C/P: WG Members) on Mountain Highway Tunnels (WG-4)**



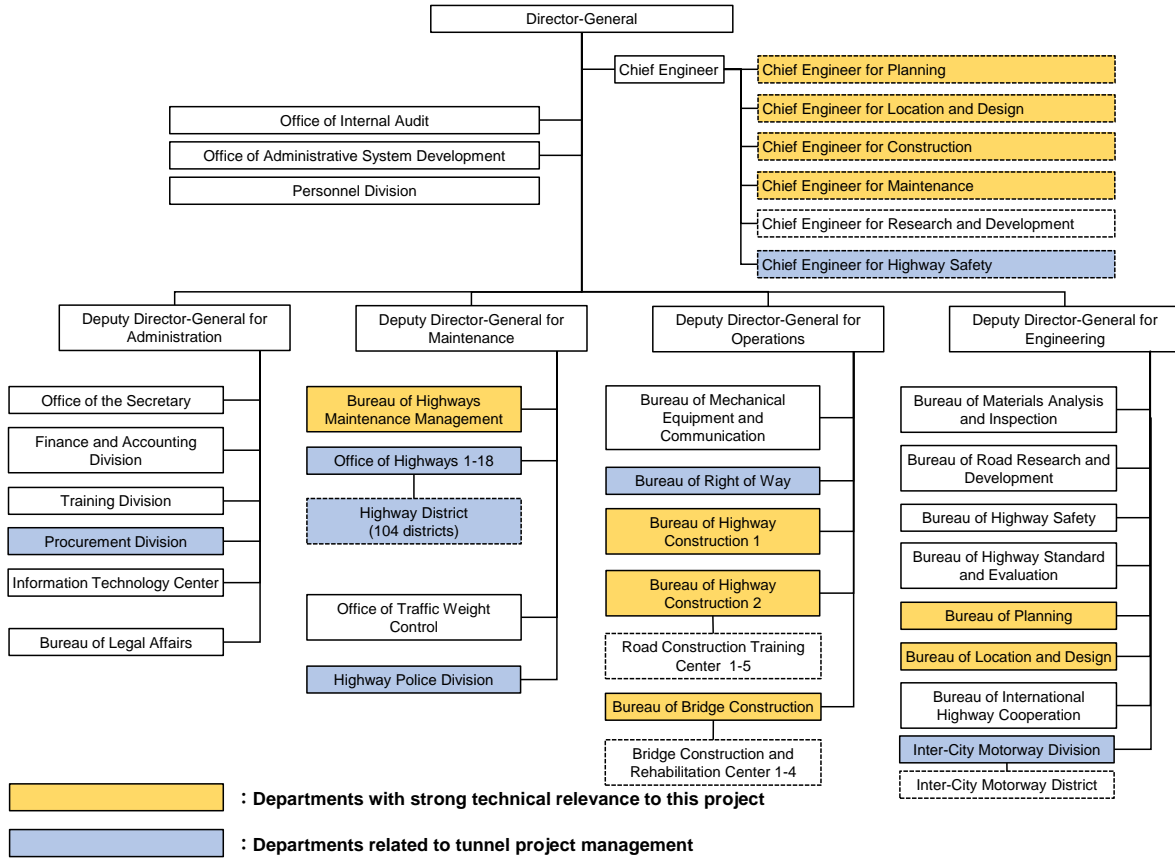
Source: Based On the Web Survey Results (Compiled by JICA Expert Team)

**Figure 2-7 Knowledge Level of DOH Personnel (C/P: WG Members) on Mountain Highway Tunnels 【WG-5】**

### 2.3.1.3 Establishment of a New Department Responsible for Mountain Highway Tunnel Operations

#### (1) Current Situation Analysis for Establishing a New Department Responsible for Mountain Highway Tunnel Projects

The Bureaus and Divisions within DOH are established according to their respective scopes and functions, with the responsible departments changing according to each stage of the project cycle. Figure 2-8 and Table 2-21 show the departments related to tunnel project management. For example, the Bureau of Planning and the Bureau of Location and Design, which are responsible for the upstream stages (planning, investigation, and design) of the tunnel project cycle, are positioned under the Deputy Director-General for Engineering.



Source: Based on DOH Annual Report 2023 (Compiled by JICA Expert Team)

**Figure 2-8 Departments Related to Tunnel Project Management**

**Table 2-21 Departments Related to the Tunnel Management Cycle in DOH**

Bureaus/Divisions		Bureau of Planning	Bureau of Location and Design	Procurement Division	Bureau of Right of Way	Bureau of Highway Construction 1	Bureau of Highway Construction 2	Bureau of Bridge Construction	Inter-City Motorway Division	Highway Police Division	Bureau of Highways Maintenance Management
Planning	Master Plan	◎									
	Priority Setting	◎									
F/S	Preliminary Design	◎									
	EIA	◎									
	Alignment & Cross section	◎									
Design	Detailed Design		◎								
Construction	Land Acquisition				○						
	Procurement (Construction)			○		◎	◎	◎			
	Supervision					◎	◎	◎			
	Design change	△	△			◎	◎	◎			
O&M	Operation								●	●	
	Maintenance										◎

【Legend】

◎:High Technical Relevance to Tunnel Project Management (High Relevance to the Project)

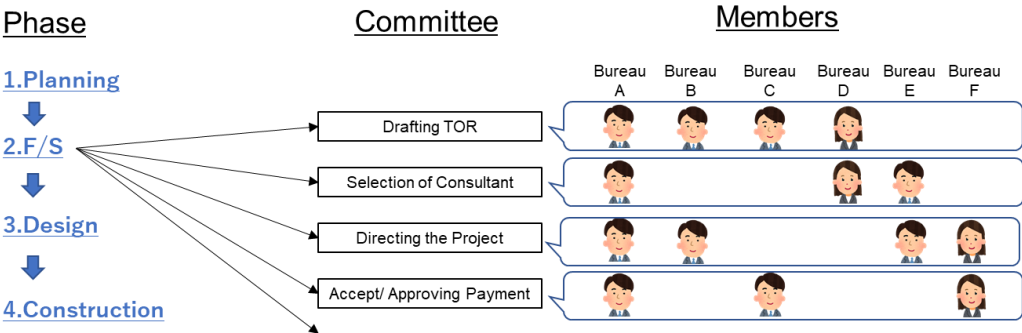
○:Involved in Tunnel Project Management (Not Exclusive to Tunnel Project Management)

●:Specialized management tailored to tunnel oversight is required for long tunnels.

As mentioned earlier, the organizational structure of DOH assigns responsible departments according to each stage of the project. For project implementation, however, a cross-functional committee system is utilized. The committee system operates as follows:

- Particularly in large-scale projects, committees with distinct roles are established for each project phase. For instance, in the feasibility study (F/S) phase, when a consultant contract is executed, committees are formed for each stage, including "TOR Preparation," "Consultant Selection," "Progress Management," and "Payments."
- The committee plays a role in advancing the project and grants approval for it to proceed to the next phase.
- Committee members are selected from relevant departments based on the committee's purpose. While external personnel may participate, there has been little precedent for this.

Figure 2-9 illustrates the structure of the committee system.



**Figure 2-9 Illustration of Committees Operating within DOH**

Table 2-22 shows the members of the Design Committee for the Krabi Bypass Project. Under the Chief Engineer for Design, members are selected from each phase, including planning, design, construction, and O&M, indicating that departments other than the Bureau of Location and Design are also involved.

**Table 2-22 Members of the Design Committee for the Krabi Bypass Project**

No.	Position/Responsibility	Department
1	Chief Engineer	Chief Engineer for Location and Design
2	Director	Bureau of Location and Design
3	Deputy Director 1	Bureau of Location and Design
4	Deputy Director 2	Bureau of Location and Design
5	Senior Engineer (Professional Level)	Bureau of Planning
6	Senior Engineer	Bureau of Materials Analysis and Inspection
7	Civil Works Technician (Senior Level)	Bureau of Right of Way
8	Representative	Bureau of Road Construction 1
9	Representative	Krabi Highway District
10	Survey	Bureau of Location and Design
11	Highways Design	Bureau of Location and Design
12	Senior Engineer (Professional Level)	Bureau of Location and Design
13	Structure Design	Bureau of Location and Design

No.	Position/Responsibility	Department
14	Project Manager	Bureau of Location and Design
15	Highways Design (Secretary)	Bureau of Location and Design
16	Highways Design (Secretary)	Bureau of Location and Design
17	Structure Design	Bureau of Location and Design
18	Geologist	Bureau of Location and Design

DOH is organized by functional bureaus/divisions rather than on a project-by-project basis. In other words, the responsible bureaus/divisions changes according to each phase of a project. For project execution, however, a cross-functional committee system is employed to oversee projects. Furthermore, DOH has a management structure that allows for project-based oversight. In large-scale projects, the Chief Engineer, who is the second-ranking official in the organization, is involved in committee operations and holds significant authority in project management. For the establishment of a new organization, it is deemed practical to adopt this existing system.

## **(2) Method for Allocating the New Department**

In establishing the project implementation framework, a set of basic policies was formulated. Initially, issues were identified from three perspectives when constructing the implementation framework for tunnel projects: "Background of DOH Operations," "Characteristics of Tunnel Projects," and "Current Status of DOH Organization."

### **I. Issues Based on the Background of DOH Operations**

The development of road networks is being actively planned under 20-year and 10-year plans, some of which include routes requiring tunnels. Developing rational tunnel plans is critical for securing appropriate budgets and ensuring smooth project progress, and DOH is required to implement the planning phase promptly and effectively.

### **II. Issues from the Characteristics of Tunnel Projects**

In tunnel projects, cross-phase review and coordination are especially important. Since it is impossible to fully understand the geological conditions, design changes and structural adjustments are often necessary during construction. In some cases, it may be required to revert to the design phase even during the construction stage. Similarly, it is essential to secure construction budgets in the planning phase with potential design changes in mind, as well as to establish operational methods, including disaster prevention, at the earliest stage possible. Various ancillary facilities are installed within the limited space of tunnel structures, and their arrangement and necessity vary depending on their purpose and operational methods. Therefore, each department must understand not only the phase it is responsible for but also the conditions and policies of other phases. An effective measure to address this issue is the establishment and updating of various manuals to ensure comprehensive phase-by-phase implementation.

### **III. Current Status and Challenges of DOH Organization**

DOH has limited experience in tunnel projects and lacks specialized tunnel engineers. Through the WG activities of this project, individual capacity building is expected, along with an enhancement of technical skills and accumulation of expertise through the establishment and updating of manuals. At this stage, it is necessary to proceed with both human resource development and project

implementation in parallel. The basic response policies for constructing the project implementation framework, considering these issues, are summarized in Table 2-23.

**Table 2-23 Basic Policies for Constructing the Project Implementation Framework**

Viewpoint	Issues/Background	Basic Policy
1. Tasks by DOH	<ul style="list-style-type: none"> <li>DOH needs <b><u>to proceed tunnel development projects promptly</u></b>, while road network development is being actively planned, such as 20-year plans and 10-year plans.</li> <li>In particular, <b><u>early and appropriate implementation of the planning</u></b> is required.</li> </ul>	<ol style="list-style-type: none"> <li><b><u>Utilize the most of the current organization and work flow</u></b></li> <li><b><u>Consider the optimal organization structure for each phase in order to respond quickly to the preceding planning phase</u></b></li> </ol>
2. Issues specific to Tunnel Project	<ul style="list-style-type: none"> <li>In tunnel projects, measures across each phase is necessary. <ul style="list-style-type: none"> <li>Prompt response to design changes that occur at the construction phase (including structure changes)</li> <li>Facility design considering operation</li> <li>Budget preparation to design changes</li> </ul> </li> </ul>	<ol style="list-style-type: none"> <li><b><u>Close cooperation between each phase and bureau</u></b></li> </ol> <p>*Countermeasures other than organizational structure</p> <ul style="list-style-type: none"> <li>Preparation of various manuals and guidelines and the update</li> </ul>
3. Issues within DOH	<ul style="list-style-type: none"> <li><b><u>Few tunnel engineers and experience</u></b></li> </ul>	<ol style="list-style-type: none"> <li><b><u>Efficient deployment of Engineers</u></b></li> <li><b><u>Utilization of experts outside the DOH</u></b></li> </ol> <p>*Countermeasures other than organizational structure</p> <ul style="list-style-type: none"> <li>Capacity development through WG activities</li> <li>Preparation of various manuals and guidelines and the update</li> </ul>

The challenge under “I. Tasks by DOH” is the prompt execution of tunnel development. When forming a new organization or unit, significant changes to the organizational structure, roles, and authority of each department may require time for procedural adjustments and could lead to decreased work efficiency, adversely affecting the speed of project implementation. Therefore, the first basic policy is to make maximum use of the current organizational structure and project implementation framework of DOH, minimizing the impact on the project system. The second basic policy is to establish an optimal organizational framework for each project phase to adapt flexibly to planning and design phases that are already underway.

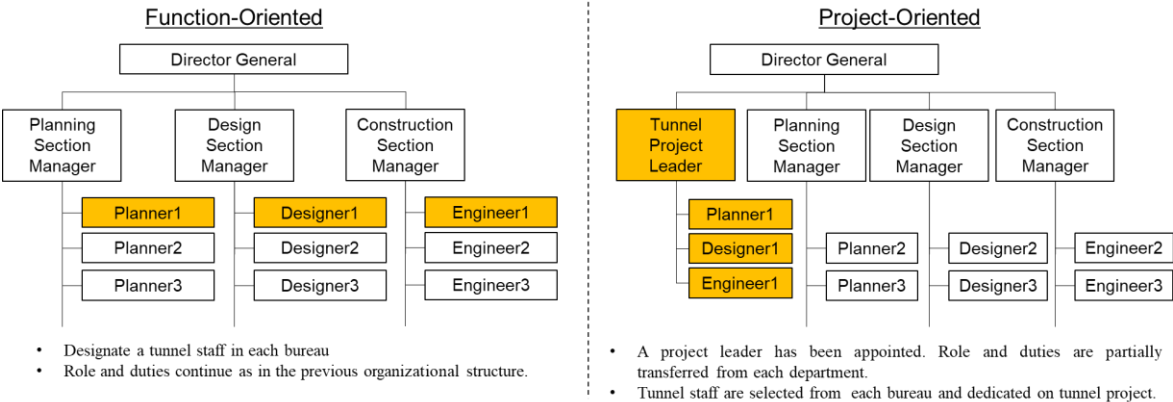
For “II. Issues specific to Tunnel Project,” the need for cross-phase coordination is addressed by establishing a project implementation framework that promotes close cooperation between phases and departments. This serves as the third basic policy.

For “III. Issues within DOH,” concerning the shortage of engineers, efficient allocation of engineers is adopted as the fourth basic policy, and the use of external experts as the fifth basic policy.

Based on these policies, the project implementation framework will be examined moving forward. Considering DOH’s current project implementation framework, Figure 2-10 presents two possible configurations for the placement of the tunnel project unit.

The left configuration is based on a functional organizational structure, whereby each department designates personnel responsible for tunnels. The roles and authority remain as they are, and projects are advanced through interdepartmental cooperation. This is the current system employed by DOH, where the committee-based approach enhances collaboration between departments.

The right configuration involves establishing a new project-based unit, which oversees the entire tunnel project cycle as a single unit. In this case, certain roles and authority are partially delegated to the leader of the new unit. Members are selected from each department and dedicated solely to the tunnel project.



Source: JICA Expert Team

**Figure 2-10 Method for Allocating the New Department (Example)**

A hybrid approach combining the two patterns is also conceivable; however, the fundamental difference lies in whether or not authority is delegated from each department. In the case of establishing a new project-based unit, authority across each phase is transferred to the leader of the new unit. The key point in selecting a framework, therefore, is whether such a strong leader is required. However, in DOH's current project implementation framework, a committee system is utilized for large projects, with the Chief Engineer, the second-ranking official, acting as the leader, effectively providing the necessary strong leadership. By applying a similar committee system to tunnel projects, the difference between the two patterns becomes negligible.

Based on this, Figure 2-11 presents the evaluation results of the two patterns in terms of alignment with the basic policies for project implementation outlined in the previous section.

	Function-Oriented (with committee system)	Project-Oriented
<b>Necessity of Transfer of power</b>	<p><b>Unnecessary (Very Good)</b></p> <ul style="list-style-type: none"> <li>No need to transfer power from each bureau.</li> </ul>	<p><b>Necessary (Poor)</b></p> <ul style="list-style-type: none"> <li>Need to transfer power from each bureau.</li> </ul>
<b>Impacts of reorganization</b>	<p><b>Smaller (Very Good)</b></p> <ul style="list-style-type: none"> <li>Small change from the current DOH project implementation structure.</li> </ul>	<p><b>Bigger (Poor)</b></p> <ul style="list-style-type: none"> <li>Big change from the current DOH project implementation structure.</li> </ul>
<b>Communication between phases</b>	<p><b>Possible (Good)</b></p> <ul style="list-style-type: none"> <li>Can be improved with utilization of committee system.</li> </ul>	<p><b>Easy (Good)</b></p> <ul style="list-style-type: none"> <li>Best for tunnel projects.</li> <li>But staffs outside the tunnel section are less involved in tunnel project.</li> </ul>
<b>Efficient deployment of Engineers</b>	<p><b>Efficient for implementing roles by bureaus (Good)</b></p> <ul style="list-style-type: none"> <li>Control of workload in each phase is possible.</li> <li>Especially in Design phase, knowledge for tunnel is required. It is effective to designating a person in charge of tunnel.</li> </ul>	<p><b>Efficient for tunnel project (Good)</b></p> <ul style="list-style-type: none"> <li>Best for tunnel projects.</li> <li>But depending on project situation, some members don't have tasks.</li> </ul>
<b>Utilization of experts outside the DOH</b>	<p><b>Possible (Good)</b></p> <ul style="list-style-type: none"> <li>Participation of outside experts in committee is possible.</li> </ul>	<p><b>Possible (Fair)</b></p> <ul style="list-style-type: none"> <li>Need discussion how to get them involved.</li> </ul>
<b>Evaluation</b>	<b>Preferred</b>	<b>Unpreferred</b>

**Figure 2-11 Comparison Results of Proposed Tunnel Project Unit Configurations**

Regarding the first basic policy for constructing the project implementation framework, “Minimization of Impact from Establishing the New Framework,” the Function-Oriented structure, which does not involve authority delegation, received a higher evaluation compared to the Project-Oriented structure. For other items as well, the Function-Oriented organizational structure was rated equally or more favorably. This evaluation assumes the appropriate use of the committee system currently employed by DOH. As a result, the Function-Oriented approach is considered the overall preferred framework.

Based on these considerations, five points outlined in Table 2-24 were proposed to DOH as measures for the tunnel project implementation framework at the 2nd JCC meeting, and DOH indicated that these points would be considered in future deliberations.

**Table 2-24 Proposal for the Tunnel Project Implementation Framework**

Proposal for the Tunnel Project Implementation Framework for DOH
1. New Bureau will not be established at this time
2. Utilization of Committee system
3. Consideration of designation of Tunnel Design Engineer in Bureau of Location and Design.
4. Consideration of establishment of “Tunnel Construction Unit” in Bureau of Bridge Construction after construction contracts are planned.
5. Consideration of establishment of “Bureau of Tunnel Construction” and “Tunnel Construction and Rehabilitation Center” after the tunnel projects increase.

Regarding items "1." and "2." of the proposal, DOH currently has tunnel projects in the planning and detailed design phases. To expedite these projects, it is deemed preferable to maintain the existing organizational structure rather than establishing a new one. By adopting the committee system DOH

uses in other projects for its tunnel projects, coordination between project phases and departments can be enhanced. As further measures to strengthen collaboration and address the shortage of engineers, we proposed: 1) including representatives from all phases (from planning to O&M) in the committee members, and 2) actively incorporating external personnel. For "3.," the proposal is to designate personnel who have acquired tunnel technology through this project and are motivated as "tunnel engineers." In the Bureau of Location and Design, each engineer is assigned roles such as "road engineer" or "bridge engineer." Similarly, it is recommended to designate tunnel engineers, ideally at a stage when sufficient knowledge of tunnel projects has been acquired through this project. Additionally, considering that there are no designated engineers for the Krabi Bypass Project at present, we advised DOH to continue examining the necessity and effectiveness of this proposal within the organization. Regarding "4." and "5.," DOH currently has three construction supervision departments, and to ensure efficient allocation of tunnel engineers, we proposed establishing a Tunnel Construction Unit within the Bureau of Bridge Construction. Given that current tunnel projects are in the planning and design stages, the setup of this unit was deemed premature, and its establishment was recommended at the stage when construction contracts are in sight. The initial construction is expected for the Krabi Bypass in 2025. If tunnel projects increase in the future, it may become challenging to manage them solely with the proposed Tunnel Construction Unit. Therefore, we proposed establishing an independent Bureau of Tunnel Construction as well as a "Tunnel Construction and Rehabilitation Center." The timing for these initiatives depends on the situation but is expected to be in over five years.

**2.3.2 Output 2**

The achievement status related to Output 2 is shown in Table 2-25.

**Table 2-25 Achievement status related to Output 2**

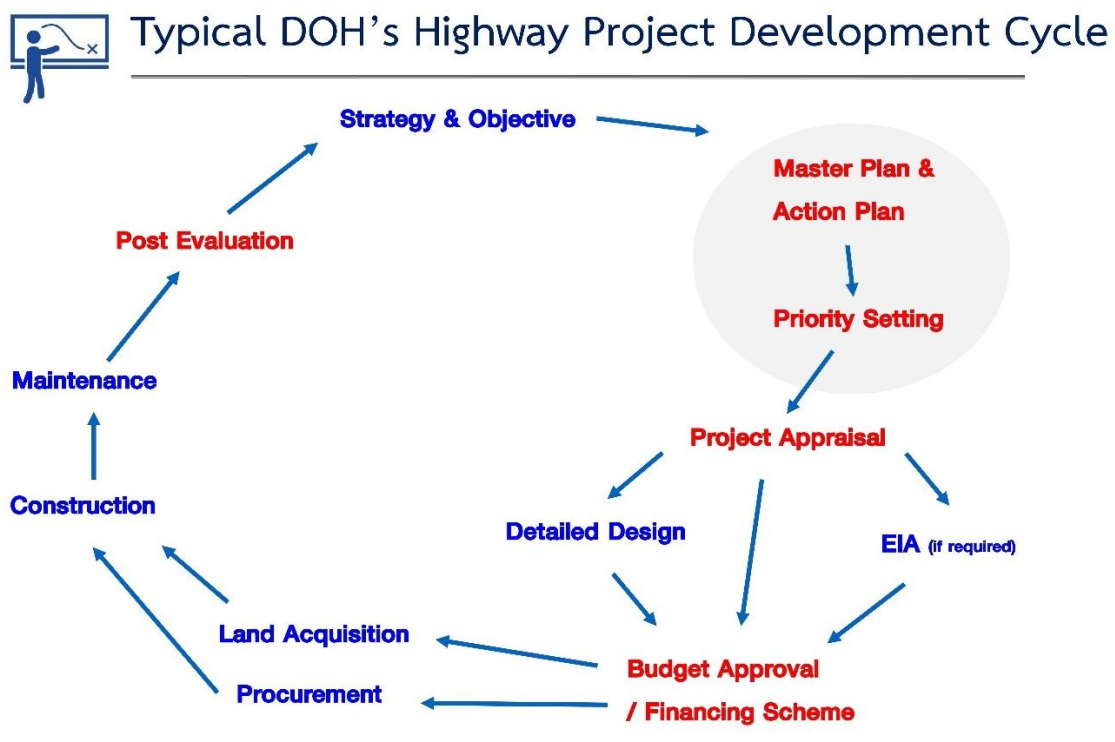
Output 2	DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.
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Indicators	Actual Results	Achievement Rate
<p><b><u>Indicator 2-1</u></b> The management cycle of mountain highway tunnel projects is clarified in DOH.</p>	<ul style="list-style-type: none"> <li>• To collect and analyze the information on existing management cycle of road project including tunnel project in DOH (30%/30%)</li> <li>• To develop a management cycle of mountain tunnel project in DOH (70%/70%)</li> </ul>	100%
<p><b><u>Indicator 2-2</u></b> A program of mountain highway tunnel construction projects is prepared by DOH.</p>	<ul style="list-style-type: none"> <li>• To review the 20-years Development Plan (30%/30%)</li> <li>• To draft a program (implementation plan) of mountain tunnel project in DOH (70%/70%)</li> </ul>	100%
<p><b><u>Indicator 2-3</u></b> A draft guideline for supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle.</p>	<ul style="list-style-type: none"> <li>• To draft the manual on supervision and inspection of mountain tunnel construction (25%/25%)</li> <li>• To prepare the training materials for mountain tunnel engineering (25%/25%)</li> <li>• To draft the guideline for operation and maintenance of highway tunnels (25%/25%)</li> <li>• To draft the contract guideline for design change of mountain tunnel (25%/25%)</li> </ul>	100%
<p><b><u>Indicator 2-4</u></b></p>	<ul style="list-style-type: none"> <li>• To review an EIA report for past projects of DOH. (20%/20%)</li> </ul>	100%

Indicators	Actual Results	Achievement Rate
A report on environmental issues and measures of mountain highway tunnel projects is prepared.	<ul style="list-style-type: none"> <li>To hold a technical lecture on environmental issues and measures of mountain highway tunnel. (30%/30%)</li> <li>To prepare a report on environmental issues and measures of mountain highway tunnel (Chapter-4 of the Planning Manual for Road Tunnels). (50%/50%)</li> </ul>	

### 2.3.2.1 Management Cycle for DOH’s Mountain Highway Tunnel Operations

The DOH Project Development Cycle is shown in Figure 2-12. Broadly categorized, it follows the flow of Planning → Design → Construction → Maintenance, with a subsequent phase for post-project evaluation, which feeds back into the next planning cycle.



Source: DOH's Highway Master Plan 2017-2026, Bureau of Planning, DOH

**Figure 2-12 DOH Project Development Cycle**

Road development is managed on a route-by-route basis, and mountain road tunnels are positioned as integral components of specific road sections. Therefore, even when mountain road tunnels are considered as standalone projects, their implementation processes are incorporated into the aforementioned procedures. In other words, the management cycle of mountain road tunnels aligns with the project implementation cycle for road development. Consequently, adopting the existing project implementation cycle as a basic framework in DOH's tunnel project cycle is expected to facilitate smooth project execution.

However, compared to general sections, tunnel sections, similar to long-span bridges, require significantly higher costs. Thus, careful estimation of project costs and duration is essential. Moreover,

it should be noted that tunnel projects may require cross-phase considerations and responses. For instance, as it is challenging to fully grasp subsurface conditions, design modifications or, in some cases, structural changes may become necessary. This necessitates addressing issues in the construction phase by revisiting the design phase. Similarly, during the project planning stage, it is advisable to secure a construction budget that anticipates potential design changes and to establish operational methods, including disaster prevention measures, in the early stages of the project.

To address these challenges, two countermeasures can be proposed. The first is the establishment of an implementation framework that strengthens coordination and information sharing between phases. This is related to the construction of the tunnel project implementation organization described in Outcome 1, and it corresponds with the content outlined in the previous section. The second is to develop and update various manuals to ensure that all necessary matters are comprehensively identified and executed at each phase.

### **2.3.2.2 Development of the Implementation Schedule for Mountain Highway Tunnel Projects**

A list of tunnels anticipated in the expressway development plan was compiled with the cooperation of DOH (Table 2-26). The rationale for creating this list is as follows: by involving engineers who gained experience through the current JICA technical cooperation project, it is expected that more accurate cost estimates and construction period projections will enable effective prioritization.

#### **1. Prioritization during the planning phase:**

As shown in Figure 2-12, prioritization is performed based on criteria such as the C/B ratio for each route, and the selected projects are advanced to the investigation phase. For this reason, rough cost and construction period estimates are required, and assumptions regarding road structures must be made. Particularly, tunnels and long-span bridges, which are expected to involve project costs an order of magnitude higher than general sections, require careful estimation in terms of their technical complexity and cost. Therefore, it is proposed to pre-identify long tunnels or tunnels expected to pose technical challenges and, with the involvement of experienced personnel, conduct a series of technical studies and cost estimates at a consistent technical level. Based on this process, a project implementation schedule for mountain tunnels should be prepared.

#### **2. Tunnels, like bridges, require specialized designers, contractors, and manufacturers:**

Since tunnels and bridges are realized through the involvement of professionals with specialized technical expertise, it is preferable to disclose the scale of the market for construction projects not only within Thailand but also internationally in advance.

The implementation schedule for mountain highway tunnel projects shall align with the overarching route-based road network development plan. In the creation of this higher-level plan, the importance of each route is evaluated from a national perspective; therefore, the priority of development is not anticipated to be affected solely by the existence of a tunnel. Consequently, the mountain highway tunnel

project implementation schedule developed by DOH is defined as one that identifies tunnel sections based on the latest higher-level plan, detailing scale and construction timing as extracted from this plan.

Given this context, the function and characteristics of the mountain highway tunnel project implementation schedule are clarified as follows. The implementation schedule has two primary characteristics: (1) "The tunnel project implementation schedule is developed internally and is not publicly disclosed"; (2) "The schedule serves primarily as a verification tool for the higher-level route development plan rather than as a foundation for formulating a direct action plan. Table 2-26 lists tunnel sections organized according to the route development plan to formulate the mountain highway tunnel project schedule. The base route development plan used is the Intercity Motorway and Railway Network Development Plan (MR-Map) covering all of Thailand. This plan spans over 6,000 km across 10 routes, with start times for each section categorized into four periods: short-term (up to 2027), medium-term (up to 2032), long-term (up to 2042), and beyond. The estimated investment requirements are THB 460 billion for the short-term, THB 410 billion for the medium-term, and THB 780 billion for the long-term.

**Table 2-26 List Organized by Focusing on Tunnel Sections**

**Motorway**

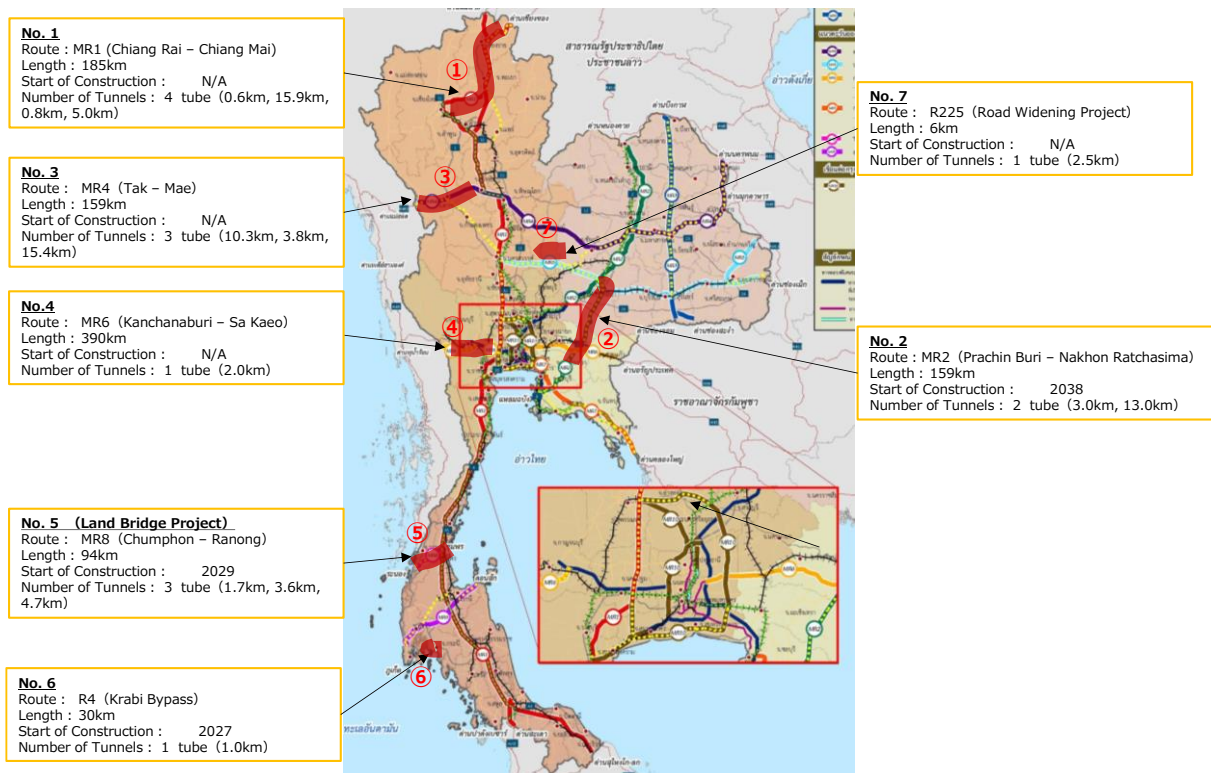
No.	Route No.	Name	Total Length of Route (km)	Tunnel	Schedule	Ref. Route No.
				No. of Tunnels (Location)	Construction Start	
1	MR1	Chiang Rai - Narathiwat	2,164		-	
1-1		Chiang Rai - Chiang Mai	185	4	N/A	
1-2		Chiang Mai - Phitsanulok		No info.	N/A	
1-3		Phitsanulok - Nakhon Sawan	144	No info.	2033-2042	M5
1-4		Nakhon Sawan - Suphan Buri	129	No info.	2033-2042	M5
1-5		Suphan Buri - Nakorn Pathom	70	No info.	2028-2032	M91
1-6		Nakhon Pathom - Pak Tho	61	No info.	~2027	M8
1-7		Pak Tho - Cha Am	59	No info.	2033-2042	M8
1-8		Cha Am - Narathiwat		No info.	N/A	M8
1-9		Songkhla - Sadao	69	No info.	~2027	M85
2	MR2	Nong Khai (Nong Khai checkpoint)-Chonburi (Laem Chabang)	897		-	
2-1		Nong Khai - Khon Kaen	378	No info.	N/A	M6
2-2		Khon Kaen - Nakhon Ratchasima	204	No info.	2033-2042	M6
2-3		Nakhon Ratchasima - Prachinburi	159	2	~2027	M61
2-4		Prachinburi - Laem Chabang	156	No Tunnel	2033-2042	M61
3	MR3	Bueng Kan - Surin	481	No info.	N/A	M64
4	MR4	Tak - Nakhon Phanom	872	3	N/A	M54,63
5	MR5	Nakhon Sawan - Ubon Ratchathani (The 6th Friendship Bridge)	703		-	
5-1		Nakhon Sawan - Nakhon Ratchasima	229	No info.	N/A	M62
5-2		Nakhon Ratchasima - Ubon Ratchathani	474	No info.	2033-2042	M62,65
6	MR6	Kanchanaburi - Sa Kaeo (Aranyaprathet checkpoint)	390	1	-	
6-1		Kanchanaburi - Bangkok(Western side of 3rd Ring road)			N/A	M81
6-2		Bangkok(Eastern side of 3rd Ring road) - Sa Kaeo			N/A	M71
7	MR7	Chonburi-Trad (Klong Yai checkpoint)	452	No info.	N/A	M72
8	MR8	Chumphon-Ranong	94	3	~2027	M83
9	MR9	Phuket-Suratthani	236	No info.	N/A	M84
10	MR10	Bangkok Outer Ring Road, Round 3	481		-	
10-1		Suphan Buri - Highway 32	38	No info.	2033-2042	M91
10-2		Highway 32 - 305	68	No info.	2028-2032	M91
10-3		Highway 305 - 34	52	No info.	~2027	M91
10-4		Highway 34 - Nakhon Pathom	103	No info.	2028-2032	M91
10-5		Suphan Buri - Bang Pa In	58	No info.	2033-2042	M51
10-6		Bang Pa In - Rangsit	22	No Tunnel	~2027	M5
10-7		Bang Pa-In - Bang Bua Thong	34	No Tunnel	~2027	M9
10-8		Bang Bua Thong - Bang Khun Thian	36	No Tunnel	~2027	M9
10-9		2nd Ring road connecting West and East	4	No Tunnel	~2027	M9
10-10		Ban Phaeo - Pak Tho	47	No info.	2033-2042	M82
10-11		Chatuchot - Eastern side of 3rd Ring road	19	No Tunnel	~2027	M71

**Highway**

No.	Route No.	Name	Total Length of Route (km)	Tunnel	Schedule	Ref. Route No.
				No. of Tunnels (Location)	Construction Start	
1	R4	Krabi bypass	30	1	N/A	
2	R225	R225 Road widening at Chaiyaphum	6	1	N/A	
3		Satun-Perlis	17	1	N/A	

**Table 2-27 Tunnel Construction Planned List (Excerpt from Table 2-26)**

No.	Class	Route No.	Name	Total Length of Route (km)	Tunnel Section		Schedule Construction Start	ref. Route No.
					No. of Tunnels (Location)	Length (km)		
1	Motorway	MR1	Chiang Rai - Narathiwat	2,164	-	-	-	
			Chiang Rai - Chiang Mai	185	4	0.6, 15.9, 0.8, 5.0	N/A	
2	Motorway	MR2	Nong Khai (Nong Khai checkpoint)-Chonburi (Laem Chabang)	897	-	-	-	
			Nakhon Ratchasima - Prachinburi	159	2	3, 13	2038	M61
3	Motorway	MR4	Tak - Nakhon Phanom	872	3	10.3, 3.8, 15.4	N/A	M54,63
4	Motorway	MR6	Kanchanaburi - Sa Kaeo (Aranyaprathet checkpoint)	390	1	2	-	
5	Motorway	MR8	Chumphon-Ranong	94	3	1.7, 3.6, 4.7	2029	M83
6	Highway	R4	Krabi bypass	30	1	1	2027	
7	Highway	R255	R255 Road widening at Chaiyaphum	6	1	2.5	N/A	



**Figure 2-13 Proposed Tunnel Construction Sites**

Based on these project schedules, it was decided to provide guidance to support DOH's future rational tunnel development planning. To obtain more specific information on construction timing, an inquiry was made to DOH's Bureau of Planning; however, as mentioned above, tunnels are part of a higher-level route development plan with a strong policy-driven component, so no useful information could be obtained. Consequently, instead of focusing on individual tunnels, efforts were directed toward raising DOH's awareness of the importance of a dedicated tunnel development schedule. Here, "importance" refers to "the need to gradually accumulate tunnel construction experience and enhance capabilities" (see Table 2-28).

**Table 2-28 Points to Consider in the Implementation Schedule for Mountain Highway Tunnel Projects**

Points to Consider in the Implementation Schedule for Mountain Highway Tunnel Projects
<p>1. Adopt a phased approach to accumulating tunnel construction experience and improving capabilities</p> <p><b>【Reason and Perspective】</b></p> <p>1) Smooth Acquisition of Technology</p> <p>a) Technical proficiency of DOH staff and the accumulation of technical skills within the organization (initially, a model where specific staff members lead skill enhancement efforts is also acceptable)</p> <p>b) Understanding the unit cost required for construction and maintenance in Thailand</p> <p>2) Gradual Development of Tunnel Project Systems within DOH</p> <p>a) Efficient utilization of DOH personnel</p> <p>b) Decision-making on the appropriate timing for organizational strengthening</p> <p>3) Effective Utilization of the Tunnel Construction Industry</p> <p>a) Promoting the technical maturity of construction contractors in Thailand</p> <p>b) Dissemination of technical guidelines domestically</p> <p>c) Avoiding the concentration of tunnel construction projects in the same period</p> <p>2. To achieve the above, incorporate specific details regarding tunnel locations and lengths into the route development plan</p> <p><b>【Reason and Perspective】</b></p> <p>1) Recognition that tunnels are a key component of route development plans</p> <p>2) The need to reflect DOH’s tunnel project management capabilities at that time in the route development plan</p>

To help DOH understand the significance and objectives of these considerations, a proposed tunnel project implementation schedule was compiled as much as possible, as shown in Figure 2-14. This visualizes the construction timeline exclusively for tunnel projects, with points to consider highlighted in red. This is just an example, but additional information to include in its creation would be construction timing and construction difficulty, such as tunnel length, cross-sectional area, and geological conditions. Using this, the feasibility of the project can be reviewed from the aforementioned perspective, and if difficulties are anticipated, the process can revert to the route development plan.

Route	Tunnel Section (only)											
	ID #	Length (km)	Construction Period (year)	Construction schedule								
				Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8-	
Route A	Tunnel 1	1.3	3									
Route B	Tunnel 1	1.7	3									
	Tunnel 2	3.6	3									
	Tunnel 3	4.7	4									
Route C	Tunnel 1	3	3									
	Tunnel 2	13	9									
Route D	Tunnel 1	0.6	3									
	Tunnel 2	15.9	9									
	Tunnel 3	0.8	3									
	Tunnel 4	5	4									
Route E	Tunnel 1	10.3	8									
	Tunnel 2	3.8	4									
	Tunnel 3	15.4	9									
Route F	Tunnel 1	2	4									

**Figure 2-14 Example of Points to Consider in the Implementation Schedule for Mountain Highway Tunnel Projects**

The above content was presented during meetings with DOH representatives from the Bureau of International Highway Cooperation and the Bureau of Planning, as well as during the 3rd JCC held in March 2022, with a request to treat it as a subject for future consideration. Another purpose of organizing the tunnel project implementation schedule was to gather information for evaluating and shaping Japan’s approach to cooperation with Thailand in this field. While this does not represent a direct output, it is recognized as contributing to the national interests of both Japan and Thailand. As for developments regarding road development plans in Thailand that include tunnels, DOH is advancing the Intercity Motorway and Railway Network Development Plan (MR-Map) for the entirety of Thailand, with its progress made publicly available in July-August 2023. This plan covers over 6,000 km across 10 routes, with commencement times for each route or section categorized into four periods: short-term (up to 2027), medium-term (up to 2032), long-term (up to 2042), and beyond. The construction start times and investment levels are THB 460 billion for the short-term (up to 2027), THB 410 billion for the medium-term (up to 2032), and THB 780 billion for the long-term (up to 2042). In the short-term development plan, the only route that includes a tunnel is MR8, which connects Chumphon and Ranong in southern Thailand. Construction is scheduled to begin in 2027 and be completed by 2030. Since this is the earliest planned development route, it is necessary to continue closely monitoring its progress. This route is part of a national project known as the "Land Bridge Project," which aims to provide an alternative route connecting the Gulf of Thailand and the Andaman Sea by land, bypassing the shipping lanes of the Strait of Malacca. Therefore, this project encompasses not only road construction but also the development of railways and ports.

### **2.3.2.3 Preparation of Guidelines for Mountain Highway Tunnel Construction and Maintenance**

Through investigations conducted as part of WG activities, it was confirmed that pavement management systems and bridge management systems have been established for roads and road structures managed by DOH. Additionally, it was noted that laser profilers are being trialed for pavement inspections. However, for road tunnel structures, including underpasses, while regular inspections of facilities such as lighting and pumps are conducted to some extent, there is no systematic inspection record or inventory sheet, nor are any manuals in place. Before the start of this project, DOH had begun studying the “TOMIE (Tunnel Operations, Maintenance, Inspection, and Evaluation Manual) FHWA-HIF-15-005/July 2015” as a manual for road tunnel operations and maintenance. However, since it had not addressed specific content, advanced examples and insights from Japan’s road facility maintenance experience were actively introduced and incorporated into the guidelines. The activities progressed as planned, with discussions on the main items and content of the guidelines beginning in 2023 and receiving approval in September 2023. In December 2022, a fire occurred in the wildlife corridor tunnel on R304, and in October 2023, flooding caused tunnel inundation upstream. In response, DOH requested lectures, training, and the addition of disaster response operations for tunnels to the “Guidelines for Operation & Maintenance.” Consequently, additional training was conducted, and the results were compiled into supplementary materials and training resources for the operation and maintenance guidelines.

### **2.3.2.4 Issues and Countermeasures Related to Environmental and Social Considerations in Mountain Highway Tunnel Projects**

#### **(1) Overview**

At the beginning of this project, there was no construction record of mountain highway tunnels in Thailand, and DOH lacked awareness of potential environmental impacts associated with advancing tunnel projects. They held an optimistic view that tunnel construction could minimize environmental alterations. Moreover, DOH was well acquainted with Thailand’s environmental impact assessment system and considered it unnecessary to receive technical transfer from Japan, structuring project activities based on this understanding. However, after the project commenced, DOH was informed that in Japan, issues such as the impact of tunnel construction on groundwater had become social concerns. This information resulted in DOH expressing a strong interest in Japan’s environmental investigations for tunnels and a desire for technology transfer in this field. Given this background, additional short-term experts were dispatched, and reports related to environmental and social considerations were prepared to support activities addressing environmental and social considerations in tunnel planning.

#### **(2) Legal Framework**

The development process of Thailand’s environmental policies and organizational structure shares similar background characteristics with Japan’s experience. Following the rapid industrialization and urbanization from the 1960s onward, which brought environmental issues to the forefront—similar to Japan’s period of high economic growth—the Improvement and Conservation of National

Environmental Quality Act was enacted. In 1975, the Environmental Impact Assessment (EIA) system was integrated into the Enhancement and Conservation of the National Environment Quality Act, which was later updated by the Enhancement and Conservation of National Environment Quality Act of 1992. Furthermore, a notification from the Ministry of Natural Resources and Environment in 2012 revised the EIA process. For projects that do not require the full precision of an EIA through screening, an Initial Environmental Examination (IEE) is required, while projects with significant health impacts must prepare an Environmental Health Impact Assessment (EHIA). Other relevant laws related to environmental and social considerations include the Land Act, Forest Act, and the Land Expropriation Act, establishing a legal framework for environmental and social considerations within Thailand.

### **(3) Organizational and Registration Systems**

The Ministry of Natural Resources and Environment (MoNRE) and the Office of Natural Resources and Environmental Policy and Planning (ONEP) serve as administrative authorities for EIAs, receiving applications from project operators. Operators contract registered and authorized local firms (such as environmental consultants) listed by ONEP to conduct the relevant assessments (EIA, IEE, EHIA, etc.) and prepare the required reports. ONEP performs the initial review of submitted EIA reports and also functions as the secretariat for higher-level committees or, in some cases, processes that include submitting the case to the Cabinet. Within DOH, an Environmental Group with approximately 10 staff members is established within the Bureau of Planning to handle environmental impact assessments. DOH generally coordinates with ONEP through this Environmental Group; however, in some projects where the Bureau of Location and Design or Bureau of International Highway Cooperation holds technical responsibility, including environmental and social considerations, the Environmental Group's screening function may be bypassed.

### **(4) EIA Approval Procedure**

The EIA procedures based on domestic laws are considered to generally meet the standards required by the JICA Environmental and Social Considerations Guidelines. For example, regulations include provisions for two opportunities for public participation (stakeholder consultations). The submitted draft Environmental Impact Assessment report undergoes a preliminary review by ONEP, followed by deliberation by the Expert Review Committee (ERC), appointed by the National Environment Board (NEB). If approval is granted by the committee or if there is no response from the ERC within the specified timeframe, the report is considered approved. Additionally, for government-related projects that require an EIA, Cabinet approval may be necessary for certain projects.

### **(5) Reports on Environmental and Social Considerations (Environmental Aspects Related to Tunnels: Scoping)**

The environmental scoping for mountain highway tunnel projects is generally similar to that of typical road sector projects. However, specific impacts attributable to tunnels need to be carefully examined. In particular, mountain highway tunnel projects must pay special attention to hydrological impacts, including those on groundwater. The tunnel-specific considerations are presented in Figure 2-15 and Table 2-29.

Major Possible Impacts on Environmental and Social Considerations Caused by a Tunnel Project in Mountainous Regions



Figure 2-15 Environmental Impact Image of Tunnel Projects

Table 2-29 Key Environmental Elements in the Implementation of Tunnel Projects

	Items	Impacts	Major Mitigation	Monitoring
<b>A. Pollution</b>	A-1 Ambient Air	- Exhaust gas - Dust / Particulate matter	- Ventilation shaft - Jet fan	PM, CO, NOx, SOx, etc.
	A-2 Surface Water	- Water volume - Water quality	- Drainage systems	pH, turbidity, etc.
	A-3 Groundwater	- Water level - Water quality	- Drainage systems	Water level and quality
	A-4 Noise and Vibration	- Noise - Vibration	- Noise barrier	Noise and Vibration
	A-5 Light	- Road lightning - Tunnel lightning	- Lightning facilities	Interview from farmers
	A-6 Soil/Muck Dumping	- Soil contamination - Leachate water quality	- Coverage - Chemical treatment	Soil pollution items
	A-7 Blasting (Dynamite)	- Noise and Vibration - Bad odor	- Noise barrier - License	Blasting plan Noise measurement
<b>B. Natural</b>	B-1 Deforestation	- Tree cutting - Flora - Protected forests	- Alternative plantation - Slope greening	EMP/EMoP
	B-2 Ecosystem	- Fauna - Flora - Protected areas	- Replantation - Fencing	EMoP including roadkill monitoring
<b>C. Social</b>	C-1 Land Acquisition	- Land acquisition - Resettlement - Private properties	- Alternative routes - Compensation - Assistance - Livelihood restoration	Internal/External Monitoring in RAP
	C-2 Public Use	- Mountain climbing - Fishing	- Guiding facilities for natural environment	EMP/EMoP and RAP
	C-3 Water Use	- Water volume (surface and groundwater)	- Alternative source	water volume

	Items	Impacts	Major Mitigation	Monitoring
	C-4 Traffic Accident	- Car accident - Pedestrian crossing	- Road signs - Safety facilities	Periodic report from district offices
	C-5 Bypassed Routes	- Community separation - Socio-economic isolation	- Job training, if any	Socio-economic monitoring by RAP

## (6) Others

In addition to the previously mentioned content, the report on environmental and social considerations for mountain highway tunnels also compiled case studies of mountain highway tunnel projects both domestically and internationally. It was confirmed with DOH that, particularly at the policy and planning stages of road network development, considering tunnel options allows for a multifaceted examination, including environmental load reduction, improvement of travel efficiency, and reduction of maintenance burdens.

### 2.3.3 Output 3

The achievement status related to Output 3 is shown in Table 2-30.

**Table 2-30 Achievement status related to Output 3**

Output 3	DOH's capacity of investigation on mountain highway tunnels is enhanced.
----------	--

Indicators	Actual Results	Achievement Rate
<b>Indicator 3-1</b> A draft manual on investigation of mountain highway tunnel is prepared by DOH.	<ul style="list-style-type: none"> <li>· To draft a manual on investigation of mountain highway tunnel (50%/50%)</li> <li>· To finalize the manual on investigation of mountain highway tunnel (50%/50%)</li> </ul>	100%
<b>Indicator 3-2</b> The draft guidelines for determination of scope of work for investigation of mountain highway tunnel are prepared by DOH.	<ul style="list-style-type: none"> <li>· To draft standard specifications on investigation of mountain tunnel (50%/50%)</li> <li>· To finalize the standard specifications on investigation of mountain tunnel (50%/50%)</li> </ul>	100%
<b>Indicator 3-3</b> The draft guidelines for cost estimation of mountain highway tunnel investigation is prepared by DOH.	<ul style="list-style-type: none"> <li>· To draft a manual on cost estimation of mountain tunnel investigation (50%/50%)</li> <li>· To finalize the manual on cost estimation of mountain tunnel investigation (50%/50%)</li> </ul>	100%
<b>Indicator 3-4</b> Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.	<ul style="list-style-type: none"> <li>· To select the sites of Pilot Study for tunnel investigation (30%/30%)</li> <li>· To conduct the Pilot Study for tunnel investigation in reference to the manuals/specifications (70%/70%)</li> </ul>	100%

#### 2.3.3.1 Preparation of the Investigation Manual of Road Tunnels

In the Preparation of the *Investigation Manual of Road Tunnels* (hereafter referred to as the Investigation Manual), emphasis was placed on incorporating ground classification methods, investigation techniques,

and investigation concepts suitable for Thailand's topography and geology, based on Japanese standards, while considering the results of preliminary interviews (baseline surveys). Specifically, as mentioned in the manual, Thailand, like Japan, has regions with complex geological conditions. Therefore, unlike regions in Europe and the United States, where homogeneous geological conditions are widely distributed, detailed geological investigations are necessary. However, due to budget constraints, a combined method of elastic wave exploration and boring investigation, which has been established in Japan, was adopted.

There are ground classification methods such as the Q-Value and RMR methods. However, these methods rely solely on the results of boring surveys (core samples) for evaluation. As a result, in areas with complex geological conditions, the survey costs can become significant. In Japan, based on the construction experience of over 10,000 tunnels, a ground classification method has been established that links survey results—such as elastic wave velocity and core sample conditions—with support patterns. After thorough discussions with the DOH, it was agreed to adopt the Japanese ground classification method in Thailand's manual.

These points were explained and discussed with the Department of Highways (DOH), and as a result, approval was obtained to adopt Japan's ground classification method in the Thai manual. The development of the Investigation Manual was carried out through WG-1, where basic knowledge was fostered, and discussions and reviews regarding the content were conducted primarily through lecture-style sessions based on the proposed table of contents of the manual.

As part of the 2022 activities, a lecture on Chapter 7, "Geological Risks in Tunnel Construction," was completed during the 5th WG-1 meeting held on February 28, and the draft of the Investigation Manual was finalized. Subsequently, the draft was updated by incorporating the results of the pilot studies from the Krabi Bypass Project and the Tak Method Project, and the final version was developed. The final version of the Investigation Manual was presented during the 12th JWG held on August 24, 2022, and received approval during the 4th JCC held on September 22, 2022.

The table of contents of the Investigation Manual is as follows:

Basic version

- CHAPTER 1 General on Geological Investigation
- CHAPTER 2 Geological Features in Thailand
- CHAPTER 3 The Objectives and Selection of Investigation Items in Each Stage
- CHAPTER 4 Deliverables of Investigation Results

Practical version

- CHAPTER 5 Characteristics of Various rock and Geological structure
- CHAPTER 6 Special Ground Conditions
- CHAPTER 7 Geological Risk in Tunnel work
- Appendix: Methodology of Investigation

### **2.3.3.2 Preparation of Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels**

Following the JCC's approval in September 2021 of the *Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Civil Works) (Draft)* (hereafter referred to as the Tunnel Common Specifications (Draft)), activities to finalize the Tunnel Common Specifications (Draft) for Investigation were conducted via WG-3 from late 2021 to September 2022, as described in 2.7.2.1(4), through a pilot study. Initially, the relationship between the *Common Specifications*, which form part of the contract in Japan, and the *Special Specifications*, which reflect project-specific characteristics (whereby the Special Specifications reference relevant items in the Common Specifications to clarify contractual requirements), was explained once more. Specifically, examples of NEXCO's *Special Specifications* were presented, illustrating how references to the *Common Specifications* are framed. Subsequently, a pilot study was conducted using the Krabi Bypass Project and the Tak-Mae Sod Project as case studies. Based on the results, the final version was created and received approval at the JCC meeting in September 2022.

### **2.3.3.3 Preparation of Draft Guidelines for Design Change of Road Tunnel Projects**

The *Draft Guidelines for Design Change of Road Tunnel Projects* (hereafter referred to as the Design Change Guidelines) were developed through WG-3, with a strong emphasis on explaining the necessity of establishing such guidelines by introducing examples from Japan, alongside discussions with members. In particular, for mountain highway tunnel projects, design changes due to unforeseen circumstances by both the client and contractor are unavoidable and tend to increase project costs, making it extremely important to recognize the necessity for design changes. Furthermore, inappropriate construction costs and schedule settings may not only degrade working conditions but also lead to a decline in construction quality. Therefore, it was valuable for the Thai side to deepen their understanding, as these guidelines would not be effectively utilized without a clear understanding of its purpose. The Design Change Guidelines were structured as a reference document that reflects the importance of design changes, based on the "Design Change Guidelines" established in Japan, while reviewing the existing design change procedures in Thailand. This document does not outline a new procedural method for design changes; rather, it identifies key points that should be confirmed during design changes. The guidelines were developed while incorporating requests from the Thai side.

Ultimately, the Draft Design Change Guidelines were submitted to the JCC in September 2023 and received approval.

1. Overview of Design Change Part	
Page-3	
> Outline of this guideline	
Name	Descriptions
Guidelines for Design Change of Road Tunnel Projects	This guideline is set for securing the quality of public procurements under unforeseen conditions at first contract.
Contents	Descriptions
Who use this guideline and who have responsible to obey this guideline?	DOH and contractors use this guideline when design change is needed.
Why we need to set this guideline?	To assure the quality of outputs of contracts (Design/Investigation, Construction)
What are the main contents?	Basic stances of client and contractor for design change are described, and some examples of design change will be listed.
This guideline aims to describe basic stance or thought for design change process, and does not suggest to change conventional procedure of design change in DOH.	

Importance of the Guidelines

3. Description of Contents	
Page-4	
<b>3. Procedure of Design Change</b>	
Main Topics	
<ul style="list-style-type: none"> <li>✓ General process of design change is described.</li> <li>✓ Necessary procedures are listed for both the client (DOH) and the consultant or contractor.</li> <li>✓ The order of design change should be agreed with documents.</li> </ul>	
<b>4. Consideration at Procurement Stage</b>	
Main Topics	
<ul style="list-style-type: none"> <li>✓ The importance of clarifying conditions of initial contract is described.</li> <li>✓ The check points at cost estimation are described. The client (DOH) also should site investigation beforehand if necessary.</li> <li>✓ The time for completion of the contract should be considered based on the features of the contracts.</li> </ul>	
<b>5. Consideration at Procurement Stage</b>	
Main Topics	
<ul style="list-style-type: none"> <li>✓ The contractor should make time schedule of the works with clarifying the milestones.</li> <li>✓ The time schedule should be sheared to the client (DOH), and be checked by each other.</li> </ul>	

Important point of each chapter

**Figure 2-16 WG-3 Documents (Draft Guidelines for Design Change of Road Tunnel Projects)**

### 2.3.3.4 Preparation of Guidelines for Cost Estimation of Road Tunnel Projects for Investigation

The *Guidelines for Cost Estimation of Road Tunnel Projects for Investigation* (hereafter referred to as the Guidelines) were developed through the activities of WG-4. This document is positioned as guidelines to facilitate cost estimation for investigation work related to mountain highway tunnels. The Preparation process involved lectures and discussions with WG members and proceeded as follows:

STEP 1: Collection of information on cost estimation methods related to road construction within DOH

STEP 2: Drafting of the table of contents for the Cost Estimation Guidelines (Draft)

STEP 3: Drafting of the main text of the Cost Estimation Guidelines (Draft)

In STEP 1, we compared the cost estimation methods for road construction between DOH and Japan (NEXCO), identifying differences (see Table 2-31) to clarify the approach for preparing the *Guidelines for Cost Estimation of Road Tunnel Projects for Investigation*. Based on the comparison results, we incorporated a simplified version of Japanese cost estimation methods into the guidelines. Additionally, the table of contents and main text structure followed the framework of NEXCO's *Guidelines for Cost Estimation of Investigation Work* (General Provisions, Soil and Geological Investigation, Surveying, Technical Work), with further refinements made through discussions and WG-4 activities with WG members. The *Guidelines for Cost Estimation of Road Tunnel Projects for Investigation* were formally approved at the JCC in September 2022.

**Table 2-31 Comparison of Cost Estimation Methods between DOH and NEXCO**

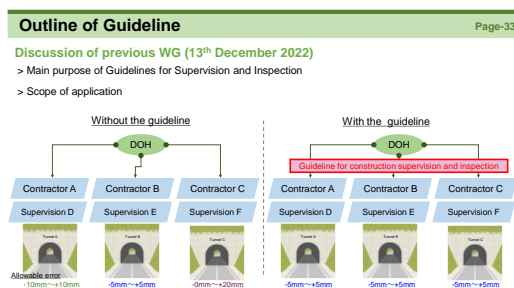
Items	NEXCO Cost Estimation Method	DOH Cost Estimation Method
Types of Contracts	Unit Price Contract	Lump-Sum Contract
Cost Estimation Structure	Detailed breakdown of items such as transportation expenses, daily allowances, lodging costs, and report preparation expenses is provided in the cost estimation.	Transportation expenses, daily allowances, lodging costs, and report preparation expenses are included under direct labor costs and general administrative expenses as substitute costs, making the estimation process simpler.
Standard Market Unit Prices	Standard market unit prices are adjusted based on conditions (partially	Standard market unit prices are not adjusted, and market unit prices for various conditions are accumulated in a database for use.

Items	NEXCO Cost Estimation Method	DOH Cost Estimation Method
	incorporated into the Cost Estimation Guidelines (Draft)).	
Standard Work Rates (Technical Work)	Standard work rates are used for each task (partially incorporated into the Cost Estimation Guidelines (Draft)).	Standard work rates are not available for each task; instead, Engineer MM (man-month) rates are set and used according to the scale of the overall project.

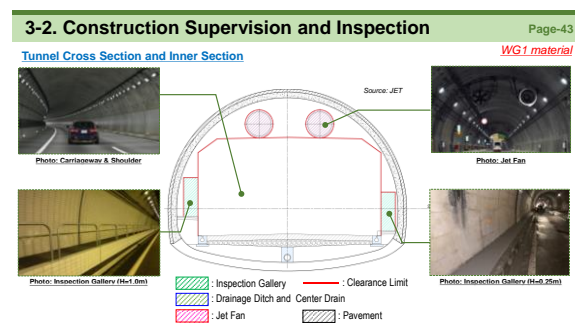
### 2.3.3.5 Preparation of Draft Guidelines for Supervision and Inspection of Road Tunnel Construction

The *Draft Guidelines for Supervision and Inspection of Road Tunnel Construction (Construction)* (hereafter referred to as the Guidelines) were developed through WG-4. Emphasis was placed on explaining the necessity of establishing these guidelines, as well as the importance of equipping DOH, the future managing authority, with this document to enable the maintenance and management of tunnel structures with consistent quality. The Guidelines include not only the main tunnel construction but also auxiliary facilities within the tunnel, making it essential to understand various installations. Given the significant overlap with other guidelines produced within this project, careful attention was given to ensure consistency with the content presented by other WGs and to avoid discrepancies in explanations from the Japanese side. The Guidelines were structured based on the construction management standards established in Japan, while verifying similar standards existing in Thailand. It details measurement items, measurement locations, and key considerations necessary for proper construction management. Since there is no experience with road tunnel construction, additional explanations of each construction type covered in each chapter were provided as needed during the Preparation process.

Ultimately, the Draft Guidelines for Supervision and Inspection of Road Tunnel Construction (Construction) were submitted to the JCC in September 2023 and received approval.



Importance of the Guidelines



Relevance to Other WGs

**Figure 2-17 WG-4 Documents (Draft Guidelines for Supervision and Inspection of Road Tunnel Construction)**

### 2.3.4 Output 4

The achievement status related to Output 4 is shown in Table 2-32.

**Table 2-32 Achievement status related to Output 4**

Output 4	DOH's capacity of design on mountain highway tunnel is enhanced.	
Indicator	Achievement	Achievement Rate
<b>Indicator 4-1</b> A draft manual on design of mountain highway tunnel is prepared by DOH.	<ul style="list-style-type: none"> <li>To draft a manual on design of mountain tunnel (50%/50%)</li> <li>To finalize the manual on design of mountain tunnel (50%/50%)</li> </ul>	100%
<b>Indicator 4-2</b> The draft guidelines for determination of scope of work for design of mountain highway tunnel are prepared by DOH.	<ul style="list-style-type: none"> <li>To draft standard specifications on design of mountain tunnel (50%/50%)</li> <li>To finalize the standard specifications on design of mountain tunnel (50%/50%)</li> </ul>	100%
<b>Indicator 4-3</b> The draft guidelines for cost estimation of mountain highway tunnel are prepared by DOH.	<ul style="list-style-type: none"> <li>To draft a manual on cost estimation of mountain tunnel design (50%/50%)</li> <li>To finalize the manual on cost estimation of mountain tunnel design (50%/50%)</li> </ul>	100%
<b>Indicator 4-4</b> Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.	<ul style="list-style-type: none"> <li>To select the sites of Pilot Study for tunnel design (50%/50%)</li> <li>To conduct the Pilot Study for tunnel design in reference to the manuals/specifications (50%/50%)</li> </ul>	100%

#### 2.3.4.1 Preparation of Design Manual of Road Tunnels

The *Design Manual of Road Tunnels* was developed through the activities of WG-1. This manual is broadly divided into the “Civil Works Part (Structural Design)” and the “Tunnel Facilities Part (Facilities Design)” (see Figure 2-18). For the Civil Works Part, from March to July 2022, six technical lectures were conducted, covering topics such as tunnel cross-section design, ground classification, portal design, support structure design, and construction planning, based on Japanese technical standards related to tunnel structures (see Figure 2-19). As indicated in 2.3.3.1, Japan's ground classification method was explained as being suitable for Thailand. Consequently, approval was obtained from the Department of Highways (DOH) to adopt Japan's standards as a basis for use in Thailand. Based on this content, WG-1 members collaboratively created the *Draft Design Manual of Road Tunnels (Design) (Civil Works Part)*, which was approved at the 4th JCC in September 2022. For the Tunnel Facilities Part, from June 2022 to February 2023, five technical lectures were conducted, covering topics such as emergency facilities, ventilation systems, and lighting systems within tunnels, based on Japanese technical standards related to tunnel facilities (see Figure 2-19). Standards for the installation of emergency equipment also exist in Europe and the United States. A comparative review of these standards was conducted, but the specifications in Japan, which provide detailed regulations on installation intervals and technical requirements, were explained as being more suitable. Consequently, approval was obtained from the Department of Highways (DOH) to adopt Japan's specifications. Based

on this content, WG-1 members collaboratively created the *Draft Design Manual of Road Tunnels (Design) (Tunnel Facilities Part)*, which was approved at the 5th JCC in March 2023. Subsequently, from April to July 2023, a pilot project was conducted using the approved *Draft Design Manual of Road Tunnels (Design) (Civil Works Part and Tunnel Facilities Part)*, finalizing the manual (for details, see Section 2.7.2). The finalized manual received approval at the 6th JCC in September 2023. Additionally, the preparation policy and content of the *Design Manual of Road Tunnels (Design)* were reviewed by the JICA Technical Advisory Committee, and the manual was prepared with consideration of the committee members' feedback.

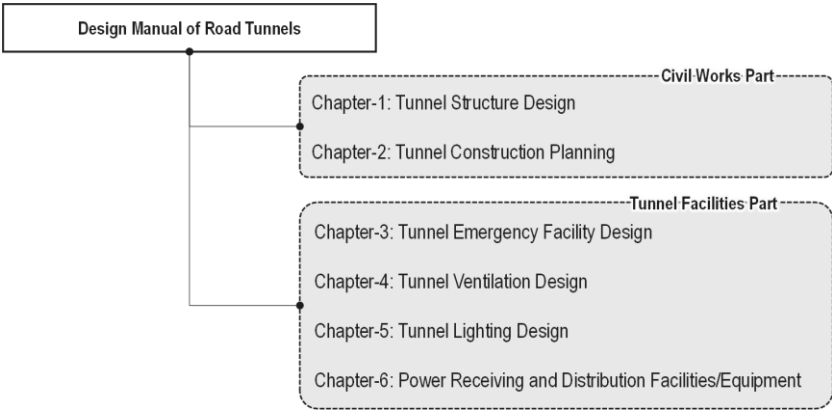


Figure 2-18 Structure of the *Design Manual of Road Tunnels (Design)*



WG1-8 (Lecture on Tunnel Cross-Section Design)

**4. Chapter 1.7 Ground Classification**

**Ground Classification (Elastic Wave Velocity)**

Assumption: Rock Type = H-Massive (Granite)

**How to evaluate the ground class by the elastic wave velocity?**

- To evaluate the rock types based on the representative rock name of the ground (See the table shown in last slide)
- To check the range of elastic wave velocity for the ground class (B, CI, CII, etc.) in accordance with the rock classification table shown in right side figure.
- Range of the elastic wave velocity in case of H-Massive (Granite) is as below.

Ground Class	Rock Types	Rock Name	Elastic Wave Velocity (Vp)
B			More than 4.5km/s
CI	H-Massive	Granite	3.7 - 5.0 km/s
CII			3.0 - 4.0 km/s
DI			2.0 - 3.0 km/s
DII			Not Applicable

WG1-9 (Lecture on Ground Classification)

Figure 2-19 Progress of Manual Preparation in WG1

2.3.4.2 Preparation of Planning Manual of Road Tunnels

The *Planning Manual of Road Tunnels* was developed through the activities of WG-2. This manual is divided into the "Civil Works Part (Mountain Highway Planning and Mountain Highway Tunnel Planning)" and the "Environmental Part (Environmental and Social Considerations in Mountain Highway Tunnel Projects)" (see Figure 2-20).

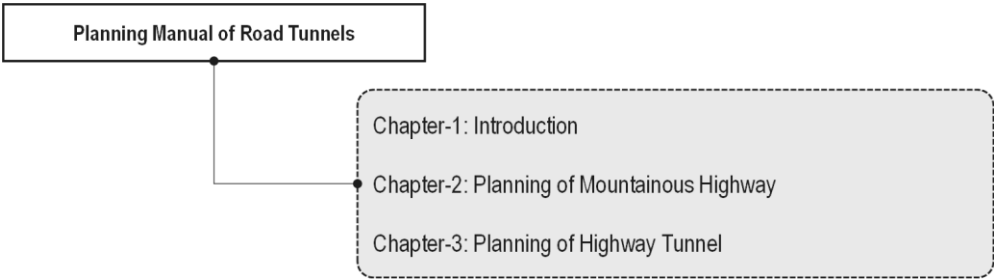
For the Civil Works Part, from February to June 2022, six technical lectures were conducted based on DOH standards and Japanese technical standards related to tunnel structures. These lectures covered

mountain highway planning and mountain highway tunnel planning (including standard cross-section design, ground classification, portal planning, support structure design, basic construction planning, and preliminary cost estimation) (see Figure 2-21). Based on this content, WG-2 members collaboratively created the *Draft Planning Manual of Road Tunnels (Planning)*, which was approved at the 4th JCC in September 2022.

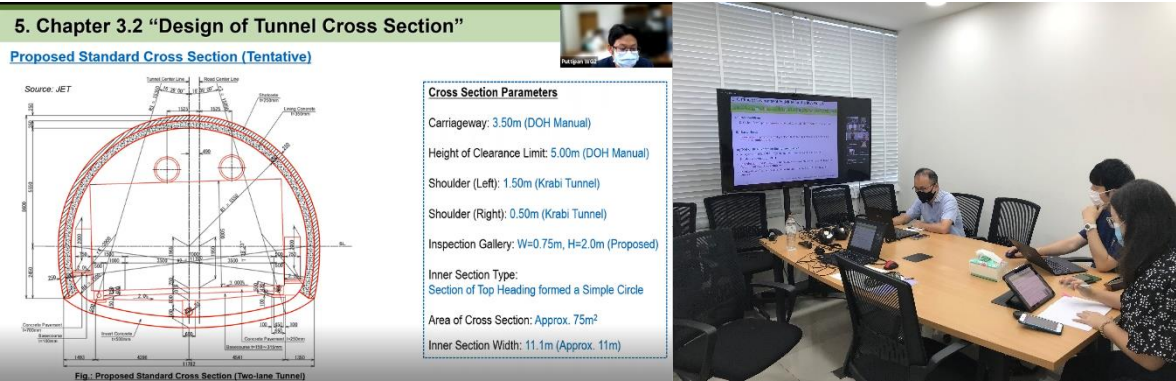
Subsequently, from April to July 2023, a pilot project was conducted using the approved *Draft Planning Manual of Road Tunnels (Planning)*, finalizing the manual (for details, see Section 2.7.2). The finalized manual received approval at the 6th JCC in September 2023.

Additionally, between May and November 2022, WG-2 conducted three technical lectures on environmental and social considerations in mountain highway tunnel projects and reviewed DOH’s existing EIA reports. This facilitated technology transfer regarding the environmental measures to be considered in mountain highway tunnel projects.

The preparation policy and content of the *Planning Manual of Road Tunnels (Planning)* were reviewed by the JICA Technical Advisory Committee, and the manual was prepared with consideration of the committee members’ feedback.



**Figure 2-20 Structure of *Planning Manual of Road Tunnels (Planning)***



WG2-07(Standard Cross-Section Planning for Tunnels)

WG2-08(Lecture on Environmental and Social Considerations)

**Figure 2-21 Progress of Manual Preparation in WG-2**

### 2.3.4.3 Preparation of the Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Design)

The *Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Design) (Draft)* were developed through the activities of WG-3 (see Figure 2-22 to Figure 2-25). The guidelines are divided into “Part 1: Civil Works” and “Part 2: Tunnel Facilities” (see Figure 2-18). For the civil works section, NEXCO’s *Common Specifications for Investigation, Chapter 5: Design, Section 5-8 Tunnel Design* was referenced, while for the facilities section, relevant parts of the *Common Specifications for Investigation of Facility Work, Chapter 4: Design of Mechanical, Electrical, and Communication Work* were referenced to create the draft.

All of them are organized by the standard design work content and results required for each design phase. The table of contents and a summary of the contents were presented to the WG for approval by WG-3 members, and the main text was subsequently prepared and approved at the 4th JCC in September 2022.

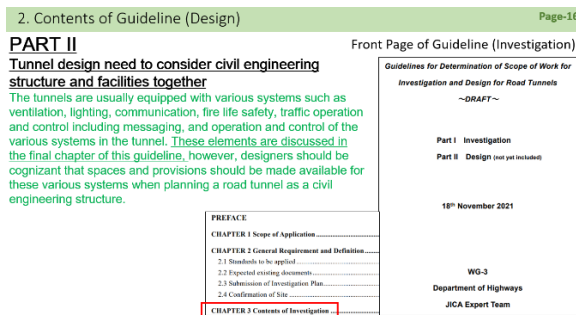


Figure 2-22 Explanation of the Structure of the Design Guidelines

Phase	Contents	Deliverables	Scale	Size
Detail	Plan	Plan drawings	1/500~1/2,500	A3
	Profile	Longitudinal section drawings	V=250 H=2,500	A3
Design	Geological plan and profile	Geological plan and profile drawings with rock classification	1/2,500	A3
	Tunnel Cross Sections	Design report	-	A3
	Cross section	Standard cross sections drawings	1/75~1/125	A3
		Support drawings	1/75	A3
	Cross section C type	Waterproofing drawings	1/125	A3
		Injection drawings	-	A3
	Portal Design	Reinforcing bar drawings	-	A3
		Design Report	-	A4
	Drainage design	Portal general drawings	1/125~1/250	A3
		Portal reinforced bar drawings	1/125	A3
Construction equipment plan	Design Report	-	A4	
	Layout drawings of temporary facilities	1/1,250	A3	
	Construction process drawings	1/125	A3	
Summary of Tunnel Plan	Summary report of tunnel plan	-	A4	
	Quantity Calculation	Quantity Calculation sheet	-	A4

Figure 2-23 Example of Content in the Design Guidelines (Civil Works): List of Required Deliverables

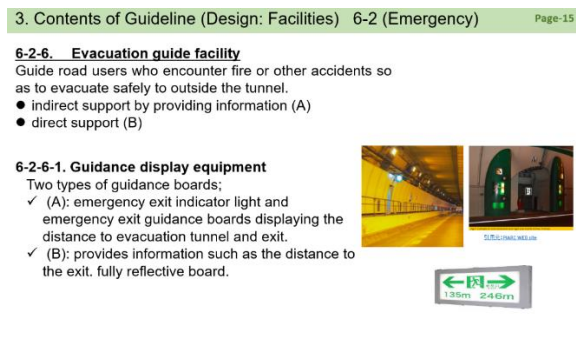


Figure 2-24 Example of Presentation Materials (PPT) for WG Explanation of the Design Guidelines (Tunnel Facilities)

No.	Item	Selection of Equipment & Specification	Cable *1)	
1	Automatic reporting equipment	○	○	(a) Fire detection device
2	Manual reporting equipment	○	○	(b) Terminal board
3	Water spray equipment	○	○	(c) Receiving device
4	Duct cooling equipment	○	○	(d) Transmission method
5	Fire hydrant equipment	○	○	(e) Arrangement and installation method
6	Water distribution equipment	○	○	(a) Automatic valve device
7	Water intake equipment	○	○	(b) Spray head
8	Water storage tank	○	○	(c) Valves
9	Installation of pumps	○	○	(d) Installation method
10	Doors for evacuation tunnel	○	○	Connecting study with water intake source
11	Control systems	○	○	1) Main water tank 2) Priming tank

\*1) Cable  
• Selection and specifications of electric wire cables, etc.  
• Selection and specifications of electric wire protection materials (including underground boxes)

\*2) Pipe  
• Determination of pipe diameter  
• Selection of piping method and pipe material

Figure 2-25 Example of Content in the Design Guidelines (Tunnel Facilities): List of Required Deliverables

Subsequently, activities to finalize the *Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Design) (Draft)* were conducted through WG-3 from April to September 2023 using a pilot study. The Krabi Bypass Project was selected as the pilot study subject, and DOH compared the contents of the TOR for design work prepared by DOH with those in the *Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Design) (Draft)*. Through this process, DOH gained a deeper understanding of the document while providing feedback

for revisions. These revision requests from DOH were incorporated, and the final version was completed. The finalized version received approval at the JCC held in September 2023.

1-6. Pilot Study (1/5)		Page-16
<b>Pilot Study by DOH</b>		
Fill up the relevant description of the <b>Scope of Works</b> in TOR in the following sheets to confirm the followings;		
1) Which items in the guidelines are included in the TOR		
2) Which items in the guidelines are not included in the TOR		
Note) This does not necessarily mean the problem		
3) Which items in the TOR are not included in the guidelines		
Note: Considering the DOH's definition of "Definitive design"		
<b>EXPECTATION</b>		
1) Understand the difference between "Definitive design" of DOH and "Detailed design" of NEXCO		
2) Understand the guidelines and how to use them		
3) Confirm additional description, if any, necessary to finalize the guidelines		
We would like to discuss about the result of DOH work in the next WG early July in 2023.		

**Figure 2-26 Content and Expectations of the Pilot Study**

WG-3 Guideline		4.11 Tunnel design and construction method
ITEMS	CONTENT	
<b>Chapter 6 Detailed Design</b>		
6.6 Tunnel Cross Section and Support Design	The tunnel cross-section design selects or designs the tunnel cross section applied to this design from the data arranged in 2.2.2 on the excavation method; determines the support work shape, dimensions, the erection interval, and the like	Items Included In the TOR "TOR: 4.11.1 Road engineering design in tunnel" The consultant must consider the number of traffic lanes, road width within the tunnel, tunnel layout, alignment and grade, and drainage system, all in accordance with international standards such as AASHTO. TOR 4.11.2.1 Support structure system
6.7 Portal Design	design details of the portal structure shown in the design documents (result of 4.4) in the contract documents and is classified as follows: - Category A or B - (depend on structure type)	Items not included in the TOR
6.8 Drainage Design	6.8.1 Structural Design 6.8.2 System Diagram	Items Included In the TOR "TOR: 4.11.1 Facility design in tunnels" "Structural Design" and "System Diagram" should be included in TOR
6.9 Construction Planning	① Time schedule ② Temporary equipment plan (ventilation, water supply) ③ Secondary electricity power facilities ④ Environmental measures (against noise and vibration, etc.) ⑤ Treatment plan for polluted water ⑥ Others (Temporary construction yard, measurement plan, during tunnel excavation)	Items not included in the TOR "TOR: 4.11.3 Procedures and methods for constructing tunnels" but not mentioned implicitly (usual engineers must understand the construction planning as a common sense) But ⑤, ⑥ not included in TOR

**Figure 2-27 Example of Pilot Study Results Report**

**2.3.4.4 Preparation of the Guidelines for Cost Estimation of Road Tunnel Projects for Design and Construction**

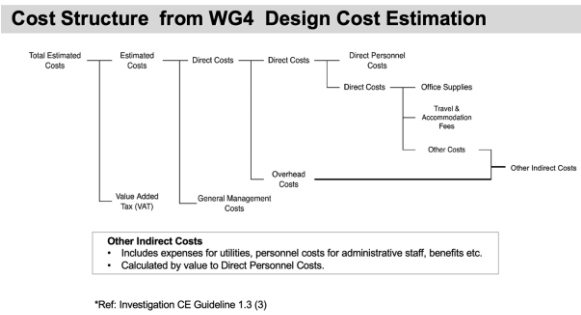
The Draft *Guidelines for Cost Estimation of Road Tunnel Projects (Design)* were developed through the activities of WG-4. This document is positioned as guidelines to facilitate cost estimation for design work related to mountain highway tunnels. The Preparation process involved lectures and discussions with WG members and proceeded as follows:

- STEP 1: Collection of information on cost estimation methods related to road construction within DOH and introduction of examples from Japan
- STEP 2: Drafting of the table of contents for the Cost Estimation Guidelines
- STEP 3: Drafting of the main text of the Cost Estimation Guidelines

In STEP 1, the cost estimation methods used in DOH and Japan (NEXCO) for road design were explained, discussing differences to clarify the approach for preparing the *Guidelines for Cost Estimation of Road Tunnel Projects (Design)*. Based on the comparison results, a simplified adaptation of Japanese cost estimation methods was incorporated into the guidelines. The table of contents and main text structure followed NEXCO's *Tunnel Design Cost Estimation Standards* (site surveys, design meetings, basic design, detailed design, etc.), with further refinements made through discussions and WG-4 activities with WG members to determine the cost estimation methods and prepare the *Guidelines for Cost Estimation of Road Tunnel Projects (Design)*.

Subsequently, WG-4 conducted a pilot study as part of the activities to finalize the *Guidelines for Cost Estimation of Road Tunnel Projects (Design)*. The Krabi Bypass Project was selected as the pilot study subject, and cost estimation was performed using the *Guidelines for Cost Estimation of Road Tunnel Projects (Design)*. Through the pilot study and Q&A sessions, participants gained a deeper understanding of cost estimation concepts and methods. Modifications were made to the *Guidelines for*

Cost Estimation of Road Tunnel Projects (Design) based on these activities, and the final version received approval at the JCC in September 2023.



Total Cost Estimation of Basic Design (Civil)	
<b>(1) Direct Cost (A+B)</b>	
<b>A) Direct Personnel Expenses</b>	
① Basic design + Field Investigation + Meeting = 292,185 + 152,063 + 122,025 <calculated previous slides> = <b>566,273 (THB)</b>	
<b>B) Direct Costs</b>	
② Office Supplies, Travel and Accommodation Fees = <b>100,000 (THB)</b> (Assumption, depend on Contractor)	
③ Other Indirect Costs = Direct Personnel Expenses x 0.35 / (1- 0.35) <Ref: 'Investigation CE Guideline 1.10 (2)> = ( ① ) × 0.53 = (566,273) × 0.53 = <b>304,916 (THB)</b>	
<b>(2) General Management Costs</b>	
④ General Management Costs = Operational Costs x 0.35 / (1- 0.35) <Ref: 'Investigation CE Guideline 1.10 (2)> = ((①+②+③) × 0.53 = (566,273 + 100,000 + 304,916) × 0.53 = 971,199 × 0.53 = <b>522,948 (THB)</b>	
<b>Total Basic Design Cost</b>	
566,273 (①) + 100,000 (②) + 304,916 (③) + 522,948 (④) = <b>1,494,137 (THB)</b> + VAT	

Figure 2-28 Presentation Materials on Cost Estimation Structure

Figure 2-29 Calculation Results from the Pilot Study

The Draft *Guidelines for Cost Estimation of Road Tunnel Projects (Construction)* were developed through the activities of WG-4, similarly to the Design Edition. This document is positioned as a draft version to facilitate understanding of the cost estimation concepts related to mountain highway tunnel construction. The preparation process involved discussions and activities with WG members (WG-4) and proceeded as follows:

- STEP 1: Drafting of the table of contents for the Cost Estimation Guidelines
- STEP 2: Drafting of the main text of the Cost Estimation Guidelines

In STEP 1, the general outline of Japan’s (NEXCO) cost estimation methods for tunnel construction was explained, allowing discussions on differences between both parties and clarifying the approach for preparing the Draft *Guidelines for Cost Estimation of Road Tunnel Projects (Construction)*. In STEP 2, discussions were held through WG activities to draft the guidelines, aiming to provide a clear understanding of the cost estimation concepts related to mountain highway tunnel construction.

**2.4 Project Purpose**

The achievement status related to Project Purpose is shown in Table 2-33.

**Table 2-33 Achievement status of Project Purpose**

Project Purpose	A base of management of mountain highway tunnel projects is established in DOH.	
Indicator	Achievement Status (as of December 2024)	Achievement Rate
<b>Indicator 1</b> DOH assigns not less than 5 staff members who are in charge of tunnel project. (investigation and design)	18 DOH personnel have been assigned to the Krabi Bypass Project, which includes the Mountain Highway Tunnel.	100%
<b>Indicator 2</b> At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.	The manuals developed under this project are being utilized for the detailed tunnel design of the Krabi Bypass Project and the reassessment of facilities for the Wildlife Corridor Tunnel.	100%

## 2.5 PDM Revised History

PDM Revised History is shown in Table 2-34.

**Table 2-34 PDM Revised History**

Date	Version	Main Revisions
21 June 2021	1.0	—
10 March 2022	2.0	<p><u>Objectively Verifiable Indicators</u>  <b>【Addition】</b>            2-4. A report on environmental issues and measures of mountain highway tunnel projects is prepared.</p> <p><u>Inputs (The Japanese Side)</u>  <b>【Addition】</b>            2-4. To study environmental issues and measures of mountain highway tunnel project</p> <p><u>Inputs (The Japanese Side)</u>  <b>【Addition】</b>            Environmental and Social Consideration</p> <p><b>【Reason】</b>            After the commencement of the technical cooperation project, we informed DOH that issues such as the impact of tunnel construction on groundwater have become social concerns in Japan. In response, DOH expressed a deep interest in environmental studies related to tunnels conducted in Japan and made a strong request for technology transfer in this field.</p>
22 September 2022	3.0	<p><u>Inputs (The Japanese Side)</u>  <b>【Name Change】</b>            Tunnel Planning ⇒Tunnel Planning (Location and Structure)            Environmental and Social Consideration            ⇒Tunnel Planning (Environmental and Social Consideration)</p>
22 March 2023	4.0	<p><u>Inputs (The Thai Side)</u>  <b>【Change in the Number of WG Members】</b>            43⇒65</p>
26 September 2023	5.0	<p><u>Inputs (The Japanese Side)</u>  <b>【Addition】</b>            Implementation of Additional Training for WG-5            Extension of the Project Period to February 2025</p> <p><b>【Reason】</b>            In December 2022, a fire incident occurred inside the operational Wildlife Corridor Tunnel on R304. Furthermore, in October 2023, flooding occurred on the upstream side of the tunnel, causing the tunnel to be submerged. In response to these events, DOH requested the JICA Expert Team to provide lectures and training on tunnel operations during disaster scenarios and to incorporate these outcomes into the "Guidelines for Operation &amp; Maintenance."</p>
18 December 2024	6.0	As described in section 2.6, the names of the manuals and guidelines created in this project have been aligned with the notation on the Project Design Matrix (PDM).

## 2.6 Technical Cooperation Documents

### 2.6.1 Policy for Manuals and Guidelines Preparation

The following policies were adhered to in the preparation of manuals and guidelines (hereafter referred to as manuals) for this project:

- DOH’s existing manuals, guidelines, and procurement systems are respected to the greatest extent possible.
- All manuals are created through the activities of the Working Groups (WGs) conducted as part of this project.
- The following documents currently in use in DOH projects are reviewed to ensure compatibility with DOH’s current practices:
  - a. Common Specifications
  - b. Special Specifications
  - c. Technical Specifications
  - d. Standard Specifications for Structures
  - e. Terms of Reference (TOR) for Investigation, Design, and Construction
  - f. Other documents related to the management of mountain highway and tunnel projects
- Based on the review results of the above existing technical manuals and guidelines, supplementary technical specifications and regulations will be added as necessary to implement tunnel projects (investigation, design, planning, cost estimation, and contract management). This is done with reference to the similarity between Thailand’s and Japan’s geological characteristics and is based on expert experience and manuals and guidelines widely used in Japanese tunnel projects. In cases where counterparts (C/P) reference standards from Europe or the U.S., supplementary explanations are provided regarding the background and reasons for adopting Japanese standards to facilitate understanding.
- Once the draft is completed, it undergoes consultation with the Advisory Committee (see Section 2.7.5), and feedback is provided to DOH on comments and suggestions for appropriate revisions.
- The final reviewers are members of the Technical Review Committee, as indicated in Section 2.7.6.
- The finalized manuals aim to be institutionalized within DOH as ministerial ordinances or directives.

### 2.6.2 Definition of Manuals

The definitions of the manuals and guidelines were determined through consultation with DOH, as shown in Table 2-35. The English version of the manuals is regarded as the official version, with a Thai translation provided as a reference document.

**Table 2-35 Definitions of Manuals and Guidelines**

Type	Definition	Note
Manuals	<ul style="list-style-type: none"> <li>• Documents that specify methods, technical standards, and criteria for tunnel planning, investigation, and design.</li> </ul>	When the manual is stipulated in the Terms of Reference (TOR), users must adhere to the guidelines specified in this manual.

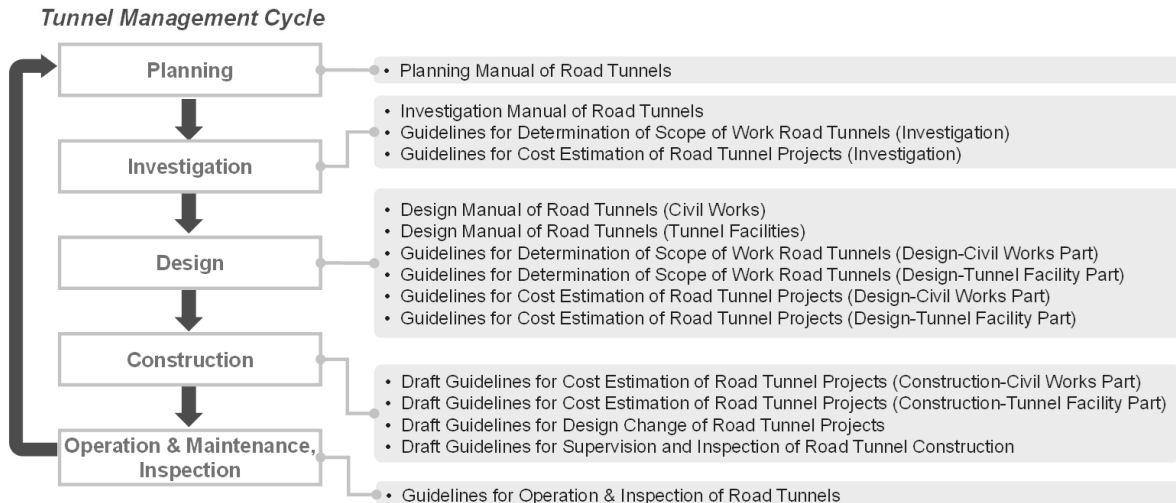
Type	Definition	Note
	<ul style="list-style-type: none"> <li>Documents that provide explanations related to tunnel planning, investigation, and design, which are new areas of work for DOH.</li> </ul>	
Guidelines	<ul style="list-style-type: none"> <li>Other documents beyond those mentioned above.</li> <li>Guidelines for the implementation of tunnel projects. *Note: Contracting, cost estimation, supervision, operation, and maintenance are conducted as part of DOH's routine work and are not considered new areas.</li> </ul>	<p>These guidelines include technical guidance and approaches; users are not necessarily required to strictly follow them.</p> <p>Some guidelines are draft guidelines because these draft guidelines do not include a pilot study.</p>

### 2.6.3 Titles and Systematization of Manuals

The content initially specified in PDM ver.0 was subdivided, supplemented, and organized into separate volumes for ease of use, with the names of each manual agreed upon with DOH, as shown in Table 2-36. Furthermore, these manuals are designated as official DOH publications, and they were organized and systematized to facilitate DOH's future management of the entire tunnel project (Figure 2-30). This figure illustrates which documents are relevant at each stage of the tunnel management cycle and is included at the beginning of all manuals. Additionally, for guidelines where a pilot study has not been conducted, they are to remain in a "draft" state as the final deliverables of this project, per agreement with DOH.

**Table 2-36 List of Manuals Developed in the Project**

Manual Names in PDM ver.0	Manual Names Agreed with DOH (Approved in PDM ver.6.0)
Investigation Manual of Road Tunnels	Investigation Manual of Road Tunnels (including Appendix)
Design Manual of Road Tunnels	Design Manual of Road Tunnels (Civil Works)
	Design Manual of Road Tunnels (Tunnel Facilities)
	Planning Manual of Road Tunnels
Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels	Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Civil Works)
	Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Tunnel Facilities)
Draft Guidelines for Design Change of Road Tunnel Projects	Draft Guidelines for Design Change of Road Tunnel Projects
Guidelines for Cost Estimation of Road Tunnel Projects for Design (Civil Works, Tunnel Facilities, Civil Works)	Guidelines for Cost Estimation of Road Tunnel Projects for Investigation
	Guidelines for Cost Estimation of Road Tunnel Projects for Design (Civil Works)
	Guidelines for Cost Estimation of Road Tunnel Projects for Design (Tunnel Facilities)
	Draft Guidelines for Cost Estimation of Road Tunnel Projects for Construction (Civil Works)
	Draft Guidelines for Cost Estimation of Road Tunnel Projects for Construction (Tunnel Facilities)
Draft Guidelines for Supervision and Inspection of Road Tunnel Construction	Draft Guidelines for Supervision and Inspection of Road Tunnel Construction
Guidelines for Operation & Maintenance of Road Tunnels	Guidelines for Operation and Inspection of Road Tunnels



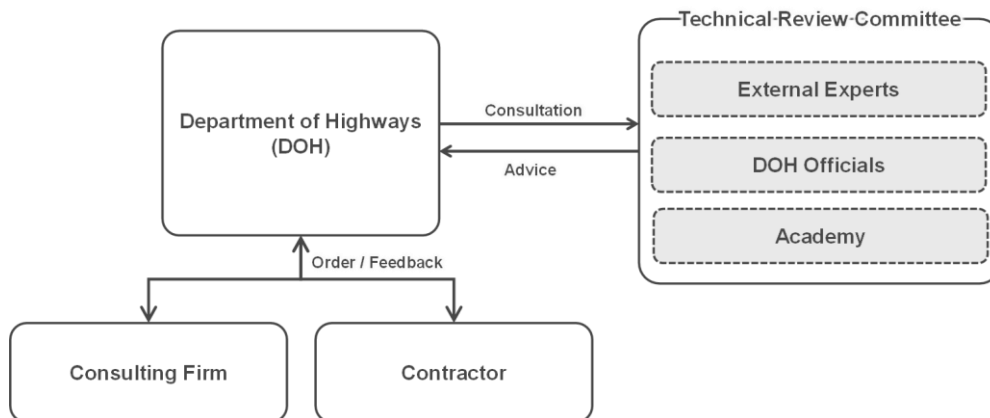
**Figure 2-30 Tunnel Management Cycle**

#### 2.6.4 Scope of the Manuals

The technical standards for road tunnels specify a maximum cross-sectional width of 14 meters (sufficient for two lanes and a sidewalk). For tunnels exceeding this width, review by an external committee and additional design considerations are required. In the case of long tunnels, in addition to increased geological risks, tunnels extending over 3 kilometers are classified as Grade A according to the road tunnel emergency facilities installation standards. This classification necessitates a wide range of emergency facilities, which in turn impact the tunnel structure. Notably, Japan has approximately 11,000 mountain highway tunnels, of which only about 1.5% are longer than 3 kilometers, with the majority being under 3 kilometers.

Considering these factors, along with DOH’s lack of experience in mountain highway tunnel projects, the scope of application for the three manuals developed in this project (the *Investigation Manual of Road Tunnels*, the *Design Manual of Road Tunnels* (Civil Works and Tunnel Facilities), and the *Planning Manual of Road Tunnels*) was set to “cross-sectional width: 14 meters or less, length: 3.0 kilometers or less,” with agreement from DOH.

For tunnel projects exceeding this scope, it was recommended to establish an external expert committee (Technical Review Committee), as shown in Figure 2-31, to thoroughly discuss and review the investigation, planning, and design methods.



**Figure 2-31 Proposed Structure of the External Expert Committee (Technical Review Committee)**

### 2.6.5 Training Materials

In addition to the above, presentation materials used in WG sessions (explanatory materials for the manuals) have been compiled into training materials.

## 2.7 Other Activities

### 2.7.1 Selection of Pilot Study Sites

In the project, a pilot study was conducted under the following guidelines, utilizing ongoing DOH projects to achieve efficient and effective capacity building.

Principle 1:	Review one Feasibility Study related to mountain highway tunnels in the East-West Economic Corridor project (The Intercity Motorway Tak-Mae Sod Section) currently planned by DOH.
Principle 2:	Conduct 1–2 investigation and design projects for relatively short tunnels (a few hundred meters in length) or medium-length tunnels (approximately 1,000 to 2,000 meters in length).

Based on the above guidelines, evaluation criteria for selecting pilot study sites were established as shown in Table 2-37. Using these criteria, the six projects proposed by DOH (No.1 to No.6 in Table 2-38) were evaluated, and at the 1st JCC, three projects (No.1, No.4, and No.6 in Table 2-38) were selected as pilot study sites. Subsequently, considering the "Study Work to Develop Plans for the Development of the Intercity Highway Network and the Rail System (MR Map)" reported in September 2021 (see Figure 2-32), two additional candidate sites (No.7 and No.8 in Table 2-38, refer to location map at the beginning) were proposed by DOH at the 2nd JCC.

However, due to the large project scale and lower feasibility compared to other projects, two sites, No.1 and No.4 in Table 2-38, were ultimately selected. Additionally, it was proposed to use the R304 Wildlife

Corridor Tunnel as a subject for training on existing tunnel facilities. Thus, three pilot study sites in total were agreed upon with DOH during the second JCC meeting.

**Table 2-37 Evaluation Criteria for Selecting Pilot Study Sites**

Evaluation Criteria		Score		
		3 (Excellent)	2 (Good)	1 (Fair)
1	Project Priority	High Priority: Covered by the 20-Year Plan	High Priority (Routes outside the 20-Year Plan)	Other routes
2	Project Implementation Schedule	Investigation or design work to be conducted by 2024	—	Schedule for investigation or design work is undecided
3	Tunnel Technical Level	Includes investigation or design for tunnels under 1km	Tunnel investigation or design for tunnels between 1km and 3km included	Tunnel investigation or design for tunnels of 3km or longer included
4	Environmental and Social Considerations	Minimal impact	Moderate impact	Significant or uncertain

**Table 2-38 Pilot Study Candidate Sites and Selection**

No.	Candidate Site Front Location Map: Refer to the road network in Thailand and the proposed pilot study sites.	Evaluation Criteria				Total Score	Evaluation Results	
		Project Priority	Project Implementation Schedule	Tunnel Technical Level	Environmental and Social Considerations		Principle1	Principle2
1	Pilot Study Candidate1 The Intercity Motorway: Tak-Mae Sod section	—	—	—	—	—	★	
2	Pilot Study Candidate2 The Intercity Motorway: Kanchanaburi-Phu Nam Ron section	3	1	2	2	8		
3	Pilot Study Candidate3 National Highway 223	1	1	2	2	6		
4	Pilot Study Candidate4 Krabi Bypass Construction Project	2	3	2	3	10		★
5	Pilot Study Candidate5 Satun-Perlis Highway Project	2	1	1	2	6		
6	Pilot Study Candidate6 Chiang Mai – Chiang Rai Motorway Project	2	3	3	1	9		
7	Pilot Study Candidate7 Chumphon – Ranong Motorway Project	***	***	***	***	***		
8	Pilot Study Candidate8 Nakhon Ratchasima - Chonburi (Laem Chabang) Motorway Project	***	***	***	***	***		

★: Projects Selected for the Pilot Study

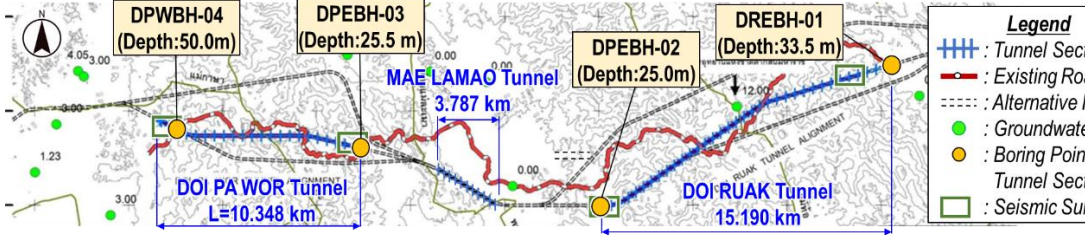


**2.7.2 Implementation of Pilot Study**

The Krabi Bypass Project (Figure 2-33) is a DOH-commissioned project, with the conceptual design (at the detailed design level) initiated in February 2021, and as of December 2024, internal procedures for environmental approval are underway. The Tak-Mae Sod Project (Figure 2-34) involves plans for three long tunnels, and although the feasibility study (FS) was completed in 2020, no progress has been made as of December 2024.



**Figure 2-33 Outline of the Krabi Bypass Project**



**Figure 2-34 Outline of the Tak-Mae Sod Project**

**2.7.2.1 The Krabi Bypass Project**

**(1) Utilization and Finalization of the Investigation Manual of Road Tunnels (Draft)**

A review of the existing FS and DD outcomes of the Krabi Bypass Project was conducted, along with a field survey by DOH (WG members) and JICA experts. This survey aimed to carry out a pilot study using the *Investigation Manual of Road Tunnels (Draft)* based on the results of the planned road tunnel in this section.

**(a) 1<sup>st</sup> Site Visit**

From March 7, 2022, a field survey was conducted over two days with approximately 40 participants, including the DOH Chief Engineer, committee members, and WG members. The primary objective of this survey was to utilize the *Investigation Manual of Road Tunnels*, focusing on examining the topographical and geological conditions as well as the social environment within the construction area. Based on the manual, explanations and discussions were held regarding which surveys should be conducted at specific locations. Subsequently, on March 25, a review was conducted concerning

the content, location, and quantity of borehole surveys to be carried out at the tunnel portal sites. Additionally, key points for the field survey were compiled into a checklist and explained on-site.



**Figure 2-35 1<sup>st</sup> Site Visit of the Krabi Bypass Project**

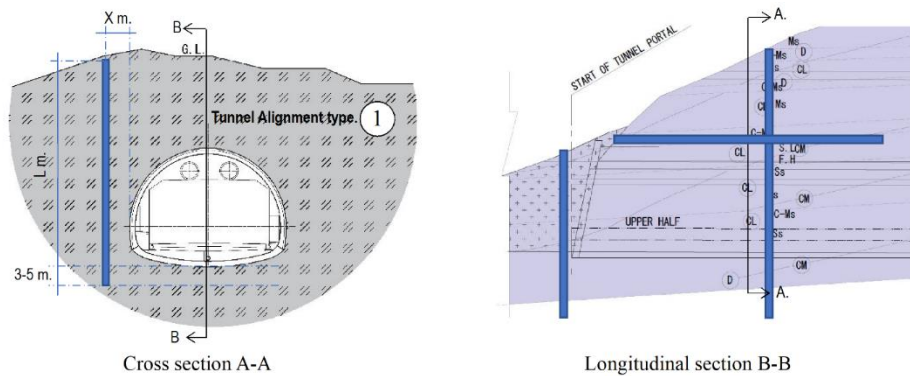
**(b) 2<sup>nd</sup> Site Visit**

From September 25, 2022, a two-day field survey was conducted by Dr. Noppadol Phien-Wej (Asian Institute of Technology), a candidate for the DOH Technical Support Committee; Professor Nobuharu ISAGO, Chair of the JICA Technical Advisory Committee (Tokyo Metropolitan University); and JICA experts. The primary objective of this survey was to utilize the *Investigation Manual of Road Tunnels*, focusing on examining the topographical and geological conditions of the site, the social environment within the construction area, and the observation of borehole cores obtained through geological surveys.



**Figure 2-36 2<sup>nd</sup> Site Visit of the Krabi Bypass Project**

Based on the implementation of the first pilot study for the Krabi Bypass and the discussions with WG members during the site investigation of the Tak Mae Sod Project mentioned later, it was determined that specific investigation case studies should be included in the Investigation Manual. The following content was added to the manual.



**Figure 2-37 Specific Examples of Investigation Boreholes Added to the Investigation Manual**

**(c) 3<sup>rd</sup> Site Visit**

From October 27, 2022, a two-day field survey was conducted by DOH environmental department personnel and JICA experts (environmental and tunnel planning) for this project. The primary objective of this survey was to utilize the environmental sections of the *Planning Manual of Road Tunnels*, conducting a field investigation of the social environment and providing lectures and practical inspections focusing on key EIA considerations for road tunnel projects.



**Figure 2-38 3<sup>rd</sup> Site Visit of the Krabi Bypass Project**

**(2) Utilization and Finalization of the Planning Manual of Road Tunnels (Draft)**

Using the design results of the Krabi Bypass Project as a case study, an exercise (pilot study) was conducted with WG-2 members to calculate the estimated tunnel costs and develop the tunnel construction schedule based on the *Planning Manual of Road Tunnels* (see Figure 2-39).

Through this exercise (pilot study), participants gained a deeper understanding of the cost estimation

and construction schedule development methods described in the *Planning Manual of Road Tunnels (Draft)* and confirmed that there were no issues with these methods.

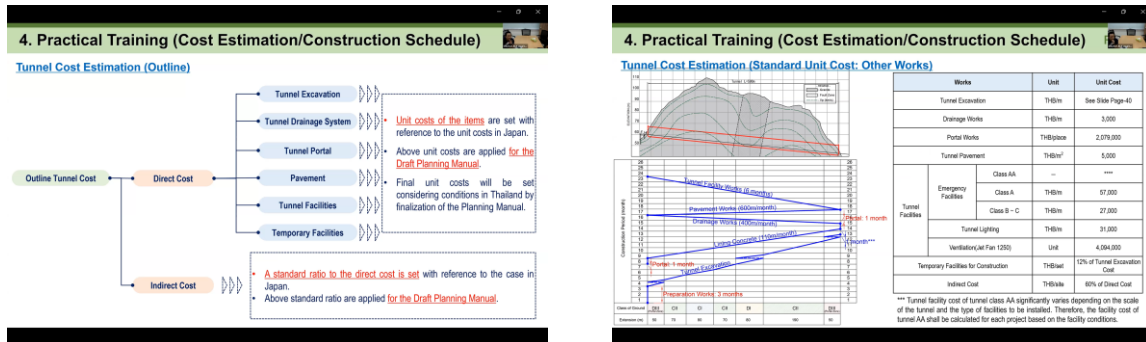
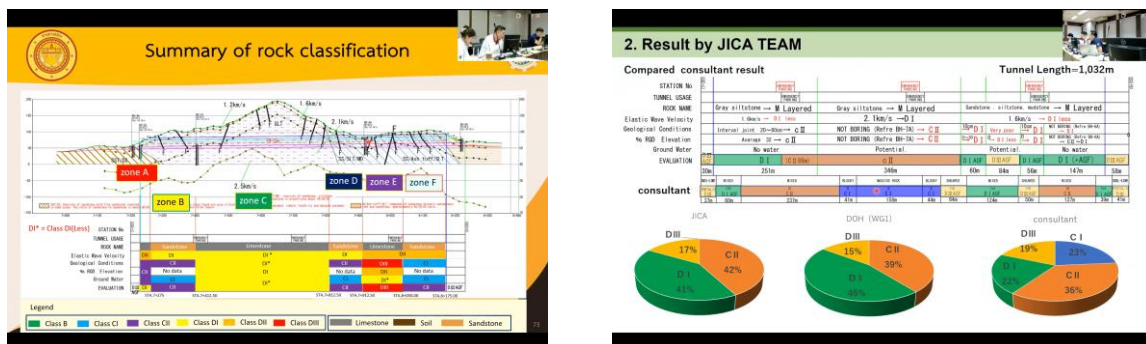


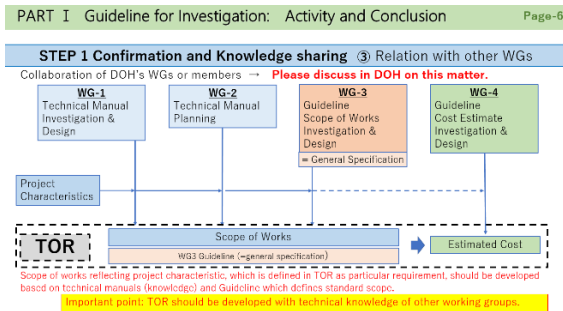
Figure 2-39 Implementation Status of the Pilot Study for the *Planning Manual of Road Tunnels*

### (3) Utilization and Finalization of the Draft Design Manual of Road Tunnels [Civil Works & Tunnel Facilities]

Using the design results of the Krabi Bypass Project as a case study, an exercise (pilot study) was conducted with WG-1 members to classify the tunnel ground (Civil Works Part) and examine the tunnel emergency facilities (Tunnel Facilities Part) based on the Draft *Design Manual of Road Tunnels*. (see Figure 2-40). Through this exercise (pilot study), participants gained a deeper understanding of the ground classification methods (Civil Works Part), and emergency facility examination methods (Tunnel Facilities Part) outlined in the Draft *Design Manual of Road Tunnels* and confirmed that there were no issues with these methods.



at the time of commissioning. As a result, it was determined that the *Common Specifications* would serve as a useful reference for DOH in creating the SOW, and no major revisions to the draft content were necessary. However, feedback was provided requesting terminology alignment with the *Cost Estimation Guidelines* prepared by WG-4 and the addition of a step-by-step implementation process chart for investigation and design. These revisions were incorporated, and the final version was completed (see Figure 2-43).





**Figure 2-41 Diagram of the Cooperative Framework for the Pilot Study**

**Preliminary Pilot Study (Homework) by DOH**  
Please try to develop the **Scope of Works** in TOR

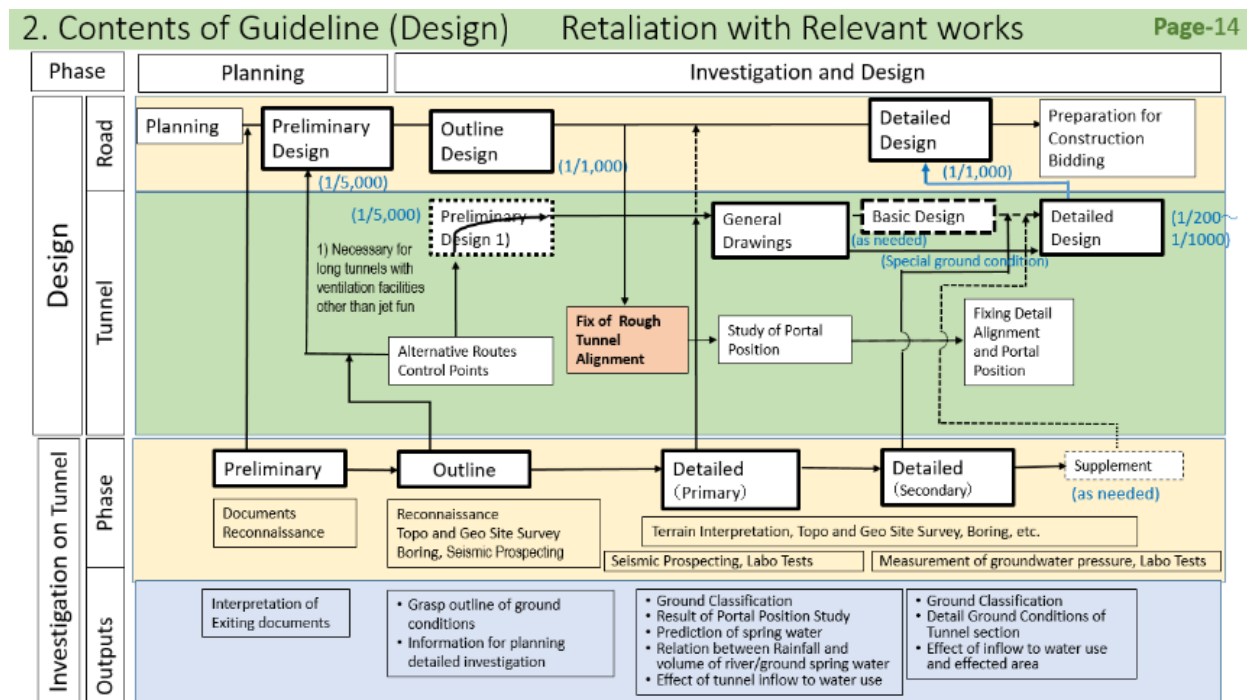
Note:  
1) Please develop a TOR similar to P-6,7 in this PPT using "Draft Guideline (Investigation)" instead of GSI etc.  
2) Please assume main works which are summarized by JET as in the next page  
3) Please itemize them if DOH finds some items of the draft guideline to be revised

Expectation:  
1) DOH can understand the contents of "Draft Guideline (Investigation)" (**Please read it!**)  
2) DOH can understand the structure of description of "Scope of work" which consists of particular requirements with reference to the general specification ("Draft Guideline (Investigation)")

Songkran Vacation? 9<sup>th</sup> April ~ 17<sup>th</sup> April  Golden Week Vacation? 29<sup>th</sup> April ~ 8<sup>th</sup> May 

We would like to discuss about the result of DOH work in the next WG3 at 9th~13th of May 2022.

**Figure 2-42 Explanation of the Pilot Study**



**Figure 2-43 "Step-by-Step Investigation and Design (Civil Works) Flowchart" Added to the Final Version**

**(5) Utilization and Finalization of the Draft Guidelines for Cost Estimation of Road Tunnel Projects [Investigation & Design]**

For the *Guidelines for Cost Estimation of Road Tunnel Projects (Investigation)*, a case study was conducted to deepen mutual understanding, referencing examples from the Krabi Bypass Project and NEXCO Central Japan and aligning with the *Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Investigation)*. Additionally, discussions were held based

on example materials to review and improve the guidelines, with supplementary materials added. Terminology was also standardized with WG-3's *Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Investigation)*, completing the final version (see Figure 2-44 and Figure 2-45).

For the *Guidelines for Cost Estimation of Road Tunnel Projects (Design)*, cost estimation was conducted using the guidelines based on the Krabi Bypass Project example.

**2. Pilot Study on Krabi BP Project (if we apply "Guidelines") Page-11**

**Model Answer: STEP1 Check the Scope and Application Section**

**3.3 Geological Survey Boring**

The section explains the standard cost estimation method for Geological Survey Boring

(A) Scope  
The Geological Survey Boring shall be estimated based on the standard market unit prices.

(B) Application  
The standard market unit prices are applicable only to the geological survey borings with defined types and specifications in Table 2-3 and 2-4. The reference quotation should be obtained for cases outside of application. 2-3 and 2-4

✓ The cost estimation method in "Guidelines" is only applicable to the geological survey boring with defined types and specification.  
=> Unless specified, the reference quotation need to be obtained.  
✓ The price includes only for "Boring", but for "other processes in Geo Survey"  
✓ The cost estimation method is "standard market unit prices and its correction".

Figure 2-4 Scope of the Section

Table 2-3 Standard Unit Prices of Geological Survey Boring (Type)

Table 2-4 Standard Unit Prices of Geological Survey Boring (Depth)

**Figure 2-44 Pilot Study Presentation Materials**

English_WG3	Englis_WG4	Recommendation
Synoptic Topographic and Geological Investigation	Investigation Plan	Outline Topographic and Geological Investigation
Supplement Geotechnical Investigation	Investigation Plan	Supplemental Geotechnical Investigation
Investigation Planning	Investigation Plan	Investigation Planning
Implementation Plan of Investigation	Investigation Plan	Implementation Plan of Investigation
Draft Plan of Following Investigation	Successive Investigation Plan	Draft Plan of Subsequent Investigation
Draft Plan of Hydrological Investigation	Hydrological Investigation Plan	Draft Plan of Hydrological Investigation
Comprehensive Analysis	Comprehensive Analysis	Comprehensive Analysis
Comprehensive Topographic and Geological Analysis	Geographical & Topological Comprehensive Analysis	Comprehensive Topographical and Geological Analysis
Comprehensive Analysis of Overall Investigation	Investigative Comprehensive Analysis	Comprehensive Analysis of Overall Investigation
Comprehensive Hydrological Analysis	Hydrological Comprehensive Analysis	Comprehensive Hydrological Analysis
Terrain Interpretation	Topographic Decipherment	Topographical Features Interpretation
Reconnaissance of Topography and Geology	Geological Field Investigation	Field Investigation on Topographical and Geological Conditions
Stratum and Geologic Cross-Section	Stratigraphic and Geological Cross Section	Stratigraphic and Geological Cross Section
Profile of Excavation Category	Longitudinal View of Evacuation	Longitudinal View of Evacuation Category
Cross Section of Excavation Category	Cross-Sectional View of Evacuation	Cross-Sectional View of Evacuation Category
	Modification of Stratigraphic and Geological Longitudinal View	Modification of Stratigraphic and Geological Longitudinal View
Settlement and Stability Analysis	Subsidence and Stability Analysis	Subsidence and Stability Analysis
Soil and Geogological Investigation	Geological Survey	Soil and Geological Investigation
	Side Width Stake Survey	Survey for Staking Right-of-Way
Geophysical Exploration	Geophysical Exploration	Geophysical Exploration
Seismic prospecting	Seismic prospecting	Seismic prospecting
Stacking Method	Stacking Method	Stacking Method
Transportation in the field	Transportation in the field	On-site Transportation

**Figure 2-45 Terminology Standardization Materials**

## (6) Design Drawing Review Using the Draft Design Manual of Road Tunnels

The mountain highway tunnel project (Krabi Bypass Project) is a DOH-commissioned project, with conceptual design (at the detailed design level) underway since February 2021. To promote understanding of the technical content of the *Draft Design Manual of Road Tunnels* and identify potential issues, the JICA expert team conducted a design review of the Krabi Bypass Project's design drawings, utilizing the manual draft alongside WG1 members and the Project Committee members of the Krabi Bypass Project (see Table 2-39). Specific review contents and items for design incorporation are shown in Table 2-40. Regular review meetings were held to discuss issues and improvements in the design results related to tunnel route selection, geological survey planning for the tunnel section, tunnel design (structure and facilities), and other areas, cross-referencing the manual draft.

Regarding the installation standards for tunnel emergency facilities in various countries, the standards of Japan, the United States, and India were compared and analyzed. After examining the characteristics of each standard, discussions were held with the DOH, and it was confirmed that the Japanese standards would be used as the basis. The reason for selecting the U.S. and Indian standards for comparison is that the U.S. NFPA (National Fire Protection Association) standards were applied to the Krabi Bypass Tunnel, and India is the only country in Asia, other than Japan, where installation standards have been well established.

This initiative, using tangible project outcomes, improved DOH personnel's technical evaluation skills for mountain highway tunnel planning and design, contributing to the rationalization of tunnel design outputs and cost reduction for the Krabi Bypass Project.

**Table 2-39 Implementation Status of Review Meetings**

Date	Review Meeting	Overview
26 October 2021	1 <sup>st</sup> Review Meeting	<ul style="list-style-type: none"> <li>• Overview and Progress Status of the Krabi Project</li> <li>• Discussions on Review Points</li> </ul>
3 December 2021	2 <sup>nd</sup> Review Meeting	<ul style="list-style-type: none"> <li>• Review of Ventilation System Evaluation Results</li> </ul>
25 March 2022	3 <sup>rd</sup> Review Meeting	<ul style="list-style-type: none"> <li>• Review of Tunnel Geological Survey Content</li> <li>• Review of Tunnel Operation Policy and Cross-Section Design</li> <li>• Review of Emergency Equipment Design and Ventilation System Evaluation Results</li> </ul>
8 June 2022	4 <sup>th</sup> Review Meeting	<ul style="list-style-type: none"> <li>• Review of Design Drawings (May 2022 Edition)</li> </ul>
20 September 2022	5 <sup>th</sup> Review Meeting	<ul style="list-style-type: none"> <li>• Review of Design Drawings (September 2022 Edition)</li> </ul>
10 January 2023	6 <sup>th</sup> Review Meeting	<ul style="list-style-type: none"> <li>• Review of Design Drawings (December 2022 Edition)</li> </ul>

**Table 2-40 Outcomes of the Review Activities**

Review Items	Review Content	Reflection on Design
Route Selection	<ul style="list-style-type: none"> <li>• Evaluation of Tunnel Route Alignment</li> <li>• Evaluation of the Horizontal and Vertical Plans for the Tunnel Section</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluated as appropriate for the overall tunnel route alignment</li> <li>• Pointed out large-scale cut on the eastern portal and proposed reconsidering the eastern portal location of the northern tunnel (no design adjustments made).</li> </ul>
Geological Survey Content	<ul style="list-style-type: none"> <li>• Evaluation of the Appropriateness of Geological Survey Methods and Plans</li> <li>• Proposal of Geological Surveys Based on Terrain and Geological Conditions of the Tunnel Section</li> </ul>	<ul style="list-style-type: none"> <li>• Proposed a phased survey (preliminary survey ⇒ first survey ⇒ second survey) for efficient investigation.</li> <li>• Recommended seismic wave exploration for the tunnel section (seismic wave exploration implemented).</li> <li>• Proposed boring locations at the portals considering terrain and geological characteristics.</li> </ul>
Tunnel Design (Structure)	<ul style="list-style-type: none"> <li>• Tunnel Width Configuration</li> <li>• Tunnel Cross-Sectional Shape</li> <li>• Tunnel Operation Method (Motorcycle Tunnel Feasibility)</li> <li>• Tunnel Support Structure Design</li> <li>• Tunnel Portal Design</li> <li>• Tunnel Pavement</li> </ul>	<ul style="list-style-type: none"> <li>• Suggested reducing the shoulder width (left shoulder from 3.0m to 1.5m, right shoulder from 2.0m to 0.5m).</li> <li>• Proposed improvements for space allocation for embedded pipes, signage space, and overall cross-section control (adjustments led to a reduced cross-section).</li> <li>• Raised concerns about the operation of the motorcycle tunnel.</li> <li>• Suggested widening the emergency parking area within the tunnel (adjustments made, contributing to a reduced cross-section).</li> <li>• Highlighted concerns regarding tunnel cross-section design, support structure design, tunnel pavement, and errors in diagram annotations (all issues corrected).</li> </ul>
Tunnel Design (Facilities)	<ul style="list-style-type: none"> <li>• Ventilation Equipment Consideration</li> <li>• Emergency Equipment Consideration</li> <li>• Electrical Room Layout Plan</li> </ul>	<ul style="list-style-type: none"> <li>• Reviewed ventilation calculation methods and content, leading to a reduction in jet fan units from 24 to 8 per tunnel.</li> <li>• Compiled emergency equipment standards from various countries (NFPA, Japanese standards, Indian standards).</li> <li>• Raised concerns regarding the layout of the electrical room inside the tunnel.</li> </ul>

## 2.7.2.2 Tak-Mae Sod Project

### (1) Site Visit

In addition to reviewing the existing FS results of the Tak-Mae Sod Project, a field survey was conducted over two days from June 20, 2022, by JICA experts and local staff to carry out a pilot study utilizing the *Investigation Manual of Road Tunnels (Draft)*, based on the alignment plan for the road tunnel planned for this section (see Figure 2-47).

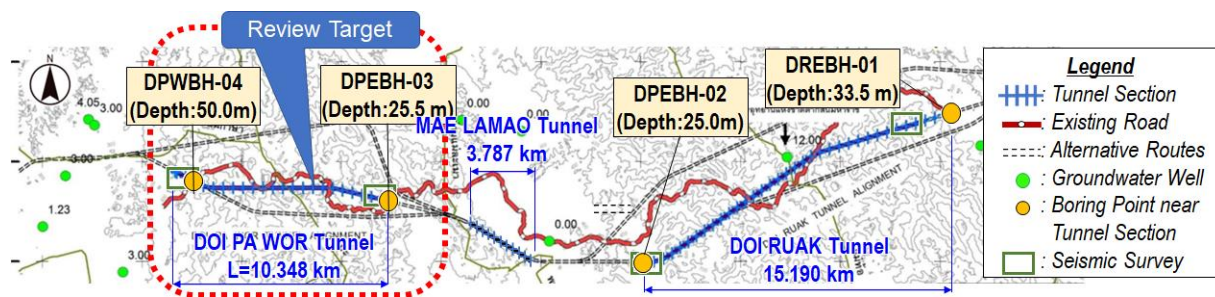


Figure 2-46 Field Survey Scope of the Tak-Mae Sod Project



Figure 2-47 Field Survey Status of the Tak-Mae Sod Project

### (2) Utilization and Finalization of the Investigation Manual of Road Tunnels (Draft)

The tunnel where geological surveys were conducted based on the existing FS was selected for review. The FS results were reviewed, and as a pilot study for the *Investigation Manual of Road Tunnels (Draft)*, a plan for topographic and geological surveys was formulated, and a trial exercise to create the Terms of Reference (TOR) was conducted for DOH working members. By comparing their answers with those provided by JICA experts and providing feedback, issues and additional items for the manual draft were identified. Since detailed design for the Tak-Mae Sod Project is not scheduled in the near term, the

*Design Manual (Draft)* was similarly be finalized through trial design exercises using this project as a case study.

**2.7.3 Baseline Survey**

The baseline survey was conducted with the following objectives:

- To understand the current status of the organizational structure, jurisdiction, personnel, and budget within DOH related to the establishment of a new department responsible for mountain highway tunnel projects.
- To review the personnel (and their respective departments) and capabilities of the counterparts (C/P) involved in this project.
- To assess the current status of organizations related to mountain highway tunnel projects, including relevant government agencies, academic associations, and the private sector.
- To organize the above information and conduct a situational review for establishing a new department responsible for mountain highway tunnel projects, analyze issues related to each output, and validate the PDM’s relevance.

An overview of the baseline survey is shown in Table 2-41.

**Table 2-41 Overview of Baseline Survey**

Survey Method	Survey Period	Survey Targets
Questionnaire Survey	March 2021~ October 2021	DOH / Relevant Ministries / Private Sector
Interview	March 2021~ October 2021	DOH / Relevant Ministries / Private Sector
Web Questionnaire	July 2021	DOH Staffs(C/P)
Collection of Related Materials	March 2021~ October 2021	DOH / Relevant Ministries / Private Sector

**2.7.4 Japan Training**

**2.7.4.1 1<sup>st</sup> Japan Training**

The first Japan training was conducted over 14 days from November 16 to 29, 2022, with the objective of introducing technical elements related to planning, design, construction, and supervision of mountain highway tunnels in Japan, thereby supplementing on-site project activities and acquiring relevant knowledge. The training was divided into two teams: one for high-level officials (7 days) and one for trainees (14 days). The training mainly focused on facility tours and construction site visits related to overall mountain highway tunnel projects, specifically targeting managerial-level participants. The training curriculum is shown in Table 2-42, and photos from the training are presented in Table 2-43.





- Executives (3 participants):20 November ~26 November 2022 (Departure and Arrival Dates for Thailand)
- Trainees (10 participants):16 November 2022 ~29 November 2022 (Departure and Arrival Dates for Thailand)

**Table 2-42 Training Schedule (1<sup>st</sup> Japan Training)**

Date	Details	Instructor	Contents
Thursday 17 November AM	<b>【Lecture】</b> Orientation	CTII Hitomi Iwamasa	<ul style="list-style-type: none"> <li>• Outline of Japan Training</li> </ul>
Thursday 17 November PM	<b>【Lecture】</b> Lectures on NEXCO business introduction, expressway overview, cost estimation	NEXCO Central Toshiyuki Oka	<ul style="list-style-type: none"> <li>• Company profile of NEXCO Central</li> <li>• Background and history of Japan's highway development, highway projects, and the privatization of highway operations</li> <li>• Tunnel and bridge projects (including construction and maintenance technology), and traffic control</li> <li>• International business conducted by NEXCO Central</li> </ul>
Friday 18 November AM	<b>【Lecture • Observation】</b> NEXCO Central Control Center	NEXCO Central Hisaya Hirose	<ul style="list-style-type: none"> <li>• Connection to the Ichinomiya Central Control Tower for an overview and explanation of its functions</li> </ul>
Friday 18 November PM	<b>【Observation】</b> Training facilities (E-Mac) Kagahara (E-Mac)	Central Nippon Highway Engineering Nagoya Co., Ltd. Hiroshi Uchida	<ul style="list-style-type: none"> <li>• Introduction to training methods using models of tunnels, bridges, and pavements, and facility tours</li> </ul>
Saturday 19 November AM/PM	<b>【Observation】</b> Mountain Highway in Mie Prefecture	CTII Hitomi Iwamasa	<ul style="list-style-type: none"> <li>• Viewing of renovation works under NEXCO Central Japan's jurisdiction and road and tunnel facilities in Mie Prefecture from the vehicle window</li> </ul>
Sunday 20 November AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>• Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 21 November AM/PM	<b>【Observation】</b> <ul style="list-style-type: none"> <li>• Yoro Tunnel</li> <li>• Funakiyama Tunnel</li> </ul>	NEXCO Central Toshiyuki Oka	<ul style="list-style-type: none"> <li>• Site visits to the Yoro Tunnel and Funakiyama Tunnel construction sites, with explanations on safety management and construction considerations</li> </ul>
Tuesday 22 November AM/PM	<b>【Observation】</b> <ul style="list-style-type: none"> <li>• Fuji IC</li> <li>• Yamakita PR facilities</li> <li>• Shin-Tomei(Kawachikawa Bridge, Kawanishi, Yamakita Smart IC)</li> </ul>	NEXCO Central Hisaya Hirose	<ul style="list-style-type: none"> <li>• Visit to the Shin-Fuji IC facility, including an introduction to its functions and facility tour</li> <li>• Field visit to Shin-Tomei Expressway (Kawachigawa Bridge, Kawanishi construction, Yamakita Smart IC) with explanations of construction site details and considerations</li> </ul>
Wednesday 23 November (National Holiday) AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>• Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Thursday 24 November AM/PM	<b>【Lecture】</b> Company Information <b>【Observation】</b> Metropolitan Express Way <b>【Observation】</b> Control Room	Metropolitan Expressway Company Limited Shinichiro Hiyamizu	<ul style="list-style-type: none"> <li>• Introduction to projects by Metropolitan Expressway Co., Ltd., and lecture on tunnel disaster prevention</li> <li>• Overview of Metropolitan Expressway facilities from the vehicle window</li> <li>• Visit to the traffic control room to observe operations</li> </ul>
Friday 25 November AM	<b>【Lecture】</b> Design method of tunnels and rock cavities centered on numerical analysis	Tokyo Metropolitan University Nobuharu Isago	<ul style="list-style-type: none"> <li>• Introduction to tunnel construction methods, deformation, and design examples using numerical analysis</li> </ul>
Friday 25 November PM	<b>【Lecture】</b> Introduction of NILM	Ministry of Land, Infrastructure, Transport and Tourism National	<ul style="list-style-type: none"> <li>• Video explanation of projects by the NILM</li> <li>• Facility tours of full-scale tunnel models and ancillary facilities at the test track</li> </ul>

Date	Details	Instructor	Contents
	【Observation】 Full-Scale Tunnel and Test Track Tour	(MLIT), Institute for Land and Infrastructure Management (NILM)	
Saturday 26 November AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Sunday 27 November AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 28 November AM	Presentation	JICA Suguru Jonokuchi	<ul style="list-style-type: none"> <li>Reporting on what was learned during the training and presenting plans for application after returning to the home country</li> <li>Overall assessment by JICA</li> <li>Overall assessment by the consultant</li> <li>Presentation of completion certificates</li> </ul>
Monday 28 November PM	【Lecture】 Introduction to BIM/CIM Systems, Benefits, and Case Studies	CTIE Rei Fujita Chie Kaise	<ul style="list-style-type: none"> <li>Introduction to the BIM/CIM system and benefits in investigation and design work by MLIT</li> <li>Examples of BIM/CIM utilization in tunnel investigation and design work</li> </ul>

**Table 2-43 Photos of 1<sup>st</sup> Japan Training**

	
17 November Lecture of NEXCO Central	18 November Online meeting with NEXCO Central Control Center
	
18 November E-MAC Observation 1	18 November E-MAC Observation 2



21 November NEXCO Central Yoro Tunnel  
Observation 1



21 November NEXCO Central Yoro Tunnel  
Observation 2



21 November NEXCO Central Funakiyama Tunnel  
Observation 1



21 November NEXCO Central Funakiyama Tunnel  
Observation 2



22 November22 NEXCO Central Shin-Tomei 1



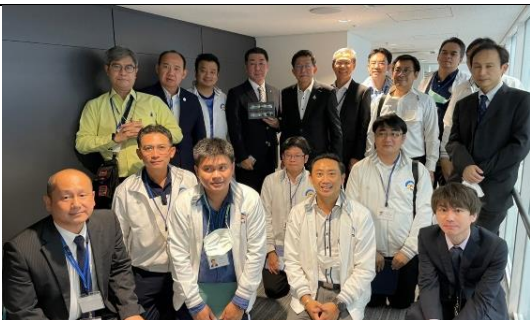
22 November NEXCO Central Shin-Tomei 2



24 November Lecture by Metropolitan Expressway



24 November Observation of Metropolitan  
Expressway Control Rooms 1



24 November Observation of Metropolitan Expressway  
Control Rooms 2



25 November Lecture by Professor Isago

	
25 November NILM (Full-Scale Tunnel Observation)	25 November NILM (Test Track Tour Observation)
	
25 November MLIT 1	25 November MLIT 2
	
28 November Presentation	28 November Closing Ceremony

#### 2.7.4.2 2<sup>nd</sup> Japan Training

The second Japan training was focused on “Investigation, Design, and Planning of Mountain Highway Tunnels” for engineers involved in practical work. It was conducted over 14 days from May 10 to 23, 2023, with the objective of encouraging trainees to share their training outcomes with other staff in WGs and similar settings upon their return, thus reinforcing the trainees' knowledge and application of insights gained in Japan. The training curriculum is shown in Table 2-44, and photos from the training are presented in Table 2-45.

**Table 2-44 Training Schedule (2<sup>nd</sup> Japan Training)**

Date	Details	Instructor	Contents
Thursday 11 May AM	【Lecture】 Orientation	JICA Tsukuba Center	• Outline of Japan Training
Thursday 11 May PM	【Lecture】 Lectures on NEXCO business introduction, expressway overview, cost estimation	NEXCO Central Hisaya Hirose	• Company profile of NEXCO Central • Background and history of Japan's highway development, highway projects, and the privatization of highway operations • Tunnel and bridge projects (including construction and maintenance technology), and traffic control

Date	Details	Instructor	Contents
			<ul style="list-style-type: none"> <li>International business conducted by NEXCO Central</li> </ul>
Friday 12 May AM	【Lecture】 E-Mac Training Facilities	Central Nippon Highway Engineering Nagoya Co., Ltd. Hiroshi Uchida	<ul style="list-style-type: none"> <li>Introduction to training methods using models of tunnels, bridges, and pavements, and facility tours</li> </ul>
Friday 12 May PM	【Lecture】 Introduction of NILM 【Observation】 Full-Scale Tunnel and Test Track Tour	MLIT, NILM	<ul style="list-style-type: none"> <li>Video explanation of projects by the NILM</li> <li>Facility tours of full-scale tunnel models and ancillary facilities at the test track</li> </ul>
Saturday 13 May AM/PM	【Observation of Public Facilities in Tokyo】	CTII Hitomi Iwamasa	<ul style="list-style-type: none"> <li>Observation of traffic conditions in Shibuya, Tokyo, including trains, buses, and pedestrian flows.</li> </ul>
Sunday 14 May AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 15 May AM/PM	【Lecture】 Company Information 【Observation】 Metropolitan Express Way 【Observation】 Control Room	Metropolitan Expressway Company Limited Shinichiro Hiyamizu	<ul style="list-style-type: none"> <li>Introduction to projects by Metropolitan Expressway Co., Ltd., and lecture on tunnel disaster prevention</li> <li>Overview of Metropolitan Expressway facilities from the vehicle window</li> <li>Visit to the traffic control room to observe operations</li> </ul>
Tuesday 16 May AM/PM	【Lecture】 VR Introduction 【Observation】 VR Experience	Forum 8	<ul style="list-style-type: none"> <li>Introduction to VR Case Studies</li> <li>Experience in Creating Tunnel Facilities Using VR</li> <li>Hands-on Experience with VR Equipment</li> </ul>
Wednesday 17 May AM/PM	【Observation】 • Matsuda Project PR Center • Site Visit to the Shin-Tomei Expressway (Takamatsu Tunnel Construction, Nakatsugawa Bridge, Mukaihara Section in Yamakita Town)	NEXCO Central Hisaya Hirose	<ul style="list-style-type: none"> <li>At the Matsuda Project PR Center, an introduction was given on the project plan for the Shin-Tomei construction and the road structures, including tunnels and bridges.</li> <li>During the site visit to the Shin-Tomei construction (Takamatsu Tunnel, Nakatsugawa Bridge, and Mukaihara Section in Yamakita Town), the actual construction sites were visited, with an overview and key considerations in construction explained.</li> </ul>
Thursday 18 May AM/PM	【Lecture】 Geological Survey for Tunnel Construction 【Observation】 Research Facility Tour	Konoike Construction Co., Ltd Takashi Kouma	<ul style="list-style-type: none"> <li>Lecture on geological investigation related to tunnel construction</li> <li>Introduction of equipment used in geological investigations, with practical examples</li> <li>Tour of the research facilities owned by Konoike Construction Co., Ltd.</li> </ul>
Friday 19 May AM/PM	【Observation】 Introduction to Construction Supervision Utilizing BIM(i-Construction)	MLIT Joso National Highway Office	<ul style="list-style-type: none"> <li>Introduction to construction sites utilizing i-Construction</li> <li>Equipment demonstration</li> </ul>
Saturday 20 May AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Sunday 21 May AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 22 May AM	Presentation	JICA Kazuki Yamada	<ul style="list-style-type: none"> <li>Reporting on what was learned during the training and presenting plans for application after returning to the home country</li> </ul>

Date	Details	Instructor	Contents
			<ul style="list-style-type: none"> <li>• Overall assessment by JICA</li> <li>• Overall assessment by the consultant</li> <li>• Presentation of completion certificates</li> </ul>

**Table 2-45 Photos of 2<sup>nd</sup> Japan Training**

<p>11 May NEXCO Central Lecture</p>	<p>12 May Central Nippon Highway Engineering Lecture 1</p>
<p>12 May Central Nippon Highway Engineering Lecture 2</p>	<p>12 May NILM</p>
<p>12 May NILM (Full-Scale Tunnel Observation)</p>	<p>12 May NILM (Test Track Tour Observation)</p>
<p>15 May Observation of Metropolitan Expressway Control Rooms</p>	<p>16 May Lecture by Forum Eight</p>



### 2.7.4.3 3<sup>rd</sup> Japan Training

The third Japan training, similar to the second Japan training, focused on “Construction Supervision with Emphasis on Contract Changes and Cost Estimation” for engineers involved in practical work. The training was scheduled for 14 days from January 10 to 23, 2024, targeting eight trainees, with visits and lectures set primarily in Tokyo, Osaka, and Aichi. The training curriculum is shown in Table 2-46, and photos from the training are presented in Table 2-47.

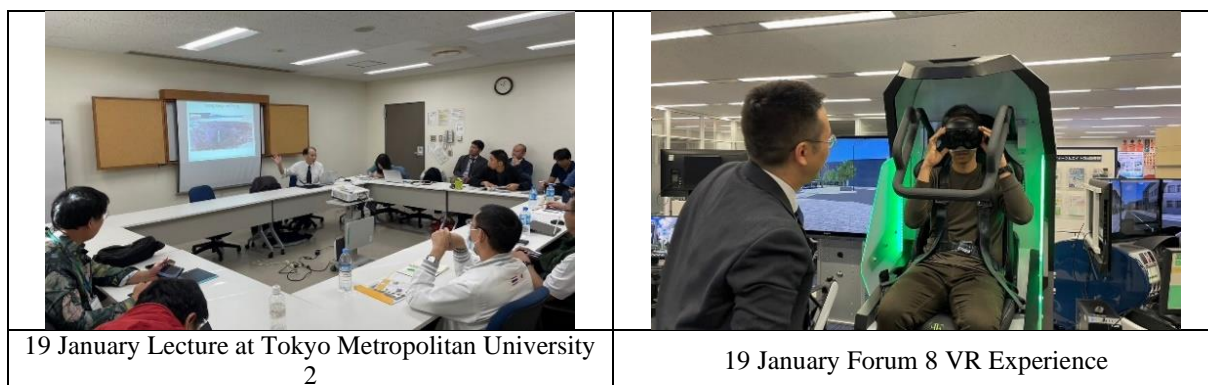
**Table 2-46 Training Schedule (3<sup>rd</sup> Japan Training)**

Date	Details	Instructor	Contents
Thursday 11 January AM	【Lecture】 Orientation	JICA Tokyo Center	• Outline of Training in Japan
Thursday 11 January PM	【Observation】 Umihotaru	TPM Project Member	• Observation of shield machinery used and construction methods employed during the opening of Umihotaru, along with a visit to the actual tunnel
Friday 12 January AM/PM	【Lecture】 Company Information	Metropolitan Expressway Company Limited	• Introduction to projects by Metropolitan Expressway Co., Ltd., and lecture on tunnel disaster prevention and contract modification

Date	Details	Instructor	Contents
	<b>【Observation】</b> Metropolitan Express Way <b>【Observation】</b> Control Room	Hayato Takase	<ul style="list-style-type: none"> <li>• Overview of Metropolitan Expressway facilities from the vehicle window</li> <li>• Visit to the traffic control room to observe operations</li> </ul>
Saturday 13 January AM/PM	<b>【Observation of Public Facilities in Tokyo】</b>	CTII Hitomi Iwamasa	<ul style="list-style-type: none"> <li>• Observation of traffic conditions in Shibuya, Tokyo, including trains, buses, and pedestrian flows.</li> </ul>
Sunday 14 January AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>• Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 15 January AM/PM	<b>【Lecture】</b> Geological Survey for Tunnel Construction <b>【Observation】</b> Research Facility Tour	Konoike Construction Co., Ltd Takashi Kouma	<ul style="list-style-type: none"> <li>• Lecture on geological investigation related to tunnel construction</li> <li>• Introduction of equipment used in geological investigations, with practical examples</li> <li>• Presentation of Real Case Studies Related to Geological Assessment</li> <li>• Tour of the research facilities owned by Konoike Construction Co., Ltd.</li> </ul>
Monday 16 January PM	<b>【Lecture】</b> Lectures on NEXCO business introduction, expressway overview, cost estimation	NEXCO Central Hisaya Hirose	<ul style="list-style-type: none"> <li>• Company profile of NEXCO Central</li> <li>• Background and history of Japan's highway development, highway projects, and the privatization of highway operations</li> <li>• Tunnel and bridge projects (including construction and maintenance technology), and traffic control</li> <li>• International business conducted by NEXCO Central</li> </ul>
Tuesday 17 January AM/PM	<b>【Lecture】</b> E-Mac Training Facilities	Central Nippon Highway Engineering Nagoya Co., Ltd. Hiroshi Uchida	<ul style="list-style-type: none"> <li>• Introduction to training methods using models of tunnels, bridges, and pavements, and facility tours</li> </ul>
Wednesday 18 January AM	<b>【Observation】</b> • Site Visit (Yoro Tunnel South Construction)	NEXCO Central Hisaya Hirose	<ul style="list-style-type: none"> <li>• Introduction to the Project Plan and Road Structures (Tunnels, Bridges, etc.) Related to the Yoro Tunnel South Construction</li> <li>• Visit to the Actual Construction Site with an Overview Explanation and Key Considerations in Construction</li> </ul>
Friday 19 January AM	<b>【Lecture】</b> Design method of tunnels and rock cavities centered on numerical analysis	Tokyo Metropolitan University Nobuharu Isago	<ul style="list-style-type: none"> <li>• Presentation of Tunnel Design Changes Using Real Case Examples</li> </ul>
Friday 19 January PM	<b>【Lecture】</b> VR Introduction <b>【Observation】</b> VR Experience	Forum 8 Katsumi Matsuda	<ul style="list-style-type: none"> <li>• Introduction to VR Case Studies</li> <li>• Experience in Creating Tunnel Facilities Using VR</li> <li>• Hands-on Experience with VR Equipment</li> </ul>
Saturday 20 January AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>• Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Sunday 21 January AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>• Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 22 January AM	Presentation	JICA Ryogo Oishi	<ul style="list-style-type: none"> <li>• Reporting on what was learned during the training and presenting plans for application after returning to the home country</li> <li>• Overall assessment by JICA</li> <li>• Overall assessment by the consultant</li> <li>• Presentation of completion certificates</li> </ul>

**Table 2-47 Photos of 3<sup>rd</sup> Japan Training**

	
<p>11 January Umihotaru Observation</p>	<p>12 January Lecture &amp; Observation Metropolitan Expressway 1</p>
	
<p>12 January Lecture &amp; Observation Metropolitan Expressway 2</p>	<p>15 January Lecture &amp; Observation Konoike Construction Co., Ltd</p>
	
<p>17 January E-MAC Observation</p>	<p>18 January NEXCO Central Site Visit 1</p>
	
<p>18 January NEXCO Central Site Visit 2</p>	<p>18 January NEXCO Central Site Visit 3</p>
	
<p>18 January Showroom of Central Nippon Highway Engineering</p>	<p>19 January Lecture at Tokyo Metropolitan University1</p>



#### 2.7.4.4 4<sup>th</sup> Japan Training



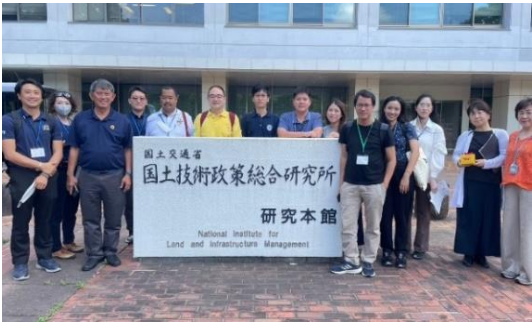
The fourth Japan training was conducted for engineers involved in practical work, focusing on “Safety Management, Operation, and Maintenance.” The session lasted 14 days, from June 6 to 17, 2024, with 12 trainees participating, and included visits and lectures primarily in Tokyo, Osaka, and Aichi. The training curriculum is shown in Table 2-48, and photos from the training are presented in Table 2-49. In conjunction with this training, a visit to Japan was also arranged for two Thai university professors involved in tunnel-related academic associations in Thailand. This visit spanned seven days, from June 9 to 15, 2024, during which they paid courtesy visits to the Japan Society of Civil Engineers on the 13th and the Japan Tunneling Association on the 14th, exchanging views on industry-academia-government collaboration and future interactions.

**Table 2-48 Training Schedule (4<sup>th</sup> Japan Training)**

Date	Details	Instructor	Contents
Thursday 6 June AM	【Lecture】 Orientation	JICA Tokyo Center	<ul style="list-style-type: none"> <li>Outline of Training in Japan</li> </ul>
Thursday 6 June PM	【Lecture】 Operation and Maintenance Management of roads and tunnels in Japan	CTII Moriyasu Furuki	<ul style="list-style-type: none"> <li>Overview of Roads and Tunnels in Japan</li> <li>Introduction to the Evolution and Current State of Maintenance and Management</li> </ul>
Friday 7 June AM	Transfer (Tokyo→Nagoya)	CTII Hitomi Iwamasa	<ul style="list-style-type: none"> <li>Transfer</li> </ul>
Friday 7 June PM	【Lecture】 Lecture on NEXCO Business Introduction and Expressway Overview	Central Nippon Expressway Co., Ltd., Daiku Komori	<ul style="list-style-type: none"> <li>Company profile of NEXCO Central</li> <li>Background and history of Japan’s highway development, highway projects, and the privatization of highway operations</li> <li>Background and history of Japan’s highway development, highway projects, and the privatization of highway operations</li> <li>International business conducted by NEXCO Central</li> </ul>
Saturday 8 June AM/PM	【Cultural Exchange】	CTII Hitomi Iwamasa	<ul style="list-style-type: none"> <li>Visit to Nagoya City (Nagoya Castle, Toyota Commemorative Museum of Industry and Technology)</li> </ul>
Sunday 9 June AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Monday 10 June AM	【Observation】 <ul style="list-style-type: none"> <li>Technical Exhibit Introduction Tour</li> </ul>	Central Nippon Highway Engineering Nagoya Co., Ltd. Michiyasu Arai	<ul style="list-style-type: none"> <li>Introduction of Products Developed by the Company</li> </ul>

Date	Details	Instructor	Contents
Monday 10 June PM	【Lecture】 E-MacTraining Facilities Tour	Central Nippon Highway Engineering Nagoya Co., Ltd. Hiroshi Uchida	<ul style="list-style-type: none"> <li>Introduction to training methods using models of tunnels, bridges, and pavements, and facility tours</li> </ul>
Tuesday 11 June AM	【Observation】 <ul style="list-style-type: none"> <li>Site Visit (Yoro Tunnel South Construction)</li> </ul>	NEXCO Central Daiku Komori	<ul style="list-style-type: none"> <li>Introduction to the Project Plan and Road Structures (Tunnels, Bridges, etc.) Related to the Yoro Tunnel South Construction</li> <li>Visit to the Actual Construction Site with an Overview Explanation and Key Considerations in Construction</li> </ul>
Tuesday 12 June AM	【Lecture】	MLIT, NILIM,	<ul style="list-style-type: none"> <li>Video explanation of projects by the NILIM</li> <li>Facility tours of full-scale tunnel models and ancillary facilities at the test track</li> </ul>
Tuesday 12 June PM	【Lecture】 Introduction of NILM 【Observation】 Full-Scale Tunnel and Test Track Tour	MLIT, NILIM,	<ul style="list-style-type: none"> <li>Video explanation of projects by the NILIM</li> <li>Facility tours of full-scale tunnel models and ancillary facilities at the test track</li> </ul>
Wednesday 13 June AM/PM	【Lecture】 Company Information 【Observation】 Metropolitan Express Way 【Observation】 Control Room	Metropolitan Expressway Company Limited Hayato Takase	<ul style="list-style-type: none"> <li>Introduction to projects by Metropolitan Expressway Co., Ltd., and lecture on tunnel disaster prevention and contract modification</li> <li>Overview of Metropolitan Expressway facilities from the vehicle window</li> <li>Visit to the traffic control room to observe operations</li> </ul>
Friday 14 June AM	【Observation】 Umihotaru	Metropolitan Expressway Company Limited Hayato Takase	<ul style="list-style-type: none"> <li>Observation of shield machinery used and construction methods employed during the opening of Umihotaru, along with a visit to the actual tunnel</li> </ul>
Friday 14 June PM	【Observation】 Shodo Tunnel Site visit	East Nippon Expressway Co., Ltd. Daisuke Matsumoto	<ul style="list-style-type: none"> <li>Visit to Shōdo Tunnel, the World's Largest Cross-Section Tunnel</li> <li>Overview Explanation of the Tunnel, Including Key Considerations in Construction</li> </ul>
Saturday 15 June AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Sunday 16 June AM/PM	Material Arrangement Preparation for Presentation		<ul style="list-style-type: none"> <li>Organizing knowledge and technology acquired during the training, and holding meetings to prepare for presentations</li> </ul>
Sunday 17 June AM	Presentation	JICA Jun Kunihiro	<ul style="list-style-type: none"> <li>Reporting on what was learned during the training and presenting plans for application after returning to the home country</li> <li>Overall assessment by JICA</li> <li>Overall assessment by the consultant</li> <li>Presentation of completion certificates</li> </ul>

Table 2-49 Photos of 4<sup>th</sup> Japan Training

	
<p>10 June Observation E-MAC</p>	<p>10 June Observation Kawashima PA</p>
	
<p>11 June NEXCO Central Yoro Tunnel Observation 1</p>	<p>11 June NEXCO Central Yoro Tunnel Observation 2</p>
	
<p>12 June NEXCO Central Lecture 1</p>	<p>12 June NEXCO Central Lecture 2</p>
	
<p>12 June NILM Lecture 1</p>	<p>12 June NILM Lecture 2</p>
	
<p>12 June NILM Lecture 3</p>	<p>13 June Lecture &amp; Observation Metropolitan Expressway</p>



### 2.7.5 JICA Technical Advisory Committee

As previously mentioned, DOH has no prior experience in implementing mountain highway tunnel projects, and related manuals and guidelines have not yet been developed. Therefore, the project has created technical manuals, which were finalized following pilot studies and subsequent revisions. Moving forward, it is anticipated that DOH will independently utilize these manuals in future mountain highway tunnel projects. On the other hand, this project is JICA's first full-scale technical cooperation project involving mountain highway tunnels. To effectively and smoothly carry out project activities—such as the Preparation of technical manuals and the implementation of pilot studies—guidance from domestic experts is essential. For this reason, JICA Technical Advisory Committee (see Table 2-50) was established with the following objectives: to discuss the overall project plan, strategic direction, investigation and analysis methods, deliverables, and essential matters related to tunnel construction and maintenance. The record of JICA Technical Advisory Committee meetings is shown in Table 2-51.

1. Technical guidance, consultation on various manuals, and advice on applicability to Thailand
2. Advice on introducing optimal road tunnel project methods based on Thailand's project management practices
3. Recommendations on advanced technologies and methods that should be actively promoted in Thailand as it initiates new road tunnel projects
4. Advice on collaboration with academic organizations and associations to support the retention and continuous development of technical expertise after project completion

**Table 2-50 JICA Technical Advisory Committee (Member List)**

Position	Name	Affiliation
Chair	Nobuharu Isago	Faculty of Urban Environmental Sciences, Tokyo Metropolitan University
Member	Yasuhiro Ishikawa	Japan Tunneling Association
Member	Toshio Suzuki	Division Chief for Tunnel Division and Road Research Department, Nippon Expressway Research Institute Company Limited

**Table 2-51 Record of JICA Technical Advisory Committee**

Committee	Date	Discussion Items
1st JICA Technical Advisory Committee	22 September 2021	<ul style="list-style-type: none"> <li>• Reference materials from Japan for technical deliverables (manuals) of this project</li> <li>• Handling of exceptional items in Japanese laws and standards compared to foreign countries</li> <li>• Technical deliverables</li> <li>• Technical and project issues for pilot study candidate sites</li> </ul>
2nd JICA Technical Advisory Committee	15 April 2022	<p>Conducted the following consultations:</p> <ul style="list-style-type: none"> <li>• Writing policy for the Design Manual of Road Tunnels (Draft) [Planning &amp; Design]</li> </ul>
3rd JICA Technical Advisory Committee	18 August 2022	<p>Conducted the following consultations:</p> <ul style="list-style-type: none"> <li>• Writing policy for the Investigation Manual of Road Tunnels</li> <li>• Writing policy for the Design Manual of Road Tunnels (Draft) [Planning &amp; Design]</li> </ul>
4th JICA Technical Advisory Committee	20 February 2023	<p>Conducted the following consultations:</p> <ul style="list-style-type: none"> <li>• Design Manual of Road Tunnels [Tunnel Facilities]</li> <li>• Report on Guidelines for Preparation of Specifications [Design]</li> <li>• Report on Cost Estimation Guidelines [Design]</li> <li>• Writing policy for the Guidelines for Operation &amp; Maintenance of Road Tunnels</li> <li>• Progress report on pilot studies</li> </ul>
5th JICA Technical Advisory Committee	23 August 2023	<p>Conducted the following consultations:</p> <ul style="list-style-type: none"> <li>• Planning Manual (Draft)</li> <li>• Design Manual (Draft) [Structural &amp; Facilities]</li> <li>• Guidelines for Preparation of Specifications [Design]</li> <li>• Design Change Guidelines</li> <li>• Cost Estimation Guidelines [Design]</li> <li>• Guidelines for Supervision and Inspection of Road Tunnel Construction</li> <li>• Guidelines for Operation &amp; Maintenance of Road Tunnels</li> <li>• Progress status of pilot studies</li> </ul>
6th JICA Technical Advisory Committee	13 March 2024	<ul style="list-style-type: none"> <li>• Project progress report</li> <li>• Advice on advanced technologies and methods that should be actively promoted in Thailand as it initiates new road tunnel projects</li> </ul>

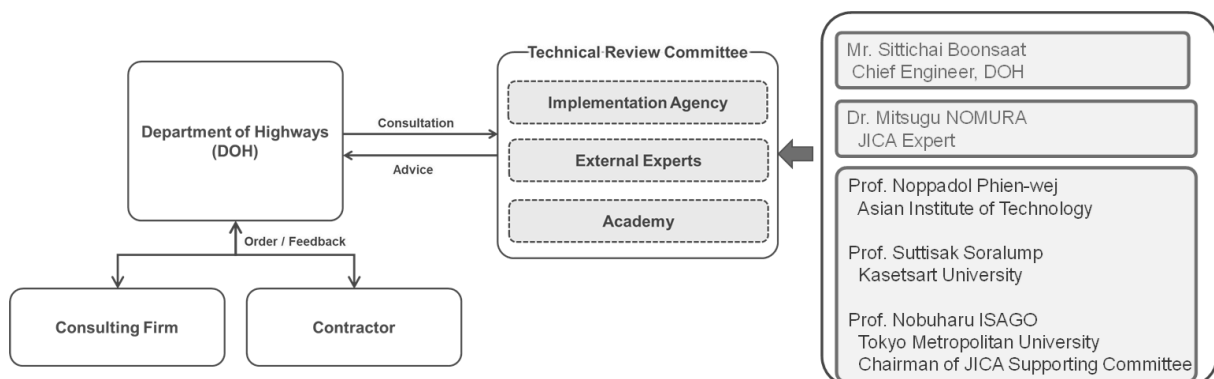
Committee	Date	Discussion Items
		<ul style="list-style-type: none"> <li>Advice on collaboration with academic organizations and associations to support the retention and continuous development of technical expertise post-project</li> </ul>
7th JICA Technical Advisory Committee (in Bangkok)	19 December 2024~ 21 December 2024	<ul style="list-style-type: none"> <li>Presentations by committee members at the 4th Technical Seminar</li> <li>Exchange meeting with DOH</li> <li>Site survey of Highway 304 Wildlife Corridor Tunnel</li> </ul>

### 2.7.6 Activities for Establishing a Technical Review Committee in DOH

As a road operator, DOH will be responsible for determining policies, directions, and plans for future tunnel projects. Therefore, in addition to the existing internal committee within DOH mentioned in Section 2.3.1.3, the JICA expert team proposed in June 2022 the establishment of a Technical Review Committee for tunnel projects within DOH, including external experts. The Technical Review Committee is envisioned as a committee comprising DOH personnel, experts in tunnel and geotechnical engineering, and academics and researchers, providing objective advice on policies and designs for tunnel projects. Such committees are also operational in Japan and serve the following purposes and roles:

- Technical advice for tunnel projects exceeding the scope of the manuals (tunnel length approximately 3 km, or tunnel width approximately 14 m or more)
- Technical advice for exceptionally challenging tunnel projects

Although the ongoing Krabi Bypass Project does not exceed a tunnel length of 3 km, the JICA expert team proposed, as shown in Figure 2-48, the establishment of a Technical Review Committee for this project to help DOH understand specific procedures. However, as indicated in 2.3.1.3, immediate establishment of this committee as an official DOH entity is challenging and requires internal coordination within DOH. Therefore, after consultations with DOH and committee members, it was decided to set up and operate the committee on a trial basis.



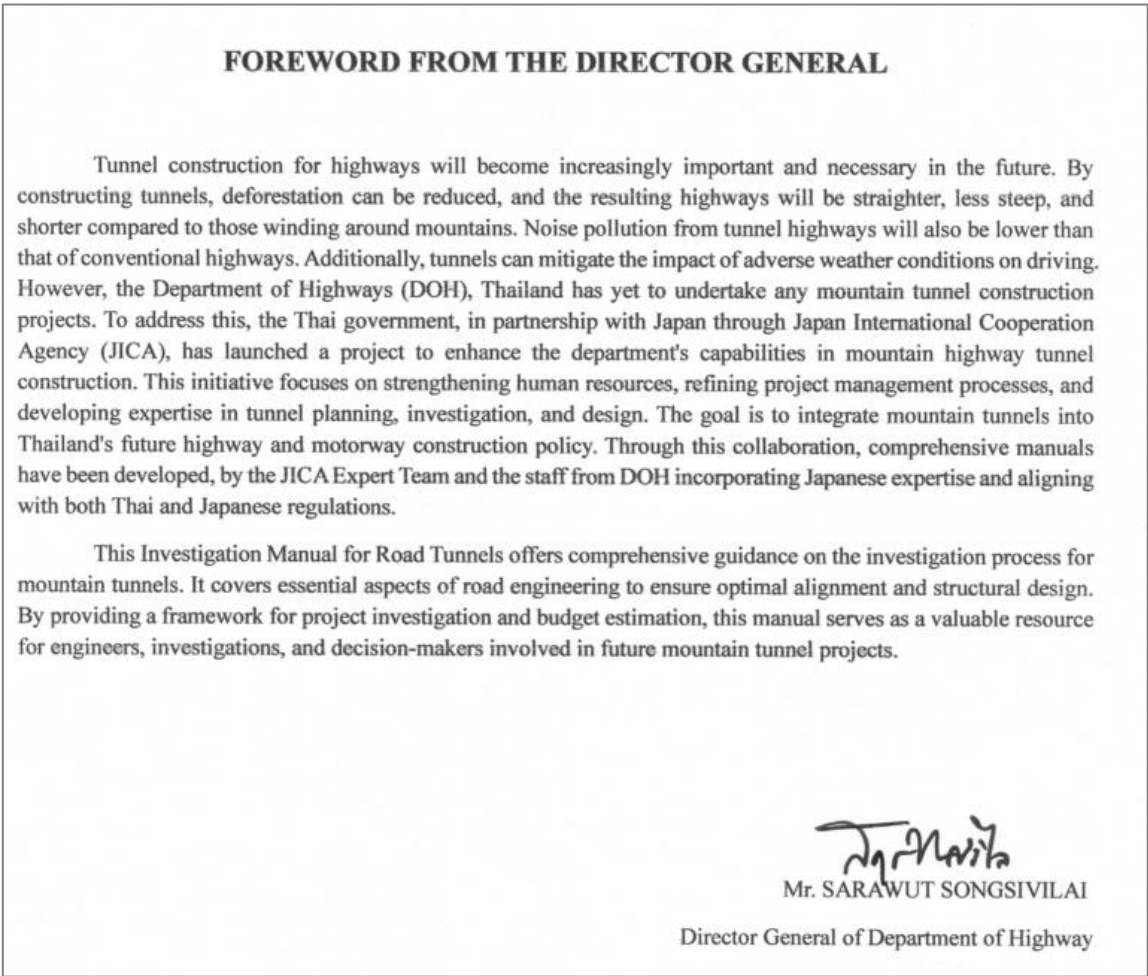
**Figure 2-48 Structure and Members of JICA Technical Advisory Committee**

In the Krabi Bypass, where a pilot study is underway, a joint field survey was conducted on September 26, 2022, followed by the first trial Technical Committee meeting (unofficial) on September 27. During

this committee meeting, the above members gathered to discuss and unanimously agreed to continue these activities in the future.

**2.7.7 Approval of Manuals in DOH**

All manuals created in this project were approved at the 6th JCC held on September 26, 2023. Subsequently, responses to questions from DOH WG members and additional training sessions were conducted, and the manuals were updated. After English proofreading, the manuals were finalized following a final review by Professor Noppadol Phien-wej and Professor Suttisak Sorolump, members of the Krabi Bypass Project Technical Review Committee. On September 13, 2024, the then-Director General Sarawut Songsivilai (succeeded by Apirat Chaiwongnoi on October 1, 2024) signed all manuals (see Figure 2-49). With this, the manuals became official DOH documents, marking the completion of their dissemination within DOH as part of this project. The process of codification will require review by other departments and additional time, and DOH has been requested to initiate this procedure following the project’s conclusion.



**Figure 2-49 DOH Internal Approval of Manuals by the DG (Investigation Manual Version Only)**

**2.7.8 Technical Seminar**

**2.7.8.1 Overview**

With the objective of introducing the benefits of Japanese technology in Thailand through presentations by DOH personnel, Thai experts, and Japanese experts, an annual technical seminar was held in a hybrid format (in-person and online) hosted by the JICA expert team. The seminar was widely promoted to Thai stakeholders (public agencies, academic associations, private companies, etc.) and featured a full day of project activity introductions and keynote lectures by experts. From the second seminar onward, after the Covid-19 pandemic subsided, opportunities were provided for Japanese companies with local branches in Thailand to showcase and present technologies, with a focus on Japan's mountain tunnel projects. The recruitment of participating Japanese companies was widely announced through the Construction Division of the Bangkok Chamber of Commerce to solicit applicants.

**2.7.8.2 1<sup>st</sup> Technical Seminar (19<sup>th</sup> November 2021)**

The first technical seminar was held on November 19, 2021, in the DOH training room (Table 2-52). This seminar included a presentation on the *Investigation Manual of Road Tunnels (Draft)* by the DOH Working Group leader, an introduction to Japanese technology by JICA experts, and a lecture on Thai geology by Professor Suttisak Sorolump from Kasetsart University.

In addition to counterparts, the seminar attracted a diverse range of participants, including DOH general staff, university affiliates, and private companies, with a total of 149 attendees—34 in person and 115 online.

**Table 2-52 Photos of 1<sup>st</sup> Technical Seminar**



### 2.7.8.3 2<sup>nd</sup> Technical Seminar (27 September 2022)

The second technical seminar was held on September 27, 2022, in the DOH training room (Table 2-53). Publicity efforts included displaying seminar posters in DOH facilities and posting announcements on DOH's Facebook page, resulting in a large attendance of 255 participants, including DOH general staff and representatives from related Thai agencies and companies. During the morning presentations, each Working Group leader presented on the finalized manuals produced within this technical project. In the afternoon, Professor Noppadol Phien-wej from the Asian Institute of Technology, headquartered in Thailand, delivered a lecture on "Experiences with Mountain Highway Tunnel Projects in Thailand," followed by a lecture by Professor Nobuharu ISAGO from Tokyo Metropolitan University on "The Importance of Investigation in Tunnel Construction." Presentations and exhibits by Japanese companies introducing Japanese technology were also held concurrently. The Q&A session featured lively discussions and exchanges of ideas, reflecting DOH's strong enthusiasm for tunnel projects and resulting in a highly productive seminar.

**Table 2-53 Photos of 2<sup>nd</sup> Technical Seminar**



### 2.7.8.4 3<sup>rd</sup> Technical Seminar (29 September 2023)

The third technical seminar was held on September 29, 2023, in the auditorium at DOH (Table 2-54). Extensive publicity efforts, including posters displayed in DOH facilities, flyer distribution, and posts on DOH's official Facebook page, led to high attendance, with 108 in-person attendees and 350 online participants from DOH general staff, related Thai agencies and companies, and Japanese companies. In the morning session, leaders of each Working Group in this project presented on the finalized manuals as project deliverables. In the afternoon, Professor Akutagawa from Kobe University gave a lecture on “On-Site Visualization: A New Method for Infrastructure Monitoring,” followed by technology introduction presentations by Japanese companies. The afternoon session included technical presentations from a total of 8 Japanese companies, showcasing and explaining technologies and products related to tunnel projects in Japan. Concurrently with the seminar, exhibition booths were set up in the lecture hall, with 10 Japanese companies displaying their offerings. Attendees were observed attentively engaging with materials and equipment demonstrations at each booth.

**Table 2-54 Photos of 3<sup>rd</sup> Technical Seminar**





**2.7.8.5 4<sup>th</sup> Technical Seminar (20 December 2024)**

On December 20, 2024, the 4th Technical Seminar was held in the auditorium of DOH (Table 2-55). Similar to the 3rd Technical Seminar, extensive promotional activities were conducted, resulting in significant participation from DOH staff, relevant Thai organizations and companies, as well as Japanese companies. The seminar attracted 108 on-site attendees and 350 online participants.

During the 4th seminar, three JICA Technical Advisory Committee members, as mentioned in section 2.7.5, attended the event on-site. Presentations were delivered by Chairman Sagan on “Considerations for Utilizing Manuals Developed in the Technical Cooperation Project,” by Committee Member Ishikawa on “Introduction of the Japan Tunnel Engineering Association,” and by Committee Member Suzuki on “Operation and Maintenance of Expressway Tunnels in Japan.”

Additionally, presentations were given by Shimizu Corporation on the “Davao City Tunnel Construction Project in the Philippines” and by Hazama Ando Corporation on the “Nagdhunga Tunnel Construction Project in Nepal.” Furthermore, technical introduction lectures by Japanese companies were conducted. In parallel with the seminar, exhibition booths were set up in the lecture hall, with five Japanese companies participating as exhibitors.

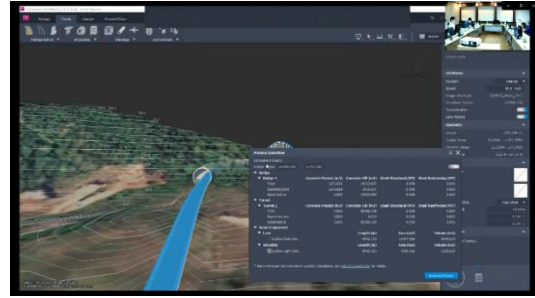
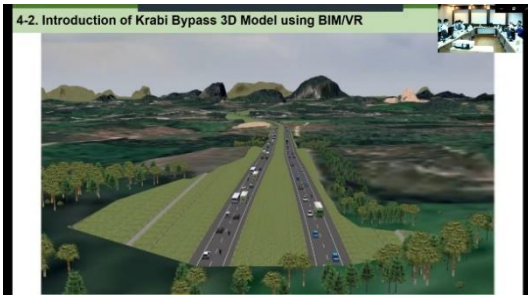
**Table 2-55 Photos of 4<sup>th</sup> Technical Seminar**





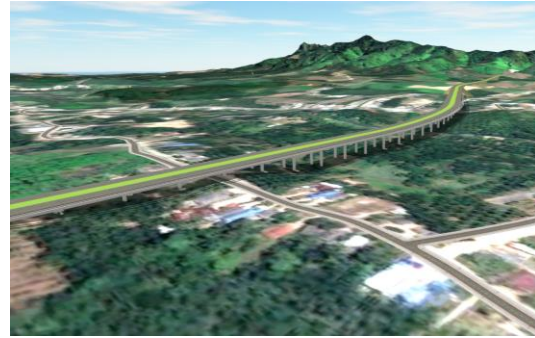
### 2.7.9 BIM/CIM • VR Training

In February 2022 with WG-2, March with WG-1, and in June at the 11th JWG, training sessions and demonstrations on mountain highway route selection using BIM/CIM and VR were conducted, using the ongoing Krabi Bypass Project as a case study (See Figure 2-50 and Figure 2-51). Due to highly positive feedback from DOH staff, a BIM/CIM and VR workshop was held in July, with over 10 participants attending in person to operate the procured 3D CAD and VR software, further deepening their understanding.



4-2. Introduction of Krabi Bypass 3D Model using BIM/VR Page-52

- Driving controller (steering & pedal set) is installed and ready to play.
- Please come to our office.
- The virtual experience of Krabi Bypass is waiting for you.



**Figure 2-50 BIM/CIM, VR Presentation at 11<sup>th</sup> JWG**



**Figure 2-51 Photos of BIM/Cim, VR Seminar**

In June 2023, a training session on the application of BIM/CIM for route selection was conducted, indicating a high level of interest in this technology. As part of this project, guidelines on the use of BIM/CIM were created and compiled as a technical cooperation document.

## 2.7.10 Public Relations Activities

### 2.7.10.1 Facebook Posts

As part of the PR, the project activities are introduced on DOH's Facebook page. A record of posts to date is shown in Table 2-56 and Figure 2-52.

**Table 2-56 Record of Facebook Posts**

No.	Date	Contents
1	18 November 2021	The 2nd Joint Coordinating Committee on the Project for Capacity Development on Tunnel Project Management in Thailand
2	19 November 2021	The 1st Technical Seminar on the Project for Capacity Development on Tunnel Project Management in Thailand
3	14 September 2022	The 2nd Technical Seminar on the Project for Capacity Development on Tunnel Project Management in Thailand
4	27 September 2022	The 2nd Technical Seminar on the Project for Capacity Development on Tunnel Project Management in Thailand
5	8 March 2023	The Department of Highway Bridge Center 3 (Pathum Thani) welcomed a delegation of JICA expert team from Japan, to visit and attend a lecture on the work of the center
6	26 September 2023	The 6th Joint Coordinating Committee on the Project for Capacity Development on Tunnel Project Management in Thailand
7	29 September 2023	The 3rd Technical Seminar on the Project for Capacity Development on Tunnel Project Management in Thailand
8	17 December 2024	The 4th Technical Seminar on the Project for Capacity Development on Tunnel Project Management in Thailand
9	18 December 2024	The 8th Joint Coordinating Committee on the Project for Capacity Development on Tunnel Project Management in Thailand



18 November 2021



14 September 2022



8 March 2023



17 December 2024

Figure 2-52 Facebook Page of DOH

### 2.7.10.2 Project Website Update in JICA Website

To promote a broader understanding of the project activities in Japan, a project website was launched on the JICA website, featuring project news. A record of published posts to date is shown in Table 2-57 and Figure 2-53.

Table 2-57 Record of the publication in JICA Website

No.	Date	Contents
1	March 2021	Kick-off Meeting
2	March 2021	1st Joint Working Meeting
3	April 2021	2nd Joint Working Meeting
4	June 2021	3rd Joint Working Meeting
5	June 2021	4th Joint Working Meeting
6	June 2021	1st Joint Coordinating Committee
7	July 2021	1st Lecture
8	November 2021	2nd Joint Coordinating Committee
9	November 2021	1st Technical Seminar
10	March 2022	Tunnel Investigation OJT
11	March 2022	3rd Joint Coordinating Committee
12	September 2022	4th Joint Coordinating Committee
13	September 2022	2nd Technical Seminar
14	November 2022	1st Japan Training
15	March 2023	5th Joint Coordinating Committee
16	May 2023	2nd Japan Training
17	September 2023	6th Joint Coordinating Committee
18	September 2023	3rd Technical Seminar
19	March 2024	7th Joint Coordinating Committee
20	December 2024	8th Joint Coordinating Committee
21	December 2024	4th Technical Seminar

● トンネル建設・案件監理にかかる能力向上プロジェクト



対象国：  
タイ  
課題：  
運輸交通  
署名日：  
2020年9月29日  
協力期間：  
2020年12月28日から2024年  
12月13日  
相手国機関名：  
タイ王国運輸省高速道路局

タイは中所得国ですが、バンコク周辺地域と地方部の地域間経済格差は非常に大きいです。また、タイにおける道路を使用した旅客及び貨物輸送の割合は約85%と高く、道路は重要な交通インフラです。しかし、地方部の山岳地帯では走行し難い道路が多いため、良好な線形を確保できる大断面と非常用設備が必須の山岳トンネルの建設が計画されています。タイは経験を有していないため、調査・計画・設計、施工管理及び維持管理の能力向上が必要です。そこで、本プロジェクトでは、道路インフラを管轄する運輸省が合理的なトンネル建設及び維持管理手法を習得・実施し、同手法がタイに定着することを目指します。

● [プロジェクト概要へ](#)

更新情報

- 2023年8月27日 ● 「プロジェクトニュース」を更新しました。
- 2021年8月2日 ● プロジェクトホームページを新規開設しました。

関連リンク

● [タイ（各国における取り組み）](#)

- メニュー
- [プロジェクト概要](#)
  - [プロジェクトニュース](#)

ODA見える化サイト

この案件の関連情報を、ODA見える化サイトでもご覧いただくことができます。

● [ODA見える化サイトへ](#)

● 第1回講義の開催

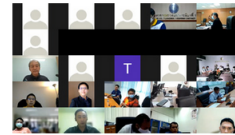
2021年7月14日

2021年7月14日に、JICA専門家チームによる第1回講義がオンラインで実施され、約120名が参加しました。この講義は全4回からなるもので、プロジェクトの理解促進と最先端のトンネル技術の習得を目的に、運輸省高速道路局（Department of Highways：DOH）の全職員を対象として、カウンターパートとJICA専門家チームが協働して開催しました。

第1回講義では野村専門家よりトンネル概論をテーマに、トンネルに係る計画、設計、施工、設備等を網羅的に紹介するとともに、日本での事例紹介を行いました。

講義後の質疑応答では、多くの質問が寄せられ活発な意見交換がなされ、参加者の意欲の高さや熱意が感じられました。

講義内容は、DOHトレーニング部門を通じてDOHに公開される予定です。



第1回講義の様子 (1)



第1回講義の様子 (2)

Project Website

July 2021 1<sup>st</sup> Lecture

Source: JICA Website

Figure 2-53 Project Website (Project News)

2.7.10.3 Creation of Project Logo

A project logo featuring an elephant, a symbol of Thailand, was created and incorporated into presentation materials and the project jumper mentioned below, fostering a sense of unity among stakeholders and promoting the project (see Figure 2-54).

- ◆ “tpm” comes from the project tile.
  - Project for Capacity Development on **T**unnel **P**roject **M**anagement in Thailand
  - Figures show highway and tunnel portal. This means that we are heading to the project goals.
- ◆ 3 circles represent relationship among DOH, JICA and road users.
- ◆ An “Elephant” is hidden.

PM → Pm → [Image of a tunnel entrance] → [Image of an elephant]

Figure 2-54 Project Logo

2.7.10.4 Creation of Project Jumpers and Eco-bag

Jumpers (130 units) and eco-bags (100 units) were created for project stakeholders to wear, promoting the project through these items (see Figure 2-55).



《PR Jumpers》

《Eco-bags》

《Status of Wearing Jumpers》

Figure 2-55 Jumpers and Eco-bags for PR

### 2.7.10.5 Other PR Activities (Media Coverage and Seminar)

#### (1) Presentation at JICA Knowledge Seminar

A presentation introducing the Project was given at the JICA Transport Knowledge Seminar on November 22, 2022.

独立行政法人 国際協力機構  
JICA Knowledge Management Network Seminar

**道路アセットマネジメント技術  
～最先端技術の技術協力への適用～**

JICAでは「道路アセットマネジメントプラットフォーム」を立ち上げ、開発途上地域における道路インフラのアセットマネジメント手法に基づいた効果的かつ効率的な道路行政の実現に向けて支援に取り組んでいます。本セミナーでは、道路アセットマネジメント分野の協力の担い手である皆様に対し、最先端の技術を紹介し、実用化推進を図ることを目的としております。なお、本セミナーは土木学会認定CPDプログラムです。(2.4単位を予定)

SESSION 1	「JICA技術協力プロジェクトの現場紹介～タイ国トンネルプロジェクト監理能力向上プロジェクト～」 株式会社建設技術国際センター 交通部門 土田 貴之 様
SESSION 2	「全世界・開発途上国における性能規定型道路維持管理にかかる技術協力に関する調査(プロジェクト研究)最終報告書概要」 株式会社オリエンタルコンサルタンツグローバル 道路交通事業部 道路技術部 小林 圭昭 様
SESSION 3	「磁気センシングとIoTによる鉄材破断の非破壊検査」 コニカミノルタ株式会社 EICジャパン 山田 隆史 様
SESSION 4	「戦略的予防保全+ONE＝点検DX+簡易補修」 アイセイ株式会社 技術開発部設備グループ 藤田 昌臣 様

○参加登録  
11月20日(日)までに参加登録用フォームより参加申し込みをお願いします。(オンライン開催)  
(参加登録フォームはこちら)

○留意事項  
▶採選の録音及び録画は禁止させていただきます。  
▶申し込み後、アンケートを配信いたしますので、ご協力をお願い致します。  
▶土木学会継続教育CPDプログラム付与を希望される方  
▶当方でアンケートをの徹底により採録確認を行います。  
▶土木学会による実務研修の開催されるアンケートを全項目記入の上11/29(火)までに提出いただきます。  
(アンケートにおいて100文字以上の所感を記載いただけます。100文字に満たない場合はCPD単位付与はいたしかねます。)  
▶受講証明書はセミナーからのアンケートをの徹底により送付いたします。  
▶土木学会以外の団体に提出する場合は提出先団体に事前にご確認ください。他団体が運営するCPD制度に関する内容については同様にいたしかねます。

2022年11月22日(火) 10時00分～12時30分 (入場9:45～)

**参加無料** ○主催 独立行政法人 国際協力機構 社会基盤部 運輸交通グループ  
道路アセットマネジメントプラットフォーム事務局  
お問合せ JICA社会基盤部 電話:03-3503-4131 郵:〒100-8501 東京都千代田区千代田

Figure 2-56 Seminar Information Brochure

#### (2) Published in the magazine Civil Engineering Construction

An introductory article on this project was published in the December 2022 issue of the magazine *Civil Engineering Construction*.



Source: The magazine *Civil Engineering Construction*, December 2022

Figure 2-57 An article in the magazine *Civil Engineering Construction*

(3) Published on *Gifu Shimbun Web*

The site visit of the first training session in Japan was featured on *Gifu Shimbun Web* on November 21, 2022.



Source: *Gifu Shimbun Web*

Figure 2-58 An article on *Gifu Shimbun Web*

2.7.11 Preparation of VR Materials

The manuals created in this project total over 1,000 pages and constitute eight technical volumes in hard copy. Considering Thailand’s reliable internet infrastructure, even in rural areas, and the common use of smartphones and tablets for viewing documents, the manuals were primarily delivered to DOH in electronic (PDF) format (hard copies were provided for requested quantities). For the updated manuals produced through the Krabi Bypass Project pilot study, much of the information, data, and drawings pertain specifically to Krabi Bypass, enhancing users' ability to visually connect with the text and improving comprehension. To support this, a VR-based instructional tool using DX technology was also created and delivered in addition to the standard PDF format. This tool links a 3D model of the Krabi Bypass with the manuals, developed as a cloud-based VR platform system known as F8VPS, which

greatly enhances user convenience and accessibility to data. Users can access the specified URL from any web browser to simultaneously view the 3D tunnel model of the Krabi Bypass and the manuals, with easy navigation to specific information as needed. Instructions for using the system were provided in February 2025 to DOH's primary users, with maintenance instructions provided to the IT department. Following project completion, DOH will disseminate the system to relevant stakeholders and begin operation.

◆ This is just a completion image. Operation step is as below.

**STEP-1**

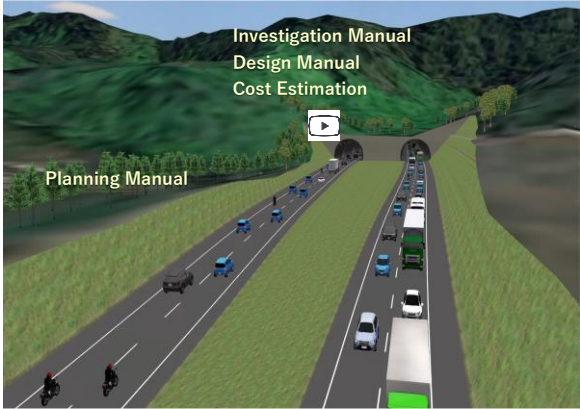
- ✓ Access to F8VPS from browser (Microsoft Edge or Google Chrome) from your devices
- ✓ Input User ID and Password and Log-in

**STEP-2**

- ✓ Open 3D-VR model like right side view
- ✓ Operate the model and change view as you like
- ✓ Access to necessary information

**STEP-3**

- ✓ If you want to check how to design of the tunnel portal, you can go near the tunnel portal and get the investigation manual by clicking the link.
- ✓ If other related information (youtube, design drawing, or TOR) is attached in this system, you can get further information.



**Figure 2-59 Explanation of VR Instruction Tool**

## CHAPTER 3 PROJECT EVALUATION

### 3.1 Results of Review based on 6 DAC Evaluation Criteria

Project evaluation was conducted using the six DAC (Development Assistance Committee) evaluation criteria from the Organization for Economic Cooperation and Development: Relevance, Coherence, Effectiveness, Impact, Sustainability, and Efficiency. Each criterion was rated on a four-point scale: 4 “Very High,” 3 “High,” 2 “Some Issues,” and 1 “Low.” Based on the flow in Figure 3-1 defined by JICA Project Evaluation Guidance, the overall project evaluation was then rated on a four-tier scale: “A: Very High,” “B: High,” “C: Some Issues,” and “D: Low,” derived from the results of the five evaluation criteria. These evaluations were jointly reviewed and confirmed by the Counterparts (C/P) and the expert team, with the overall project rating determined as “A: Very High.” The detailed evaluation results for each criterion are presented below.

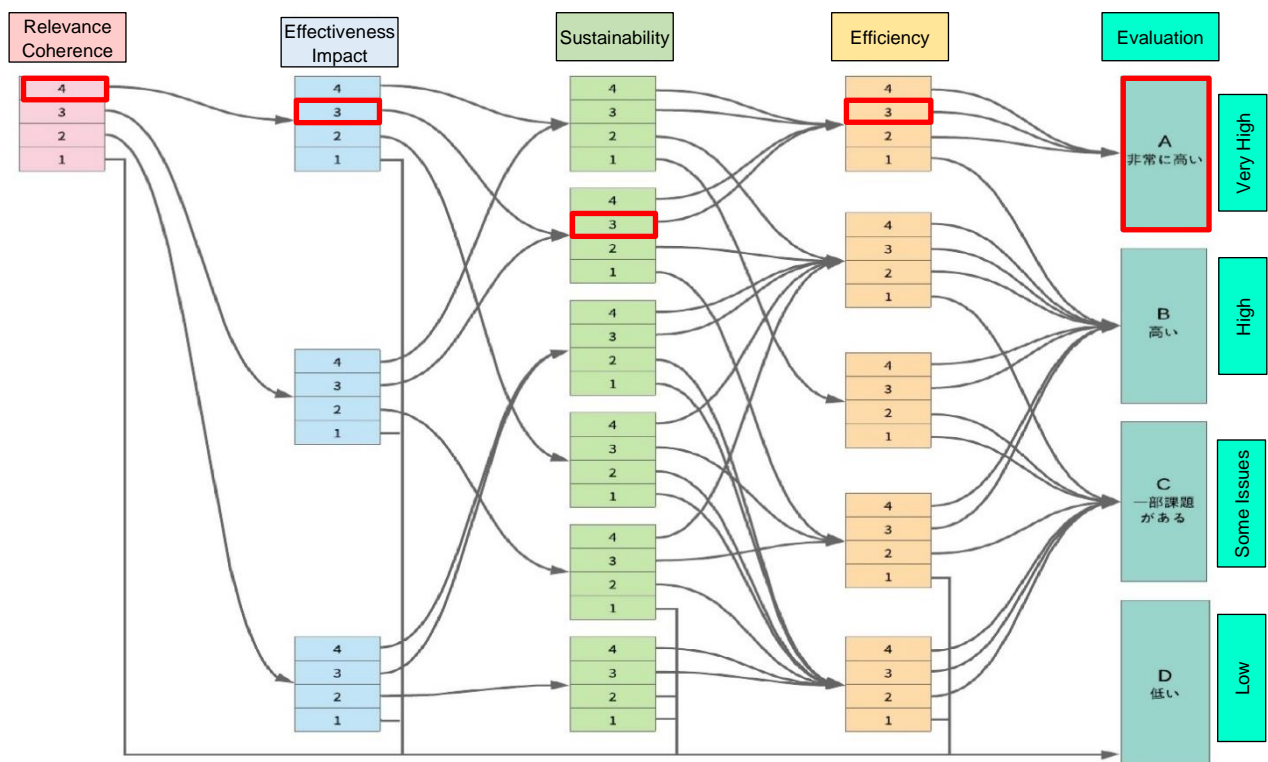


Figure 3-1 Overall Evaluation of the Project

#### 3.1.1 Relevance

##### Evaluation:4 “Very High”

##### (1) Alignment with Thailand's Development Policy

The "12th National Economic and Social Development Plan (2017–2021)," a key development policy of Thailand, and the "Intercity Motorway Development Master Plan (2017–2036)" prepared by DOH, emphasize new road construction and improvement of existing roads. This Master Plan outlines an investment of approximately 2 trillion baht (about 6.5 trillion yen) to develop a restricted-access road

network of approximately 6,600 km. Included in this network are routes connecting major cities in mountainous regions by expressway, which involve the planning of multiple mountain highway tunnels to ensure optimal road alignment, including proposed long tunnels extending over 10 km. Therefore, this project aligns with Thailand's development policy.

## **(2) Alignment with C/P Needs**

Thailand, as a middle-income country, faces a significant economic disparity between the central and northeastern regions, highlighting rural development as a critical development need. Addressing the gap between the Bangkok metropolitan area and rural areas is an ongoing challenge, with regional economic revitalization being increasingly prioritized. National highways and expressways are planned as part of the national policy, and mountain highway tunnel construction is positioned as a key component of this policy. In particular, mountain highway tunnels are in high demand in the mountainous areas of northwestern and southern Thailand and in the plateau regions of the east, where tunnel construction is essential to establish a road network that ensures travel safety and disaster resilience. The implementation schedule for mountain highway tunnel projects must also align with the broader road network development plans, with individual tunnel construction projects expected to proceed in line with the nationwide road network development strategy. Moreover, the joint development plan for Thailand's intercity highways and rail network (MR-Map) is underway, encompassing over 6,000 km across 10 routes, with a total project cost of 3.3 trillion yen—demonstrating Thailand's commitment to road network development. However, DOH under the Ministry of Transport has no previous experience with mountain highway tunnel construction, nor does it have established manuals for planning and design of mountain highway tunnels, making capacity building in managing such projects an urgent need. Therefore, this project aligns with Thailand's development needs in regional development and road network improvement and is progressing in line with Thai government policies.

### **3.1.2 Coherence**

#### **Evaluation: 4 “Very High”**

##### **(1) Alignment with Japan's Aid Policy**

Japan has established close relations with Thailand across various fields, including politics, economics, and culture, under their strategic partnership. For Thailand, Japan ranks as the top country in both foreign investment and aid. To support Thailand's social and economic development, Japan has provided approximately 2.8 trillion yen in ODA as of 2018, focusing primarily on infrastructure projects such as Suvarnabhumi International Airport, subways and railways, and water treatment facilities. Additionally, Thailand plays a central role in the ASEAN community and is key to the development of the Mekong region in a free and open Indo-Pacific. Japan needs to actively collaborate with Thailand to address common regional issues, such as enhancing ASEAN connectivity, deepening economic integration, and reducing disparities. In this context, the basic policy of Japan's ODA is "promoting mutual benefit based on a strategic partnership and fostering autonomous regional development." This project addresses

Thailand's development need for road network expansion and contributes to solving the challenge of human resource development in the industrial sector. It also aligns with Japan's ODA policy of supporting Thailand's autonomous development. Furthermore, this project may indirectly contribute to enhancing ASEAN connectivity; road network development is expected to promote logistics within ASEAN and deepen economic integration. In conclusion, this project is highly consistent with Japan's aid policy.

## **(2) Synergies and Interrelations with Other JICA Projects and Support**

In the Krabi Bypass Project, used as a case study in this project's pilot study, the investigation and design manuals developed under this project enabled a review and rationalization of existing detailed design outputs. This led to a request from DOH for support in the tunnel construction of the Krabi Bypass Project through a yen loan. As of December 2024, a formal request has not yet been made to the Japanese government, but if the project is implemented as a yen loan project in the future, DOH will manage the tunnel project using the manuals created in this project. Additionally, DOH is currently overseeing the feasibility study (FS) for mountain highway tunnels in the Land Bridge Project, where the manuals developed under this project are confirmed to be in use. Furthermore, the joint development plan for Thailand's intercity highways and rail network (MR-Map) includes the MR2 and MR8 plans, which involve tunnels. These factors indicate that the outcomes of this project will have a significant impact and relevance for DOH in managing and implementing future tunnel projects.

## **(3) Project Overview and Relevance to the SDGs**

This project is related to the following SDG goals:

- **Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation**  
This project contributes to the "high-quality infrastructure development" in Thailand and strengthens the foundation for industrial development. It also promotes industrial advancement and innovation through capacity building of Thai engineers.
- **Goal 8: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all**  
High-quality infrastructure enhances logistics efficiency and creates jobs, contributing to Thailand's economic growth.
- **Goal 11: Make cities inclusive, safe, resilient, and sustainable**  
Developing a safe and efficient road network improves access to urban areas, alleviates traffic congestion, and contributes to sustainable urban development.
- **Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development**  
Through the strategic partnership between Japan and Thailand, the project aims to achieve the SDGs by sharing expertise and fostering cooperation between the two countries.

In this way, this project plays a significant role in the achievement of the SDGs.

**3.1.3 Effectiveness**

**Evaluation: 4 “Very High”**

**(1) Achievement of Outputs and Project Goals**

As shown in Table 3-1, this project is considered to have achieved outputs beyond the initial plan.

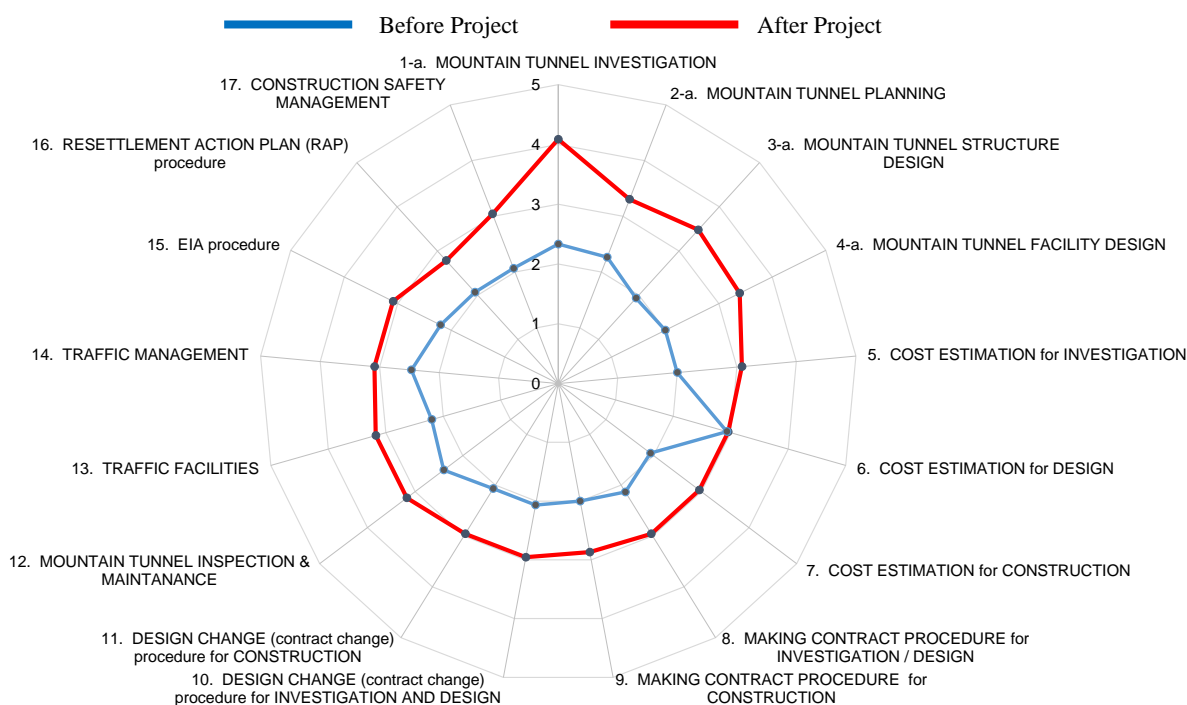
**Table 3-1 Status of Achievement of Outputs and Project Goals**

Outputs		Status of Achievement
<b>【Output 1】</b>	DOH's human resources, institution and scope of works on tunnel project are established.	Indicators such as the establishment of a department responsible for tunnel projects, staffing, and clarification of responsibilities have all been achieved. The approach focused on maximizing the use of DOH's existing organizational and project implementation structures to minimize the impact on the organizational framework. Additionally, core trainers were developed and actively presented at JCC meetings and seminars, establishing them within DOH as "Tunnel-knowledgeable team members". As a result, counterparts have been appointed as internal committee members for the Krabi Bypass Project.
<b>【Output 2】</b>	DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.	Indicators such as the identification of the management cycle for mountain highway tunnels, the formulation of a development program, the establishment of supervision and inspection guidelines, and the investigation of environmental issues and countermeasures have all been achieved. In particular, regarding environmental and social considerations, additional activities beyond the original plan were carried out, including the dispatch of short-term experts and the preparation of reports. Furthermore, DOH's environmental division has taken a proactive approach, with increased cross-departmental collaboration. For instance, requests were made for JICA expert team members to participate as observers in DOH internal discussions, counterparts made individual visits to the JICA expert team office, and technical consultations were held on other tunnel projects. These actions indicate a deepening understanding and proactive measures within DOH regarding tunnel project management.

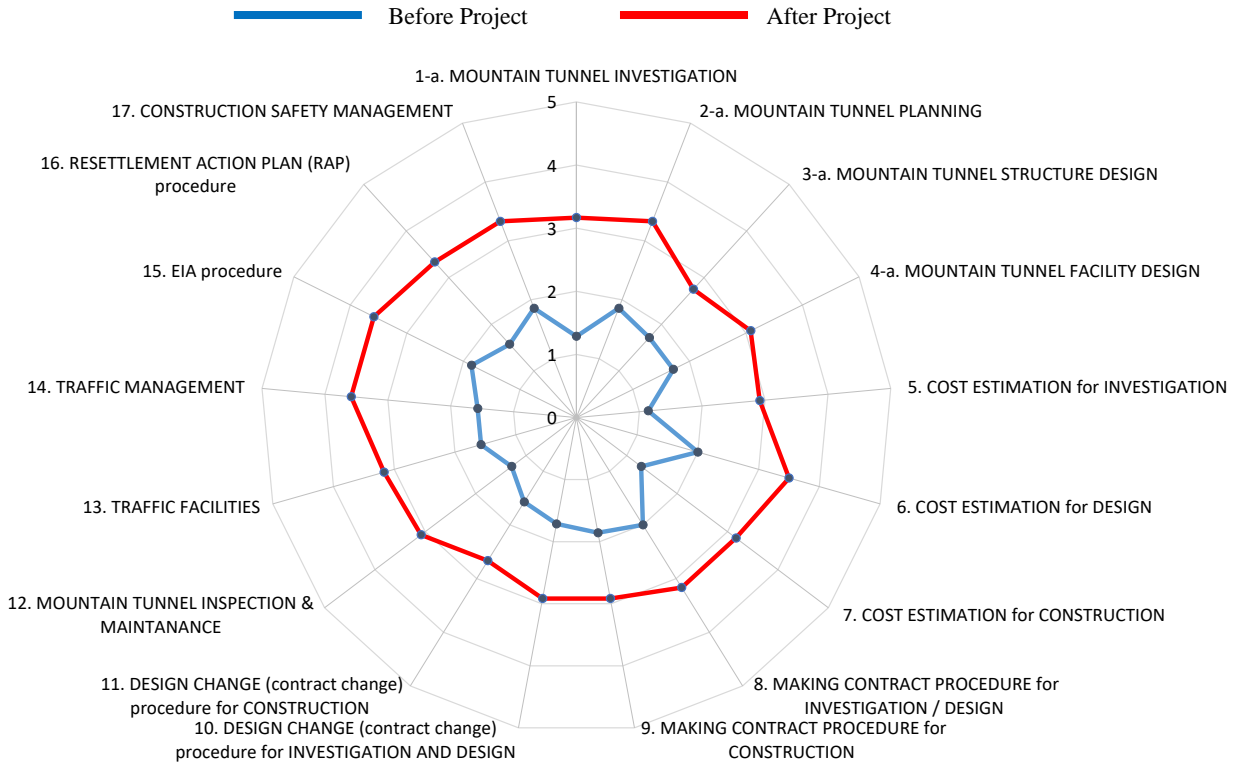
Outputs		Status of Achievement
【Output 3】	DOH's capacity of investigation on mountain highway tunnels is enhanced.	A review was conducted using the created manuals on the design drawings for the Krabi Bypass Project. This contributed to enhancing the technical evaluation capabilities of DOH staff as the project client in actual tunnel projects, while also promoting project rationalization and cost reduction. Additionally, to increase awareness and enforceability of the manuals, the internal circulation within DOH was completed within this project. Furthermore, to improve user understanding and accessibility of the manuals, a VR-based instructional tool utilizing DX technology was created, allowing DOH staff across Thailand to access the manuals anytime, anywhere.
【Output 4】	DOH's capacity of design on mountain highway tunnel is enhanced.	

## (2) Understanding Level of C/P

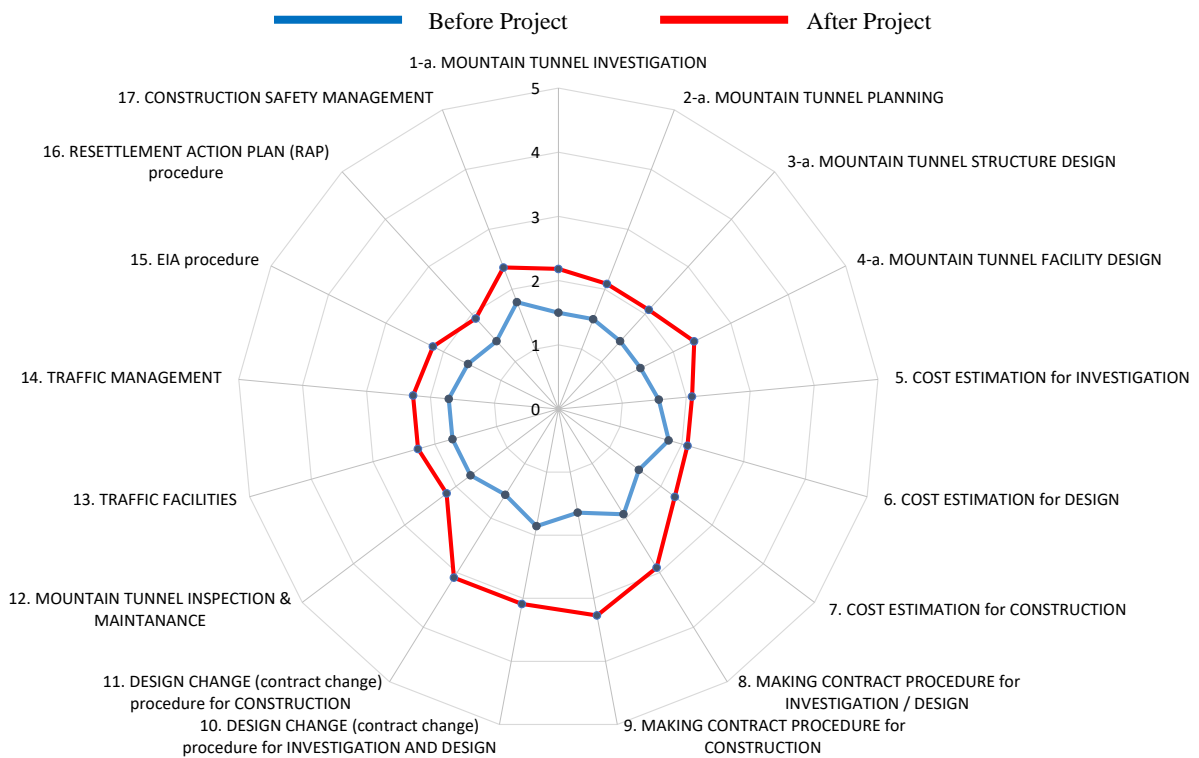
The counterparts' (C/P) understanding level was assessed by comparing pre- and post-project knowledge levels regarding mountain highway tunnel projects between the baseline survey (Figure 2-3 to Figure 2-7) and the end of project activities (December 2024). As shown in Figure 3-2 to Figure 3-6. It is confirmed that this project has significantly improved the knowledge and understanding of mountain highway tunnel projects compared to the initial level.



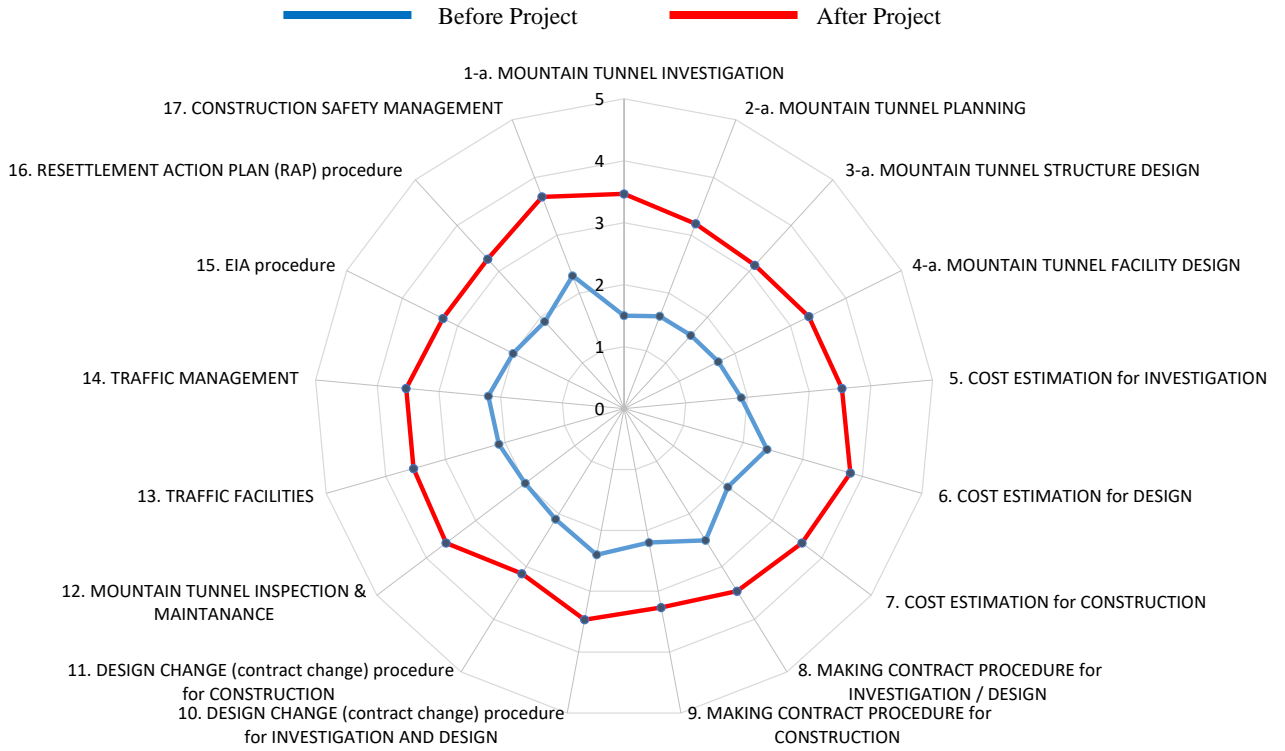
**Figure 3-2 Before / After-Project Comparison of Knowledge Level on Mountain Highway Tunnels [WG-1]**



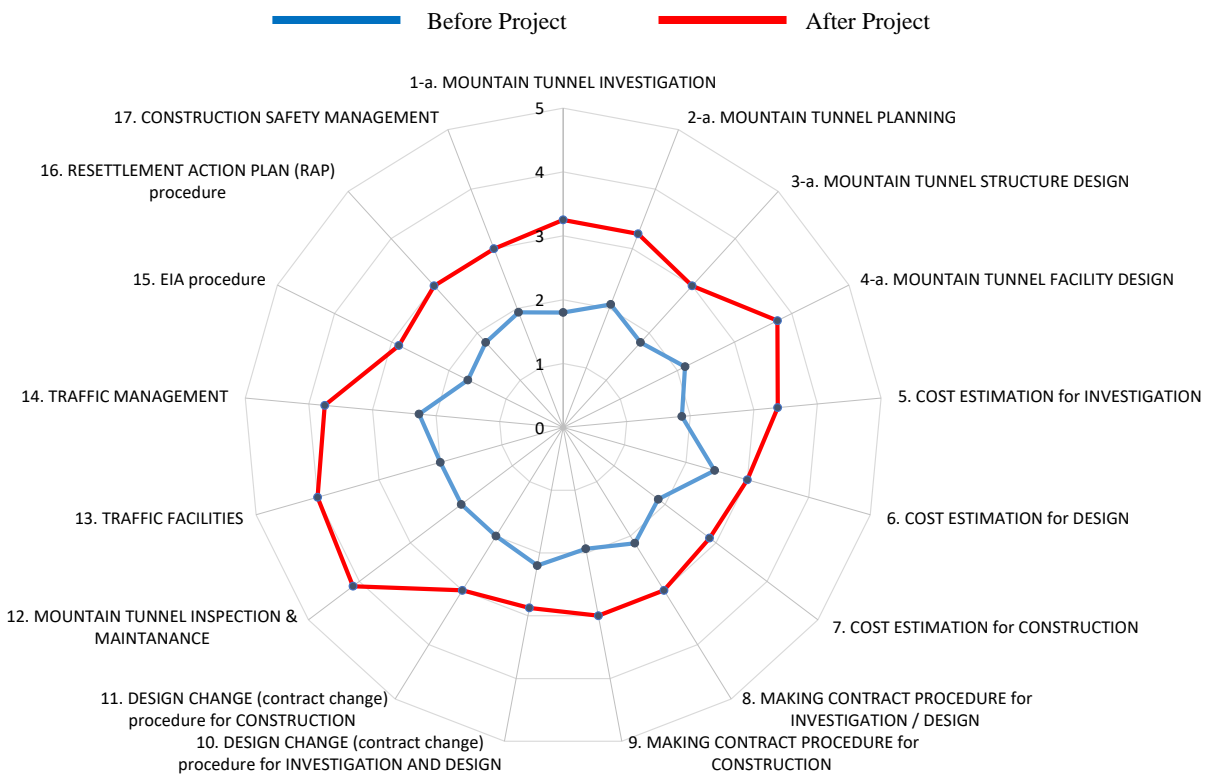
**Figure 3-3 Before / After-Project Comparison of Knowledge Level on Mountain Highway Tunnels [WG-2]**



**Figure 3-4 Before / After-Project Comparison of Knowledge Level on Mountain Highway Tunnels [WG-3]**



**Figure 3-5 Before / After-Project Comparison of Knowledge Level on Mountain Highway Tunnels [WG-4]**



**Figure 3-6 Before / After-Project Comparison of Knowledge Level on Mountain Highway Tunnels [WG-5]**

### **3.1.4 Impact**

#### **Evaluation: 2 “Some Issues”**

##### **(1) Impact Toward the Achieving Overall Goal Goals**

To enable DOH to independently manage mountain highway tunnel projects, it is necessary to strengthen the "Construction" and "Operation & Maintenance" stages within the tunnel project cycle, which were only briefly covered in this project. Initially, this project planned to include these stages within the scope as "Phase 2" to provide comprehensive technical support across the tunnel project cycle; however, budget constraints and the current progress of DOH's tunnel projects prevented this from being realized. To achieve overall goal, it is essential for DOH to utilize the manuals created in this project, carry out ongoing and autonomous training, and periodically update the manuals.

##### **(2) Other Impacts**

To sustain the long-term impact, it is essential for DOH to continue accumulating experience in mountain highway tunnel projects, adhere to the manuals, and autonomously review and update them as necessary. Since this project has completed the internal dissemination of the manuals within DOH, their continued use is anticipated, and the impact is deemed largely achieved. However, ongoing monitoring is considered necessary to ensure sustainability.

### **3.1.5 Sustainability**

#### **Evaluation: 3 “High”**

##### **(1) Policy Aspect**

The Land Bridge Project, currently a focus of the Thai government, includes mountain highway tunnel sections, with the feasibility study (FS) for these tunnels underway as of December 2024. Additionally, the MR2 and MR8, part of Thailand's intercity highway and railway joint development plan (MR-Map), also include tunnels. Furthermore, the Krabi Bypass Project is currently undergoing internal procedures, suggesting that mountain highway tunnel projects in Thailand are expected to be continuously implemented and expanded in the future.

##### **(2) Organizational Aspect**

DOH already operates a technical committee system for each project, and in this project, the establishment of a tunnel project-specific committee utilizing this existing structure was proposed and accepted by DOH. Therefore, a foundation has been established for the organizational and sustainable implementation of related activities even after the project ends. This committee is staffed with the necessary personnel, and the decision-making process is clearly defined, which makes it likely that DOH will be able to manage it independently in the future. Furthermore, DOH has a dedicated Training Division responsible for internal human resource development, where training is systematically

conducted. It is expected that the personnel trained in this project will play a central role in sharing knowledge across the organization.

### **(3) Technical Aspect**

Although the capabilities for implementing tunnel projects in the "planning, investigation, and design" stages have been strengthened, as mentioned above, the capabilities in the "construction" and "operation & maintenance" stages, where no pilot study has been conducted, remain limited.

As described in Section 3.1.3, it is considered that DOH has acquired enhanced implementation capabilities for the "Planning, Investigation, and Design" phases of tunnel projects. However, as mentioned above, since pilot studies have not been conducted for the "Construction" and "Operation and Maintenance" phases, the capabilities in these stages remain limited.

Various manuals were developed using standards employed in Japan due to the similarities in geological conditions, with necessary adjustments made through thorough consultations with C/P to ensure compatibility with Thai conditions. Consequently, even when future challenges arise, it is expected that solutions can be easily derived by referring to Japanese precedents, thereby ensuring a high level of sustainability.

### **(4) Financial Aspect**

DOH has established a system for securing the funds necessary for tunnel projects through loans, domestic funds, PPP, and other sources, with the expectation of securing related budgets even after project completion. Additionally, knowledge of budget management is well established within DOH, supporting the prospect of long-term financial sustainability.

### **(5) Environmental and Social Aspects**

This project strengthened environmental and social capacities in tunnel projects by introducing Japanese case studies on environmental and social considerations, providing technical support, and maintaining close communication and discussions with the Environmental Group, Bureau of Planning, DOH. Since DOH has extensive experience in environmental and social considerations for infrastructure projects other than tunnels, it is expected that the outcomes supported by this project will be fully utilized in future tunnel projects.

## **3.1.6 Efficiency**

### **Evaluation: 3 “High”**

#### **(1) Efficiency of the Japanese Side Input**

The deployment of experts proceeded according to the initial plan. Although there were cases requiring quarantine, PCR testing, and vaccinations due to the impact of COVID-19 shortly after the project commenced, measures such as remote meetings and effective utilization of national staff enabled completion largely in line with the original deployment plan. As for the project schedule, an approximately two-month extension was made from the initial plan due to requests from DOH for

additional training,.. However, the project goals were achieved without any change in the expert deployment volume.

## **(2) Efficiency of the Thai Side Input**

The Thai side's active participation in activities, provision of a project office, and cooperation in organizing and coordinating meetings and seminars were carried out as planned, contributing substantially to the project's successful completion.

## **3.2 Project External Factors and Project Risk Management**

Before the start of this project, the following three points were established as external conditions for achieving outputs and project goals:

1. The policy for road infrastructure construction in Thailand, including the intercity highway construction plan, remains unchanged.
2. The project management method utilizing the manuals and reference materials created in this project is maintained.
3. Staff in the department established through this project are retained.

During the project period, there was a change in staff regarding point 3); however, DOH promptly appointed replacements, so there was no significant impact on project progress.

## **3.3 Lessons Learned and Issues Identified**

### **3.3.1.1 Fostering Project Ownership**

In this project, many C/P actively participated in WGs, training sessions, and seminars. Additionally, the attentive response of JICA experts and communication primarily in the native language (Thai) fostered a mutual trust, establishing an implicit rule within DOH that "when in doubt, consult the JICA expert team first." Furthermore, opportunities for C/P to present at WGs, JCCs, and seminars, the inclusion of their names in manuals, and participation in training in Japan helped maintain high motivation levels among C/P until the project's end. As a result, C/P engaged in the project with enthusiasm and cooperation, fostering a sense of project ownership that became a strong driving force toward achieving the project outputs.

### **3.3.1.2 Accumulation of Experience**

This project significantly contributed to the project formation and enhancement of management capabilities for mountain highway tunnel construction in Thailand. However, Thailand requires additional experience in tunnel construction projects to reach a sustainable expertise level, necessitating ongoing efforts to improve capabilities. In particular, the "Construction" and "Operation &

Maintenance" stages remain as future challenges, as no pilot study was conducted in these areas during this project.

### **3.3.1.3 Sustainable Technical Development**

To achieve safe and sustainable mountain highway tunnel construction in Thailand, it is essential for DOH to take the lead in continuous human resource development, technology advancement, and strengthening collaboration with relevant organizations, utilizing the knowledge, experience, and lessons learned from this project.

## CHAPTER 4 FOR THE ACHIEVEMENT OF OVERALL GOALS AFTER THE PROJECT COMPLETION

### 4.1 Prospects to Achieve Overall Goal

Overall Goal is as follows.

<p><b>【Overall Goal】</b> Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.</p> <p><b>【Indicators】</b></p> <ol style="list-style-type: none"> <li>1) The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</li> <li>2) At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.</li> </ol>
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**Table 4-1 Prospects for Achieving Overall Goal**

Indicators	Situation at the End of the Project
<p><b>1) The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</b></p>	<p>Based on the following observations, steady progress is being made toward realization, and the prospects for achievement are considered high:</p> <ul style="list-style-type: none"> <li>• The Thai government is prioritizing road development through mountainous areas to address the growing demand for road traffic accompanying economic growth, with mountain highway tunnel construction playing a crucial role in this effort.</li> <li>• The goals of this project have been achieved, and DOH has successfully enhanced its capabilities in mountain highway tunnel construction projects.</li> <li>• DOH is utilizing the manuals developed in this project and has begun specific tunnel construction projects, such as the Krabi Bypass Project and the Wildlife Corridor Tunnel.</li> <li>• The Thai government continues to promote large-scale road network development plans, including the Land Bridge Project and MR-Map, which include mountain highway tunnels.</li> </ul>
<p><b>2) At least 1 mountain highway tunnel projects proceed to the</b></p>	<p>Further evidence supporting a high likelihood of achievement includes:</p>

Indicators	Situation at the End of the Project
<b>stage of investigation, design and/or construction.</b>	<ul style="list-style-type: none"> <li>• In the Krabi Bypass Project, some of the manuals developed in this project have been referenced, with the detailed tunnel design completed and internal procedures for construction currently underway.</li> <li>• The feasibility study for the mountain highway tunnel component of the Land Bridge Project was commissioned by DOH in June 2024 and is now in progress.</li> </ul>

#### 4.2 Plan of Operation and Implementation Structure of the Thai Side to Achieve Overall Goal

Action Plan for achieving the Overall Goal is shown in Table 4-2.

**Table 4-2 Action Plan for achieving the Overall Goal**

Indicators	Action Plan by DOH
1) The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.	<ul style="list-style-type: none"> <li>• Review of the Intercity Highway Development Master Plan (2017-2036), based on the application of mountain highway tunnels</li> <li>• Clarification of development priorities</li> <li>• Securing project budgets</li> </ul>
2) At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.	<ul style="list-style-type: none"> <li>• Project approval for the Krabi Bypass through EIA approval</li> <li>• Establishment and operation of a technical review committee for mountain highway tunnel projects outside the scope of the manuals</li> <li>• Establishment of a framework to receive advice from experts and experienced individuals during the construction and operation &amp; maintenance stages</li> </ul>

#### 4.3 Recommendations for the Thai Side

##### (1) Establishing a Flexible System for Design Changes in Mountain Highway Tunnel Construction

In mountainous areas, frequent geological and environmental changes make design alterations unavoidable; establishing an appropriate design modification system can mitigate risks to the schedule and costs.

##### (2) Aligning DOH's Tunnel Project Plans with Thailand's Overall Road Network Development Plans

Maintaining alignment with long-term national infrastructure plans will prevent resource waste and enable efficient road network development.

**(3) Managing Environmental Impact Assessments and Hydrological Risks for Tunnel Projects**

By considering impacts on water quality and levels and implementing appropriate measures, adverse effects on the surrounding environment can be prevented, contributing to sustainable development.

**(4) Developing Standardized Supervision and Inspection Standards for Tunnel Construction**

Setting unified standards is essential to ensure the quality and long-term durability of tunnel structures.

**(5) Establishing a Technical Review Committee and a System for Expert Advice**

Receiving advice from external experts will enhance DOH's technical capabilities, enabling accurate decision-making for high-complexity tunnel projects.

**(6) Specialized Training and Proper Allocation of Tunnel Engineers**

Assigning specialized engineers for each project phase facilitates smooth project implementation and contributes to project success.

**(7) Securing Adequate Funding at the Initial Project Stages**

Ensuring appropriate funding to accommodate design changes and unforeseen events will increase project stability.

**(8) Ensuring Close Coordination and Information Sharing Between Project Phases**

Streamlined information sharing across all stages of the tunnel project cycle will prevent rework and redundant efforts, promoting efficient overall project progression.

**(9) Establishing a Management Cycle for Tunnel Projects**

Creating a consistent management cycle from design to construction and maintenance will enable smooth overall project advancement.

**(10) Enhancing Overall Technical and Management Capabilities Related to Tunnel Projects**

By allowing DOH personnel to accumulate experience progressively, technical responsiveness in future tunnel projects can be improved.

**4.4 Monitoring Plan from the End of the Project to Ex-post Evaluation**

After the project's completion, it is recommended to conduct regular monitoring for post-evaluation as shown in Table 4-3.

**Table 4-3 Draft Monitoring Plan**

Overall Goal: Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.		
Monitoring Schedule	1 <sup>st</sup> year	March 2026
	2 <sup>nd</sup> year	March 2027
	3 <sup>rd</sup> year	March 2028
Indicator	Monitoring Method	
1) The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.	1) Review of Regular Reports Verify the implementation status of each project in the list based on regular project progress reports and completion reports. 2) Monitoring the Update Frequency of the Planning List Track the update frequency and content changes in the mountain highway tunnel planning list to ensure continuous progress. 3) Verification of Meeting Records with Relevant Departments Check the records of regular meetings and discussions with relevant departments to confirm that each project is being properly managed according to the list.	
2) At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.	1) On-Site Inspections and Progress Checks Conduct on-site inspections of actual project locations to confirm whether projects are progressing through the investigation, design, or construction stages. 2) Analysis of Progress Reports Analyze tunnel project progress or completion reports to verify that at least one project is advancing as planned.	

## *Appendix*

### Appendix-1 : Results of the Project

- A1-1. List of JICA Project Expert Team
- A1-2. List of Counterparts
- A1-3. Participants of JCC Meeting

### Appendix -2 : List of Manuals and Guidelines Produced by the Project

### Appendix -3 : PDM and PO

- A3-1. Project Design Matrix (PDM) Ver.0
- A3-2. Project Design Matrix (PDM) Ver.1.0
- A3-3. Project Design Matrix (PDM) Ver.2.0
- A3-4. Project Design Matrix (PDM) Ver.3.0
- A3-5. Project Design Matrix (PDM) Ver.4.0
- A3-6. Project Design Matrix (PDM) Ver.5.0
- A3-7. Project Design Matrix (PDM) Ver.6.0



# *Appendix-1*

## *Results of the Project*

A1-1. List of JICA Project Expert Team

A1-2. List of Counterparts

A1-3. Participants of JCC Meeting



### A1-1. List of JICA Project Expert Team

Name	Position	Affiliation
<b>JICA Experts</b>		
1. Mr. ENDO Kurato	Project Expert	JICA
2. Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
3. Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
4. Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
5. Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
6. Mr. MURASE Susumu	Tunnel Design (Facilities)	Oriental Consultants Global, Co., Ltd.
7. Mr. YONEMOTO Hiroya / Mr. OKA Toshiyuki / Mr. HIROSE Hisaya	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
8. Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
9. Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
10. Mr. MITSUO Jun	Geological Investigation	Eight-Japan Engineering Consultants Inc.
11. Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
12. Mr. TAKASE Hayato / Mr. ISHIDA Kazuhisa	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
13. Ms. IWAMASA Hitomi	Training Planning	CTI Engineering International Co., Ltd.
14. Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
15. Mr. Akira YAMASHITA	Environmental and Social Consideration	CTI Engineering International Co., Ltd.
16. Mr. FURUKI Moriyasu	Project Adviser	CTI Engineering International Co., Ltd.
<b>Technical Assistants</b>		
17. Mr. Chuchat Suwut (Local Staff)	Technical Assistant	JICA Expert Team
18. Mr. Supawit Srisupap (Local Staff)	Technical Assistant	JICA Expert Team
19. Ms. Tapanee Boripuntaveenun (Local Staff)	Technical Assistant	JICA Expert Team
20. Mr. Pongpan Nampraditkul (Local Staff)	Technical Assistant	JICA Expert Team

## A1-2. List of Counterparts

<b>JCC Core Member</b>				
<b>No.</b>	<b>Affiliations in JCC</b>	<b>Name</b>	<b>Position</b>	<b>Period</b>
1	Chairperson	Mr. Sarawut Songsivilai	Director-General of Department of Highways	6/2021 – 9/2024
		Mr. Apirat Chaiwongnoi	Director-General of Department of Highways	10/2024 – 2/2025
2	Deputy Chairperson	Dr. Montri Dechasakulsom	Deputy Director-General for Engineer	6/2021 – 2/2024
		Mr. Piyapong Jiwattanakulpaisarn	Deputy Director-General	3/2024 – 2/2025
3	Project Director	Mr. Sittichai Boonsaat	Chief Engineer for Location and Design	6/2021 – 2/2025
4	Project Manager	Dr. Danai Ruengsorn	Director of Bureau of International Highways Cooperation	6/2021 – 1/2024
		Dr. Tunwin Svasdisant	Director of Bureau of International Highways Cooperation	2/2024 – 2/2025
5	Committee Secretary	Dr. Piya Chootinan	Deputy Director, Bureau of International Highways Cooperation	6/2021 – 8/2022
		Dr. Prechaporn Suwatnodom	Deputy Director, Bureau of International Highways Cooperation	9/2022 – 1/2024
		Dr. Bhanitiz Aursudkij	Deputy Director, Bureau of International Highways Cooperation	2/2024 – 2/2025

<b>No.</b>	<b>Name</b>	<b>Position</b>	<b>Affiliation in JCC</b>
<b>JCC Member</b>			
6	Mr. Sawang Booranathananukit	Director of Bureau of Highway Construction 1	JCC Member, Group Leader of WG3
7	Mr. Wirote Kongkeaw	Civil Engineer, Expert Level, Bureau of Location and Design	JCC Member, Group Leader of WG1
8	Mr. Pornchai Silarom	Civil Engineer, Expert Level, Department of Highway Bridge Center 3 (Pathum Thani)	JCC Member, Group Leader of WG4
9	Dr. Tunwin Svasdisant	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management	JCC Member, Group Leader of WG5
10	Dr. Puttipan Seraneeprakarn	Civil Engineer, Senior Professional Level, Bureau of Planning	JCC Member, Group Leader of WG2
11	Dr. Bhanitiz Aursudkij	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation	Secretary

No.	Name	Position	Affiliation in JCC
<b>WG Members</b>			
12	Dr. Auckpath Sawangsuriya	Civil Engineer, Expert Level, Bureau of Road Research and Development	Deputy Group Leader
13	Dr. Suphat Chummuneerat	Civil Engineer, Senior Professional Level, Bureau of Location and Design	Member
14	Dr. Poranic Jitareekul	Civil Engineer, Senior Professional Level, Bureau of Materials Analysis and Inspection	Member
15	Dr. Sukit Yindeesuk	Civil Engineer, Expert Level, Bureau of Location and Design	Member
16	Dr. Wasin Rujikietgumjorn	Civil Engineer, Senior Professional Level, Bureau of Location and Design	Member
17	Mr. Tawich Chobpanich	Civil Engineer, Professional Level, Bureau of Location and Design	Member
18	Mr. Wanpiya Sanukool	Civil Engineer, Practitioner Level, Bureau of Location and Design	Member
19	Mr. Nopphanan Phannakham	Civil Engineer, Practitioner Level, Bureau of Materials Analysis and Inspection	Member
20	Mr. Piyapan Chayaphan	Geologist, Practitioner Level, Bureau of Location and Design	Member
21	Mr. Thitipat Rulak	Civil Engineer, Practitioner Level, Bureau of Planning	Member
22	Mr. Surachead Lekhacharakul	Civil Engineer, Practitioner Level, Bureau of Location and Design	Secretary
23	Mr. Songsuk Thongtaeng	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Assistant Secretary
24	Mr. Supachai Mahakit	Civil Engineer, Expert Level, Bureau of Location and Design	Member
25	Mr. Lalit Sawadimongkol	Geologist, Expert Level, Bureau of Materials Analysis and Inspection	Member
26	Dr. Chairat Supachawarote	Civil Engineer, Expert Level, Bureau of Materials Analysis and Inspection	Member
27	Mr. Saranruek Meemoosaw	Civil Engineer, Senior Professional Level, Bureau of Location and Design	Member
28	Mr. Preecha Jirawanwassana	Geologist, Senior Professional Level, Bureau of Materials Analysis and Inspection	Member
29	Mr. Tawich Chobpanich	Civil Engineer, Professional Level, Bureau of Location and Design	Member

No.	Name	Position	Affiliation in JCC
30	Mr. Arom Prasarnsuktawee	Geologist, Professional Level, Bureau of Materials Analysis and Inspection	Member
31	Mr. Wanpiya Sanukool	Civil Engineer, Practitioner Level, Bureau of Location and Design	Member
32	Mr. Tanawoot Kongsung	Civil Engineer, Practitioner Level, Bureau of Location and Design	Member
33	Ms. Plengpin Jirawakiet	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Member
34	Mr. Harit Prasertsin	Civil Engineer, Practitioner Level, Bureau of Planning	Secretary
35	Mr. Pipat Chuensujit	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Member
36	Mr. Supachai Sukvanichnant	Civil Engineer, Practitioner Level, Bureau of Planning	Member
37	Ms. Thitichayaporn Sittisorn	Environmentalist, Practitioner Level Bureau of Planning	Member
38	Mr. Akachai Preeda	Civil Engineer, Professional Level, Inter - City Motorway Division	Member
39	Mr. Sirawit Onsungnoen	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Member
40	Ms. Ausma Binhreem	Economist, Practitioner Level, Bureau of Planning	Assistant Secretary
41	Dr. Pattarathep Sillaparcharn	Civil Engineer, Senior Professional Level, Inter - City Motorway Division	Deputy Group Leader
42	Dr. Piya Chootinan	Deputy Director of Bureau of International Highways Cooperation	Member
43	Mr. Thaweesak Rujijunyawat	Civil Engineer, Expert Level, Bureau of Location and Design	Deputy Group Leader
44	Mr. Teerapun Phumrattanaprapin	Civil Engineer, Expert Level, Bureau of Bridge Construction	Member
45	Mr. Nuttapon Wilaisatteewanich	Civil Engineer, Senior Professional Level, Bureau of Highway Construction 2	Member
46	Mr. Natee Pungvora-asn	Civil Engineer, Professional Level, Bureau of Highway Construction 1	Member
47	Ms. Suchaphat Chotruksa	Civil Engineer, Professional Level, Bureau of Highway Standard and Evaluation	Secretary
48	Ms. Yanika Laikitpanit	Foreign Relations Officer, Professional Level Bureau of International Highways Cooperation	Assistant Secretary

No.	Name	Position	Affiliation in JCC
49	Ms. Aree Jirachawanwisuth	Supply Analyst, Senior Professional Level, Procurement Division	Member
50	Mr. Panupong Manoyen	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Member
51	Mr. Pramesh Tonmaneeewattana	Civil Engineer, Senior Professional Level, Bureau of Bridge Construction	Deputy Group Leader
52	Mr. Wiroj Lomvong	Civil Works Technician, Senior Level, Bureau of Bridge Construction	Member
53	Mr. Anantasak Prapatsorn	Civil Engineer, Practitioner Level, Bureau of Bridge Construction	Member
54	Mr. Anupon Krisdaniramit	Civil Engineer, Practitioner Level, Bureau of Highways Maintenance Management	Member
55	Mr. Wikarin Sornthom	Civil Engineer, Practitioner Level, Bureau of Road Research and Development	Member
56	Mr. Nattawut Eakkitti	Civil Engineer, Professional Level, Bureau of Bridge Construction	Secretary
57	Mr. Suppakorn Suttipan	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Assistant Secretary
58	Mr. Wutthichai Budda	Civil Engineer, Senior Professional Level, Bridge Construction and Rehabilitation Center 1	Member
59	Mr. Wichai Wongvisit	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation	Member
60	Mr. Teerawut Anuyato	Civil Engineer, Professional Level, Bureau of Highway Standard and Evaluation	Member
61	Ms. Nanicha Subhanka	Civil Engineer, Professional Level, Bureau of Bridge Construction	Member
62	Mr. Meechai Bunloed	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Member
63	Mr. Krissada Pongprasert	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation	Member
64	Mr. Jakapant Pattanakriengkrai	Civil Engineer, Senior Professional Level, Bureau of Highways Maintenance Management	Deputy Group Leader

No.	Name	Position	Affiliation in JCC
65	Dr. Pattharin Sarutipand	Civil Engineer, Senior Professional Level, Bureau of Planning	Member
66	Mr. Youngpin Kaewnet	Electrical Engineer, Senior Professional Level, Bureau of Mechanical Equipment and Communication	Member
67	Mr. Surachit Boonton	Mechanical Engineer, Expert Level, Bureau of Mechanical Equipment and Communication	Member
68	Mr. Nutavoot Hatsadeevijit	Civil Engineer, Professional Level, Bureau of International Highways Cooperation	Member
69	Ms. Suchawan Chunarong	Civil Engineer, Practitioner Level, Bureau of Highways Maintenance Management	Member
70	Mr. Witthawat Pattanakriengkrai	Civil Engineer, Professional Level, Bureau of Highways Maintenance Management	Secretary
71	Mr. Rattasard Srichumpu	Civil Engineer, Practitioner Level, Bureau of Highways Maintenance Management	Assistant Secretary
72	Mr. Anucha Thiputhai	Director of Prachin Buri Highway District	Member
73	Mr. Natchanon Junkong	Acting Director of Krabi Highway District	Member
74	Mr. Phongsathorn Brahmahitadara	Civil Engineer, Senior Professional Level Bureau of International Highways Cooperation	Member
75	Mr. Nanthawoot Boonintra	Civil Engineer, Professional Level, Bureau of Highways Maintenance Management	Member
76	Mr. Wattana Appassakij	Civil Engineer, Practitioner Level, Bureau of Highways Maintenance Management	Member

### A1-3. Participants of JCC Meeting

(1) Members list of the 1<sup>st</sup> JCC (21<sup>st</sup> June 2021)

No.	Name - Surname	Affiliations in JCC	Position
1	Dr. Montri Dechasakulsom	Deputy Chairperson	Deputy Director-General for Engineering
2	Mr. Sittichai Boonsaat	Project Director	Chief Engineer for Location and Design
3	Dr. Danai Ruengsom	Project Manager	Director of Bureau of International Highways Cooperation
4	Dr. Piya Chootinan	Committee	Deputy Director of Bureau of International Highways Cooperation
5	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design
6	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
7	Mr. Sawang Booranathananukit	JCC Member, Group Leader of WG3	Director of Procurement Division
8	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Acting Civil Engineer, Expert Level, Bureau of Bridge Construction
9	Dr. Tunwin Svasdisant	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management
10	Dr. Bhanitiz Aursudkij	Secretary	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation
11	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
12	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
13	Ms. Wipawan Jandej	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
14	Mr. KOYANAGI Yoshimoto	Director	Infrastructure Department, JICA HQ
15	Mr. KIMATA Toshio	Senior Advisor	Infrastructure Department, JICA HQ
16	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
17	Mr. WACHI Takashi	-	Team 1, Transportation Group, Infrastructure Department, JICA HQ
18	Mr. MORITA Takahiro	Chief Representative	JICA Thailand Office
19	Mr. IWASE Hideaki	Representative	JICA Thailand Office
20	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
21	Mr. ENDO Kurato	Project Expert	JICA
22	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.

No.	Name - Surname	Affiliations in JCC	Position
23	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
24	Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
25	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
26	Mr. YONEMOTO Hiroya	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
27	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
28	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
29	Mr. MITSUO Jun	Geological Investigation	Eight-Japan Engineering Consultants Inc.
30	Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
31	Mr. KUROKAWA Seiji	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
32	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
33	Mr. FURUKI Moriyasu	Project Adviser	CTI Engineering International Co., Ltd.
34	Mr. Chuchat Suwut	Technical Assistant (Local Staff)	JICA Expert Team
35	Mr. Supawit Srisupap	Technical Assistant (Local Staff)	JICA Expert Team
36	Ms. Tapanee Boripuntaveenun	Technical Assistant (Local Staff)	JICA Expert Team
37	Mr. SEKIZAWA Takafumi	Observer	Second Secretary, Embassy of Japan

(2) Members list of the 2nd JCC (18th November 2021)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Sarawut Songsivilai	Chairperson	Director-General
2	Mr. Sittichai Boonsaat	Project Director	Chief Engineer for Location and Design
3	Dr. Danai Ruengson	Project Manager	Director of Bureau of International Highways Cooperation
4	Dr. Piya Chootinan	Committee	Deputy Director of Bureau of International Highways Cooperation
5	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
6	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
7	Mr. Sawang Booranathananukit	JCC Member, Group Leader of WG3	Director of Bureau of Highways Construction 1
8	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Civil Engineer, Expert Level, Bureau of Bridge Construction
9	Dr. Tunwin Svasdisant	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management
10	Dr. Bhanitiz Aursudkij	Secretary	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation
11	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
12	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
13	Ms. Wipawan Jandej	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
14	Mr. KOYANAGI Yoshimoto	Director	Infrastructure Department, JICA HQ
15	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
16	Mr. KIMATA Toshio	Senior Advisor	Infrastructure Department, JICA HQ
17	Mr. ASHINO Masato	-	Infrastructure Department, JICA HQ
18	Mr. MORITA Takahiro	Chief Representative	JICA Thailand Office
19	Mr. YUASA Keiichiro	Senior Representative	JICA Thailand Office
20	Mr. ENDO Kurato	Project Expert	JICA
21	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
22	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
23	Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
24	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
25	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
26	Mr. MITSUO Jun	Geological Investigation	Eight-Japan Engineering Consultants Inc.
27	Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
28	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
29	Mr. Chuchat Suwut	Technical Assistant (Local Staff)	JICA Expert Team
30	Mr. Supawit Srisupapal	Technical Assistant	JICA Expert Team

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
		(Local Staff)	
31	Ms. Tapanee Boripuntaveenun	Technical Assistant (Local Staff)	JICA Expert Team
32	Mr. Pongpan Nampraditkul	Technical Assistant (Local Staff)	JICA Expert Team
33	Mr. SEKIZAWA Takafumi	Observer	Second Secretary, Embassy of Japan
34	Ms. Supapan Tiapiriyakij	Observer	Minister Counselor, TICA

(3) Members list of the 3rd JCC (10th March 2022)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Sittichai Boonsaat	Project Director	Chief Engineer for Location and Design
2	Dr. Piya Chootinan	Committee	Deputy Director of Bureau of International Highways Cooperation
3	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design
4	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
5	Mr. Sawang Booranathananukit	JCC Member, Group Leader of WG3	Director of Bureau of Highways Construction 1
6	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Civil Engineer, Expert Level, Bureau of Bridge Construction
7	Dr. Tunwin Svasdisant	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management
8	Dr. Bhanitiz Aursudkij	Secretary	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation
9	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
10	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
11	Ms. Wipawan Jandej	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
12	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
13	Mr. ASHINO Masato	-	Infrastructure Department, JICA HQ
14	Mr. MORITA Takahiro	Chief Representative	JICA Thailand Office
15	Mr. IWASE Hideaki	Representative	JICA Thailand Office
16	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
17	Mr. ENDO Kurato	Project Expert	JICA
18	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
19	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
20	Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
21	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
22	Mr. MURASE Susumu	Tunnel Design (Facilities)	Oriental Consultants Global, Co., Ltd.

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
23	Mr. OKA Toshiyuki	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
24	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
25	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
26	Mr. MITSUO Jun	Geological Investigation	Eight-Japan Engineering Consultants Inc.
27	Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
28	Mr. ISHIDA Kazuhisa	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
29	Mr. TAKASE Hayato	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
30	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
31	Ms. IWAMASA Hitomi	Training Planning	CTI Engineering International Co., Ltd.
32	Mr. Chuchat Suwut	Technical Assistant (Local Staff)	JICA Expert Team
33	Mr. Supawit Srisupap	Technical Assistant (Local Staff)	JICA Expert Team
34	Ms. Tapanee Boripuntaveenun	Technical Assistant (Local Staff)	JICA Expert Team
35	Mr. Pongpan Nampraditkul	Technical Assistant (Local Staff)	JICA Expert Team
36	Mr. SEKIZAWA Takafumi	Observer	Second Secretary, Embassy of Japan
37	Mrs. Arunee Hiam	Observer	Director of Development Promotion and Coordination Division, TICA
38	Ms. Supapan Tiapiriyakij	Observer	Minister Counselor, TICA
39	Mr. Sinpira Nakchamrassri	Observer	Development Cooperation Officer, TICA

(4) Members list of the 4th JCC (22nd September 2022)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Sarawut Songsivilai	Chairperson	Director-General
2	Dr. Montri Dechasakulsom	Deputy Chairperson	Deputy Director-General for Engineer
3	Dr. Danai Ruengsonn	Project Manager	Director, Bureau of International Highways Cooperation
4	Dr. Prechaporn Suwatnodom	Committee	Deputy Director, Bureau of International Highways Cooperation
5	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design
6	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
7	Mr. Sawang Booranathananukit	JCC Member, Group Leader of WG3	Director of Bureau of Highways Construction 1
8	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Civil Engineer, Expert Level, Bureau of Bridge Construction

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
9	Dr. Tunwin Svasdisant	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management
10	Dr. Bhanitiz Aursudkij	Secretary	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation
11	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
12	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
13	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
14	Mr. JONOKUCHI Suguru	Project Coordinator	Infrastructure Department, JICA HQ
15	Mr. SUZUKI Kazuya	Chief Representative	JICA Thailand Office
16	Mr. KAWABE Ryoichi	Senior Representative	JICA Thailand Office
17	Mr. IWASE Hideaki	Representative	JICA Thailand Office
18	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
19	Mr. ENDO Kurato	Project Expert	JICA
20	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
21	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
22	Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
23	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
24	Mr. MURASE Susumu	Tunnel Design (Facilities)	Oriental Consultants Global, Co., Ltd.
25	Mr. OKA Toshiyuki	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
26	Mr. HIROSE Hisaya	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
27	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
28	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
29	Mr. MITSUO Jun	Geological Investigation	Eight-Japan Engineering Consultants Inc.
30	Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
31	Mr. IJIMA Yuichi	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
32	Mr. TAKASE Hayato	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
33	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
34	Ms. IWAMASA Hitomi	Training Planning	CTI Engineering International Co., Ltd.
35	Mr. FURUKI Moriyasu	Project Adviser	CTI Engineering International Co., Ltd.
36	Mr. Chuchat Suwut	Technical Assistant (Local Staff)	JICA Expert Team
37	Mr. Supawit Srisupap	Technical Assistant (Local Staff)	JICA Expert Team
38	Ms. Tapanee Boripuntaveenun	Technical Assistant (Local Staff)	JICA Expert Team
39	Mr. Pongpan Nampraditkul	Technical Assistant (Local Staff)	JICA Expert Team
40	Mr. SEKIZAWA Takafumi	Observer	Second Secretary, Embassy of Japan
41	Mrs. Arunee Hiam	Observer	Director of Development Promotion and Coordination Division, TICA
42	Ms. Supapan Tiapiriyakij	Observer	Minister Counselor, TICA
43	Mr. Sinpira Nakchamrassri	Observer	Development Cooperation Officer, TICA

(5) Members list of the 5th JCC (22nd March 2023)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Sittichai Boonsaat	Project Director	Chief Engineer for Location and Design
2	Dr. Danai Ruengporn	Project Manager	Director, Bureau of International Highways Cooperation
3	Dr. Prechaporn Suwatnodom	Committee	Deputy Director, Bureau of International Highways Cooperation
4	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design
5	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
6	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Civil Engineer, Expert Level, Bureau of Bridge Construction
7	Dr. Tunwin Svasdisant	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management
8	Dr. Bhanitiz Aursudkij	Secretary	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation
9	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
10	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
11	Mr. KOYANAGI Yoshimoto	Director	Infrastructure Department, JICA HQ
12	Mr. KIMATA Toshio	Senior Advisor	Infrastructure Department, JICA HQ
13	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
14	Mr. JONOKUCHI Suguru	Project Coordinator	Infrastructure Department, JICA HQ
15	Mr. KAWABE Ryoichi	Senior Representative	JICA Thailand Office
16	Mr. ENDO Yasuyuki	Representative	JICA Thailand Office
17	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
18	Mr. ENDO Kurato	Project Expert	JICA
19	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
20	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
21	Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
22	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
23	Mr. MURASE Susumu	Tunnel Design (Facilities)	Oriental Consultants Global, Co., Ltd.
24	Mr. HIROSE Hisaya	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
25	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
26	Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
27	Mr. TAKASE Hayato	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
28	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
29	Ms. IWAMASA Hitomi	Training Planning	CTI Engineering International Co., Ltd.
30	Mr. Chuchat Suwut	Technical Assistant (Local Staff)	JICA Expert Team
31	Mr. Supawit Srisupap	Technical Assistant (Local Staff)	JICA Expert Team
32	Ms. Tapanee Boripuntaveenun	Technical Assistant (Local Staff)	JICA Expert Team
33	Mr. Pongpan Nampraditkul	Technical Assistant (Local Staff)	JICA Expert Team
34	Mr. OZAWA Haruka	Observer	Second Secretary, Embassy of Japan
35	Ms. Supapan Tiapiriyakij	Observer	Minister Counselor, TICA
36	Ms. Kodchakorn Vongassavanarumol	Observer	Program Officer, TICA

(6) Members list of the 6th JCC (26th September 2023)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Sittichai Boonsaat	Project Director	Chief Engineer for Location and Design
2	Dr. Danai Ruengsorn	Project Manager	Director, Bureau of International Highways Cooperation
3	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design
4	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
5	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Civil Engineer, Expert Level, Bureau of Bridge Construction
6	Dr. Tunwin Svasdisant	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Bureau of Highways Maintenance Management
7	Dr. Bhanitiz Aursudkij	Secretary	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
8	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
9	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Practitioner Level, Bureau of International Highways Cooperation
10	Mr. KOYANAGI Yoshimoto	Director	Infrastructure Department, JICA HQ
11	Mr. KIMATA Toshio	Senior Advisor	Infrastructure Department, JICA HQ
12	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
13	Mr. OHISHI Ryogo	Project Coordinator	Infrastructure Department, JICA HQ
14	Mr. KAWABE Ryoichi	Senior Representative	JICA Thailand Office
15	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
16	Mr. ENDO Kurato	Project Expert	JICA
17	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
18	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
19	Dr. NOMURA Mitsugu	Tunnel Planning	CTI Engineering International Co., Ltd.
20	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
21	Mr. MURASE Susumu	Tunnel Design (Facilities)	Oriental Consultants Global, Co., Ltd.
22	Mr. HIROSE Hisaya	Tunnel Cost Estimation (Investigation, Design, Construction/ Civil)	Central Nippon Expressway Co., Ltd.
23	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
24	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
25	Mr. MITSUO Jun	Geological Investigation	Eight-Japan Engineering Consultants Inc.
26	Mr. ISEKI Yasufumi	Contract Management (Investigation, Design)	Oriental Consultants Global, Co., Ltd.
27	Mr. IJIMA Yuichi	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
28	Mr. TAKASE Hayato	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
29	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
30	Ms. IWAMASA Hitomi	Training Planning	CTI Engineering International Co., Ltd.
31	Mr. FURUKI Moriyasu	Project Adviser	CTI Engineering International Co., Ltd.
32	Mr. Chuchat Suwut	Technical Assistant (Local Staff)	JICA Expert Team
33	Mr. Supawit Srisupap	Technical Assistant (Local Staff)	JICA Expert Team
34	Ms. Tapanee Boripuntaveenun	Technical Assistant (Local Staff)	JICA Expert Team

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
35	Mr. Pongpan Nampraditkul	Technical Assistant (Local Staff)	JICA Expert Team
36	Mr. OZAWA Haruka	Observer	Second Secretary, Embassy of Japan
37	Ms. Supapan Tiapiriyakij	Observer	Minister Counselor, TICA
38	Ms. Kodchakorn Vongassavanarumol	Observer	Program Officer, TICA

(7) Members list of the 7th JCC (26th March 2024)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Piyapong Jiwattanakupaisarn	Deputy Chairperson	Deputy Director-General
2	Dr. Tunwin Svasdisant	Project Manager	Director, Bureau of International Highways Cooperation
3	Dr. Bhanitiz Aursudkij	Committee, Secretary	Deputy Director, Bureau of International Highways Cooperation
4	Mr. Wirote Kongkeaw	JCC Member, Group Leader of WG1	Civil Engineer, Expert Level, Bureau of Location and Design
5	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Bureau of Planning
6	Mr. Sawang Booranathananukit	JCC Member, Group Leader of WG3	Director, Bureau of Highway Construction 1
7	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Civil Engineer, Expert Level, Bridge Construction and Rehabilitation Center 3
8	Dr. Apichai Issariyanukula	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Inter-City Motorway Division
9	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
10	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Professional Level, Bureau of International Highways Cooperation
11	Prof. Dr. Noppadol Phienwej	Technical advisor / Technical Review Committee	Asian Institute of Technology
12	Prof. Dr. Suttisak Soralump	Technical advisor / Technical Review Committee	Kasetsart University
13	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
14	Mr. MINAMI Keisuke	Manager	Southeast Asia Department, JICA HQ
15	Mr. OHISHI Ryogo	Project Coordinator	Infrastructure Department, JICA HQ
16	Mr. SUZUKI Kazuya	Chief Representative	JICA Thailand Office
17	Ms. HIROTA Yuko	Representative	JICA Thailand Office
18	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
19	Mr. ENDO Kurato	Project Expert	JICA
20	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
21	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
22	Mr. SAWADA Kentaro	Tunnel Design (Structure)	CTI Engineering International Co., Ltd.
23	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation	Central Nippon Expressway Co., Ltd.

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
		(Investigation, Design, Construction/ Facilities)	
24	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
25	Mr. TAKASE Hayato	Contract Management (Construction)	Metropolitan Expressway Co., Ltd.
26	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
27	Ms. IWAMASA Hitomi	Training Planning	CTI Engineering International Co., Ltd.
28	Mr. Chuchat Suwut (Local Staff)	Technical Assistant	JICA Expert Team
29	Mr. Supawit Srisupap (Local Staff)	Technical Assistant	JICA Expert Team
30	Ms. Tapanee Boripuntaveenun (Local Staff)	Technical Assistant	JICA Expert Team
31	Mr. Pongpan Nampraditkul (Local Staff)	Technical Assistant	JICA Expert Team
32	Ms. Wisansaya Jamjumras	Observer	Project Coordinator, TICA
33	Mr. Sinpira Nakchamrassri	Observer	Project Coordinator, TICA

(8) Members list of the 8th JCC (18th December 2024)

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
1	Mr. Piyapong Jiwattanakulpaisarn	JCC Deputy Chairperson	Deputy Director-General
2	Mr. Tanin Rirattanapong	-	Chief Engineer (Planning)
3	Dr. Tunwin Svasdisant	JCC Project Manager	Director, Bureau of International Highways Cooperation
4	Dr. Bhanitiz Aursudkij	JCC Committee, Secretary	Deputy Director, Bureau of International Highways Cooperation
5	Dr. Puttipan Seraneeprakarn	JCC Member, Group Leader of WG2	Civil Engineer, Senior Professional Level, Inter-City Motorway Division
6	Mr. Aekpong Sedthamanop	JCC Member, Group Leader of WG3	Director, Bureau of Highway Construction 1
7	Mr. Pornchai Silarom	JCC Member, Group Leader of WG4	Director, Bangkok Highway District
8	Dr. Apichai Issariyanukula	JCC Member, Group Leader of WG5	Civil Engineer, Expert Level, Inter-City Motorway Division
9	Ms. Manlika Nuankerd	Assistant Secretary	Director of Foreign Relations Group, Bureau of International Highways Cooperation
10	Ms. Yanika Laikitpanit	Assistant Secretary	Foreign Relations Officer, Professional Level, Bureau of International Highways Cooperation
11	Dr. Poranic Jitareekul	Member of WG1	Civil Engineer, Expert Level, Bureau of Materials Analysis and Inspection
12	Mr. Thanawan Phiophuead	Member of WG1	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation
13	Mr. Piyapan Chayaphan	Member of WG1	Geologist, Practitioner Level, Bureau of Location and Design

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
14	Mr. Surachead Lekhacharakul	Secretary of WG1	Civil Engineer, Practitioner Level, Bureau of Location and Design
15	Dr. Pattarathep Sillaparcharn	Member of WG2	Civil Engineer, Senior Professional Level, Inter - City Motorway Division
16	Mr. Akachai Preeda	Member of WG2	Civil Engineer, Professional Level, Inter - City Motorway Division
17	Mr. Sirawit Onsungnoen	Member of WG2	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation
18	Mr. Supachai Sukvanichnant	Member of WG2	Civil Engineer, Practitioner Level, Bureau of Planning
19	Ms. Jinjutha Jitanuntarat	Member of WG2	Environmentalist, Practitioner Level, Bureau of Planning
20	Mr. Natee Pungvora-asn	Member of WG3	Civil Engineer, Professional Level, Bureau of Highway Construction 1
21	Mr. Wutthichai Budda	Member of WG4	Civil Engineer, Senior Professional Level, Bridge Construction and Rehabilitation Center 1
22	Mr. Teerawut Anuyato	Member of WG4	Civil Engineer, Professional Level, Bureau of Highway Standard and Evaluation
23	Mr. Anupon Krisdaniramit	Member of WG4	Civil Engineer, Practitioner Level, Bureau of Highways Maintenance Management
24	Mr. Nattawut Eakkitti	Secretary of WG4	Civil Engineer, Professional Level, Bureau of Bridge Construction
25	Mr. Bhongsathorn Brahmahitadara	Member of WG5	Civil Engineer, Senior Professional Level, Bureau of International Highways Cooperation
26	Mr. Wisarute Kussalanuparb	Member of WG5	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation
27	Mr. Rattasard Srichumpu	Secretary of WG5	Civil Engineer, Professional Level, Bureau of Highways Maintenance Management
28	Mr. Phatthanapong Thongsuk	Department of Highways	Civil Engineer, Expert Level, Bureau of Bridge Construction
29	Mr. Nawapol Brahmajaree	Department of Highways	Civil Engineer, Senior Professional Level, Bureau of Road Construction 2
30	Mr. Worapong Tangkitsiri	Department of Highways	Civil Engineer, Senior Professional Level, Bureau of Highway Standard and Evaluation
31	Mr. Sarawut Tassiri	Department of Highways	Civil Engineer, Senior Professional Level, Office of Traffic Weight Control
32	Mr. Tawin Tiratanapakhom	Department of Highways	Civil Engineer, Senior Professional Level, Bureau of Location and Design
33	Ms. Rattanawadi Phukham	Department of Highways	Civil Engineer, Senior Professional Level, Bureau of Highways Maintenance Management
34	Ms. Paverean Mudcharoen	Department of Highways	Civil Engineer, Professional Level, Bureau of Bridge Construction
35	Mr. Kamonpong Pathomame	Department of Highways	Civil Engineer, Practitioner Level, Bureau of International Highways Cooperation

No.	Name - Surname	Affiliations in JCC	Positions and Affiliations
36	Ms. Boonyawee Worasarn	Department of Highways	Foreign Relations Officer, Professional Level, Bureau of International Highways Cooperation
37	Prof. Dr. Noppadol Phienwej	Technical advisor / Technical Review Committee	Asian Institute of Technology
38	Prof. Dr. Suttisak Soralump	Technical advisor / Technical Review Committee	Kasetsart University
39	Mr. KAWAHARA Shuntaro	Senior Advisor	Infrastructure Department, JICA HQ
40	Mr. OHISHI Ryogo	Project Coordinator	Infrastructure Department, JICA HQ
41	Mr. KAWABE Ryoichi	Senior Representative	JICA Thailand Office
42	Ms. HIROTA Yuko	Representative	JICA Thailand Office
43	Ms. Katharine Maneethapodi	Senior Program Officer	JICA Thailand Office
44	Mr. ENDO Kurato	Project Expert	JICA
45	Dr. TSUCHIDA Takayuki	Team Leader/ Mountain Highway Planning 1	CTI Engineering International Co., Ltd.
46	Mr. OGAWA Junichiro	Deputy Team Leader/ Mountain Highway Planning 2	CTI Engineering International Co., Ltd.
47	Mr. UCHIDA Hiroshi	Tunnel Cost Estimation (Investigation, Design, Construction/ Facilities)	Central Nippon Expressway Co., Ltd.
48	Mr. TOMITA Teppei	Construction Plan/ Safety Management	Eight-Japan Engineering Consultants Inc.
49	Ms. YAGI Masako	Project Monitoring/ Public Relations	CTI Engineering International Co., Ltd.
50	Mr. Chuchat Suwut (Local Staff)	Technical Assistant	JICA Expert Team
51	Mr. Supawit Srisupap (Local Staff)	Technical Assistant	JICA Expert Team
52	Ms. Tapanee Boripuntaveenun (Local Staff)	Technical Assistant	JICA Expert Team
53	Mr. Pongpan Nampraditkul (Local Staff)	Technical Assistant	JICA Expert Team
54	Mr. OZAWA Haruka	Second Secretary	Embassy of Japan in Thailand



## ***Appendix-2***

### ***List of Manuals and Guidelines Produced by the Project***



## **List of Manuals and Guidelines Produced by the Project**

1. Investigation Manual of Road Tunnels (including Appendix)
  
- 2-1. Design Manual of Road Tunnels (Civil Works)
- 2-2. Design Manual of Road Tunnels (Tunnel Facilities)
  
3. Planning Manual of Road Tunnels
  
- 4-1. Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Civil Works)
- 4-2. Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Tunnel Facilities)
  
5. Draft Guidelines for Design Change of Road Tunnel Projects
  
- 6-1. Guidelines for Cost Estimation of Road Tunnel Projects for Investigation
- 6-2. Guidelines for Cost Estimation of Road Tunnel Projects for Design (Civil Works)
- 6-3. Guidelines for Cost Estimation of Road Tunnel Projects for Design (Tunnel Facilities)
- 6-4. Draft Guidelines for Cost Estimation of Road Tunnel Projects for Construction (Civil Works)
- 6-5. Draft Guidelines for Cost Estimation of Road Tunnel Projects for Construction (Tunnel Facilities)
  
7. Draft Guidelines for Supervision and Inspection of Road Tunnel Construction
  
8. Guidelines for Operation & Maintenance of Road Tunnels



## ***Appendix-3***

### ***PDM and PO***

- A3-1. Project Design Matrix (PDM) Ver.0
- A3-2. Project Design Matrix (PDM) Ver.1
- A3-3. Project Design Matrix (PDM) Ver.2
- A3-4. Project Design Matrix (PDM) Ver.3
- A3-5. Project Design Matrix (PDM) Ver.4
- A3-6. Project Design Matrix (PDM) Ver.5
- A3-7. Project Design Matrix (PDM) Ver.6



## A3-1. Project Design Matrix (PDM) Ver.0

### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 0

**Implementing Agency:** Department of Highways (DOH)

Dated: 21 July 2020

**Target Group:** DOH's Engineers


**Period of Project:** 4 Years

**Project Site:** Whole Thailand

**Model Site:**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	<p>1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</p> <p>2. At least XX mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.</p>	<p>- Revision of the list of short- and long-term project plans</p> <p>- Confirmation of the progress based on the list of short- and long-term project plans</p> <p>- Results of order and management of new mountain highway projects</p>			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	<p>1. DOH assigns not less than XX staff members who are in charge of tunnel construction.</p> <p>2. At least XX mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.</p>	<p>- DOH's structure regulation or organogram</p> <p>- Short- and long-term lists of project plans</p>	<p>- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed.</p> <p>- The project management methods that utilize manuals and references prepared in the Project are preserved.</p> <p>- Staff of the section established in the Project is maintained.</p>		
<b>Outputs</b>					
<p>1. DOH's human resources, institution and scope of works on tunnel project are established.</p> <p>2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</p>	<p>1-1. Unit or section in charge of tunnel project in DOH is established.</p> <p>1-2. Enough human resources are assigned to the section.</p> <p>1-3. The responsibilities of the section are clarified.</p> <p>2-1. The management cycle of mountain highway tunnel projects is clarified in DOH.</p> <p>2-2. A program of mountain highway tunnel construction projects is prepared by DOH.</p> <p>2-3. A draft manual on supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle.</p>	<p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Working record of the section's staff</p> <p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Preparation of the project management cycle (draft)</p> <p>- Short-term list of project plans</p> <p>- Long-term list of project plans</p> <p>- Draft Manual of supervision and inspection</p>			

<p>3. DOH's capacity of investigation on mountain highway tunnels is enhanced.</p>	<p>3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH.  3-2. The draft standard specifications on investigation of mountain highway tunnel are prepared by DOH.  3-3. The draft manual on cost estimation of mountain highway tunnel investigation is prepared by DOH.  3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft Manual on investigation of mountain highway tunnel  - Draft standard specifications on investigation of mountain highway tunnel  - Draft manual on investigation and cost estimation of mountain highway tunnel  - The pilot study (investigation of mountain highway tunnel)</p>	<p>- Staff of the section established in the Project is maintained.</p>		
<p>4. DOH's capacity of design on mountain highway tunnel is enhanced.</p>	<p>4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.  4-2. The draft standard specifications on design of mountain highway tunnel are prepared by DOH.  4-3. The draft manual on cost estimation of mountain highway tunnel is prepared by DOH.  4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft manual on design of mountain highway tunnel  - Standard typical cross sections of mountain highway tunnel  - Draft standard specifications on design of mountain highway tunnel  - Draft manual on cost estimation  - Pilot study (design of mountain highway tunnel)  - Contract drawings</p>			

Activities	Inputs		Important Assumptions
	The Japanese Side	The Thai Side	
<p>1-1. To review present organization structure and works in DOH  1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management  1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management  2-1. To identify management cycle for mountain highway tunnel  2-2. To prepare programs of mountain highway tunnel construction as the management cycle  2-3. To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle</p>	<p>1. Dispatch of JICA Experts  (1) Long-term Expert  Chief Advisor  (2) Short-term Experts  1). Team Leader/Mountain Highway Planning  2). Tunnel Planning/Environmental and Social Consideration  3). Tunnel Design (Structure)  4). Tunnel Design (Facilities)  5). Tunnel Cost Estimation  6). Tunnel Geology  7). Contract Management  8). Project Coordinator / Training Planning  9). Project Monitoring  2. Training for Counterpart Personnel  1) Training in Japan  2) Seminars and Trainings in Thailand  3. Cost for the daily activities of JICA Experts</p>	<p>1. Allocation of Counterpart Personnel  1) Project Director  2) Project Manager  3) Counterpart (Highway)  4) Counterpart (Tunnel)  5) Counterpart (Structure)  6) Counterpart (Geology)  7) Counterpart (Facility-Electricity, Facility-Machinery)  8) Counterpart (Construction Management)  9) Counterpart (Maintenance Management)  10) Counterpart (Technical Standard)  11) Counterpart (Cost Estimation)  12) Counterpart (Procurement)  13) Counterpart (Environment)</p>	<p>- Main C/P members are continuously allocated during the Project period.</p> <p><b>Pre-Conditions</b></p> <p>1. Candidate sites for pilot studies exist.  2. Core C/P members of the Project are assigned.</p>
<p>3-1. To prepare the draft manual on investigation of mountain highway tunnel  3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p>		<p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p>	<p style="text-align: center;"></p> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>

<p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p>	<p>3. Running expenses necessary for the implementation of the Project including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	
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# Plan of Operation ver.0

Project Title: Project for Capacity Development on Tunnel Project Management in Thailand																			
Version: 0 Dated: 21 February 2020 Monitoring																			
Plan of Operations																			
Inputs	1st Year				2nd Year				3rd Year				4th Year						
	Year	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
Expert in charge	Year																Remarks	Issue	Solution
Name	Plan	Actual																	
Training in Japan																			
Activities	Year																Responsible Organization	Achievements	Issue & Countermeasures
Sub-Activities	Year	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III			
Output 1: DOH's human resources, institution and scope of works on tunnel project are established.																			
1.1 To review present organization structure and works in DOH	Plan	Actual	Review															JICA Expert Team	DOH
1.2 To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management	Plan	Actual		Clarification														JICA Expert Team	DOH
1.3 To identify works and responsibilities of the section in charge of mountain highway tunnel project	Plan	Actual		Clarification														JICA Expert Team	DOH
Output 2: DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.																			
2.1 To identify management cycle for mountain highway tunnel	Plan	Actual		Clarification														JICA Expert Team	DOH
2.2 To prepare programs of mountain highway tunnel construction as the management cycle	Plan	Actual			Project planning													JICA Expert Team	DOH
2.3 To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle	Plan	Actual																JICA Expert Team	DOH
Output 3: DOH's capacity of investigation on mountain highway tunnels is enhanced.																			
3.1 To prepare the draft manual on investigation of mountain highway tunnel	Plan	Actual		Drafting														JICA Expert Team	DOH
3.2 To prepare the draft standard specifications on investigation of mountain highway tunnel	Plan	Actual		Drafting														JICA Expert Team	DOH
3.3 To prepare the draft manual on cost estimation of mountain highway tunnel investigation	Plan	Actual		Drafting														JICA Expert Team	DOH
3.4 To select the pilot study site for mountain highway tunnel investigation	Plan	Actual			Site Selection													JICA Expert Team	DOH
3.5 To implement the pilot study for mountain highway tunnel investigation	Plan	Actual																JICA Expert Team	DOH
Output 4: DOH's capacity of design on mountain highway tunnel is enhanced.																			
4.1 To prepare the draft manual on design of mountain highway tunnel	Plan	Actual		Drafting														JICA Expert Team	DOH
4.2 To prepare the draft standard specifications on design of mountain highway tunnel	Plan	Actual		Drafting														JICA Expert Team	DOH
4.3 To prepare the draft manual on cost estimation of mountain highway tunnel design	Plan	Actual		Drafting														JICA Expert Team	DOH
4.4 To select the pilot study site for mountain highway tunnel design	Plan	Actual			Site Selection													JICA Expert Team	DOH
4.5 To implement the pilot study for mountain highway tunnel design	Plan	Actual																JICA Expert Team	DOH
Monitoring Plan																			
Monitoring																			
Kick-Off Meeting	Plan	Actual																	
Joint Coordinating Committee	Plan	Actual																	
Final Seminar	Plan	Actual																	
Submission of Monitoring Sheet	Plan	Actual																	
Reports/Documents																			
Inception Report	Plan	Actual																	
Project Completion Report	Plan	Actual																	

## A3-2. Project Design Matrix (PDM) Ver.1.0

### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 1.0

**Implementing Agency:** Department of Highways (DOH)

Dated: 29 June 2021


**Target Group:** DOH's Engineers

**Period of Project:** Jan,2021 - Dec,2024 (4 Years)

**Project Site:** Motorways and national highways managed by DOH

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	<p>1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</p> <p>2. At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.</p>	<p>- Revision of the list of short- and long-term project plans</p> <p>- Confirmation of the progress based on the list of short- and long-term project plans</p> <p>- Results of order and management of new mountain highway projects</p>			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	<p>1. DOH assigns not less than 5 staff members who are in charge of tunnel construction.</p> <p>2. At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.</p>	<p>- DOH's structure regulation or organogram</p> <p>- Short- and long-term lists of project plans</p>	<p>- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed.</p> <p>- The project management methods that utilize manuals and references prepared in the Project are preserved.</p> <p>- Staff of the section established in the Project is maintained.</p>		
<b>Outputs</b>					
<p>1. DOH's human resources, institution and scope of works on tunnel project are established.</p> <p>2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</p>	<p>1-1. Unit or section in charge of tunnel project in DOH is established.</p> <p>1-2. Enough human resources are assigned to the section.</p> <p>1-3. The responsibilities of the section are clarified.</p> <p>2-1. The management cycle of mountain highway tunnel projects is clarified in DOH.</p> <p>2-2. A program of mountain highway tunnel construction projects is prepared by DOH.</p> <p>2-3. A draft manual on supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle.</p>	<p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Working record of the section's staff</p> <p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Preparation of the project management cycle (draft)</p> <p>- Short-term list of project plans</p> <p>- Long-term list of project plans</p> <p>- Draft Manual of supervision and inspection</p>			

3. DOH's capacity of investigation on mountain highway tunnels is enhanced.	<p>3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH.</p> <p>3-2. The draft standard specifications on investigation of mountain highway tunnel are prepared by DOH.</p> <p>3-3. The draft manual on cost estimation of mountain highway tunnel investigation is prepared by DOH.</p> <p>3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft Manual on investigation of mountain highway tunnel</p> <p>- Draft standard specifications on investigation of mountain highway tunnel</p> <p>- Draft manual on investigation and cost estimation of mountain highway tunnel</p> <p>- The pilot study (investigation of mountain highway tunnel)</p>	- Staff of the section established in the Project is maintained.		
4. DOH's capacity of design on mountain highway tunnel is enhanced.	<p>4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.</p> <p>4-2. The draft standard specifications on design of mountain highway tunnel are prepared by DOH.</p> <p>4-3. The draft manual on cost estimation of mountain highway tunnel is prepared by DOH.</p> <p>4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft manual on design of mountain highway tunnel</p> <p>- Standard typical cross sections of mountain highway tunnel</p> <p>- Draft standard specifications on design of mountain highway tunnel</p> <p>- Draft manual on cost estimation</p> <p>- Pilot study (design of mountain highway tunnel)</p> <p>- Contract drawings</p>			

Activities	Inputs		Pre-Conditions
	The Japanese Side	The Thai Side	
<p>1-1. To review present organization structure and works in DOH</p> <p>1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management</p> <p>1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management</p>	<p>1. Dispatch of JICA Experts (1) Long-term Expert Chief Advisor (2) Short-term Experts 1). Team Leader / Mountain Highway Planning 1 2). Deputy Team Leader/Mountain Highway Planning 2 3). Tunnel Planning 4). Tunnel Design (Structure) 5). Tunnel Design (Facilities) 6). Cost Estimation (Investigation, Design, Construction/Civil) 7). Cost Estimation (Investigation, Design, Construction/Facilities) 8). Construction Plan / Safety Management 9). Geological Investigation for Tunnel Planning and Design 10). Contract Management (For Investigation and Design) 11). Contract Management (For</p>	<p>1. Allocation of Counterpart Personnel 1) JCC Chairperson 2) JCC Deputy Chairperson 3) JCC Project Director 4) JCC Project Manager 5) JCC Committee 6) JCC Members (WG1 leader) 7) JCC Members (WG2 leader) 8) JCC Members (WG3 leader) 9) JCC Members (WG4 leader) 10) JCC Members (WG5 leader) 11) Secretary 12) WG Members: 43 persons</p> <p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p> <p>3. Running expenses necessary for the implementation of the Project</p>	<p>1. Candidate sites for pilot studies exist. 2. Core C/P members of the Project are assigned.</p> <p style="text-align: center;"></p> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>
<p>2-1. To identify management cycle for mountain highway tunnel</p> <p>2-2. To prepare programs of mountain highway tunnel construction as the management cycle</p> <p>2-3. To prepare the draft manual on supervision and inspection of mountain highway</p>			

<p>tunnel construction and maintenance considering the management cycle</p> <p>3-1. To prepare the draft manual on investigation of mountain highway tunnel</p> <p>3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p> <p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>Construction)</p> <p>12). Training Planning</p> <p>13). Project Monitoring / Public Relations</p> <p>2. Training for Counterpart Personnel</p> <p>1) Training in Japan</p> <p>2) Seminars and Trainings in Thailand</p> <p>3. Cost for the daily activities of JICA Experts</p> <p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p> <p>4. Equipment</p> <p>1) UC-win/Road advanced</p> <p>2) Geomap 3D</p> <p>3) Monitor</p> <p>4) Laptop PC etc.</p> <p>5) AUTODESK Architecture, Engineering &amp; Construction Collection</p>	<p>including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	
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### A3-3. Project Design Matrix (PDM) Ver.2.0

#### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 2.0

**Implementing Agency:** Department of Highways (DOH)

Dated: 10 March 2022


**Target Group:** DOH's Engineers

**Period of Project:** Jan,2021 - Dec,2024 (4 Years)

**Project Site:** Motorways and national highways managed by DOH

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	<p>1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</p> <p>2. At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.</p>	<p>- Revision of the list of short- and long-term project plans</p> <p>- Confirmation of the progress based on the list of short- and long-term project plans</p> <p>- Results of order and management of new mountain highway projects</p>			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	<p>1. DOH assigns not less than 5 staff members who are in charge of tunnel construction.</p> <p>2. At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.</p>	<p>- DOH's structure regulation or organogram</p> <p>- Short- and long-term lists of project plans</p>	<p>- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed.</p> <p>- The project management methods that utilize manuals and references prepared in the Project are preserved.</p> <p>- Staff of the section established in the Project is maintained.</p>		
<b>Outputs</b>					
<p>1. DOH's human resources, institution and scope of works on tunnel project are established.</p> <p>2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</p>	<p>1-1. Unit or section in charge of tunnel project in DOH is established.</p> <p>1-2. Enough human resources are assigned to the section.</p> <p>1-3. The responsibilities of the section are clarified.</p> <p>2-1. The management cycle of mountain highway tunnel projects is clarified in DOH.</p> <p>2-2. A program of mountain highway tunnel construction projects is prepared by DOH.</p> <p>2-3. A draft manual on supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle.</p> <p>2-4. A report on environmental issues and measures of mountain</p>	<p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Working record of the section's staff</p> <p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Preparation of the project management cycle (draft)</p> <p>- Short-term list of project plans</p> <p>- Long-term list of project plans</p> <p>- Draft Manual of supervision and inspection</p> <p>- Report on environmental issues and measures of mountain highway tunnel project</p>			

	highway tunnel projects is prepared.				
3. DOH's capacity of investigation on mountain highway tunnels is enhanced.	<p>3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH.</p> <p>3-2. The draft standard specifications on investigation of mountain highway tunnel are prepared by DOH.</p> <p>3-3. The draft manual on cost estimation of mountain highway tunnel investigation is prepared by DOH.</p> <p>3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft Manual on investigation of mountain highway tunnel</p> <p>- Draft standard specifications on investigation of mountain highway tunnel</p> <p>- Draft manual on investigation and cost estimation of mountain highway tunnel</p> <p>- The pilot study (investigation of mountain highway tunnel)</p>	- Staff of the section established in the Project is maintained.		
4. DOH's capacity of design on mountain highway tunnel is enhanced.	<p>4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.</p> <p>4-2. The draft standard specifications on design of mountain highway tunnel are prepared by DOH.</p> <p>4-3. The draft manual on cost estimation of mountain highway tunnel is prepared by DOH.</p> <p>4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft manual on design of mountain highway tunnel</p> <p>- Standard typical cross sections of mountain highway tunnel</p> <p>- Draft standard specifications on design of mountain highway tunnel</p> <p>- Draft manual on cost estimation</p> <p>- Pilot study (design of mountain highway tunnel)</p> <p>- Contract drawings</p>			

Activities	Inputs		Pre-Conditions
	The Japanese Side	The Thai Side	
<p>1-1. To review present organization structure and works in DOH</p> <p>1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management</p> <p>1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management</p> <p>2-1. To identify management cycle for mountain highway tunnel</p> <p>2-2. To prepare programs of mountain highway tunnel construction as the management cycle</p>	<p>1. Dispatch of JICA Experts (1) Long-term Expert Chief Advisor (2) Short-term Experts 1). Team Leader / Mountain Highway Planning 1 2). Deputy Team Leader/Mountain Highway Planning 2 3). Tunnel Planning 4). Tunnel Design (Structure) 5). Tunnel Design (Facilities) 6). Cost Estimation (Investigation, Design, Construction/Civil) 7). Cost Estimation (Investigation, Design, Construction/Facilities) 8). Construction Plan / Safety Management 9). Geological Investigation for Tunnel Planning and Design 10). Contract Management (For</p>	<p>1. Allocation of Counterpart Personnel 1) JCC Chairperson 2) JCC Deputy Chairperson 3) JCC Project Director 4) JCC Project Manager 5) JCC Committee 6) JCC Members (WG1 leader) 7) JCC Members (WG2 leader) 8) JCC Members (WG3 leader) 9) JCC Members (WG4 leader) 10) JCC Members (WG5 leader) 11) Secretary 12) WG Members: 43 persons</p> <p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p>	<p>1. Candidate sites for pilot studies exist. 2. Core C/P members of the Project are assigned.</p> <p style="text-align: center;"></p> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>

<p>2-3. To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle</p> <p>2-4. To study environmental issues and measures of mountain highway tunnel project</p> <p>3-1. To prepare the draft manual on investigation of mountain highway tunnel</p> <p>3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p> <p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>Investigation and Design)</p> <p>11). Contract Management (For Construction)</p> <p>12). Training Planning</p> <p>13). Project Monitoring / Public Relations</p> <p>14). Environmental and Social Consideration</p> <p>2. Training for Counterpart Personnel</p> <p>1) Training in Japan</p> <p>2) Seminars and Trainings in Thailand</p> <p>3. Cost for the daily activities of JICA Experts</p> <p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p> <p>4. Equipment</p> <p>1) UC-win/Road advanced</p> <p>2) Geomap 3D</p> <p>3) Monitor</p> <p>4) Laptop PC etc.</p> <p>5) AUTODESK Architecture, Engineering &amp; Construction Collection</p>	<p>3. Running expenses necessary for the implementation of the Project including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	
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## A3-4. Project Design Matrix (PDM) Ver.3.0

### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 3.0

**Implementing Agency:** Department of Highways (DOH)

Dated: 22 September 2022


**Target Group:** DOH's Engineers

**Period of Project:** Jan,2021 - Dec,2024 (4 Years)

**Project Site:** Motorways and national highways managed by DOH

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted. 2. At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.	- Revision of the list of short- and long-term project plans - Confirmation of the progress based on the list of short- and long-term project plans - Results of order and management of new mountain highway projects			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	1. DOH assigns not less than 5 staff members who are in charge of tunnel construction.  2. At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.	- DOH's structure regulation or organogram  - Short- and long-term lists of project plans	- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed. - The project management methods that utilize manuals and references prepared in the Project are preserved. - Staff of the section established in the Project is maintained.		
<b>Outputs</b>					
1. DOH's human resources, institution and scope of works on tunnel project are established.  2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.	1-1. Unit or section in charge of tunnel project in DOH is established. 1-2. Enough human resources are assigned to the section. 1-3. The responsibilities of the section are clarified.  2-1. The management cycle of mountain highway tunnel projects is clarified in DOH. 2-2. A program of mountain highway tunnel construction projects is prepared by DOH. 2-3. A draft manual on supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle. 2-4. A report on environmental issues and measures of mountain	- Reports of DOH's institutional structure - DOH's internal regulations etc. - Working record of the section's staff  - Reports of DOH's institutional structure - DOH's internal regulations etc. - Preparation of the project management cycle (draft)  - Short-term list of project plans - Long-term list of project plans  - Draft Manual of supervision and inspection  - Report on environmental issues and measures of mountain highway tunnel project			

	highway tunnel projects is prepared.				
3. DOH's capacity of investigation on mountain highway tunnels is enhanced.	<p>3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH.</p> <p>3-2. The draft standard specifications on investigation of mountain highway tunnel are prepared by DOH.</p> <p>3-3. The draft manual on cost estimation of mountain highway tunnel investigation is prepared by DOH.</p> <p>3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft Manual on investigation of mountain highway tunnel</p> <p>- Draft standard specifications on investigation of mountain highway tunnel</p> <p>- Draft manual on investigation and cost estimation of mountain highway tunnel</p> <p>- The pilot study (investigation of mountain highway tunnel)</p>		- Staff of the section established in the Project is maintained.	
4. DOH's capacity of design on mountain highway tunnel is enhanced.	<p>4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.</p> <p>4-2. The draft standard specifications on design of mountain highway tunnel are prepared by DOH.</p> <p>4-3. The draft manual on cost estimation of mountain highway tunnel is prepared by DOH.</p> <p>4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft manual on design of mountain highway tunnel</p> <p>- Standard typical cross sections of mountain highway tunnel</p> <p>- Draft standard specifications on design of mountain highway tunnel</p> <p>- Draft manual on cost estimation</p> <p>- Pilot study (design of mountain highway tunnel)</p> <p>- Contract drawings</p>			

Activities	Inputs		Pre-Conditions
	The Japanese Side	The Thai Side	
<p>1-1. To review present organization structure and works in DOH</p> <p>1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management</p> <p>1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management</p> <p>2-1. To identify management cycle for mountain highway tunnel</p> <p>2-2. To prepare programs of mountain highway tunnel construction as the management cycle</p>	<p>1. Dispatch of JICA Experts (1) Long-term Expert Chief Advisor (2) Short-term Experts 1). Team Leader / Mountain Highway Planning 1 2). Deputy Team Leader/Mountain Highway Planning 2 3). Tunnel Planning (Location and Structure) 4). Tunnel Planning (Environmental and Social Consideration) 5). Tunnel Design (Structure) 6). Tunnel Design (Facilities) 7). Cost Estimation (Investigation, Design, Construction/Civil) 8). Cost Estimation (Investigation, Design, Construction/Facilities) 9). Construction Plan / Safety Management</p>	<p>1. Allocation of Counterpart Personnel 1) JCC Chairperson 2) JCC Deputy Chairperson 3) JCC Project Director 4) JCC Project Manager 5) JCC Committee 6) JCC Members (WG1 leader) 7) JCC Members (WG2 leader) 8) JCC Members (WG3 leader) 9) JCC Members (WG4 leader) 10) JCC Members (WG5 leader) 11) Secretary 12) WG Members: 43 persons</p> <p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p>	<p>1. Candidate sites for pilot studies exist. 2. Core C/P members of the Project are assigned.</p> <p style="text-align: center;"></p> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>

<p>2-3. To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle</p> <p>2-4. To study environmental issues and measures of mountain highway tunnel project</p> <p>3-1. To prepare the draft manual on investigation of mountain highway tunnel</p> <p>3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p> <p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>10). Geological Investigation for Tunnel Planning and Design</p> <p>11). Contract Management (For Investigation and Design)</p> <p>12). Contract Management (For Construction)</p> <p>13). Training Planning</p> <p>14). Project Monitoring / Public Relations</p> <p>2. Training for Counterpart Personnel</p> <p>1) Training in Japan</p> <p>2) Seminars and Trainings in Thailand</p> <p>3. Cost for the daily activities of JICA Experts</p> <p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p> <p>4. Equipment</p> <p>1) UC-win/Road advanced</p> <p>2) Geomap 3D</p> <p>3) Monitor</p> <p>4) Laptop PC etc.</p> <p>5) AUTODESK Architecture, Engineering &amp; Construction Collection</p>	<p>3. Running expenses necessary for the implementation of the Project including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	
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# Plan of Operation Ver.3.0

## Plan of Operation

Version 3.0  
Dated : 22 September 2022

Project Title: Project for Capacity Development on Tunnel Project Management in Thailand		Monitoring																Remarks	Issue	Solution
Inputs		2021				2022				2023				2024						
Expert in charge		Year	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>Expert</b>																				
Team Leader/Mountain Highway Planning 1	Takayuki TSUCHIDA	Plan																		
Deputy Team Leader/Mountain Highway Planning 2	Junichiro OGAWA	Actual																		
Tunnel Planning (Location and Structure)	Mitsugu NOMURA	Plan																		
Tunnel Planning (Environmental and Social Consideration)	Akira YAMASHITA	Actual																		
Tunnel Design (Structure)	Kentaro SAWADA	Plan																		
Tunnel Design (Facilities)	Susumu MURASE	Actual																		
Cost Estimation (Investigation, Design, Construction/Civil)	Hiroya YONEMOTO	Plan																		
Cost Estimation (Investigation, Design, Construction/Facilities)	Toshiyuki OKA	Actual																		
Construction Plan / Safety Management	Hiroshi UCHIDA	Plan																		
Geological Investigation for Tunnel Planning and Design	Teppi TOMITA	Actual																		
Contract Management (For Investigation and Design)	Jun MITSUO	Plan																		
Contract Management (For Construction)	Yasufumi ISEKI	Actual																		
Training Planning	Hayato TAKASE/Yuho IJUMA	Plan																		
Project Monitoring/Public Relations	Hitomi IWAMASA	Actual																		
Training in Japan	Masako YAGI	Plan																		
Equipment		Actual																		
UC-win/Road advanced		Plan																		
Geomap 3D		Actual																		
Monitor		Plan																		
Laptop PC		Actual																		
AUTODESK Architecture, Engineering & Construction Collection		Plan																		
		Actual																		
<b>Activities</b>																				
Sub-Activities																				
Expert in charge																				
<b>Output 1: DOH's human resources, institution and scope of works on tunnel project are established.</b>																				
1.1 To review present organization structure and works in DOH		Plan																		
		Actual																		
1.2 To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management		Plan																		
		Actual																		
1.3 To identify works and responsibilities of the section in charge of mountain highway tunnel project management		Plan																		
		Actual																		
<b>Output 2: DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</b>																				
2.1 To identify management cycle for mountain highway tunnel		Plan																		
		Actual																		
2.2 To prepare programs of mountain highway tunnel construction as the management cycle		Plan																		
		Actual																		
2.3 To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle		Plan																		
		Actual																		
2.4 To study environmental issues and measures of mountain highway tunnel project		Plan																		
		Actual																		
<b>Output 3: DOH's capacity of investigation on mountain highway tunnels is enhanced.</b>																				
3.1 To prepare the draft manual on investigation of mountain highway tunnel		Plan																		
		Actual																		
3.2 To prepare the draft standard specifications on investigation of mountain highway tunnel		Plan																		
		Actual																		
3.3 To prepare the draft manual on cost estimation of mountain highway tunnel investigation		Plan																		
		Actual																		
3.4 To select the pilot study site for mountain highway tunnel investigation		Plan																		
		Actual																		
3.5 To implement the pilot study for mountain highway tunnel investigation		Plan																		
		Actual																		
<b>Output 4: DOH's capacity of design on mountain highway tunnel is enhanced.</b>																				
4.1 To prepare the draft manual on design of mountain highway tunnel		Plan																		
		Actual																		
4.2 To prepare the draft standard specifications on design of mountain highway tunnel		Plan																		
		Actual																		
4.3 To prepare the draft manual on cost estimation of mountain highway tunnel design		Plan																		
		Actual																		
4.4 To select the pilot study site for mountain highway tunnel design		Plan																		
		Actual																		
4.5 To implement the pilot study for mountain highway tunnel design		Plan																		
		Actual																		
<b>Monitoring Plan</b>																				
Monitoring																				
Joint Coordinating Committee																				
		Plan																		
		Actual																		
Technical Seminar																				
		Plan																		
		Actual																		
Submission of Monitoring Sheet																				
		Plan																		
		Actual																		
<b>Reports/Documents</b>																				
Reports																				
		Plan																		
		Actual																		

## A3-5. Project Design Matrix (PDM) Ver.4.0

### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 4.0

**Implementing Agency:** Department of Highways (DOH)

Dated: 22 March 2023


**Target Group:** DOH's Engineers

**Period of Project:** Jan,2021 - Dec,2024 (4 Years)

**Project Site:** Motorways and national highways managed by DOH

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	<p>1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</p> <p>2. At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.</p>	<p>- Revision of the list of short- and long-term project plans</p> <p>- Confirmation of the progress based on the list of short- and long-term project plans</p> <p>- Results of order and management of new mountain highway projects</p>			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	<p>1. DOH assigns not less than 5 staff members who are in charge of tunnel construction.</p> <p>2. At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.</p>	<p>- DOH's structure regulation or organogram</p> <p>- Short- and long-term lists of project plans</p>	<p>- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed.</p> <p>- The project management methods that utilize manuals and references prepared in the Project are preserved.</p> <p>- Staff of the section established in the Project is maintained.</p>		
<b>Outputs</b>					
<p>1. DOH's human resources, institution and scope of works on tunnel project are established.</p> <p>2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</p>	<p>1-1. Unit or section in charge of tunnel project in DOH is established.</p> <p>1-2. Enough human resources are assigned to the section.</p> <p>1-3. The responsibilities of the section are clarified.</p> <p>2-1. The management cycle of mountain highway tunnel projects is clarified in DOH.</p> <p>2-2. A program of mountain highway tunnel construction projects is prepared by DOH.</p> <p>2-3. A draft manual on supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle.</p> <p>2-4. A report on environmental issues and measures of mountain</p>	<p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Working record of the section's staff</p> <p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Preparation of the project management cycle (draft)</p> <p>- Short-term list of project plans</p> <p>- Long-term list of project plans</p> <p>- Draft Manual of supervision and inspection</p> <p>- Report on environmental issues and measures of mountain highway tunnel project</p>			

	highway tunnel projects is prepared.				
3. DOH's capacity of investigation on mountain highway tunnels is enhanced.	<p>3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH.</p> <p>3-2. The draft standard specifications on investigation of mountain highway tunnel are prepared by DOH.</p> <p>3-3. The draft manual on cost estimation of mountain highway tunnel investigation is prepared by DOH.</p> <p>3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft Manual on investigation of mountain highway tunnel</p> <p>- Draft standard specifications on investigation of mountain highway tunnel</p> <p>- Draft manual on investigation and cost estimation of mountain highway tunnel</p> <p>- The pilot study (investigation of mountain highway tunnel)</p>		- Staff of the section established in the Project is maintained.	
4. DOH's capacity of design on mountain highway tunnel is enhanced.	<p>4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.</p> <p>4-2. The draft standard specifications on design of mountain highway tunnel are prepared by DOH.</p> <p>4-3. The draft manual on cost estimation of mountain highway tunnel is prepared by DOH.</p> <p>4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft manual on design of mountain highway tunnel</p> <p>- Standard typical cross sections of mountain highway tunnel</p> <p>- Draft standard specifications on design of mountain highway tunnel</p> <p>- Draft manual on cost estimation</p> <p>- Pilot study (design of mountain highway tunnel)</p> <p>- Contract drawings</p>			

Activities	Inputs		Pre-Conditions
	The Japanese Side	The Thai Side	
<p>1-1. To review present organization structure and works in DOH</p> <p>1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management</p> <p>1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management</p> <p>2-1. To identify management cycle for mountain highway tunnel</p> <p>2-2. To prepare programs of mountain highway tunnel construction as the management cycle</p> <p>2-3. To prepare the draft manual on supervision and</p>	<p>1. Dispatch of JICA Experts (1) Long-term Expert Chief Advisor (2) Short-term Experts 1). Team Leader / Mountain Highway Planning 1 2). Deputy Team Leader/Mountain Highway Planning 2 3). Tunnel Planning (Location and Structure) 4). Tunnel Planning (Environmental and Social Consideration) 5). Tunnel Design (Structure) 6). Tunnel Design (Facilities) 7). Cost Estimation (Investigation, Design, Construction/Civil) 8). Cost Estimation (Investigation, Design, Construction/Facilities) 9). Construction Plan / Safety Management 10). Geological Investigation for Tunnel</p>	<p>1. Allocation of Counterpart Personnel 1) JCC Chairperson 2) JCC Deputy Chairperson 3) JCC Project Director 4) JCC Project Manager 5) JCC Committee 6) JCC Members (WG1 leader) 7) JCC Members (WG2 leader) 8) JCC Members (WG3 leader) 9) JCC Members (WG4 leader) 10) JCC Members (WG5 leader) 11) Secretary 12) WG Members: 65 persons</p> <p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p> <p>3. Running expenses necessary for</p>	<p>1. Candidate sites for pilot studies exist. 2. Core C/P members of the Project are assigned.</p> <p style="text-align: center;"></p> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>

<p>inspection of mountain highway tunnel construction and maintenance considering the management cycle</p> <p>2-4. To study environmental issues and measures of mountain highway tunnel project</p> <p>3-1. To prepare the draft manual on investigation of mountain highway tunnel</p> <p>3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p> <p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>Planning and Design</p> <p>11). Contract Management (For Investigation and Design)</p> <p>12). Contract Management (For Construction)</p> <p>13). Training Planning</p> <p>14). Project Monitoring / Public Relations</p> <p>2. Training for Counterpart Personnel</p> <p>1) Training in Japan</p> <p>2) Seminars and Trainings in Thailand</p> <p>3. Cost for the daily activities of JICA Experts</p> <p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p> <p>4. Equipment</p> <p>1) UC-win/Road advanced</p> <p>2) Geomap 3D</p> <p>3) Monitor</p> <p>4) Laptop PC etc.</p> <p>5) AUTODESK Architecture, Engineering &amp; Construction Collection</p>	<p>the implementation of the Project including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	
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# Plan of Operation Ver.4.0

## Plan of Operation

Version 4.0

Dated : 22 March 2023

Project Title: Project for Capacity Development on Tunnel Project Management in Thailand		Monitoring																Remarks	Issue	Solution
Inputs		2021				2022				2023				2024						
Expert in charge		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
<b>Expert</b>																				
Team Leader/Mountain Highway Planning 1	Takayuki TSUCHIDA	[Gantt chart for 2021-2024]																		
Deputy Team Leader/Mountain Highway Planning 2	Junichiro OGAWA	[Gantt chart for 2021-2024]																		
Tunnel Planning (Location and Structure)	Mitsugu NOMURA	[Gantt chart for 2021-2024]																		
Tunnel Planning (Environmental and Social Consideration)	Akira YAMASHITA	[Gantt chart for 2021-2024]																		
Tunnel Design (Structure)	Kentaro SAWADA	[Gantt chart for 2021-2024]																		
Tunnel Design (Facilities)	Susumu MURASE	[Gantt chart for 2021-2024]																		
Cost Estimation (Investigation, Design, Construction/Civil)	Hiroya YONEMOTO/Toshiaki OKA	[Gantt chart for 2021-2024]																		
Cost Estimation (Investigation, Design, Construction/Facilities)	Hiroshi UCHIDA	[Gantt chart for 2021-2024]																		
Construction Plan / Safety Management	Teppi TOMITA	[Gantt chart for 2021-2024]																		
Geological Investigation for Tunnel Planning and Design	Jun MITSUO	[Gantt chart for 2021-2024]																		
Contract Management (For Investigation and Design)	Yasufumi ISEKI	[Gantt chart for 2021-2024]																		
Contract Management (For Construction)	Hayato TAKASE/Yuichi IJIMA	[Gantt chart for 2021-2024]																		
Training Planning	Hironori IWAMASA	[Gantt chart for 2021-2024]																		
Project Monitoring/Public Relations	Massaka YAGI	[Gantt chart for 2021-2024]																		
<b>Training in Japan</b>																				
<b>Equipment</b>																				
UC-win/Road advanced		[Gantt chart for 2021-2024]																		
Geomap 3D		[Gantt chart for 2021-2024]																		
Monitor		[Gantt chart for 2021-2024]																		
Laptop PC		[Gantt chart for 2021-2024]																		
AUTODESK Architecture, Engineering & Construction Collection		[Gantt chart for 2021-2024]																		
<b>Activities</b>																				
Sub-Activities																				
Expert in charge																				
<b>Output 1: DOH's human resources, institution and scope of works on tunnel project are established.</b>																				
1.1 To review present organization structure and works in DOH		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
1.2 To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
1.3 To identify works and responsibilities of the section in charge of mountain highway tunnel project management		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
<b>Output 2: DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</b>																				
2.1 To identify management cycle for mountain highway tunnel		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
2.2 To prepare programs of mountain highway tunnel construction as the management cycle		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
2.3 To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
2.4 To study environmental issues and measures of mountain highway tunnel project		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
<b>Output 3: DOH's capacity of investigation on mountain highway tunnels is enhanced.</b>																				
3.1 To prepare the draft manual on investigation of mountain highway tunnel		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
3.2 To prepare the draft standard specifications on investigation of mountain highway tunnel		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
3.3 To prepare the draft manual on cost estimation of mountain highway tunnel investigation		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
3.4 To select the pilot study site for mountain highway tunnel investigation		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
3.5 To implement the pilot study for mountain highway tunnel investigation		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
<b>Output 4: DOH's capacity of design on mountain highway tunnel is enhanced.</b>																				
4.1 To prepare the draft manual on design of mountain highway tunnel		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
4.2 To prepare the draft standard specifications on design of mountain highway tunnel		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
4.3 To prepare the draft manual on cost estimation of mountain highway tunnel design		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
4.4 To select the pilot study site for mountain highway tunnel design		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
4.5 To implement the pilot study for mountain highway tunnel design		[Gantt chart for 2021-2024]																JICA Expert Team	DOH	
<b>Monitoring Plan</b>																				
Monitoring																				
Joint Coordinating Committee		[Gantt chart for 2021-2024]																		
Technical Seminar		[Gantt chart for 2021-2024]																		
Submission of Monitoring Sheet		[Gantt chart for 2021-2024]																		
Reports/Documents																				
Reports		[Gantt chart for 2021-2024]																		

## A3-6. Project Design Matrix (PDM) Ver.5.0

### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 5.0

**Implementing Agency:** Department of Highways (DOH)

Dated: 26 March 2024


**Target Group:** DOH's Engineers

**Period of Project:** Jan,2021 - Feb, 2025 (4 Years and 2 Months)

**Project Site:** Motorways and national highways managed by DOH

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted. 2. At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.	- Revision of the list of short- and long-term project plans - Confirmation of the progress based on the list of short- and long-term project plans - Results of order and management of new mountain highway projects			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	1. DOH assigns not less than 5 staff members who are in charge of tunnel project. (investigation and design)  2. At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.	- DOH's structure regulation or organogram  - Short- and long-term lists of project plans	- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed. - The project management methods that utilize manuals and references prepared in the Project are preserved. - Staff of the section established in the Project is maintained.		
<b>Outputs</b>					
1. DOH's human resources, institution and scope of works on tunnel project are established.  2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.	1-1. Unit or section in charge of tunnel project in DOH is established. 1-2. Enough human resources are assigned to the section. 1-3. The responsibilities of the section are clarified.  2-1. The management cycle of mountain highway tunnel projects is clarified in DOH. 2-2. A program of mountain highway tunnel construction projects is prepared by DOH. 2-3. A draft manual on supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle. 2-4. A report on environmental issues and measures of mountain	- Reports of DOH's institutional structure - DOH's internal regulations etc. - Reports of DOH's institutional structure - DOH's internal regulations etc. - Reports of DOH's institutional structure - DOH's internal regulations etc. - Preparation of the project management cycle (draft)  - Short-term list of project plans - Long-term list of project plans  - Draft Manual of supervision and inspection  - Report on environmental issues and measures of mountain highway tunnel project			

	highway tunnel projects is prepared.				
3. DOH's capacity of investigation on mountain highway tunnels is enhanced.	<p>3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH.</p> <p>3-2. The draft standard specifications on investigation of mountain highway tunnel are prepared by DOH.</p> <p>3-3. The draft manual on cost estimation of mountain highway tunnel investigation is prepared by DOH.</p> <p>3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft Manual on investigation of mountain highway tunnel</p> <p>- Draft standard specifications on investigation of mountain highway tunnel</p> <p>- Draft manual on investigation and cost estimation of mountain highway tunnel</p> <p>- The pilot study (investigation of mountain highway tunnel)</p>		- Staff of the section established in the Project is maintained.	
4. DOH's capacity of design on mountain highway tunnel is enhanced.	<p>4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.</p> <p>4-2. The draft standard specifications on design of mountain highway tunnel are prepared by DOH.</p> <p>4-3. The draft manual on cost estimation of mountain highway tunnel is prepared by DOH.</p> <p>4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.</p>	<p>- Draft manual on design of mountain highway tunnel</p> <p>- Standard typical cross sections of mountain highway tunnel</p> <p>- Draft standard specifications on design of mountain highway tunnel</p> <p>- Draft manual on cost estimation</p> <p>- Pilot study (design of mountain highway tunnel)</p> <p>- Contract drawings</p>			

Activities	Inputs		Pre-Conditions
	The Japanese Side	The Thai Side	
<p>1-1. To review present organization structure and works in DOH</p> <p>1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management</p> <p>1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management</p> <p>2-1. To identify management cycle for mountain highway tunnel</p> <p>2-2. To prepare programs of mountain highway tunnel construction as the management cycle</p> <p>2-3. To prepare the draft manual on supervision and</p>	<p>1. Dispatch of JICA Experts (1) Long-term Expert Chief Advisor (2) Short-term Experts 1). Team Leader / Mountain Highway Planning 1 2). Deputy Team Leader/Mountain Highway Planning 2 3). Tunnel Planning (Location and Structure) 4). Tunnel Planning (Environmental and Social Consideration) 5). Tunnel Design (Structure) 6). Tunnel Design (Facilities) 7). Cost Estimation (Investigation, Design, Construction/Civil) 8). Cost Estimation (Investigation, Design, Construction/Facilities) 9). Construction Plan / Safety Management 10). Geological Investigation for Tunnel</p>	<p>1. Allocation of Counterpart Personnel 1) JCC Chairperson 2) JCC Deputy Chairperson 3) JCC Project Director 4) JCC Project Manager 5) JCC Committee 6) JCC Members (WG1 leader) 7) JCC Members (WG2 leader) 8) JCC Members (WG3 leader) 9) JCC Members (WG4 leader) 10) JCC Members (WG5 leader) 11) Secretary 12) WG Members: 70 persons</p> <p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p> <p>3. Running expenses necessary for</p>	<p>1. Candidate sites for pilot studies exist. 2. Core C/P members of the Project are assigned.</p> <p style="text-align: center;"></p> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>

<p>inspection of mountain highway tunnel construction and maintenance considering the management cycle</p> <p>2-4. To study environmental issues and measures of mountain highway tunnel project</p> <p>3-1. To prepare the draft manual on investigation of mountain highway tunnel</p> <p>3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p> <p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>Planning and Design</p> <p>11). Contract Management (For Investigation and Design)</p> <p>12). Contract Management (For Construction)</p> <p>13). Training Planning</p> <p>14). Project Monitoring / Public Relations</p> <p>2. Training for Counterpart Personnel</p> <p>1) Training in Japan</p> <p>2) Seminars and Trainings in Thailand</p> <p>3. Cost for the daily activities of JICA Experts</p> <p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p> <p>4. Equipment</p> <p>1) UC-win/Road advanced</p> <p>2) Geomap 3D</p> <p>3) Monitor</p> <p>4) Laptop PC etc.</p> <p>5) AUTODESK Architecture, Engineering &amp; Construction Collection</p>	<p>the implementation of the Project including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	
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# Plan of Operation Ver.5.0

## Plan of Operation

Version 5.0  
Dated : 28 March 2024

Project Title: Project for Capacity Development on Tunnel Project Management in Thailand

Inputs	Expert in charge	Year	2021				2022				2023				2024				Remarks	Monitoring	
			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		Issue	Solution
<b>Expert</b>																					
Team Leader/Mountain Highway Planning 1	Takayuki TSUCHIDA	Plan																			
Deputy Team Leader/Mountain Highway Planning 2	Junichiro OGAWA	Actual																			
Tunnel Planning (Location and Structure)	Mitsugu NOMURA	Plan																			
Tunnel Planning (Environmental and Social Consideration)	Akira YAMASHITA	Actual																			
Tunnel Design (Structure)	Kentaro SAWADA	Plan																			
Tunnel Design (Facilities)	Susumu MURASE	Actual																			
Cost Estimation (Investigation, Design, Construction/Civil)	Hiroya YONEMOTO/ Toshitaka OKA	Plan																			
Cost Estimation (Investigation, Design, Construction/Facilities)	Hiroshi UCHIDA	Actual																			
Construction Plan / Safety Management	Teppi TOMITA	Plan																			
Geological Investigation for Tunnel Planning and Design	Jun MITSUO	Actual																			
Contract Management (For Investigation and Design)	Yasufumi ISEKI	Plan																			
Contract Management (For Construction)	Hayato TAKASE/Tsuchi IJIMA	Actual																			
Training Planning	Hikomi IWAMASA	Plan																			
Project Monitoring/Public Relations	Masako YAGI	Actual																			
<b>Training in Japan</b>		Plan																			
<b>Equipment</b>		Plan																			
UC win/Road advanced		Actual																			
Geomap 3D		Plan																			
Monitor		Actual																			
Laptop PC		Plan																			
AUTODESK Architecture, Engineering & Construction Collection		Actual																			

Activities	Sub-Activities	Expert in charge	Year	2021				2022				2023				2024				Responsible Organization	Achievements	Issue & Countermeasures
				I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
<b>Output 1: DOH's human resources, institution and scope of works on tunnel project are established.</b>																						
1.1	To review present organization structure and works in DOH		Plan																	JICA Expert Team	DOH	
1.2	To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management		Actual																	JICA Expert Team	DOH	
1.3	To identify works and responsibilities of the section in charge of mountain highway tunnel project management		Plan																	JICA Expert Team	DOH	
<b>Output 2: DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</b>																						
2.1	To identify management cycle for mountain highway tunnel		Plan																	JICA Expert Team	DOH	
2.2	To prepare programs of mountain highway tunnel construction as the management cycle		Actual																	JICA Expert Team	DOH	
2.3	To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle		Plan																	JICA Expert Team	DOH	
2.4	To study environmental issues and measures of mountain highway tunnel project		Actual																	JICA Expert Team	DOH	
<b>Output 3: DOH's capacity of investigation on mountain highway tunnels is enhanced.</b>																						
3.1	To prepare the draft manual on investigation of mountain highway tunnel		Plan																	JICA Expert Team	DOH	
3.2	To prepare the draft standard specifications on investigation of mountain highway tunnel		Actual																	JICA Expert Team	DOH	
3.3	To prepare the draft manual on cost estimation of mountain highway tunnel investigation		Plan																	JICA Expert Team	DOH	
3.4	To select the pilot study site for mountain highway tunnel investigation		Actual																	JICA Expert Team	DOH	
3.5	To implement the pilot study for mountain highway tunnel investigation		Plan																	JICA Expert Team	DOH	
<b>Output 4: DOH's capacity of design on mountain highway tunnel is enhanced.</b>																						
4.1	To prepare the draft manual on design of mountain highway tunnel		Plan																	JICA Expert Team	DOH	
4.2	To prepare the draft standard specifications on design of mountain highway tunnel		Actual																	JICA Expert Team	DOH	
4.3	To prepare the draft manual on cost estimation of mountain highway tunnel design		Plan																	JICA Expert Team	DOH	
4.4	To select the pilot study site for mountain highway tunnel design		Actual																	JICA Expert Team	DOH	
4.5	To implement the pilot study for mountain highway tunnel design		Plan																	JICA Expert Team	DOH	

Monitoring Plan	Year	2021				2022				2023				2024				Remarks	Issue	Solution
		I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
<b>Monitoring</b>																				
Joint Coordinating Committee	Plan																			
Technical Seminar	Actual																			
Submission of Monitoring Sheet	Plan																			
<b>Reports/Documents</b>																				
Reports	Plan																			

## A3-7. Project Design Matrix (PDM) Ver.6.0

### Project Design Matrix

**Project Title:** Project for Capacity Development on Tunnel Project Management in Thailand

Version 6.0

**Implementing Agency:** Department of Highways (DOH)

Dated: 18 December 2024

**Target Group:** DOH's Engineers

**Period of Project:** Jan,2021 - Feb, 2025 (4 Years and 2 Months)

**Project Site:** Motorways and national highways managed by DOH

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions	Achievement	Remarks
<b>Overall Goal</b>					
Mountain highway tunnel construction projects are formulated and managed by DOH as part of the national policy of highway and motorway construction.	<p>1. The list of planned mountain highway tunnel project is revised, and the listed projects are continuously promoted.</p> <p>2. At least 1 mountain highway tunnel projects proceed to the stage of investigation, design and/or construction.</p>	<p>- Revision of the list of short- and long-term project plans</p> <p>- Confirmation of the progress based on the list of short- and long-term project plans</p> <p>- Results of order and management of new mountain highway projects</p>			
<b>Project Purpose</b>					
A base of management of mountain highway tunnel projects is established in DOH.	<p>1. DOH assigns not less than 5 staff members who are in charge of tunnel project. (investigation and design)</p> <p>2. At least 2 mountain tunnel projects (investigation and design) are planned on the basis of standards and guidelines etc. prepared in the Project.</p>	<p>- DOH's structure regulation or organogram</p> <p>- Short- and long-term lists of project plans</p>	<p>- Thailand's orientation of road infrastructure construction, including inter-city highway construction plan, is not changed.</p> <p>- The project management methods that utilize manuals and references prepared in the Project are preserved.</p> <p>- Staff of the section established in the Project is maintained.</p>		
<b>Outputs</b>					
<p>1. DOH's human resources, institution and scope of works on tunnel project are established.</p> <p>2. DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.</p>	<p>1-1. Unit or section in charge of tunnel project in DOH is established.</p> <p>1-2. Enough human resources are assigned to the section.</p> <p>1-3. The responsibilities of the section are clarified.</p> <p>2-1. The management cycle of mountain highway tunnel projects is clarified in DOH.</p> <p>2-2. A program of mountain highway tunnel construction projects is prepared by DOH.</p> <p>2-3. A draft guideline for supervision and inspection of mountain highway tunnel construction and maintenance is prepared considering the project management cycle.</p>	<p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Reports of DOH's institutional structure</p> <p>- DOH's internal regulations etc.</p> <p>- Preparation of the project management cycle (draft)</p> <p>- Short-term list of project plans</p> <p>- Long-term list of project plans</p> <p>- Draft Guidelines for Supervision and Inspection of Road Tunnel Construction</p> <p>- Draft Guidelines for Design Change of Road Tunnel Projects</p> <p>- Guidelines for Operation and Inspection of Road Tunnels</p>			

	2-4. A report on environmental issues and measures of mountain highway tunnel projects is prepared.	- Report on environmental issues and measures of mountain highway tunnel project			
3. DOH's capacity of investigation on mountain highway tunnels is enhanced.	3-1. A draft manual on investigation of mountain highway tunnel is prepared by DOH. 3-2. The draft guidelines for determination of scope of work for investigation of mountain highway tunnel are prepared by DOH. 3-3. The draft guidelines for cost estimation of mountain highway tunnel investigation are prepared by DOH. 3-4. Mountain highway tunnel project(s) on investigation is/are managed in reference to the draft manuals and terms of reference for the pilot study.	- Investigation Manual of Road Tunnels (including Appendix)  - Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Civil Works and Tunnel Facilities) - Guidelines for Cost Estimation of Road Tunnel Projects for Investigation  - The pilot study (investigation of mountain highway tunnel)		- Staff of the section established in the Project is maintained.	
4. DOH's capacity of design on mountain highway tunnel is enhanced.	4-1. A draft manual on design of mountain highway tunnel is prepared by DOH.  4-2. The draft guidelines for determination of scope of work for design of mountain highway tunnel are prepared by DOH.  4-3. The draft guidelines for cost estimation of mountain highway tunnel are prepared by DOH.  4-4. Mountain highway tunnel project(s) on design is/are managed in reference to the draft manuals and terms of reference for the pilot study.	- Planning Manual of Road Tunnels - Design Manual of Road Tunnels (Civil Works) - Design Manual of Road Tunnels (Tunnel Facilities) - Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Civil Works) - Guidelines for Determination of Scope of Work for Investigation and Design for Road Tunnels (Tunnel Facilities) - Guidelines for Cost Estimation of Road Tunnel Projects for Design (Civil Works) - Guidelines for Cost Estimation of Road Tunnel Projects for Design (Tunnel Facilities) - Pilot study (design of mountain highway tunnel)			

Activities	Inputs		Pre-Conditions
	The Japanese Side	The Thai Side	
1-1. To review present organization structure and works in DOH 1-2. To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management	1. Dispatch of JICA Experts (1) Long-term Expert Chief Advisor (2) Short-term Experts 1). Team Leader / Mountain Highway Planning 1	1. Allocation of Counterpart Personnel 1) JCC Chairperson 2) JCC Deputy Chairperson 3) JCC Project Director 4) JCC Project Manager	1. Candidate sites for pilot studies exist. 2. Core C/P members of the Project are assigned.

<p>1-3. To identify works and responsibilities of the section in charge of mountain highway tunnel project management</p> <p>2-1. To identify management cycle for mountain highway tunnel</p> <p>2-2. To prepare programs of mountain highway tunnel construction as the management cycle</p> <p>2-3. To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle</p> <p>2-4. To study environmental issues and measures of mountain highway tunnel project</p> <p>3-1. To prepare the draft manual on investigation of mountain highway tunnel</p> <p>3-2. To prepare the draft standard specifications on investigation of mountain highway tunnel</p> <p>3-3. To prepare the draft manual on cost estimation of mountain highway tunnel investigation</p> <p>3-4. To select the pilot study site for mountain highway tunnel investigation</p> <p>3-5. To implement the pilot study for mountain highway tunnel investigation</p> <p>4-1. To prepare the draft manual on design of mountain highway tunnel</p> <p>4-2. To prepare the draft standard specifications on design of mountain highway tunnel</p> <p>4-3. To prepare the draft manual on cost estimation of mountain highway tunnel design</p> <p>4-4. To select the pilot study site for mountain highway tunnel design</p> <p>4-5. To implement the pilot study for mountain highway tunnel design</p>	<p>2). Deputy Team Leader/Mountain Highway Planning 2</p> <p>3). Tunnel Planning (Location and Structure)</p> <p>4). Tunnel Planning (Environmental and Social Consideration)</p> <p>5). Tunnel Design (Structure)</p> <p>6). Tunnel Design (Facilities)</p> <p>7). Cost Estimation (Investigation, Design, Construction/Civil)</p> <p>8). Cost Estimation (Investigation, Design, Construction/Facilities)</p> <p>9). Construction Plan / Safety Management</p> <p>10). Geological Investigation for Tunnel Planning and Design</p> <p>11). Contract Management (For Investigation and Design)</p> <p>12). Contract Management (For Construction)</p> <p>13). Training Planning</p> <p>14). Project Monitoring / Public Relations</p> <p>2. Training for Counterpart Personnel</p> <p>1) Training in Japan</p> <p>2) Seminars and Trainings in Thailand</p> <p>3. Cost for the daily activities of JICA Experts</p> <p>1) Local staffing</p> <p>2) Travel costs</p> <p>3) Consumables</p> <p>4) OA equipment</p> <p>5) Others (if necessary)</p> <p>4. Equipment</p> <p>1) UC-win/Road advanced</p> <p>2) Geomap 3D</p> <p>3) Monitor</p> <p>4) Laptop PC etc.</p> <p>5) AUTODESK Architecture, Engineering &amp; Construction Collection</p>	<p>5) JCC Committee</p> <p>6) JCC Members (WG1 leader)</p> <p>7) JCC Members (WG2 leader)</p> <p>8) JCC Members (WG3 leader)</p> <p>9) JCC Members (WG4 leader)</p> <p>10) JCC Members (WG5 leader)</p> <p>11) Secretary</p> <p>12) WG Members: 71 persons</p> <p>2. Office in the building of DOH for the Project with furniture and utilities such as telephone line, electricity, internet connection, etc.</p> <p>3. Running expenses necessary for the implementation of the Project including travel expenses and allowance for the participants of the training.</p> <p>4. Necessary budget for pilot study including investigation, design and tender document preparation.</p>	<div style="text-align: center;">  </div> <p style="text-align: center;"><b>&lt;Issues and countermeasures&gt;</b></p>
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# Plan of Operation Ver.6.0

Version 6.0  
Dated : 18 December 2024

Project Title: Project for Capacity Development on Tunnel Project Management in Thailand

Inputs	Expert in charge	Year	2021				2022				2023				2024				2025	Remarks	Monitoring		
			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			Issue	Solution	
<b>Expert</b>																							
Team Leader/Mountain Highway Planning 1	Takayuki TSUCHIDA	Plan																					
Deputy Team Leader/Mountain Highway Planning 2	Junichiro OGAWA	Actual																					
Tunnel Planning (Location and Structure)	Mitsugu NOMURA	Plan																					
Tunnel Planning (Environmental and Social Consideration)	Akira YAMASHITA	Actual																					
Tunnel Design (Structure)	Kenfaro SAWADA	Plan																					
Tunnel Design (Facilities)	Susumu MURASE	Actual																					
Cost Estimation (Investigation, Design, Construction/Call)	Hiroya TONEMOTO	Plan																					
Cost Estimation (Investigation, Design, Construction/Facilities)	Toshiyuki OKI/Hiroya HIRASE	Actual																					
Construction Plan / Safety Management	Teppi TOMITA	Plan																					
Geological Investigation for Tunnel Planning and Design	Jun MITSUO	Actual																					
Contract Management (For Investigation and Design)	Yasufumi ISEKI	Plan																					
Contract Management (For Construction)	Haruto TAKASE/Yuichi KUMAI	Actual																					
Training Planning	Hiromi IWAMASA	Plan																					
Project Monitoring/Public Relations	Misako YAGI	Actual																					
<b>Training in Japan</b>																							
<b>Equipment</b>																							
UC-winRoad advanced		Plan																					
Geomap 3D		Actual																					
Monitor		Plan																					
Laptop PC		Actual																					
AUTODESK Architecture, Engineering & Construction Collection		Plan																					
<b>Activities</b>																							
Sub-Activities	Expert in charge	Year	2021				2022				2023				2024				2025	Responsible Organization	Achievements	Issue & Countermeasures	
			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	Japan	THAI		
Output 1: DOH's human resources, institution and scope of works on tunnel project are established.																							
1.1	To review present organization structure and works in DOH	Plan																		JICA	Expert Team	DOH	
1.2	To identify the most suitable section in DOH and necessary personnel in charge of mountain highway tunnel project management	Actual																		JICA	Expert Team	DOH	
1.3	To identify works and responsibilities of the section in charge of mountain highway tunnel project management	Plan																		JICA	Expert Team	DOH	
Output 2: DOH's understanding on the management cycle of mountain highway tunnel projects is enhanced.																							
2.1	To identify management cycle for mountain highway tunnel	Plan																		JICA	Expert Team	DOH	
2.2	To prepare programs of mountain highway tunnel construction as the management cycle	Actual																		JICA	Expert Team	DOH	
2.3	To prepare the draft manual on supervision and inspection of mountain highway tunnel construction and maintenance considering the management cycle	Plan																		JICA	Expert Team	DOH	
2.4	To study environmental issues and measures of mountain highway tunnel project	Actual																		JICA	Expert Team	DOH	
Output 3: DOH's capacity of investigation on mountain highway tunnels is enhanced.																							
3.1	To prepare the draft manual on investigation of mountain highway tunnel	Plan																		JICA	Expert Team	DOH	
3.2	To prepare the draft standard specifications on investigation of mountain highway tunnel	Actual																		JICA	Expert Team	DOH	
3.3	To prepare the draft manual on cost estimation of mountain highway tunnel investigation	Plan																		JICA	Expert Team	DOH	
3.4	To select the pilot study site for mountain highway tunnel investigation	Actual																		JICA	Expert Team	DOH	
3.5	To implement the pilot study for mountain highway tunnel investigation	Plan																		JICA	Expert Team	DOH	
Output 4: DOH's capacity of design on mountain highway tunnel is enhanced.																							
4.1	To prepare the draft manual on design of mountain highway tunnel	Plan																		JICA	Expert Team	DOH	
4.2	To prepare the draft standard specifications on design of mountain highway tunnel	Actual																		JICA	Expert Team	DOH	
4.3	To prepare the draft manual on cost estimation of mountain highway tunnel design	Plan																		JICA	Expert Team	DOH	
4.4	To select the pilot study site for mountain highway tunnel design	Actual																		JICA	Expert Team	DOH	
4.5	To implement the pilot study for mountain highway tunnel design	Plan																		JICA	Expert Team	DOH	
<b>Monitoring Plan</b>		Year	2021				2022				2023				2024				2025	Remarks	Issue	Solution	
<b>Monitoring</b>			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I				
Joint Coordinating Committee	Plan	▲	1st JCC	2nd JCC	3rd JCC	4th JCC	1st JCC	2nd JCC	3rd JCC	4th JCC	1st JCC	2nd JCC	3rd JCC	4th JCC	1st JCC	2nd JCC	3rd JCC	4th JCC					
Technical Seminar	Actual	▲	1st Technical Seminar	2nd Technical Seminar	3rd Technical Seminar	4th Technical Seminar	1st Technical Seminar	2nd Technical Seminar	3rd Technical Seminar	4th Technical Seminar	1st Technical Seminar	2nd Technical Seminar	3rd Technical Seminar	4th Technical Seminar	1st Technical Seminar	2nd Technical Seminar	3rd Technical Seminar	4th Technical Seminar					
Submission of Monitoring Sheet	Plan	▲	1st-01	1st-02	1st-03	1st-04	1st-05	1st-06	1st-07	1st-08	1st-09	1st-10	1st-11	1st-12	1st-13	1st-14	1st-15	1st-16					
<b>Reports/Documents</b>																							
Reports	Plan	▲	Work Process	Project Report (1)	Project Report (2)	Project Report (3)	Project Report (4)	Project Report (5)	Project Report (6)	Project Report (7)	Project Report (8)	Project Report (9)	Project Report (10)	Project Report (11)	Project Report (12)	Project Report (13)	Project Report (14)	Project Report (15)					