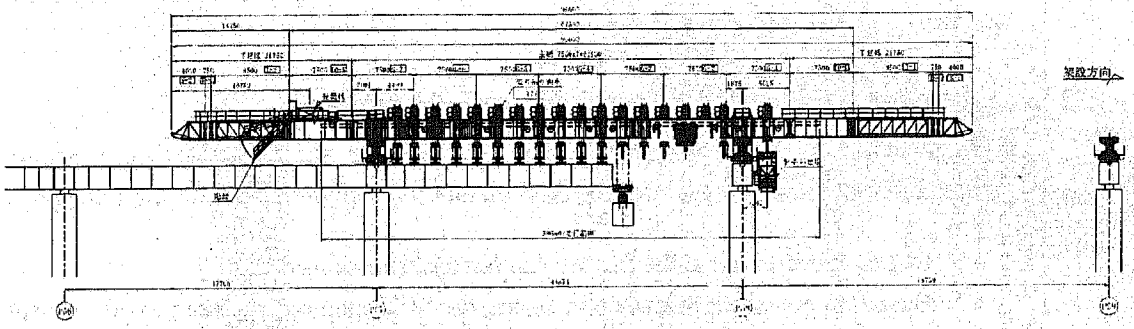
(4) ***Construction Equipment***

The construction equipment is shown on Appendix-4 "List of Construction Equipment". While most of them can be procured in Vietnam, some items which could not be procured locally will be imported from Japan.

1) Erection Girder for the Construction of the Approach Bridge

SBS erection method is applied for construction of the approach bridge. The erection girder for this method is shown in the figure below. The movable hanging equipment is not available in Vietnam, and hence, is planned to be procured from Japan.



Source: Study Team

Figure 2.6-8 Erection Girder

2) Pile-Driven Hammer

In Vietnam, procurement of pile-driven hammer for foundation with steel pipe sheet pipe (D=1200) and steel pile (D=800) is impossible. Therefore, the 15-ton hydraulic hammer will be procured from Japan while the base machine, barge (400 ton) and tugboat will be procured in Vietnam.

2.6.4. Construction Method

(1) ***General***

Generally, the construction method proposed in the F/S is acceptable. Some updated comments are introduced below:

(2) ***Road Works***

Soft ground treatment by sand pile with preloading method is adopted in the F/S. It is basically accepted but other options will be further studied in the detailed design stage i.e. vacuum consolidation method.

(3) ***Substructure of Approach Bridge***

In order to ensure the 30 months construction period, steel pile foundation method is deemed reliable to save time.

(4) ***Superstructure of Approach Bridge***

In order to reduce the construction period, and ensure bridge durability and easy maintenance in the future, PC-box girder is proposed in this Study. Consequently, either the SBS erection

method or movable scaffolding system (MSS) erection method may be adopted as discussed below.

(5) ***Substructure of the Main Bridge***

The water depth at the main bridge foundation site is exceeding 10 m. In such depth, the temporary cofferdam structure should be constructed with double sheet pile cofferdam method or a steel pipe well foundation. Considering construction safety, it is proposed to adopt the steel pipe well foundation method for the main piers' foundations.

(6) ***Superstructure of the Main Bridge***

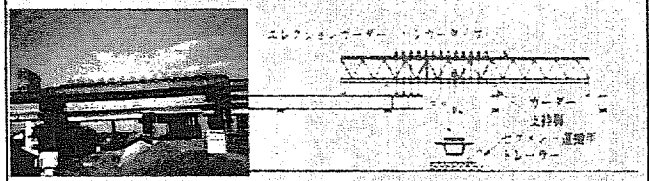
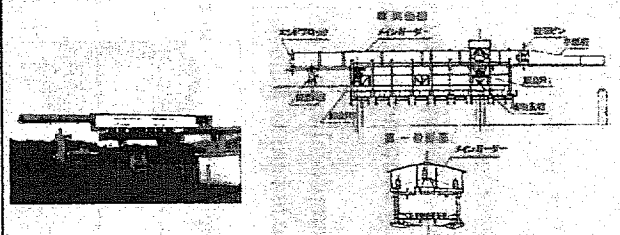
Adoption of balanced-cantilever erection method for the superstructure, as also mentioned in the F/S, is reasonable and desirable.

(7) ***Comparison of Erection Method for the Approach Bridge***

The table showing comparison between SBS Method and MSS Method is shown below. Results of comparison reveal that the SBS method is more preferable for the following reasons.

- Segment preserved at the factory can have well-managed quality.
- Based on actual performance in Japan, the MSS method is limited to 50-m spans. On the other hand, the project requirement is 60 m.
- Construction period is the shortest.

Table 2.6-6 Comparison between SBS and MSS

Item	1 : Span by span erection method	2 : Movable scalfolding erection method
Image drawing		
Outline	- Segment produced in Yard will be transported to the bridge construction site. Then using erection girder to erect span one by one. - After erect segment on the pier, installing the Erection girder assembler, lifting segment one by one by hanging equipment, place, set it on fixed location - Carrying out the tension after hanging segment of 1 span. - After 1 span erection, moving Erection girder forward, and repeating the same erection	- From the structure on main girder, hanging Scalfolding, no need to use the falsework from the ground, erecting span one by one. - Erecting block on pier by fixed falsework erection. - Assembling main girder, set up supporting members. - From falsework suspended by Main girder, erecting span one by one. - Demolishing hanging scalfolding, moving Main girder forward, and repeating the same erection.
Applicable span and girder span-height length	40m~50m (Max span length:66.3m) 1/17~1/20	30m~45m (Max span length:50.0m) 1/17~1/20
Standard schedule	Install & demolish erec.equip. 60 days Main girder erection 15 days ※Span length is estimated as 60m	Install & demolish erec.equip. 60 days Main girder erection 25 days/1span ※Span length is estimated as 60m
Advantageous	- Since Segment can parallel process at site and at the Yard, it can significantly reduce construction period. - After manufacturing, the Segment can be kept in Yard. Shrinkage and Creep Effects is small so prestress efficient is high. - Segment is preserved at the factory can have well-managed quality	- At Erection time, it can be secure in the space under girder, so there are unconstrained of girder height. - In Japan, it is covered with shed, so it does not depend on weather - The same work is repeated, so it is good for training worker.
Disadvantageous and attension	- It is not suitable cost if it is not large-scale construction. - Since there are no continuous reinforcing at segment joint, The careful design of the joint is required (limitation of stress). - It needs to check during transporting/lifting - Segment (or cast-in-situ) at pier must be erected in advance - Equipment with specified performance may required according to segment weight.	- Same with method in the left, cost for assembling/demolishing equipment is high, so it is only appropriate for large bridges (5000m2 or more) - It must be almost the same length of the spans - Block at pier must be erected in advance - Scalfolding/Supporting with vacant box need to assemble separately. - Japan has many projects with hollow slab bridge and and girder bridge by using this method, but a little of box girder.

Source: Study Team

(8) ***Drawings of Construction Methods***

The construction outline drawings of the abutment, substructure, and superstructure of the approach bridge are shown in Sheets C-01 to C-05. Meanwhile, drawings of the substructure and superstructure of the main bridge are shown in Sheets C-06 and C-07 in Appendix-1 "Drawings".

2.6.5. Temporary Facility Plan

(1) ***Construction Yard***

Temporary facilities are needed at the site that will be utilized while managing the construction activities, and as manufacture yard, stock yard and locations for concrete batching plants.

The necessary yard area based on similar construction and empirical area for SBS construction method is approximately 150,000 m^2 in total. The items included are as follows:

Table 2.6-7 Necessary Yard Areas for Span-By-Span (SBS) Method

Main Office, Motor Pool, Concrete Batching Plant,	18,000 m^2
Fabrication Yard for PC-Segment for SBS method	60,000 m^2
Steel Pipe Sheet Pile and Steel Pipe Pile Stock Yard	20,000 m^2
Rebar Fabrication and Stock yard, Formwork/Scaffolding Fabrication and Stock Yard	45,000 m^2
Wharf, Temporary Slope for Deck Barge	7,000 m^2
Total	150,000 m^2

Source: Study Team

(2) ***Temporary Construction Road and Temporary Bridge/Staging***

From Tan Vu intersection to the location planned to be filled in the future, cofferdam and temporary road by embankment method is necessary for the substructure's construction. Based on these structures, the temporary works for superstructure and substructure for the wharf and pier at the sea side are carried out.

2.6.6. Construction Period of 30 months

Construction schedule is updated to 32 months based on discussions between JICA and MOT. Updated construction schedule is shown in Appendix-10.

The following are construction schedules for 30 months duration studied before the JICA Follow-up Mission.

As shown in tables below, construction commences from July 2012 and ends in December 2014, covering a total of 30 months. This period is six months shorter than that in the F/S report.

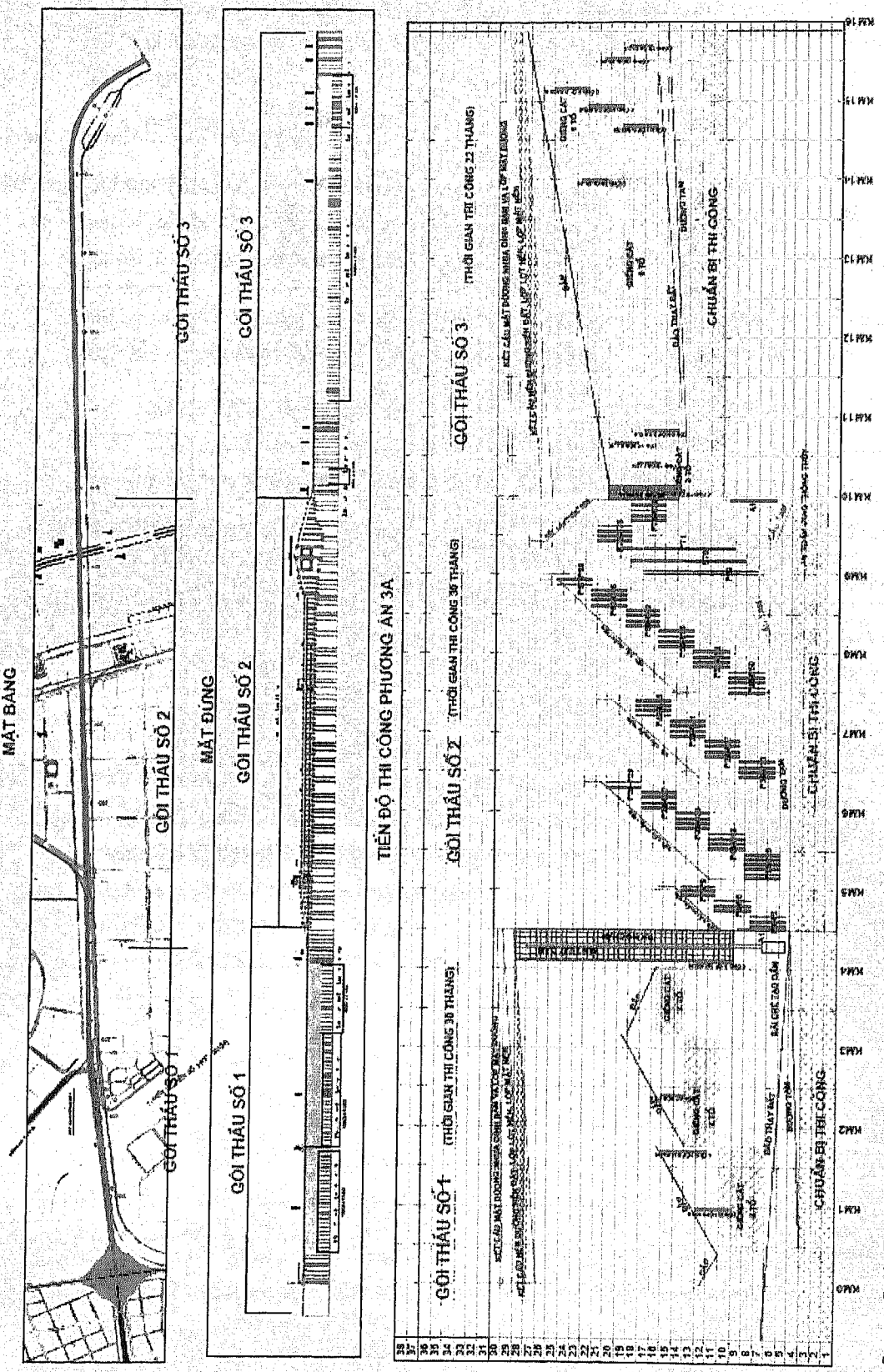
The main reason leading to a shorter construction time is the selection of the steel pile foundation method, steel pipe well foundation method and the SBS erection method for the approach bridges.

Table 2.6-8 Construction Schedule (Road Section)

This table is updated after discussion between JICA and MOT as presented in Appendix-10.

Table 2.6-9 Construction Schedule (Bridge Section, 32 months)

This table is updated after discussion between JICA and MOT as presented in Appendix-10.



Source: Study Team

Figure 2.6-9 Construction Schedule (30 Months)

2.8. Operation and Maintenance Plan

2.8.1. Review of the F/S

In the F/S, operation and maintenance (O&M) plan was examined. However, despite the specific designs and features of the proposed road and bridge, the descriptions seem more like an O&M manual rather than O&M plan that requires overall framework in terms of institutional, technical and financial aspects.

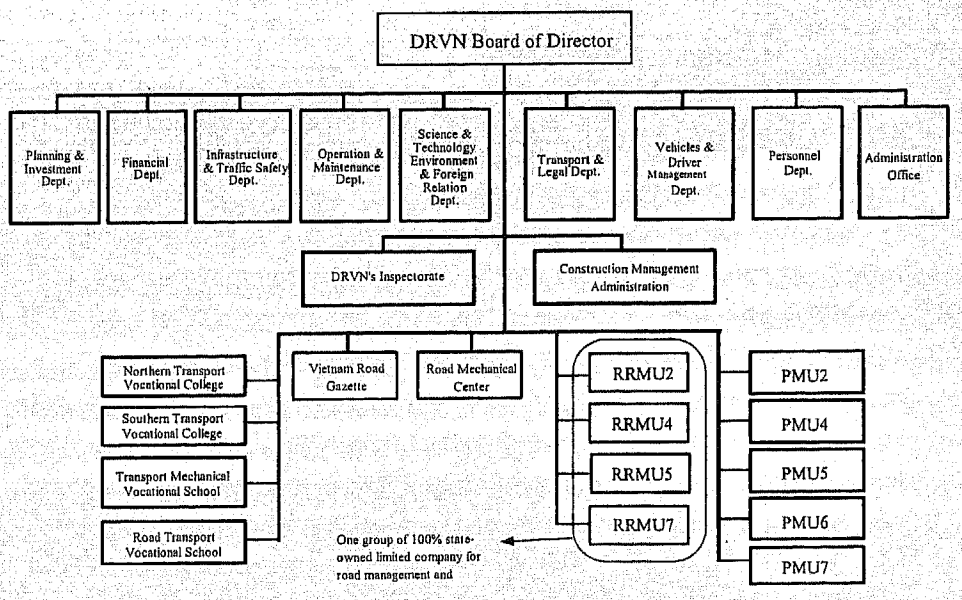
In this Study, in order to propose development of O&M framework for Tan Vu – Lach Huyen Highway, present conditions associated with O&M works in Vietnam are reviewed. Furthermore, the existing institutions in-charge of O&M, standards, and work systems are investigated.

2.8.2. Institutional Structure and Capacity for O&M

(1) Overview of the Present Condition of O&M Structure

The O&M organizations under MOT, include the Directorate of Roads for Vietnam[2] (DRVN) and Vietnam Expressway Corporation (VEC), which was established in accordance with development of expressway project. The O&M organizations for national highway and expressway in Vietnam confirmed in this Study are as discussed below.

National highways in Vietnam are under the control of DRVN, of which four Regional Road Management Units (RRMU Nos. 2, 4, 5 and 7) are in-charge of the road operation of national highways in each region. Figure 2.8-1 shows the organization chart of DRVN.



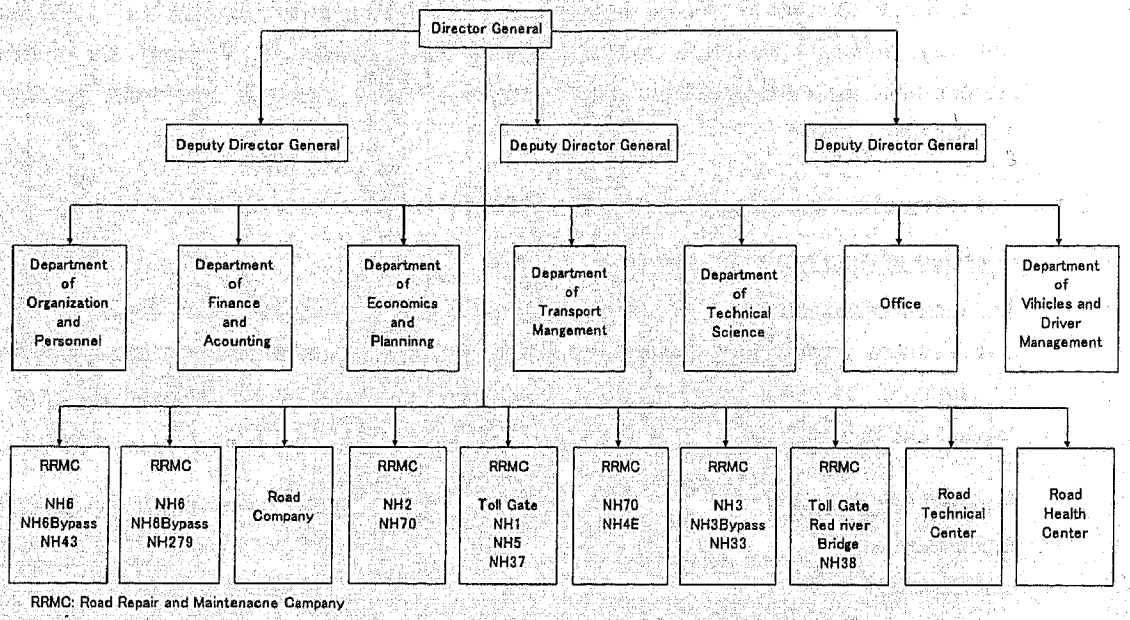
Source: Prepared based on Prime Minister Decision No: 107/2009/QĐ-TTg,
and Minutes of Discussions on Lach Huyen Port Infrastructure Construction Project between JICA and GOV on June 18, 2010.

Figure 2.8-1 Organization Chart of DRVN

[2] Vietnam Road Administration (VRA) was reformed to Directorate of Roads for Vietnam (DRVN) in May 2010.

RRMU2 (Regional Road management Unit No.2) is in charge of the O&M of the project road. Figure 2.8-2 shows organization chart of RRMU2.

Each RRMU, under its jurisdiction, has 9 to 14 Road Repair and Management Companies (RRMC), each of which has three to seven divisions to undertake actual road maintenance works.

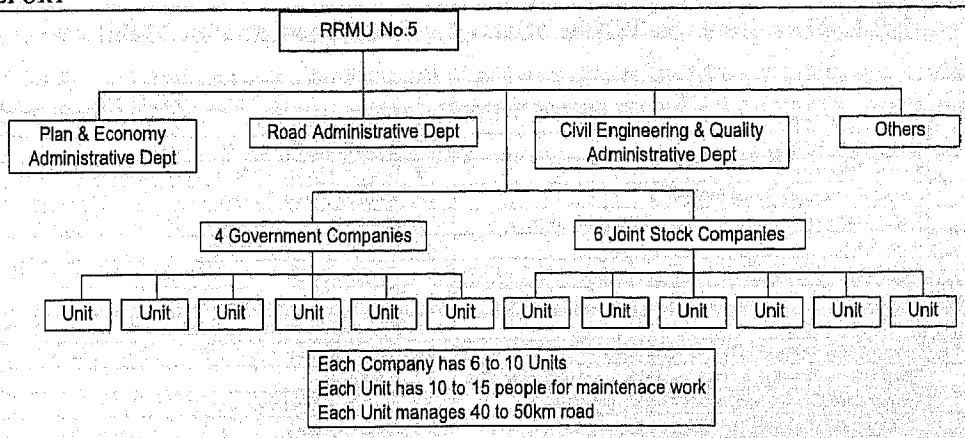


Source: JICA

Figure 2.8-2 Organization Chart of RRMU2

(2) Preceding Example of Highway O&M work in Vietnam

As an actual previous example of highway O&M, practices undertaken by RRMU No. 5 are worth being reviewed. Under RRMU No. 5, as shown in the organizational chart in Figure 2.8-3, are ten O&M companies consisting of four government companies, and six joint stock companies. Hai Van Tunnel Management and Development Company (HAMADECO), which operates the Hai Van Tunnel located north of Da Nang is one of the government companies. Under each company are six to ten maintenance units, which implement road maintenance and repair works. Each unit consists of 10 to 15 workers, and operates approximately 40 to 50 km of national highway.



Source: Study on Da Nang-Quang Ngai Expressway Project, JETRO 2008.

Figure 2.8-3 Organization Chart of RRMU No.5

Table 2.8-1 shows an example of the O&M work system undertaken by each unit under RRMU No. 5.

Table 2.8-1 Example of O&M Work System in RRMU No. 5

Work Item		Implentation	Frequency	Work Method	Notes
Daily Inspection		Each Unit	Daily	Patrol by Motorcycle, and report	Especially side-slope and bridges
Maintenance Work	Road Surface Clearing	Each Unit	Properly	All by hand	Only urban area uses vehicles
	Water Way Clearing	Each Unit	Properly	All by hand	
Repair Work	Road Surface Repair (small)	Each Unit	Properly	Potholes: By asphalt material	
				Cracks: By sealing	
	Road Surface Repair (major)	Cooperation with Several Units	-	Utilizing Geo-textile	Each company has an asphalt plant
	Side Slope Repair (small)	Unit	-	Simple repair such as soil removing	
	Side Slope Repair (major)	Construction Team	-	Slope protection, or Retaining wall	Implements after rainy season

Source: Study on Da Nang-Quang Ngai Expressway Project, JETRO 2008.

(3) Present Standards of O&M work in Vietnam

Regarding O&M in Vietnam, there are some works or technical standards adopted for national highways. O&M work on national highways by RRMU is implemented according to two types of standards, namely the "Technical Standards for Road Routine Maintenance", and "Road Maintenance Routine Standards". The former defines items of road inspections, procedures of pavement repair, and quantitative technical standards such as International Roughness Index (IRI). The latter provides frequency of road patrol and inspections on different types of roads, frequency of road or waterway cleaning, and quantitative standards of road repair. Tables 2.8-2 and 2.8-3 present the items in these two standards.

Also, during maintenance works, some traffic regulations such as lane regulation are implemented. The standards of such regulations are provided by the "Regulations of Road Signals".

Table 2.8-2 Items in Technical Standards for Road Routine Maintenance

Chapter	Title	Contents of Chapter 2 and 3	
1	General Regulation	2.1	File Document Work
2	Management Work	2.2	Road Safety Corridor Management
3	Routine Maintenance	2.3	Inspect, Monitor Technical Condition of the Facilities
4	Commissioning and Result Evaluation	2.4	Classify, Assess Technical Condition of the Facilities
5	Traffic Safety Guarantee in Road Routine Maintenance	2.5	Traffic Count
6	Work Safety	2.6	On-Duty for Traffic Safety
7	Environment Protection	2.7	Bridge Guard
Appendix	Title	2.8	Bridge and Road Registration
1	Equipment of Patrol	2.9	Statistics for Monitoring, Analysing the Causes of Traffic Accidents
2	Permissible Roughness of Road Pavement	3.1	Road Pavement
3	Classification Standard of Road and Bridge to make Repair Plan	3.2	Road Side
4	Vehicle Classification and Traffic Count Report Sample	3.3	Road Side Waterway / Ditch
5	Road Accident Report Sample	3.4	Road Surface
6	Amount of Required and Emulsified Asphalt for 2 layers	3.5	Retaining Wall
7	Standard Check-up for Routine Maintenance	3.6	Spillway and Subway / Duct
8	Check-up Report Sample for Road Routine Maintenance	3.7	Tunnel
9	Sample Report of Remaining Issues for Routine Maintenance	3.8	Road to Ferry
		3.9	Emergency Road
		3.10	Drainage Pipe / Culvert
		3.11	Bridge
		3.12	Facilities for Road Management Work
		3.13	Road Signals
		3.14	Routine Management of Trees

Source: Technical Standards for Road Routine Maintenance, VRA

Table 2.8-3 Items in Road Maintenance Routine Standards

Chapter	Title
1	Routine Management, Maintenance of Asphalt Concrete Road Surface
2	Routine Management, Maintenance of Cement Concrete Road Surface
3	Routine Management, Maintenance of Asphalt Crush Rock
4	Routine Management, Maintenance of Crush Rock Aggregate
5	Routine Management, Maintenance of Soil Road
6	Routine Management, Maintenance of Class I and Class II Road with 4 Motorized Traffic Lanes
7	Routine Management, Maintenance of Roads and Bridges with Length 25m ≤ L ≤ 300m

Source: Road Maintenance Routine Standards, VRA

In terms of the work system in RRMU, small and medium works are implemented by each unit, while major works are initiated through the cooperation of some units under the same company. Each company has one asphalt plant and utilizes it for major pavement repairs. Moreover, each company has a construction team that works on major disaster repairs. Materials for construction are obtained basically within the territory of each unit.

(4) State Funding Procedures for O&M of National Highway

Article 48 of the new Road Law No.23/2008/QH12 stipulates that road maintenance fund should be obtained from the: (i) state budget; (ii) road use's incomes (iii) and other regulated incomes.

In general, income sources related to road use could be diversified into toll collection, additional collection on vehicle verification, issuance of driving license, over-sized and over-

loaded permission, roadside advertisement, and public sale of registration number by vehicle owners. The international donor community has recommended on establishing a fund to secure a sufficient budget source for road system maintenance. However, fund mobilization from other sources has not been promoted, resulting in heavy reliance on the state budget.

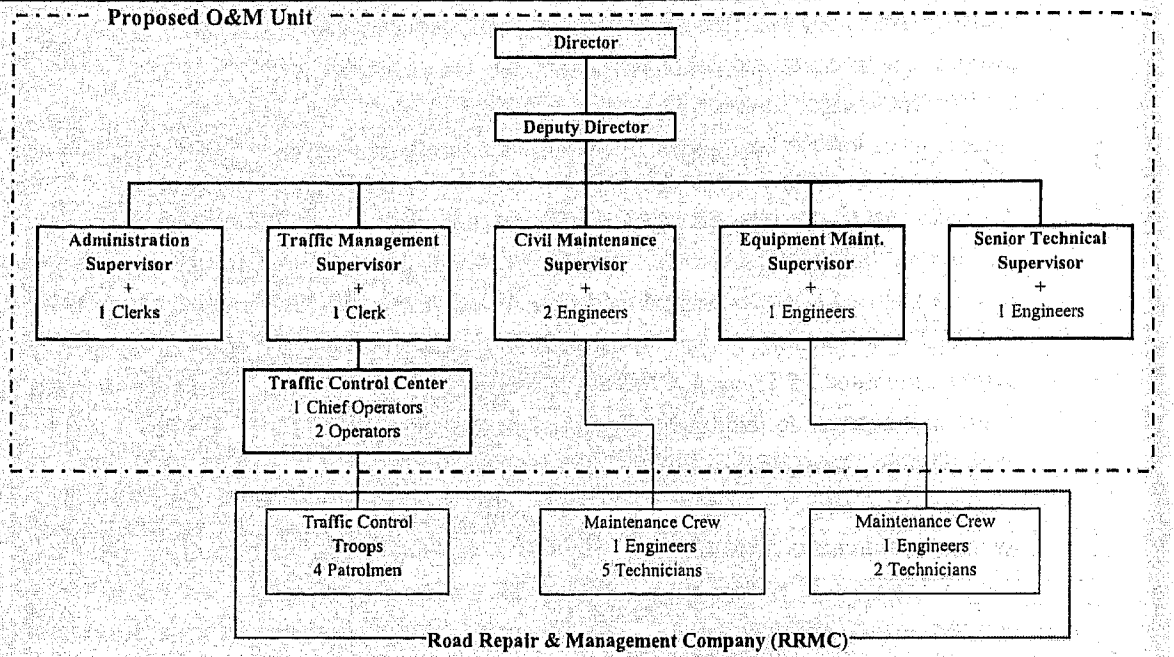
Annually, MOT prepares an expense program and coordinates with MOF for fund allocation for national highway maintenance. Subsequently, MOT hands over the approved expenditure program (agreed between both ministries) to VRA (currently DRVN). VRA allocates the funds to RRMUs and authorizes these to localities of national highway management. RRMU and the local Department of Transport (DOT) then organize bidding and allocate bidding packages of road maintenance to bidding winners. Road maintenance companies would obtain their expenditures from VRA's branches or local treasury branches. A previous study (New National Highway No.3 and Regional Road Network Construction Project) indicated that the average maintenance costs spent by RRMU 2 on the existing National Highway No.3 range from VND 10 – 20 million per km for regular works and VND 200 – 300 million per km for periodic works. However, such amounts are minimal and requirements are at least three times more. Recent reports of MOT and VRA stated that the allocated budget only satisfied 50% of the total required amount for road management and maintenance.

2.8.3. Operation and Maintenance Plan

(1) O&M Plan

As overviewed for the O&M practices of RRMU No.5, for the Tan Vu-Lach Huyen Highway, which will extend to some 16 km, one unit of O&M should be dedicated from the existing unit. Alternatively, a new company should be established under RRMU No. 2, which will be responsible for carrying out O&M of the new highway. As RRMC under the RRMU No. 2 undertakes the maintenance works for National Highway No. 3, the dedicated O&M unit under RRMU No.2 should play the major role in the O&M activities. Such organization/unit should have suitable locations, structures, and number of staff considering conditions for O&M such as road and bridge structure, and traffic characteristics. With the establishment of O&M organization/unit, appropriate facilities and equipments such as office building, vehicles, systems, and materials and equipments for maintenance works are indispensable.

It is proposed to assign an O&M unit from RRMU No.2 as indicated in the following organization structure.



Source: Study Team

Figure 2.8-4 Proposed Structure of O&M Unit

The proposed O&M unit will be duly responsible for the following O&M activities.

Traffic management: Traffic surveillance and control inclusive of patrols, emergency site management and breakdown assistance services, vehicle regulation, and disaster management.

Routine maintenance: Inspection, cleaning, traffic accident recovery works, and traffic regulation.

Repair works: Pavement renovation, and repair of bridges and structures.

Rehabilitation: Pavement rehabilitation, reinforcement / improvement of bridges and structures, restoration of embankment settlement, slope protection, and rehabilitation of traffic safety and control facilities.

According to the required activities, DRVN shall need to divert or recruit not only five supervisors, four engineers and two clerks, but also 13 staff comprising of four patrolmen, two engineers and seven technicians from RRMC to be mobilized for O&M works.

(2) Cost Estimate for O&M Activities

The previous study on New National Highway No.3 and Regional Road Network Construction Project indicates that the unit costs for the routine maintenance, repair works and rehabilitation of the highway in Vietnam can be assumed at 40% of those in Japan. Thus, the annual cost requirement for O&M activities are estimated as annual recurrent expenditures for VRA as presented below.

Table 2.8-4 Annual Operating Cost for O&M Unit

Subgroup	Cost Item	Position	Unit Cost (Mil.VND/annum)	Qty.	Total (Mil.VND/annum)
O&M Unit	Personnel	Director	180	1	180
		Deputy Director	160	1	160
		Supervisor	125	5	625
		Clerk	70	2	140
		Engineer	100	4	400
	Supply, Utility, Housing, Machinery, etc.		12	LS	12
Traffic Control Center	Personnel	Chief Operator	80	1	80
		Operator	45	2	90
		Patrolman	47	4	188
	Supply, Utility, Housing, Machinery, etc.		6	LS	6
	Miscelaneous (communication, fuels, sundries etc.) (10% of Personnel Cost)				186
Maintenance Crew	Personnel	Engineer	95	2	190
		Technician	51	7	357
				Total	2,614

Source: JICA Study 2010 (unit cost is adapted from New National Highway No.3 and Regional Road Network Construction Project)

Table 2.8-5 Annual Cost for Routine / Repair Works

Item	Unit Cost (Mil.VND/km/annum	Length (km)	Total (Mil.VND/annum)
Cleaning	233	10.44	2,433
Earthwork Maintenance	536	10.44	5,596
Bridge Maintenance	453	5.44	2,464
Lighting	190	15.88	3,017
		Subtotal	13,510
	Indirect Cost (10% of the above)		1,351
		Total	14,861

Source: JICA Study 2010 (unit cost is adapted and adjusted from New National Highway No.3 and Regional Road Network Construction Project, which initially applied JH empirical data.)

The total recurrent costs associated with O&M works are thus estimated at some VND 17,500 million per annum, which is approximately half of the estimate in the F/S (VND 35,000 million per annum at 2010 price). In addition to the above, indicative costs for major maintenance work that will be required for every 5-10 years are estimated as follows.

Table 2.8-6 Cost Estimate for Major Rehabilitation

Item	Qty.	Total (Mil.VND)
Replacement of expansion joints	LS	9,702
Replacement of asphalt pavement	LS	18,934
Replacement of waterproofing work	LS	36,111
	Total	64,747

Source: JICA Study 2010

As part of major rehabilitation works according to the design specifications of the road and bridge sections, the expansion joints on the bridge part should be replaced every 5-10 years after its opening. Similarly, asphalt pavement and associated structures for waterproofing should be replaced every 5-10 years periodically. The estimated costs are VND 64,747 million in total, which is slightly more than half of those in the F/S (VND 115,500 million at 2010 price including large area road resurfacing and major road maintenance).

(3) Further Study and Recommendation

Framework of O&M works for Tan Vu-Lach Huyen Highway has been proposed under the study. Necessary recurrent expenditures and budget requirement for major rehabilitation works are preliminarily estimated as well. However, initial investment cost for facilities, procurement of equipment and materials are not considered in this Study.

Given the situation that O&M budget for national roads usually satisfies only 50% of those requiring O&M, obtaining sufficient budget for such activities would be a challenging role for DRVN/RRMU. In addition, since the highway will open as a toll-free road, O&M budget cannot be supported by toll revenues but through advertising and other tax revenues. Therefore, O&M works should be conducted in a cost-efficient and streamlined manner.

Since the project facilities are totally additional road and bridge under the jurisdiction of RRMU No. 2, its existing resources that should be allocated for O&M activities could be an additional budgetary burden. As a responsible organization, RRMU No. 2 could either divert its existing resources such as human resources, equipment and materials into O&M activities of Tan Vu-Lach Huyen Highway, or establish an independent management unit as proposed in this section, partly utilizing the existing resources. Based on this perception, the following arrangements are recommended:

1) RRMU should scrutinize its own resources to assess what are necessary and what are not in consultation with DRVN and MOT.

2) Based on the above assessment, it will be necessary to assess the required procurement items and its associated costs including building, office facilities, vehicles, equipment for routine/repair works, spare parts and traffic control and safety during the detailed design stage.

3) In the detailed design stage, annual recurrent costs for O&M activities and organizational framework should be updated and finalized based on the final specifications for the road and bridge structures.