BASIC DESIGN STUDY REPORT
ON
THE PROJECT
FOR
IMPROVING THE PUBLIC TRANSPORTATION
IN
THE KINGDOM OF NEPAL

AUGUST 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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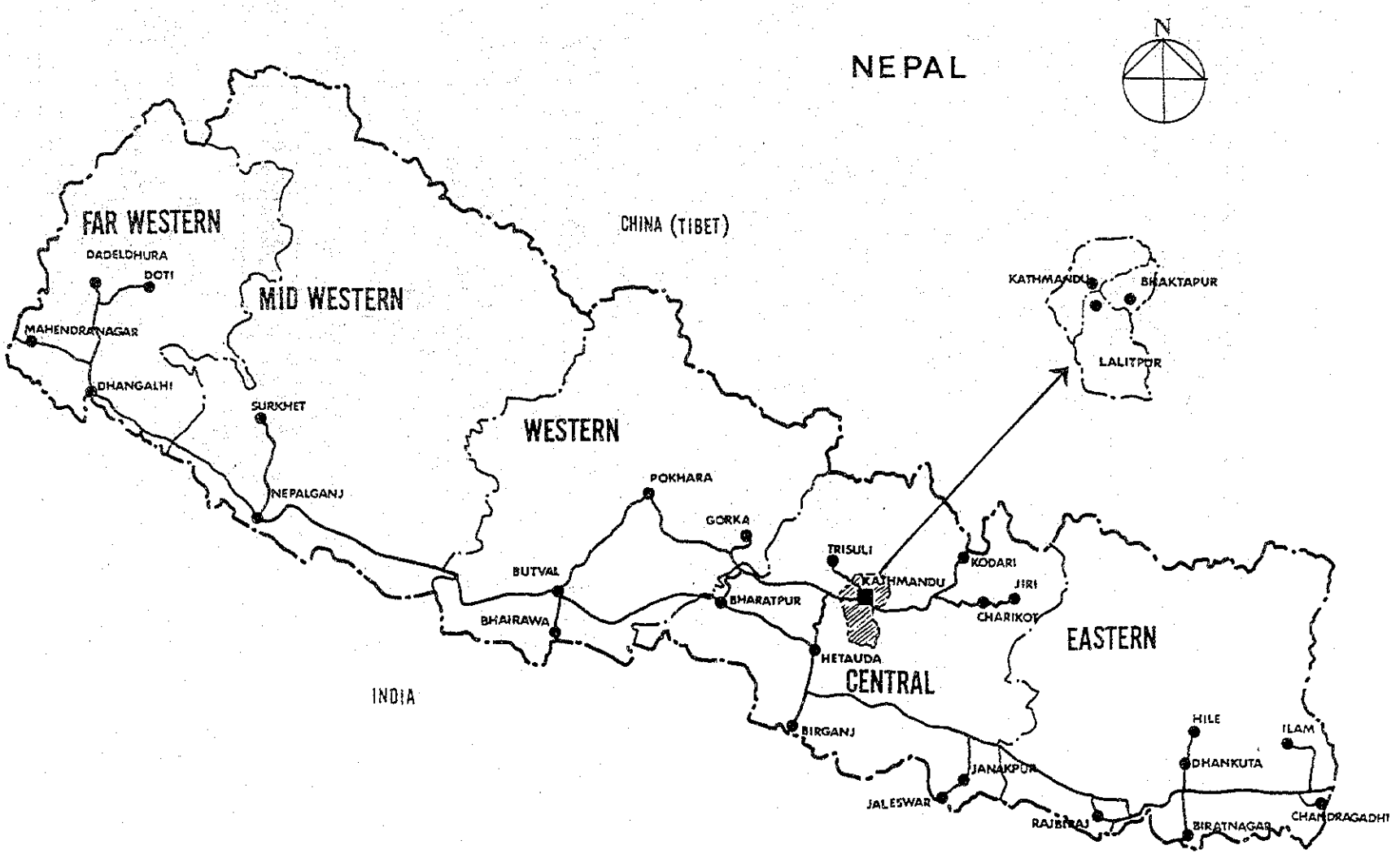
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BHAIRAWA
INDIA
TRISULI
KATHMANDU
BHARATPUR
HETAUDA
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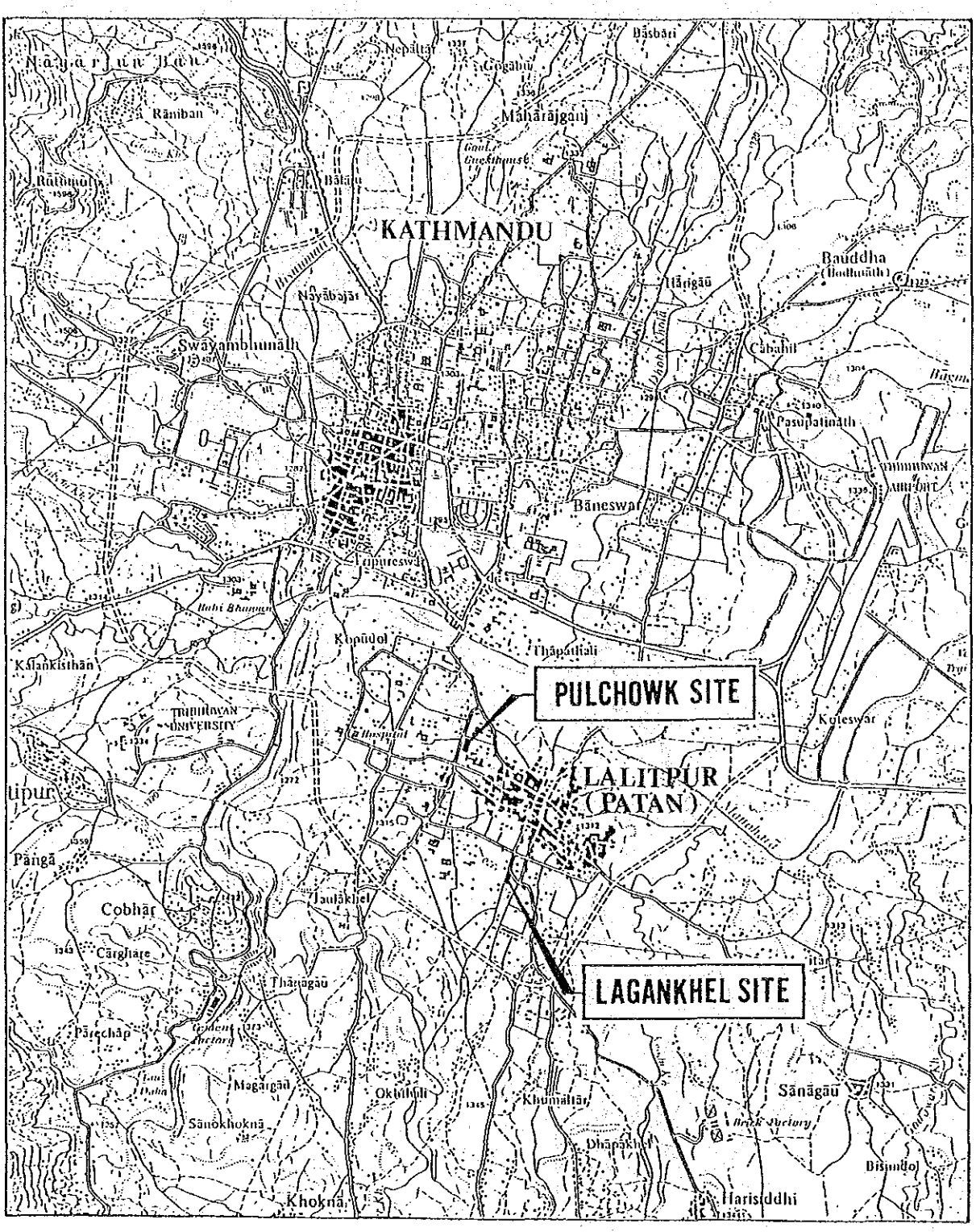
BHAKTAPUR
LALITPUR
BIRGANJ
JANAKPUR
JALESWAR
RAJBIRAJ
HILE
ILAM
DHANKUTA
BIRATNAGAR
CHANDRAGADHI

LOCATION MAP



PREFACE

In response to the request of His Majesty's Government of Nepal, the Government of Japan has decided to conduct a basic design study on the Project for Improving the Public Transportation and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Nepal a study team headed by Mr. Takashi Eizuka, Chief of the Service Section, the Vehicle Service Division, the Land Transportation Department, the Ministry of Transport from March 29 to April 15, 1988.

The team had discussions on the Project with the officials concerned of His Majesty's Government of Nepal and conducted a field survey in the Kathmandu area. After the team returned to Japan, further studies were made, a draft report was prepared and a mission to explain and discuss it was dispatched to Nepal. As a result, the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of His Majesty's Government of Nepal for their close cooperation extended to the team.

August, 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

List of Abbreviations

OHP : Overhead Projector

NTC : Nepal Transport Corporation

WSSC : Water Supply & Sewage Corporation

UNDP : United Nations Development Programme

OH : Overhaul

OJT : On-the-Job Training

LPG : Liquefied Petroleum Gas

SUMMARY

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The land transportation in the Kingdom of Nepal depends greatly on buses. Today, buses are the principal means of transportation for the people living in Kathmandu.

A public corporation, Sajha Yatayat, was established in 1962 to commence public operated bus transportation as part of the arrangement of a Kathmandu municipality transportation network. Sajha was provided with 82 buses and a repair shop as grant aid from the Government of Japan in 1979 and 1984. Sajha presently owns 102 buses and services 14 city routes in the Kathmandu municipality and 6 long routes making it the largest bus corporation in the Kingdom of Nepal.

However, since much of the road condition is severe, the establishment of good repair facilities to repair overtaxed buses is an urgent matter for Sajha. In order to overcome these conditions, His Majesty's Government of Nepal set up a Project to repair non-operating buses and improve the repair shop, and requested grant aid of the Government of Japan.

In response to this request, the Government of Japan provided spare parts, tools and 20 new buses under the Grant Aid Program of 1987. Also a basic design study was decided to excute a bus repair shop equipped with necessary tools and machines, and the Japan International Cooperation Agency (JICA) sent a basic design study team headed by Mr. Takashi EIZUKA, Chief of the Service Section, the Vehicle Service Division, the Land Transportation Department, the Ministry of Transport to the Kingdom of Nepal for 18 days from March 29, 1988 to April 15, 1988.

The study team met with the authorities concerned in His Majesty's Government of Nepal to discuss the contents of the request, surveyed proposed construction site as well as conditions related to construction, and collected necessary information and data. After returning to Japan, the study team analyzed and studied the survey results as well as the collected information, and prepared a basic design consisting of an execution plan, tools and machine selection, a water supply plan and a maintenance plan. Also a draft final report of the basic design study was prepared.

JICA sent the study team to the Kingdom of Nepal from July 17, 1988 to July 24, 1988 to submit and explain the draft final report of the basic design study.

In this plan, a heavy repair shop, an administration office, a deep tube well and a parking lot are constructed adjacent to the existing repair shop at the Pulchowk site in Lalitpur (Patan) City for establishing the central bus repair facility and traffic control operation of Sajha. Also, a tyre retreading shop, a body shop and a parking lot are constructed at the Lagankhel site in Lalitpur, 1.5 km away from the Pulchowk site for repairing the body of buses and for providing a parking lot for repaired buses.

The outline of the project plan is as follows:

(1) Equipment and facility

Site	Equipment and Facility	Main Functions
Pulchowk	Heavy repair shop	Overhaul of main parts such as power plant and transmission
	Administration office	Office work for administration, accounting, traffic control and procurement, as well as training for bus repair
	Parking lot	Parking buses for repair and some repaired buses
	Deep tube well	Pumping and filtering ground water
Lagankhel	Body shop	Body metal work and painting
	Tyre retreading shop	Tyre retreading
	Parking lot	Parking repaired buses

(2) Tools and machines

Site	Facility	Main tools and Machines
Pulchowk	Heavy repair shop	Crankshaft grinder, cylinder boring machine, portal crane, cylinder honing machine, twin post lift, air compressor, brake drum lathe, others
	Administration office	Copy machine, OHP, others (training equipment)
	Parking lot	Bus washing machine, fuel supply stand, others
Lagankhel	Body shop	Arc welder, others

In order to implement this project, it is estimated that a contribution amounting to about ¥13 million is necessary from the Nepalese side.

For the implementation of this project, 5 months after execution of Exchange of Notes between His Majesty's Government of Nepal and the Government of Japan is required for the execution of consultant contract, preparation of detailed design and tender documents, tender, evaluation of tender, and execution of contract. Twelve months is necessary for a construction period.

The executing agency for this project for His Majesty's Government of Nepal is Sajha which is under the jurisdiction of the Ministry of Works and Transport. Since Sajha Yatayat is operated as an independent agency, it will conduct all operation and maintenance during construction and after completion.

The implementation of this project is expected to enlarge the bus repair capacity, improve bus operation and to contribute greatly to sound management of Sajha Yatayat. Also, this will improve safety, reliability and sound operation of buses as well as provide better bus service for the people of Nepal.

This Project is most suitable to implement under the Grant Aid Program of Japan, and an early execution of this Project is desired.

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CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

The main passenger transportation in the Kingdom of Nepal is by bus and, with the exception of air transportation between distant cities, it is the only scheduled transportation and provides an important service. In 1962, Sajha Yatayat (hereinafter referred as "Sajha") was established to provide public operated bus transportation as part of the organization of the Kathmandu municipality transportation system.

The Government of Japan provided grant aid to Sajha in 1979 and 1984, and is still providing technical assistance such as acceptance of trainees and dispatch of experts. This Project has served to position Sajha as an indispensable transportation agency for the daily life of the people, and its blue coloured buses are very popular under the name of "blue bus".

Today, it is an urgent matter for Sajha to improve operation and maintenance of buses in order to maintain a good bus operation service. In view of such urgent necessity, His Majesty's Government of Nepal prepared a "Public Transportation Improvement Project" to upgrade its bus repair system, and requested a grant aid of the Government of Japan for implementing this Project.

In response to this request the Government of Japan provided bus spare parts and tools in the Grant Aid Program of 1987, and decided to conduct a basic design study for enlarging repair facilities. JICA sent a basic design study team for the survey of improving public transportation in the Kingdom of Nepal headed by Mr. Takashi EIZUKA, Chief of the Service Section, the Vehicle Service Division, the Land Transport Engineering Department, the Ministry of Transportation, to the Kingdom of Nepal.

The study team conducted a site survey for a period of 18 days from March 29, 1988 to April 15, 1988 to confirm the contents and the necessity of tools and machines as well as the proposed construction site. During this survey, discussions were held with the related agencies of His Majesty's Government of Nepal, and the agreement on major items was recorded in a Minutes of discussions signed by Mr. Takashi EIZUKA leader of the study team and Mr. G.P. RANJITKAR, Joint Secretary of the Ministry of Works and Transport representing His Majesty's Government of Nepal on April 7, 1988.

After returning to Japan, the study team evaluated the suitability of the Project based on its site survey, and prepared a basic design consisting of an execution plan, tools and machine selection, a water supply plan, a maintenance plan, and a project cost estimate.

JICA prepared its "Draft Final Report of Basic Design Study" and sent a study team to the Kingdom of Nepal for 8 days from July 17, 1988 to July 24, 1988 to explain and to discuss the contents of the report with the representatives of His Majesty's Government of Nepal. The agreement on major items between both parties was recorded in a Minutes of Discussions signed by Mr. Hideo ONO, Resident Representative of JICA in Nepal and Mr. G. P. RANJITKAR, Joint Secretary of the Ministry of Works and Transport on September 7, 1988. The members and itinerary of the study team, a list of authorities concerned, and the Minutes of Discussions are attached as reference in the appendix.
This report presents the results of the basic design study.

CHAPTER 2 BACKGROUND

CHAPTER 2 BACKGROUND

2.1 Public Transportation in the Kingdom of Nepal

2.1.1 General Transportation Conditions

The Kingdom of Nepal is a land locked country, located on the southern slopes of the Himalaya mountain range extending 880 km, east to west (longitude 80°00'E. - 88°15'E.), and 240 km, north to south (latitude 26°15'N. - 30°30'N.), with an estimated population of 15,022,000 in 1981.

Since the Kingdom of Nepal is a mountainous country with no river suited for transportation, all transportation is by road, air, ropeway or railway. Furthermore, the country's mountainous terrain makes the development of these transportation means difficult as well as expensive.

The first modern transportation systems introduced into the Kingdom of Nepal were the ropeway constructed between Dhorsing - Mata Tirtha in 1922 and the railway constructed between Raxaul - Amlekhgunj in 1928. However, these systems only serve a small part of the country. From 1950, His Majesty's Government of Nepal started constructing roads and bridges to establish a network connecting isolated villages in the Kingdom of Nepal. Today, although the road network leaves much to be desired, it is now possible to travel to different parts of the country without having to pass through neighbor nations.

Table 1 Transportation Systems in Nepal (1985/1986)

System	Air	Railway	Ropeway	Road
Distance (km)	3,383	53	43	5,925

His Majesty's Government of Nepal is actively developing air transportation in line with its promotion of tourist business, especially the development of air routes from Kathmandu to distant and high altitude parts of the country. However, the daily transportation means of the common people are roads with the exception of railway servicing a limited area.

The total road extension developed up to 1985/1986 is 5,925 km classified into highways, feeders, district roads and city roads, also 2,724 km or 46% of these roads are paved (Table 2). Highways near cities or on flat land are widely paved, but those in mountainous areas, as well as feeders and district roads mostly remain unpaved. Furthermore, since much of the paved roads in mountainous areas are damaged severely by floods and landslides, many districts should be considered as unpaved.

Table 2 Breakdown of Road Extension (1985)

Unit: km

Classification	Paved Road	General Road	Unpaved Road	Total
Highway	1,704 (86.9%)	95 (4.9%)	161 (8.2%)	1,960 (100%)
Feeder	581 (31.0%)	335 (17.9%)	959 (51.1%)	1,875 (100%)
District road	63 (5.1%)	275 (22.5%)	886 (72.4%)	1,224 (100%)
City road	376 (43.4%)	213 (24.6%)	277 (32.0%)	866 (100%)
Total	2,724 (46.0%)	918 (15.5%)	2,283 (38.5%)	5,925 (100%)

2.1.2 Bus Transportation

(1) Long route

Although His Majesty's Government of Nepal is aggressively promoting air routes, the volume of air transportation is limited, and since the rates are high, bus will be the only scheduled transportation for most people in Nepal, and will continue to play an important role in the transportation of the country. Today, many bus routes connect Kathmandu and different local cities, and other routes connect local cities. However, these routes are serviced by small private parties (small firms or individuals), whose limited financial resources as well as strict foreign exchange restriction make it difficult for them to purchase new buses. Therefore, the buses in operation are all old buses worn by severe road conditions. Under such condition many bus routes are terminated or temporarily closed, so the actual bus operation status is not clear.

The main long routes originating from Kathmandu are shown in Table 3. The Pokhara route, which is the main tourist route, provides the most service with 3 - 6 buses operating daily, including express and night services. Since buses must drive over mountain passes to enter or leave Kathmandu valley, drivers are required to posses bus repair knowledge and skill, and buses must carry spare tyres, oil and tools.

Table 3 Bus Schedule at Kathmandu

Destination	Distance (km)	Travelling time (hours)
Kodari	80	6:00
Trishuli	70	4:00
Pokhara	202	7:00
Birganj	276	8:00
Bhairahawa	288	8:00
Biratnagar	530	12:00
Janakpur	380	10:00
Kankadbhitta	596	14:00 - 15:00
Gurkha	142	6:00
Jiri	190	9:00
Nepalganj	480	12:00

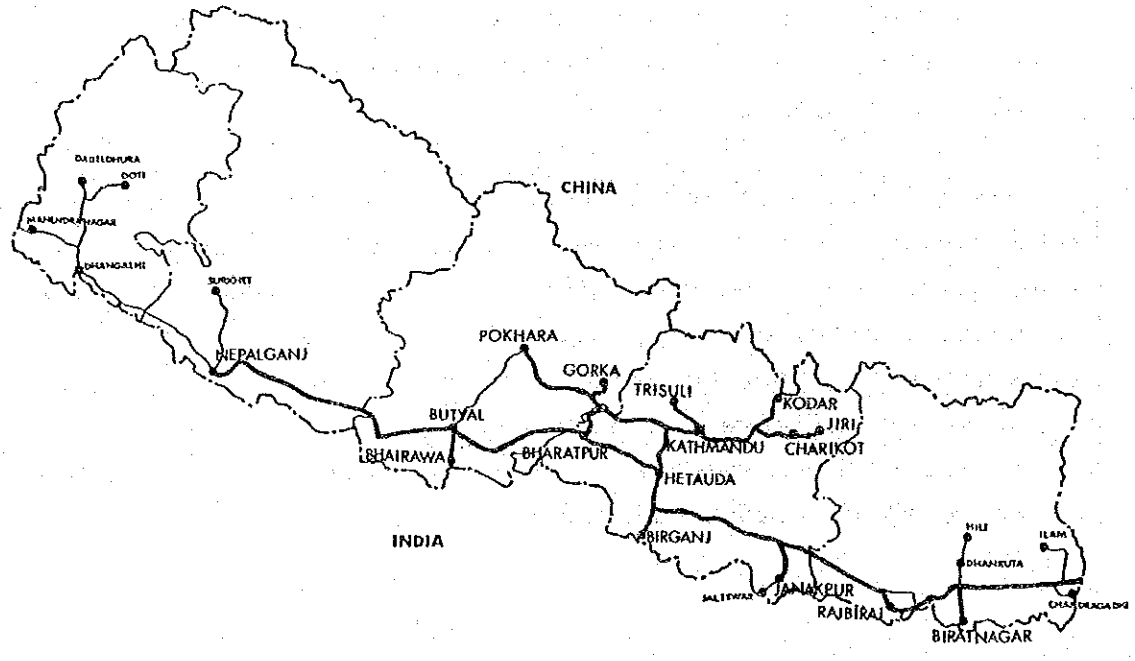


Fig. 1 Bus Route Map (Long Route)

(2) City Route

In the Kingdom of Nepal, the transportation means in the city are: bus trolley bus, taxi, tempo (tricycle), rickshaw and tanga. However, since the only city with population exceeding 100 thousand is the Kathmandu Metropolitan[1/], other cities are not of a size to merit the introduction of modern transportation means, and rely mainly on rickshaw and tanga.

Since bus transportation is cheap and able to transport a large number of people, it is the principal transportation means for the general public in the Kathmandu Metropolitan. Since the roads are narrow, almost all buses are a minibus type. The passenger transportation cars in the Bagmati zone[2/] are shown in Table 4, but it should be noted that within the private car classification, a large number of non-registered commercial cars (illegal commercial cars) is included.

Table 4 Number of Passenger Transportation Cars in Bagmati Zone (as of March 5, 1988)

Classification	Bus	Passenger Car	Tempo	Rickshaw
Government	112	583	43	-
Public Agency	97	663	30	-
Foreign Diplomat	10	495	16	-
Private	596	6,160	83	-
Commercial	1,105	1,767	910	470
Total	1,920	9,668	1,082	470

1/ Kathmandu Metropolitan: Includes the 3 cities of Kathmandu, Lalitpur, Bhakatapur.

2/ Bagmati zone: Administrative zone including Kathmandu valley.

Some say that the daily number of people utilizing buses is 200,000; however, since the buses are filled to over 100% of passenger capacity in daytime and to over 200% during morning/evening rush hours, it is quite evident that there is a shortage of operating buses.
Furthermore, owing to the increase of population in the Kathmandu Metropolitan, the requirement for bus transportation is expected to increase (Table 5 and Fig. 2). On the other hand, in the case of private buses, operated mostly by individuals or small firms, there is no coordination or control over bus schedule, route and number of buses, so bus operation is not efficient at all.

Table 5 Population in Kathmandu Metropolitan

	1961	1971	1981
Kathmandu	121,019	150,402	235,160
Lalitpur	47,731	59,049	93,544
Bhaktapur	35,355	45,100	79,875

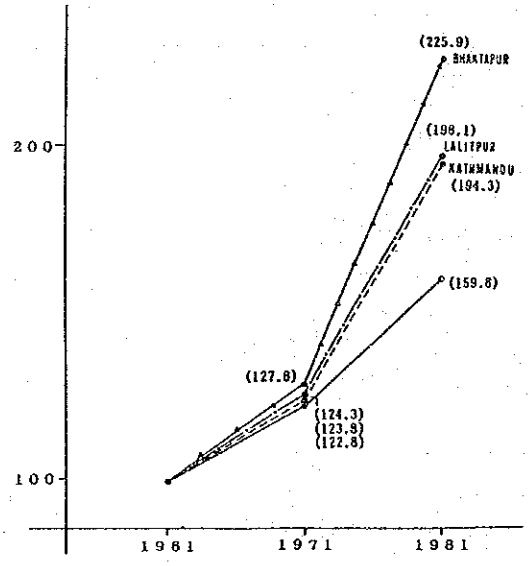


Fig. 2 Index of Population Increase in Kathmandu Metropolitan

Since the buses in the city route are operated by small firms similar to that in the long route, the buses are almost all old and worn with the engine system and spring system damaged due to overload. Furthermore, bus terminals are always crowded with people and buses, because the most widely used West German mini-buses have loading and unloading doors at the rear of the bus.

2.1.3 Public Transportation Corporations

Two public corporations — Nepal Transport Corporation (hereinafter referred to as NTC) and Sajha Yatayat (hereinafter referred to as Sajha) — are also involved in public transportation. They are both under the administration of the Ministry of Works and Transport and NTC mainly operates cargo transportation while Sajha mainly operates passenger transportation.

(1) NTC

NTC operates ropeway, railway, trolley bus as well as trucks for cargo transportation which is its main line of business. Owing to the geographical features of the Kingdom of Nepal, transportation between India has always been thriving, especially the cargo transportation route through the Port of Calcutta which is indispensable for the foreign trade of Nepal.

Passenger transportations undertaken by NTC are railway and trolley bus transportations. The railway constructed in 1928 connects the 53 km distance between Razaul and Amlekhgunj near the Indian border. This railway, serving a limited local area, was originally constructed for cargo transportation.

The trolley bus transportation between Kathmandu and Bhaktapur overlaps with bus routes operated by Sajha. This trolley bus route was opened in 1976 with the introduction of 22 trolley buses under the economic and technical assistance of the People's Republic of China. Since the trolley buses, with a passenger capacity of 63 persons (28 seats, 35 standing space), are sturdily built and well maintained, 13 buses are still in operation even after 12 years. There are some plans to extend the routes or increase trolley buses, but the enforcement plans are not established yet.

(2) Sajha

Sajha was established in 1962 for reorganizing the transportation system in Kathmandu Metropolitan. Later in 1979 in accordance with the "Public Transportation Expansion Program", 35 buses, with spare parts and a maintenance plant, with necessary equipment and materials, were provided by grant aid from Japan; furthermore, another 47 buses, with spare parts, were provided as grant aid in 1984. These expansion measures helped to build up Sajha into an agency indispensable for the people living in Kathmandu Metropolitan and today the Sajha buses are known popularly by the people as the "blue bus".

2.2 Outline of Sajha Yatayat

2.2.1 Organization and Management

(1) Organization

Sajha is a cooperative under the administration of the Ministry of Works and Transport, (His Majesty's Government of Nepal has a share of 97%) and the Secretary of the Ministry is the Chairman of the Board which is the highest decision-making organ of Sajha. Sajha is organized into 5 departments and 21 sections as shown in Fig. 3.

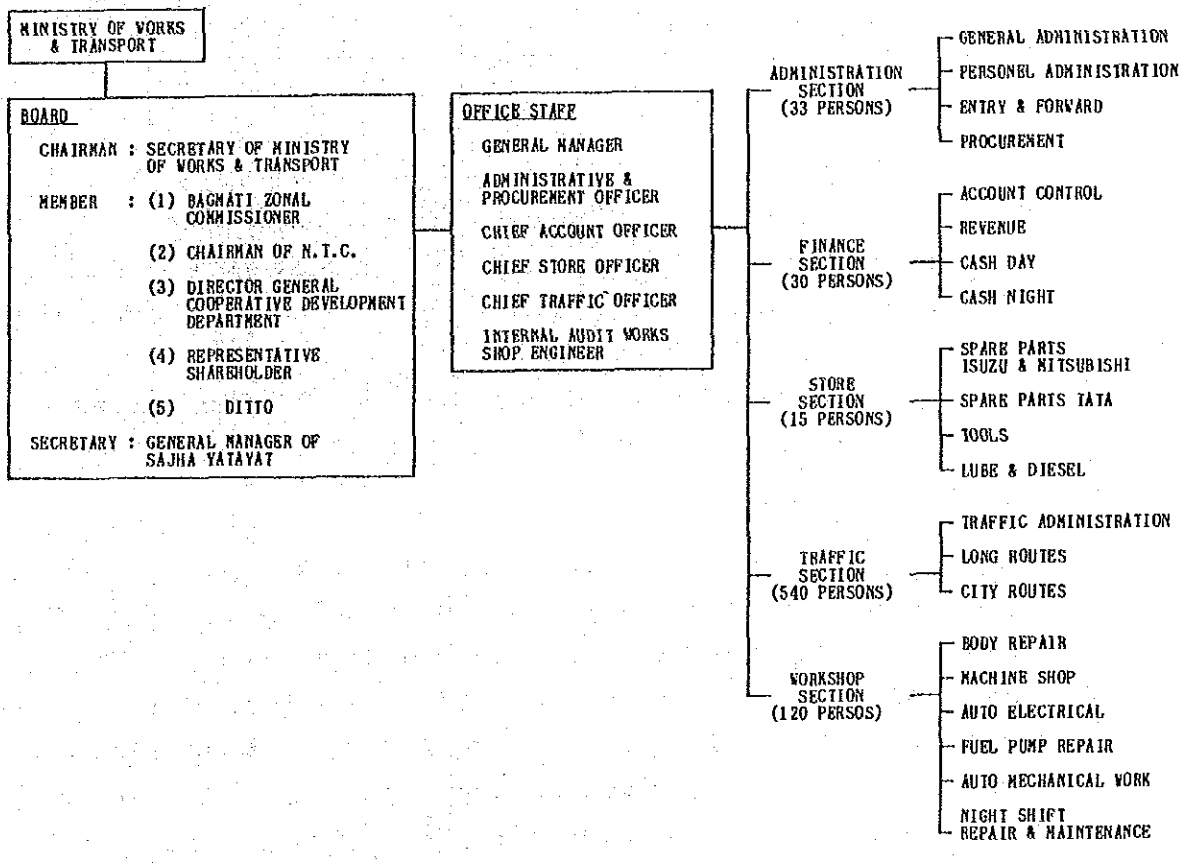


Fig. 3 Organization of Sajha Yatayat

(2) Employees

The total number of personnel employed by Sajha is presently 738 employees as shown in Table 6. The operation department employs 540 people including bus drivers and conductors. The maintenance department consists of 6 sections including body, mechanical and electrical employees shown in Table 6.

Table 6 Breakdown of Employees in Maintenance Department

Engineers	4 persons
Skilled workers	19 persons
Semi-skilled workers	13 persons
Non-skilled workers	16 persons
Labourers	48 persons
Nighttime maintenance	20 persons

(3) Operation

The Board Meeting is held once a month, while the Section Chief's Meeting is held once a week to decide and transmit the operation policy of Sajha. The General Manager is responsible for the execution of the operation and management of employees. He also serves as the pipeline of communication between the Board and the employees.

The fiscal year of Sajha is from July 16 to July 15, but loss and profit, bus operation, personnel deployment and other important matters are reviewed at mid term. The income and expense for the past five year period is shown in Fig. 4. In the year 1981/1982, 35 buses and a maintenance plant provided as grant aid in 1979 started operation, in the year 1986/1987, 47 buses provided as grant aid in 1984 started operation, but data for this year was not prepared.

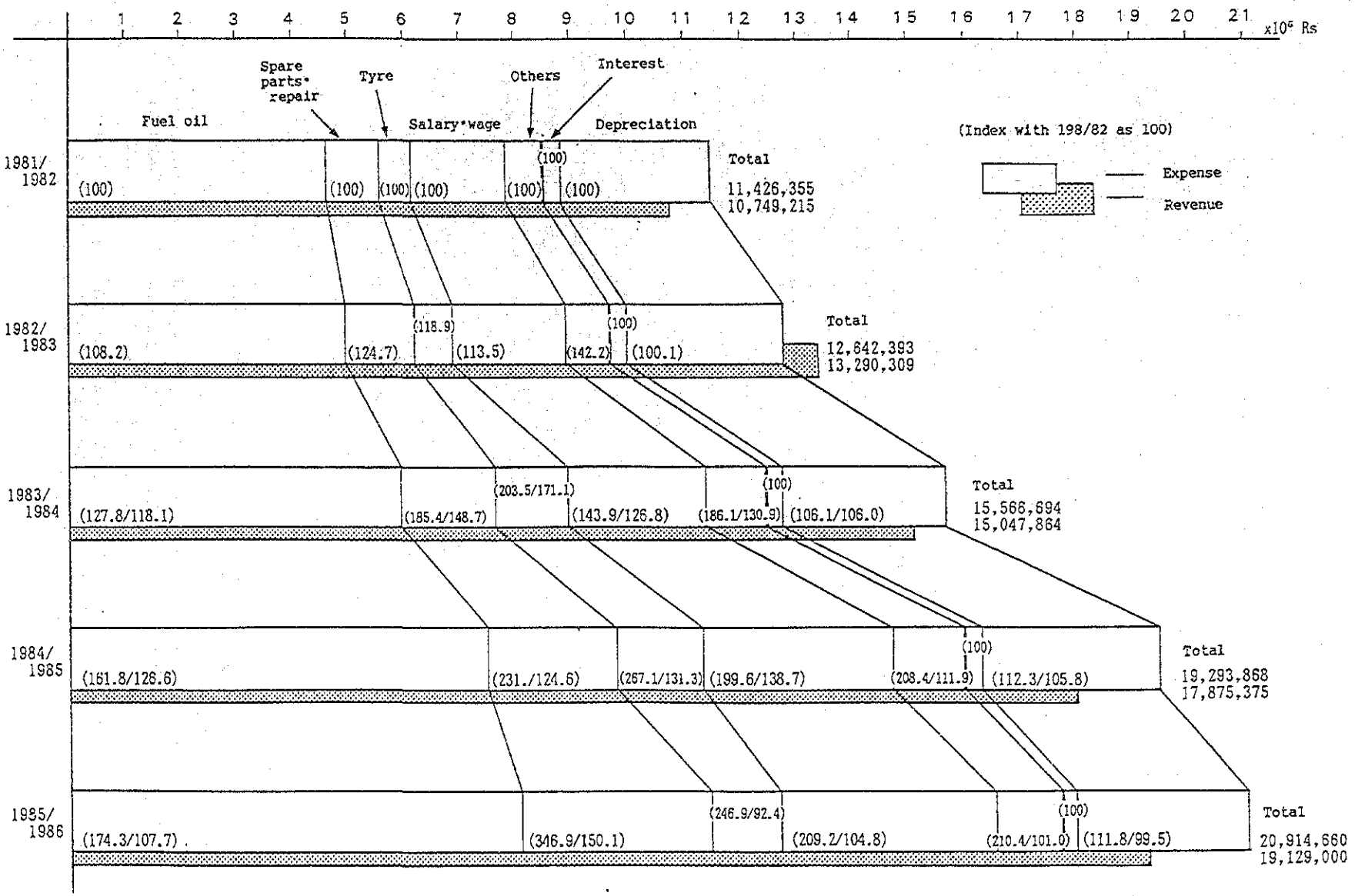


Fig. 4 Expense and Revenue Balance for Last 5 Years

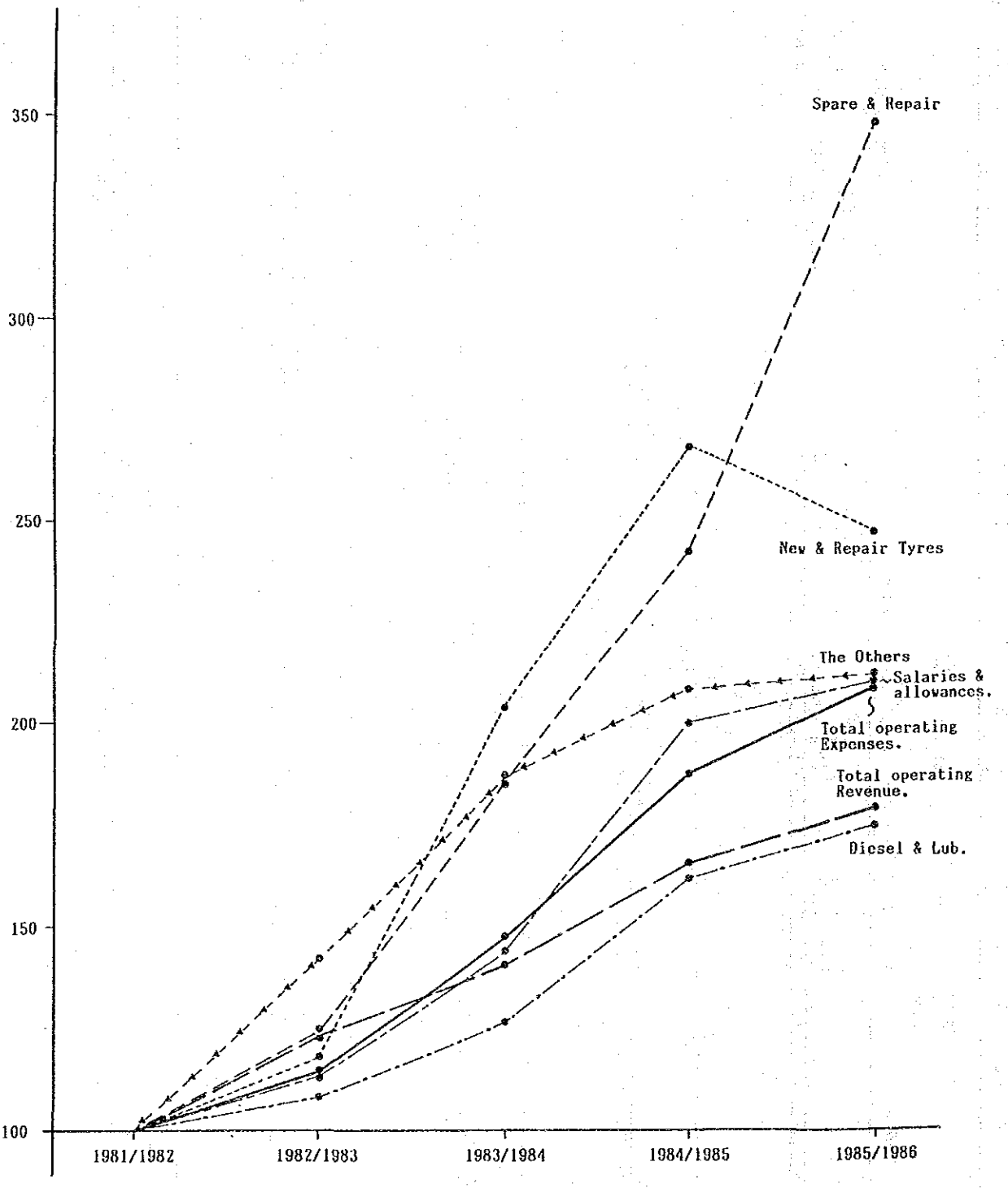


Fig. 5 Rate of Revenue and Main Expense Increase During Last 5 Years

Profit was realized only in the 1982/1983 year and losses were recorded in all other years. The profit for 1982/ 1983 occurred because an efficient operation was realized owing to low breakdown of buses, sufficient spare parts, tyres, etc., remaining from the grant aid buses and spare parts. However, after this year both spare parts and tyres became depleted, causing increased procurement cost resulting in rising losses each year. In 1985/1986, when non-operating buses started appearing, spare parts procurement as well as repairs started increasing rapidly, but procurement of tyres decreased together with increase of salary and wages, fuel procurement costs and other direct operating costs of buses (refer to Fig. 5). This indicates a reduction in bus operation efficiency. (Here, buses are depreciated over 10 years by the straight line method.)

The percentage of labour cost is normally highest in bus operating costs, but in the Kingdom of Nepal, owing to low labour costs, even though the number of employees is high, the percentage of labour costs is low, while fuel and lubrication costs, tyre procurement costs together with spare parts procurement and repair costs are high.

2.2.2 Bus Operation

(1) Number of buses

Sajha presently owns 82 Japanese buses: 35 Isuzu buses (operating from 1981), and 47 Mitsubishi buses (operating from 1986) (Table 7); also about 20 Tata buses (Indian) which are mostly left unrepaired and the number of buses that can be operated after repair is expected to be about 5.

Table 7 Number of Buses (excludes Tata buses) as of April 1, 1988

Manu-facturer	Operating	Non-operating (Repair Required)			Total
		Small Repair	Overhaul	Sub Total	
Isuzu bus	13	0	22	22	35
Mitsubishi bus	26	8	13	21	47
Total	39	8	35	43	82

The 35 buses shown in Table 7 as requiring overhaul have damaged engines, transmissions, steering gears or chassis, and they are awaiting spare parts for repair.

Among the buses waiting to be repaired, some buses are cannibalized by removing usable spare parts to be used in other buses and they have transmissions, suspensions, instruments, etc. removed and just the bus chassis remain.

The main reasons for breakdown are overload, overwork, and dirtiness caused by unpaved road. These buses including those for small repairs are waiting to be repaired with spare parts and materials provided by the grant aid in 1987.

(2) City route buses

Sajha is presently operating 14 bus routes in the Kathmandu Metropolitan (Table 8 and Fig. 6). The 7 routes, established by the 1979 expansion plan, are included in routes Nos. 1, 2, 4, 5, and 10 shown in the above table.

Since the number of daily operating buses changes frequently, the number of buses operating in each route as well as the turnover of buses are not clear.

However, from the number of operating buses, the daily average travelling distance, and number of passengers per bus, it is estimated that the number of passengers is about 50,000 according to the following calculation.

Passenger per bus:

52 passenger capacity x 2.0 = 104

Daily travelling distance per bus:

150 km/day

Average business operating distance:

10.2 km

Number of buses operating in city route:

Japanese buses (44) + Indian buses (Tata 5) - long route buses (16) = 33

Total daily number of passengers:

$$104 \text{ passenger/day} \times \frac{150 \text{ km/day}}{10.2 \text{ km}} \times 33 \text{ buses}$$

= 50,470 passengers/day

Table 8 Sajha Bus Route in Kathmandu Metropolitan

No.	Route	Business Distance (km)
1	Ratna Park - Lagankhel	7.5
2	Ratna Park - Jorpati	11
3	Ratna Park - Airport	8
4	Ratna Park - Kirtipur	10
5	Jamal - Budhanikantha	12
6	Jamal - Balaju	6
7	Bir Hospital - Swayambu	5
8	Bir Hospital - Tangal	5
9	Bir Hospital - Bhaktapur	16
10	Shahid Gate - Thankot	13
11	Shahid Gate - Pherping	16
12	Lagnakhel - Gadavari	11
13	Lagankhel - Chapagaon	6
14	Circular Route on Ring Road	27

The driver team (1 driver, 2 conductors) work in two shifts, the early shift (5:00 or 6:00 - 14:00) and the late shift (14:00 - 22:00) by receiving a work order each day from the operating department. Recently, with the increase of non-operating buses, there is a surplus of drivers and conductors, so for accidents and break-downs caused by negligence of drivers or conductors, the responsible driver or conductor is penalized by being suspended.

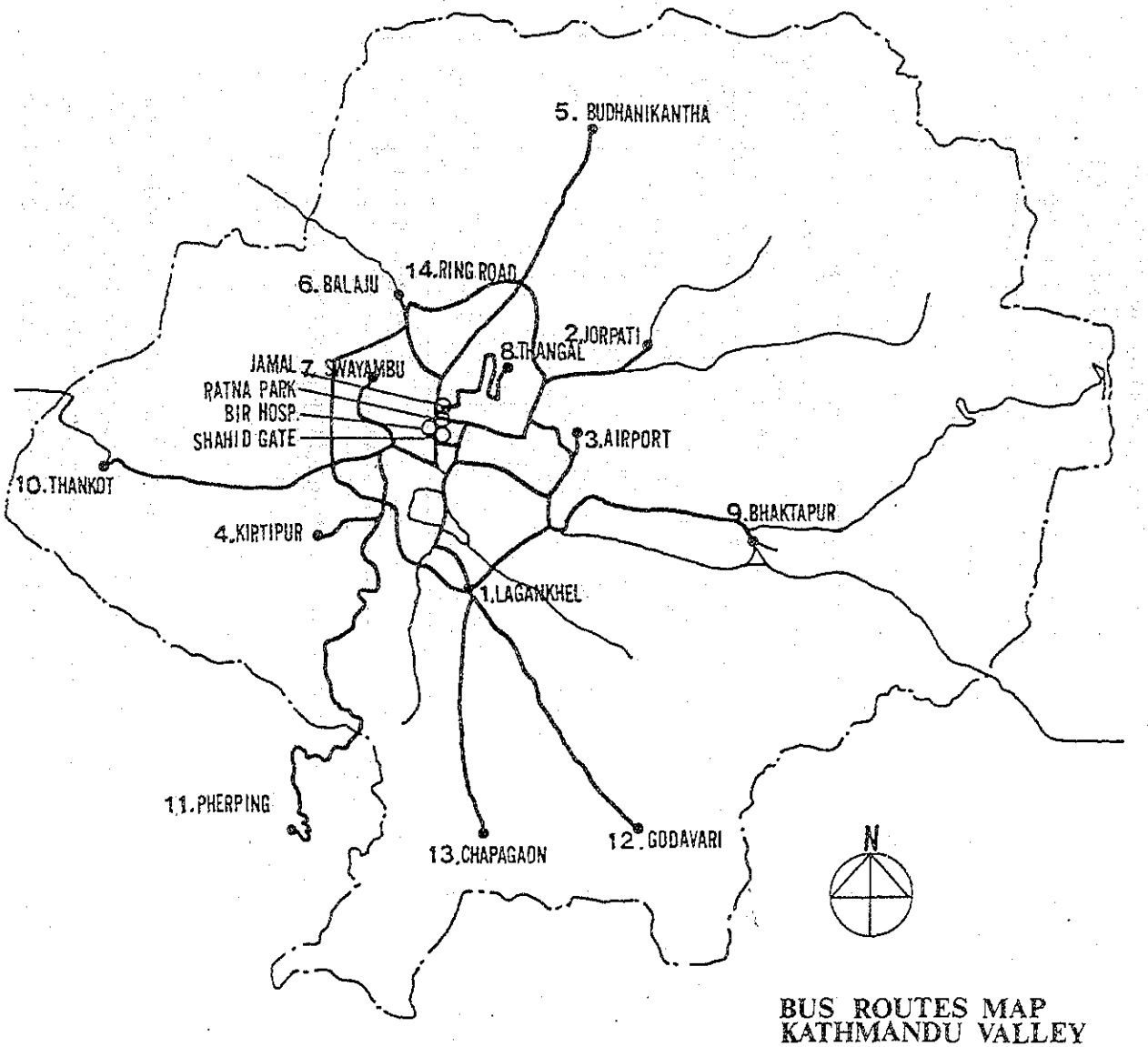


Fig. 6 Bus Routes (City Route) of Sajha Yatayat

(3) Long-distance buses

Sajha started operating long-distance buses from Kathmandu in 1986/1987. Sajha started this service to satisfy the increasing foreign tourist demand, the result of the government's promotion of tourist business, which could not be met by private bus firms, and also to improve profits.

Table 9 Sajha Long-distance Bus Service

No.	Route	Distance km	Passenger Capacity person/bus	Schedule bus/day	Number of Buses	One-way Fare Ps/L
1	Ratna Park - Biratnagar (N)	530	35	1 (0)	3 (0)	107.00
2	Ratna Park - Bhairhawa (N)	280	39	1	3	61.45
3	Ratna Park - Bhairhawa (D)	280	46	1	2	61.00
4	Ratna Park - Birgunj (D)	276	46	2	4	54.00
5	Ratna Park - Pokhara (D)	202	52	1	2 (3)	38.25
6	Ratna Park - Janakpur (D)	380	46	1	2	74.00
7	Ratna Park - Trishulee (D)	70	40	1	2	17.00
Total				8 (7)	18 (16)	

Note: Figures in brackets are estimates for first half of 1988/1989.
(N): Night operation
(D): Day operation

The routes are shown in Table 9 and Fig. 7. But with the reduction of the number of operating buses, the No.1 Biratnagar route will be closed and two buses will be increased in the No. 5 Pokhara route from the first half of 1988/1989.

The purpose of Sajha was originally to provide city route bus services, but in order to establish a sound business base as well as to improve profits, high profit routes are important.

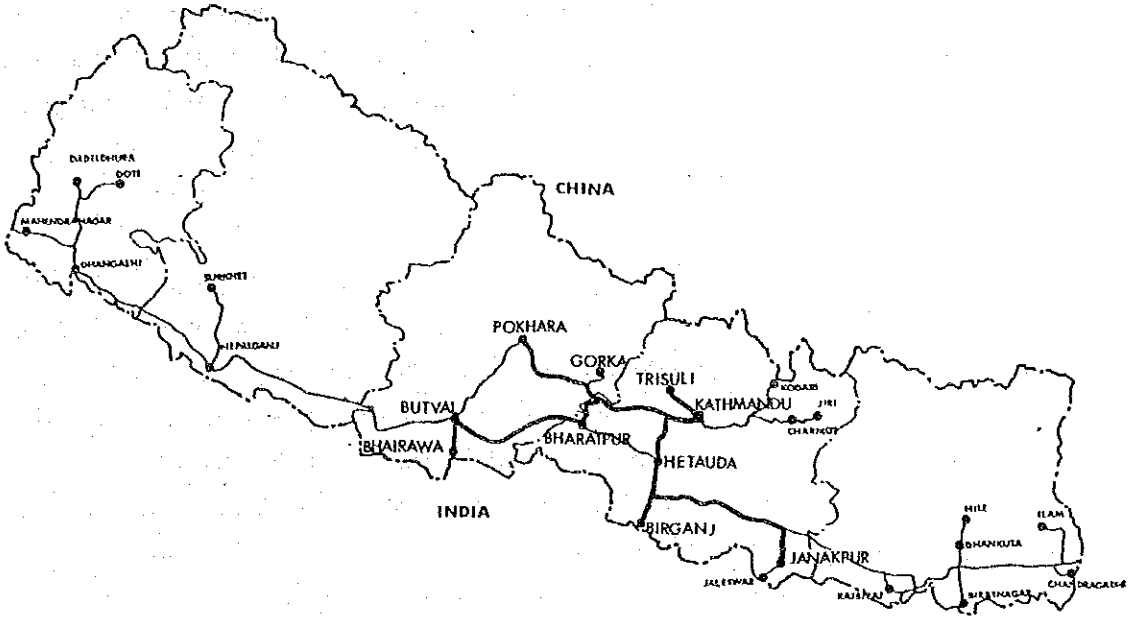


Fig. 7 Long-distance Routes of Sajha Yatayat

2.2.3 Bus Maintenance Shop

The present bus maintenance shop was constructed in 1979 under the grant aid of Japan together with the supply of equipment, 35 buses and spare parts. The maintenance shop consists of facilities for repairing 3 buses, inspecting and maintaining 2 buses at one time, an inspection line, a fuel supply stand, an inspection pit, a washing stand and a parking lot. This was planned for servicing the 35 grant aid provided buses as well as the 15 Indian buses owned by Sajha totalling 50 buses.

(1) Maintenance facility

Today, Sajha owns 82 Japanese buses and a number of Tata buses, and it is clear that the facility is overtaxed. Furthermore, owing to the increasing breakdowns caused by severe operating condition and to lack of spare parts, the number of buses waiting to be maintained and repaired are increased.

Also replacement of tyres, repairing and painting bus bodies, and replacement of engine oil are all performed in the parking lot. At times, overhauling such as removal of engines, drive shafts, and differential gears are performed in the parking lot too.

(2) Inspection facility

The inspection facility for bus maintenance and inspection is not fully used now, because so many buses are driving in and out of the parking lot creating a dangerous situation. His Majesty's Government of Nepal has newly decreed commercial vehicles inspection system in Nepal and since there are no other inspection

facilities, this facility is being used for such inspection. Therefore, at present, ordinary vehicles are entering the premises making it more crowded and creating chaos.

(3) Fuel supply stand

Since the waterproof protection of the underground tank cover is damaged, the tank cannot be used in the wet season. Furthermore, since its capacity (20 m^3 or 2 days supply) is insufficient to cope with the increasing number of cars, repairs are urgently required.

(4) Inspection pit

An inspection pit is most important for checking buses back from operation, but owing to poor road conditions, bus bottoms, especially in the wet season, become very dirty making it difficult to find cracks in chassis, loose bolts and oil spillage. Therefore, a high pressure water washing equipment is required.

(5) Washing stand

Although the washing stand is operating, water is leaking from some parts and efficiency is greatly reduced. In Japan, washing stands have a life of 7 - 8 years, but in Nepal owing to poor water quality and excessive dirtiness, as well as long operation hours, the washing stand reaches the limit of its life expectency much earlier.

(6) Parking lot

The parking lot was originally designed for 35 buses, but it is now crowded with over two times this number. Even though lighting is provided in the morning when buses are driven out and at night, it is dangerous because of poor visibility. On top of this, as described earlier, buses which cannot enter the maintenance facility are being maintained and repaired here; tyre replacing also takes place. Therefore, a parking lot of a size to accommodate the number of buses is necessary.

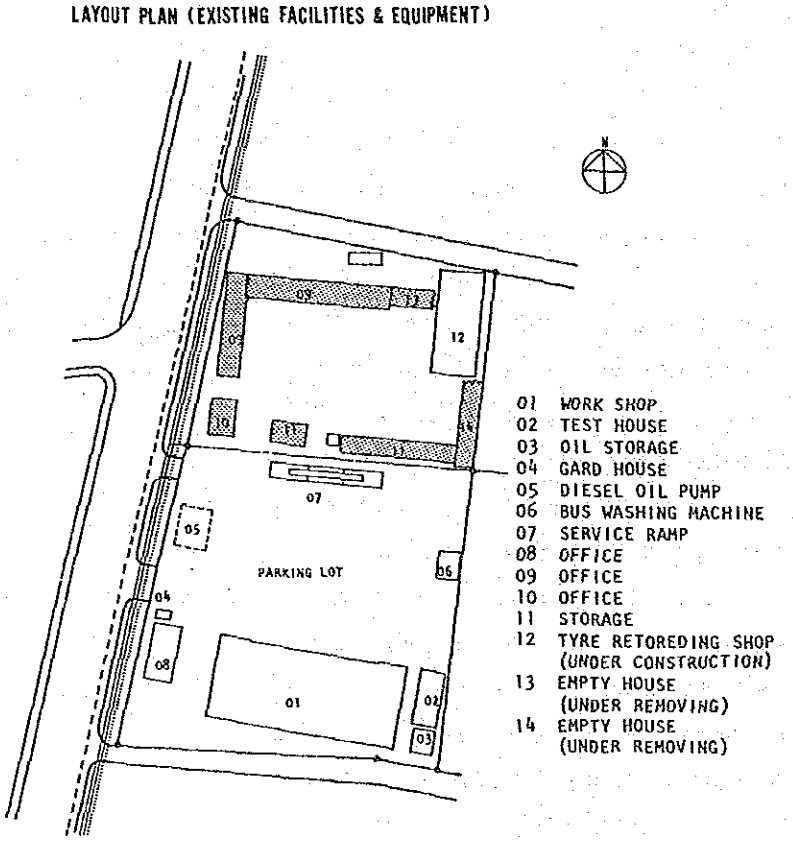


Fig. 8 Layout Plan of Existing Facilities and Equipment

2.3 Status of Facilities, Tools and Machinery

2.3.1 Facilities

Sajha owns land at Pulchowk and Lagankhel in Lalitpur (Patan) city, with the main facilities concentrated at Pulchowk (refer to Table 10). About 2/3 of this site is covered by the maintenance shop constructed under the 1979 grant aid while an administrating office and a warehouse are standing on the remaining 1/3 of the site.

Table 10 Main Facilities

Items	Structure	Floors Above Ground	Total Floor Area	Remarks
Bus maintenance plant	Brick and partially steel frame	1	1,098.3	1979 grant aid
Inspection facility	Brick	1	90.2	1979 grant aid
Paint, oil storage	Brick	1	25.7	1979 grant aid
Guard room	Brick	1	3.3	1979 grant aid
Office building				
Daily work	Brick	2	162.5	
Administration	Brick	2	450.0	
Operation	Brick	1	65.0	
Warehouse	Brick	1	171.0	
Tyre retreading shop	Brick	1	300.0	Under construction
Unoccupied building	Brick	1	105.0	Being torn down
Unoccupied building	Brick	1	125.0	Being torn down

In Lagankhel, there is a practically unused building of about 800 m^2, with unrepaired buses and tyres.

2.3.2 Equipment

(1) Bus maintenance and repair tools

The main maintenance and repair tools were provided under the 1979 grant aid, but many of the small tools (impact wrench, etc.) are damaged. These small tools are planned to be replaced under the 1987 grant aid.

(2) Inspection equipment

Brake testers, sideslip testers, speedometer testers, toe-in gauges, etc. are all in a good operating condition.

(3) Tyre retreading equipment

The tyre retreading equipment, provided under the 1984 grant aid, has not been installed. The parts for the boiler such as pipes, valves and joints are rusted and bent, and must be repaired. The electric circuit, burner and internal mechanism must also be repaired and adjusted.

(4) Diesel generator

The diesel generator was granted together with the tyre retreading equipment.

2.3.3 Water Supply Facility

The present water supply facility was granted under the Grant Aid Program in 1979. It can supply water for washing 50 buses and for 75 workers amounting to 75 ton/day and consists of the following equipment:

(1) Primary water tank of 30 m^3 capacity

(2) Two H 15 m x 100 ℓ/min turbine pumps to lift water to the elevated tank

(3) One elevated tank of 1 m^3 capacity

(4) Secondary tank of 12 m^3 capacity (for bus washing)

(5) One 33 m.Aq x 220 ℓ/min turbine pump for bus washing

These pieces of equipment are all operating satisfactorily, but with the increase of buses and personnel, a shortage of water supply has occurred. On top of this, the recent rapid urbanization has created a change in municipal water supply conditions and sufficient water cannot be received. In order to cover this insufficiency, the capacity of the present water supply facility should be reviewed together with measures to secure a reliable water source.

2.4 Background and Contents of Request

2.4.1 Background of Request

Sajha presently owns 102 buses, 82 Japanese buses and 20 Indian Tata buses, but actually only 44 Japanese buses and a few Tata buses or only half of the buses are operating. The main reasons for such condition may be summarized as follows:

(1) Critical parts for operation are damaged.

(2) Replacement of spare parts is difficult.

(3) The present maintenance shop is insufficient for repairing the present number of buses, and is grossly overtaxed.

In order to improve bus operation efficiency, increase reliability and extend services of Sajha, the only public bus transportation agency, His Majesty's Government of Nepal prepared the "Project for Improving Public Transportation" and requested the Japanese Government to provide grant aid for this project.

In compliance with this request the Japanese Government decided to provide bus spare parts, maintenance equipment and 20 buses in 1987 together with this basic design study to upgrade and expand the bus maintenance shop under the grant aid for 1988.

2.4.2 Contents of Request

His Majesty's Government of Nepal requested a maintenance shop, tools, machines and spare parts in the request, but since tools, machines and bus spare parts had already been decided under the grant aid of 1987, this report is concerned with grant aid for the bus maintenance shop and facilities consisting of the following items.

(1) Expansion of present facilities (Pulchowk Site)

- (a) Bus maintenance shop
- (b) Administration office
- (c) Parking lot
- (d) Fuel supply stand
- (e) Water supply facility by deep tube well
- (f) Installation of tyre retreading equipment
- (g) Installation of diesel generator

(2) Construction of new facilities (Lagankhel)

- (a) Bus maintenance shop
- (b) Administration office
- (c) Parking lot
- (d) Fuel supply stand
- (e) Bus washing stand
- (f) Water supply facility by deep tube well

CHAPTER 3 DESCRIPTION OF THE PROJECT

CHAPTER 3 DESCRIPTION OF THE PROJECT

3.1 Objective of the Project

The objective of the project is to contribute to the welfare of the people of the Kingdom of Nepal by extending and improving public transportation as well as enhancing its reliability. For this purpose, the following two items will be implemented.

(1) Improve the present Sajha bus repair facilities to raise bus operation efficiency.

(2) Establish a thorough checking and inspection procedure for preventing serious and unrepairable breakdowns and thus increase reliability as well as to reduce operating costs such as fuel and oil costs, spare parts and tyre procurement cost, thereby improving Sajha's financial condition.

3.2 Study of the Project

3.2.1 Requirements

(1) Expansion of inspection, maintenance and repair functions

At present, the work at the Sajha maintenance shop, aside from tyre, oil and grease replacement, is limited to repair of breakdowns; scheduled inspection and maintenance are insufficient. The breakdowns mainly concern engines, differentials, suspensions, clutches and transmissions which are major repairs requiring much time (refer to Table 8). The lack of technicians and skilled workers also aggravate the situation. Although this maintenance shop was originally planned for servicing a maximum 50 buses, it is now required to service 102 buses; 82 buses plus 20 additional bases under the grant aid of 1988. This does not include the Tata buses.

Therefore, in order that Sajha may fulfill its original function and provide a reliable bus operation, the following items should be implemented.

(a) Extend the bus maintenance shop with equipment for major repair

(b) Establish a scheduled inspection and maintenance procedure

(c) Upgrade the technical skills of technicians and workers

(2) Production of retread tyres

Tyres and brakes are the most important parts of a bus. However, since tyres are not manufactured in Nepal, new tyres must be imported, making them very expensive. Therefore, tyres are being retread by importing rubber from nearby countries, but most of such operation is conducted by cottage industries with no quality control, only relying on the operator's skill. Since difference in tyre sizes will unbalance the vehicle, also, since insufficient binding of rubber build-up causes tyres to burst, tyre retreading facilities were included in the grant aid of 1984.

If they are installed and operated to produce retread tyres, a better quality control can be realized and bus maintenance expenses can be reduced. Also, should the purchase of new tyres be increased, it would contribute to safer operation.

The tyre retreading facilities have 5 retreading machines which in Japan retread 1 tyre/hour/machine. When applied in Nepal, the monthly production is estimated as follows:

7 tyres/day/machine x 5 machines
x 25 days/month x 0.5 x 0.8 = 350 tyres/month

where: Working hours: 7 hours a day
Working days: 25 days a month
Work efficiency: 0.5
Operation efficiency: 0.8

The consumption of tyres, when new tyres are used in the front wheels and retread tyres are used in the rear wheels, would be as follows:

Retread tyres

4 tyres/bus x 5,000 km/8,000 km x 102 buses
= 255 tyres

where: Bus travelling distance: 5000 km/bus/month
Life of retread tyres: 10,000 - 8,000 km

When workers become skilled, production should be able to meet the demand. During the site survey, it was found that retread tyres were sold at Rp.1,200 for rebuilt tyre and Rp.1,650 for retread tyres. The retreading plants at present take about 4 hours to retread one tyre.

(3) Training for drivers and technicians

Sajha should provide training for drivers, technicians and workers continuously, to prevent operation rate from falling due to poor maintenance and breakdown. First, Japanese experts will train drivers and technicians to become instructors and in turn they will train drivers, technicians and workers. Effective training can be expected by combining "on-the-job training" with class-room lectures.

Driver training

Drivers are required to hold a driver's license, but tests are not enforced as strictly as in Japan, so the skill of the drivers is not very high. The bus controlling skill obtained from experience is good, but

knowledge of bus mechanisms is poor, so the drivers tend to overtax the bus they drive. Therefore basic driving knowledge and the inspection a driver should perform before driving need to be taught.

Maintenance technician training

The skill of technicians is not high, for example the skill and knowledge of an "engineer" is lower than that of a "third grade maintenance technician" in Japan. It is necessary to implant the concept of scheduled inspection and maintenance, as well as to start training and instruction from the very basic knowledge.

(4) Improving the management of Sajha and bus operation

The present condition requires buses both in city and long-distance routes to be operated at their maximum efficiency. An efficient bus operation schedule which provides for scheduled inspection and maintenance, without reducing passenger utilization, must be established.

3.2.2 Workshop, Tools, Machinery and Facility

(1) Workshop

The request by His Majesty's Government of Nepal consists of extending the present workshop at the Pulchowk site and of constructing a new workshop at the Lagankhel site. The plan provides Pulchowk to be the major workshop with a minor repair shop together with a fuel supply stand and a bus washing stand at Lagankhel. However, this plan creates duplication of workshops,

manpower, spare parts, fuel oil and management especially when both workshops are only 2 km apart. It is better to clarify and separate the functions at each site so that they may operate more efficiently as one organization as shown below.

Site	Operation	Main Function	Facility
Pulchowk Site	1. Minor repair shop (Present shops)	. Daily and scheduled inspection and maintenance . Replacement and repair of small parts . Replacement of oil and grease . Replacement and repair of tyres	Fuel supply stand Inspection stand Bus washing stand
	2. Major repair shop	. Scheduled overhaul . Replacement of major parts . Disassembly and repair of major parts	Major repair shop
	3. Administration and training	. General affairs, accounting, operation, procurement, training	Administration office
	4. Parking lot	Park buses for repair as well as for operation	Parking lot
Lagankhel Site	1. Body repair	Metal working, welding, painting	Body shops
	2. Tyre retreading	Retread tyres	Tyre retreading shop
	3. Parking lot	Park buses	Parking lot

Each operation department will require the following rooms:

(a) Major repair shop: Workshops, spare parts storeroom, tools storeroom, oil and lubrication storeroom

(b) Administration and training department: Offices, meeting room, training room

(c) Tyre retreading shop: Shop, boiler room

(d) Body shop: Metal working shop, painting shop

(2) Tools and machinery

The following types of tools and machines are necessary to fulfill the activities of each department.

(a) Major repair shop
Cylinder boring machine, cylinder honing machine, crankshaft grinder, brake drum lathe, air compressor, portal crane, auto-lift, etc.

(b) Administration and training department
Copy machine, overhead projector (OHP), etc.

(c) Tyre retreading shop
Lacking parts such as pipes, valves, etc.

(d) Body shops
Welding equipment, etc.

(e) Parking lot
Bus washing stand, fuel supply stand

(3) Water supply facility

The request from His Majesty's Government of Nepal regarding water supply facility consist of the following items:

(a) Construction of water supply facility required in line with the extension of repair shop, and

(b) Construction of deep tube wells to overcome the present daily water shortage.

These items will be addressed as follows:

(a) In the basic design, the number of equipment, frequency of usage, and specific consumption will be studied for determining equipment layout and manning program.

(b) In order to determine the possibility of water supply by deep tube wells, water resource survey on municipal water supply as well as water flow will be studied to select the most desirable water source from the economical as well as technical viewpoint. With the approval of His Majesty's Government of Nepal, a site survey was conducted.

The water supplied to Sajha from municipal water supply in 1987 is shown in Table 11.

Table 11 Water Supply to Sajha from Municipal Water Supply

(Daily, monthly average, 1987)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Daily supply (tons)	11	13	9	5	3	17	41	50	43	38	23	9

Note: Daily yearly average was 21.8 tons/day.

3.3 Outline of the Project

3.3.1 Organization and Operation of Executing Agency

(1) Executing agency

This Project is to be executed by Sajha Yatayat (Sajha) a cooperative directly administered by the Permanent Secretary for Transportation of the Ministry of Works and Transport, His Majesty's Government of Nepal.

The facilities, equipment and materials, provided under grant aid, are government property entrusted to Sajha for utilization and operation.

Although Sajha is a cooperative directly administered by the Ministry of Works and Transport, the government only provides capital investment, and the cooperative is a self-supporting operation receiving no subsidies from a government budget. In this project, the counterpart is Sajha.

(2) Organization

In order to operate the Project smoothly after its implementation, the reorganization of Sajah was decided as shown in Fig. 9 by the Board in May 1988.

The main reorganized points are that the Workshop is separated into 3 shops along the line of activities, namely, heavy duty shop, minor duty shop, and body and retread tyre shop. Also sub-stations of Store Section are set up in the heavy duty shop and the minor duty shop to clarify the division of maintenance shops as well as to strengthen the parts and oil control management. Furthermore, teams in every shops are set up for different jobs and a leader is assigned to each team.

This reorganization aims to create an efficient operation by simplifying office and administration works and coordinating shop works. Once the operation of this organization is established and the preparation of facilities and equipment are arranged, the expected results should be achieved.

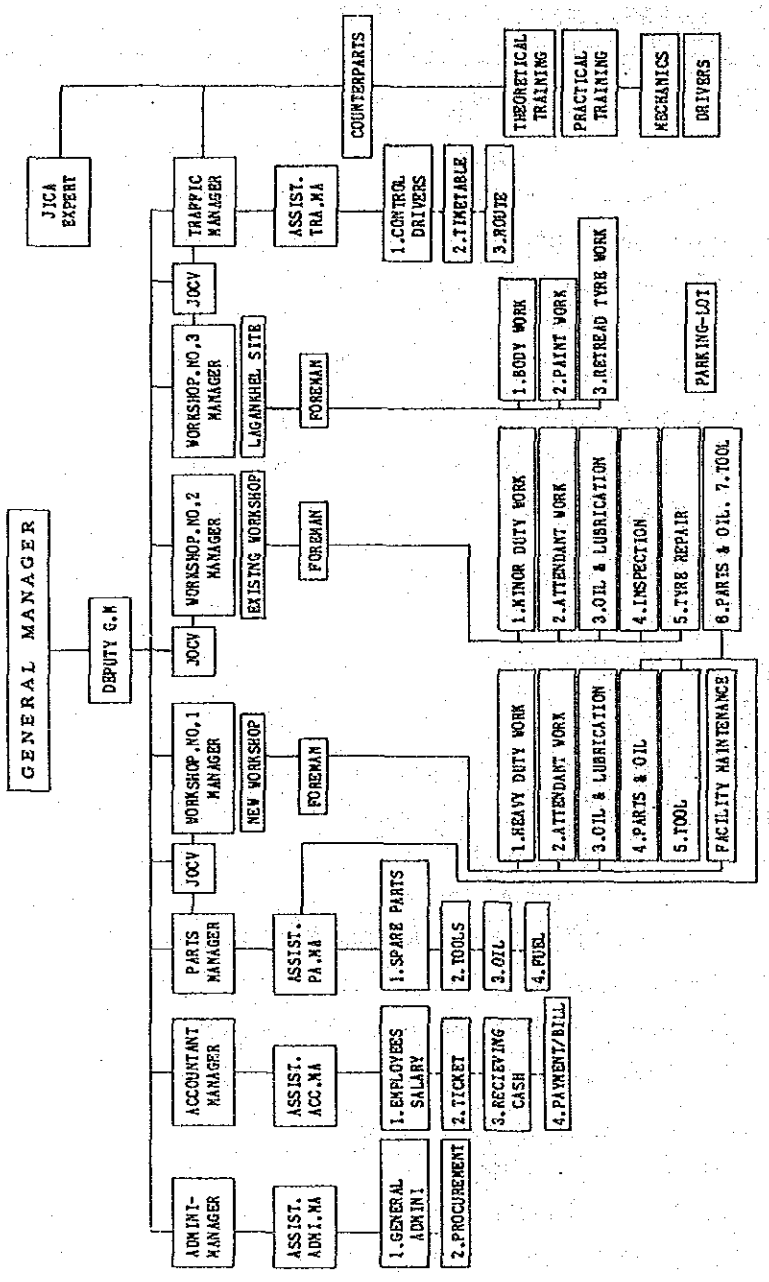


Fig. 9 New Organization of Sajha

(3) Operation

① Operation expenses

The past five years of financial reports of Sajha, excluding long route operation which was not opened, are shown in Fig. 4. The long-distance routes during July - December 1987 all showed a profit with the exception of the night operation of the Bhairwara - Ratna Park route, and the total income was Rp.806,557.13. The Bhairwara route showed a deficit owing to higher fuel, oil, spare parts and tyre costs than other routes owing to more severe road conditions.

Since Sajha is a cooperative for providing public service, it cannot terminate a route just because the route does not pay. However, Sajha should be able to improve its profitability by extending long-distance routes without disrupting its city route within the Kathmandu Metropolitan.

According to the 1988/1989 budget, decided by the Board and approved by the Government, a revenue increase of Rp.1,965,000 is estimated. The increase consists of advertisement revenue Rp.1,220,000, bus charter revenue Rp.500,000, and long route revenue Rp.245,000.

After spare parts for present buses, additional 20 buses and a repair shop are provided under the 1988 grant aid, 102 buses will be operating which should contribute greatly to operation revenue. However, with the increase of operation revenue, operating expenses will also rise; furthermore increases in depreciation cannot be neglected. Sajha must concentrate on improving operation management such as lowering operating costs through strict bus inspection and maintenance and upgrading employees' skill and quality.

Table 12 Long-distance Route Record (July - December 1987)

Route (from Ratna Park)	Operated Months	No. of Buses	Operation Revenue (Rp)	Operating Costs (Rp)	Income (Rp)
Birgunj (day)	6	4	1,428,391.41	978,025.55	450,365.86
Trishulee (day)	6	2	585,383.70	511,214.91	74,168.79
Janakpur (day)	4	2	703,449.60	543,123.44	160,326.16
Pokhara (day)	6	3	713,003.30	570,726.06	142,277.24
Bhairwara (day)	6	2	865,692.70	794,02.07	71,640.63
Bhairhawa (Night)	6	3	733,822.85	866,044.40	Δ92,221.55
Total	-	16	5,069,743.56	4,263,186.43	806,557.13

② Manning schedule

The present manning shall be kept for the operation and administration departments, but in order to assure smooth operation when this project is executed, the manning schedule shown in Table 13 should be implemented.

Table 13 Manning Schedule

Work Classification	Present Employees (Night)	Increased Employees	Total (Night)
1. Mechanic	43 (6)	35	78 (6)
2. Inspection, checking	6 (4)	10	16 (4)
3. Tire repair	8 (4)	-	8 (4)
4. Body	8	8	16
5. Electric	4 (2)	-	4 (2)
6. Interior finishing	4	-	4
7. Fuel supply	4 (2)	-	4 (2)
8. Bus washing	4	-	4
9. Tyre retreading	-	9	-
10. Common labour	19 (2)	-	19 (2)
Total	120 (20)	62	182 (20)

3.3.2 Contents of the Project

(1) Repair workshop

The present repair shop at the Pulchowk site shall be designated as a minor repair shop to conduct scheduled inspection and maintenance, while the major repair shop provided in this project will carry out overhaul as well as major repairs.

The major bus repair consists of disassembly and repair of engines, transmissions, brakes, steering gear and suspensions together with overhaul including body repair and repainting. It was found that in Nepal overhaul is necessary after only 1/3 to 1/2 of the overhaul interval period in Japan owing to its severe topography and poor road conditions.

It is desirable to eliminate breakdown repairs through strict scheduled inspection and maintenance, but it is impossible to eliminate breakdown altogether, and a system to be able to address a certain amount of emergency breakdown should be provided. Fortunately, up to now, breakdowns during operation have not occurred (excluding minor body repairs), so the risk of such occurrence seems to be quite low.

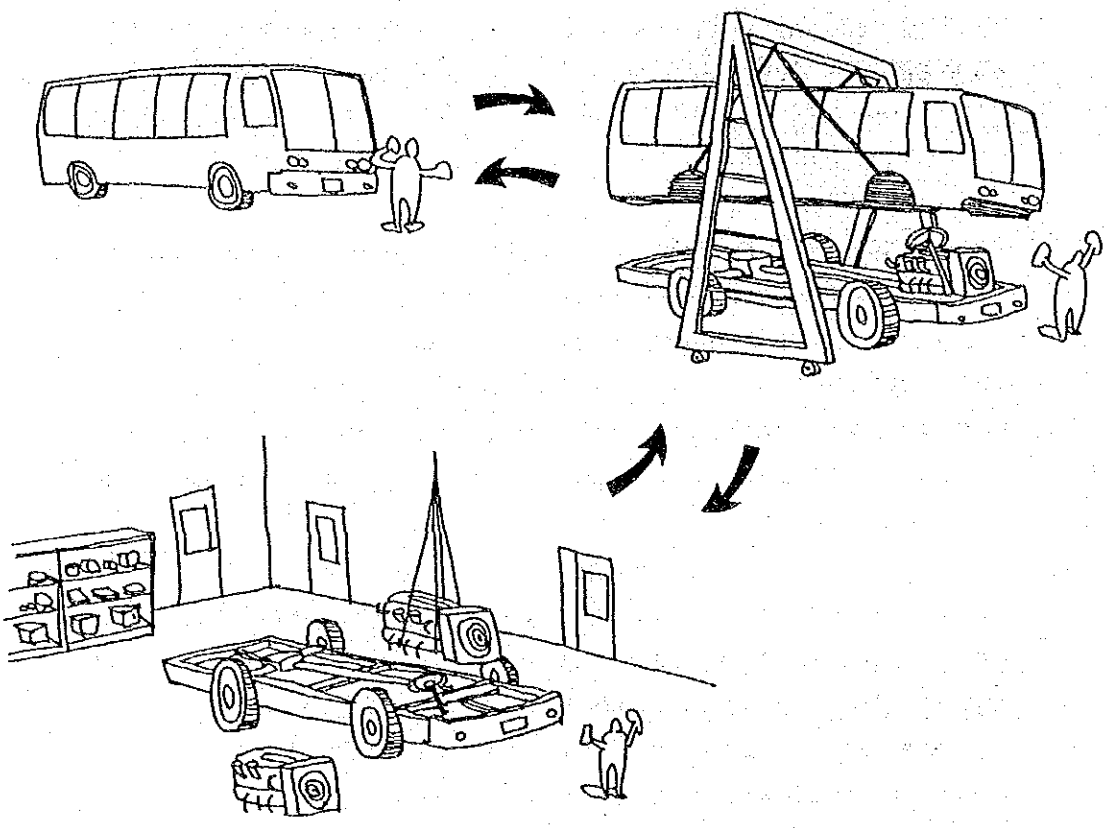
Repairs at this shop will be based on replacement of assembly by utilizing spare parts provided in the 1987 grant aid. The procedure is as listed below.

(a) Remove component parts from body

(b) Remove each component part from chassis

(c) Fix assembled and inspected component parts to body

(d) Disassemble removed component parts, then clean, repair, assemble, inspect and store.



By this method, the repair time of buses inside the plant can be minimized, thus raising operation efficiency, but a complete record of bus history and spare parts inventory must be kept by recording when, what repair and maintenance was performed on which track by replacing which spare parts.

(2) Parking lot

Parking lots are provided for both Pulchowk and Lagankhel sites. The present Pulchowk parking lot will be for buses which have been inspected and filled with fuel while the extended parking lot will be for buses waiting to be repaired. Since the capacity of the fuel supply stand and bus washing stand will be insufficient due to increase of buses, a fuel tank and fuel supply equipment are increased, but the fueling island will be at one place so that parking space will not be reduced. The capacity of the bus washing stand is increased by replacing with larger equipment in order to save parking space.

Since the Pulchowk site is near the center of the city and the site cannot be extended, a parking lot is also provided at Lagankhel. However, even with both parking lots, it is obvious that parking lots are insufficient, and His Majesty's Government of Nepal stated that they intend to secure more land for parking lots.

(3) Tyre retreading shop

Normally, a tyre retreading shop is an independent operation and the only advantage for the shop to be located within the bus repair shop site is that transportation of tyres is eliminated. The tyre retreading shop is located at the Lagankhel site, in order to ensure maximum efficiency of the bus repair shop at the Pulchowk site. The boiler is the most important equipment in a tyre retreading shop but since it was not used for more than 2-years, it should be carefully inspected by a boiler specialist during the detail design phase. Furthermore, retreading

technicians should first be trained, and production should be raised gradually corresponding to the improvement of skill of the operators.

The building for a tyre retreading shop under construction by Sajha is converted to a spare parts store for the major repair shop. The building has an effective height of 4.6 m, so part of the building height will be partitioned to provide another floor for better utilization of the building space. In this building, spare parts for major repair and repaired component parts will be stored.

(4) Administration and training

Within the administration department, only part of the general affairs department, part of the cashier section of the accounting department, the warehouse control section of the supply department and part of the operation department are located at the Pulchowk site and many of the other offices are scattered throughout the city. Since old buildings will be torn down when implementing this Project, all offices are collected together at Pulchowk for increasing efficiency of office work and reducing expenses.

Among the administration and operation department, the supply department directly influences repair activities. A systematic inventory control method will be introduced for conducting good control of spare parts, so that spare parts may be procured and delivered before they are depleted thus preventing the occurrence of buses waiting for spare parts.

Training provided by Sajha should be divided into driver training and maintenance training.

(a) Driver training

Driver training stressing safe driving as well as basic instructions on automobile mechanism, driving principles and techniques will be provided for bus drivers. The training will cover techniques to enable the drivers to conduct start-up inspection and shut-down inspection with the repair shop staff, and will be provided to all drivers for 5 days each month consisting of 60 minutes training a day in classes of 25 - 30 drivers.

(b) Training for maintenance

Training of basic technique on checking and inspection procedure, scheduled inspection and maintenance procedure, maintenance and repair of different components as well as different buses will be provided. Japanese experts will first train the chief of each team and then each chief will train workers in his respective team. A 60-minute training on one subject will be given once a week to a class of 5 - 12 persons. If necessary, training of a subject may be repeated.

An effective training can be expected when on-the-job-training (OJT) and class lectures on basic technical knowledge are combined.

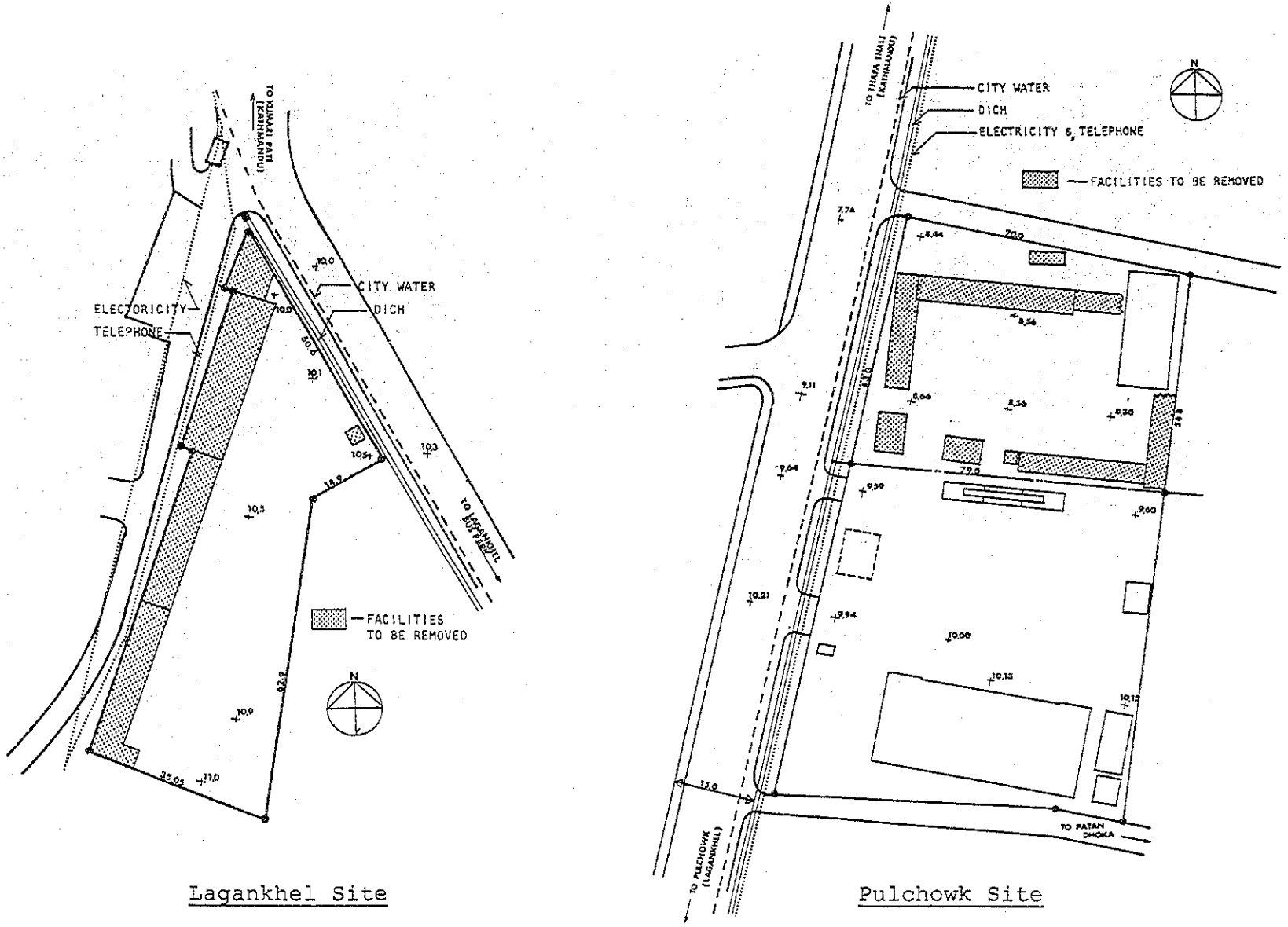
3.3.3 Project Site

(1) Proposed construction site

(a) Pulchowk site

The construction site is adjacent to the present repair shop and construction is planned considering both sites as a single site. The land slopes gently from south to north and a difference of 90 cm exists between the land surface of the construction site and that of the present repair shop site. Buildings more than 70-years old stand on the site which must be removed in order to provide a good functional layout, and the Nepal side has agreed to undertake the removal.

The area of the new construction site is 4,291 m^2 (about 70 m x 60 m) and the area of the present shop site is 6,611 m^2, so the combined area will be 10,902 m^2. A 20 m wide (road 15 m, side-walk 2.5 + 2.5 m) access road lies on the west side of the site and a 6 m wide road lies on the north side of the site. When the access road on the west side was improved, the road was higher than the parking lot pavement at the entrance of the present shop site allowing water to flow inside the site. Therefore a drainage plan for the Project including the present shop site must be designed.



Lagankhel Site

Pulchowk Site

Fig. 10 Outline of Construction Site Condition

(b) Lagankhel site

The Lagankhel site is located 1.5 km southwest (by road 2 km) of the Pulchowk site, and the Patan Hospital stands on the other side of the northeast side road, while the Lagankhel bus terminal lies on the south side. Since the bus terminal is only 150 m away, it is an ideal site. The land slopes gently from south to north on the access road side, and the topography poses no problem; the site is a north-south rectangle with a narrow part in the middle. Furthermore, the only access road into the site is on the north side with the entrance facing a three forked road. It is necessary to locate the shop where it does not disturbe the entry and exit of buses and also to plan an efficient bus parking arrangement and bus circulation.

(2) General condition

(a) Geography

The Kathmandu Valley is located in the Nepal highland at an altitude of 1,340 m 85°20' east longitude and 27°40' north latitude. The valley is surrounded by mountains of 2,000 m altitude and the southwestern part is divided by the Bagmati river. Since these mountains are steep on the outside slope and gentle on the inside slope, the Kathmandu valley area may be indicated as 64 km² or 1,074 km² depending on whether the southern part on the outside slope is included or not. This area represents 0.5% of the entire Nepal area, but includes 5% of the population of Nepal. The density of population is 570 people/km² which is

the highest in Nepal. The valley together with the capital of Kathmandu is the center of government, politics and culture. From this valley, numerous mountain ranges extend in the east-west direction, dividing the valley into northern, central and southern parts. The largest river is the Bagmati river and the rivers Vishnumati, Manohara, Dhobe, Hanumanti and Nakhu Kholas are all large branches.

(b) Geology

The Kathmandu valley is formed of the Fururio lake sedimentary strata of diluvial formation. The sedimentary strata are terraced at different altitudes and consist mainly of clay, sand and some gravel. A blue greenish clay stratum including ferric sulfate next to white diatomaceous earth containing peat strata is widely observed. Boring tests show many formations containing underground water at 270 - 375 m depth. At almost all of these boring tests inflammable gas containing 88% methane was encountered. This gas is believed to be generated by an aerobic decomposition of organic vegetation.

(c) Climate

There are two seasons; the dry season from October to May and the wet season from June to September. The rainfall distribution is not uniform with the largest rainfall occurring on the slope of the north and west sides of the valley, while rainfall on the south side is much less. According to records collected over many years, at Kathmandu, the average annual rainfall is 1,426 mm, while the

number of rainy days in a year is 97 with 21 rainy days in July and 1 rainy day in January (Table 14).

The relative humidity in Kathmandu is lowest in March at 55% and highest in August at 84% caused by the monsoon starting in May. Humidity is higher in the morning than late afternoon, also hardly no wind blows in the afternoon. The prevalent wind in the afternoon from January to May is west or north-west, and from June to December is north or east.

Table 14 Record of Annual Climate

	Monthly Rainfall (mm)	Relative Humidity (%)	Rainy Days (day)	Sunny Hours During 1 Day (hour)
January	15.8	70	1	6
February	16.5	68	5	6
March	29.5	53	2	8
April	46.3	54	6	10
May	105.7	61	10	6
June	228.2	78	15	5
July	361.0	82	21	3
August	355.0	84	20	2
September	152.5	83	12	3
October	46.2	81	4	5
November	8.2	77	1	5
December	2.6	73	5	5

	Monthly Average Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)	Rainy Days (day)
January	10.2	18.1	15	1
July	24.5	28.7	373	21
Yearly	18.7	25.4	1,426	97

(3) Infrastructure

(a) Pulchowk site

Water supply: Supplied from city water main laid along the west side road or from the east.

Drainage : Household sewage after treatment and industrial sewage after sedimentation tank are discharged into the main sewer laid under the road through the drainage ditch along the west side road.

Electricity : Electric power is received from the high tension power line (11 kV, 3-phase, 3-wire) existing along the west side road.

Telephone : Utilizes the existing 3 circuits

Gas : Supplied by LPG cylinder imported from Thailand and India.

(b) Lagankhel site

Water supply: Supplied from city water main laid along the north side road.

Drainage : Household sewage, after treatment, is discharged into the drainage ditch along the north side road.

Electricity : Electric power is received at 3-phase 400 V through a transformer from the high tension power line existing along the west side road.

Telephone : Utilizes the present 1 circuit

Gas : Supplied by LPG cylinders imported from Thailand and India.

(4) City water and other water sources

(a) City water supply

A water supply project in the Kathmandu/Lalitpur distrct was started in 1973 by the United Nations/ World Bank and the third stage is now being completed. The water intake facilities constructed up to now number 47 intakes consisting of surface and flowing water intakes 10, spring water intakes 5, and ground water intakes 32. Also 9 water storage and treatment facilities are constructed. The daily average water supply published by WSSC in 1987 may be summarized as follows:

Surface, flowing and spring water;	48,900 m^3/day
Deep tube wells (15);	31,615 m^3/day
Total	80,515 m^3/day

However, the consulting group, Binnie and Partner (B/P) estimates that 50% is lost due to leakage and pilfrage and, in the dry season (April and May), surface flow water intake is reduced together with agricultural consumption which creates another loss of 25%, totalling 75%. From this estimate, the actual water supply in the dry season may be estimated as follows:

$$80,515\ m^3/day \times (100 - 75\%) = 20,129\ m^3$$

The city water consumption is expected to increase greatly owing to concentration of population and promotion of a sewage system. WSSC estimated the city water supply in 1987 as follows:

City water supply
= 404,000 population x 112 ℓ/man/day
= 45,248 m³/day

where

404,000 population: Water supplied population
112 ℓ/man/day : Specific water consumption

This estimate shows that water is a bit short during the wet season and water is substantially short in the dry season (Table 15).

Table 15 Supply and Consumption of City Water (1987)

(Unit: m³/day)

Season	Water Supply	Water Consumption			Shortage
		Total Consumption	City Consumption	Other Incl. Leakage	
Wet season	80,515	85,523	45,248	40,248	-5,000
Dry season	64,412	89,531	45,248	44,283	-25,119

In order to correct such condition, WSSC, in its present "Third Development Plan", is installing pumps for constructing deep tube wells and repairing leakages. But since this will not provide a complete solution, a feasibility study, under the "Fourth Development Plan", was initiated last June to bring water from sources outside Kathmandu Valley. However, even if such plan is

implemented, it will take a long time and will not provide a solution for some time.

(b) Surface water flow

The Kathmandu valley is an egg shaped valley, extending 30 km east-west and 25 km north-south, surrounded by mountains 2,000 - 2,800 m high.

The valley is formed from hills of 20 to 30 m height with gradual slopes or cliffs which were created by erosion. The erosion was created by the Bangmati river flowing southwest and its branches the Monahala river, Godawari river, and Nakhu river flowing into the Banmati river which changes its course south from the eastern edge of Kathmandu/ Lalitpul city.

Water monitoring stations of the rivers in the Kathmandu valley are located at each river to monitor water flow. Water flow at these locations reach a peak in August while falling to the lowest level in March and April. Details and lowest water flow of main rivers are shown in Tables 16 and 17.

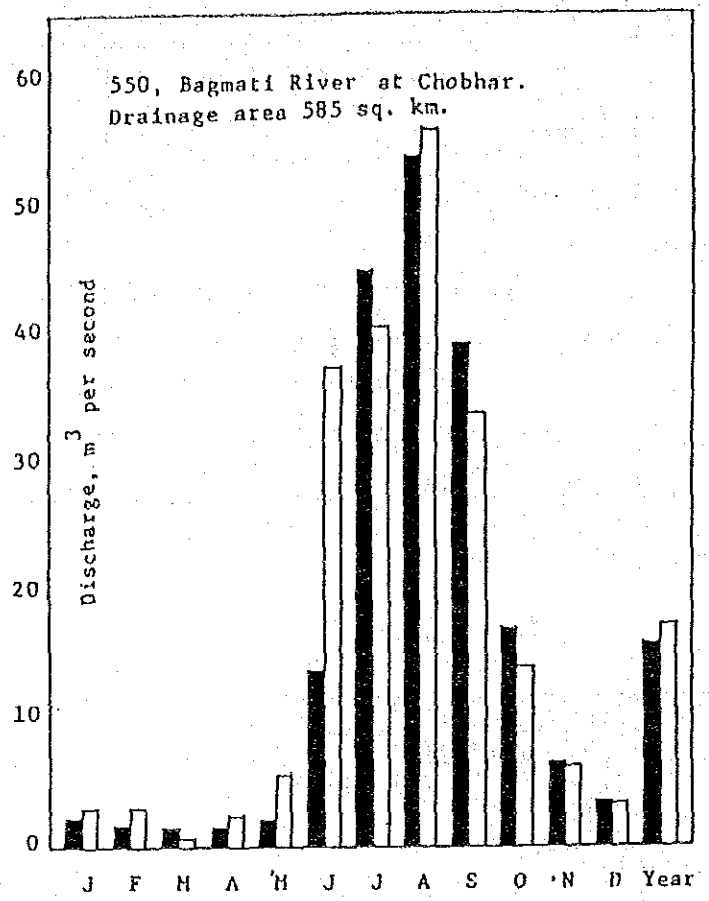
As can be seen from this table, all rivers in the Kathmandu valley can supply water throughout the year even though water flow is greatly reduced in the dry season. However, since water is quite heavily polluted in the city due to household sewage, taking water within the ring road or its downstream owing to high organic residue should be carefully considered from a sanitation standpoint.

Table 16 Water Flow of Rivers in Kathmandu Valley (1963-1976)

Items	Bagmati River		Nakhu River
	G/S No.505	G/S No.550	G/S No.540
Water collection area km^2	16.0	585.0	42.5
Average water flow m^3/sec	1.137	15.86	1.110
Maximum water flow m^3/sec	33.1 (9/4/1966)	876.0 (6/28/1972)	181.0 (8/24/1966)
Minimum water flow m^3/sec	0.02 (5/30/1970)	0.02 (6/9/1964)	0.01 (5/31/1968)
Standard water flow capacity $m^3/s/km^2$	0.07	0.027	0.026

Table 17 Minimum Water Flow Record

River	Water Collecting Area (km^2)	Minimum Flow (m^3/s)	Standard Water Flow ($m^3/s/km^2$)
Balkhn Kh (529)	?	0.100 (Apr. 16)	-
Bishunmati (536.2)	4.43	0.004 (Mar. 12)	0.0009
Bagmati Ri (505)	16.00	0.20 (May 31)	0.0125
Syalmati Kh (510)	3.34	0.021 (Apr. 23)	0.0063
Bagmati Ri (520)	56.20	0.336 (Apr. 24)	0.0060
Nagmati Kh (507)	13.70	0.13 (Apr. 23)	0.0095
Sali Nadi (531)	28.20	0.166 (May 21)	0.0059
Manohara (525)	?	0.056 (May 21)	-
Hanumante (532.5)	0.26	0.123 (Jun. 22)	0.4731
Godawari (533)	5.95	0.038 (May 3)	0.0064
Nakhnkh (539)	?	0.043 (May 6)	-
Nakhnkh (540)	42.50	0.095 (May 31)	0.0023
Bagmati Ri (550)	585.00	0.490 (May 20)	0.0008



Explanation

Average of monthly and yearly mean discharges for 1963-1976

Monthly and yearly mean discharges during 1976

Fig. 11 Variation of River Waterflow

(c) Ground water

In the Kathmandu valley, there are over 60 deep tube wells for city water supply, hotels, plants and natural gas. These wells range from 30 m to 300 m depth and 1,500 m^3/day of water is pumped up with a 6" water pump. Since the water contains iron, manganese, anmonia, etc., it is not suitable for drinking (water from wells at the foot of the mountain is drinkable).

There are 6 deep tube wells in the project area with details shown in Table 18, and in appendix 3-13.14.

Table 18 Details of Deep Tube Wells in Lalitpur Area

Location	Well Depth (m)	Dimension	Pump Depth (m)	Water Level (m)	Yield (t/day/m)
Himalaya Hotel (H.H)	220.0	10" x 60m, 6"	55	20.0	52.4
Patan High School (S.B)	136.0	6" x 61m, 4"	-	?	?
Javarake Breuery (J.D)	160.0	10" x 50m, 6"	42	16.0	48.0
Narayani Hotel (N.H)	60.0	6" x 60.0m	(50.0)	?	?
British Trading Center (B.T)	280.0	10" x 150m, 6"	(40.0)	39.4	27.6
Industrial Park (P.I)	304.0	6" x 1.0m, 4"	-	19.8	57.6

The ground water in the Kathmandu valley, especially in the Lalitpur area, has problems in water quality (as seen in Table 18), but will yield over 100 t/daily when pumps are installed deeply in the water containing formation, so it can be used for ordinary purposes (car washing) by installing water treatment equipment.

3.3.4 Outline of Workshop, Tools, Machinery and Facility

After studying this project, it was decided that the following workshop, tools, machines and water supply facility are suitable to be constructed and installed under the Japanese grant aid.

(1) Workshop

(a) Pulchowk Site

(i) Heavy Repair Shop: repair workshop, overhaul shops (engine, transmission, differential gear, suspension, steering gear, etc.) electrical shop, mechanical shop, spare parts storage, oil and lubrication storage, tool storage, air compressor room, maintenance record office, chief engineer room, engineer room, clinic, rest room, sleeping room and locker. In order to utilize the site effectively, it is desirable to locate the administration department in the same building.

(ii) Administration Department: General manager room, secretary room, meeting room, administration, cashier, traffic control, procurement and officers room are located in this department.

(iii) Training Department: One training room is located at a position easily accessible from the plant and the administration department. Tools and equipment racks as well as training materials such as an engine cut model are located in the training room.

(iv) Parking Lot: The entire parking lot is paved with concrete and the new parking lot is connected to the present parking lot through a slope so that both parking lots may be operated as a single parking lot. Smooth bus circulation and drainage system are planned for the parking lot.

(b) Lagankhel site

(i) Body Repair Shop: In order to secure a wide parking lot, all shops including the tyre treading shop are located in one building. Equipment such as an air compressor is planned to be commonly used. A sheet metal shop, a paint shop and an oil storage are provided.

(ii) Tyre Retreading Shop: An inspection room, a retreading shop, a boiler room, etc. are provided.

(iii) Parking Lot: The entire parking lot is paved with concrete. Since maintenance, fueling and washing will be carried out at the Pulchowk site, these facilities are not installed.

(2) Tools and machines

(a) Pulchowk site

(i) Heavy Repair Shop: A cylinder boring machine, a cylinder honing machine, a crankshaft grinder, a brake drum lathe, an air compressor, a portal crane, an auto-lift and other machines are installed.

(ii) Administration and Training: A copy machine, an overhead projector and other equipment are installed.

(iii) Parking Lot: Fuel supply equipment, bus washing equipment and other equipment are installed.

(b) Lagankhel site

(i) Body Shop: A welding machine, an air compressor and other equipment are installed.

(ii) Tyre Retreading Shop: Pipes, valves and other spare parts, an air compressor, a fuel tank and other equipment are installed.

(3) Water supply facility

Since city water has no quality problems and is cheap, there would be no problems if supply of city water is sufficient. However, today's water supply is not sufficient for daily water requirements, and therefore the repair shop at the Pulchowk site must be supplied with city water and other water. As a source of additional water, a comparison between surface water and ground water is shown in Table 19.

Table 19 Comparison Between Surface Water and Ground Water (Standard; City Water)

	Initial Cost	Running Cost	Reliability of Water Supply	Quality Water	Maintenance
Ground water	Δ	Δ	o	Δ	Δ
Surface water	x	x	o	x	Δ

Notes:

(1) Since water is used for washing cars and parts at the Pulchowk site, the water requirement is 50 t/day.

(2) Since there are no machines or equipment which consume large amounts of water at the Lagankhel site, city water is supplied.

(3) Three 6-ton water tank trucks are provided for supplying surface water. Transportation distance is 5 km per trip, and 3 round trips will be made daily.

(4) Water containing formation is 200 m deep, and pumps for wells are located at 250 m depth and are provided with 4" inner diameter pipes, aeration equipment and filters.

As the result of the comparison, ground water was selected; however, since water is not suitable for drinking even after aeration and filtering, it is used for washing cars and parts and other purposes.

CHAPTER 4 BASIC DESIGN

CHAPTER 4 BASIC DESIGN

4.1 Basic Policy

The basic design of facilities, materials and equipment for this project was prepared under the following basic policy.

(1) Building plan

(a) Plan building layout for most efficient operation within the limited site space.

(b) Plan the only complete large bus repair shop in the Kingdom of Nepal which will also complement existing maintenance facilities.

(c) Utilize material, equipment and work method in Nepal as much as possible and construct a plant easy to operate and maintain.

(d) Design facilities giving full consideration to climatic, historical, cultural and social conditions of Nepal.

(e) Plan a project with low operating costs to reduce excessive economic burden on the Nepal side.

(2) Tools and machinery plan

(a) Study existing tools together with those provided by 1987 grant aid for selecting items and numbers which are suitable.

(b) Select simple rugged items which are easy to use.

(c) Upgrade work efficiency, rationalize work environment, and select items which can be used safely.

(3) Water supply plan (excluding city water)

(a) Select a method which assures stable continuous supply.

(b) Select a method with the lowest running costs.

4.2 Basic Design Criteria

(1) Rooms by department

Table 20 Rooms by Department (Pulchowk Site)

Department	Room	Description
Heavy repair workshop	Repair shop	Overhauling equipment excluding engine and transmission, disassembling and reassembling parts.
	Machine washing room	Wash and clean carbon, grease and oil of engine
	Engine overhaul room	Overhaul engine and transmission
	Electric shop	Overhaul electrical equipment and parts
	Machine shop	Overhaul and manufacture of mechanical spare parts
	Parts store	Storage of small parts
	Oil storage	Storage of machine oil, grease, paint, etc.
	Tools storage	Storage of tools
	Work shop records	Record and file, histories of all buses and inventory of all parts and components
	Chief engineer office	Management of repair workshop
	Engineer room	Room for workshop engineers
	Others	Locker room, bed room, rest room for workers, shower room, welfare rooms such as clinic, power house, air compressor room and other back-up rooms

Department	Room	Description
Administration Department	General manager room	The space shall be wide enough to set up a place in the room for guests, also a typist room shall be provided next door.
	Chief administrator room	Room of chief administrator
	Chief accountant room	Room of chief accountant
	Chief procurement officer room	Room of chief procurement officer
	Chief traffic officer room	Room of chief traffic officer
	Meeting room	Room for meeting of about 10 persons
	Administration room	All office work for administration, procurement and labor are conducted here.
	Cashies room	Daily cash revenue and payment as well as accounting and financing office work are conducted here.
	Traffic control room	Daily bus traffic is controlled here.
Training Department	Training room	Training for up to 30 persons can be conducted. Space is provided for equipment cabinets, engine cut model, and other training equipment.
Others	Storage	Assembled and unassembled components are stored in this building which is an existing building provided with racks.

Table 21 Rooms by Department (Lagankhel Site)

Department	Room	Description
Body Shop	Sheet metal shop	Repair the metal sheet of bus body.
	Paint shop	Touch-up and repaint bus, but fused painting is not performed.
	Paint storage	Paint and solvent are stored.
Tyre Retreading Shop	Tyre retreading shop	After removing surface rubber of old worn tyres, new rubber is bound and retreaded.
	Boiler room	A steam boiler is installed to supply steam for tyre retreading.
	Air-compressor room	An air compressor is installed to supply compressed air for tyre retreading and for body painting.
	Tyre drying room	Old tyres are dried naturally and stored.
	Others	An administration office and a rest room are provided.

(2) Calculation of room area

(a) The calculation for the number of buses to be accommodated at the heavy repair shop which is the main facility of the project was determined as follows:

Condition

① Number and types of buses:

35 Isuzu buses, 47 Mitsubishi buses, 20 new buses to be purchased, total 102 buses

② Travelling distance and number of operating days:

Daily average travelling distance: 175 km
150 km (city route)
290 km (long route)
(150 km x 84 + 290 km x 18) ÷ 102 = 175
Monthly (yearly) operating days: 30 days (365 days)

③ Number of working hours and working days of heavy repair shop:

Daily working hours: 10 hours (8:00 AM - 6:00 PM heavy repair is not performed at night)
Monthly (yearly) working days: 30 days (365 days)

④ Repair schedule

a) Regular inspection and repair schedule

(i) 5,000 km (about 1 month) inspection and repair (12 times/year)

(ii) 20,000 km (about 4 months) inspection and repair (3 times/year)

(iii) 60,000 km (about 12 months) inspection and repair (1 time/year)

b) Overhaul

100,000 - 120,000 km
(about once one and a half year)

c) Expected breakdowns: 20 breakdowns/bus/year
(2/3 of the present condition owing to better maintenance)

d) Expected accidents: 1 accident/82 buses/year
(only one has occurred in the last 7 years)

⑤ Standard repair time

According to the observation of the skill level of technicians in the existing workshop, the repair efficiency is expected to be as shown in the following Table 22.

Table 22 Breakdown of Repair Efficiency

(Unit: hours)

	Sajha
a) Regular inspection and repair	
5,000 km inspection and repair	12
20,000 km inspection and repair	18
60,000 km inspection and repair	36
b) Overhaul	
Engine	230
Transmission	56
Differential gear	33
Other equipment (air brake, electrical equipment)	105
Maximum	230
c) Breakdown repair	9 hours/breakdown
d) Accident repair	250 hours/accident

Calculation to determine the number of buses to be repaired.

Calculation

$$\text{Number of buses} = \frac{\text{Standard repair hours} \times \text{Number of buses} \times \text{Yearly number of repairs}}{\text{Yearly working hours}}$$

① Regular inspection and repair

5,000 km inspection and repair

$$= \frac{12 \text{ hours} \times 102 \text{ buses} \times 12 \text{ times}}{365 \text{ days} \times 10 \text{ hours/day}}$$

$$= 4.02 \text{ buses}$$

20,000 km inspection and repair

$$= \frac{18 \text{ hours} \times 102 \text{ buses} \times 3 \text{ times}}{365 \text{ days} \times 10 \text{ hours/day}}$$

$$= 1.50 \text{ buses}$$

60,000 km inspection and repair

$$= \frac{36 \text{ hours} \times 102 \text{ buses} \times 1 \text{ time}}{365 \text{ days} \times 10 \text{ hours/day}}$$

$$= 0.67 \text{ buses}$$

Total 6.19 buses

These regular inspections and repairs will be conducted at the present repair shop. This will reduce the repair hours and the 5-car parking capacity will be sufficient.

② Overhaul

$$\frac{230 \text{ hours} \times 102 \text{ buses} \times 0.66 \text{ time}}{365 \text{ days} \times 10 \text{ hours/day}} = 4.24 \text{ buses}$$

③ Breakdown

$$\frac{9 \text{ hours} \times 102 \text{ buses} \times 20 \text{ times}}{365 \text{ days} \times 10 \text{ hours/day}} = 5.03 \text{ buses}$$

④ Accident

$$\frac{250 \text{ hours} \times 1 \text{ bus} \times 1 \text{ time}}{365 \text{ days} \times 10 \text{ hours/day}} = 0.068 \text{ buses}$$

②, ③, ④ Total 9.338 buses

According to the above calculation, a capacity of 9 buses is necessary, but the site configuration and area only permit 7 buses; furthermore, increasing technicians and workers at once will only result in lower quality, so it is more desirable, both from viewpoints of management and reducing labour costs, to improve efficiency through upgrading skills. Therefore the area of the heavy repair shop was set for accommodating 7 buses.

(b) The area of the rooms is calculated as shown in Table 23.

Table 23 Calculation of Room Area for Heavy Repair Shop

Room	Number	Designed Area (m^2)	Calculation
Repair shop	1	901.6	Space for 1 bus: 5.6 m x 14.0 m 7 buses: 5.6 x 14.0 x 7 = 548.8 m^2 Overhaul space (6 blocks): 5.0 m x 39.2 m = 196.0 m^2 Passway 156.8 m^2 Total 901.6 m^2
Machine washing room	1	35.0	Span 7.0 m x 5.0 m = 35.0 m^2
Engine overhaul room	2	60.0	5.0 m x 6.0 m = 30 m^2
Electricity shop	1	39.2	Span 7.0 m x 5.6 m = 39.2 m^2
Machine shop	1	78.4	Span 7.0 m x 11.2 m = 78.4 m^2
Parts store	1	39.2	Span 7.0 m x 5.6 m = 39.2 m^2
Oil storage	1	19.6	Span 7.0 m x 2.8 m = 19.6 m^2
Tool storage	1	19.6	Span 7.0 m x 2.8 m = 19.6 m^2
Battery room	1	23.8	Span 7.0 m x 3.2 m = 23.8 m^2
Air compressor room	1	23.8	Span 7.0 m x 3.2 m = 23.8 m^2
Power house	1	39.2	Span 7.0 m x 5.6 m = 39.2 m^2
Workshop records	1	17.5	Span 3.5 m x 5.0 m = 17.5 m^2
Chief engineer office	1	35.0	Span 7.0 m x 5.0 m = 35.0 m^2 (with WC)
Engineer room	1	17.5	Small office room 5.8 m^2/person x 3 persons = 17.4 m^2 Span 3.5 m x 5.0 m = 17.5 m^2
Locker room	1	44.8	Space of locker for 1 person 60 cm x 30 cm 135 persons Span 7.0 m x 6.4 m = 44.8 m^2
Bed room	1	42.5	Double bank for 24 persons: 2.0 m^2/person x 24 persons = 48 m^2 Span 8.5 m x 5 m = 42.5 m^2
Workers' rest room	1	25.0	20 persons: 1.2 m^2/person x 20 persons = 24 m^2 Span 5 m x 5 m = 25 m^2

Table 24 Calculation of Room Area for Training Department

Room	Number	Designed Area (m^2)	Calculation
General manager room	1	44.8	Span 7.0 m x 6.4 m = 44.8 m^2 (with WC and parlour set)
Secretary room	1	17.5	Small office 5.8 m^2/person x 2 persons = 11.6 m^2 Span 3.5 m x 5.0 m = 17.5 m^2 (with a waiting sofa)
Chief officer room	4	63.0	Span 3.5 m x 5.0 m = 17.5 m^2 (x 2) Span 2.8 m x 5.0 m = 14.0 m^2 (x 2)
Meeting room	1	25.5	10 persons Span 5.0 m x 5.1 m = 25.5 m^2
Traffic control room	1	39.2	5.2 m^2/person x 5 persons = 26.0 m^2 Span 7.0 m x 5.0 m = 39.2 m^2 (with Control counter)
Administration room	3	198.8	5.2 m^2/person x 32 persons = 166.4 m^2 Span 7.0 m x 5.6 m = 39.2 m^2 5.0 m x 8.4 m = 42.0 m^2 7.0 m x 16.8 m = 117.6 m^2 (with Reception and Telephone operator)
Cashier room	1	67.5	5.2 m^2/person x 10 persons = 52.0 m^2 Span 13.5 m x 5.0 m = 67.5 m^2 (with Counter)
Traffic office room	1	28.0	5.2 m^2/person x 5 persons = 26.0 m^2 Span 5.6 m x 5.0 m = 28.0 m^2
Training room	1	63.0	2.0 m^2/person x 30 persons = 60.0 m^2 Equipment space Span 7.0 m x 9.0 m = 63.0 m^2
Others		354.0	

Table 25 Calculation of Room Area for Body Shop and Tyre Retreading Shop

Room	Number	Designed Area (m^2)	Calculation
Sheet metal shop	1	96.0	Space for sheet metal work 6.0 m x 16.0 m = 76.0 m^2
Paint shop	1	96.0	Space for painting body work 6.0 m x 16.0 m = 96.0 m^2
Tyre retreading shop	1	342	Area specified in specifications of tyre retreading shop including boiler room and air compressor room
Office	1	33.5	Space for 4 persons 5.2 m^2/person x 4 persons = 20.8 m^2
Worker rest room	1	15.75	Space for 25 persons 1.5 m^2/person x 10 persons = 15.0 m^2
Others		83.1	

(3) Description of equipment

	Pulchowk Site	Lagankhel Site
(1) Water supply	Drinking water is city water. Water for washing buses is supplied from constructed deep tube wells equipped with water treatment equipment consisting of aeration and sand filter.	City water is used for all water requirement.
(2) Hot water	Hot water, heated with solar panels, is used only for showers.	Hot water, heated with solar panels, is used only for showers.

	Pulchowk Site	Lagankhel Site
(3) Drainage	Storm water and ordinary water are discharged into the drainage ditch along the road after passing through an oil trap. Sewage, after treated in a sewage treatment tank, is discharged into the drainage ditch.	Storm water and ordinary water are discharged into the drainage ditch along the road and sewage, after treated in a sewage treatment tank, is discharged into the drainage ditch.
(4) Gas	Imported LPG is used. No piping is installed as gas cylinders are located at points of usage.	Imported LPG is used. No piping is installed as gas cylinders are located at points of usage.
(5) Fire fighting equipment	No special fire fighting equipment is installed.	No special fire fighting equipment is installed.
(6) Cooling and heating equipment	No cooling and heating equipment is provided. Ventilation and ceiling fans will be provided as required.	No cooling and heating equipment is provided. Ventilation and ceiling fans will be provided as required.
(7) Power	Apart from the existing transformer, a separate transformer (high tension) is installed.	A high tension transformer is installed.
(8) Power generator	No power generator is installed	The existing power generator is installed.
(9) Lighting	Lighting of 300 lx is provided similarly to that at the existing shop office.	Lighting of 300 lx is provided similarly to that at the existing shop office.
(10) Telephone	Intershop telephone is installed utilizing the existing 3 circuits.	The existing 1 circuit is utilized.

4.3 Basic Plan

4.3.1 Site Plan

(1) Plant layout

(a) Pulchowk site

If the building under construction, originally planned as a tyre retreading shop, is used for storage and the bus flow is not changed, the north side of the site next to the storage is the best location for the heavy repair shop. Buses will enter the heavy repair shop along the present bus circulation route, so no new approach from the road is constructed, since buses will not be entering the heavy repair shop from the road. Since the level of the present site is 90 cm lower than the level of the existing repair shop, 2 one-way passage slopes are constructed between the old shop and the new shop. Bus flow is designed to follow a clockwise flow.

A deep tube well is installed at the southwest corner of the site, because the water supply distance is short and bus flow is not obstructed.

(b) Lagankhel site

Since the site configuration is irregular, the condition is not suited for a parking lot, so the shop is located at the irregular part of the site to provide the most efficient parking in this site. There are two choices for locating the shop: one near the approach to the road and the other at the

opposite side of the approach. When the shop is located at the opposite side of the approach, buses must be parked close to the approach, which will obstruct the entrance and exit of buses, so the shop is located at the most irregular part of the site near the approach.

(2) Exterior work

(a) Pulchowk site

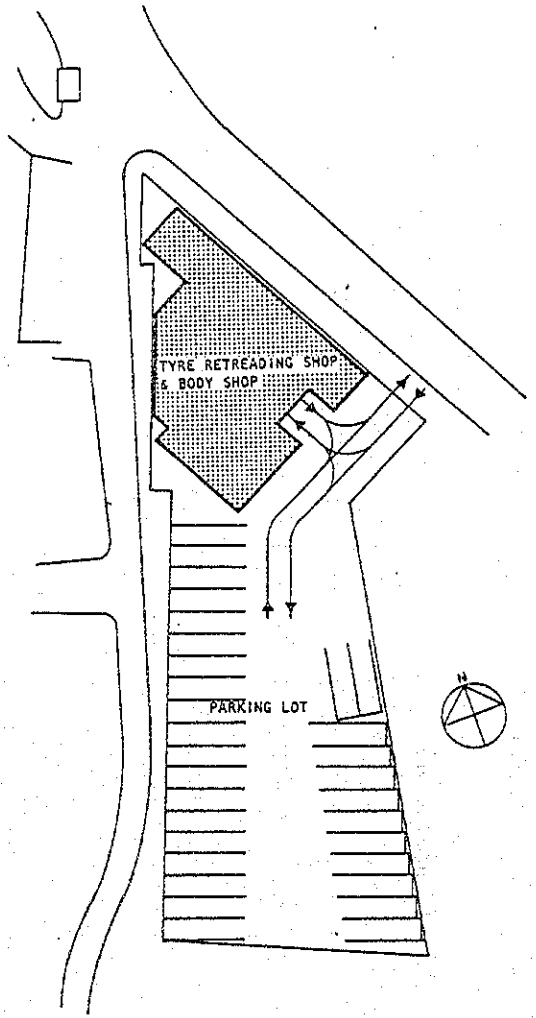
(i) Since the area where buses pass, such as parking lot is easily corroded from oil leakage, the entire area is paved with concrete as in the existing area.

(ii) Storm water drainage in this plan is combined with the existing drainage, and the last manhole is located at the northeast end of the site which is higher than the road level in order to prevent water backflow.

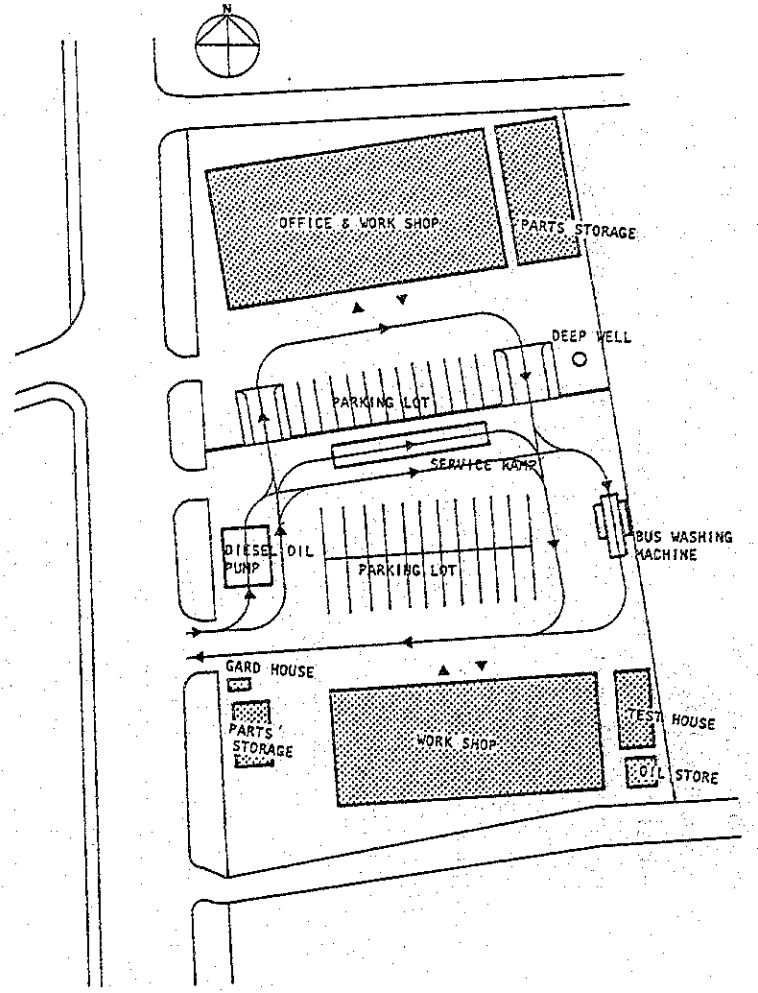
(b) Lagankhel site

(i) The parking lot is paved with concrete in the same way as the Pulchowk site.

(ii) Open ditches are provided around buildings to keep out storm water.



(Lagankhel Site)



(Pulchowk Site)

Fig. 12 Layout Plan

4.3.2 Building Plan

(1) Basic concept

(a) Heavy repair shop and administration office (Pulchowk site)

(i) In order to make maximum use of the site, the shop and office are contained in one building. But the shop area and the office area are clearly separated, and the circulation flow is separated to prevent accidents as well as to restrict entrance of unauthorized persons into the shop area.

(ii) To assure safety within the plant, passages and working area are clearly separated.

(b) Tyre retreading shop and body shop (Lagankhel site)

(i) The tyre retreading shop is planned to secure a smooth work flow. Also, sufficient area is secured to provide clearly separated passages.

(ii) In order to keep the tyre retreading shop clean, work places where dust is created are separately isolated within the shop.

(iii) Common equipment for the body shop and tyre retreading shop is located in one place.

(iv) In the body shop, ventilation is given priority in the design, but the sheet metal shop and the paint shop are considered separately.

(2) Floor plan

(a) Heavy repair shop and administration office (Pulchowk site)

(i) The heavy repair shop and the administration office are separated by locating the shop on the ground floor and the office on the first floor. The office is provided with an entrance which is entered directly from the street. The interface area between office personnel and shop workers including drivers is the traffic control room, cashier and training room. A route direct from these offices and shop is provided.

(ii) Different shops are located surrounding the repair shop, and a compact floor plan is designed with each shop having direct access to the repair shop.

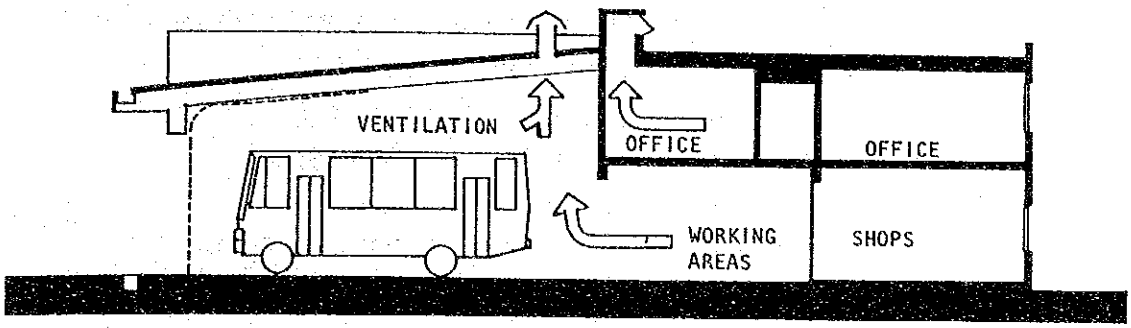
(b) Tyre retreading shop and body shop (Lagankhel site)

A plan is designed to provide a compact layout within the irregular site. Also, a buffer area is provided to prevent tyre retreading shop entrance and exit from directly crossing the bus flow.

(3) Elevation plan

(a) The exterior finish is with finishing bricks similar to the existing buildings to provide a uniform, well balanced design.

(b) Since the heavy repair shop and the administration office are combined in one building, the shop becomes covered, so forced ventilation is partially provided. Furthermore, since some of the administration departments do not face the outside, roof windows are installed to provide natural lighting and ventilation.



(c) The body shop is an open structure with a roof and simple wall to protect important parts of a bus body from wind and rain.

(4) Structure plan

(a) Basic plan

(i) The main structure is of reinforced concrete with steel beams for the ceiling of the shop area. The frame is a rigid structure with brick walls for exterior walls and partition walls.

(ii) Since the soil of the proposed site is expected to have sufficient load bearing power, a direct foundation is adopted.

(iii) Although Nepal is not an area with frequent earthquakes, there have been some severe earthquakes in the past, so seismic force is considered in all building design.

(b) Structure design

This design is based on the building code of Japan, but in view of local conditions, Indian standard has been incorporated in parts where it is desirable.

(i) Dead load

Dead load is calculated for structural members, finishing materials and other necessary loads.

(ii) Live load

Live load is calculated based on the load specified for different buildings and rooms in the building code of Japan.

(c) Structural members and others

The structure members are determined after taking into consideration the building size, structure, application together with quantity and quality of locally available materials and local building practice, as well as transportation and cost of imported materials, but it is considered that the following materials are suitable.

(i) Concrete

The supply of locally produced cement is unreliable and relies mostly on imported cement (Korea). Coarse and fine aggregates are locally available.

A batcher plant is planned for controlling concrete mix, and in view of the quality of local aggregates, a 28-day strength of 180 kg/cm² for ordinary concrete is considered suitable. Actually, the concrete mix will be determined after considering differences due to construction practice.

(ii) Steel bar

In view of the limited production capacity of local twisted bars, Japanese deformed bars SD30 are used.

Since most of the materials will be supplied from Japan, the specifications of the building code of Japan is applied for allowable stress of materials.

Unit: kg/cm²

Room	Floor, Joist	Beam, Column and Foundation	For Seismic Loads
Rooms for living purposes	180	130	60
Office and training rooms	300	180	80
Storage	500	400	200

(iii) Seismic load

According to the Indian Standard, Kathmandu is in zone V and the basic horizontal seismic factor is 0.08.

(iv) Wind load

$P = c \times q$

P = wind load kg/cm²
c = wind force factor
q = velocity force

According to the Indian Standard

q = 150 kg/cm² (c = 1.0)
c = building code of Japan

(v) Soil load bearing power

Since the soil is the same as the existing shop, load bearing power 8 t/m² (long term) is adopted.

(5) Electrical work

(a) Basic condition

Electrical work is based on Japanese electrical standards and regulations with due consideration for conditions in the Kingdom of Nepal. The specification for equipment and materials is the Japan Industrial Standard (JIS).

(b) Power station

From the site survey, it was found that power could be supplied at either 440 V/253 V, 3-phase, 4 W or 220 V/110 V, 1-phase, 3 W. A high tension power (11 kV) is received since voltage fluctuation is small and power supply is more stable, and the equipment load rate is high.

<<Pulchowk Site>>

Received power: 11 kV, 3-phase, 4 W, 50 Hz

Transformer: 11 kV/440-254 V, 3-phase, 4 W, 150 kVA 1 set

<<Lagankhel Site>>

Received power: 11 kV, 3-phase, 4 W, 50 Hz

Transformer: 11 kV/440-254 V, 3-phase, 4 W, 150 kVA 1 set

(c) Cable, power

The respective lighting panels and switchgear are connected to the power station panel by cable, and where necessary the cable is protected by cable conduit.

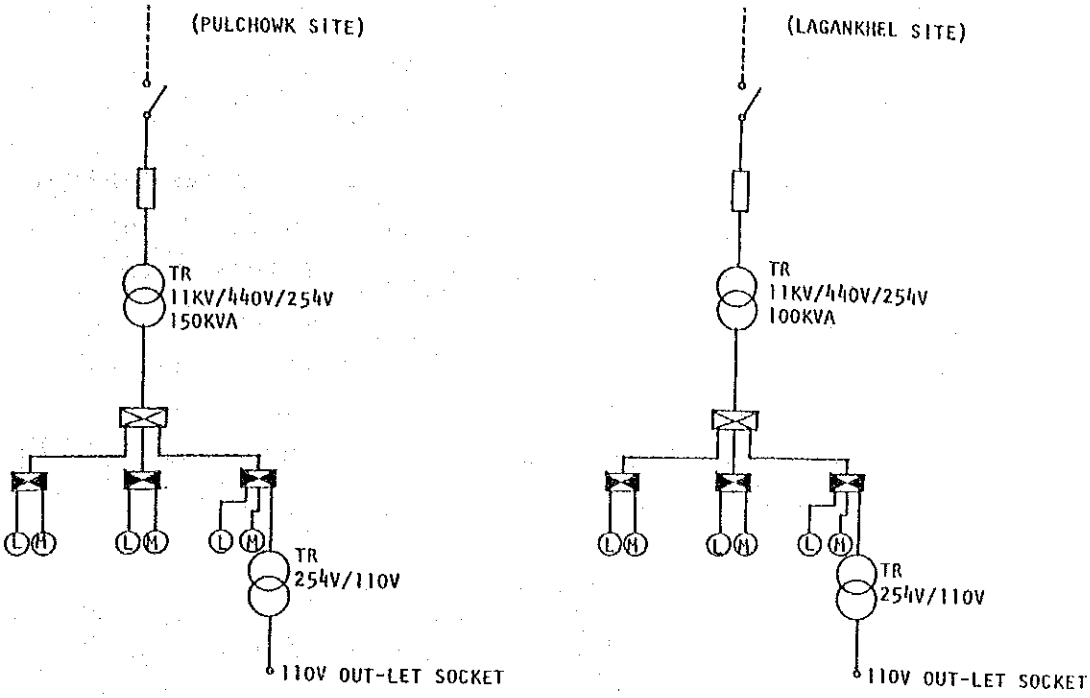
(d) Lighting

The lights are supplied at 220 V and lighting for different departments is supplied on the basis shown in Table 4-7.

Department	Light Equipment	Brightness (Lx)
Administration department	FL 40 W x 2 directly fixed V type	500
Work shop	FL 40 W x 2 directly fixed with reflector	300
Storage	FL 40 W x 2 directly fixed with reflector	150
Outside, parking lot	Sodium lamp 400 W x 2 Y type pole	10
Outside building flood light	Sodium lamp 1 kW x 2 flood light	

(e) Outlet

One-phase, 110 V outlets are provided as necessary in the administration department, storage and repair shop; a 3-phase, 440 V outlet is provided for necessary equipment and a 1-phase, 12 V outlet for battery recharging is provided in the battery room.



LOAD INTERRUPTER SWITCH

VCB:VACUUM CIRCUIT BREAKER

TR TRANSFORMER

DISTRIBUTION PANEL

POWER BOARD

Ⓜ MOTOR

Ⓛ LIGHTING

(f) Telephone

The office is provided with 3 direct circuits from the telephone exchange. In this project, only indoor wiring will be performed.

(6) Mechanical work

① Basic policy

Since standards and regulations relating to mechanical equipment is not established in the Kingdom of Nepal, the design of mechanical equipment will follow the standards for mechanical equipment in buildings established by the Ministry of Construction and the Society of Ventilation and Sanitary Engineering in Japan. Of course the local conditions of Nepal will be fully considered.

② Pulchowk site

(a) Water supply facility

(i) Water supply system

In view of the water supply condition in Nepal, the following system is planned:

- Water supply system for city water

City water is supplied through a 50 A branch pipe from the 125 A city water main to an underground water tank.

The water stored in the water tank is distributed to the drinking water line and to washing lines such as washing basins and showers by high pressure pumps. The distribution system is shown in Fig. 13.

- Water supply system for ground water

Water treatment equipment is provided for ground water. It is used for washing buses, flushing toilets and providing water during the dry season. The distribution system is shown in Fig. 14 which also shows the back-up system from city water during emergencies.

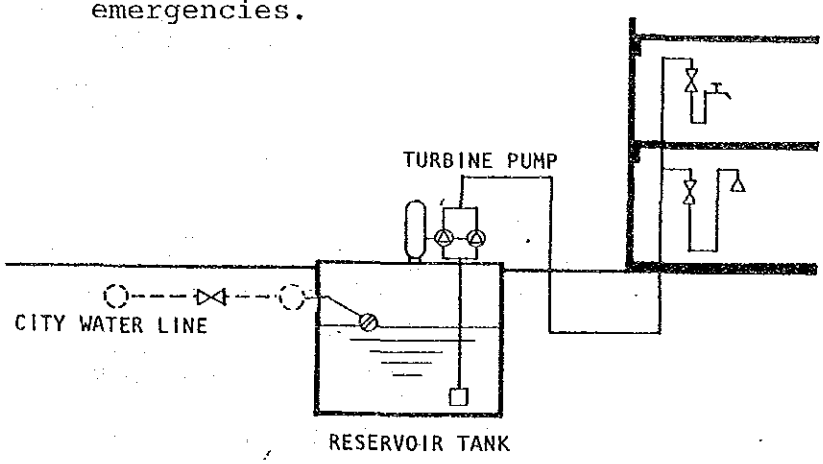


Fig. 13 City Water Distribution System

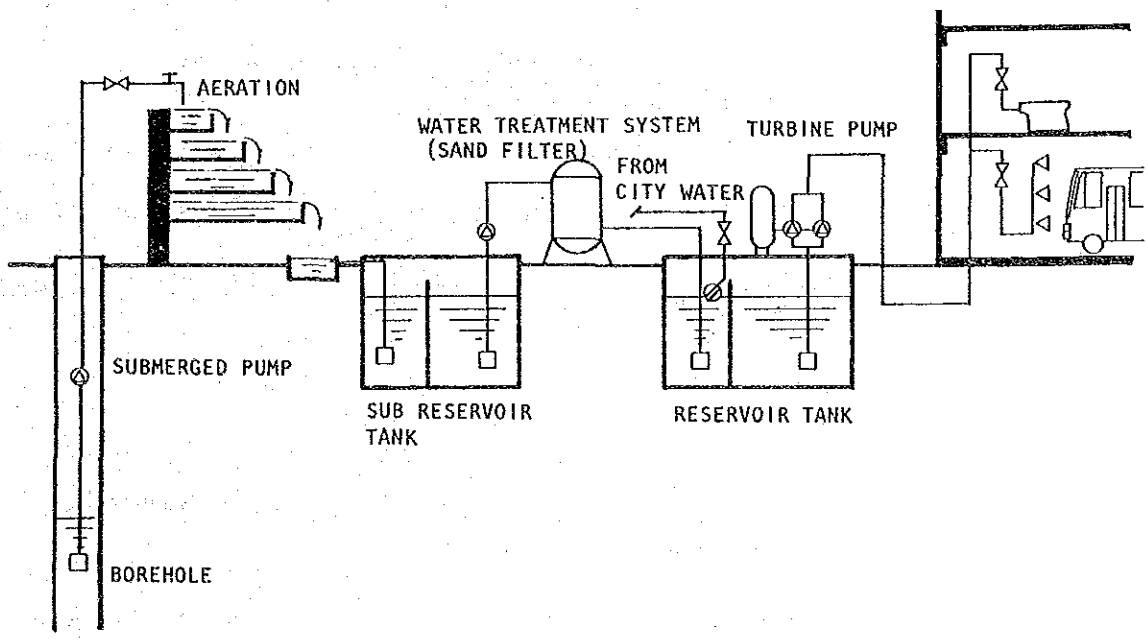


Fig. 14 Ground Water Distribution System

(ii) Planned water supply

City water

Water for employees		
180 persons x 50 ℓ/man-day	=	9,000 ℓ/day
Water for shower		
35 persons x 60 ℓ/man-day	=	2,100 ℓ/day
Water for washing bus parts		
110 buses x 0.05 x 360 ℓ/bus	=	2,000 ℓ/day
Total		13.1 m³/day

Ground water

Water for toilet		
180 persons x 60 ℓ/man-day	=	10,800 ℓ/day
Water for washing bus		
110 buses x 200 ℓ/bus x 0.9	=	19,800 ℓ/day
Water for washing bus interior		
110 buses x 100 ℓ/bus x 0.9	=	9,980 ℓ/day
High pressure washing stand		
110 buses x 0.9 ÷ 4 days x 256 ℓ/bus	=	6,600 ℓ/day
Water for washing floor		3,000 ℓ/day
Total		50.1 m³/day

(iii) Water tank capacity

A water tank is designed to cover one day supply, but a water tank for city water will carry two days supply.

Water tank for city water	30 tons x 1
Water tank for ground water	55 tons x 1

(iv) High pressure water pump

The pump for city water will have the following capacity.

Capacity shall be sufficient to cover the maximum hourly consumption.

(21,800 ℓ/day ÷ 8 h) x 2 ÷ 60 min = 95 ℓ/min

High pressure pump

32 A x 95 ℓ/min x 25 m x 1.5 kW x 3 ϕ
x 440 V x 5 Hz

Operation method

Alternate operation of pumps installed in parallel

(v) Supply plan of ground water

(Described in detail in 4.3.4 Water Supply Facility.)

(b) Drainage system

Drainage pipelines inside the building are separated into a contaminated sewage pipeline and a washing sewage pipeline. Since there are no drainage system within the site, contaminated sewage is first treated in a septic tank then discharged into the drainage ditch outside the site, while washing sewage is discharged directly into the drainage ditch. Since sewage from the workshop contains oil, oil is first removed in an oil trap then discharged to the drainage ditch. Storm water in the site is also separately drained into the outside drainage ditch.

(i) Sewage treatment

Sewage treatment is designed in accordance with the building code of Japan and the JIS standards.

Treatment method: Septic tank

Capacity: For 100 persons

(c) Hot water supply

Hot water is supplied through two systems; an electric water heater with a tank for the chief engineer room on the first floor and another for the general manager room on the second floor, while a central supply system from the solar panel will supply hot water to the shower room.

(i) Electric water heater

Floor type electric water heater with a tank.

Hot water capacity: 20 ℓ

Power requirement: 3 ϕ x 440 V x 15 kW

(ii) Solar panel

A flat type solar panel is placed on the roof to supply hot water to shower.

Heating panel: Flat type

Type: Natural circulation equipped with reflecting plates

Capacity of heat collecting panel: 9 ℓ

Effective water capacity: 200 ℓ

Number of sets: 6 sets

(d) Sanitary equipment

Low water consumption type sanitary equipment is adopted for water conservation. Toilets, washing basins, cleaning water outlets, taps and shower heads are installed as necessary.

(e) Fire fighting equipment

The following fire equipment in accordance with Japanese fire fighting codes are installed for early stage fire fighting.

Powder fire extinguishers are installed around the workshop.

(f) Heating and cooling equipment

Ceiling fans are provided in all rooms, and outlets for electric heaters are provided in all rooms.

(g) Ventilation

Ventilation is provided mainly by natural ventilation but, mechanical ventilation is provided for the following rooms:

Ceiling ventilation fan: Workshops

Ceiling fan and ventilation fan:
Storages, mechanical rooms, electrical rooms, locker rooms and toilets

③ Lagankhel site

(a) Water supply facility

(i) Water supply system

City water is supplied through a 40 A branch pipe from the city water main to a water tank. Water stored in the water tank is distributed by a high pressure pump.

(ii) Planned water supply

Water for employees
30 persons x 100 ℓ/man-day = 3,000 ℓ/day

Water for tyre retreading
1 machine x 50 ℓ/h x 8 h/day = 400 ℓ/day

water for other purposes 600 ℓ/day

Total 4.0 m^3/day

(iii) Water tank capacity

In view of the city water supply condition, the water tank is designed to cover double the planned water supply.

Water tank capacity 10 tons x 1

(iv) High pressure water pumps

The water pump will have the following capacity.

Capacity shall be sufficient to cover the maximum hourly consumption.

(4,000 ℓ/day x 8 h/day) x 2 ÷ 60 mm/h
= 20 ℓ/min

High pressure pump

32 A x 20 ℓ/min x 20 m x 0.75 kW x 3 φ x 440 V x 50 Hz

Operation method

Alternate operation of pumps installed in parallel.

(b) Drainage system

Drainage pipelines inside the building are inseparated into a contaminated sewage pipeline and a washing sewage pipeline. Contaminated sewage is first treated in a septic tank then discharged into the drainage ditch outside the site while washing sewage is discharged directly into the drainage ditch. Oil contained sewage from the paint shop is first passed through an oil trap to remove oil and is then discharged into the drainage ditch. Storm water in the site is also separately discharged into the outside drainage ditch.

(i) Sewage treatment

Sewage treatment is designed in accordance with the building code of Japan and the JIS standards.

Treatment method: Septic tank
Capacity: For 30 persons

(c) Hot water supply

Hot water to the shower room is supplied from a solar panel. No back-up heater is provided.

Heating panel: Flat type

Type: Natural circulation with reflecting plates

Capacity of heat collecting panel: 9 ℓ

Effective water capacity: 200 ℓ

Number of sets: 5 sets

(d) Sanitary equipment

Low water consumption type sanitary equipment is adopted for water conservation. Toilets, washing basins, cleaning water outlets, taps and shower heads are installed as necessary.

(e) Fire fighting equipment

The following fire fighting equipment in accordance with Japanese fire fighting codes are installed for early stage fire fighting.

Powder fire extinguishers

Powder fire extinguishers are installed around the workshop.

(f) Heating and cooling equipment

Ceiling fans are provided in office rooms and rest rooms and an outlet for oil heaters are provided in all rooms.

(g) Ventilation

Ventilation is mainly provided by natural ventilation, but mechanical ventilation is provided for the following rooms:

Ceiling ventilation fan: Tyre retreading shop

Ceiling fan and ventilation fan:
Boiler room, compressor room, toilet and shower room

(h) Others

(i) Boiler

The existing boiler is modified with piping and wiring to provide steam for the tyre retreading plant. The specifications are given below.

Steam boiler (existing)	rated capacity (steam)	500 kg/h
	fuel consumption	115 kg/h
	maximum pressure	7 kg/CM2G
	operating pressure	6 kg/CM2G
Oil tank (new)	type	underground
	capacity	5,000 ℓ
oil service tank (new)	capacity	150 ℓ
	stand	height: 1,500 mm
Others (new)	oil gear pump	
	water softener	
	steam header	

(ii) Air compressor

The existing air compressor is repaired for usage at the tyre retreading plant after installing piping and wiring. The specification of the compressor is as follows:

Compressor (existing): output 7.5 kW x 2 sets
Others (newly installed): header, etc.

(7) Building materials and construction equipment

(a) Basic condition

Based on the site survey, construction materials are selected according to the following basis.

(i) Materials easy to maintain and repair

(ii) Local materials, when supply is reliable and prices are competitive

(iii) Materials suitable for local conditions, and rational work methods

(iv) Sturdy materials which do not easily become dirty.

(b) Exterior finishing material

① Heavy repair shop and administration office

(i) Exterior wall: Architectural bricks

(ii) Roof: Reinforced concrete structures; asphalt waterproof layer covered with concrete steel structures: long corrugated iron sheets

② Tyre retreading shop

(i) Exterior wall: Architectural bricks

(ii) Roof: Long corrugated steel sheets

③ Body shop

(i) Roof: Long corrugated steel sheets

(c) Interior finish

(i) Heavy repair shop

Room	Floor	Skirt	Wall	Ceiling
Ground floor				
Repair shop	Steel trowelled concrete with surface hardener finish	Mortar VP	Mortar VP	Long steel sheet, end exposed
Machine washing room	ditto	ditto	ditto	Concrete finish EP
Engine over-haul room	ditto	ditto	ditto	ditto
Electric shop	ditto	ditto	ditto	ditto
Machine shop	ditto	ditto	ditto	ditto
Parts store	ditto	ditto	ditto	ditto
Oil storage	ditto	ditto	ditto	ditto
Tool storage	ditto	ditto	ditto	ditto
Air compressor room	Steel trowelled concrete	ditto	ditto	Cement, wood shaving panel
Power house	ditto	ditto	ditto	ditto
Clinic	Terrazzo	Terrazzo	ditto	Sound absorption board
Workshop record	ditto	ditto	Mortar EP	ditto

Room	Floor	Skirt	Wall	Ceiling
Chief engineer room	Terrazzo	Terrazzo	Mortar EP	Sound absorption board
Engineer room	ditto	ditto	ditto	ditto
Workers rest room	ditto	ditto	ditto	ditto
WC, shower room	Ceramic tile		Ceramic tile	Hardboard EP
First floor				
Locker room	Terrazzo	Terrazzo	Mortar EP	Sound absorption board
Bed room	ditto	ditto	ditto	ditto

(ii) Administration department

Room	Floor	Skirt	Wall	Ceiling
Ground floor				
Vestibule	Terrazzo	Terrazzo	Mortar EP	Sound absorption board
First floor				
General manager room, Chief officers room, Secretary room	ditto	ditto	ditto	ditto
Meeting room (1)	ditto	ditto	ditto	ditto
Meeting room (2)	ditto	ditto	ditto	ditto
Office rooms, Training room	ditto	ditto	ditto	ditto
WC	Ceramic tile		Ceramic tile	Hardboard EP
Water heating room, hall	Terrazzo	Terrazzo	Mortar VP	ditto

(iii) Tyre retreading shop

Room	Floor	Skirt	Wall	Ceiling
Shop	Steel trowelled concrete with surface hardener finish	Mortar VP	Mortar VP	Steel sheet roofing
Boiler room	Steel trowelled concrete	ditto	ditto	ditto
Air-compressor room	ditto	ditto	ditto	ditto

(iv) Body shop

Room	Floor	Skirt	Wall	Ceiling
Sheet metal shop, Paint shop	Steel trowelled concrete with surface		Partially long corrugated steel sheet	Steel sheet roofing
Administration room	Terrazzo	Terrazzo	Mortar EP	Sound absorption board
Locker room	ditto	ditto	ditto	ditto
Paint storage	Steel trowelled concrete	Mortar VP	Mortar VP	Cement, wood shaving panel
Power house	ditto	ditto	ditto	ditto

4.3.3 Tools, Machinery and Equipment

In accordance with 4.1 Basic Policy, the following tools, machines and equipment are selected.

Location	Equipment	Number
Heavy repair shop	Crankshaft grinder	1
	Cylinder boring machine	2
	Cylinder honing machine	1
	Twin post lift	2
	Air-compressor	3
	Portal crane	1
	Brake drum lathe	1
	Wheel balancer	1
	Tyre changer	1
	Tyre cart	1
	Air tower	4
	Tube fuser	3
	Air joint set	2
	Tyre bead remover	1
	Diesel smoke meter	1
	HC/CO tester	1
Body shop	Air welder 300 amp. with accessories	2
Training room	Copy machine	1
	Overhead projector	1
Parking lot	Bus washing machine	1
	Fuel supply equipment (addition)	1

4.3.4 Water Supply Facility

(1) Design of deep tube well facility

The geology of this project site is a thick layer of alluvial formation of the quaternary period. The upper 200 m is covered with lake and marsh deposits consisting of impermeable soil such as clay and silt, and the lower part consists of semi-permeable to permeable soil such as sand and silty sand. These soils are mixtures of organic matters, iron, and mica. Ground water in this formation contains much iron, manganese, ammonia, etc. The deep ground water is under a pressurized condition and in the neighborhood of the project site, the static water level rises up to 20 m below ground level. (Refer to 3.3.3 (4),(c).)

In view of such geological and water conditions, the deep tube well facilities for this project are designed as described below.

(a) Since the depth of good water containing formation was estimated as 200 m, a 250 m depth well is planned.

(b) The deep well is a cased type well consisting of a casing pipe/screen pipe for the entire length to prevent soil from collapsing and clay, mica, etc. from entering the well. Also a 4" gravel bed is installed around the pipe and the gravel diameter/slit diameter are made as small as possible. A 1.6 mm slit diameter is adopted since it is the smallest size available locally.

(c) From the results of existing wells, water volume and drop of water level caused by pumping is selected as shown below to determine the depth of housing casing and pump position.

Depth of housing casing
= natural water level + drop of water level caused by pumping + safety factor

where

Water volume = 27.6 m^3/day/m = 19 ℓ/min

Required water volume = 50.0 m^3/day = 104.2 ℓ/min
= 110 ℓ/min

Operating time = 8 hours

Drop of water level = 110 ℓ/min ÷ 19 ℓ/min/m
= 5.8 m

Safety factor = 15 m (Analysis accuracy)
+ 10 m (seasonal fluctuation)
= 25 m

(d) Ground water volume from one deep tube well is estimated as 19 ℓ/min/m which is sufficient to satisfy the water requirement.

(e) Water treatment equipment consisting of aeration and sand filters is installed to improve water quality.

The construction of a deep water tube well based on the above study is shown in Fig. 14.

(2) Submerged water pump

In view of the planned water supply and location of the submerged water pump for the deep tube well, the following capacity is necessary. (Refer to 4-3-2 (6).)

Pump specification: 150 ℓ/min x H 70 m x 3.7 kW
x 50 Hz x 254 V

Together with the pump, a power control panel, a water level detector with automatic shutdown device, a 55 m water riser pipe of 50 mm diameter, a pipe band, a sluice valve and other standard accessories are provided.

(3) Water pump (ground water)

One pump for pumping water to the sand filter and one pump for pumping water to the automatic bus washing machine are necessary. The specifications of both pumps, determined by the ground water supply and the automatic bus washing machine capacities, are as given below.

Water pump for sand filter

. Water supply:
50,000 ℓ ÷ 8 hours ÷ 60 minutes x 2 = 208 ℓ/minutes

. Capacity:
40 A x 200 ℓ/minutes x 20 m x 3.7 kW x 254 V
x 50 Hz

Water pump for automatic bus washing machine

. Water supply:
200 ℓ/bus x 70 seconds/bus x 60 seconds
= 233 ℓ/minutes

. Capacity:
40 A x 200 ℓ/minutes x 3.7 kW x 254 V x 50 Hz

(4) Sand filter

Water treatment equipment operates only during daytime, and all ground water is received during this period. In view of the Sajha Yatayat management capacity, the selected filter equipment is limited to a sand filter with washing device. Capacity filter; 50.0 m^3 ÷ 8 hours x 1.5 = 9.4 m^3/hours

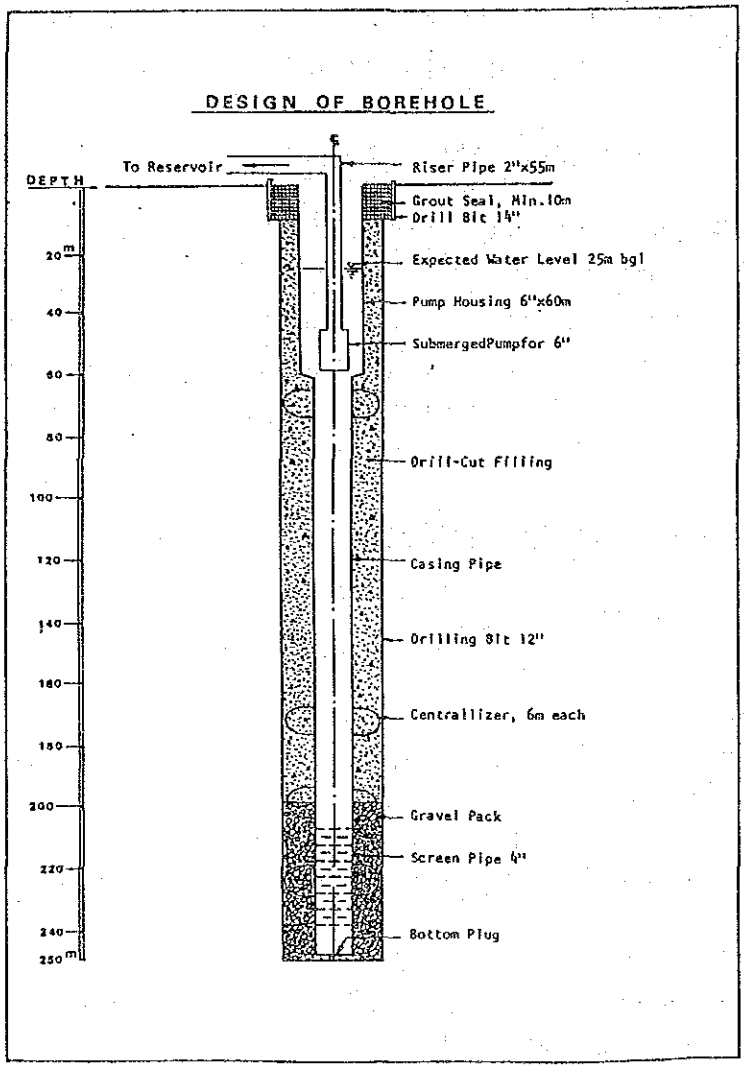


Fig. 15 Design of Borehole

4.3.5 Basic Design Drawing

(1) Floor area table

Site	Building	Structure, height	Total floor area
Pulchowk site	Heavy repair shop, administration department	Reinforced concrete, 2 stories	2,363 m²
Lagankhel site	Tyre retreading shop, body shop	Reinforced concrete, 1 story	650.6 m²
Total			3,013.6 m²

(2) Drawing list

(a) Pulchowk site

(i) Layout, scale: 1/500

(ii) Heavy repair shop, administration department first floor plan, scale: 1/200

(iii) Heavy repair shop, administration department second floor plan, scale: 1/200

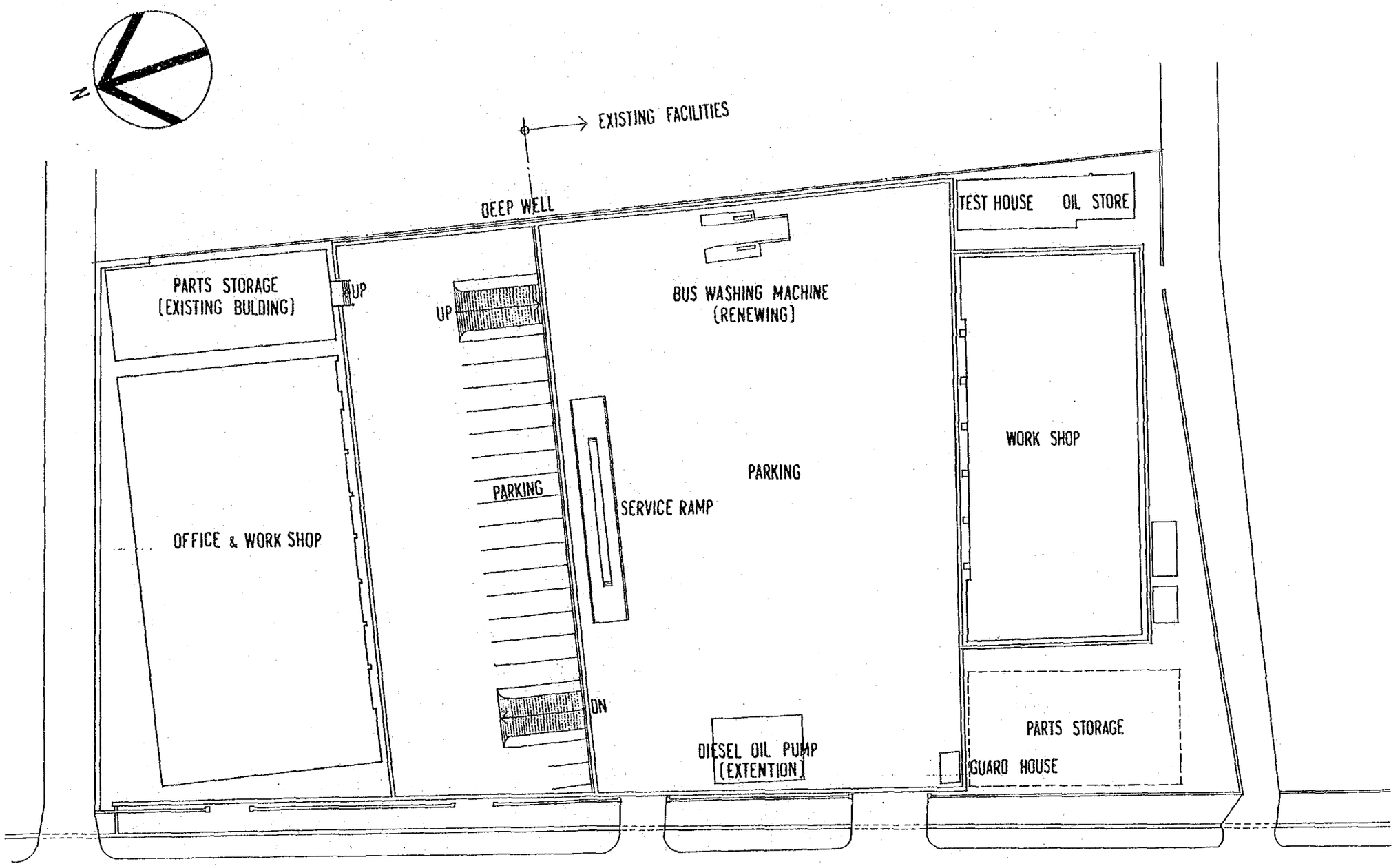
(iv) Heavy repair shop, administration department elevation, section, scale: 1/200

(b) Lagankhel site

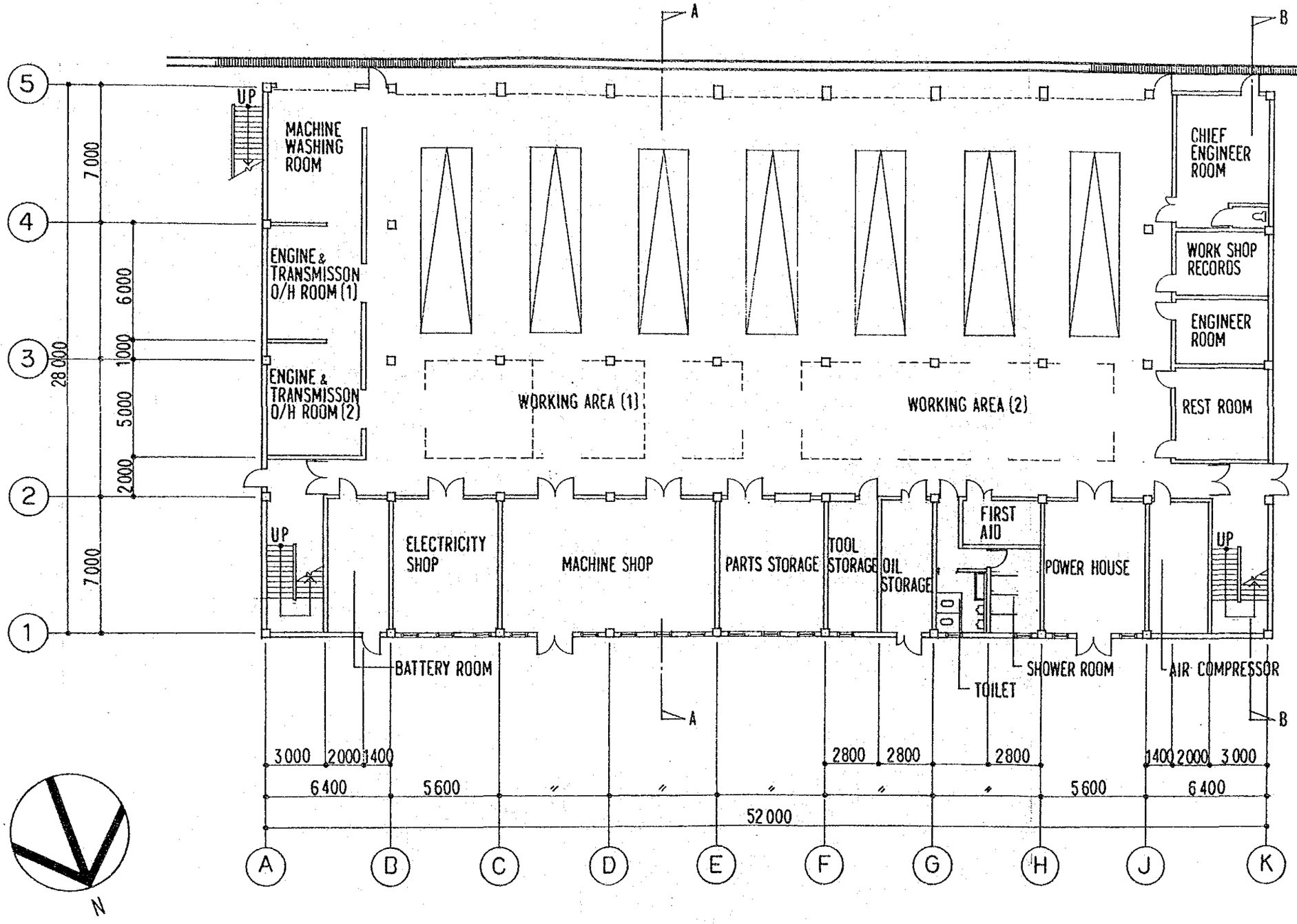
(i) Layout, scale: 1/500

(ii) Tyre retreading shop, body shop first floor plan, scale: 1/200

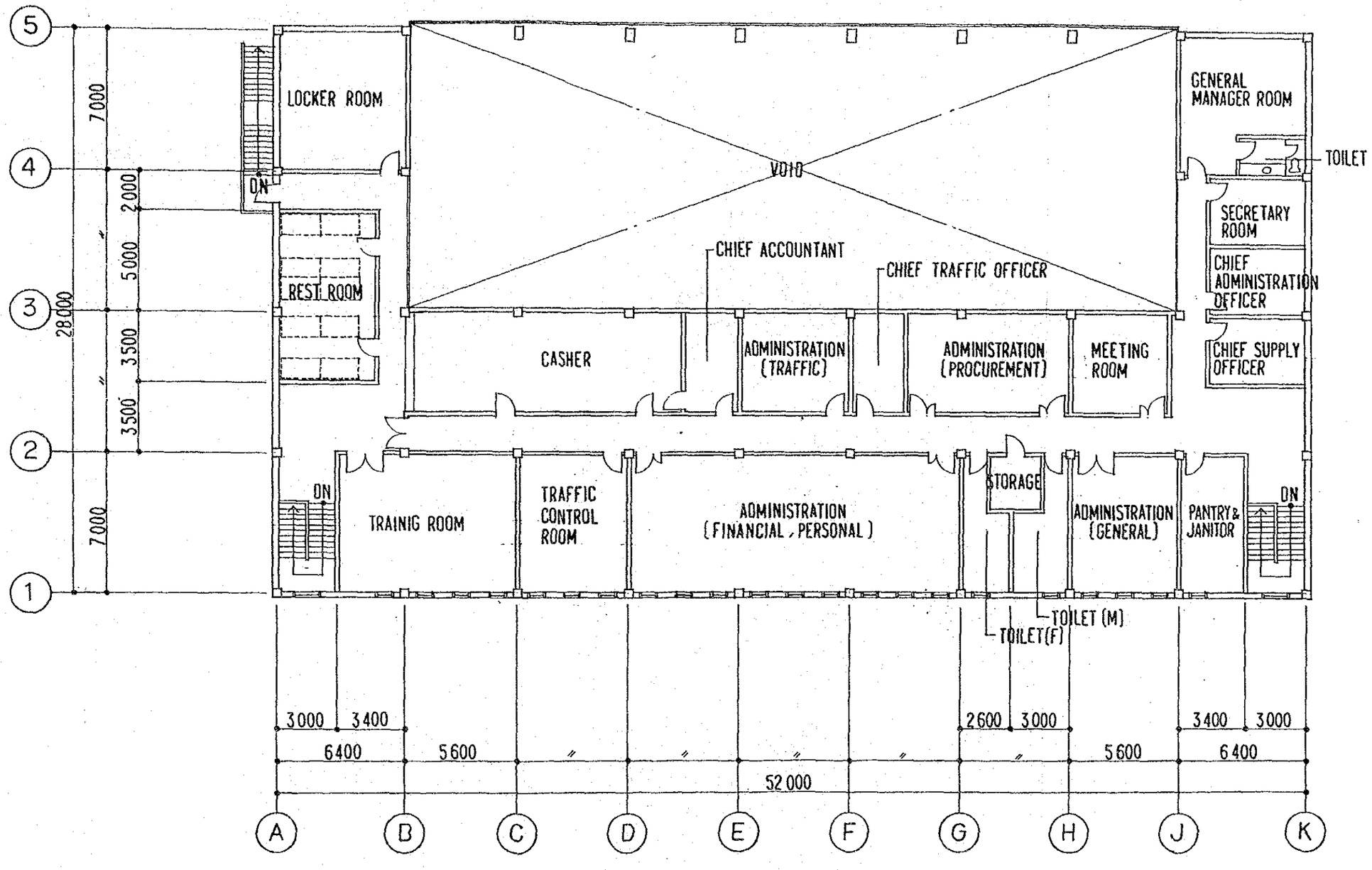
(iii) Tyre retreading shop, body shop elevation, section, scale: 1/200



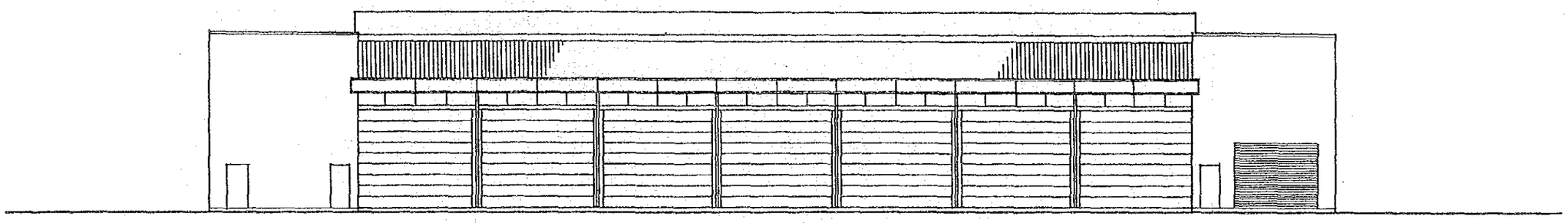
SITE PLAN S=1/500



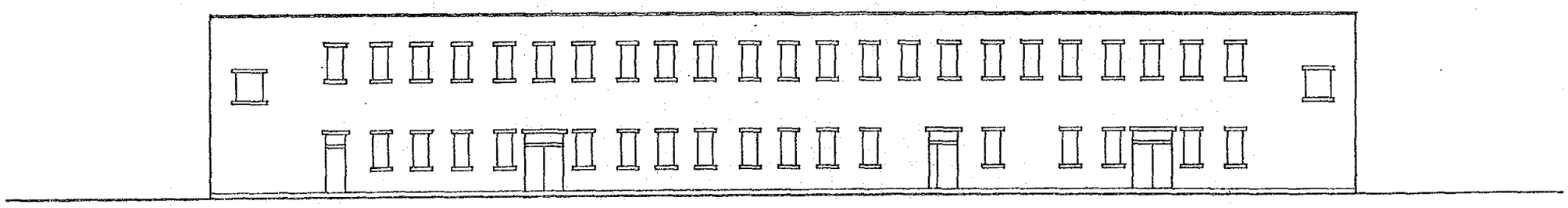
GROUND FLOOR PLAN S=1/200



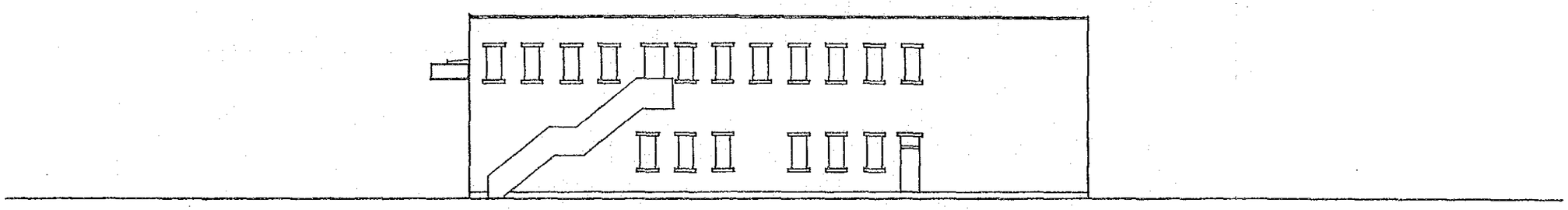
1ST FLOOR PLAN S=1/200



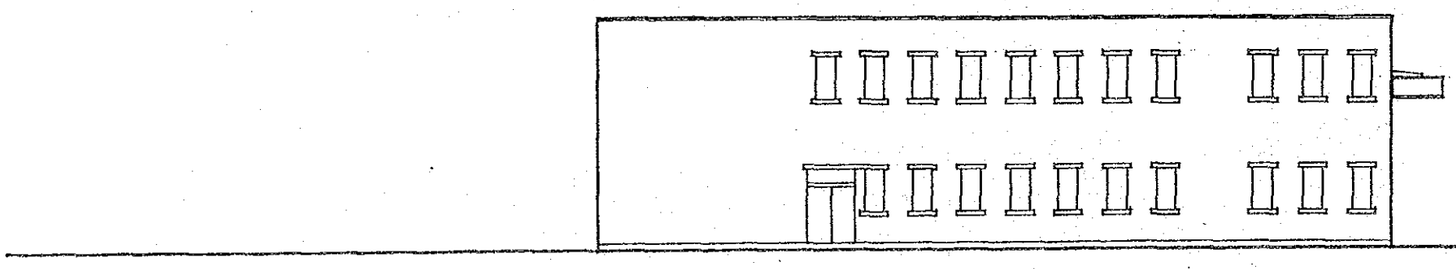
SOUTH ELEVATION S=1/200



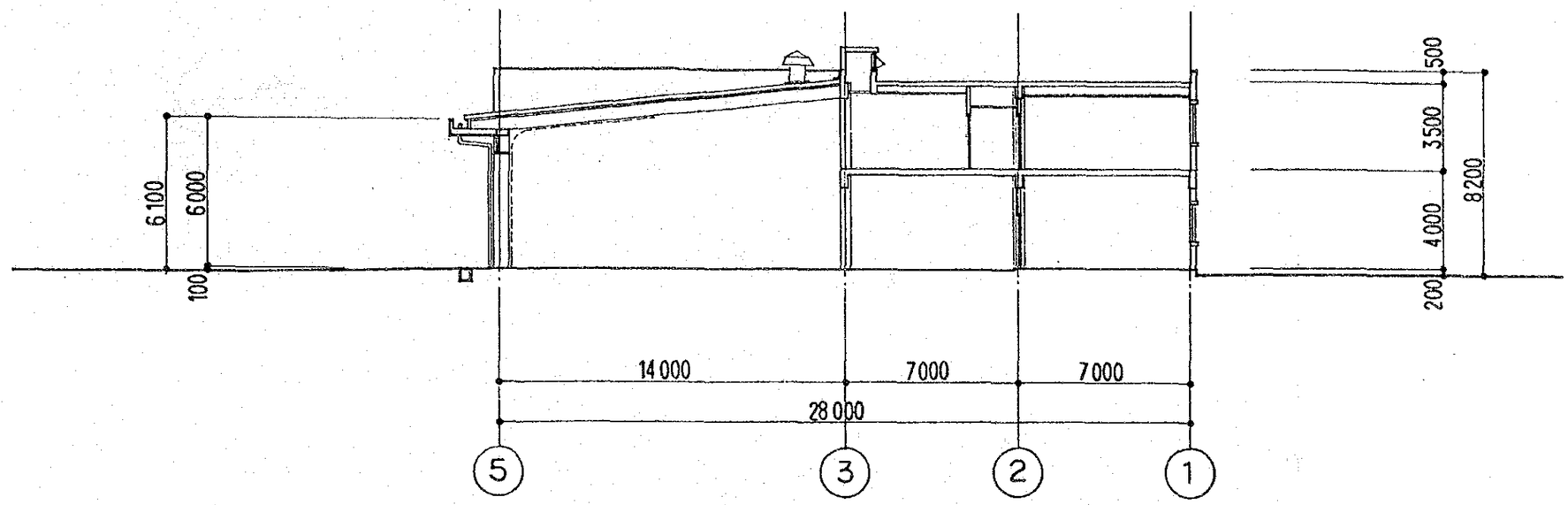
NORTH ELEVATION S=1/200



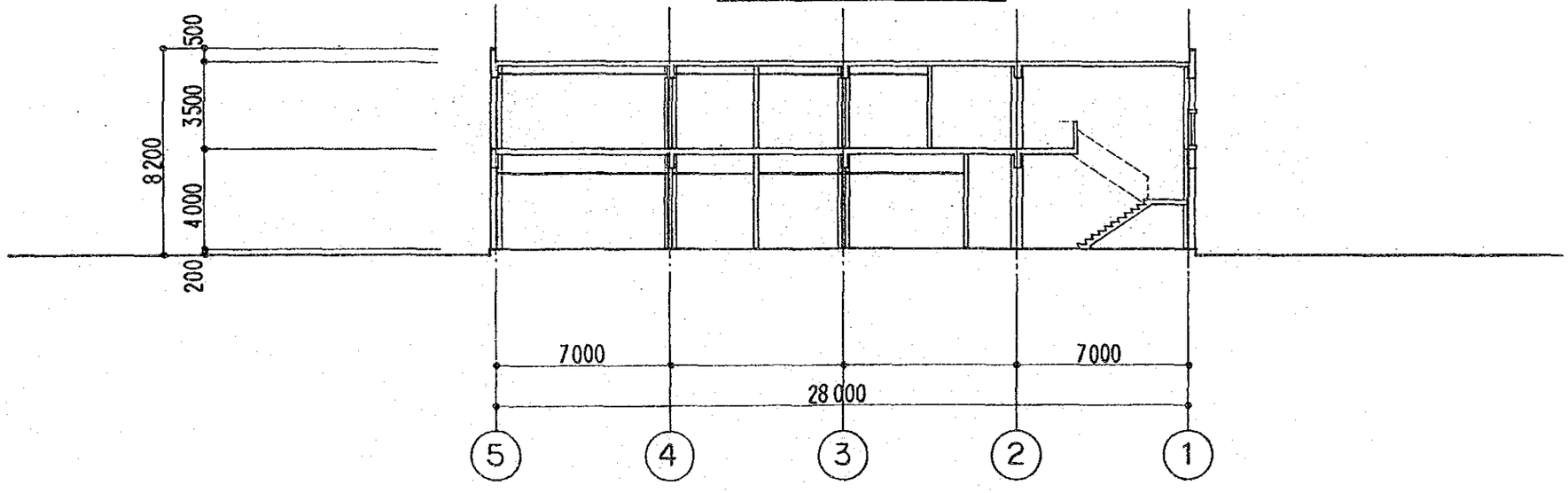
EAST ELEVATION S=1/200



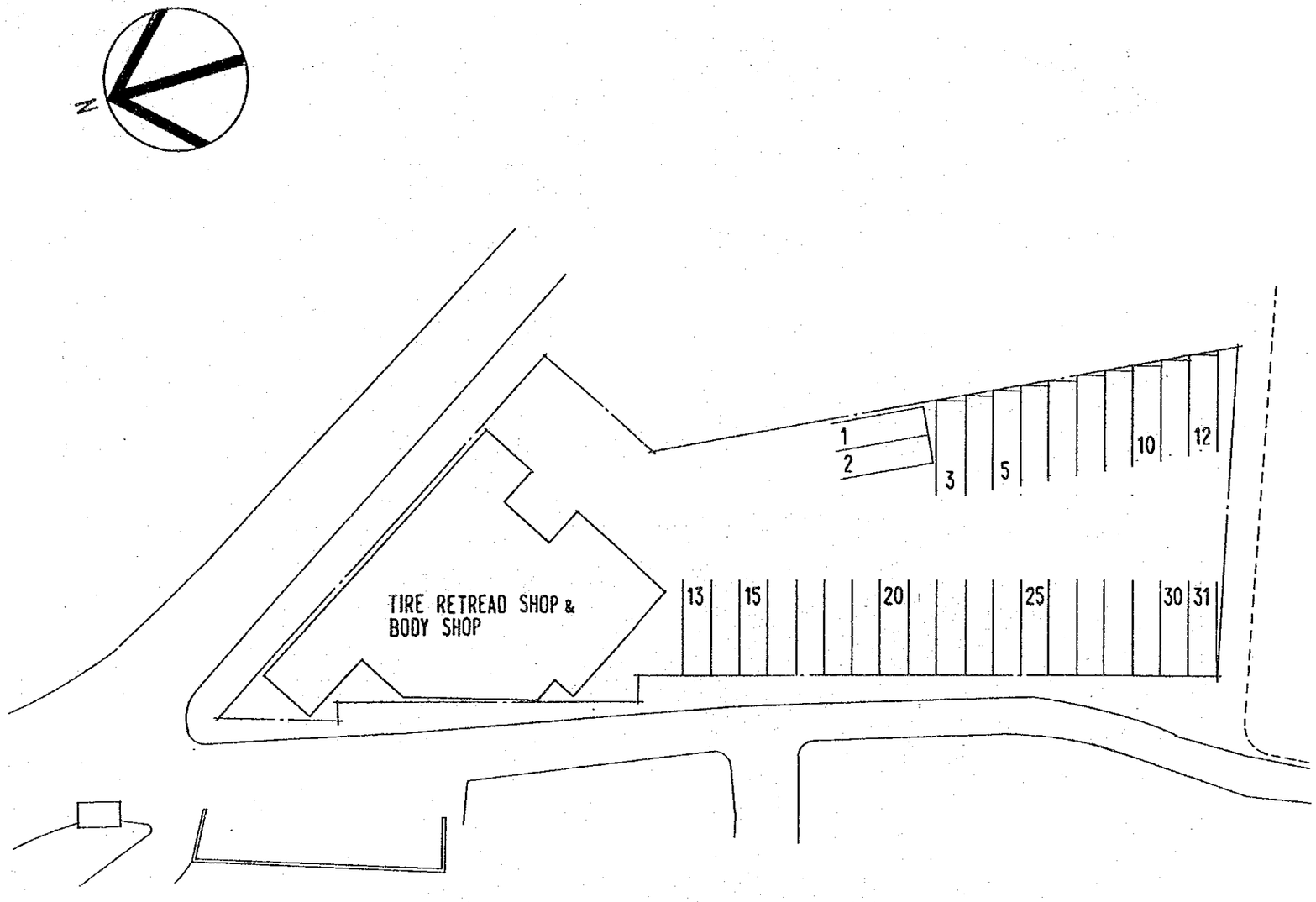
WEST ELEVATION S=1/200



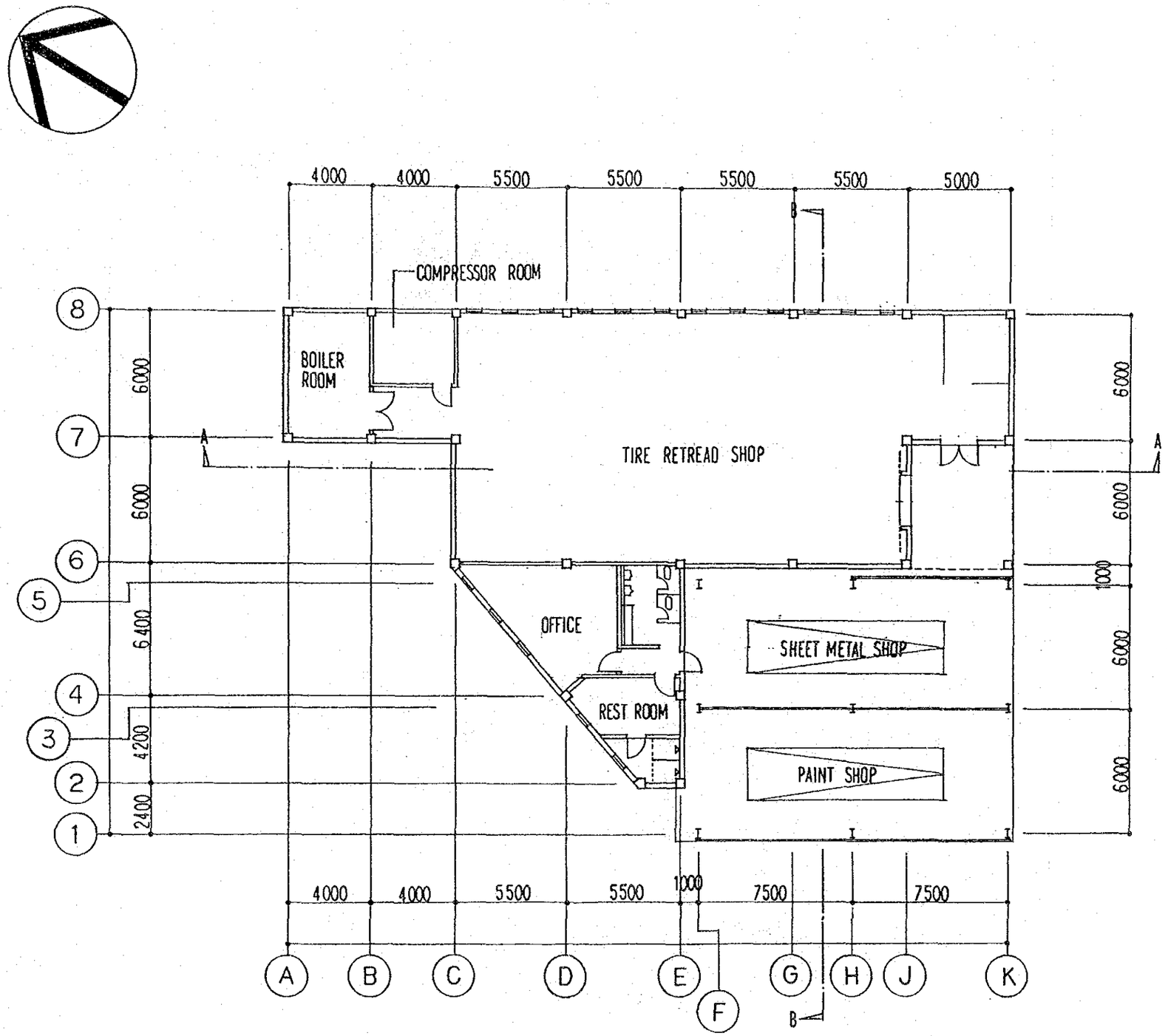
A-A SECTION S=1/200



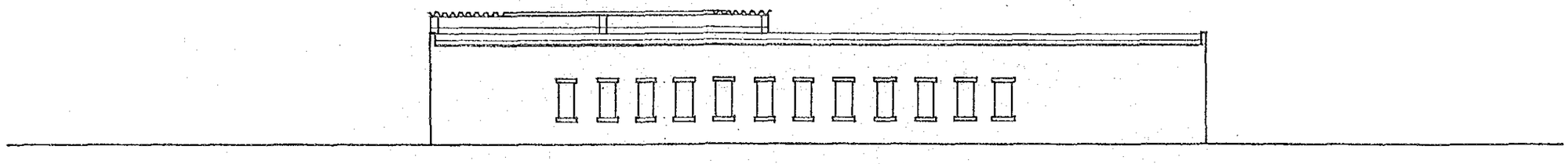
B-B SECTION S=1/200



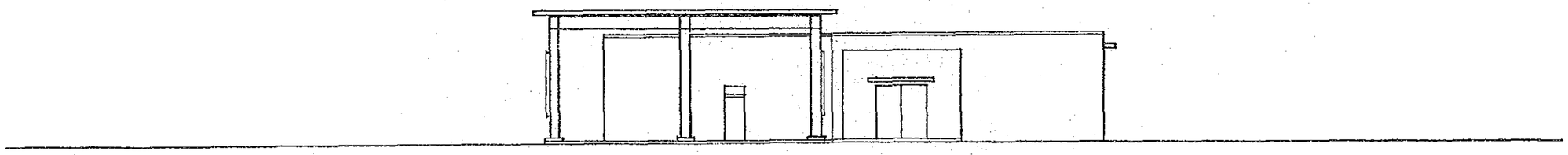
SITE PLAN S=1/500



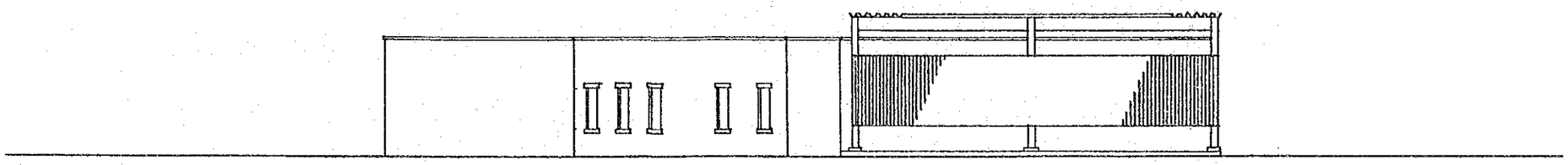
GROUND FLOOR PLAN S=1/200



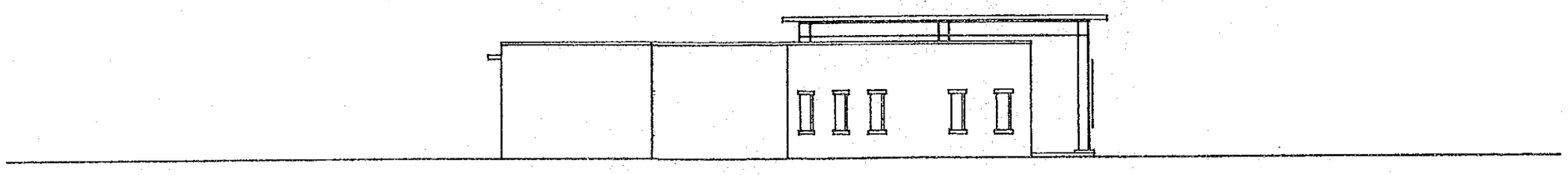
NORTH WEST ELEVATION S 1/200



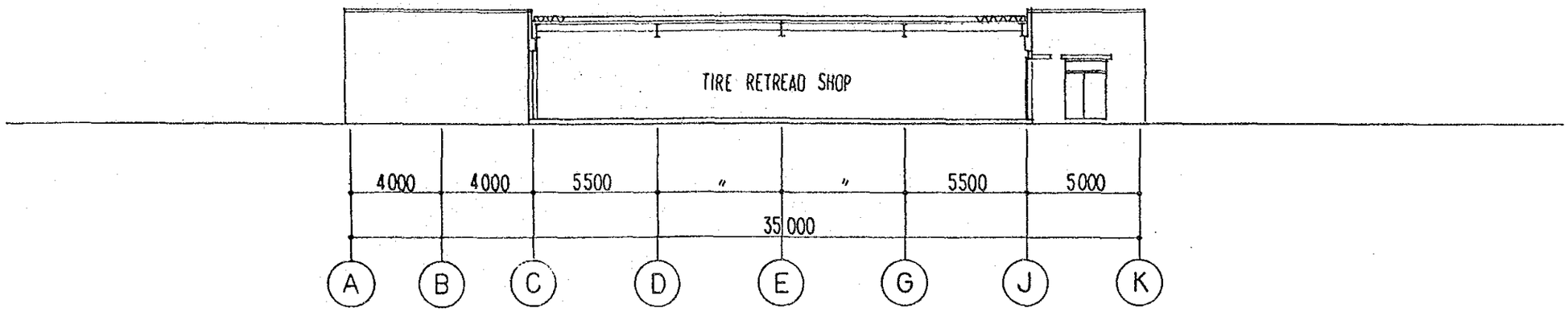
SOUTH WEST ELEVATION S 1/200



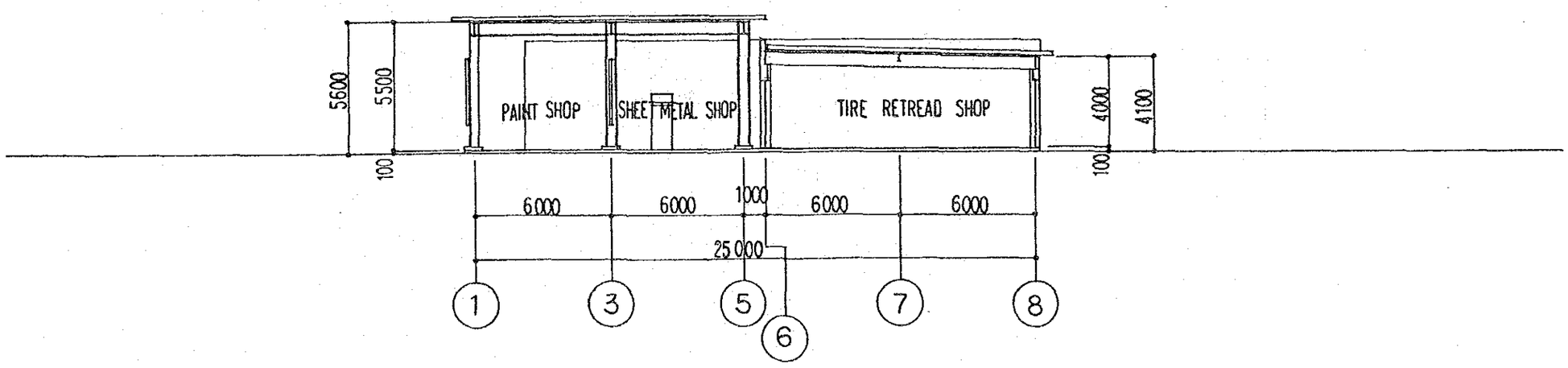
SOUTH EAST ELEVATION S 1/200



NORTH EAST ELEVATION S 1/200



A - A SECTION S=1/200



B - B SECTION S=1/200