BASIC DESIGN STUDY ON THE ESTABLISHMENT PROJECT OF THE GENERAL HOSPITAL IN SANTA CRUZ, THE REPUBLIC OF BOLIVIA

March, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Bolivia, the Government of Japan decided to conduct a survey on the Establishment Project of the General Hospital in Santa Cruz and entrusted the survey to the Japan International Cooperation Agency (JICA). The J I C A sent to Bolivia a survey team headed by Dr. Satoru Nakamura, Professor of Hospital Administration, Tokyo Medical College, from 19th October to 17th November, 1982.

The team had discussions with the officials concerned of the Government of Bolivia and conducted a field survey in Santa Cruz. After the team returned to Japan, further studies were made and 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 the Government of the Republic of Bolivia for their close cooperation extended to the team.

March , 1983

Keisuke Arita

President

Japan International Cooperation Agency

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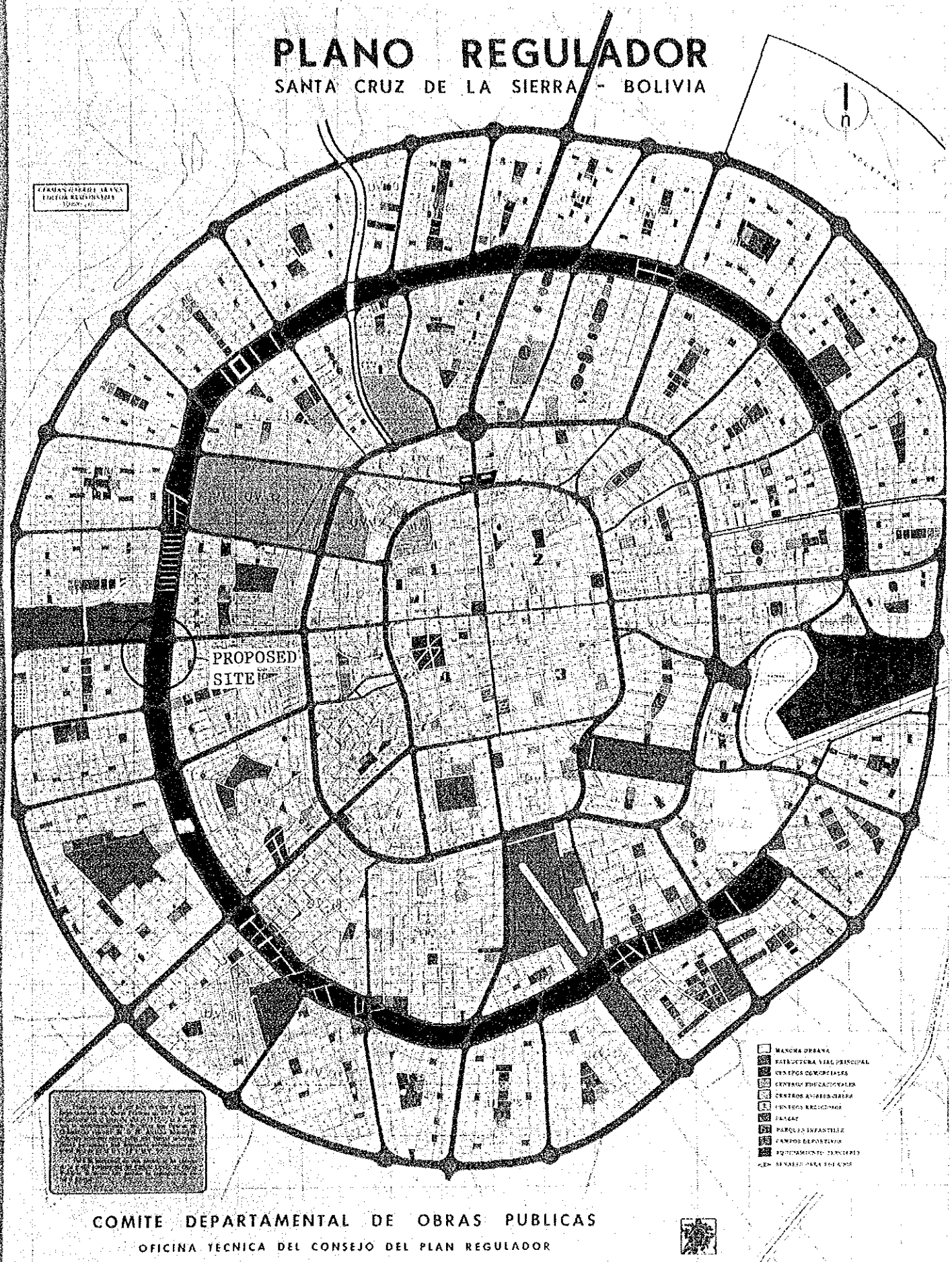

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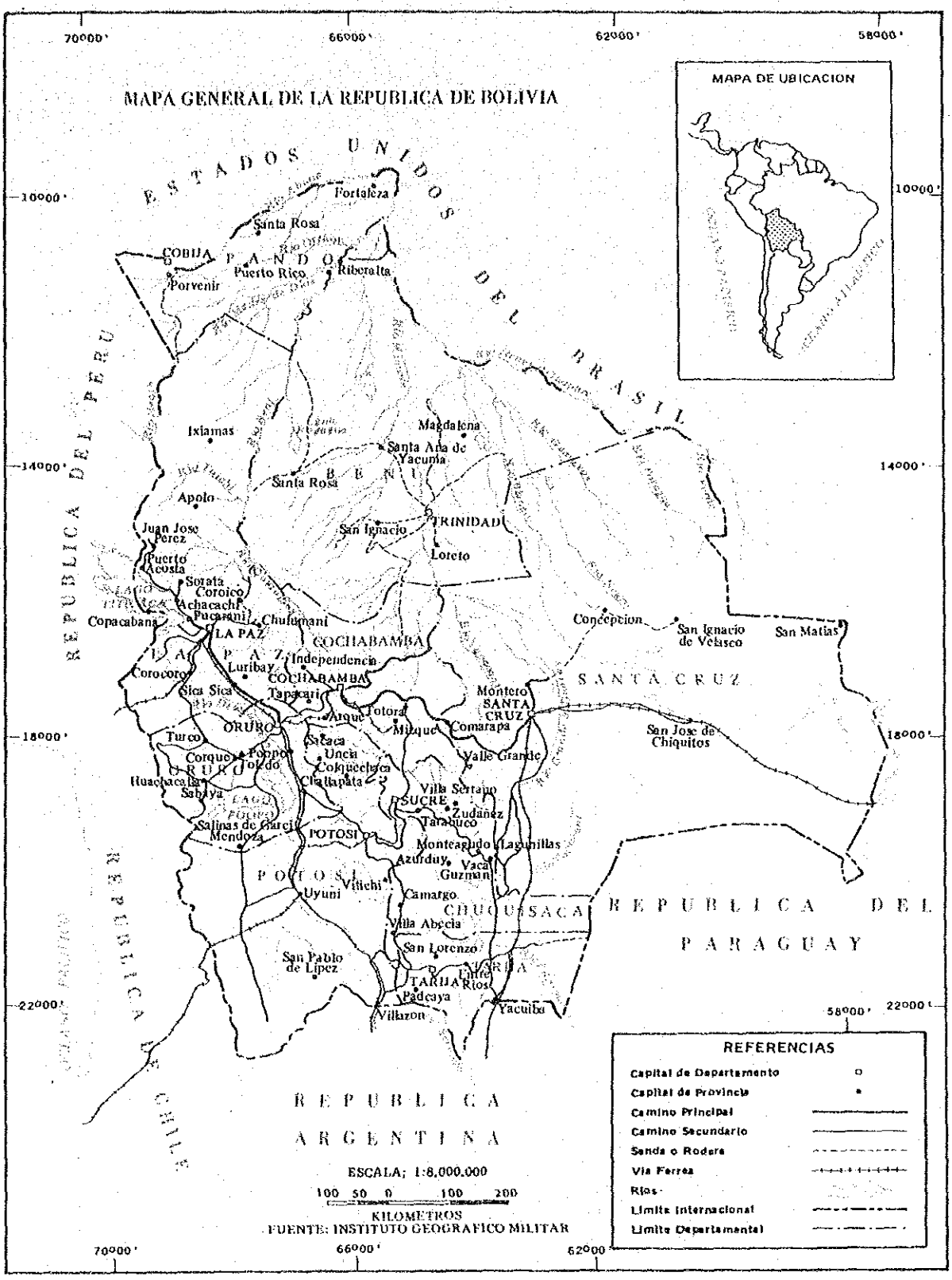
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SUMMARY

Summary

At the request of the Government of the Republic of Bolivia, the Government of Japan has agreed to consider the proposed construction of a new general hospital in Santa Cruz as a grant-aid cooperation project for fiscal year 1983. The Japan International Cooperation Agency (JICA) was asked to conduct a basic design survey.

The JICA sent a survey team, headed by Professor Satoru Nakamura of Tokyo Medical College, to Bolivia from October 19 to November 17, 1982. The team studied the background, the scope, the administration and the management of the plan and had consultations with the Bolivian governmental agencies concerned.

This report has been compiled from the results of the survey.

The State of Santa Cruz, where the proposed general hospital is to be constructed, occupies one-third of the total land area of Bolivia. The total population of 330,000 of Santa Cruz City ranks next to La Paz, the capital.

Agriculture and stock-farming have developed on the vast and fertile plain, turning the State into a center of food supply for the whole country. The State also produces petroleum and natural gas. Thus, the State has established itself as the center of the Bolivian economy.

As a result of this active economic activity, the city has been expanding. Due to a marked influx of population, the city has seen an annual population increase of 7.2%. This rate of increase is the highest among the cities of South America and the total population is expected to reach 440,000 by 1985.

With the expansion of the city, urban development has been in progress. However, national medical facilities for low and medium income groups, which account for the majority of the population, are obsolete, and incapable of coping with the drastic population increase and urban sprawl.

The only national general hospital in the city, converted from a monastry constructed in 1900, is clearly obsolete. With inadequate facilities and equipment, it can hardly play the role of a regional core hospital. In actual fact, it seems to form a source of cross infection.

The facilities at the National Children's Hospital are also obsolete, it being 34 years since the hospital was established. As a result, both infectious and non-infectious children are accommodated in the same ward. Since these are the conditions of the existing national hospitals, there is a strong need to construct a new national general hospital in Santa Cruz.

Based on the details of the Bolivian request and the results of the field survey, the survey team has produced a basic design outlining the scope and size of the proposed general hospital. The basic suggestions are as follows:

(1) The general hospital should consist primarily of Internal Medicine, General Surgery and Pediatrics departments.

(2) The capacity should be 200 beds, considered to be the minimum size for a general hospital. However, a future increase of 200 beds should be made possible.

(3) The Central Diagnosis Department should have facilities for coping with a future capacity of 400 beds.

(4) Construction, facilities and equipment should be planned for ease of maintenance and supervision.

(5) The hospital plan should allow for future expansion and remodeling of its facilities to keep up with future economic development and advancements in medical technology.

(6) Natural conditions should be fully considered. Local techniques and materials should be adopted as much as possible to reduce construction costs.

When this hospital is complete and starts operating smoothly, it is expected not only to reinforce the medical services for the city of Santa Cruz, but also to raise the level of medical services for the State as a whole.

However, as the Bolivian medical services are faced with various problems, the administration and management of the proposed general hospital are expected to face the difficulties outlined below.

(1) Administration and management

The position of the present project in the plans for Bolivian medical care in general should be established as soon as possible by the Bolivian Government.

Although the original idea was that this project would be managed by a committee formed by various related organizations in the State of Santa Cruz under the administration of the Ministry of Health, it is strongly expected that the negotiations proceed smoothly and the final agreement is reached between the two parties.

(2) Operating budget

The management of the proposed hospital is estimated to cost 430 million pesos per annum.

The Bolivian policy is that personnel and food costs required for the management of the proposed hospital will be borne by the Ministry of Health and all other expenses by related organizations of the State of Santa Cruz.

The distributions of the burden among the related organizations should be determined.

(3) Recruitment of personnel

The proposed hospital is expected to require a minimum staff of 300 persons, i.e., 50 full-time physicians, 120 nurses, 20 laboratory technicians (including assistants) and the 100 in administration and service sectors.

In view of the present condition of medical care in the State of Santa Cruz, and in Bolivia in general, recruitment of fully

qualified paramedicals and nurses is expected to prove difficult.

The Bolivian side is studying a 3-hour shift system for physicians. However, it is felt that the use of full-time physicians will be necessary.

1. INTRODUCTION

CHAPTER 1 INTRODUCTION

The Government of the Republic of Bolivia (referred to below as Bolivia) intends to provide better medical care by improving its system of medical services and facilities. There have been marked increases in population due to drastic influxes of people especially in Santa Cruz City, the capital of Santa Cruz, the largest state in Bolivia. Consequently, the expansion and improvement of medical facilities as social assets appropriate to the rapid expansion of this city have long been awaited in Bolivia.

With this background, at the end of January 1981 the Bolivian Government requested grant-aid cooperation from the Japanese Government in the construction of a new Santa Cruz General Hospital. This was followed in March 1982 by another request from the Bolivian Government in more concrete terms.

Upon these requests, the Japanese Government sent through the Japan International Cooperation Agency a Basic Design Survey Team headed by Dr. Satoru Nakamura, professor at Tokyo Medical College. This team stayed in Bolivia from October 19 to November 17, 1982, in order to evaluate the suitability of the proposed hospital construction.

In the course of the present survey, basic agreement was reached on the scope and method of grant-aid cooperation, as well as on the basic concept of the proposed hospital. The survey also covered local building conditions and related information.

This report has now been compiled from the results of the survey.

The Japanese Government has agreed to consider this project as a grant-aid cooperation project for fiscal year 1983. The Japan International Cooperation Agency was thus asked to conduct a basic design survey to determine the scope of the project.

The JICA sent a survey team, headed by Professor Satoru Nakamura of Tokyo Medical College, to Bolivia from October 19 to November 17, 1982. The team studied the background, the scope and the management of the project consulting with the Bolivian authorities concerned.

This report has been compiled from the results of the survey.

2. BACKGROUND OF THE PROJECT

2–1 General Outline of the Country

2–2 Brief Description of Santa Cruz

2–3 Local Medical Care

2–4 Requests by Bolivia

CHAPTER 2 BACKGROUND OF THE PROJECT

2-1 General Outline of the Country

Bolivia is situated in the midwest of South America. It is a landlocked country, surrounded by Brazil, Peru, Chile, Argentina and Paraguay. The country's total area is 1.09 million square km (about three times that of Japan), a third of which is made up of highland valleys and about two-thirds consisting of lowland plains. The highlands are arid and cool, whereas the lowlands are tropical or subtropical. Bolivia has a population of 5,570,000 (about 1/20 of Japan's population), 80% of whom inhabit highlands 2,500m above sea level. Indians of Aymara and Quechua extraction account for 55%, Mestizos 30% and Spaniards and other whites 15% of the population. In 1981, per capita annual income was US$570 and the literacy rate 36.7%.

2-2 Brief Description of Santa Cruz

The State of Santa Cruz is situated in the eastern part of Bolivia and occupies a third of the country. It is about the same size as Japan and it is the largest state in Bolivia. It borders on Brazil to the northeast and Paraguay to the southeast, across the vast Gran Chaco plain that spreads through Bolivia and Paraguay. The northern part is connected to the State of Beni along the Rio Grande, a tributary of the Amazon, and this area is low and swampy. The state's topography is almost level, 300∿500m above sea level, except for the western region which reaches the mountains of Cochabamba State. It is a torrid zone of high temperature and humidity.

The population of the state was about 86,000 in 1980, mostly concentrated in Santa Cruz City and the surrounding urban area. Santa Cruz City, or more properly Santa Cruz de la Sierra, is the state capital and Bolivia's second city after La Paz, having a population of 330,000 (in 1980). Santa Cruz City was developed in a low plain, 440m above sea level, while other major cities, such as La Paz, Cochabamba, Sucre and Oruro, are situated in mountainous areas about 3,000m above sea level.

Agriculture and stock-farming have been developed on the level and vast fertile land, so the state has established itself as Bolivia's food source. Petroleum and natural gas are produced and exported to Brazil and Argentina.

Santa Cruz City is economically more active than other areas of the country. The area has a strong sense of autonomy since it possesses more land and is richer than the other mountainous areas, as well as being greatly different in climate.

In recent years the influx of population to the city has been remarkable. The population is increasing by 7.2% annually: one of the highest rates in South America. In 1985, state's population is expected to be 440,000.

On the completion of Viru Viru International Airport, now being constructed to the north of the city, Santa Cruz will serve as a central entrepôt for the South America continent, and the scale of the state's structure and economy should expand rapidly.

2–3 Local Medical Care

(1) Conditions of Medical Care in Bolivia

The total population of Bolivia is 5,500,000, half of which is under 15 years old. The birthrate is 2.8%, about twice that of Japan; and the mortality rate of 2.0% is a little over three times that of Japan. The mortality rate for infants is very high; 231 of every 1,000 babies are said to die before the age of three.

According to Bolivian hospital statistics, the principal causes of death were:

1. pneumonia;
2. pulmonary tuberculosis;
3. forms of diarrhea.

From the Andes Mountains to the tropical lowlands, Bolivia has a varied climate, which makes the disease patterns of each region more intricate.

The total number of the country's medical facilities is 1,451,

the number of sickbeds 12,251, and there are 2,836 doctors, 1,359 dentists and 4,286 nurses. The average life span is 46.7 years.

The basis of medical and health services is a system of a public medical service, social and other types of insurance and free medical treatment. With the majority of the people being in poverty, the national hospitals, while serving as university teaching hospitals, provide free medical treatment under the Ministry of Health. Only three universities, La Paz, Sucre and Cochabamba, are equipped with medical schools.

Physicians working at the national hospitals work for other medical institutions or are in private practice outside hospital hours.

Public hygiene and preventive medicine are administered by local administrative bodies, planned and guided by the Ministry of Health. In reality, however, as medical and health services are inadequate and with medical facilities functioning unsatisfactorily, qualified manpower is not effectively employed, leading to a brain drain. Furthermore, many people cannot receive medical and health services, and at the same time there are many in the low-income bracket who simply lack knowledge about medical and health services.

Of the 3 million people living in rural areas, 1 million can receive vaccination or health education; but the remaining 2 million are not served at all by medical or health services.

The social health system covers only stable businesses and government employees. It has only 1 million members, one-fifth of the total population.

The Bolivian Ministry of Health has been endeavoring since 1976 to improve the regional system of medical and health services. For rural areas, in particular, the Ministry is planning to cover 3 million rural residents with medical services provided through 100 Centros de Salud Hospitalaria and other facilities:

Puesto Sanitario - 1 for each area of population less than 200,
Puesto Medico - 1 for each area of population of 200∿2,000;
Centro de Salud Hospitalaria - 1 for each area of population c. 30,000.

This regional health service network is intended to cover 80∿90% of preventive medicine, also providing 70% of medical treatment, with the remaining 30% covered by regional core hospitals.

The hospitals are broadly divisible into three types: national, social insurance and private. In the national hospitals, examination and treatment fees are determined by a social casework system based on ranking of 5∿7 grades (0∿100%) according to the patient's income level. As a result, the national hospitals tend to handle the low-income stratum.

Public welfare accounted for 11.9% of the total national budget for 1980; but the ratio fell to 6.8% in 1981 and to 2.2% in 1982. Improvement and management of national hospitals thus became increasingly difficult. Following the shift from military to civil administration in October 1982, the proportion of the national budget spent on public welfare is expected to increase.

Preventive medicine is lagging behind because of the insufficient public welfare budget and the lack of sanitary administration. The national medical facilities generally serve for primary care or secondary functions at most. Since medical insurance is undeveloped, medical expenses are high relative to the average income. Consequently medical facilities are used only when the patient's condition has deteriorated, and people tend not to take advantage of early diagnosis and treatment.

The dispensary and medical practice system is specialized and patients themselves purchase the medicine they take, and medicines and medical equipment are mostly imported: additional financial burdens for patients because of the recent currency devaluation against the dollar.

On the other hand, modern medical facilities are plentiful in social insurance hospitals and private hospitals for people in the upper income brackets: this is a major difference between national and other hospitals.

(2) Medical Care in Santa Cruz

According to Santa Cruz State statistics, the principal causes of death are:

1. accidents;

2. dysentery and forms of diarrhea;

3. diphtheria, tetanus, scarlet fever etc.

Apart from the accident rate, this pattern is typical of tropical areas.

The state has about 500 registered doctors, 120 qualified nurses and 500 assistant nurses. The numbers of qualified and assistant nurses are quite small. About 60% of the total medical staff is concentrated in Santa Cruz City. In Santa Cruz State there are about 1,620 registered sickbeds, but the population is such that there are 1.84 beds for 1,000 people, a greatly insufficient ratio.

Some hospitals in Santa Cruz City are run by the Ministry of Health, Santa Cruz Health Bureau, such as:

The National General Hospital (Hospital San Juán de Dios);

The National Children's Hospital (Hospital de Niños);

The National Maternity Hospital (Instituto de Maternidád);

The Cancer Institute (Instituto Oncologíco);

others are controlled by the insurance associations of public corporations, such as:

The Petroleum Corporation Hospital (Hospital Caja Petrolera S. S.);

The National Insurance Hospital (Hospital Caja Nacional S.S.);

The Railway Corporation Hospital (Hospital Caja Ferroviaria S. S.).

In Santa Cruz there are also national clinics and public health centers run by the Health Bureau, the Red Cross and the Public Corporation Insurance Association.

Of the above facilities, the National General Hospital, which is to form the regional core, has 432 beds and treats 7,000 inpatients per year. The facility, originally a religious house established in 1909, has deteriorated considerably.

The National Children's Hospital was founded in 1948, but deterioration due to dirt and humidity is noticeable. It has 145 beds, but it is a grossly inadequate institution where infants with and without infectious diseases are often placed in the same ward. These national hospitals, which depend on the Ministry of Health budget, have had their funds reduced and therefore do not have sufficient medical

facilities, catering only for lower-income patients.

The Petroleum Corporation Hospital was completed in 1973 and has 100 beds. It prides itself on its modern facilities and efficient medical equipment, and so is the most reliable hospital in Santa Cruz, treating people in middle and high income brackets. However, those able to benefit from the good medical facilities in the Petroleum Corporation Hospital or in the private hospitals are limited to a small circle.

2-4 Requests by Bolivia

In such social and medical conditions, the Bolivian Government has strongly felt the need for the improvement and expansion of the Santa Cruz General Hospital as the "core" hospital for the fast-growing state.

In January 1981 and March 1982, the Bolivian Government requested grant-aid cooperation from the Japanese Government for the establishment of the proposed hospital.

The Bolivian request concerns the construction of a modern general hospital with a capacity of 350 beds, centering around three departments, Internal Medicine, General Surgery and Pediatrics, in Santa Cruz. It lists five reasons for the necessity of such a hospital:

1) The present condition of national medical facilities cannot cope with the drastic population increase in Santa Cruz;
2) The only national general hospital in Santa Cruz (Hospital San Juan de Dios) is now obsolete;
3) Modern medical facilities are needed where young, foreign-trained medical personnel can work to their fullest ability;
4) A modern hospital is needed as the basis for regional medical services and also as the core hospital for the region;
5) Internal medicine and surgery departments account for 60% of the total beds in Santa Cruz administered by the Ministry of Health. With the obsolescence of the National Children's Hospital, improvement is strongly needed in three departments, Internal Medicine, General Surgery and Pediatrics.

3. OUTLINE OF THE PROPOSED SITE

3–1 Proposed Construction Site

3–2 Natural Conditions

3–3 City Planning and Related Regulations

3–4 Infrastructure of the Surrounding Area

3–5 Local Building Conditions

3–6 Local Construction Cost

CHAPTER 3 OUTLINE OF THE PROPOSED SITE

3–1 Proposed Construction Site

The proposed construction site for this hospital is 2.4 km from the center of Santa Cruz City to the west on Av. Kennedy and faces the Interno and Externo (inner and outer roadways) of 3º Anillo (No. 3 Loop Road). The site measures about 200m × 150m or 30,897m^2. The site was purchased by Santa Cruz City and the state of Santa Cruz Development Corporation (CORDECRUZ) and donated to the Ministry of Health. According to the urban plan of the Municipal Planning Agency, the area between Interno and Externo of 3º Anillo is reserved for public use. In the near future (3∿5 years), 3º Anillo will be completed as a one-way street for Interno and Externo. The area around the site is residential.

The site is largely flat and is low for the city: about 4.0 m lower than the center. According to information obtained at the site, is often covered with about 50 cm of water during the rainy season. Tropical evergreens such as mangoes, palms and tamarinds grow on the site. According to a survey, there are about 70 trees with trunks of about 50 cm diameter and their density is estimated at about 15 per area of 20 m × 20 m. They are about 50∿100 years old and about 20 m high.

Transport to the site is by municipal bus traveling through Av. Kennedy and 3º Anillo.

3–2 Natural Conditions

(1) Climate of Santa Cruz City

The city is situated in the tropics and has an average temperature of 27°C in summer and 20°C in winter. The average maximum temperature is 31°C in summer and 24°C in winter, and the average minimum temperature is 21°C in summer and 15°C in winter. Extremes of 41°C and 2°C have been recorded. Humidity averages at 60∿70%. It is hot in the daytime but cool at night, thus being quite agreeable.

A northwesterly wind constantly prevails and the average wind velocity is 4.6m/sec. From May to October a southeasterly wind occasionally blows and the temperature subsequently drops.

The rainy season lasts from October to March and the dry season from April to September, with a monthly rainfall of 39∿91 mm in the dry and 94∿176 mm in the rainy season. The average annual rainfall is 1170 mm. It was 2061 mm in 1981 and 600 mm in January of that year, 3.4 times the average for that month.

The design strength of buildings against rainfall is 150 mm/h, as against 50∿100 mm/h for Tokyo.

(2) Disasters in Santa Cruz City

No disasters are recorded.

1) Earthquakes

There are records of small tremors in the nation's mountainous cities, such as La Paz, Sucre and Cochabamba, but no earthquakes have been recorded for Santa Cruz.

2) Storm and flood damage

a. No storm damage has been recorded.

b. Floods frequently occur in western areas of the city. When rainfall is large and sudden, flooding of around 50 cm occurs in these lower areas owing to insufficient sewage capacity.

3) Lightning and tornados

a. Lightning occurs frequently. It causes no damage apart from power failures due to its striking power lines, etc.

b. Tornados have never been recorded.

4) Insect damage

No mass insect damage is recorded, but there are many flies and mosquitoes.

5) Other damage

Landslides, snow and ice damage have not been recorded.

(3) Ground of the Site

For the ground survey of the proposed site, 1.5 m deep borings were carried out at 3 locations. Furthermore, local surveyors are employed to make a survey of the soil at 5 locations to a total depth of 46.4 m.

The whole area of the proposed site was once a river bed with deposits of earth and sand. The course of the Rio Piray is now 1.5 km to the west.

The soil is generally composed of topsoil and clay to a depth of about 1.0 m. Parts of the ground are very soft. Underneath are layers of fine sands. The deeper the ground, the more distinct these layers become. According to boring data for the wells of Santa Cruz City, the sand layers continue but do not reach the rock bed.

In places, a clayey sand is caught between the layers in lens-shape deposits. These were created by sediment from the river.

Standard penetration tests result in an N value of 10∿20 to a depth of near 8.0 m, and 20∿30 deeper than 8.0 m where it shows the softer ground of the sand layers.

The underground water level is 1.0 m below the surface, within sandy soil, and is therefore rather high. The sandy layers are saturated by underground water easily carried from far away and by percolated water from the Rio Piray. The underground water level can be expected to change seasonally and annually according to precipitation.

3-3 City Planning and Related Regulations

(1) Building Standards

The area and district regulations of Santa Cruz City are prescribed by the City Planning Department of Santa Cruz. The building-to-land ratio, and the distance of the outer walls from the site boundaries, etc. are regulated. The proposed site is in an area used for public facilities. The outer walls must be set back 10 m from the site boundary.

Detailed building regulations differ according to the purpose of the building. For hospital buildings, regulations apply to wards and rooms, related hallways and stairs, water tanks and parking areas.

(2) Structural Design Standards

There are no special construction design standards and so construction engineers use either ACI (US) or DIN (West German) standards. The authorities concerned have approved the use of Japanese standards for the design of this hospital.

(3) Standards for Electrical Installations

No complete regulations are provided for electrical and related work and so the standards of the exporting countries are used. The main standards used are those of:

Norma Para Instalaciones Eléctricas of the Ministry of Housing and Construction of Bolivia;
NEC (National Electric Code, U.S.A.);
AWG (American Wire Gage, U.S.A.);
ABNT (Asociación Brasileras Normas Técnicas, Brazil).

(4) Water Supply and Sewer Installations Standards

Technical standards are prescribed by the Water Board of Santa Cruz City: these are currently being revised. The local authorities concerned with the hospital construction stated in a meeting that they would respect Japanese building regulations and technical standards.

3-4 Infrastructure of the Surrounding Area

(1) Power Supply

Power for Santa Cruz City is supplied by 4 gas turbine generators of 22,800 kW of CRE (Cooperativa Rural de Electrificación). With the increasing demand for power of recent years, an additional power plant of 22,800 kW is scheduled.

There is a local substation near the site equipped with 20 MVA transformer capacity and 10kV overhead power cable is installed along 3º Anillo.

The power supply for the hospital can be drawn from these 10 kV power lines and a sufficient capacity is secured. Actual voltage is 10 kV ± 5% and frequency 50 Hz ± 1%.

(2) Telephone

The telephone system is operated in Santa Cruz by COTAS (Cooperativa de Teléfones Automaticos de Santa Cruz de la Sierra Limitada).

There are 36,000 telephone subscriptions, which are serviced by one telephone office. A new telephone office is scheduled to open near the proposed site in 3 years time to meet increasing demand.

Overhead telephone lines are installed along Av. Kennedy on the north side of the proposed site, providing for sufficient circuits. Overhead telephone lines are scheduled to be buried underground in the future.

(3) Communication

International communication is developing vigorously in Santa Cruz City.

There are 350 telex machines and this number will soon increase 15∿20%.

There are 14 radio stations, one nationally run and the rest civil commercial stations. Nine of these are AM and five FM.

There is only one TV station, run by the university. Telecasting hours are 11:30∿13:30 and 18:00∿24:00 on weekdays and 18:00∿24:00 in weekends, and programs are in color. There is also an ENTEL (Empresa Nacional de Telecommunicaciones) channel telecast from La Paz station using a micro circuit.

(4) Water Supply

Water supply is procured from wells 160∿350 m deep at 7 places within Santa Cruz City to provide city water to the proposed site of the hospital construction.

A 200 mm dia. water pipe is buried under the footpath of the street on the east side of the site (3º Anillo Interno) and a 150 mm dia. main pipe is under the footpath of Av. Kennedy on the north side. The size of the pipe is sufficient to supply the hospital. The water quality has a hardness of as high as 168 and scaling is liable to form inside the piping, but little decay of the piping material should occur. The hardness is mostly due to calcium.

(5) Sewer

The city planning of Santa Cruz completely separates sewerage and rain water. Public sewers are fully installed within 2º Anillo. Furthermore a sewer system is being planned outside 2º Anillo. Sewerage and drainage from the proposed site will be connected by extensions to sewers planned by the city for the construction of the hospital.

Night soil is carted away from districts where no public sewerage is available. Sewage is discharged into the Rio Piray after it is purified naturally in a large pool about 2 km north of the residential district of Santa Cruz.

Rainwater is led to the Rio Piray through open ditches made along the boundary of the site and the road. Santa Cruz plans to build open ditches 8 m wide and 1.2 m deep between the boundary line on the west side of the proposed site and sidewalks, within 2∿3 years. Rainwater from the proposed site can be all discharged into the ditches.

(6) Natural gas

Natural gas is not widely used for the general public as city gas, but it is used for large consumers, who use natural gas lines placed underground along Av. Kennedy, north of the proposed site. It is the cheapest energy source in Santa Cruz and is used for gas turbine generators, air conditioning and for industrial fuels, etc.

The specifications of the natural gas supply are: pipe dia. of 150 mm, daily feeding capacity of 15,000,000 ft^3, methane as main component (86.16%), thermal value of 9,300 $kcal/m^3$ and relative weight against air of 0.65.

When using natural gas as a fuel for boilers and kitchens, it can be fed through the gas pipes under the sidewalk of Av. Kennedy.

3–5 Local Building Conditions

(1) Condition of Building Materials

a) Building materials in Bolivia

Building materials produced in Bolivia include cement, timber,

bricks, tiles, terrazzo-block, slates, fabricated aluminum sash, vinyl piping and other PVC goods, plate glass, and styrol insulation materials.

The percentage of domestic materials has increased recently, owing to industrialization, but important materials for modern building — such as steel, aluminum, PVC materials, and plant machinery and equipment — are still being imported.

b) Building materials in Santa Cruz City

Production of building materials is more developed in Santa Cruz than elsewhere in Bolivia. Materials produced in Santa Cruz include bricks, tiles, terrazzo-block, and wooden goods such as fixtures, furniture and plywood. However, such important building materials as cement and steel are imported from other parts of the country or from abroad.

(2) Buildings in Santa Cruz City

City planning in Santa Cruz is based on roads radiating in all directions from the center square. Four loop roads are planned.

The oldest part of the city is inside the first loop road, and this is where government offices and churches have been built. Urbanization is well under way inside the second loop road. The town is expanding outward with the rapid increase of population in recent years, but there is enough room for building in the area of the 3rd and 4th loop roads.

Local buildings generally have either one or two stories and are of brick. To counter the high temperature and humidity, buildings are generally built with ventilation and designed to avoid the afternoon sun; and large gardens, outer hallways and terraces are provided. Inclined roofing with Spanish tiles prevents rain and heat. Outer walls are finished with mortar and coated with paint. The ground floor is generally of mortar covered with terrazzo-block. For concrete block buildings, a hollow concrete slab called aligerado is used on the second floor and above. Large buildings mostly have patios showing the influence of Spanish construction.

The use of reinforced concrete has increased rapidly in recent

years. The "Banco Nacional de Bolivia" building, with 12 floors above ground and two below, and the 6-story "Edificio-La Corporación de Deserrollo" office building both now under construction are of reinforced concrete, using aluminum curtain walls on the outside and central air conditioning. The work is executed by contractors in La Paz. The cost of construction is US$1,000/m^2 for the former and US$625/m^2 for the latter, but the cost breakdown is not known.

Construction work on Viru Viru International Airport by a Japanese contractor is under way about 15 km north of Santa Cruz. Japanese products, such as sashes, glass, ceiling materials, waterproof and fabricated metal, are used as construction materials. Machinery and equipment for the plant and airport facilities are mostly Japanese made.

(3) Air Conditioning, Heating, and Ventilation Equipment in Santa Cruz City

The climate of Santa Cruz is tropical and air conditioning equipment is widespread. Air conditioning systems are mostly of the window type. The system in which ducts are connected to separate coolers for each room is also used in offices. Central air conditioning is known but is little used. Hospitals in the city run by public corporations, and the private sector have air conditioning in every ward: in the national hospitals, however, main rooms in the central area are air conditioned but not wards.

Ventilation systems seldom use forced ventilation, but mostly natural ventilation. Windows or pipe shafts are used for ventilation in bathrooms and toilets. When forced ventilation is used, such as in laboratories, air is discharged through ventilation fans installed in walls or windows. Air-conditioned rooms are generally unventilated. Ducts are rarely used for air conditioning and ventilation.

(4) Water Supply, Drainage and Sanitary Installations

Sanitary facilities in Santa Cruz are well developed, with water supply and sewer systems, and flush toilets are used.

Water supply is made from city water mains for one- and two-story buildings, and high level and other water tanks are used for buildings

over 3 stories. White gas and PVC piping are used.

Cast iron, PVC, lead and white gas piping are used indoors as piping material, and ceramic piping outdoors. Hot water supply is either storage type or instant type using electric heater. Central hot water supply systems are popular in hospitals and hotels. White gas and copper piping are used for this.

An indoor fire hydrant is required for large offices and factories. White gas piping is used.

(5) Electrical Installations in Santa Cruz City

Electrical appliances and machines in Bolivia are mostly imported. Simple panelboard, lighting equipment and PVC products are assembled in Bolivia from imported parts. The performance of electrical appliances and machines therefore depends on the standards of the countries of manufacture.

Public power and telephone installations in Santa Cruz are almost complete and expansion of the system is being planned to cope with the recent increased inflow of population and expanded city functions. There are few tall and large buildings and installations are much simpler than in Japanese buildings. In particular, legal standards are not fully systematized for communication and other low-power electrical installations or for emergency systems. However, some buildings now under construction are tall (banks) and large (Viru Viru International Airport), and installations are becoming more sophisticated with automatic emergency controls.

(6) Elevators in Santa Cruz City

Since there are few buildings of more than 5 stories, elevators are rarely installed. The number of elevators is expected to increase rapidly with the many buildings now under construction or being planned.

Elevator equipment is all imported and control systems are simple AC devices.

At present in La Paz, US and Italian equipment is most widely employed and the maintenance system is well developed.

3-6 Local Construction Cost

The value of Bolivian currency fluctuated widely against the US dollar in 1982. A rate of 25 pesos per US dollar, stable since early 1979, dropped to 44 pesos on February 5, 1982. Owing to the shortage of US dollars, the devaluation of the peso against the US dollar continued: 76 pesos in March, 80 in April, 103 in May, 111 in June, 168 in July, 233 in August, 270 pesos, the lowest, in September, and 211 pesos in October. On November 20, the government announced a new policy, fixing the peso at 200 against the US dollar. Commodity prices increased rapidly: 3∿7 times for domestic goods and 10 times for imports. The price of construction materials also showed a general upward trend similar to that of other commodities. But since the fluctuation is expected to continue, study must be continued.

As for wage trends, the minimum basic wage increased from 2745 pesos in early 1982 to 5445 pesos on February 5 and 8490 pesos on November 6. This shows an annual rate of increase of over 300%. The following table shows these wages converted into US dollars.

Exchange rate against the US dollar	Wage	Converted
25 pesos/US$	2745 pesos	US$ 109.8
45 pesos/US$	5445 pesos	US$ 123.7
200 pesos/US$	8490 pesos	US$ 42.5

The table shows that although wages more than tripled, they declined in terms of the US dollar. They are expected to increase in the future, along with commodity prices.

The following gives results of unit cost of construction as given by local contractors.

One unit housing	US$ 600 - 800/m^2
Office building	US$ 600 - 1000/m^2
Hotel or bank	US$ 800 - 1200/m^2

These values, however are only guides and details such as the condition of the building, installations and condition of fixtures and appliances, important for evaluation, are not known. Construction cost, customarily calculated separately, is rather large and expenses the owner must bear are considered large.

4. CONCEPTUAL FRAMEWORK

4–1 Direction of the Project

4–2 Objectives

4–3 Facilities

4–4 Coverage

4–5 Organization

CHAPTER 4 CONCEPTUAL FRAMEWORK

4-1 Direction of the Project

Taking local medical conditions into account, the Bolivian government expects the hospital to provide medical attention for low income classes and to serve as a "core" hospital for the region. Important factors in determining the scale necessary for the hospital to achieve those functions are, with the increasing medical requirements: (1) securing full-time doctors, (2) securing a high level of medical care (3) estimating operating costs and (4) securing optimal management ability including data control. If medical treatment of low income classes were planned at too low a level, the functions required of a core hospital might not be achieved, making it more difficult to secure first-class personnel and resulting in the facilities being left unused.

However, if extremely high level care were aimed at, present conditions would not allow easy acquisition of sufficiently skilled medical staff, leading to higher costs and limiting the scope of medical treatment. In the current medical situation in Bolivia and the state of Santa Cruz, enough doctors may be secured, but the quality and quantity of paramedical aid have not reached a satisfactory level.

Furthermore, the Bolivian side is not expected to be able to give much support for the running costs of the hospital. In these circumstances, the 350 beds requested by the Bolivian government seem to be excessive at the present time for a hospital managed by the Ministry of Health. Therefore, it seems advisable to reduce the number of the beds to 200, the minimum for a general hospital, while allowing for future expansion of wards.

However, the functions necessary for a core hospital for the region will be established for the Central Diagnosis Department and allowance will be made for future ward additions.

Also, the project will be designed to require the lowest maintenance costs possible.

4–2 Objectives

In Santa Cruz City, which has seen continuing population growth, the hospital is largely intended to function as a center for local clinics. It will also provide medical care to low-income classes. It is intended to improve medical techniques through these activities as well as to build a local medical system for Santa Cruz State and greatly improve medical conditions.

4–3 Facilities

Clinics are classified into Internal Medicine, General Surgery and Pediatrics.

They will include plastic surgery, ophthalmology, otorhinolaryngology, urology and dermatology. They will not include obstetrics, a cancer center or psychotherapy, because the existing national clinics already carry these out effectively.

The hospital will comprise an outpatient department, central diagnosis department, ward department, administration department and services department.

There will initially be 200 beds, which may later increase to 400.

There are estimated to be 350∿600 outpatients a day, including the emergency department.

4–4 Coverage

The hospital will largely serve the general public of Santa Cruz City.

More widely, it will cover the whole area of Santa Cruz State, which occupies 1/3 of the total area of Bolivia. The hospital will offer high quality clinical and consulting services surpassing those of nearby medical institutions. It will function as a core hospital, in cooperation with nearby institutions.

4–5 Organization

The hospital will have the following departments.

(1) Department of Internal Medicine

General internal disorders will be treated. Also, urological and gynecological cases will be dealt with when possible.

(2) Department of General Surgery

General surgery cases will be dealt with. As many ophthalmological, otorhinolaryngological and plastic surgery cases will also be treated as possible.

(3) Department of Pediatrics

General pediatric cases and pediatric surgery cases will be treated. However, new-born and prematurely born infants will not be treated.

(4) Radiology Department

General X-ray diagnosis will be performed. Neither X-ray nor radioisotope treatment will be carried out.

(5) Clinical Laboratory

Biochemical laboratory tests, pathological, blood, bacterial and other tests will be performed. Also, physiological examinations will be conducted using ultrasonic diagnosis devices, electroencephalographs, electrocardiographs, endoscopes, etc.

(6) Emergency Ward

Emergency consulting and treatment will be given at all hours. Emergency operations will also be undertaken.

(7) Central Operating Theaters

General operations will be carried out. Heart surgery and neurosurgery will not be performed.

(8) I.C.U., C.C.U. Departments

Intensive care of serious cases will be given.

(9) Central Sterilization and Supply Department

Supply, cleaning, sterilization and disinfection of clinical equipment and operating apparatus as well as control of materials and

equipment will be undertaken.

(10) Nursing Department

This will deal with matters related to nursing in the various clinical departments, and train and supervise nurses.

(11) Dispensary

This will prepare general medicines and prescriptions.

(12) Administration Department

This will deal with general administration, personnel, accounting and other medical affairs concerning hospitalization, record medical histories and feed patients. It will also control supplies, and deal with repairs and maintenance.

(13) Regional Medical Service

This will collect and propagate medical information in active co-operation with provincial and city medical institutions.

5. BASIC DESIGN

5–1 Basic Design Policy

5–2 Site Plan Building Layout

5–3 Planning

5–4 Materials and Construction Methods

5–5 Structural Design

5–6 Installation Design

5–7 Medical Equipment

5–8 Architectural Drawings

CHAPTER 5 BASIC DESIGN

5-1 Basic Design Policy

The following items are fundamental to the design of the hospital.

(1) It will be a general hospital with Departments of Internal Medicine, General Surgery and Pediatrics.

(2) The proposed number of beds is 200.
In the future, an additional 200 beds can be accommodated. The Central Diagnosis Department will have facilities for 400 beds.

(3) To suit the climate of Santa Cruz, natural ventilation, natural lighting and measures against humidity during the rainy season will be adopted.

(4) The hospital design will allow for future expansion and remodeling of its facilities to keep up with economic development and changes in medical technology.

(5) Construction methods and building equipment will be selected for easy maintenance and supervision.

(6) Conditions of construction in Santa Cruz must be fully recognized, and to attain cost savings local techniques and materials will be employed as much as possible.

(7) The design must contribute to the city plan of Santa Cruz.

5-2 Site Plan Building Layout

The site is rectangular, running from north to south with Av. Kennedy at its north, and nearly flat. The floor area of the hospital will be a little over 11,000 m^2 and the site area of 30 hectares is not sufficient for a purely horizontal layout that would allow space for future expansion, space between buildings to provide proper air circulation, parking and porch areas. Therefore, some of the buildings must be multistoried, eliminating excessive flow lines and with minimum construction space.

Two entrances will be placed on the approach roads at both the north and east sides of the site: on Av. Kennedy, a trunk road for the city, and on a side road inside No. 3 Loop Road. Parking and porch space will also be provided.

Walkway and roadway will be separated to maintain pedestrian safety.

The buildings will be divided according to function with four wings: O.P.D., Central Diagnosis, Wards and Service.

The O.P.D. Wing will be north towards the main approach, and the Service Wing on the south side of the site, facing the usual wind direction.

Wards will be arranged in the middle of the west side, a relatively quiet and well ventilated area, and future expansion made in the south.

The Central Diagnosis Wing will be in the middle of the east side with a clear division of functions. The wards that can be arranged vertically will be four-story and the Central Diagnosis Wing and the O.P.D. Wing two story.

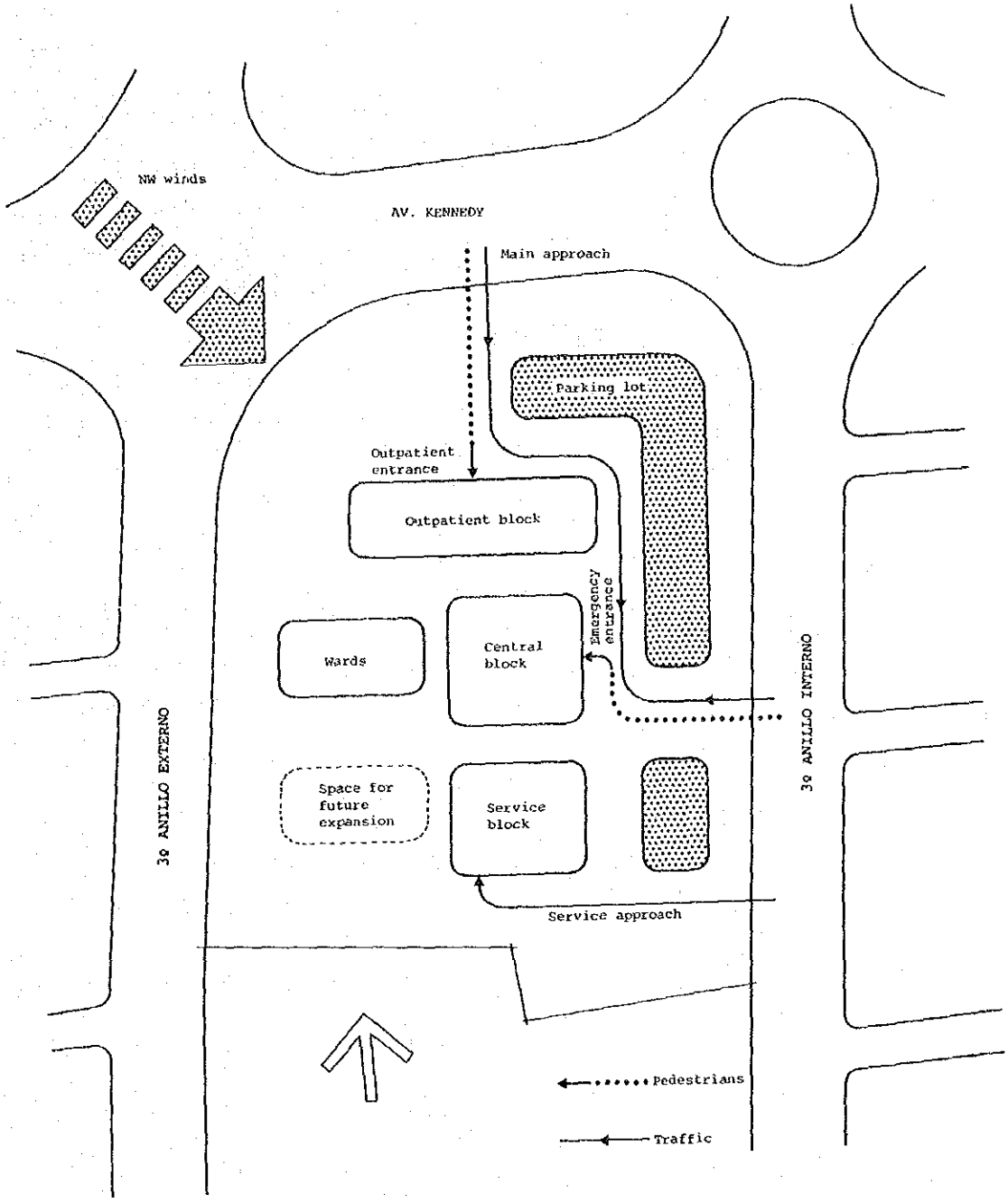
The Service Wing, comprising a high-roofed machine room and a kitchen requiring ventilation through the ceiling, will be single-story.

The approach to the buildings will have a general outpatient entrance, emergency entrance, service entrance and staff entrance, separating patients, staff and service personnel.

Trees are to be left standing as much as possible to fence the site and harmonize with the buildings.

The site is on low land, so the buildings risk being flooded

during the rainy season. To avoid this hazard, drainage routes of rain-water must be fully provided by Santa Cruz City, and also the first floor of the buildings and their surroundings will be raised about 1 m above their present level.



5-3 Planning

(1) O.P.D. Wing

The O.P.D. Wing will have two stories. The first floor will have the O.P.D., reception and pharmacy department, and the second floor will accommodate the administration department.

1) O.P.D.

The O.P.D. will comprise Internal Medicine, General Surgery and Pediatrics, each department having a waiting area for outpatients. General Surgery will be placed near the Central Diagnosis Wing because of its close relation to the Radiology Department. Pediatrics will be a little apart from Internal Medicine and General Surgery and close to the pediatric wards on the first floor.

In Bolivia, outpatients are generally seen during morning hours at national hospitals. Therefore, the number of rooms must be enough to handle an estimated 350∿600 outpatients in about 4 hours in the morning.

· The waiting rooms for outpatients will be well ventilated with natural light from the patios.

General reception and central diagnosis record rooms will be placed accessibly.

2) Administration

The Director's office, medical office, meeting room, library and other rooms will be on the second floor.

The night duty rooms will be near the Central Diagnosis Wing.

(2) Central Diagnosis Wing

The Physiological Examination Department, Radiology Department and Laboratories closely related to the O.P.D. will be on the 1st floor.

The Emergency Department will be in the same block as it is closely related to the Radiology Department.

Operating rooms, Central Sterilization and Supply, and the I.C.U. and C.C.U., which require exceptional cleanliness, will be on the second floor and closed to visitors. Special wards such as I.C.U. and C.C.U.

will be near those rooms requiring especial cleanliness, and at the end of the flow lines.

1) Emergency Department

After-hours treatment for accidents and other emergencies will be given after the O.P.D. is closed, with a separate entrance beside the O.P.D. As well as the consulting rooms, a small operating room and observation room, etc. are provided.

2) Radiology Department

X-ray diagnosis will be the major function of this department. The X-ray rooms will allow for installation of several X-ray machines. When a CT scanner is later introduced, one room will be allocated for its use. To allow efficient operation by a small number of people, it will be provided with a separate corridor.

3) Physiological Examination Department

An endoscope room and ultrasonic diagnosis room will be put where natural light can be obtained.

The electroencephalograph and cardiograph rooms, which require electromagnetic isolation, will be provided inside.

The department will be located near both the O.P.D. and wards for easy access.

4) Clinical Laboratory

Facing the main hallway will be a reception for urine- and blood-testing rooms and the clinical laboratory. Inside, in addition to a bacteriological laboratory and washing room, a large room will be provided to cope with advances and changes in laboratory equipment and technology.

5) Operating Theater Section

Operating theaters are to be divided into clean areas for O.P.D. operations and completely sterile areas. Also, a clean supply system will be adopted to prevent the flow of operating instruments from disturbing operations.

6) I.C.U., C.C.U.

I.C.U. and C.C.U., which carry out intensive care for serious cases, will be positioned near operating theaters. In order to cope with sudden kidney trouble, ARTIFICIAL DIALYSING APPARATUS will be installed later.

7) Central Sterilization and Supply

Equipment supply and sterilization will be carried out for each clinical department. Rooms are to be arranged so as not to mix un-sterilized with sterilized equipment. C.S.S., largely concerned with supplying equipment to operating theaters, will be arranged next to operating theaters.

(3) Ward

One nursing unit (N.U.) comprises 50 beds, and so the 200 beds will make up 4 nursing units. The four will be:
Internal Medicine, General Surgery, Pediatrics, and auxiliary.

Wards are to be built in 4 stories to allow room on the site for future plans.

The pediatrics ward is to be placed on the first floor for safety and to use the garden as a playground. The operating theaters will be on the second floor, to put them into close contact with surgical wards. The auxiliary and Internal Medicine wards will be on the third and fourth floor respectively.

Elevators for beds, and stairs, are used for vertical movement (vertical circulation).

A patio (courtyard) in the ward wing will allow good ventilation and lighting.

Nurse stations and nursing utilities will be at convenient locations in the center for overall supervision of the wards.

Wards will be generally composed of rooms of five beds, with 2-bed and single rooms for serious and other cases. A toilet is to be installed in each room.

The pediatrics ward will have isolated sick rooms for communicable diseases.

(4) Service Wing

The Service Wing will comprise a kitchen, laundry, electrical room, machine room, warehouse and workshop.

The kitchen will be closest to the wards to allow wagon service. A cafeteria for staff employees will face an open garden. Kitchen and laundry will face the service yard.

The electrical and machine rooms will be close to the Central Diagnosis Wing, because of high energy consumption.

A materials warehouse to store substantial amounts of medical supplies, parts and other goods will be provided.

The autopsy laboratory and morgue will also be in the Service Wing.

5-4 Materials and Construction Methods

In selecting materials and techniques, local construction methods and materials must be employed as much as possible in consideration of the climate of Santa Cruz. This is also very important for future repairs, improvements and additions.

This planning must be made with this in mind as well as overall function, appearance, etc.

Since many reinforced concrete buildings have been built recently and cement, aggregate, steel bars and formwork and easily available, the main structure of the hospital will be built of reinforced concrete. However, since concrete is more costly than bricks, bricks will be widely used for the walls rather than concrete.

The finishing materials for the floors, walls and ceiling must be selected to minimize damage to the walls due to rising damp, and soiling of the wall and ceiling due to mildew. For hospital buildings, solid materials and heavy duty and easily-cleaned materials must be selected for cleanliness. For instance, terrazo block is to be used for the floor and ceramic tiles for the walls of the visiting areas in the O.P.D. Wing, where soiling often occurs, to permit washing with water. Likewise such materials as are easily cleaned and sterilized will be used for the operating rooms, I.C.U., and C.C.U., where especial

cleanliness is required. An outline of the method used for each item is given below.

a) Temporary Work

Simple temporary installations such as temporary fences and scaffolding will be used. This will be planned to assure worker safety and accuracy and efficiency of work.

b) Earth Work

Since the foundation of buildings will be shallow, excavation can be made by manual labor. Heavy equipment will be used for digging out tree roots. Since surface soil is very soft, earth work will avoid the rainy season.

c) Piling Work

Concrete piling will be used because of the low bearing capacity of the ground. Pilings will be formed at the site and then driven by hammer.

d) Concrete Work

Ordinary portland cement will be used, produced in Cochabamba or Sucre.

Great care must be taken in ensuring quality control of the transportation and storage of the cement, especially in the rainy season.

River stones and river sand collected in suburbs 40 km from Santa Cruz will be used for aggregate.

The strength of concrete of 210 kg/cm^2 will be easily achieved. Concrete will be mixed using a mixer installed at the site and formed by manpower.

Cranes will be used for lifting above the second floor. The amount of concrete will be $10 \sim 12$ m^3 a day.

e) Formwork

Ocho boards 1 inch thick fastened with nails and wire will be used for formwork.

Round logs of about 10 cm dia. will be used as posts to support formwork. Manufacture of plywood formwork has recently started, and use of this material must be considered.

f) Reinforced Concrete Work

Reinforcing bars are not produced in Bolivia and are imported from Argentina, Brazil, Chile and Japan. Several kinds of steel are being imported, and those equivalent to the Japanese deformed steel bar SD30 are widely used and will be adopted for the work. Reinforcing work can be executed with sufficient precision since the diameter of the steel bars used is small. Reinforcing bars can be fabricated at the site.

g) Brickwork

Brickwork is the most commonly used and reliable method of construction in Santa Cruz. There are many brick factories in the city: quality is high, and production capacity sufficient. Specially-shaped bricks can be made to order. There are two types of bricks used for structure work, one for posts with small holes (ladrillo 21 huecos) and the other wall bricks with 6 holes (ladrillo 6 huecos). Compression strength is 7 kg/cm^2 for the former and 5 kg/cm^2 for the latter.

h) Roofing Work

Most roofing in Santa Cruz is inclined, with Spanish tiles. This work method is effective against rain and enhances thermal insulation. Unglazed tiles will be used which have high absorbency due to a low calcination temperature. These darken after several years due to mildew.

With regard to waterproofing of concrete roofs, Japanese specifications will be used since local specifications, materials and techniques are inadequate.

i) Comparison of Local and Proposed Work Methods

Work methods proposed for the project that differ from the local work method are compared and the reasons for their adoption given below.

Comments are also made on the techniques.

Item	Work method predominant locally	Proposed work method	Comments
Foundation	Brick foundation	Piling foundation	Excellent durability
First floor	Earth floor slab	Concrete slab	Good against subsidence of banked soil
Roof tiling	Spanish tiles fixed with clay	Spanish tiles fixed with wire and mortar	With the local method, clay contains moisture and the tiles themselves are not firmly fixed. The proposed work method offers firm fixing of tiles and little moisture is obsorbed.
Under-roofing board	Wickerwork of split bamboo and clay	Plywood 25mm thick	Durable and easy to repair
Floor finish	Terrazzo block	Terrazzo block	Durable and suits local cleaning method
		PVC tiling	Easy to keep clean
Wall finish	Brick, plaster or mortar, paint finish	Brick, lime, mortar, paint finish or tiling	Mortar-finish walls become damp near the floor, attract mold and are unsanitary. The proposed method uses tiles in easily-soiled areas to facilitate cleaning and maintain a healthy and sanitary environment.
Ceiling finish	Lath, stucco, covered with earth mixed with stalks	Flat asbestos board, paint finish or rock wool sound absorption board	Moisture-proof and sanitary
Moisture proofing of wall	Asphalt pitch	Asphalt pitch	Improves proof against moisture and durability of wall against capillarity
Moisture proofing of floor	Nil	Polystyrene film	Improves proof against moisture and durability of floor against capillarity

5-5 Structural Design

(1) Construction Planning

Santa Cruz City is far removed from earthquake zones and there is little possibility of tremors. Wind is not particularly strong. There is little outer force that needs to be considered for exertion of horizontal pressure and little effect will be brought upon structural design.

a) Two types of construction are employed, fabricated construction using bricks and reinforced concrete construction. In view of the number of stories, size of span and flexibility of room arrangements, pure rigid-frame structure may be the most appropriate, with reinforced construction of posts, beams and floors.

b) For the foundation, direct foundation (mat or cloth foundation), ground-improved foundation (replaced with rubble concrete or good soil) and pile foundation have been considered.
In consideration of the bearing strength of ground, mat or piling foundations are selected as methods that will provide the best bearing strength in structural calculation. Piling foundation is relatively economical and has therefore been selected.

c) Bricks will be used for outer and inner walls. For outer walls, which will stand for a long time, transmission of vertical load and bearing of wind load are also considered.

d) Most floor slabs used will be solid because of the many pipes going through the floor. There are no standards for structural design in Bolivia nor clear data for the method of calculation and material strength, etc. Therefore, various standards of the Japan Architectural Institute will be used for structural design, and conditions of the site also considered.

(2) Design Loads

a) Fixed Loads

These are calculated for all materials used.

b) Live Loads

Live loads of Japanese construction standard laws and ordinances are generally used. For special-purpose rooms, values are calculated for actual conditions.

Use	Load (kg/cm^2)
Surgery	300
Ward	180
X-ray room	500
Office	300
Warehouse	500
Common area	300
Roof	180

c) Wind Loads

From the actual condition of the site, wind load is calculated at 4m above ground with a wind velocity of 30 m/sec. In terms of wind pressure, it amounts to about 60 kg/m^2.

d) Earthquakes

Not considered.

(3) Materials Used

a) Concrete

Design standard strength of concrete will be FC = 210 kg/cm^2 and deviation will be within 50 kg/cm^2. Therefore, strength after mixture is to be 260 kg/cm^2.

b) Reinforcing Bars

SD30 deformed bars will be used.

c) Bricks

Bricks baked at high temperature with high dimensional precision will be used.

5-6 Installation Design

The following principles are generally adopted in designing installations of the hospital.

1. Japanese machines, equipment and materials will be used when these are not procurable locally.
2. Installations will allow easy maintenance and supervision, and reliable and durable materials will be used.
3. Operating costs will be kept as low as possible.
4. Work and equipment standards will follow Bolivian law. Japanese law will be applied beyond these legal standards.
5. Maintenance tools, supplies and spare parts will be made available.
6. Installation design will be carried out to allow for future expansion.

(1) Electrical Installations

a) Supply Installations

Power lines are placed on the inner roadway (Interno) of No.3 Loop Road. Power will be drawn from the 3-phase 3-cable 10kV 50Hz power line and led to the electrical room of the hospital using a single special underground circuit.

Telephone lines will be taken from the overhead telephone cable installed on Av. Kennedy and led to the switch room of the hospital through special underground line.

b) Power Reception and Transformation

3-phase 3-line 10kV 50Hz power will be transformed to 3-phase 4-line 380V/220V 50Hz and distributed to each outlet.

Load voltage will be standardized:

Single-phase 220V - for lighting and plug sockets

3-phase 380V - for heavy machinery

c) Emergency Generator

Power seldom fails in Santa Cruz but there are cases of failure due to lightning and scheduled stoppages for maintenance. At such times an emergency generator of 200 KVA will supply power for surgical

operations, laboratories, storing valuable goods, security lighting, elevators, water supply, etc.

d) Power Supply

Air conditioning power, ventilation power and water pump power and power for medical equipment will be supplied. Operation will be simple and clear, and available for each application.

e) Lighting and Plug Sockets

Main light source will be fluorescent lamps. Incandescent lamps and other light sources will be used as required. Switches will allow fine control of the area illuminated, allowing cost reduction. The sockets use single-phase 220V as standard and power supply will be made from emergency generator in case of power failure for important loads. Lighting standards for main rooms are given below.

Illuminance (Lux)	Rooms
500	Surgeries, consultation rooms, emergency wards
400	Offices, meeting rooms, library, laboratories
300	Kitchen, dining hall, central sterilization and supply room, entrance halls
200	Waiting rooms, X-ray room, machine rooms
100	Endoscopic inspection room, wards, toilets, hallways

f) Telephone Switchboard

A special automatic switchboard (APBX) will be installed. Telephone sets will be installed in major rooms to communicate inside and outside the hospital.

g) Public Address System

Public address and emergency announcements can be made throughout the whole hospital. For special purposes, special individual public address installations will be provided.

h) Nurse Call System

Communication between nurse stations and patients in the hospital will be possible for each nursing unit.

i) Interphone System

Interphones will be installed for communication required for the management and functioning of the hospital.

j) Television

A TV antenna will be installed on the roof and connections will be installed where TV sets are to be placed.

k) Battery Clocks

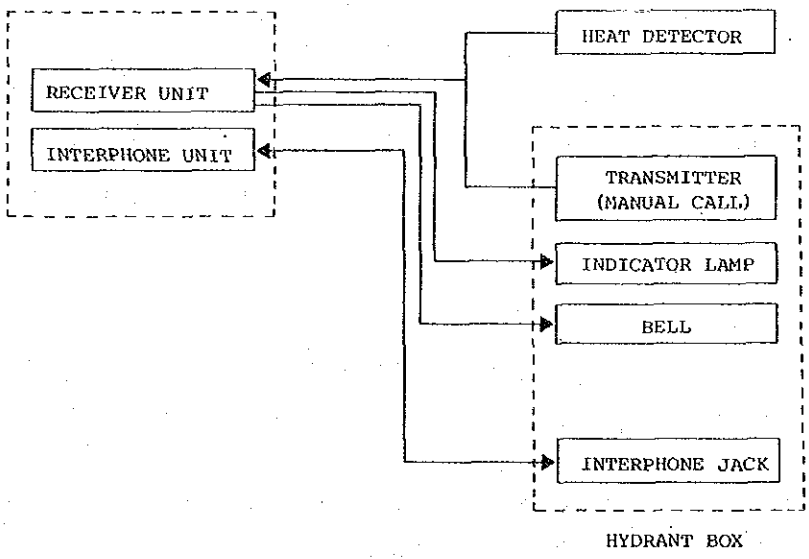
Battery clocks will be installed in major rooms.

l) Street Lamps

Street lamps and luring lamps will be installed along walkways within the site.

m) Fire Sensor Installations

Equipment that automatically detects fires and gives an alarm will be installed. Thermal-type sensors will be installed in major rooms.



Outline of the System

n) Lightning Arresters

Lightning arresters will be installed on the roofs of the buildings to prevent damage by lightning, and rods will be brought down and grounded.

o) Elevators

One elevator for beds will be installed in the Central Diagnosis Wing and two in the wards.

(2) Air Conditioning

a) Central Diagnosis Wing: Main Rooms

Air conditioning for surgery, central sterilization and supply room, I.C.U., and C.C.U., where especial cleanliness is required and cannot employ standard window coolers.

Air will be cooled and cleaned by air conditioners equipped with water-washable high performance filters.

For cooling, cold water made by freezers installed in the machine room will be fed to the air conditioners. The freezer used will be an absorption-type freezer with few revolving parts and requiring little maintenance. The freezer makes cold water using steam generated in boiler, which in turn uses natural gas for its fuel.

b) Central Diagnosis Wing: Other Rooms

1) Room with windows and outer walls:
Cooling will employ window-type coolers.

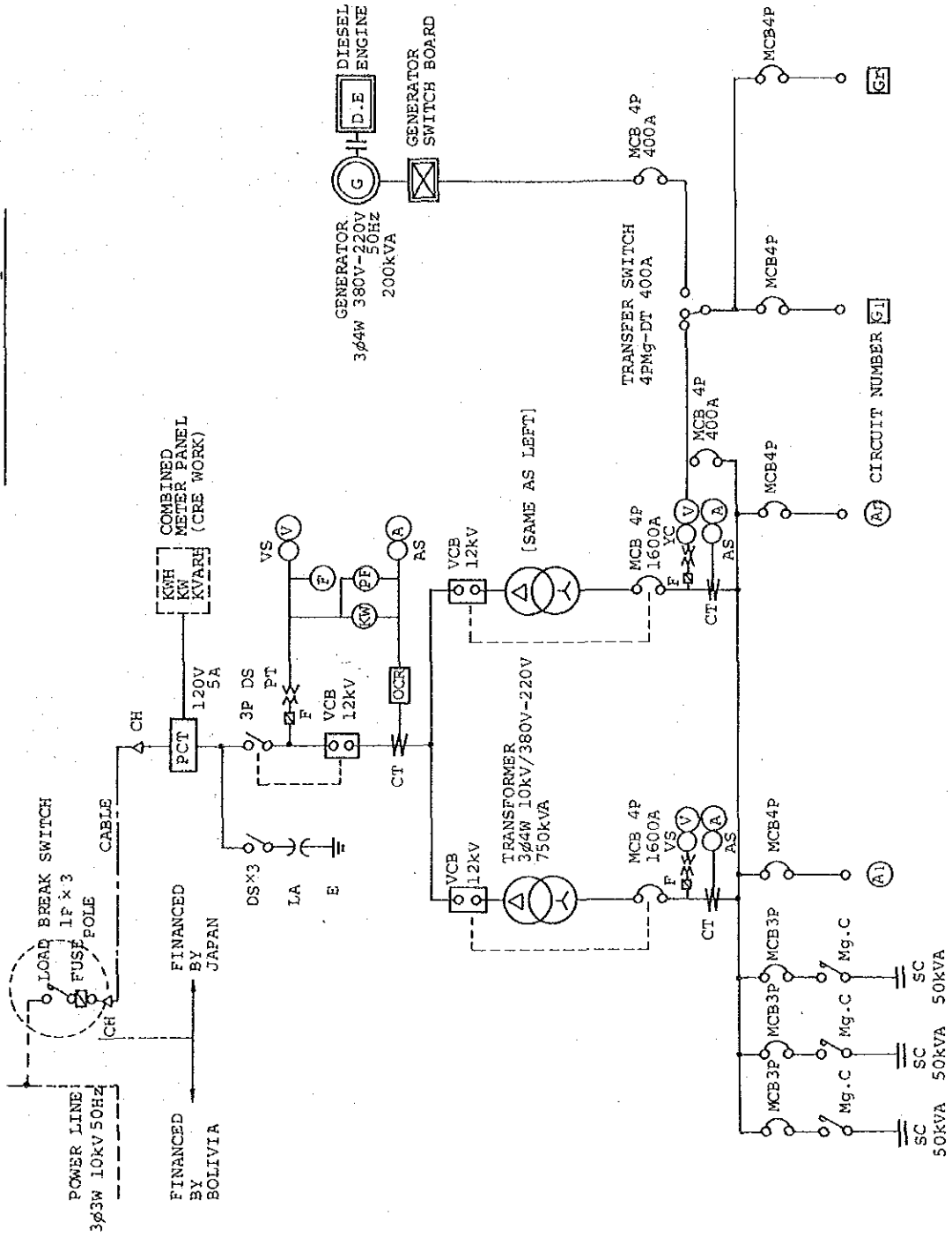
2) Rooms without window or outer walls:
Separate-type coolers or fan coils using cold water will be used.

c) Wards

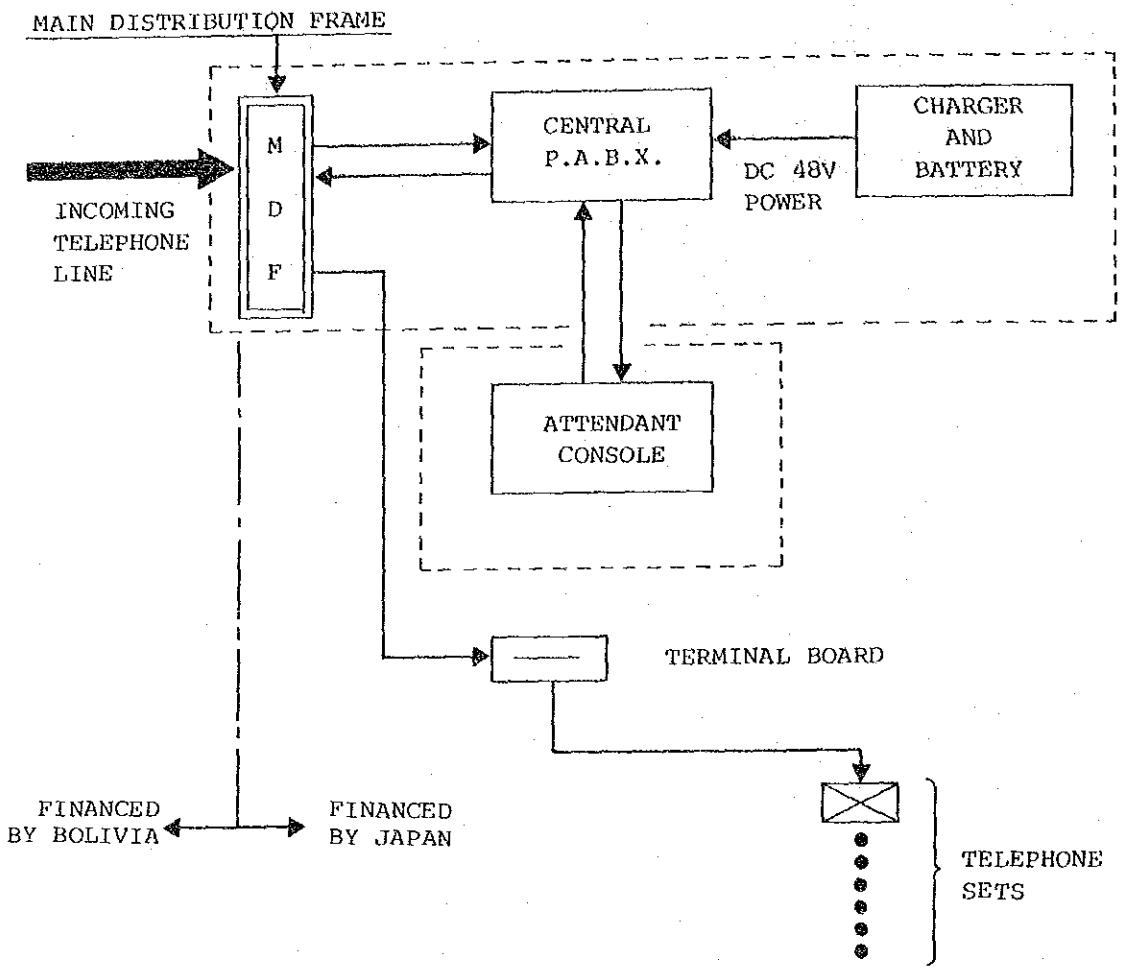
1) In general, wards other than nurse stations will not be cooled. Separate-type coolers or fan coils using cold water will be installed in nurse stations.

2) Natural ventilation will be considered for wards and over-head fans will be installed.

Power Service System

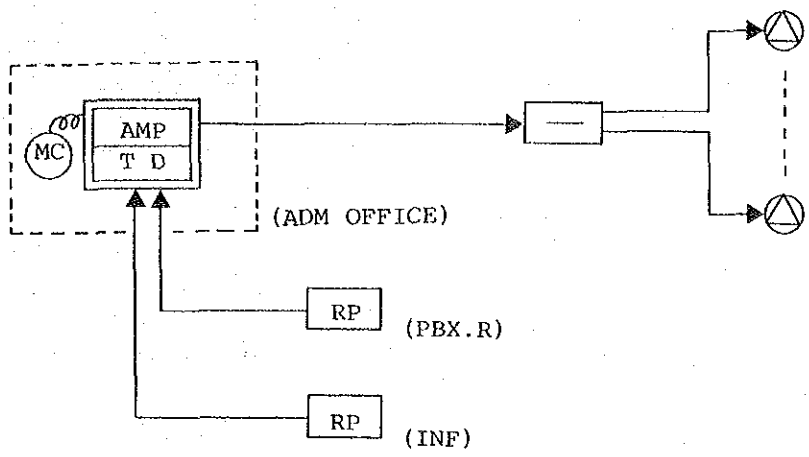


Telephone (PABX) System



Public Address System

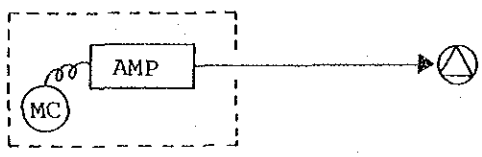
A) PA SYSTEM



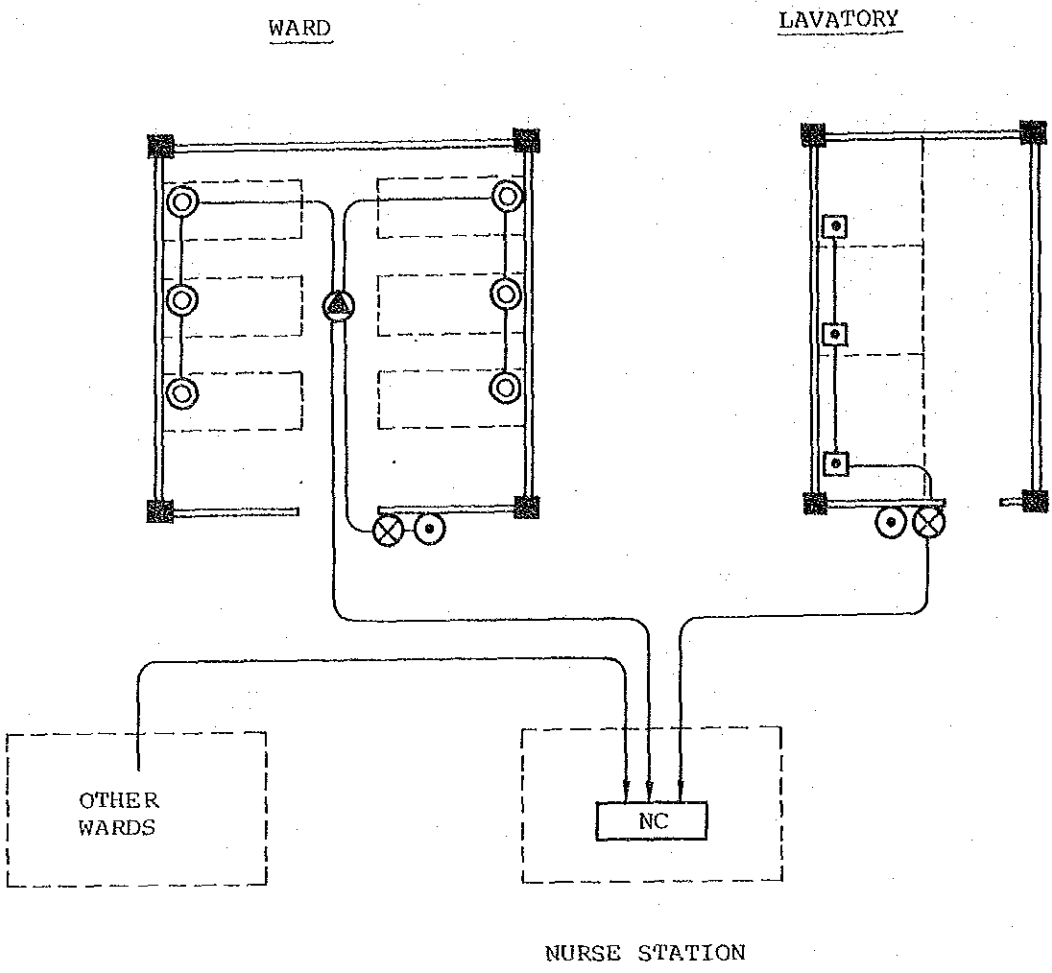
SYMBOL NAME

AMP	:	AMPLIFIER
TD	:	CASSETTE TAPE DECK
RP	:	REPEATER
	:	TERMINAL BOARD
MC	:	MICROPHONE
	:	SPEAKER

B) LOCAL PA SYSTEM



Nurse Call System

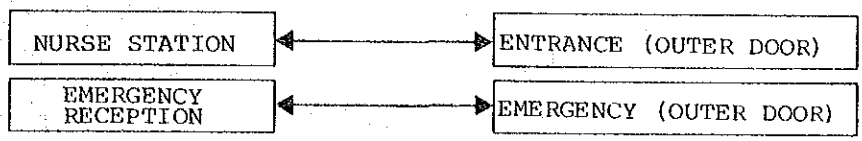


SYMBOL NAME

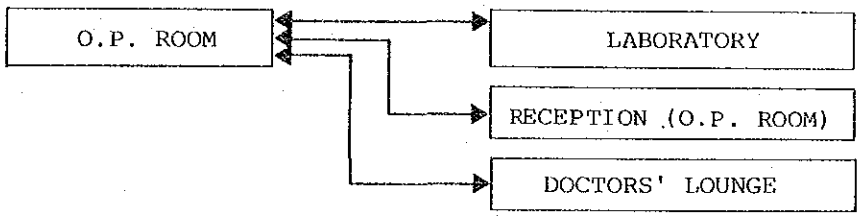
NC	NURSE CALL MASTER UNIT
	SPEAKER AND MICROPHONE
	CALL BUTTON SWITCH
	INDICATOR LAMP
	RESET BUTTON SWITCH
	CALL BUTTON SWITCH WITH LAMP

Interphone System

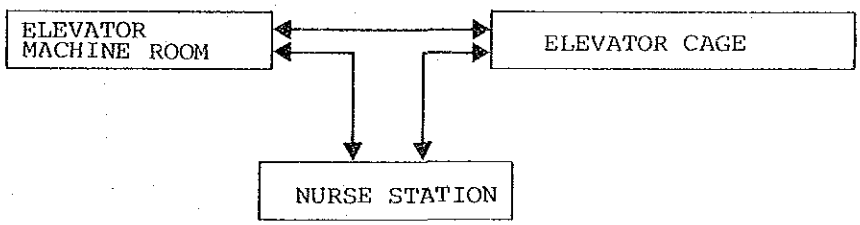
NIGHT RECEPTION



OPERATION ROOM



ELEVATOR



DARKROOM

d) Other Areas

Lobby, hallway, kitchen, washing room, closet, toilet, warehouse, machine room, electrical room and other rooms will not require air-conditioning.

(3) Ventilation Equipment

Natural ventilation will be generally used, and mechanical ventilation used as little as possible.

(4) Water Supply, Sewage and Sanitary Equipment

a) Water Supply System

More than half a day's supply of water will be stored in a water tank and lifted to a high-level water tank by pump. Then water will be supplied to various places by gravity. Water for steam boiler, hot water tank, washing machines, pure-water vessels for medical use and wash basins for operation will be supplied through a water softener. Vinyl chloride lined steel piping and vinyl chloride piping are to be used.

b) Hot Water Supply System

A centralized hot water supply system with large hot water tank will be installed. Soft water and steam will be mixed and hot water produced. Copper or heat-resistant vinyl chloride lined steel pipe and heat-resistant vinyl chloride piping will be employed.

c) Sewer System

Sewerage and miscellaneous drainage will be combined and separated from rain water discharge. Ventilation in sewer pipes will use wet air ventilation, extension ventilation and loop ventilation systems. Floor drainage is also to be installed. Discharge from wash basin, shower, etc. will be led to traps and sealed to avoid evaporation.

Sewerage and miscellaneous drainage will be discharged into the public sewage line. Rain water will be led outside the site through open ditches and discharged into public open ditches outside the site. Most rain water will be discharged to a large side ditch planned on

the west side and some to ditches on the north and east sides. Indoor sewage will use cast iron piping and vinyl chloride thick piping, and outside sewage will use ceramic piping.

Open ditches will be constructed of brick to drain away rain water, and some concrete and reinforced ceramic piping will also be used. Drainage water inspection boxes will be constructed of bricks with mortar finish.

d) Sanitary Installations

Toilet bowls will use construction with little trapping and much water saving. Urinals will be push-button type with flush valves. Wash basins will have soap containers, shelves and mirrors. Various sinks for medical use will be generally stainless steel or ceramic.

e) Fire Hydrant System

Indoor hydrants will be installed on each floor. Water will be fed from a high-level water tank using water pressure without installing fire pumps, to reduce maintenance. Water pumps will operate automatically when discharging water, along with the lowering of the water level in the high-level water tank. CO_2 fire extinguishers will be installed where necessary.

f) Kitchen Installations

Kitchen utensils suitable for local cooking will be installed. Natural gas will be used as fuel. Steam will be used for warmers, etc. Automatic kitchen utensils will be used as little as possible to minimize maintenance. Large refrigerators will be installed to store meat, fish, eggs, milk, bread, etc. in separate rooms. Ventilation in the kitchen will largely depend on by natural ventilation.

g) Laundry Equipment

Washing equipment using water will be installed. Sinks, washing machines, dehydrators, dryers, sheet rolling machines, pressing machines, and iron tables will be installed. A place for natural air drying will also be considered. Steam will be used as the heat source.

h) Central Oxygen and Suction System

Central oxygen and suction system will be installed. In the Central Diagnosis Wing and the wards oxygen and suction outlets will be installed where required.

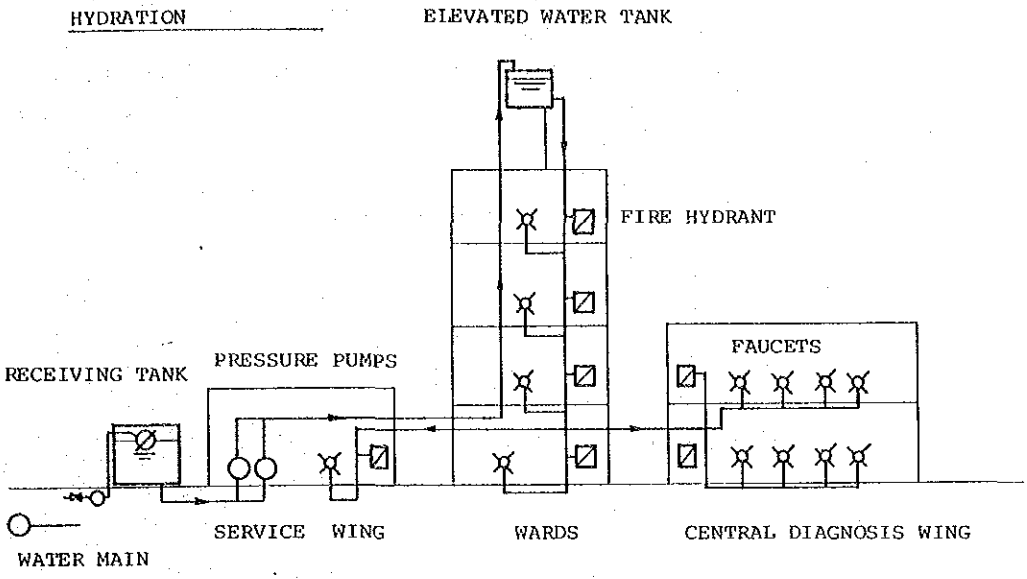
(5) Boiler Installation

The size of the hospital means that steam is required for laundry and kitchens. A steam boiler will be indispensable.

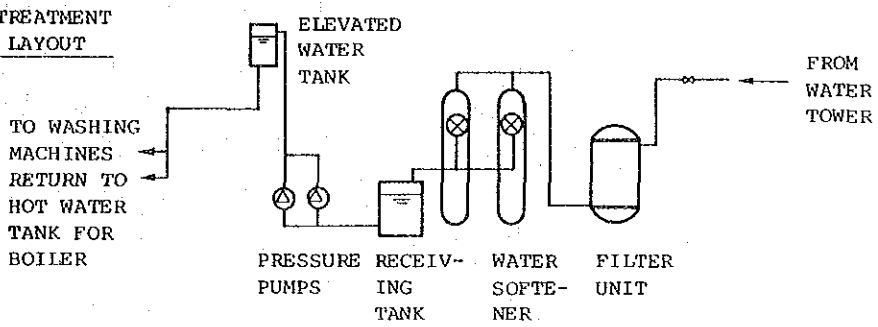
This boiler provides autoclaves, hot-water heat source and freezer energy source for the central main part of the buildings.

System Layout

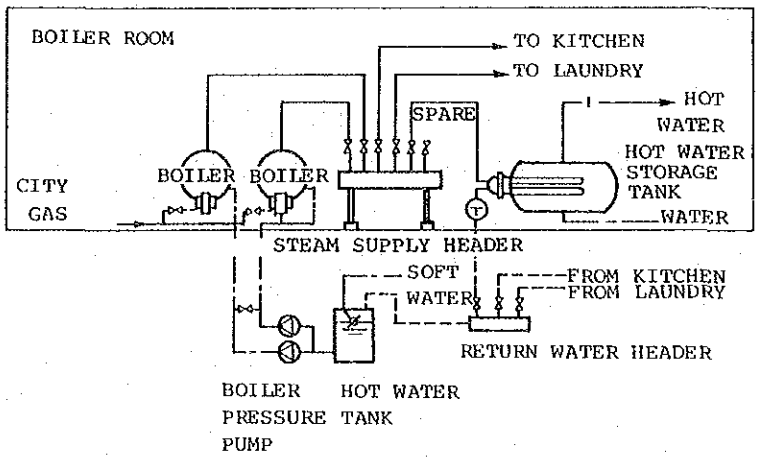
WATER SUPPLY & FIRE HYDRATION



WATER TREATMENT SYSTEM LAYOUT



BOILER SYSTEM LAYOUT



5-7 Medical Equipment

The functions of this hospital are to allow advanced tertiary medical services and to be a core hospital for the region. Medical equipment will be chosen to cope with future changes in the medical situation, after comprehending education programs on the doctor and paramedical level, and estimated operation costs and maintenance, etc., as a whole. The main points are as follows.

(1) Selection of Equipment

For indispensable equipment in general, equipment will be selected that can give more correct diagnoses and better treatment. Equipment for treating contagious children's diseases presently widespread in Santa Cruz, and equipment and materials now lacking for difficult diagnosis are given priority. Also a wide range of equipment that can cope with various diseases that may arise in the future will be selected.

Further, the medical equipment will include equipment and material such as surgical equipment, special operation equipment and post-surgery care equipment (vital signs monitor, artificial respiration equipment) to fulfil tertiary medical functions. It will also include laboratory equipment (chemical testing of blood, electrolytic measuring equipment) to carry out appropriate medication and treatment.

(2) Functions and System of Equipment and Materials

Recently medical equipment and materials have been increasingly automated to obtain more accurate and precise results. While automatic machines are accurate, they consume more supplies and reagents than do manual or semi-automatic machines.

This problem is very important since most medical equipment in Bolivia is imported. Also, maintenance is more complicated for automatic machines. Therefore, equipment systems must employ as many manual or semi-automatic machines as possible. This will also greatly assist understanding the real functions of the equipment.

(3) Range of Equipment and Materials

Modern medical treatment requires many auxiliary materials and supplies. Their cost must eventually be met by the operation of this hospital, but for the time being the plan will include a substantial amount of auxiliary equipment and materials to help operation.

(4) Operation of Medical Equipment and Training

Recent medical equipment requires expert technique for smooth and proper operation. Minimum training programs to enable effective operation of the equipment will be considered.

MEDICAL EQUIPMENT LIST

OUTPATIENT DEP.

1. General Diagnostic Instrument Set
2. Otorhinolaryngology Diagnostic Instrument Set
3. Diagnostic Instruments (Pediatric)
4. Urological Examination Equipment
5. Ophthalmology Diagnostic Equipment

DISPENSARY

1. Medicine Refrigerator
2. Safe (for medicine)
3. Water Still
4. Water Softener

RADIOLOGY DEP.

1. X-Ray Radiographic Apparatus
2. X-Ray TV Radiography Fluoroscopic System
3. X-Ray Layergraph Apparatus
4. Angiograph X-Ray Apparatus
5. Mobile X-Ray Apparatus
6. Auto-Thermo Central Developing Tank
7. Darkroom Accessories
8. X-Ray Protective Accessories

PHYSICAL EXAMINATION DEP.

1. Pneumatometric Instruments
2. Electrocardiograph Apparatus
3. Electroencephalograph Apparatus
4. Ultrasonic Diagnostic Equipment
5. Endoscopic Instruments

LABORATORY

1. Blood Bank Refrigerator
2. Incubator
3. Analytical Balance
4. Freezer
5. Binocular Microscope
6. Triocular Microscope Apparatus
7. Photomicrographic Apparatus
8. Fluoroscence Microscope
9. Refrigerator
10. Centrifuge
11. Drying Oven
12. Coagulometer
13. Autoclave
14. Anaerobic Cultivation System Set
15. PH Meter
16. Electrophoresis Apparatus
17. Clinical Spectrophotometer
18. VIS-Spectrophotometer
19. Double Beam UV-VIS Spectrophotometer
20. Chloride Counter
21. Water Still
22. Calcium Analyzer
23. Electrolyte Analyzer
24. Osmometer
25. Reagents and Clinical Test Materials

EMERGENCY DEP.

1. Examination Instrument Set
2. Refrigerator
3. Simple Operating Table, Mobile Type
4. D.C. Defibrillator
5. Anesthesia Apparatus
6. Water Sterilizer
7. Autoclave

CENTRAL STERILIZATION AND SUPPLY DEP.

1. Autoclaves
2. E.O.G. Sterilizer
3. E.O.G. Aerator
4. Hot Air Sterilizer

OPERATION THEATER

1. Universal Operating Tables
2. Operating Lights
3. Anesthesia Apparatus with Standard Accessories
4. Electro Surgical Unit (solid state circuit type)
5. Powered Bone Surgical Instrument Set
6. Water Sterilizer
7. Mobile X-TV Apparatus
8. Operating Instrument Set
9. Operating Room Materials

I.C.U. / C.C.U.

1. I.C.U. Patient Beds
2. Patient Monitoring System
3. Automatic Ventilator
4. I.C.U. Infant Incubator
5. Blood Gas Analyzer
6. Electrolyte Analyzer
7. Simple Rapid Blood Chemical Analyzer

8. Blood Pressure Measurement Apparatus

PATHO-ANATOMY

1. Mortuary Refrigerator
2. Autopsy Table

WARD SECTION

1. Patient Beds
2. Patient Care Instruments
3. Ward Utensils
4. Isolation Ward Equipment

5-8 Architectural Drawings

(1) Perspective

(2) Site Layout Plan

(3) 1st Floor Plan

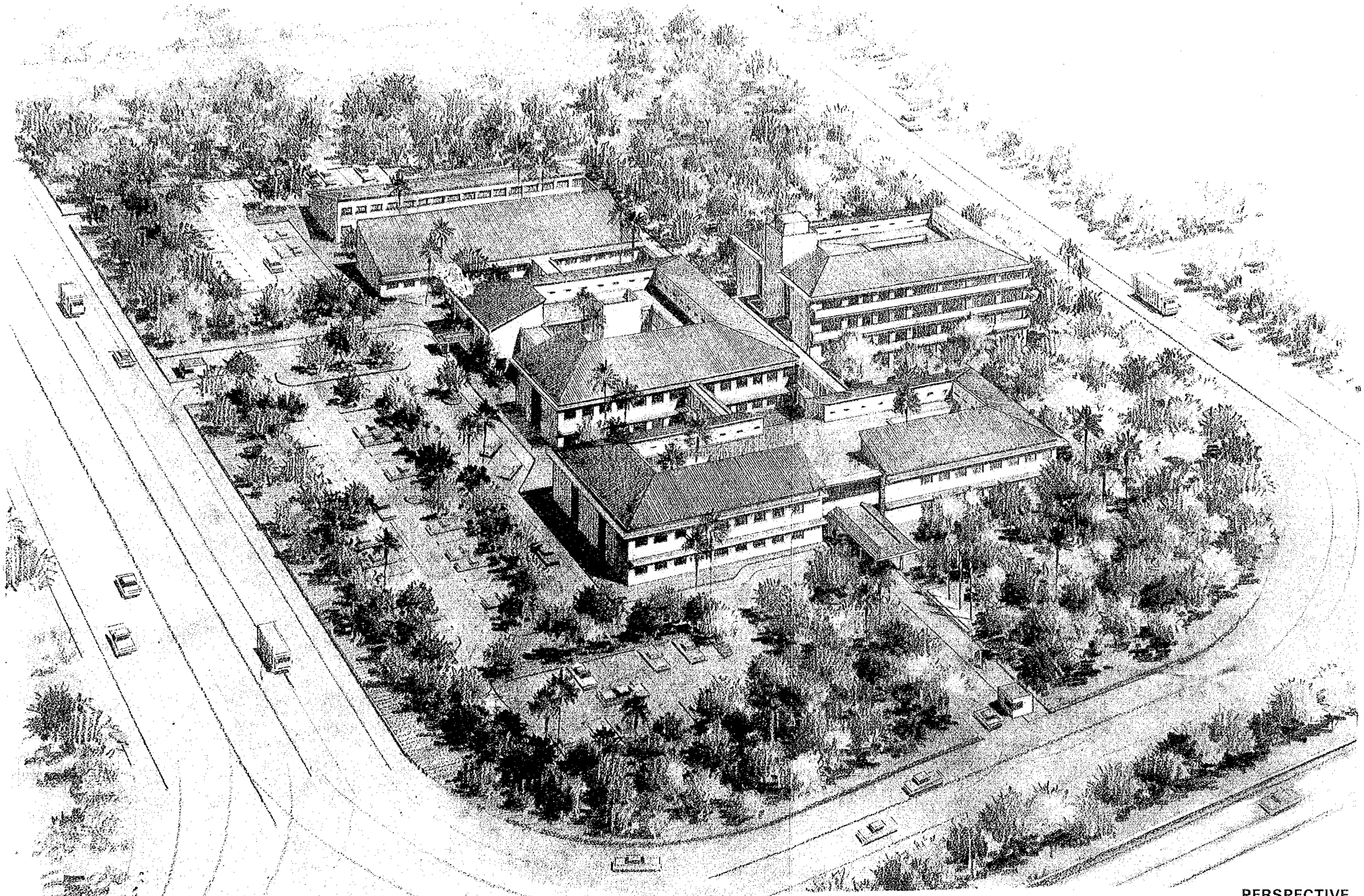
(4) 2nd Floor Plan

(5) 3rd & 4th Floor Plan

(6) Elevation & Section-1

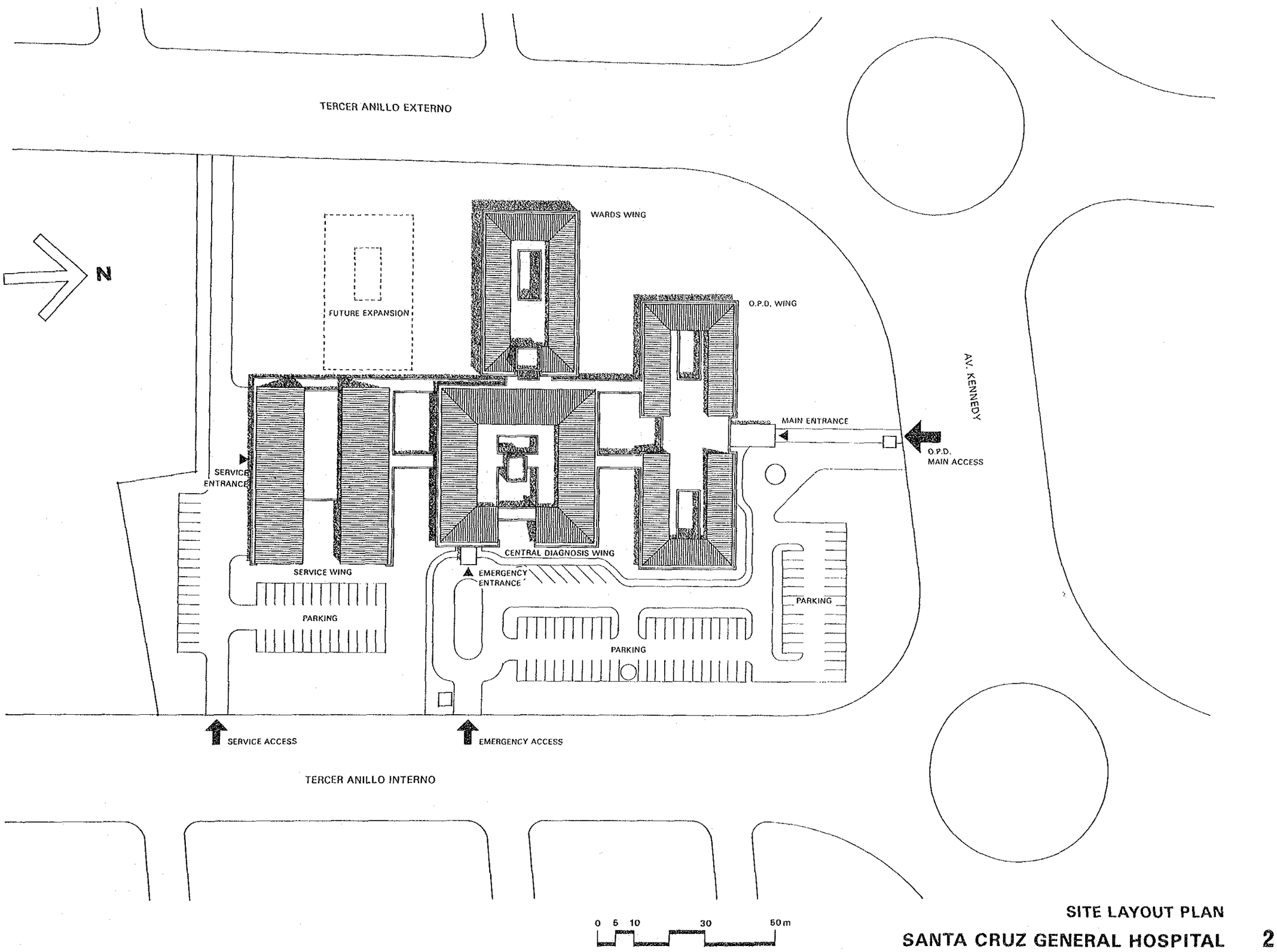
(7) Elevation & Section-2

(8) Floor Area Summary



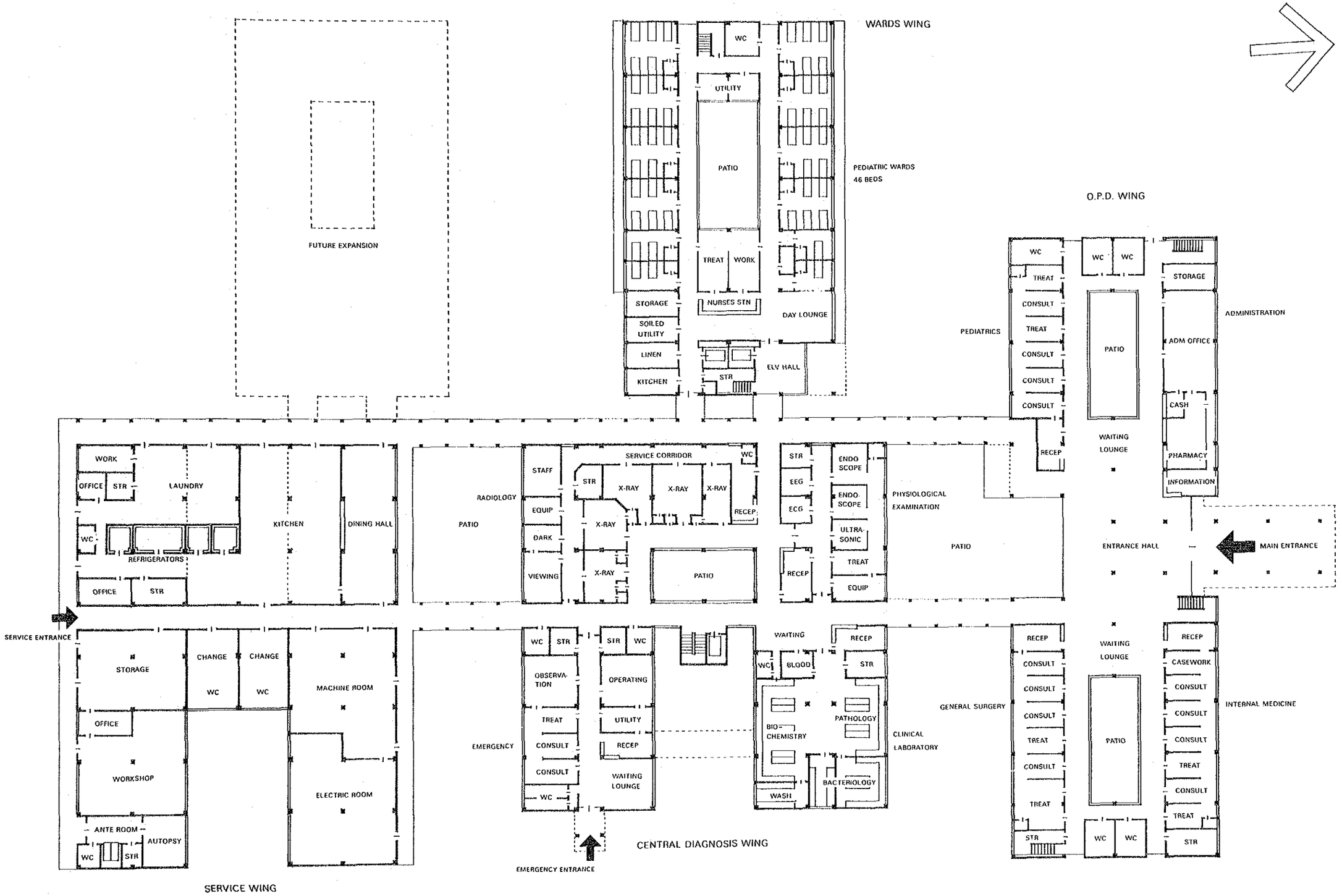
PERSPECTIVE

SANTA CRUZ GENERAL HOSPITAL 1



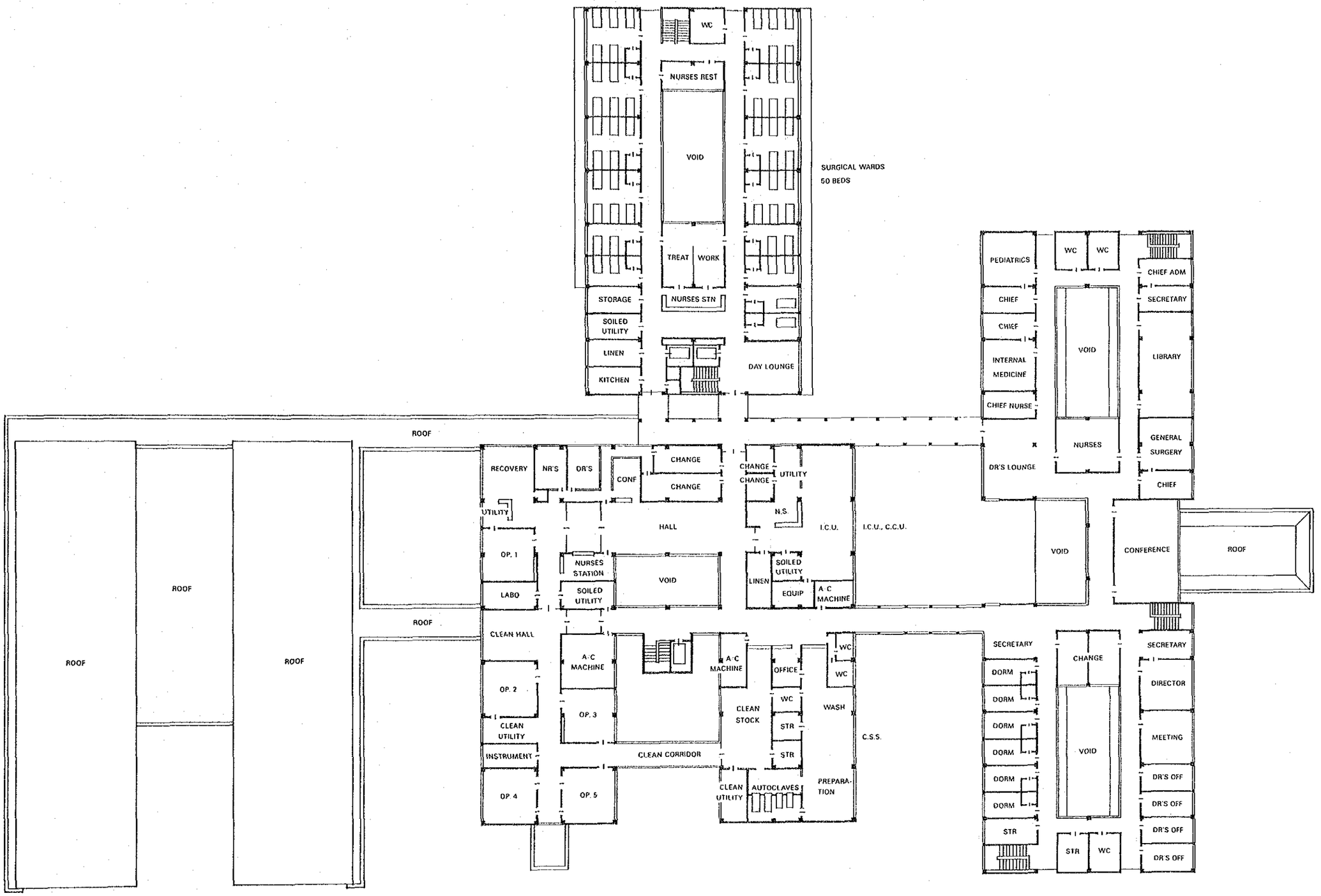
SITE LAYOUT PLAN

SANTA CRUZ GENERAL HOSPITAL 2



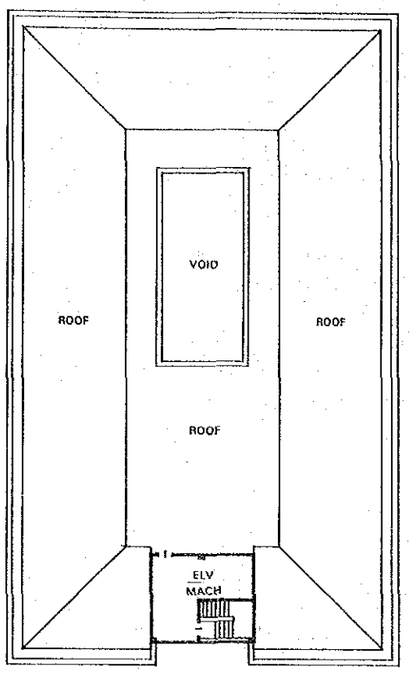
1st FLOOR PLAN

SANTA CRUZ GENERAL HOSPITAL 3

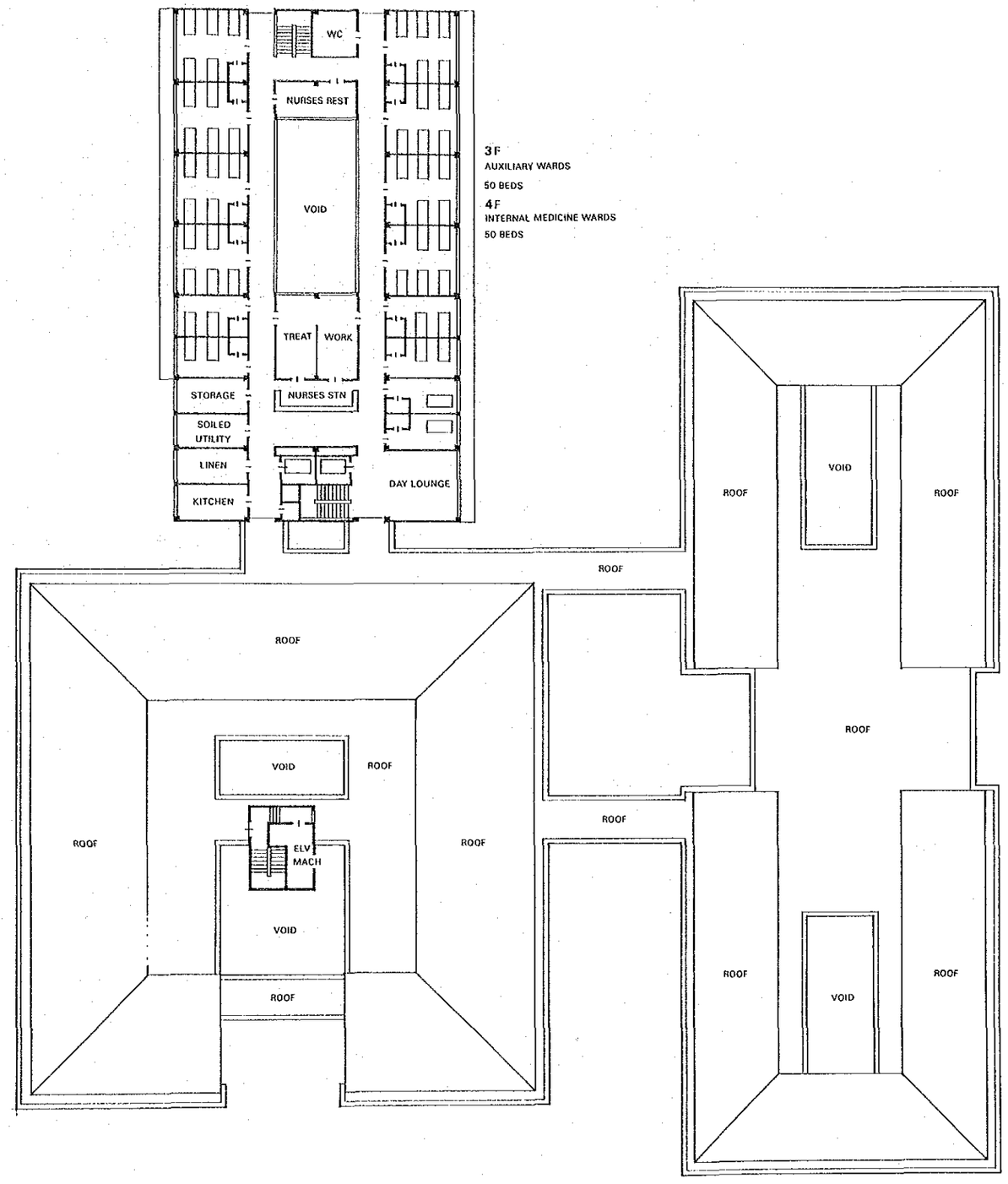


2nd FLOOR PLAN

SANTA CRUZ GENERAL HOSPITAL 4



ROOF PLAN OF WARDS WING



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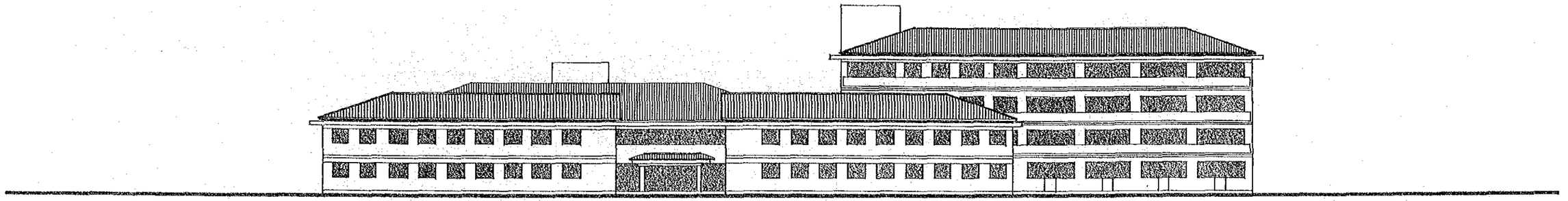
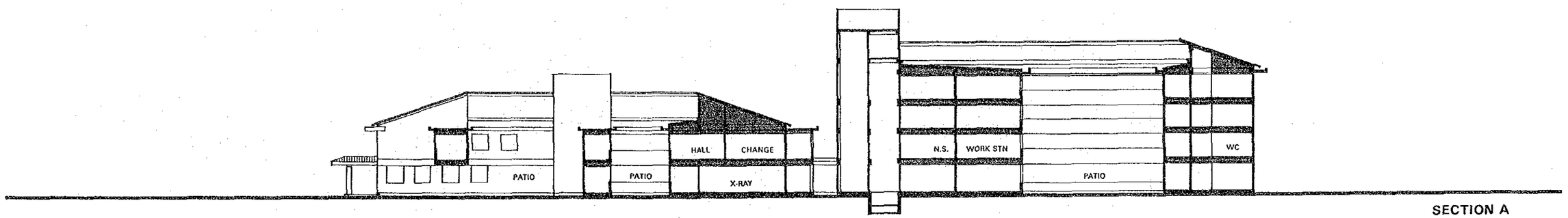
3rd & 4th FLOOR PLAN

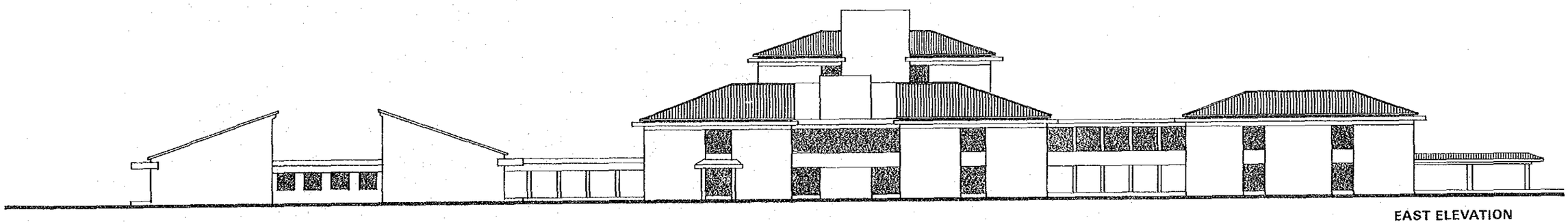
SANTA CRUZ GENERAL HOSPITAL 5



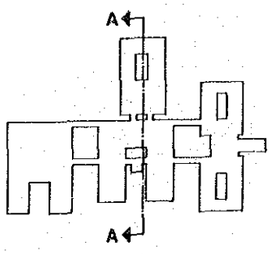
NORTH ELEVATION

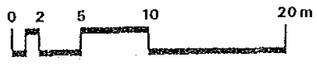


SECTION A



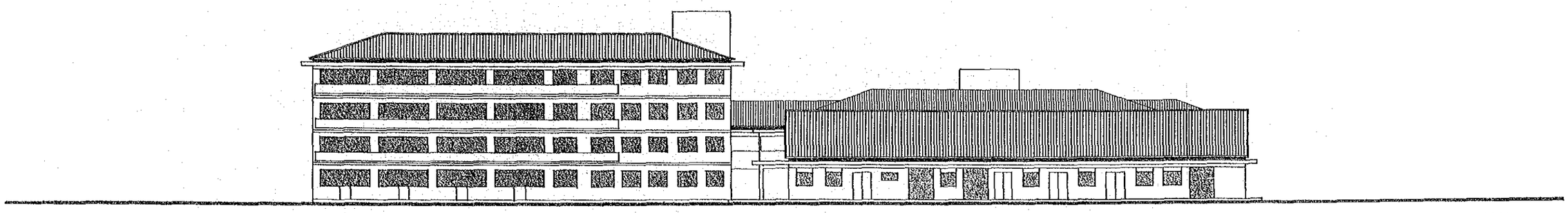
EAST ELEVATION



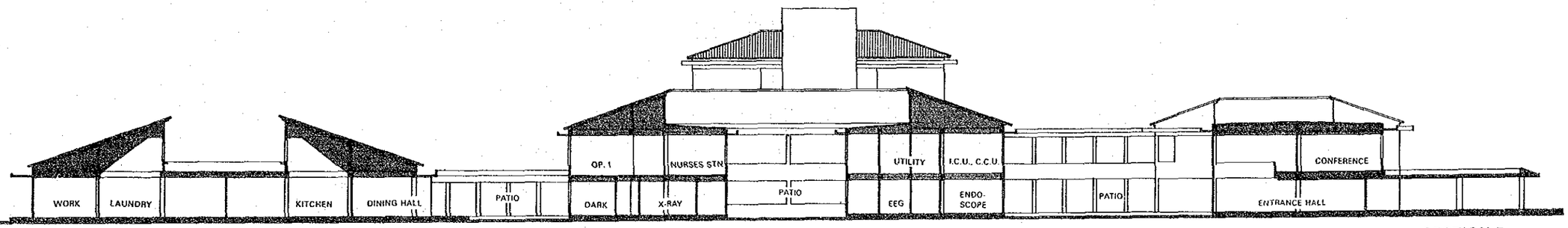


ELEVATION & SECTION 1

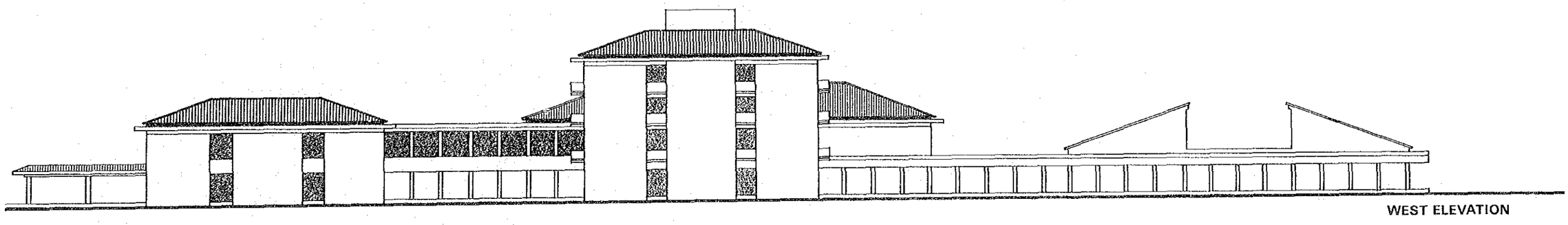
SANTA CRUZ GENERAL HOSPITAL 6



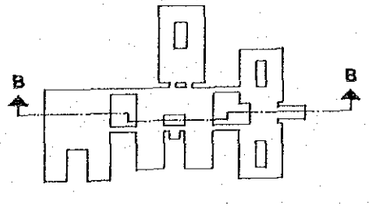
SOUTH ELEVATION

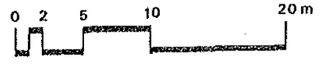


SECTION B



WEST ELEVATION





ELEVATION & SECTION 2

SANTA CRUZ GENERAL HOSPITAL 7

(8) Floor area summary

Name of Buildings	Floor Area
O.P.D. Wing	Approx. 2,800 m^2
Central Diagnosis Wing	Approx. 2,900 m^2
Wards Wing	Approx. 3,600 m^2
Service Wing	Approx. 1,500 m^2
Corridors, etc.	Approx. 600 m^2
Total	Approx. 11,400 m^2