8.4.4 Conceptual Design of Stormwater Drainage System

(1) Premise of stormwater drainage system design

The basic concept of drainage system design is, in principle, to maintain the same hydrographic flow in the district after development of the IMT as occurs is in the existing state.

(a) Estimated existing hydrographic flow

The existing hydrographic flow cannot be determined in detail because the surrounding area is flat and with the limited topographical survey, rainfall drainage paths are sometimes not clear. The assumed drainage area is shown in Fig. 8.4.6 based on the topographic map of the surrounding district. The flat area acts as an overland flow path.

(b) Hydrographic flow after development

The catchment area will not be changed by development except for minor changes in flow routes. The surface rainwater flow quantity will increase due to higher runoff but this shall be adjusted using a retention pond and the discharged flow quantity will be maintained at the existing flow. While the total flow quantity is unchanged, it is however necessary to improve (or construct) the down stream drain because the discharge from the retention pond is concentrated at one point as distinct from the overland flow or sheet flow that now occurs.. This design is based on the premise that the down stream drain will be improved.

(2) Basic concept of drainage district

The division of drainage, in principle, shall be maintained in the existing state. The area is divided into an outer site and an inner site; the runoff coefficient will increase in the latter but not in the former.

Rainfall in the outside area will be discharged by the existing flow route as far as possible. The rainfall within the site will be collected into the retention pond located on the north-west of the site where discharge flow will be controlled. District drainage after development will be divided into 4 areas as shown in Fig. 8.4.6. The IMT site is located in the north-west part of the district.

(a) Characteristics of each area in existing state

Area - 1 extends to the west from the ridge of the hill located on the eastern side of the site. Rainfall in this area flows to the north-west and is dammed by the existing bund located on the eastern side of NH - 8.

Area - 2 extends to the north from the ridge of the hills located to the south-east side of the site. Rainfall in this area flows to the north and is dammed by the existing bund, as for area - 1, located on the eastern side of NH - 8.

Collected rainfall at the bund located on the eastern side of the NH - 8, is discharged to Manesar Nala on the northern side of the site by the channel that crosses NH - 8. It s presumed that a part of the rainfall infiltrates into ground. The bund has the same function as a retention pond.

Area - 3 extends to the north through to the IMT site boundary from the ridge of hills located to the southern side of the site.

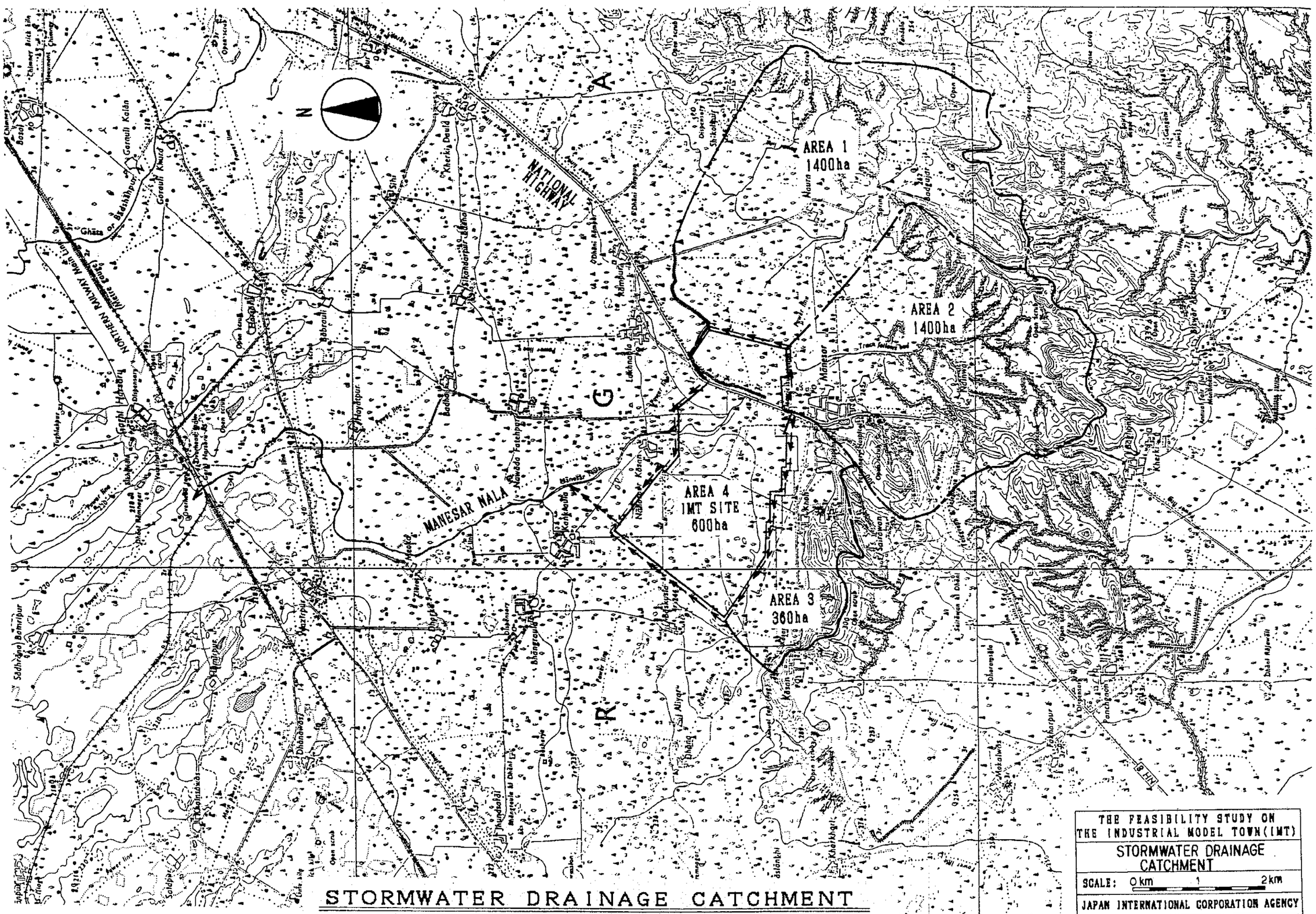
(b) Each area after development

The concept for drainage of each area after development is shown in Fig. 8.4.7 and is described below. Rainfall from area - 1 and area - 2 is collected on the eastern side of the NH - 8, as in the existing state. It will be discharged to the Manesar Nala located to the north of the site, through the culvert and open channel that will be constructed along the north boundary of the site.

A part of the existing bund located on the eastern side of the NH - 8, will be removed for development. Consequently, new bund construction is necessary on the east side of the site. The bund will effectively retain water and create a retention pond.

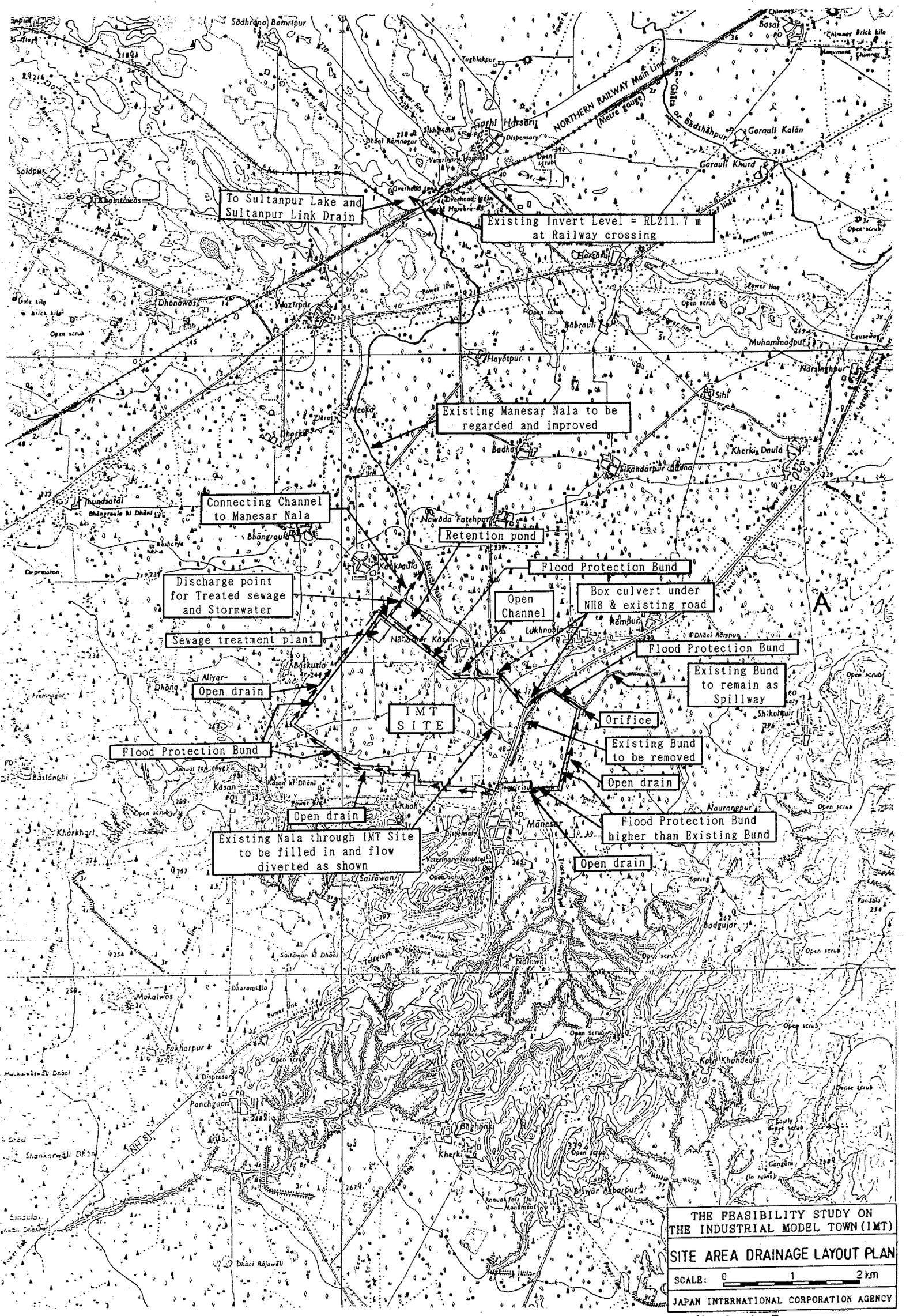
Flow of rainfall within the site (600 ha) shall be controlled before discharge because the runoff coefficient will be altered. Flow will be collected and drained by inlets, underground pipes and open drains into the retention pond located to the north-west of the site. After sand sedimentation, it will be discharged. The site area is extensive, and the construction cost will increase if an underground piping system is adopted for stormwater drainage of the whole area. Therefore, a wide open channel will be provided along the north boundary of the site, and stormwater will be diverted into it by several underground pipes running from south to north.

Rainfall in area - 3 will be discharged into the existing Manesar Nala located on the north side of the site through an open drain along the boundary.



STORMWATER DRAINAGE CATCHMENT

fig. 8-4-6



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THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)

SITE AREA DRAINAGE LAYOUT PLAN

SCALE: 0 1 2 km

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fig. 8-4-7

(3) Design condition of rainfall drainage system

(a) Design stormwater runoff

Design stormwater runoff shall be calculated by the following rational formula:

$$Q = (1/360) \cdot C \cdot I \cdot A$$

where, Q : Design stormwater runoff (m^3/sec)
C : Runoff coefficient
I : Design rainfall intensity (mm/hr)
A : Drainage area (ha)

(b) Design return period

The design return period of drainage system will be as follows:

1) Design of drainage pipes

According to the description given in "Manual on Sewerage and Sewage Treatment" (Ministry of Urban Development, New Delhi), drainage pipes will be designed for a 2 year return period applying the classification of the area as "Commercial and High Priced Area".

The road levels will be planned to be lower than the levels of housing lot, so that the roads can work as a drain to prevent the housing, commercial and industrial lots from flooding in the event of a less frequent storm.

2) Design of excavated retention pond

A 5 years return period will be adopted for design of the excavated retention pond, which will be constructed to the northwest of IMT site.

3) Design of flood protection bund on the east of the site

The flood protection bund on the east of the site will be designed for a 50 years return period for safety, because the IMT is located in the downstream side of the bund.

4) Design of spillways

Spillways will be designed for a 100 years return period considering the flood case.

(c) Design rainfall intensity

Design rainfall intensity, in general, is expressed as a function of the duration of storm (t) as follows:

Talbot's formula

$$I = \frac{a}{t + b} \text{ mm/hr}$$

Scherman's formula

$$I = \frac{a}{t^n}$$

Combined formula of above

$$I = \frac{a}{t^n + b}$$

Constants a, b and c should be derived from recent rainfall data which indicates rainfall intensity and duration.

Rainfall data in Gurgaon obtained so far are shown in Table 8.4.4. The data that can be used to estimate the rainfall intensity are the following 2 data. Both data indicate the rainfall intensity of 50 years return period.

a) 24 hours rainfall intensity of 50 years return period 240mm
Government of India, Central Water
Commission Hydrology (CS) Directorate

b) 1 hour rainfall intensity of 50 years return period 90mm
Natural Resources of Humid
Tropical Asia, Natural resources
Research, XII, UNESCO, 1974

Rainfall intensity curve based on this data and using the above formulas are shown in Fig. 8.4.8 A and Fig. 8.4.8 B. Comparing with rainfall intensity curves for Tokyo and Brisbane (Australia), the following formula was provisionally adopted for the rainfall intensity curve for a 50 years return period.

$$I = \frac{3500}{t^{0.8} + 12} \text{ mm/hr (50 year return period)}$$

Since no data was available for the rainfall intensity for a 2 year return period and 5 year return period, rainfall intensity is estimated from the ratio of the rainfall intensity of each return period to that of 50 years return period in Tokyo and Brisbane as follows:

Unit: mm/hr

Return period	Tokyo		Brisbane		Gurgaon Estimated	
	60 min.	24 hr.	60 min.	24 hr.	60 min.	24 hr.
50 years	95.8	14.4	99.7	11.7	90.0	10.0
2 years	40.3	6.7	47.4	5.4	40.3	4.6
ratio	0.421	0.465	0.475	0.462	0.448	0.463
5 years	59.0	9.1	62.2	7.2	55.8	6.2
ratio	0.616	0.629	0.624	0.615	0.620	0.622

From above the rainfall intensity curves were presumed as shown in Fig. 8.4.8 C, Fig. 8.4.8 D and Fig. 8.4.8 E, Fig. 8.4.8 F and the following formulas were adopted.

$$I = \frac{1800}{t^{0.8}+18} \text{ mm/hr (2 year return period)}$$

$$I = \frac{2100}{t^{0.8}+18} \text{ mm/hr (5 year return period)}$$

The 1-day point probable maximum precipitation of 400 mm/day (=16.7 mm/hr) given by INDIA METEOROLOGICAL DEPARTMENT, NEW DELHI will be used for the 100 years return period.

This is almost the same as 100 years return period in Tokyo. Therefore, the formula for Tokyo is adopted.

$$I = \frac{2200}{t^{2/3}+4.5} \text{ mm/hr}$$

PRECIPITATION DATA

1. GURGAON

No	Data source	Data Period	Annual			Monthly Mean Maximum		Daily (24hr)				3 Hour Maximum		Hour Maximum	
			Mean	Maximum				Maximum		Probable Maximum					
			Amount	Amount	Year	Amount	Month	Amount	Return period year	Amount	Return period year	Amount	Return period year	Amount	Return period year
				187% Given in percentage to mean annual rainfall											
1	IMD *1	74 years	662.7	1239	1977	201	Aug.	269.2	09. SEP. 1875	—	—	—	—	—	—
2	IMD *2	—	—	—	—	—	—	—	—	400	5000-10000	—	—	—	—
3	CS *3	—	—	—	—	—	—	240	50	—	—	—	—	—	—
4	UNESCO *4	—	—	—	—	—	—	—	—	—	—	—	—	90	50
5	Haryana *5	1 year	—	477.7	1991	272.9	Aug.	—	—	—	—	—	—	—	—
6	Haryana *5	1987-1991	449	—	—	184.8	Aug.	—	—	—	—	—	—	—	—
7	Haryana *5	1966-1991	—	783	1985	—	—	—	—	—	—	—	—	—	—
8	RMC *6	1 year	—	844.4	1990	196.6	Aug.	—	—	—	—	—	—	—	—
9	RMC *6	1 year	—	696.8	1991	471.6	Aug.	—	—	—	—	—	—	—	—
10	RMC *6	1 year	—	393.3	1992	192.9	Aug.	—	—	—	—	—	—	—	—

Data sources

*1 "Climate of Harayana and Union Territories of Dehli and Chandigrah" Goverment of India, India Meteorological department 1991

*2 "Meteorological Monograph Hydrology/No. 11/1988 "Generalized Maps of 1 day point provable maximum precipitation" India Meteorological Department New Dehli

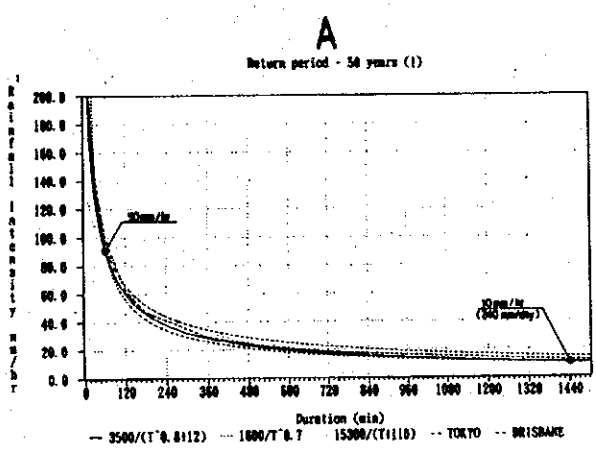
*3 Goverment of India, Central Water Commission Hydrology (CS) Directorate

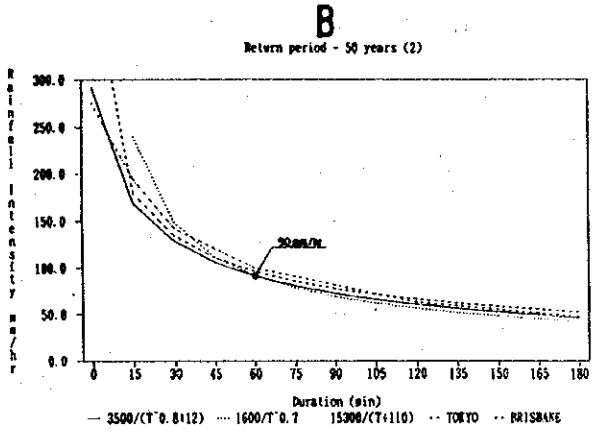
*4 "Natural Resources of Humid Tropical Asia" Natural Resources Research, XII, UNESCO

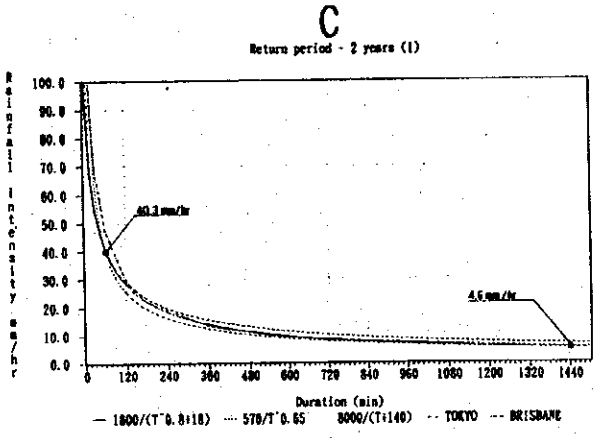
*5 Director of Land Records, Haryana

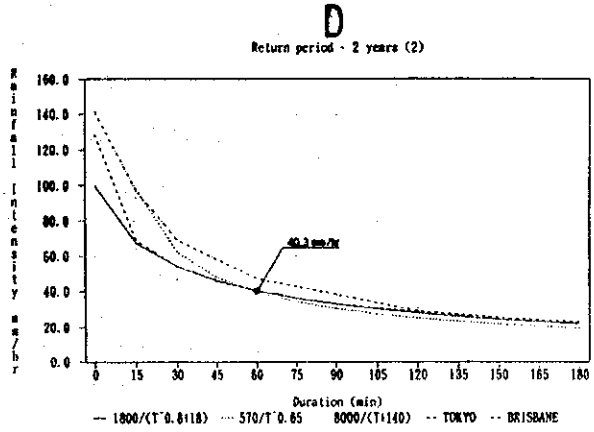
*6 Regional Meteorological Centre, New Dehli

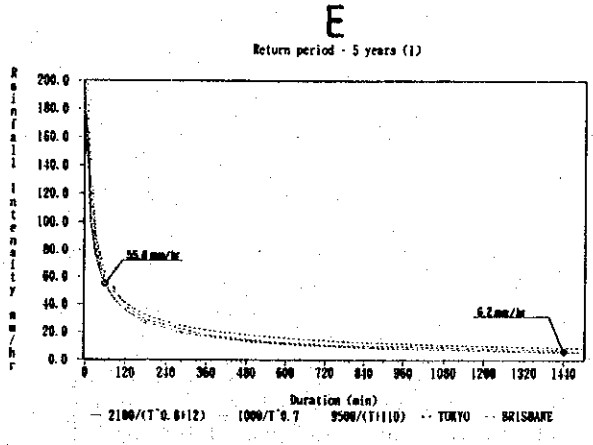
TAB. 8-4-4 PRECIPITATION DATA

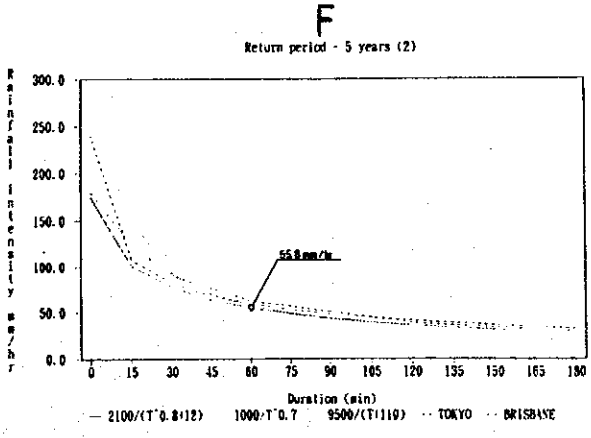












RAINFALL INTENSITY CURVES

fig. 8-4-8

(d) Runoff coefficient

Following will be used as runoff coefficient.

Residential and commercial area : C = 0.80
Industrial area : C = 0.65
Fields and undeveloped area : C = 0.30

(e) Discharge

Flow capacity will be calculated by the following Manning's formula.

$$Q = A \cdot V$$

$$V = \frac{R^{2/3} \cdot i^{1/2}}{n} \quad mm/hr$$

where,

Q : Discharge (m^3/sec)

A : Sectional area of drain (m^2)

V : Velocity of flow (m/sec)

n : Coefficient of roughness

n = 0.013 concrete pipe

n = 0.020 gutter by excavation without timbering

n = 0.017 artificial concrete canal

R : Hydraulic radius R = A/P (m)

P : Wetted perimeter of drain section (m)

i : Slope (m/m)

(f) Velocity of flow

Minimum : 0.8 m/sec

Maximum : 3.0 m/sec

(g) Manholes

Maximum spacing of manholes shall be as follows:

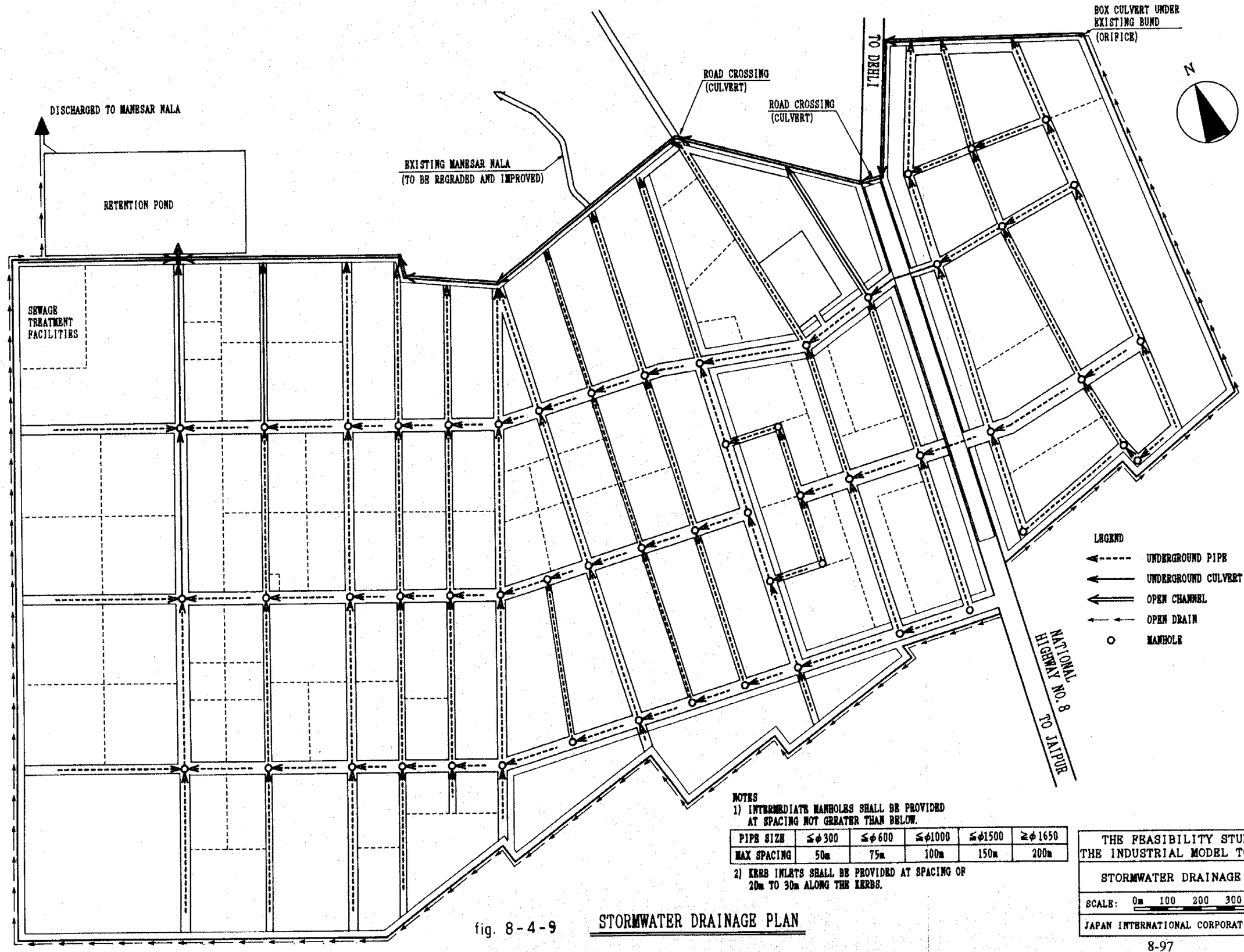
Pipe Diameter	Less than 300 mm	Less than 600 mm	Less than 1000 mm	Less than 1500 mm	More than 1650 mm
Maximum spacing	50 m	75 m	100 m	150 m	200 m

(h) Kerb inlets and lateral sewers

Spacing of collecting inlets shall be 20 m to 30 m as standard. Lateral pipes shall be ø200 mm pipe with slope more than 1%.

(i) Connection pits and pipes

Connection pits shall be provided in each area, and the rainfall in each area shall flow into main pipes through connection pipes. (See Fig. 8.4.10 through Fig. 8.4.14)



NOTES
1) INTERMEDIATE MANHOLES SHALL BE PROVIDED AT SPACING NOT GREATER THAN BELOW.

PIPE SIZE	≦φ300	≦φ600	≦φ1000	≦φ1500	≧φ1650
MAX SPACING	50m	75m	100m	150m	200m

2) KERB INLETS SHALL BE PROVIDED AT SPACING OF 20m TO 30m ALONG THE KERBS.

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
STORMWATER DRAINAGE PLAN
SCALE: 0m 100 200 300 400m
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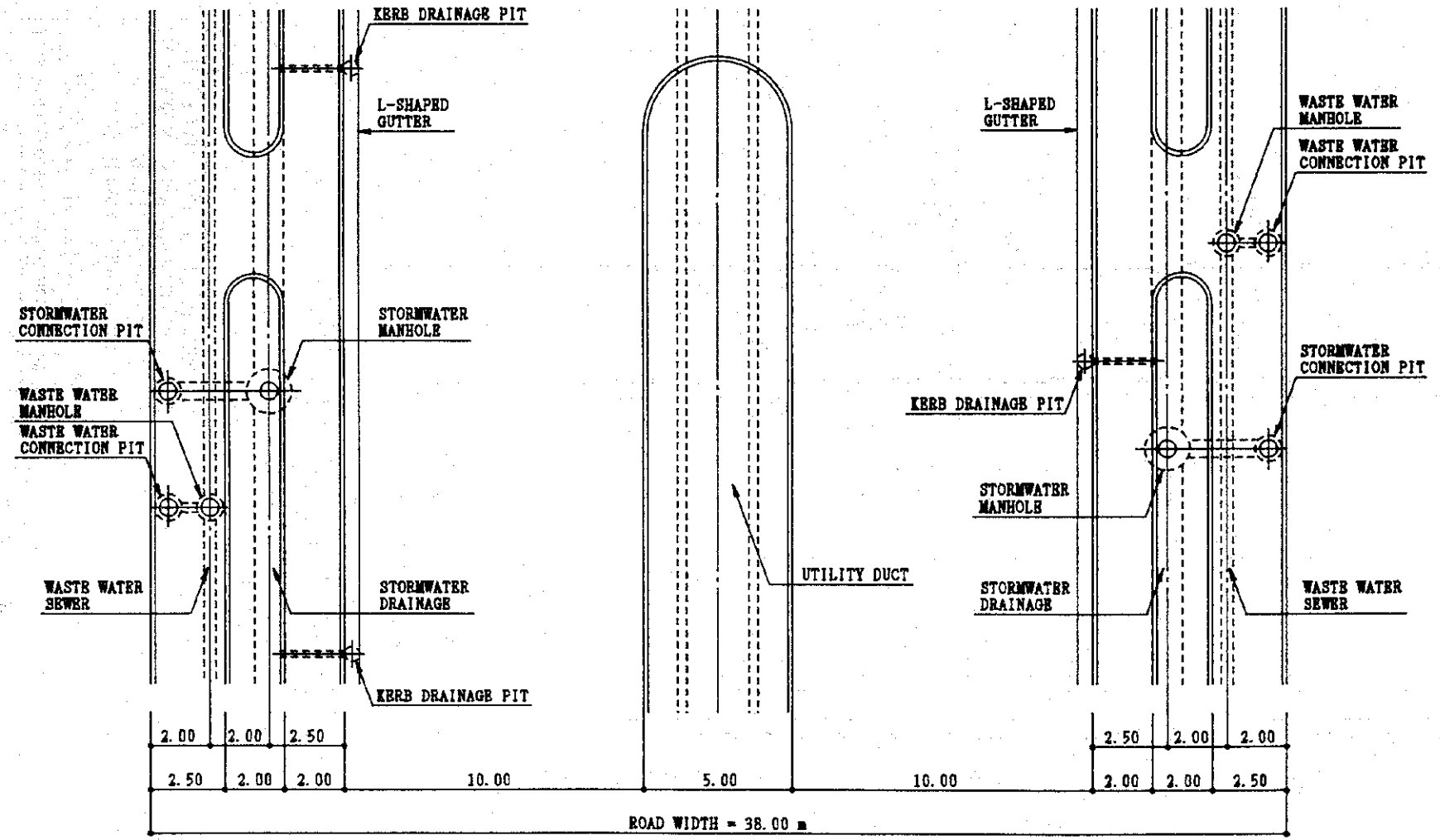
fig. 8-4-9 STORMWATER DRAINAGE PLAN



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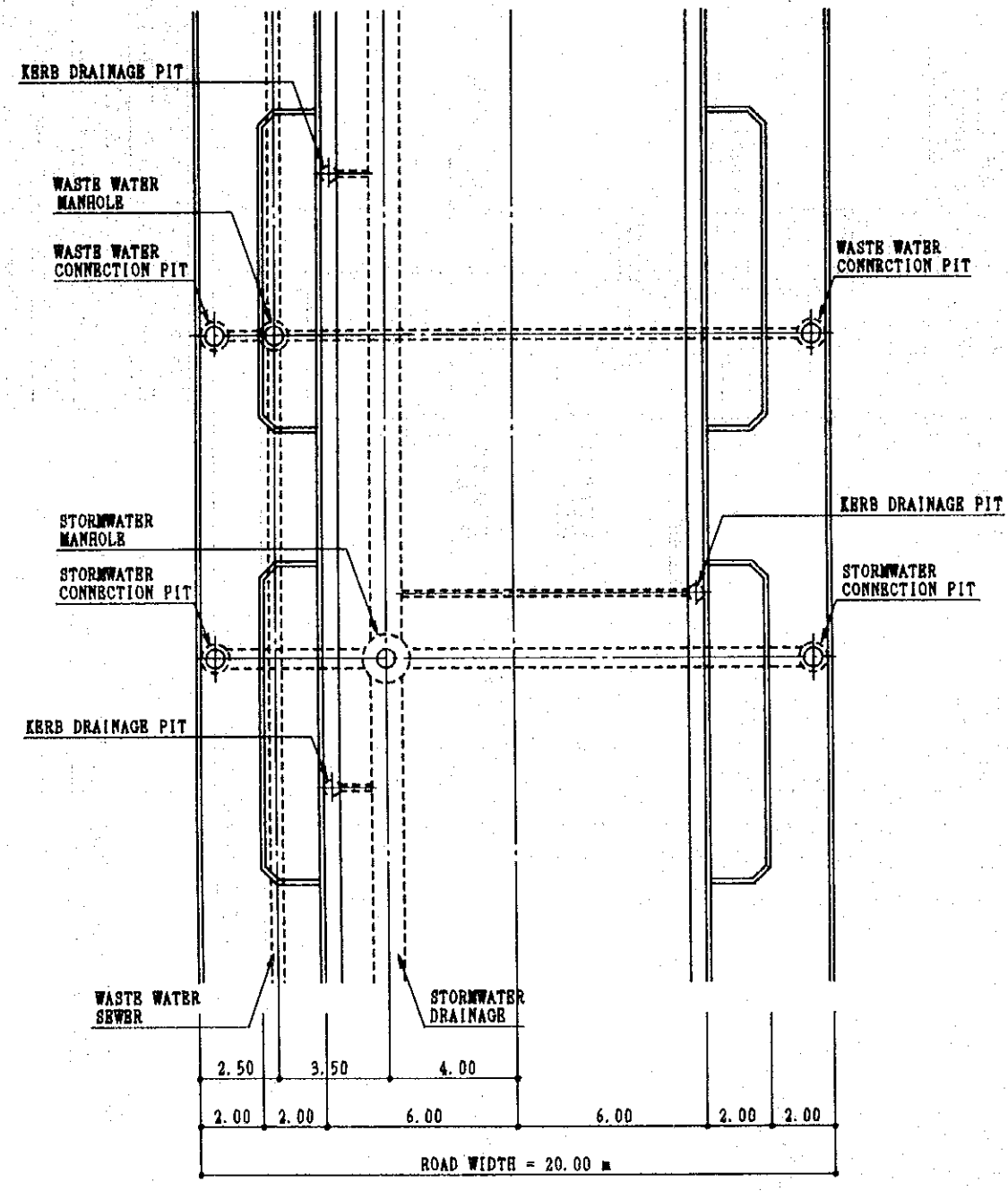
TYPICAL PLAN OF DRAINAGE SYSTEM (1/2)

fig. 8-4-10

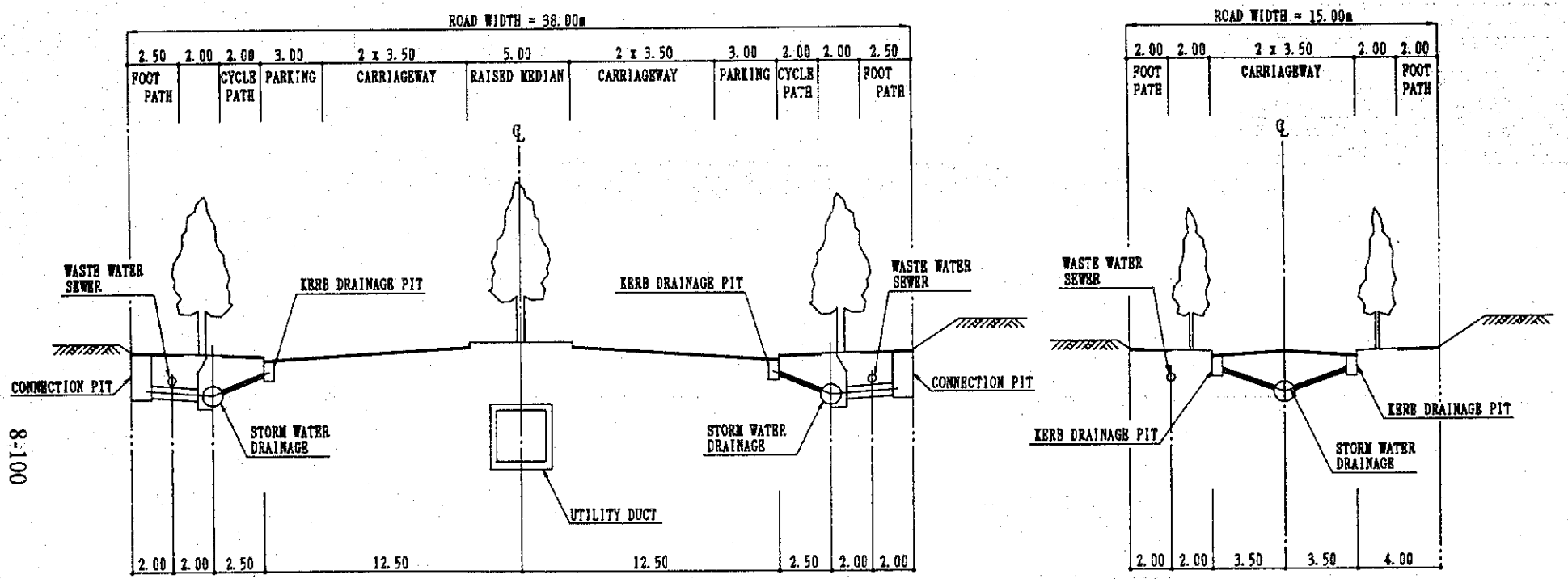
THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
TYPICAL PLAN OF DRAINAGE SYSTEM (1/2)
SCALE: 0m 2 4 6 8m
JAPAN INTERNATIONAL CORPORATION AGENCY



TYPICAL PLAN OF DRAINAGE SYSTEM (2/2)

fig. 8-4-11

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
TYPICAL PLAN OF DRAINAGE SYSTEM (2/2)
SCALE: 0m 2 4 6 8m
JAPAN INTERNATIONAL CORPORATION AGENCY

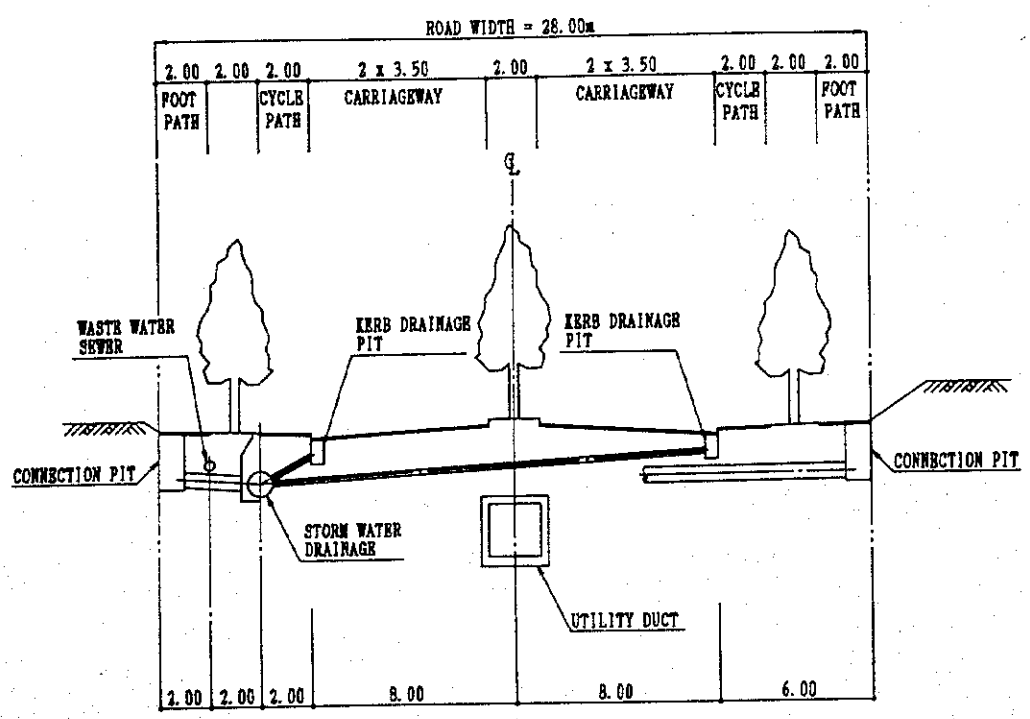


CLASS-1 ROAD

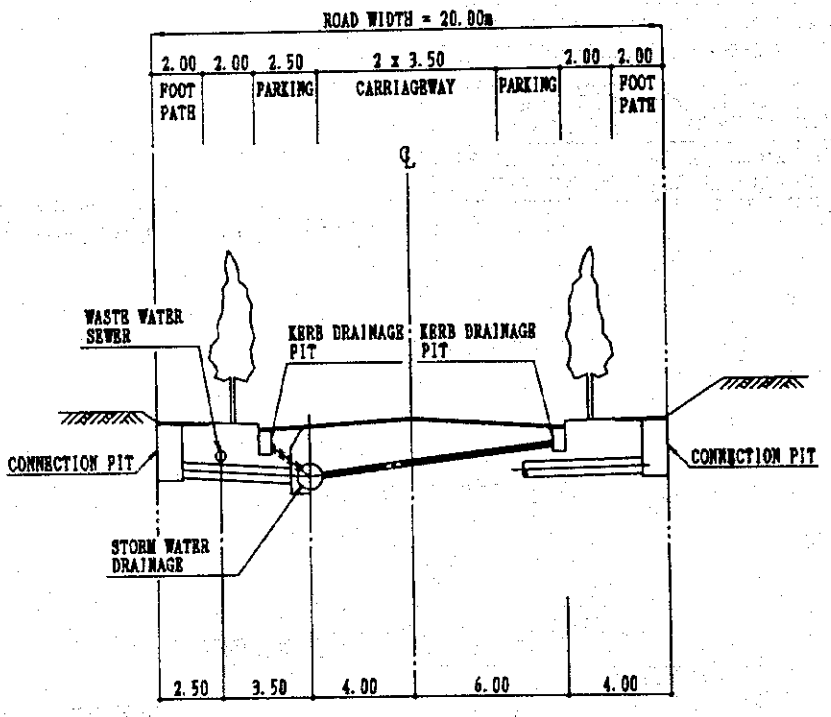
CLASS-4 ROAD

fig. 8-4-12 TYPICAL ROAD CROSS-SECTIONS FOR DRAINAGE (FOR CLASS - 1&4 ROAD)

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
TYPICAL ROAD CROSS-SECTIONS FOR DRAINAGE (1/3)
SCALE: 0m 2 4 6 8m
JAPAN INTERNATIONAL CORPORATION AGENCY



CLASS-2 ROAD



CLASS-3 ROAD

fig. 8-4-13 TYPICAL ROAD CROSS-SECTIONS FOR DRAINAGE (FOR CLASS - 2&3 ROAD)

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
TYPICAL ROAD CROSS-SECTIONS FOR DRAINAGE (2/3)
SCALE: 0m 2 4 6 8m
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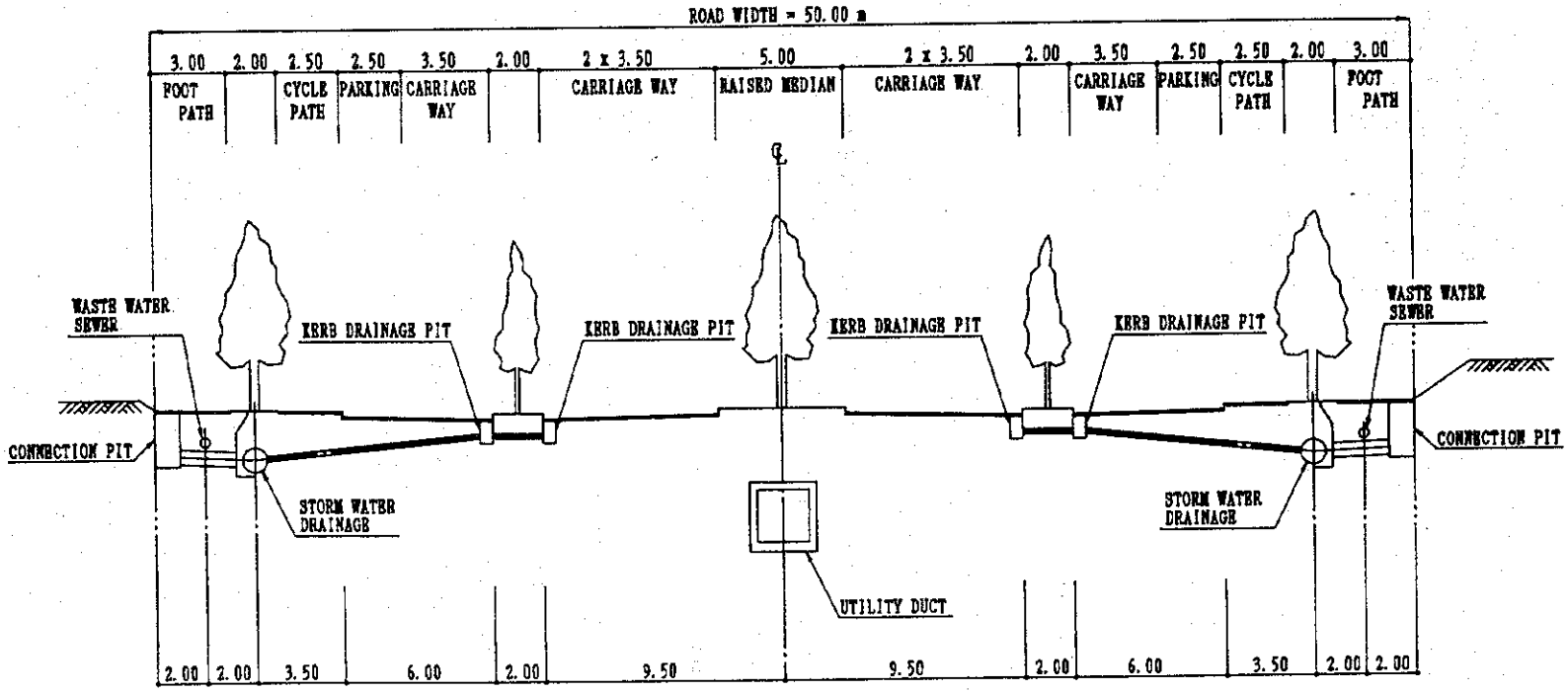

CLASS-5 BOULEVARD

fig. 8-4-14 TYPICAL ROAD CROSS-SECTIONS FOR DRAINAGE (FOR CLASS - 5 BOULEVARD)

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
TYPICAL ROAD CROSS-SECTIONS FOR DRAINAGE (3/3)
SCALE: 0m 2 4 6 8m
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(4) Conceptual design of stormwater drainage within the site

(a) Design of connection pipes and pits

The stormwater drainage within each lot shall be provided by the site developer or each facility designers by means of open channels or underground pipes to the connection pits. From these connection pits, the stormwater will flow into the main drainage line. For this infrastructure development project, the drainage system up to the connection pits shall be constructed.

Design is carried out on the assumption that connecting inlets are established in each 2.5 ha.

Drainage area	A = 2.5 ha
Runoff coefficient	C = 0.65
Pipe length	L = 400 m
Mean flow velocity	V = 1.2 m/sec
Time of inlet	t1 = 5.0 min
Time of flow	t2 = L/V = 333.3 sec = 5.6 min
Time of concentration	t = t1 + t2 = 10.6 min
Rainfall intensity	$I = 1800/(t^{0.8}+18) = 73.2$ mm/hr (2 years return period)
Runoff	$Q = (1/360)\cdot C\cdot I\cdot A = 0.330$ m^3/sec
Pipe diameter	ø = 0.600 m
Slope	i = 0.0040
Roughness coefficient	n = 0.013
Sectional area	$Ap = \pi/4\cdot D^2 = 0.283$ m^2
Wetted perimeter	$Sp = \pi\cdot D = 1.885$ m
Hydraulic radius	R = Ap/Sp = 0.150 m
Velocity of flow	$V = (1/n)\cdot R^{2/3}\cdot i^{1/2} = 1.373$ m/sec
Discharge	$Q = A\cdot V = 0.3883$ m^3/sec

Connection pits size shall be ø900 mm.

(b) Calculation of underground drainage pipes running from south to north

The stormwater within the site will be basically drained through underground pipes into an open channel constructed along the northern boundary of the site. Calculation for the underground piping running from south to north on the west side of the site is shown as follows:

Drainage area	A = 125 ha
Runoff coefficient	C = 0.65
Pipe length	L = 2000 m
Mean flow velocity	V = 1.2 m/sec
Time of inlet	t1 = 5.0 min
Time of flow	t2 = L/V = 1666.7 sec = 27.8 min
Time of concentration	t = t1 + t2 = 32.8 min
Rainfall intensity	$I = 1800/(t^{0.8}+18) = 52.5$ mm/hr
	(2 years return period)
Runoff	$Q = (1/360)\cdot C\cdot I\cdot A = 11.840 m^3/sec$
Drain size	B = 3.500 m,. H = 2.000 m (box culvert)
Slope	i = 0.0010
Roughness coefficient	n = 0.013
Sectional area	$Ap = B * H = 7.000 m^2$
Wetted perimeter	Sp = 2 * (B + H) = 11.000 m
Hydraulic radius	R = Ap/Sp = 0.636 m
Velocity of flow	$V = (1/n)\cdot R^{2/3}\cdot i^{1/2} = 1.800$ m/sec
Discharge	$Q = A\cdot V = 12.597 m^3/sec$

(c) Open channel along northern boundary of the site

All of the stormwater within the site will be collected into the open channel provided along the northern boundary of the site, and discharged at the northwest corner of the site into the retention pond constructed outside the site. The calculation for the open drain along the northern boundary of the site is as follows:

Drainage area	A = 600 ha
Runoff coefficient	C = 0.7
Pipe length	L = 4500 m
Mean flow velocity	V = 1.5 m/sec
Time of inlet	t1 = 5.0 min
Time of flow	t2 = L/V = 3000.0 sec = 50.0 min
Time of concentration	t = t1 + t2 = 55.0 min
Rainfall intensity	$I = 1800/(t^{0.8}+18) = 42.2$ mm/hr
	(2 years return period)
Runoff	$Q = (1/360)\cdot C\cdot I\cdot A = 49.207$ m^3/sec
Drain size	B =12.000 m, H = 4.000 m
Slope	i = 0.0010
Roughness coefficient	n = 0.017
Sectional area	Ap = B * H/2 = 24.000 m^2
Wetted perimeter	Sp = B + H = 16.000 m
Hydraulic radius	R = Ap/Sp = 1.500 m
Velocity of flow	$V = (1/n)\cdot R^{2/3}\cdot i^{1/2} = 2.438$ m/sec
Discharge	$Q = A\cdot V = 58.500$ m^3/sec

(5) Conceptual design of stormwater drainage outside the site

(a) Drainage of Area - 1 and Area - 2

Rainfall from area 1 and area 2 flows down the hill slope to the east side of NH - 8. It seems that rainfall is ponded temporarily by the existing bund of 4 m in height.

The storage area and capacity at present and after development are as follows:

	Storage area	Mean depth	Storage capacity
Present state	150 ha	3.5 m/2	2,625,000 m^3
After development	65 ha	3.5 m/2	1,137,500 m^3

The following formula for design of retention ponds will be used, by varying by trial and error the discharge quantity Qc, to obtain the discharge quantity when the maximum required control volume Vi for any rainfall duration is equal to the available storage control volume.

$$Vi = 60\,(ri - rc/2) \cdot \frac{ti \cdot f \cdot A}{360}$$

where,

Vi : Required storage control volume (m^3)
ri : Rainfall intensity at ti (mm/hr)
rc : Rainfall intensity equivalent to the allowable discharge volume Qc (m^3/sec) of downstream = $360 \cdot Qc/(f \cdot A)$
ti : Optional rainfall duration (min)
A : Catchment area (ha) = 2800 ha
f : Runoff coefficient = 0.3

By trial and error, choose values of Qc and ti which will result in the maximum required storage capacity Vi being approximately equal to the available storage volume:

In case of 2 years return period rainfall

$$ri = 1800/(ti^{0.8}+18)$$

Existing state

Available Storage Volume Vi = 2,625,000 m^3

For Qc= 0.06 m^3/sec
rc = 0.03mm/hr

For ti = 363,070 min
ri = 0.1mm/hr
Vi = 2,605,742 m^3

Hence, for the existing storage capacity, the required outlet capacity is only 0.06 m^3/sec

After development		Available Storage Volume Vi = 1,137,500 m^3
	For	Qc = 1.53 m^3/sec
		rc = 0.7 mm/hr
	For	ti = 6,681 min
		ri = 1.5 mm/hr
		Vi = 1,137,488 m^3

Hence, after development, the required outlet capacity increases from 0.06 m^3/sec to 1.53 m^3/sec because of the reduced storage capacity.

In case of 50 years return period rainfall

$$ri = 3500/(ti^{0.8}+12)$$

Existing state		Available Storage Volume Vi = 2,625,000 m^3
	For	Qc= 1.6 m^3/sec
		rc = 0.7 mm/hr
	For	ti = 14,018 min
		ri = 1.0 mm/hr
		Vi = 2,615,886 m^3

After development		Available Storage Volume Vi = 1,137,500 m^3
	For	Qc= 28.8 m^3/sec
		rc = 12.3 mm/hr
	For	ti = 472 min
		ri = 14.0 mm/hr
		Vi = 1,136,430 m^3

The outlet capacity of the open channel from the retention pond to the east of the IMT site will be designed for Qc = 28.8 m^3/sec, or for the flow from inside the IMT site for a 1 in 2 year rainfall, whichever is highest.

The balance of capacity, between present state and after development (1,487,500m^3) will be controlled by the retention pond at the north-west corner of the IMT site. The flow quantity equal to that of the present state can be discharged directly to Manesar Nala.

Spillway

Stormwater could potentially flow over the east side bund into the IMT at the time of flood. To avoid this, the newly constructed bund that will surround the east side of the IMT shall be higher than the existing bund, so that the existing bund can work as a spillway. Overflow water will be discharged to the north side of IMT and finally will be drained into Manesar Nala at the time of flood.

Drainage area	A = 2,800 ha
Runoff coefficient	C = 0.3

Flow length	L = 4000 m
Mean flow velocity	V = 1.0 m/sec
Time of inlet	t1 = 10.0 min
Time of flow	t2 = L/V = 4000.0 sec = 66.7 min
Time of concentration	t = t1 + t2 = 76.7 min
Rainfall intensity	$I = 2200/[t^{2/3}+4.5] = 97.6$ mm/hr (100 years return period)
Runoff	$Q = (1/360)\cdot C\cdot I\cdot A = 227.7\ m^3/sec$
	$Q' = 1.44\cdot Q = 327.8\ m^3/sec$
Overflow coefficient	C = 1.8
Overflow depth	H = 1.4 m
Spillway length	$B = Q'/[C*H^{2/3}] = 110.0$ m

(b) Drainage of area 3

Rainfall from area - 3 flows into Manesar Nala directly at present. Therefore, the stormwater can be discharged to Manesar Nala by an open drain that will be constructed along the IMT site border on the south and west sides.

Drainage area	A = 360 ha
Runoff coefficient	C = 0.3
Flow length	L = 5000 m
Mean flow velocity	V = 2.0 m/sec
Time of inlet	t1 = 10.0 min
Time of flow	t2 = L/V = 2500.0 sec = 41.7 min
Time of concentration	t = t1 + t2 = 51.7 min
Rainfall intensity	$I = 1800/[t^{0.8}+18] = 43.4$ mm/hr (2 years return period)
Runoff	$Q = (1/360)\cdot C\cdot I\cdot A = 13.0205\ m^3/sec$

For this discharge :

Drain size	B = 3.000 m, H = 2.000 m
Slope	i = 0.0025
Roughness coefficient	n = 0.020
Sectional area	$Ap = B * H = 6.000\ m^2$
Wetted perimeter	Sp = B + 2 * H = 7.000 m
Hydraulic radius	R = Ap/Sp = 0.857 m
Velocity of flow	$V = (1/n)\cdot R^{2/3} \cdot i^{1/2} = 2.256$ m/sec
Discharge capacity	$Q = A\cdot V = 13.535\ m^3/sec$, OK

(c) Retention pond

Stormwater runoff increases because the runoff coefficient will increase with development. The retention pond, which also has a function of sand sedimentation, will be provided to avoid an increase in discharge.

Calculation of retention pond capacity

$Vi = (\gamma i - \gamma c/2) * 60 * ti * f * A * 1/360$

Vi : Required control volume (m^3)

γ_i : Rainfall intensity = $2100/t^{0.8} + 12$ (mm/hr)
(5 years return period)

γc : Rainfall intensity equivalent to the allowable discharge quantity of downstream = $360 * Qc/(f*A)$ (mm/hr)

Qc : Allowable discharge quantity downstream = 12 m^3/sec

ti : Optional rainfall duration = 280 min

f : Difference of runoff coefficient between before development and after development = 0.6

A : Drainage area = 600 (ha)

Required control volume Vi = 243,000 m^3

Sand sedimentation volume

During construction Vs = 600 ha * 150 m^3/ha/year = 90,000 m^3

After completion Vs = 600 ha * 1.5 m^3/ha/year = 900 m^3

Required control volume area 1 and area 2

Ve =2,625,000 - 1,137,500 = 1,487,500 m^3

Required capacity of retention pond

During construction

V =243,000 + 90,000 + 1,487,500 = 1,820,500 m^3

After completion

V =243,000 + 900 + 1,487,500 = 1,731,400 m^3

(d) Downstream discharge

Rainfall within the site and from area 1 and area 2 will be discharged into Manesar Nala from the retention pond. Rainfall from area 3 will be discharged directly into Manesar Nala.

Sufficient capacity for 12 m^3/sec from the retention pond and 13 m^3/sec from area 3 is required.

Runoff	$Q = 12 + 13 = 25.0\ m^3/sec$
Drain size	$B = 6.000\ m, H = 2.000\ m$
Slope	$s = 0.0017$
Roughness coefficient	$n = 0.020$
Sectional area	$Ap = B * H = 12.000\ m^2$
Wetted perimeter	$Sp = B + 2 * H = 10.000\ m$
Hydraulic radius	$R = Ap/Sp = 1.200\ m$
Velocity of flow	$V = (1/n) \cdot R^{2/3} \cdot i^{1/2} = 2.328\ m/sec$
Discharge Capacity	$Q = A \cdot V = 27.936\ m^3/sec$

8.5 Electric Power Supply

8.5.1 Basic concept of Power Supply System for the IMT

(1) Estimate of Electric Power Demand

Power demand for the IMT is estimated by calculating the maximum power demand for each category and considering the "Demand factor" in each figures. The process of the calculation is shown in Table 8.5.1, total power demand for the IMT is estimated to be 110 MW.

Table 8.5.1 : Calculation of Electric Power Demand

Category	Maximum Power Demand		Demand Factor	Power Demand x Demand Factor (KW)
	Power Demand (KW)	Method of Estimating		
Factories	77,320	See Table 7.2.4	0.9	69,588
Housing	37,400	See Table 7.3.7	0.6	22,440
Social Service Facilities	28,320	See Table 7.3.7	0.6	16,992
Others (Road Lighting, etc.)	2,000	-	0.6	1,200
Total	145,040	-	-	110,220 (approx 110MW)

(2) Method of Electric Power Supply

One of the main objectives of this study, as described in chapter 5, section 5.5, is supplying stable electric power to the IMT. It is an indispensable condition to improve the level of infrastructure up to an international level.

To realize this objective, the power supply system to the IMT should have a couple of power sources. In other words, one source is the IMT as own captive power generation plant and the other source is a commercial power source from the Haryana State Electricity Boards (HSEB), so that these power supply sources can mutually back each other up. These power supply sources shall have enough capacity (110MW) individually to cover the power demand of the IMT.

However, in an ordinal operation mode, the captive power generation plant will have priority as a main power source and the commercial power source will be kept as a stand-by.

In addition, the captive power plant will have its own back-up system such as stand-by unit which will be provided so that the generation of planned capacity can be continued in case of periodical inspection and/or emergency, and a back-up system for fuel supply.

Also, the electrical power distribution system will have a ring main configuration that have a couple of power receiving circuits as mutual back-ups.

(3) Plot Plan

The main facilities of the electric power supply system for the IMT, to be located at the IMT site are shown in the following Table 8.5.2.

Table 8.5.2 : Main Facilities of Electric Power Supply System for the IMT

No.	Name of Facility	Area	Place
1)	Gas Turbine Power Generation Plant (IMT Power Plant)	220 m x 155 m Approx.	South End of the IMT Site
2)	Main Substation (IMT Main S/S)		
3)	Local Distribution Substation - 1 (IMT Local S/S No. 1)	30 m x 50 m Approx.	Within Factory Area (Outdoor)
4)	Local Distribution Substation - 2 (IMT Local S/S No. 2)	30 m x 50 m Approx.	Within Town Center Building (Indoor)

The IMT power plant will be constructed at the northern boundary of the IMT site (figure 8.1.1), considering easy access of gas pipeline and transmission line as well as the convenience of arranging the power distribution system within the IMT. An area of 5.4 ha has been planned for the power plant, of which about 3.4 ha (220m x 155m) will be actually used by the proposed power plant and the remaining area is reserved for future expansion of further units of gas turbines.

In principle, overhead installation of electric power supply system will be avoided within the IMT, and 66 KV and 11 KV cables between IMT Main S/S and IMT Local S/S's, LV transformer for distribution, etc. will be installed in the concrete cable trench. Others i.e. L.V. cables, etc. will be installed underground.

66 KV & 11 KV switchgears which is planned to be installed within the building, will be of cubicle type switchgears and/or cubicle type GIS, which is maintenance free and have a high reliability.

8.5.2 Captive Power Generation Plant (IMT Power Plant)

(1) Selection of type of IMT Power Plant

The power generation plant should be a package-type gas turbine driven power generation plant based on the following merits:

1) Minimal time required to begin generation

2) Comparatively low noise; Counter measures can be taken easily because of the high frequency of noise.

3) Since GAIL is implementing the project to extend the gas supply trunk line to Faridabad, low cost generation using natural gas can be achieved.

4) Minimal time required for construction

5) Only small quantity of cooling water required.

(2) Selection of Numbers and capacity of Gas Turbine Generating Unit (GTG)

To minimize construction cost per KW, number of unit should be one which has a capacity of 110 to 120 MW equal to the total demand of the IMT. However, this configuration has a demerit, that failure of the unit will cause complete shut down of the power plant and when considering a stand-by unit, the capacity of the stand-by unit has to be 100% capacity of the duty unit.

Then for the power generation plant of the IMT, the configuration consisting of 4 sets of frame 6 size power unit (38 MW by ISO Base Rating) which consists of 3 duty units and 1 stand-by unit is recommended. In this case, nominal plant output will be 114 MW and rate of stand-by unit to total installed capacity will be 33%.

(3) Outline of IMT Power Plant

1) Plant Layout

Proposed plant layout is shown in Fig. 8.5.1. The main points which we considered when making the plan, are as follows:

(a) Gas Turbine Generator (GTG) will be Frame 6 out door package type gas turbine generating units (3 units = duty, 1 unit = stand-by).

(b) To minimize disassembling space, we provided common space for 4 GTG in a common shed which has columns and a roof without a wall, to consider maintaining of GTG in the rain.

(c) Arrangement of GTG exhaust ducts and stacks were made so that the exhaust duct can be connected to the Waste Heat Recovery Steam Generator without modification of duct when the combined-cycle power plant is built up in the future. The height of exhaust stacks should be 45m, according to the regulations regarding the environmental act in India.

(d) The space for the following facilities is provided in the plan for future extension.

- Waste Heat Recovery Steam Generator (HRSG)
- Water Treatment Plant for HRSG
- Steam Turbine Generating Facilities for Combined-Cycle Power Plant
- Future expansion of Substation Bays

(e) Remote Control Building

GTG can be operated from local control cabinet combined with GTG package. In addition, our plan includes a remote control panel which can control and supervise fuel supply systems, substations, etc., from a remote position as well as GTG.

The remote control building is located in the plan to install the mentioned panel.

This building also has an operators room and switchgear room, etc. in which switchgears for station auxiliaries and distribution to the IMT will be installed.

(f) Site of IMT Main S/S is combined with the site of this power plant.

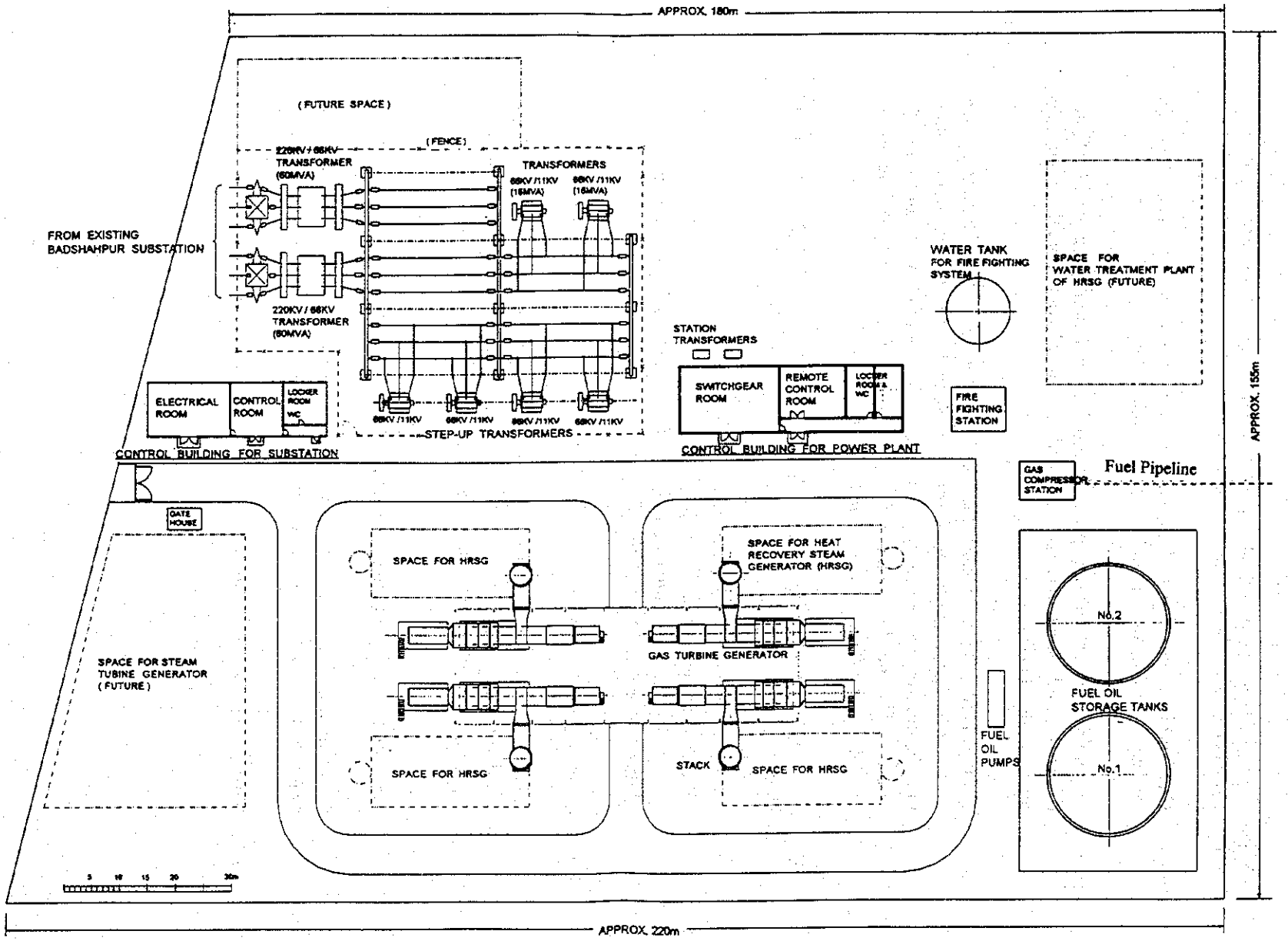


FIG 8.5.1 PLOT PLAN OF IMT POWER PLANT AND MAIN SUBSTATION

2) Plant Equipment and Auxiliary Facilities

Plant equipment is listed in Table 8.5.3, and auxiliary facilities from the points of civil and architectural views is listed in Table 8.5.4.

3) Fuel Supply System

Outline of fuel supply system is shown in Fig. 8.5.2.

Natural gas as main fuel of GTG will be supplied by fuel pipe line, of which length is 45 km from Faridabad. The planned route of fuel pipeline is shown in Fig 8.5.4. GAIL is implementing the project to extend the gas supply trunk line to Faridabad by 1996.

For the IMT Power Plant, a fuel oil storage system will be build up as a stand-by fuel system in addition to the natural gas supply system as main fuel.

If the natural gas supply system fails, the fuel supply will be switched and the fuel oil will be transferred from the fuel oil storage tanks.

Capacity of fuel oil storage is decided to consider 5 days continuous operation of 3 gas turbine units. (If the fuel oil is main fuel, 10 - 15 days continuous operation is normally considered. However 5 days duration is applied because of the fuel oil as back-up fuel.)

Thus capacity of fuel oil storage is selected as follows:

16 m^3/Hr x 24 Hr/day x 5 day x 3 units = 5,760 m^3 = 6,000m^3

Table 8. 5. 3 EQUIPMENT LIST OF IMT POWER PLANT

1/3

EQUIPMENT LIST

I. GAS TURBINE - GENERATOR

1. Gas Turbine Package
2. Air Intake System for Gas Turbine
   --- Air Filter Unit
   --- Duct
   --- Silencer
3. Exhaust Gas System
   --- Duct
   --- Silencer
4. CO_2 House for the Fire Fighting System
5. Generator Package
6. Reduction Gear
7. Control Package
8. Generator Auxiliary Compartment (GAC)

II. FUEL GAS SUPPLY SYSTEM

1. Gas Compressor
2. Gas Cooler
3. Drain Separator
4. Gas Receiver
5. Filter & Separator

} Gas Compressor Station

6. Scrubber & Demister
7. Flowmeter
8. Piping / Valves
9. Control & Instrument
10. Gas Pipeline (40km)

2/3

III. FUEL OIL SUPPLY SYSTEM

1. Fuel Oil Unloading Pump
2. Fuel Oil Storage Tank
3. Flowmeter
4. Filter & Strainer
5. Fuel Oil Forwarding Pump
6. Low Pressure Filter Skid
7. Piping / Valve
8. Control & Instrument

IV. ELECTRICAL EQUIPMENT

1. 220kv/66kv Transformer
2. 66kv/11kv Transformer
3. Station Transformer
4. Switchgear
   --- Outdoor Type
   --- Indoor Type
5. Circuit Breaker
6. Control Panel
7. Power & Control Cable
8. Grounding System
9. Lighting
   --- Indoor
   --- Outdoor
10. Steel Structure for S/S Equipment
11. Paging / Telephone System
12. Cathodic Protection System for Gas Pipeline (300A, 40km)

3/3

V. FIRE FIGHTING SYSTEM

1. Water Storage Tank
2. Water Pump
3. Jocky Pump
4. Air - Foam Plant
5. Hydrant
6. Piping / Valve
7. Control & Instrument

VI. CRANE & HOIST

1. Overhead Travelling Crane for Gas Turbine - Generator House
2. Hoist
   --- for Gas Compressor Station
   --- for Fire Fighting Pump Station
   --- for Fuel Oil Pump Station
   --- for Switchgear Room

Table 8.5.4 List of Building and Civil Works for IMT Power Plant

BUILDING

1. Gas Turbine - Generator House
2. Control Building
3. Fire Fighting Pump Station - Shed
4. Gas Compressor Station - Shed
5. Fuel Oil Pump Station - Shed
6. Gate House
7. Drinking Water Supply System
8. Sanitary System
9. Air Conditioning System

CIVIL WORK

1. Grading
2. Foundation of All Equipment & Building
3. Sewage System
4. Road
5. Trench (Piping/Cabling)
6. Fence & Gate
7. Finishing of Ground Surface

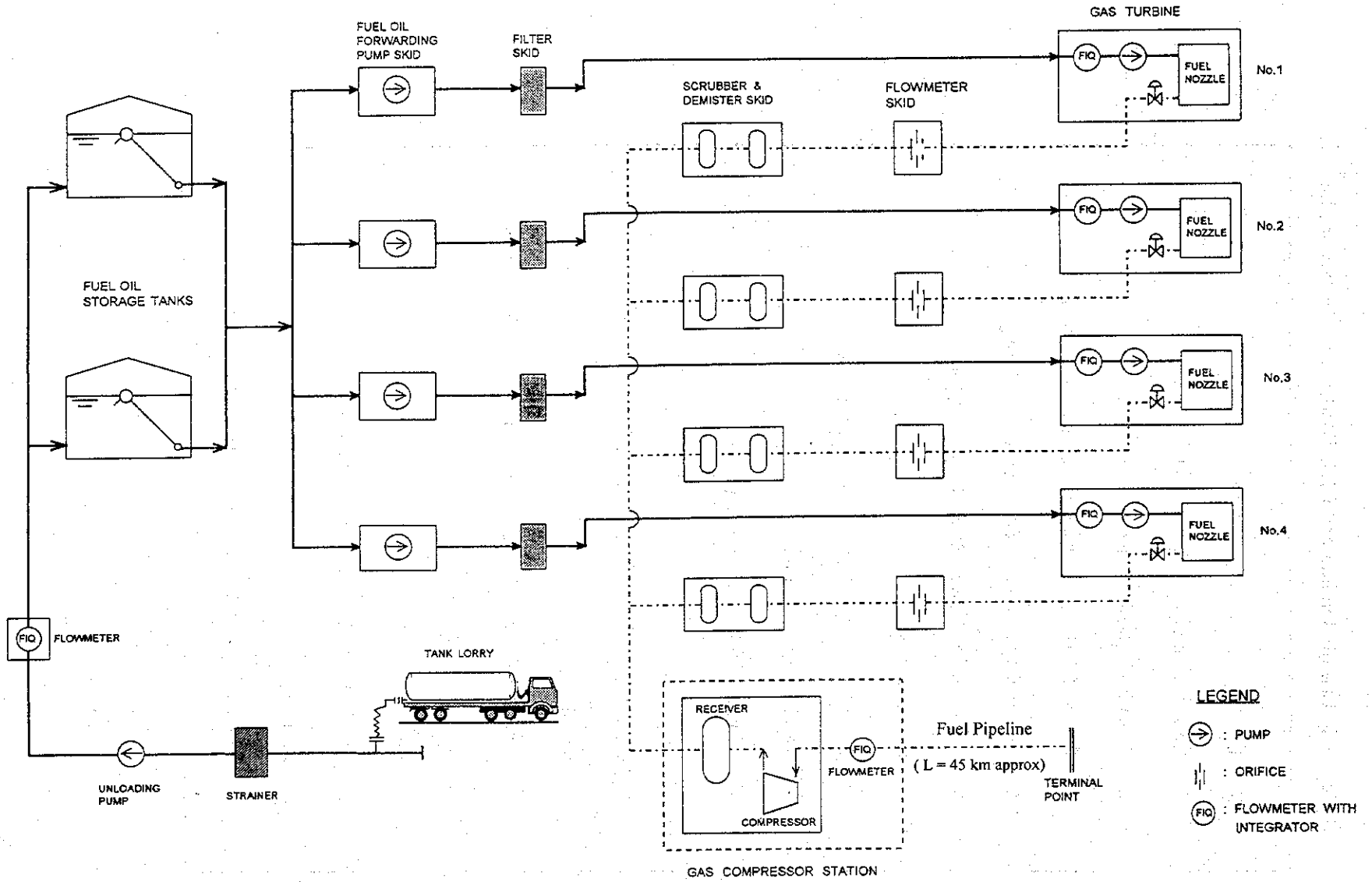


FIG 8.5.2 SCHEME OF FUEL SUPPLY SYSTEM

8.5.3 Operation Modes of Power Supply System

Based on the scheme of the power supply system shown in Fig. 8.5.3, the system is operated according to the following modes:

(1) IMT Power Plant

1) In ordinary mode, 3 units out of 4 gas turbine generating units are operated so that the power plant can supply power required by demand of the IMT, while the remaining one unit is kept as a stand-by.

2) If there are any problems with one of the operating units, the unit will be stopped and a stand-by unit will start immediately.

(2) 220 KV Transmission Line

1) Transmission line between Badshahpur S/S and IMT

This transmission line is for linking up the IMT with Badshahpur S/S, so that the operation of the IMT power supply system in cooperation with the HSEB System can be realized.

2) Transmission line up to Badshahpur S/S

According to the power requirement of the IMT, electricity will be supplied through the transmission line. At this moment, HSEB has two alternatives to supply power to Badshahpur S/S, i.e. one is from Samyapur S/S and the other is from Ash Dump S/S. And power supply route will be studied and decided finally after having done a "Load Flow Study" by HSEB.

3) Route of transmission line

Route of transmission line is shown in Fig. 8.5.4.

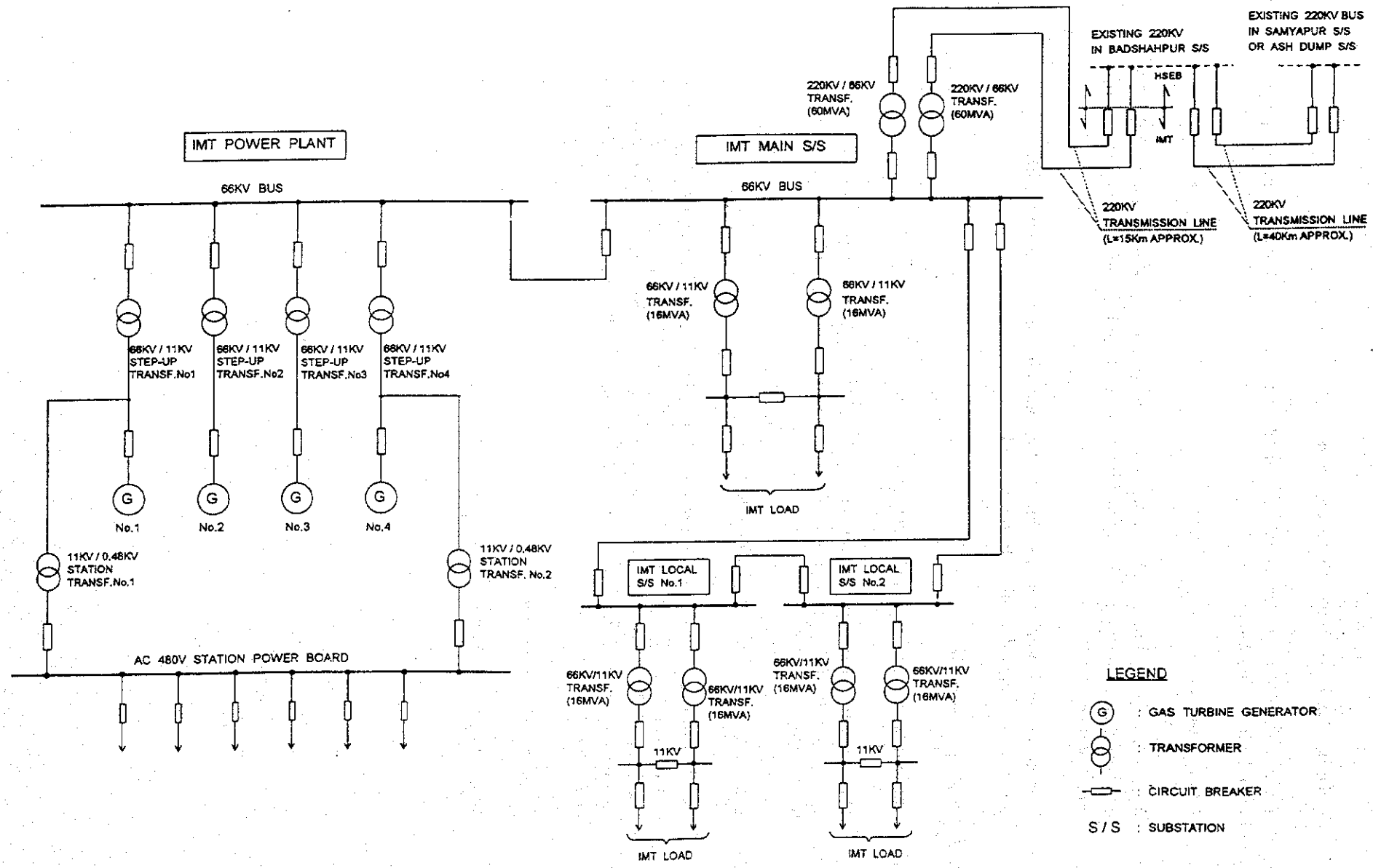
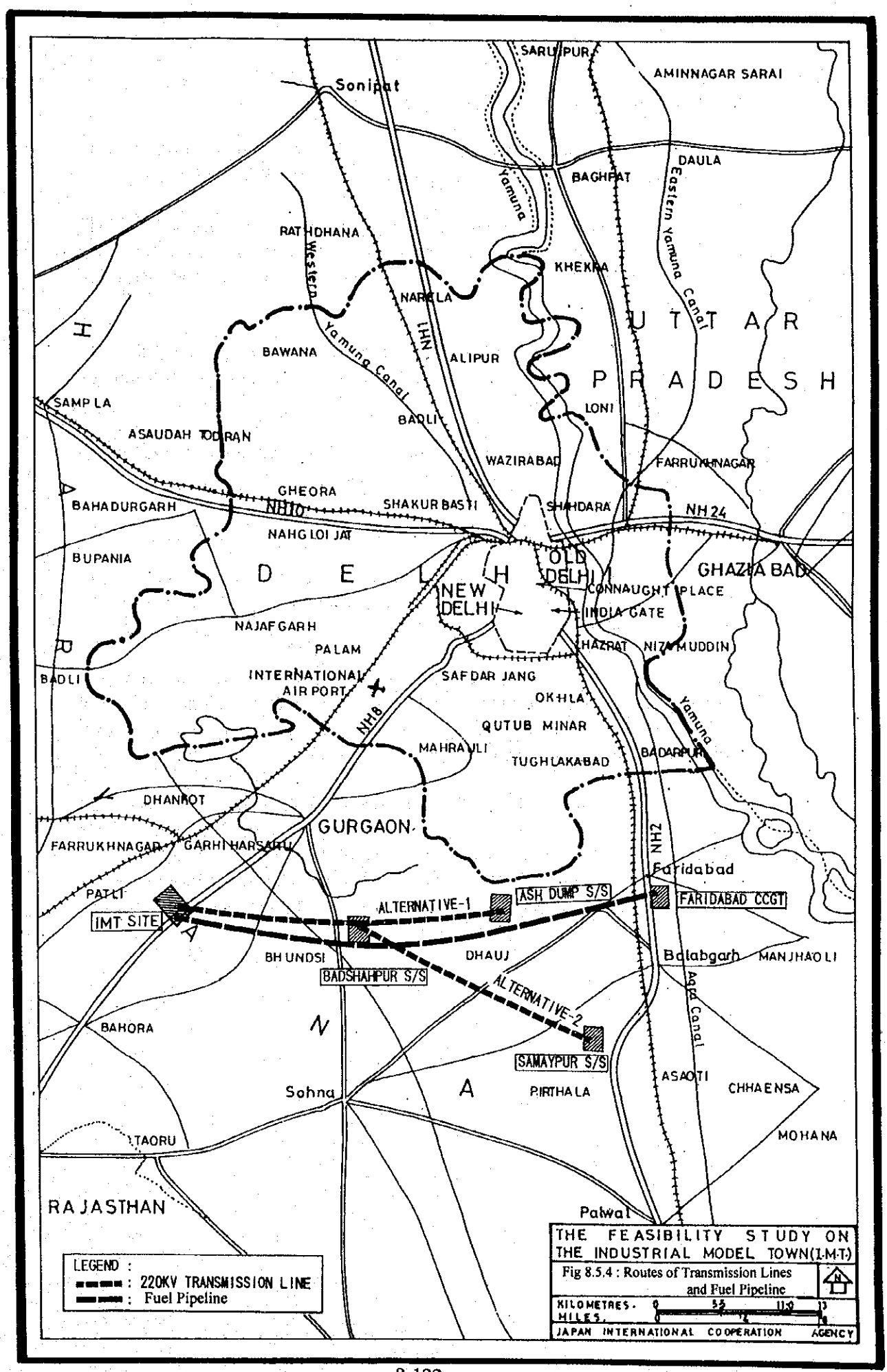


FIG 8.5.3 SCHEME OF POWER SUPPLY SYSTEM


Sonipat
SARUPUR
AMINNAGAR SARAI
DAULA
BAGHPAT
Yamuna
Eastern Yamuna Canal
RATHDHANA
Western Yamuna Canal
KHEKRA
NARELA
UTTAR PRADESH
BAWANA
ALIPUR
LHN
SAMPLA
ASAUDAH TODRAN
BADLI
LONI
WAZIRABAD
FARRUKHNAGAR
BAHADURGARH
GHEORA
NH10
SHAKUR BASTI
SHAHDARA
NH24
NAHGLOI JAT
BUPANIA
DELHI
OLD DELHI
GHAZIABAD
NEW DELHI
CONNAUGHT PLACE
INDIA GATE
NAJAFGARH
PALAM
HAZRAT NIZAMUDDIN
INTERNATIONAL AIR PORT
SAFDAR JANG
OKHLA
NH8
QUTUB MINAR
MAHRAULI
TUGHLAKABAD
BADARPUR
DHANKOT
GURGAON
FARRUKHNAGAR
GARHI HARSARU
NH2
Faridabad
PATLI
ASH DUMP S/S
FARIDABAD CCGT
IMT SITE
ALTERNATIVE-1
BHUNDSI
DHAUJ
Balabgarh
MANJHAOLI
BADSHAHPUR S/S
ALTERNATIVE-2
Agra Canal
BAHORA
SAMAYPUR S/S
ASAOTI
Sohna
PIRTHALA
CHHAENSA
TAORU
MOHANA
RAJASTHAN
Palwal
LEGEND :
220KV TRANSMISSION LINE
Fuel Pipeline
THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN(I.M.T.)
Fig 8.5.4 : Routes of Transmission Lines and Fuel Pipeline
KILOMETRES
MILES
JAPAN INTERNATIONAL COOPERATION AGENCY

(3) Main Substation (IMT Main S/S)

1) In ordinary mode, the IMT Main S/S will receive 66 KV power from the IMT power plant and transmit the 66 kV power to IMT local S/S No. 1 No. 2.

2) If 2 or more units of gas turbine generating units are tripped or failed, the IMT Main S/S will receive lacking capacity of power from Badshahpur S/S through 220 KV transmission line so that the capacity of power can be distributed within the IMT.

3) If the power demand in the IMT is reduced, the generated power of the IMT power plant, that is in excess, will be transmitted to Badshahpur S/S through 220 KV transmission line.

4) The IMT Main S/S will have the functions of Local S/S as mentioned below (4), as well as the functions as mentioned above 1) - 3).

(4) Local Substations (IMT Local S/S)

1) In ordinary mode, the IMT Local S/S will receive 66 KV power from the IMT Main S/S and step down the voltage to 11 KV so that the power can be distributed within the IMT.

2) 66 KV power receiving configuration will be the ring main system. Therefore if any receiving line is in failure, the line will be separated from the IMT Local S/S and power will be received from the other receiving line, so that the power distribution can be continued.

3) The IMT Local S/S will have 2 sections and each section has a 66/11 KV transformer and a 11 KV switchgear respectively. These 2 sections will be normally operated individually, but if one out of two transformers fail, the other transformer will supply power to both 11 KV switchgear, so that the power distribution can be continued, though the distributed power must be limited so far within the transformer capacity (16 MVA).

8.5.4 Site Construction Work Including Reconstruction of Existing Facilities

(1) Power Supply During Construction Period

The method of temporary power supply during the construction period before the completion of the power supply system as a permanent facility, should be previously considered.

There are two kinds of temporary power sources for construction purposes, i.e. one is the HSEB source and the other is a temporary power generation plant to be installed in or around the construction site. It is recommendable to receive power from the HSEB grid because Manesar Substation of HSEB is located in the proposed site of the IMT.

However, according to the fact that existing Manesar Substation is to be moved to the new site near the IMT, the construction time schedule has to be coordinated so that the electrical power can be supplied all the time from one of the two (old and new) substations.

In addition, necessary power capacity during construction for the IMT, is estimated at approximately 6,000 KVA. This capacity is assumed based on our construction experience of similar sizes as the IMT project, as shown in Table 8.5.5.

Table 8.5.5 : Assumed Power Demand During Construction

No.	Load	Total Capacity (KW)	Demand Factor	Calculated Capacity (KW)
1	Long Span Elevator	15^{KW}×10=150^{KW}	0.18	27.0
2	Drain Pumps	7.5^{KW}×60=450^{KW}	0.18	81.0
3	Mortar Mixer	10^{KW}×10=100^{KW}	0.18	18.0
4	High Washer	3.7^{KW}×10=37^{KW}	0.18	6.7
5	Water Feed Pump	5.5^{KW}×10=55^{KW}	0.18	9.9
6	Welder	14^{KW}×50=700^{KW}	0.18	126.0
7	Water Treatment FACILITY	10^{KW}×10=100^{KW}	0.18	18.0
8	Fans	5.5^{KW}×20=110^{KW}	0.18	19.8
9	Tower Crane	170^{KW}×10=1700^{KW}	0.18	306.0
10	Miscellaneous	50^{KW}	0.18	9.0
11	Mercury Lamps	1^{KW}×3110=3110^{KW}	0.9	3,109.1
12	Fluorescent Lamps	0.04^{KW}×2655=106.2^{KW}	0.9	95.6
13	Incandescent Lamps	0.1^{KW}×6497=649.7^{KW}	0.9	184.7
14	Floodlights	0.5^{KW}×165=82.5^{KW}	0.9	74.3
15	Tools	15^{KW}	0.9	13.5
	Total			**4,498.6 KW (5,700 KVA)**

(2) Removal and Reconstruction

1) Manesar Substation

Existing HSEB's Manesar Substation, of which function is receiving 66 KV power and distributing 11 KV power to the Manesar area, is located at the south end of the IMT proposed area, along National Highway No. 8.

This substation is very old and at present lies in the center of the planned green belt along the access road to the IMT. Therefore this substation should be moved to the new site near the IMT site. In the process of the removal work, construction of new Manesar Substation (new S/S) near IMT site will be commenced first, change-over of the circuits from old Manesar Substation to new S/S, and from old transmission and distribution lines (old lines) to new lines within IMT site will be followed, and demolition of old Manesar Substation will be done finally so that the duration of power cut around the Manesar area can be minimized when changing over the circuits:

Plotting of new substation will be one out of the following three considerable cases:

a) New S/S located at the northern side (Delhi side) of the IMT is to undertake all function of old S/S.

b) New S/S located at the southern side (Jaipur side) of the IMT is to undertake all function of old S/S.

c) 2 substations will be constructed at the both sides of IMT (northern and southern sides), and the function of old S/S will be divided area wise to the 2 substations.

The number and location of the substation(s) will be studied and decided finally after having done studies of the operation mode of a power distribution system.

2) Demolition and Construction of 66 KV Transmission Lines and 11 KV Distribution Lines

According to the removal of Manesar Substation as mentioned above 1), Demolition and construction of 66 KV transmission lines and 11 KV distribution lines around Manesar Substation will be needed as shown in Table 8.5.6.

Table 8.5.6 : Main Transmission and Distribution Lines to be Modified in and around the IMT

Type	Route from or to Manesar S/S	No. of Circuits
66 KV Transmission Line	From east (Badshahpur) crossing N.H. 8	2 Circuits
	From north (Gurgaon) along N.H. 8	1 Circuit
	To west (Pataudi) along N.H. 8	2 Circuits
11 KV Distribution Feeder	To north (Nakhrolla, Shikohpur & Air Cone) along N.H. 8	3 Circuits
	To north (Mohmad, Perfetti & Nsg) crossing N.H. 8	3 Circuits
	To south (Manesar area) along N.H. 8	4 Circuits
	To south (Pachgaon) along N.H. 8	2 Circuits

The time schedule for these works should be carefully studied so that the duration of power cut around the Manesar area can be minimized when changing over the circuits.

Since it is planned to demolish overhead transmission and distribution lines within the IMT site and change them to cable lines installed in cable trenches which will be previously built up by the IMT side

8.5.5 Coordination between Concerned Parties and Management Organization

(1) Work Demarkation

The power supply system for the IMT mainly consists of 220 KV transmission lines, 220/66 kV and 66/11 kV substations, a power generation plant and fuel supply pipeline. IMT and HSEB will undertake the work as shown in Table 8.5.7, except all the work for fuel pipeline i.e. provisions of land, construction, operation and maintenance to be proceeded by GAIL.

Table 8.5.7 : Work Demarkation among the Parties Concerned

Facilities	Provision of Land	Construction Work	Operation and Management
Modification of Ash Dump or Samyapur 220 KV substation to extend two 220 KV feeder bays	HSEB (already provided)	HSEB	HSEB
220 KV Double-Circuits transmission line between Samyapur or Ash Dump and Badshahpur S/S's (40 km approx.)	HSEB/IMT	HSEB	HSEB
Modification of Badshahpur 220 KV substation to extend four 220 KV feeder bays	HSEB (already provided)	HSEB	HSEB
220 KV Double-Circuits transmission line between Badshahpur S/S and IMT (15 km approx.)	IMT	HSEB	IMT/HSEB
220/66 KV substation	IMT	HSEB	IMT/HSEB
66/11 KV substation	IMT	HSEB	IMT/HSEB
11 KV and LV power distribution system	IMT	HSEB	IMT/HSEB
Demolition and reconstruction of existing substation, 66 KV transmission lines and 11 kV distribution lines	IMT	HSEB	HSEB
Cable trench for main cable route in the IMT (Mainly for 66 KV cables)	IMT	IMT	IMT
IMT power plant	IMT	IMT	IMT
Fuel pipe line (40 km approx.)	Charge on right of way for the pipe line will be paid by GAIL	GAIL	GAIL

HSEB/IMT : To be executed by HSEB and cost to be borne by IMT
IMT/HSEB : To be executed by IMT and supported by HSEB

(2) Assignment of Operation and Maintenance

(a) For the following facilities, all the work i.e. construnction, operation and maintenance will be done by HSEB

- Modification of Ash Dump or Samyapur 220 KV substation to extend two 220 KV feeder bays
- Modification of Badshapur 220 KV substation to extend four 220 KV feeder bays
- 220 KV Double-Circuits transmission line between Samyapur or Ash Dump and Badshapur S/S's (40 Km approx)
- Removal of Existing substations and distribution systems

(b) For the following facilities, all the work i.e. construnction, operation and maintenance will be done by IMT.

- A power generation plant
- Cable trenches for main cable routes within the IMT site.

(c) For the following facilities, construnction work will be done by HSEB, while operation and maintenance will be done by IMT. In this case, HSEB will cooperate with IMT i.e. manpower supply, operation and/or maintenance work under contract with IMT.

- 220 KV Double-Circuits transmission line between Badshapur S/S and IMT (15 Km approx)
- 220/66 KV and 66/11 KV substation within IMT
- Distribution facilities within IMT

(3) Application to GAIL

As soon as the gas consumption of the IMT power plant is decided, application to use natural gas should be submitted to GAIL from the Ministry of Industry, so that the supply of natural gas can be decided quickly by the approval of the Gas Linkage Committee (GLC).

8.5.6 Output and Heat Rate of Gas Turbine Generating Unit

Output and Heat Rate of Gas Turbine Generating Unit, when the fuel is natural gas, are as follows:

(1) Output of Gas Turbine Unit

1) Output of Gas Turbine Unit at ISO Rating

   (a) Base Load: 38,150 KW
   (b) Peak Load: 41,210 KW

2) Altitude Correction

   Altitude of the planned site at the IMT is 246 m (809 ft), then figure 0.97 is applied as a

correction factor.

3) Correction Factor due to Outside Temperature

Outside Temperature at Planned Site of the IMT		Correction Factor
Maximum :	116.6F (46.2C) (refer Note 1)	0.79
Mean :	96.8F (35.0C) (refer Note 2)	0.87
Minimum :	73.4F (23.4C) (refer Note 3)	0.95

Note 1 : To apply highest monthly mean of daily maximum temperatures.
Note 2 : To apply mean temperature of maximum and minimum temperatures.
Note 3 : To apply lowest monthly mean of daily minimum temperatures.

4) Output after Correction

(a) Base Load at maximum temperature
38,150 KW x 0.97 X 0.79 = 29,234.3 KW

(b) Base Load at mean temperature
38,150 KW x 0.97 x 0.87 = 32,194.8 KW

(c) Base Load at minimum temperature
38,150 KW x 0.97 X 0.95 = 35,155.2 KW

(d) Peak Load at maximum temperature
41,210 KW x 0.97 x 0.79 = 31,579.2 KW

(e) Peak Load at mean temperature
41,210 KW x 0.97 x 0.87 = 34,777.1 KW

(f) Peak Load at minimum temperature
41,210 KW x 0.97 x 0.95 = 37,975.0 KW

(2) Heat Rate of Gas Turbine Unit

1) LHV Heat Rate at ISO Rating

(a) Base Load: 38,150 KW x 2,744 Kcal/KWHr = 104.700 x 10^6 Kcal/Hr
(b) Peak Load: 41,210 KW x 2,722 Kcal/KWHr = 112.174 x 10^6 Kcal/Hr

2) Correction Factor due to Outside Temperature

Outside Temperature at planned site of the IMT	Correction Factor
Maximum: 116.6F (46.2C)	1.06
Mean: 96.8F (35.0C)	1.03
Minimum: 73.4F (23.4C)	0.02

3) Heat Rate after Correction

(a) Base Load at maximum temperature
38,150 x 1.06 x 2,744 = 110.96 x 10^6 Kcal/Hr

(b) Base Load at mean temperature
38,150 x 1.03 x 2,744 = 107.82 x 10^6 Kcal/Hr

(c) Base Load at minimum temperature
38,150 x 1.02 x 2,744 = 106.78 x 10^6 Kcal/Hr

(d) Peak Load at maximum temperature
41,210 x 1.06 x 2,722 = 118.90 x 10^6 Kcal/Hr

(e) Peak Load at mean temperature
41,210 x 1.03 x 2,722 = 115.54 x 10^6 Kcal/Hr

(f) Peak Load at minimum temperature
41,210 x 1.02 x 2,722 = 114.42 x 10^6 Kcal/Hr

(4) Fuel Consumption (Natural Gas) of Gas Turbine Unit

Heat value of natural gas is 8,500 Kcal/m^3, then fuel consumption is calculated as follows:

(a) Base Load at maximum temperature
110.96 x 10^6/8,500 = 13,054 m^3/Hr

(b) Base Load at mean temperature
107.82 x 10^6/8,500 = 12,685 m^3/Hr

(c) Base Load at minimum temperature
116.78 x 10^6/8,500 = 13,739 m^3/Hr

(d) Peak Load at maximum temperature
118.90 x 10^6/8,500 = 13,988 m^3/Hr

(e) Peak Load at mean temperature
115.54 x 10^6/8,500 = 13,593 m^3/Hr

(f) Peak Load at minimum temperature
114.42 x 10^6/8,500 = 13,461 m^3/Hr

8.6 Telecommunication

8.6.1 Estimate of Telecommunication lines

Telecommunication lines for the IMT are estimated as follows, by summarizing line numbers of each category:

Table 8.6.1 : Estimate of Telecommunication Lines

Category	Estimated Number of Lines	Method of Estimating
Factories	496	Number of Factory: 124 Lines/Factory: 4
Urban Facilities	150	1) Town Center: 10 2) Community Center: 5 3) Shopping Center: 10 4) Restaurant Build.: 10 5) Shopping Mall: 100 6) Health Care Center: 5 7) School: 5 8) Police Stn., Fire Stn.: 5
Business Support Facilities	30	1) Promotion Center: 20 2) Training Center: 5 3) Seminar House: 5
Housing High Density	100	Number of Building: 100 Line/Building: 1
Housing Medium Density	960	Number of House: 1600 Line/House: 6/10
Housing Low Density	60	Number of Company: 20 Line/House: 3
Public Telephone	100	-
Total	**1896**	-

The estimated number of telecommunication lines for the IMT are approximately 2,000 lines.

8.6.2 Basic Concept of Telecommunication Facilities for the IMT

(1) Function of Department of Telecommunications (DOT)

The Telecommunication Business within India is exclusively managed by the Department of Telecommunications (DOT), except the city calls within New Delhi and Bombay which are managed by Mahanagar Telephone Nigam Ltd. (MTNL). Long distance calls between New Delhi and Bombay are also in the scope of management by the DOT.

It is therefore understood way that the telecommunication facilities in the IMT are to be included in the DOT system and managed by the DOT. Then everything having to do with the telecommunication facilities for the IMT, i.e. procurement, installation, testing, commissioning, operation and maintenance should be managed by the DOT, while the IMT side provides building for Remote Exchange in the IMT and cable trenches for installing trunk line cables within the IMT.

(2) About the Policy to open to Foreign Investors and Private Sectors

According to the new economic policy adopted by the Central Government in May, 1994 (The National Telecom Policy 1994), it is now possible to participate in the telecom business in India for foreign investors and/or private sectors.

However, it is not recommendable to involve foreign investors and/or private sectors in the telecom business for the IMT, because of the following reasons:

1) When considering the scale of business which can be a commercial profit, the scale of the telecommunication system should have more than several hundred thousand subscriber lines as a minimum.

   To clear this requirement, the area in which a telecom system is to be set up has to be as large as one state or at least a big district. Thus the scale of the IMT is much too small, i.e. estimated subscriber's lines are just 2,000.

2) Though the policy is to open to foreign investors and/or private sectors, there are actually some unsolved problems. For example, such individual problems are how to manage, how the number of subscribers will grow, etc.

   Therefore, it is too early to involve foreign investors/private sectors in the telecom. business for the IMT.

8.6.3 Required Function of Telecommunication Facilities

(1) Line capacity has to be applicable for 2,000 of the estimated subscriber lines, and the switching equipment will have capability to extend subscriber lines without shutdown of existing lines, when more subscriber lines are required in the future.

(2) Optical fiber cable line has to be able to transmit PCM remote control signals from the computer of the Main Exchange, as well as the above mentioned capacity.

(3) The facilities should have interface matching with the following terminal devices:

- Ordinal analogue telephone set
- Digital multi-function telephone set
- Facsimile (G3, G4)
- Data terminal station (to access by 64 K bits/s interface)

8.6.4 Scheme of Telecommunication Facilities for the IMT

The Scheme of the Telecommunication Facilities for the IMT is shown in Fig. 8.6.1 and the route of the optional fiber cable line is shown in Fig. 8.6.2.

The IMT Remote Exchange will be connected with Gurgaon Main Exchange by optical fiber cable line and operated by the command from the computer in the Main Exchange.

8.6.5 Coordination between the DOT and Management Organization

(1) Work Demarcation between the DOT and the IMT

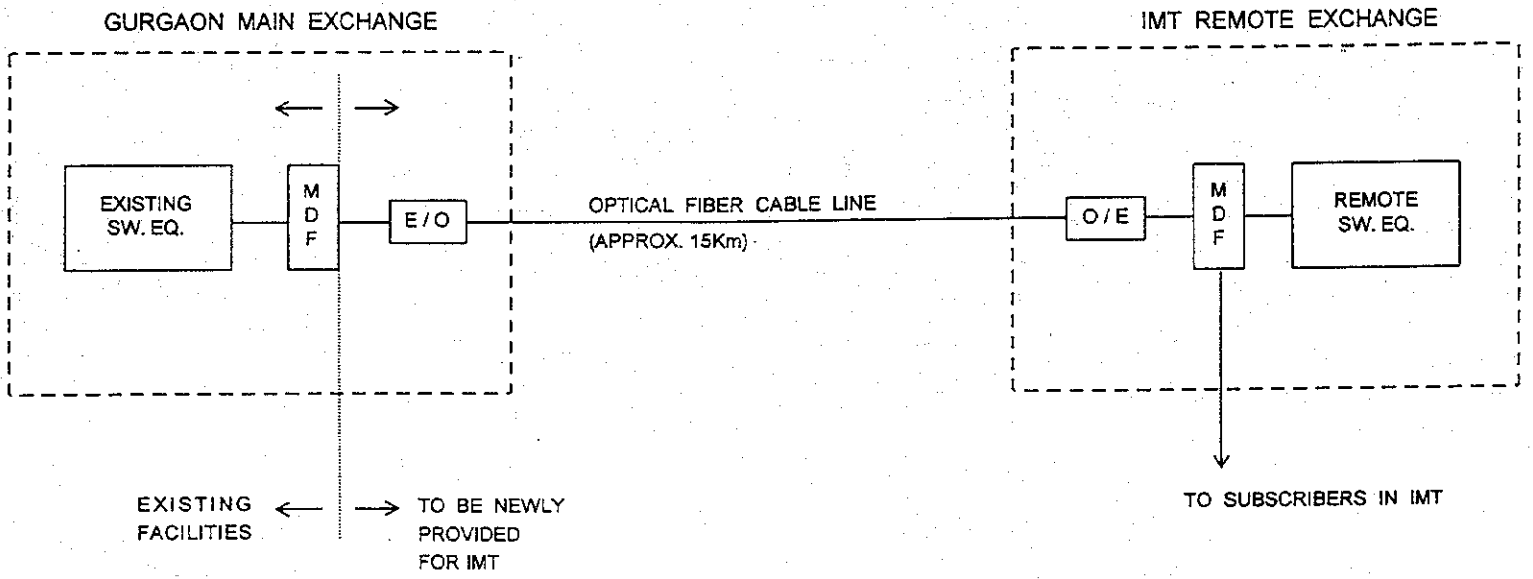
1) Items to be executed by the DOT

The following items will be executed by the DOT.

(a) Modification work in the Gurgaon Main Exchange, which is necessary for the complete functioning of the new IMT Remote Exchange.

(b) Supply and installation of Optical Fiber Cable Line to connect the Gurgaon Main Exchange and the IMT Remote Exchange (Total Length: 15 KM approx.)

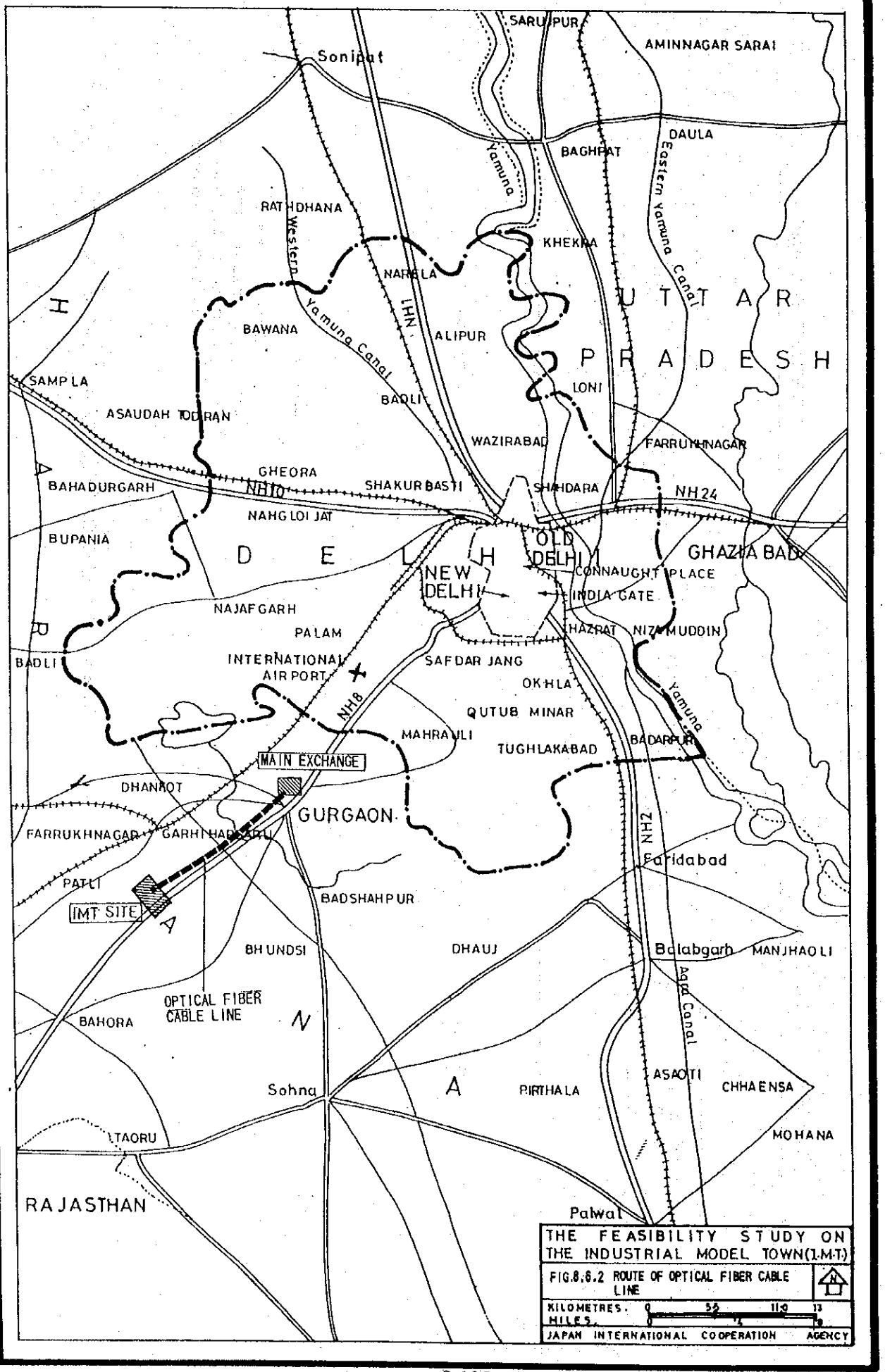
(c) Construction of building for IMT Remote Exchange : The IMT Remote Exchange building will be located within the site of the Town center. The room arrangement for the IMT Remote Exchange is shown in Fig 8.6.3.



LEGEND

SW. EQ. : SWITCHING EQUIPMENT
M D F : MAIN DISTRIBUTION FRAME
E / O : ELECTRICAL / OPTICAL CONVERTER
O / E : OPTICAL / ELECTRICAL CONVERTER

FIG 8.6.1 SCHEME OF TELECOMMUNICATION FACILITIES FOR IMT


Sonipat
SARUPUR
AMINNAGAR SARAI
DAULA
BAGHPAT
Yamuna
Eastern Yamuna Canal
RATHDHANA
Western Yamuna Canal
KHEKRA
NARELA
LHN
ALIPUR
U T T A R
P R A D E S H
BAWANA
SAMPLA
ASAUDAH TODRAN
BADLI
LONI
WAZIRABAD
FARRUKHNAGAR
GHEORA
BAHADURGARH
NH10
SHAKURBASTI
SHAHDARA
NH24
NAHGLOI JAT
BUPANIA
D E L H I
OLD DELHI
GHAZIABAD
NEW DELHI
CONNAUGHT PLACE
INDIA GATE
NAJAFGARH
PALAM
HAZRAT NIZAMUDDIN
INTERNATIONAL AIR PORT
SAFDAR JANG
OKHLA
NH8
QUTUB MINAR
Yamuna
MAHRAULI
TUGHLAKABAD
BADARPUR
MAIN EXCHANGE
DHANAOT
GURGAON
FARRUKHNAGAR
GARHIHARSARU
NH2
Faridabad
PATLI
IMT SITE
BADSHAHPUR
BHUNDSI
DHAUJ
Balabgarh
MANJHAOLI
OPTICAL FIBER CABLE LINE
BAHORA
Agra Canal
Sohna
PIRTHALA
ASAOTI
CHHAENSA
MOHANA
TAORU
RAJASTHAN
Palwal
THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN(I.M.T.)
FIG.8.6.2 ROUTE OF OPTICAL FIBER CABLE LINE
KILOMETRES 0 5.5 11.0 13
MILES 0 ½ 1 8
JAPAN INTERNATIONAL COOPERATION AGENCY

(d) Supply and installation of the following equipment in the building which will be provided for IMT Remote Exchange.

i) Digital Switching Equipment
ii) MDF
iii) Operating Console with Monitor Panel, Display, Key board, etc.
iv) DC Power Supply System (Batteries, Battery Changers, etc.)
v) AC Power Receiving and Distribution System.
vi) Emergency Diesel Engine Generating System.
vii) Other Necessary Facilities (Cables, Cable Racks, etc.)

(e) Supply and installation of trunk line cables and terminal boards within the trenches which will be provided by the IMT side.

(f) Supply and installation of public telephones.

(g) Supply and installation of cables between terminal boards and subscribers or public telephones (including cable burying).

(h) Necessary operation, management, maintenance etc., on the above mentioned facilities from (a) to (f) including to pay "Right of Way" charge for optical fiber cable line.

2) Items to be executed by the IMT side.

The following items will be executed by the IMT side.

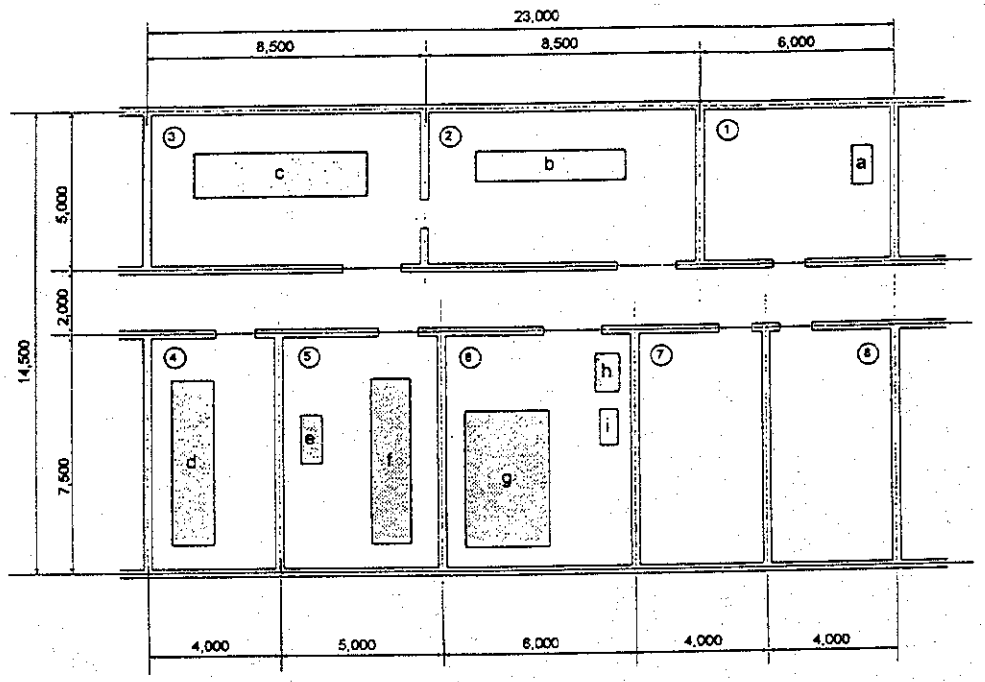
(a) Provision of land for the building of the IMT Remote Exchange : Land of 4000 m^2 will be provided within the site of the Town Center.

(b) Construction of the cable trench in which the trunk line cables will be installed.

(c) Necessary operation, management, maintenance etc., on the above mentioned facilities from of (b).

(2) Application to DOT

As soon as the execution of the IMT project is decided application to the DOT on the above mentioned matter should be done make final confirmation.



NOTES

1. NAME OF ROOM
   - ① OFFICE (1)
   - ② SWITCHING ROOM
   - ③ MDF ROOM
   - ④ BATTERY ROOM
   - ⑤ ELECTRICAL ROOM
   - ⑥ EMERGENCY DIESEL ENGINE GENERATOR ROOM
   - ⑦ STORE
   - ⑧ OFFICE (2)

2. THESE ROOMS WILL BE PROVIDED IN TOWN CENTER BUILDING.

3. EQUIPMENT
   - a : OPERATING CONSOLE
   - b : SWITCHING EQUIPMENT
   - c : MFD
   - d : BATTERY
   - e : RECTIFIER
   - f : 400V SWITCHGEAR
   - g : DIESEL ENGINE GENERATOR
   - h : DEG CONTROL PANEL
   - i : POWER STABILIZER

FIG 8.6.3 ROOM ARRANGEMENT OF IMT REMOTE EXCHANGE

8.6.6 Security Facilities (Option)

(1) General

The description of this clause is recommendation for building up the Security Facilities for the IMT as an option.

The purpose of the Security Facilities is to keep security of inhabited factories and/or offices in the IMT, especially during the day or night time.

In other words, the Security Facilities functions as guards.

(2) Components of the Security Facilities

The Security Facilities consist of the following components:

1) Central Supervising Room

In this room (which may be provided in the Town Center Building), several supervisors stays at all times to watch the supervising panel which indicates information from factories and/or offices so that, if an abnormal condition is found, they can dispatch someone to treat the problem.

This facility should have a function which enable direct communication with police station(s), fire station(s) and/or other offices concerned.

2) Devices to detect necessary information

The purpose of providing these kind of devices is to detect abnormal condition at factories and/or offices. Some of the considerable devices are as follows:

(a) Industrial Television Camera (ITV)

To supervise the entering of suspicious people. The camera transmits a TV signal (motion picture) to the central supervising room.

(b) Fire Detector

These devices detect smoke and/or abnormal high temperature and transmit the condition to the Central Supervising room.

(c) Lock Confirming Function

If doors and/or windows are left open abnormally, these conditions have to be detected. This can work more effectively when functioning together with ITV facilities.

3) Transmitting Line of the Information

This facility is to transmit the collected information to the Central Supervising room.

For this purpose, an optical fiber cable line is preferable, because the line capacity has to be rather big when a motion picture signal is transferred.

(3) Management Organization

As management organization of the Security Facilities, including the building up of the whole system, here are 2 recommended cases.

1) The operation and management center will manage the IMT will act as this role too.

2) Any private sector who contracted with the operation and management center mentioned above will act this role on behalf of the operation and management center.

8.7 Underground Utilities Duct

8.7.1 Outline of Underground Utilities Duct

(1) Objective

Supply and transaction of utilities such as electricity, telecommunications, gas, water, etc., provide the essential life support systems for life in our cities. Up to now, underground pipes and overhead cables have been mainly used for the supply system. Recently, new styles of cities have been developed. Roads are used as multipurpose space and the demand for pipes and cables has increased. As a result, repeated road excavation and so on causes interruption of traffic and impairment of view. To solve these problems, underground utilities duct which accommodates the various pipes and cables together in an underground duct have become more common.

Underground utilities ducts can be classified as "Main Utilities Ducts" and "Supply Utilities Ducts" by function and objective.

Main Utilities Duct : For main cables and pipes, not served directly to the district along the route

Supply Utilities Duct : For cables and pipes, served directly to the district along the route.

On this project, Supply Utilities Duct that supplies utilities to residential area, urban facilities, business support facilities, offices, industrial area, commercial and service area, will be constructed.

8.7.2 Design Condition of Underground Utilities Duct

(1) Accommodated utilities

Following utilities shall be accommodated.

- Electric cables
- Telecommunication cables
- Water supply pipe

Pipes for stormwater drainage, sewerage and industrial waste water, which will be designed as gravity flow, will influence the depth of the underground utilities duct. Therefore, these are excluded and buried directly in the ground.

(2) Required internal dimensions

Required internal dimensions will be based on Underground Utilities Duct Design Guidance" published by the Japan Road Association.

Minimum internal height shall be at least 2.1 m considering the average height of employees with safety helmet as 1.8 m, lighting fixtures of 0.2 m and walkway concrete thickness of 0.1 m.

Minimum internal width shall be the sum of occupied width of the utilities plus a width of 0.75 m as the walkway for maintenance works.

(3) Earth cover

Earth cover of the Standard sections shall, in general, be more than 2.5 m. As an absolute minimum, earth cover shall be greater than pavement thickness.

(4) Alignment and longitudinal alignment

Alignment of underground utilities duct, in general, shall be designed on the premise that center of the duct is matching to road center.

Longitudinal slope of underground utilities duct locations shall be more than 0.2% for drainage except for special locations.

(5) Supply limit of underground utilities duct

Supply of utilities to each lot will be limited to road edge, and they will be supplied through embedded sleeves.

(6) Special locations and related facilities

Following are considered as special locations and related facilities

Duct junctions:

Extended space to diverge pipes and cables at the road crossing will be provided.

Service connections:

Service connections are diverging points that supply pipes and cables to each lot. The service connection consists of extended space for divergence and culvert to road edge.

Entrance for materials:

Entrance to carry pipes, lines and other materials in, which will be used as manhole as well, will be provided near duct junctions.

Drain facilities:

Water that flows into the utilities duct shall be collected in sump pits via gutters, and discharged to the nearest kerb inlet by means of pumping.

Ventilation facilities:

Natural ventilation openings, which are used as an entrance as well, and forced ventilation openings shall be provided alternately in raised medians or in the foot path.

Ventilation fans shall be designed to keep the wind velocity in the duct less than 2.0 m/sec., and temperature difference between inside and outside of entrance less than 8°C.

Lighting facilities:

Lighting facilities in the utilities duct shall be designed based on following condition.

Average lighting degree shall be more than 15 lux. Reflection ratio of ceiling and wall shall be 25%.

Electricity receiving and distribution facilities:

Distribution panel for lighting, ventilation fan, pump control panel, etc. shall be provided near the entrance.

Safety facilities:

Alarm, fire extinguisher, etc.

Walkway:

Minimum thickness of 50 mm secondary concrete with drainage slopes shall be cast on the bottom slab for wear protection and to form gutters.

Steel corridor:

Steel corridor for maintenance use shall be provided where the internal height of the duct is greater.

8.7.3 Conceptual design of Underground Utilities Duct

(1) Standard sections

Two types of standard sections, as shown in Fig. 8.7.2, are designed considering pipe diameter and number of cables. Routes for each type are shown in Fig. 8.7.1.

(2) Alignment and longitudinal alignment

To use road crossing space effectively for duct junction where inner section is extended, the center of the underground utilities duct is designed to match with the road center.

Longitudinal slope was basically designed to follow the road longitudinal slope. However, at the down stream end of the site where the cross section of rainfall drainage is large, the utilities duct is designed to pass under the drainage line.

(3) Special locations

The duct junctions shall be planned to have enough space for maintenance work as well as to diverge the accommodated utilities in good order. An outline of the duct junction is shown in Fig. 8.7.3.

(4) Service connections

Service connections of pipes and cables to each lot is extended to road edges by branch duct as shown in Fig. 8.7.4. Embedded sleeves shall be provided to allow utilities supply to each lot.

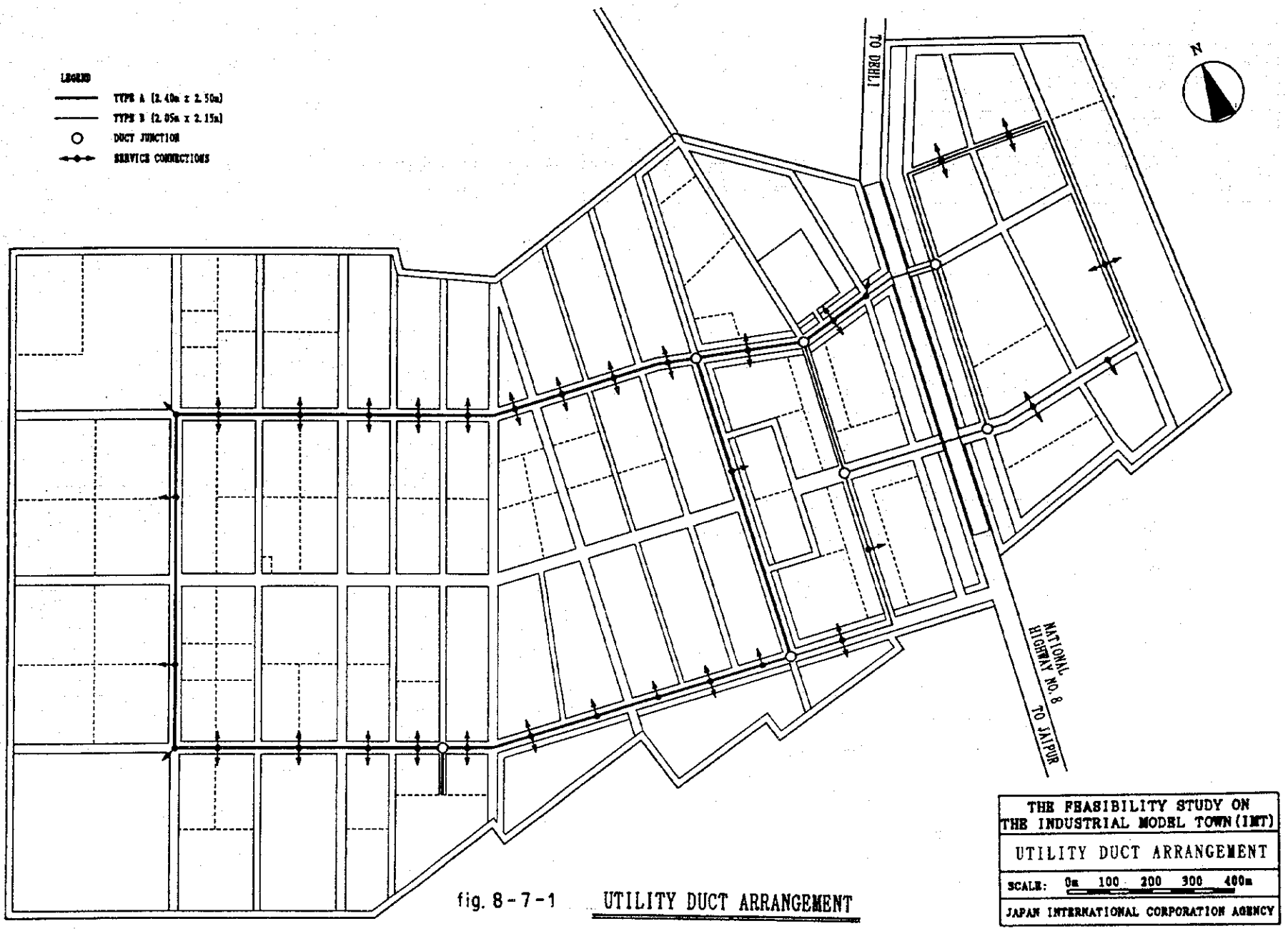
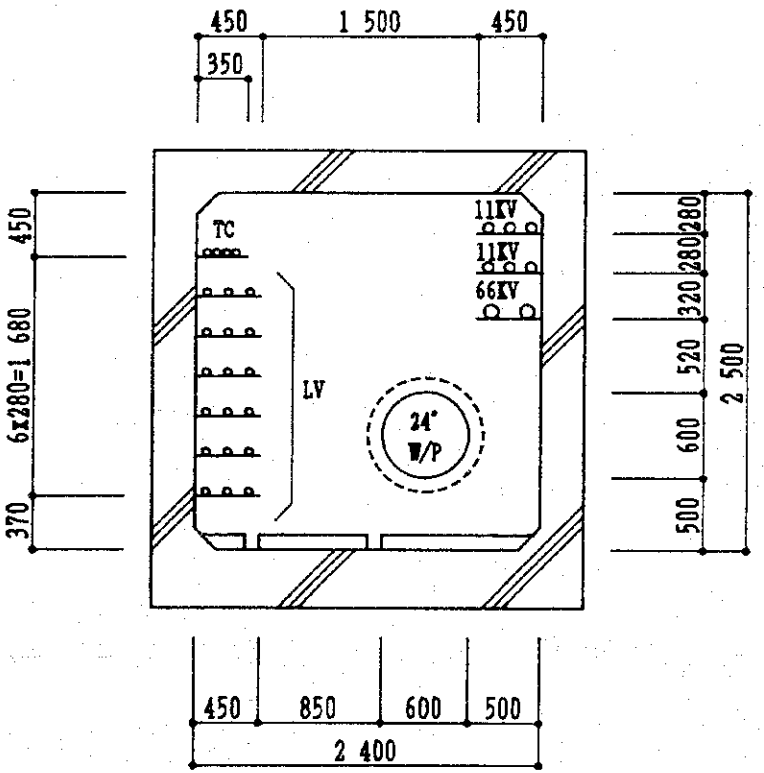
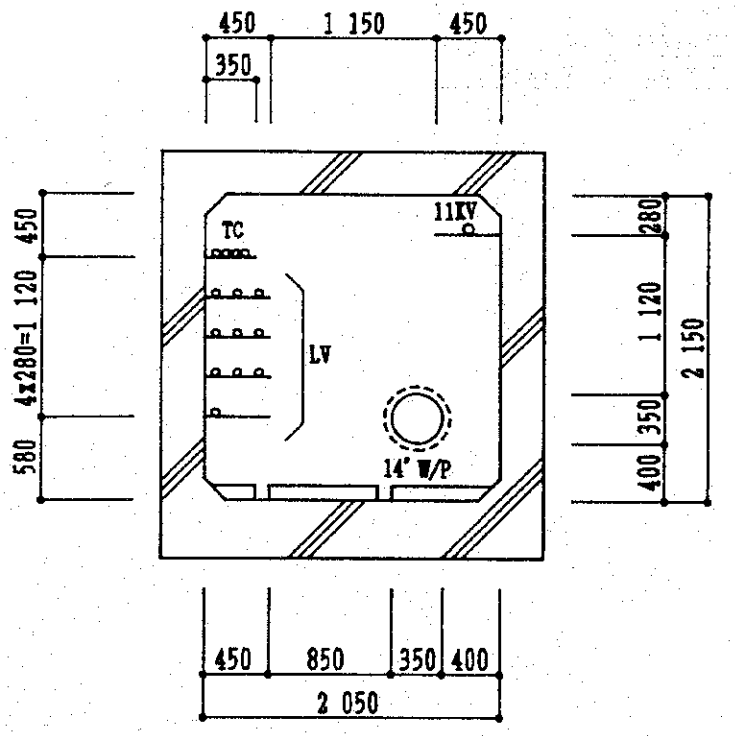


fig. 8-7-1 UTILITY DUCT ARRANGEMENT



TYPE A

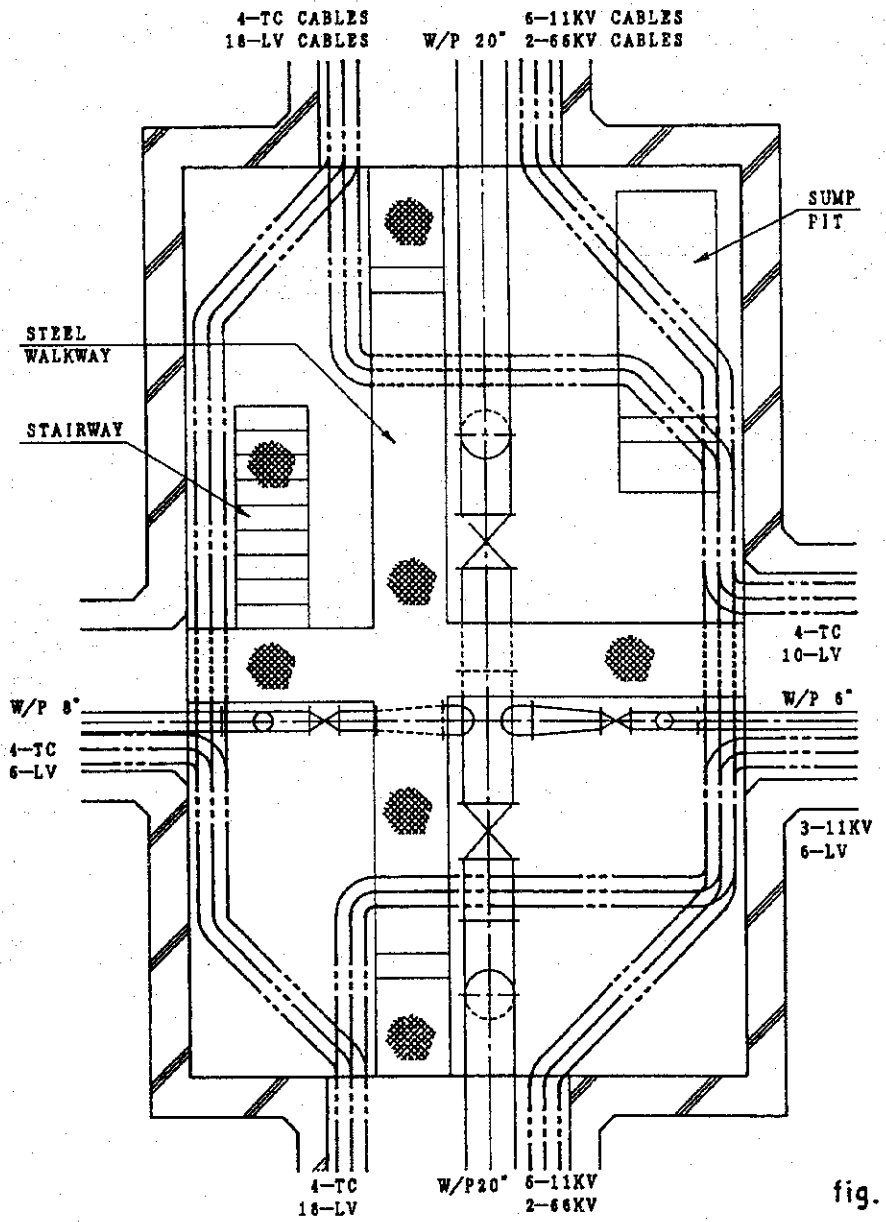


TYPE B

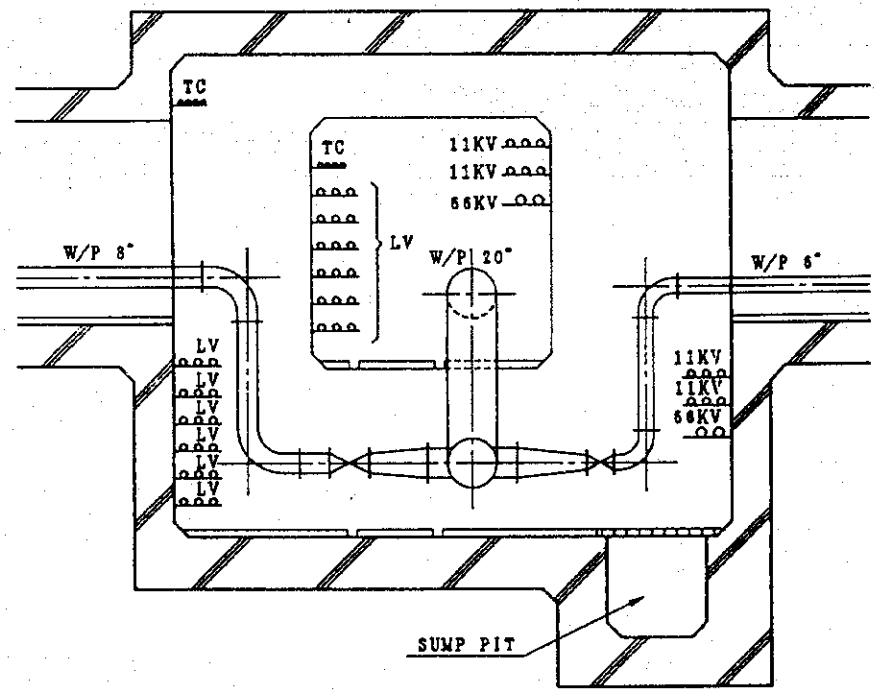
TYPICAL SECTION OF UTILITY DUCT

fig. 8-7-2

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
TYPICAL SECTION OF UTILITY DUCT
SCALE: 0m 1 2m
JAPAN INTERNATIONAL CORPORATION AGENCY



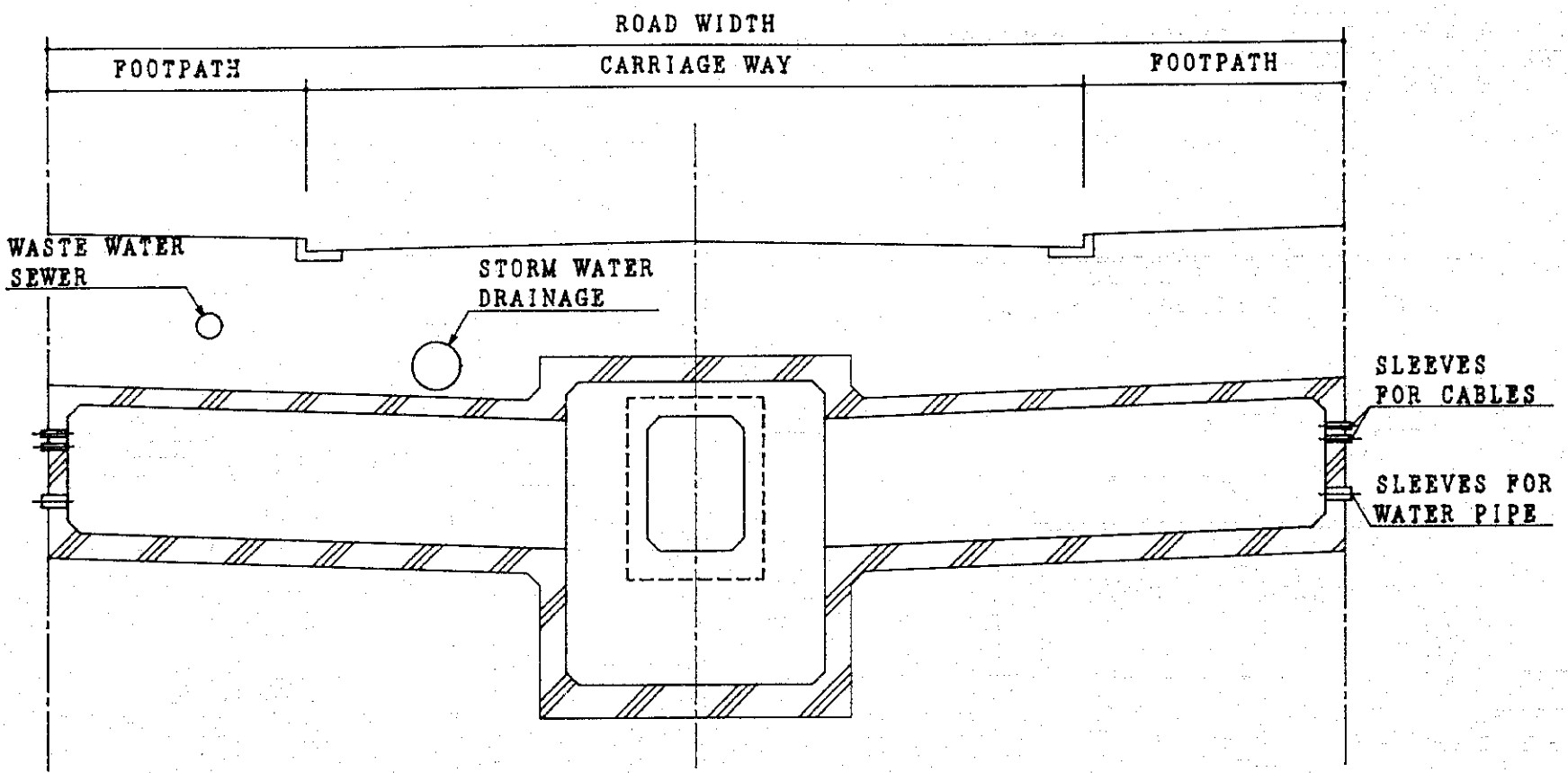
TYPICAL PLAN OF JUNCTION OF UTILITY DUCT



TYPICAL SECTION OF JUNCTION OF UTILITY DUCT

fig. 8-7-3 JUNCTION OF UTILITY DUCT

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
JUNCTION OF UTILITY DUCT
SCALE: 0m 1m
JAPAN INTERNATIONAL CORPORATION AGENCY



SERVICE CONNECTION OF UTILITY DUCT

fig. 8-7-4

THE FEASIBILITY STUDY ON THE INDUSTRIAL MODEL TOWN (IMT)
SERVICE CONNECTION OF UTILITY DUCT
SCALE: 0m 1 2 3 4m
JAPAN INTERNATIONAL CORPORATION AGENCY

8.8 Industrial Solid Waste and Pollution Control

8.8.1 Solid Waste Disposal

Table 8.8.1 was obtained from Table 7.2.4 by calculating the disposal amount of Industrial Solid Waste (ISW) for each kind of industry which will be moved into the IMT. Those values were calculated based on the data of DSIDC (Delhi State Industrial Development Corporation) on the amount of Industrial Solid Waste (ISW) per unit amount of raw material for each kind of industries. The value of total amount 74.10 ton/d is in several % error toward the value 80.44 ton/d which was calculated from the forecasted value of discharged ISW 2.9 kg/d-man in the Final Report of Master Plan Study published in December 1993.

ISW is classified as Hazardous Solid Waste (HSW) and Non-Hazardous Solid Waste (NSW). The HSW which was prescribed in the Environment Act of India enacted at 1986 should be wholly treated on the responsibility of its discharging factory. In this case, the record of disposal procedure such as its chemical & physical form, state of storage and treatment, details of transportation and treating, as well as data on environmental surveillance should be described, then the submission of them to relevant organization is requested.

There are various shapes of NSW except HSW, and most of them - eg; rubbish of metal, glass or oil waste - can be sold in India. Besides, sludge (of course no including of HSW) may be utilized for farm land, and slag or land reclamation. Thus ISW is now in such recyclable condition, so the discharged amount may be less than preestimated one.

The unit discharged amount of municipal solid waste is presumed 0.5 kg/d-man in Haryana State, so if the population of IMT in night time is 46000 (the value of D/F report in '93), the total discharged amount is

$40000 \times 0.5 = 20.0$ ton/d

As long as watching waste boxes in current Delhi City, those were almost garbage of vegetable & fruit, and scarcely paper or plastics.

Then, the residue of ISW and municipal waste from which all HSW and useful materials were taken off should be delivered to the control organization of IMT, and be ultimately used for land filling.

The total amount of solid waste altogether of ISW and municipal is

$74.10 + 20.0 = 94.10$ ton/D

If its collection in IMT is carried out once in every two days, the total collective amount is

$94.10 \times 2 = 186.2$ ton

and if ten facilities for collection site are prepared in IMT, its capacity per a site is presumed about 18 ton (the volume of the facility may be about 60 M^3 made of concrete wall).

Table 8.8.1 : Discharged Amount of Industrial Solid Waste (ISW) by Type of Industry

Selected Industry for IMT	Number of Industry	Total Area (ha)	Water Supply (m^3/D)	Electric Power Supply (kw)	Cargo Vol(1000ton/Y)		NO. of Workers	Discharge AMT. of ISW (ton/day)
					Inflow	Outflow		
Food. Beverage	5	17	3,570	3,430	85.5	112.5	790	12
Textile	5	11	920	3,930	14.0	14.0	1,960	2
Furniture	1	4	220	700	20.0	18.0	260	1
Paper	4	7	1,820	2,100	83.0	69.0	520	13
Printing	2	2	700	400	86.0	102.0	1,710	0
Chemicals	3	6	1,770	5,000	92.0	69.0	530	7
Petroleum	1	2	130	2,000	68.0	64.0	60	6
Plastics	4	15	2,600	4,600	108.0	98.0	620	8
Rubber	3	5	1,480	3,000	11.0	9.5	1,030	2
Leather	3	2	60	350	2.0	2.0	360	0
Ceramic	2	5	840	4,200	53.0	41.0	250	5
Iron, Steel	3	14	650	3,600	13.0	10.0	340	1
Non Ferrous Metals	2	9	1,100	3,500	16.0	14.5	750	1
Fabricated Metal	5	15	1,680	5,300	39.0	33.5	1,280	3
General Machinery	6	22	1,810	6,640	32.0	27.0	1,890	2
Electric Machinery	8	34	7,300	13,400	34.0	32.0	8,430	2
Transport Equipmt.	2	30	2,630	5,400	23.0	21.0	3,200	2
Precision Instrum.	5	13	900	3,250	6.0	6.0	1,870	0
Total	64	213	30,180	70,800	785.5	743.0	25,850	74

In this case the collection by assortment should be carried out and it is important to include no hazardous materials such as waste cell in it. These waste will be reclaimed to land in about 10 km distant from IMT, and its collection & delivery and transportation is managed by the control organization of IMT. Though it is essentially important to establish stabilizing and making harmless the waste reclaimed into land, the installation of some facility to prevent inflow of storm water to the land and some tough intercept sheet to prevent water leaching to underground will be required.

8.8.2 Waste Water Control

Prior to examine the water quality of discharged waste water from IMT, current water quality near to Gurgaon was measured by HSPCB (Haryana State Pollution Control Board). The sampling spots where the water sample were intaked were shown in Fig. 8.7.1. The purpose of analysis is to comprehend the change of water quality after construction of IMT pre-examining current water quality around the site of IMT.

The result of analysis was shown in Table 8.8.2. Each sample shows that the values such as BOD, COD are reasonable, but ones of heavy metals show ND (Non Detectable) and they also mentioned no need to display such values as Hg, Cd and As, because those materials don't exist in the water of India. As there are small scale factories of metal working around Gurgaon, it may be difficult to conclude no existence of those materials, but the concentration may be negligible small at present.

The quality and quantity of effluent waste water from each industry which was estimated in conceptual stage is presented in Table 8.4.2, and those disposal measure is particularly described in 8.4 including disposal system. Its basic thought is that in case that the effluent quality from some factory exceeds the standard, it shall be discharged after being treated thoroughly to decrease the concentration up to the value less than the standard, in conformity with the Water Act 1991, by its own disposal facility or their cooperative one in IMT. Especially in case of including harmful heavy metals more than the standard - eg; the effluent from plating or printing work shop -, even if the concentration of other materials is low, the facility to remove off those materials from the waste water shall be installed in its own factory. There are a few existing factories near to Gurgaon which already installed such facility.

Effluent waste water from other factories will have proper water quality as the result of each production process, so its disposal method differs from each other. But generally those processes of adsorption by activated carbon, membrane separation and ion exchange as well as various solid-liquid separative operation are effective, and some biological disposal method such as activated sludge process is also applicable to the waste water including organic materials.

Thus if those factories which will be moved into IMT in future abide by the fluent standard by the Water Act, it become possible to utilise the waste water partially for irrigation to farm land near to IMT.

The periodical inspection on the water quality of existing factories in Gurgaon is now being performed by HSPCB once or twice a year, and this conduct shall be also applied to those factories of IMT in future in cooperation with the control organization of IMT.

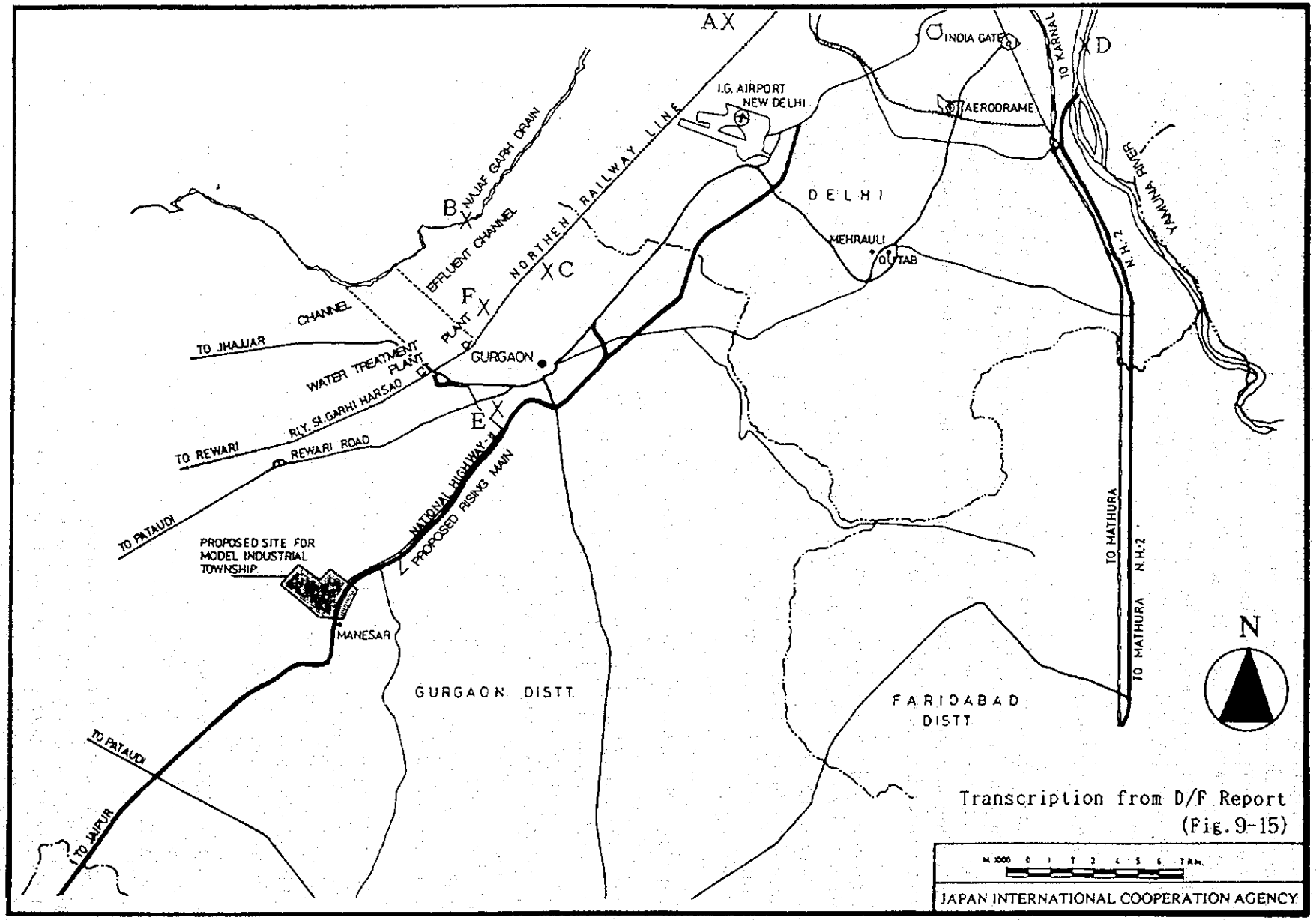


Fig 8.8.1 : Sampling Spots of Water Intaked Near Gurgaon

Table 8.8.2 : Result of Analysis of Water Sample Intaked Near Gurgaon

Sample Mark	A	B	C	D	E	F
Sampling Day	19/8/1994	19/8/1994	22/8/1994	6/9/1994	6/9/1994	22/8/1994
Sampling Spot	M/s HUDA Sector-9A Old Disposal, Gurgaon	M/s Najafgarh Drain, Gurgaon	M/s HUDA Palam Vihar, Gurgaon	M/s Najafgarh Drain, Near Yamuna River, Delhi	M/s Najafgarh Drain, Near Punjabi Bagh.	Huda Sector29 Gurgaon
Items						
1. PH Value	7.7	7.69	7.75	7.8	7.51	7.62
2. Suspended Solids (mg/l)	620	98	90	364	88	198
3. Dissolved Solids (mg/l)	1396	409	1469	746	1241	743
4. BOD for 5 days at 20℃ (mg/l)	110	38	40	160	46	78
5. COD (mg/l)	214	72	86	312	108	152
6. Chlorides as Cl^{-1} (mg/l)	318	92	354	268	238	226
7. Sulphates as SO_4 (mg/l)	108	32	170	68	72	66
8. % Sodium	52	41	45	51	58·6	43
9. Oil and Grease (mg/l)	14.6	7.4	8.4	11.6	7·6	12.4
10. Cynide as CN^{-1} (mg/l)	ND	ND	ND	ND	ND	ND
11. Chromium as Cr^{+6} (mg/l)	ND	ND	ND	ND	ND	ND
12. Nickel as Ni (mg/l)	ND	ND	ND	ND	ND	ND
13. Zinc as Zn (mg/l)	ND	ND	ND	ND	ND	ND
14. Iron as Fe^{+3} (mg/l)	ND	ND	ND	-	ND	ND
15. Copper as Cu (mg/l)	ND	ND	ND	-	ND	ND
16. Lead as Pb (mg/l)	ND	ND	ND	ND	ND	ND

8.8.3 Air Pollution Control

A few kind of industries such as chemical, ceramic and food consume much fuel as their process energy source not only as general use among them listed in Table 7.2.4. The supply of natural gas (NG) to IMT will be feasible due to the partial power supply by thermal power generation using NG as its fuel source, and as long as NG supply to those industries as process energy source is also available, the pollution emission may become scarcely problem, for the content of harmful gas such as H_2S in NG is very little according to its component table which was presented by the Gas Authority of India Limited (GAIL).

But actual supply of NG to those factories is difficult, so they cannot but apply gas oil, diesel oil and heavy oil as their energy source, and gas oil use is desirable because its pollutants content is least among them. at any rate the said industries should be thoroughly directed at the time of establishment of their factory in IMT, lest they should discharge those pollutant gases letting them abide by the Air Act enacted in 1981.

In regard to exhaust pollutant gas which is discharged from production process, the paper and iron/steel industries are in the problem for the discharge of airborne suspended solid (ASP). Those regulatory standard is shown in Table 8.8.3.

Table 8.8.3 : Dust Emission Standard in Iron and Paper Industries

Industry	Standards
Iron and steel (coke ovens)	Dust: 50 mg/Nm^3
(refractory material plants)	Dust: 150 mg/Nm^3
Pulp and paper	Dust: 250 mg/Nm^3
	H_2S: 10 mg/Nm^3

Concerning the process exhaust gas from other industries such as chemical, it is at present unknown whether what kind of gases are discharged from the process, because it surely depends on the production process. But in case that the discharge of harmful gases such as CO, halogen & halogenated gas, H_2S, NH_3, photochemical oxident as well as So_x and $No_x$is well known or probable before installation of the factory, it is required to obligate them to install some equipment to remove them off at the time of application for the factory establishment.

As to monitoring the discharge of those gases, HSPCB is now conducting that task toward existing factories in Gurgaon. So after the construction of IMT, it will be required to constitute some control organization in IMT which can perform such monitoring works in cooperation with HSPCB.

8.8.4 Other Pollution Control

As to noise emission in India, there is no regulatory distinction by the kind of industries, but respective standard value by each area as shown in Table 8.8.4. So, in case that illegal noise emission s forecasted from a factory, some countermeasure to prevent that should be beforehand established.

Table 8.8.4 : Ambient Air Quality Standards for Noise

Category of Areas	Limits in dB(A)	
	Daylight Hours (6:00 - 21:00)	Evening Hours (21:00 - 6:00)
(A) Industrial Area	75	70
(B) Commercial Area	65	55
(C)Residential Area	55	45
(D) Quite Zone	50	40
Mixed Category	Fixed by each administrative body	

Note-1: Day light is reckoned between 6 a.m. and 9 p.m.
Note -2: Evening hours are reckoned between 9 p.m. and 6 a.m.
Note-3 :The quiet zone is defined as areas upto 100 metres around such premises as hospitals, educational institutions, and courts. The Quiet Zones are to be declared by the competent Authority. Use of vehicular horns, loudspeakers, and bursting of crackers shall be banned in these zones.
Note-4: Mixed categories of areas be declared as one of the four above mentioned categories by the Competent Authority and the corresponding standards shall apply

8.8.5 Kind of Pollutive Industries

In India 21 kinds of industries are defined as pollutive ones as listed in Table 8.8.5, and required to submit environmental impact assessment (EIA). Among them the industries of * mark in the Table are presumed to join into IMT. But besides those industries, pollutive ones - eg; electric/electro, metal working and printing industries - which are feasible to emit harmful heavy metals, even if the amount might be little, shall be taken care of the emission. Such environmental regulations the firms which will move into IMT have to obey are The Environmental Act, The Water Act and The Air Act besides the submission of EIA above mentioned, and in case that they are contrary to the regulations or have a possibility to become so, they have to set up some countermeasure to clear that matter.

Although the treatment to remove off those pollutant materials so a to protect environment should be done at the generating spot in principle, these respective disposal technology has been in general situation developed in the enveloped countries in many cases, so the technical transfer from there might be taken into consideration.

Table 8.8.5 : List of Polluting Industries

No. 1*	Ferrous Metallurgical Industries	-- integrated iron and steel (metal) -- ferro-alloys -- special steels -- iron and steel castings and forgings
No. 2*	Non-Ferrous Metallurgical Industries	-- primary metallurgical producing industries, namely zinc, lead, copper and aluminum -- non-ferrous castings and forgings
No. 3	Mining Industries	-- coal washeries -- hydraulic mining -- hydraulic transport
No. 4	Ores/Mineral Processing Industries	-- Beneficiation and/or pelletization
No. 5	Coal (including coke) Industries	-- coal, lignite, coke, etc. -- fuel gases (coal gas, producer gas, water gas, etc.)
No. 6	Power Generating Industries	
No. 7*	Paper and Pulp (including paper products) Industries	-- paper: writing, printing, wrapping -- newsprint -- paperboard, strawboard -- pulp -- paper for packaging (corrugated papers, crafts paper, paper bags, etc.) -- wood pulp, mechanical, chemical (including dissolving pulp) -- sanitary paper -- cigarette paper -- insulation and other coated papers
No. 8	Fertilizer Industries	-- nitrogenous -- phosphatic -- mixed
No. 9	Cement Industries	-- portland cement (including slag cement, puzzolona cement and production) -- asbestos cement products
No. 10	Petroleum Industries	-- oil production -- oil refining -- lubricating oils and greases -- oil exploration
No. 11	Petrochemicals Industries	
No. 12	Drugs and Pharmaceuticals Industries	-- narcotics, drugs, pharmaceuticals including vitamins (antibiotics, indigenous systems of medicines recovered)
No. 13	Fermentation Industries	-- alcohol (industrial and potable)
No. 14*	Rubber (natural & synthetic) including Rubber Products Industries	-- natural and synthetic rubber -- tryes and tubes -- surgical and medical products including prophylactics/latex wear -- footwear -- other rubber products
No. 15	Paint Industries	
No. 16*	Leather Tanning Industries	
No. 17	Electro-Plating Industries	
No. 18*	Chemical Industries	-- coke oven by-products (nitrogen, oxygen, acetylene, argon, carbondioxide, sulphur dioxide, nitrous oxide, halogenatyed hydrocarbon, ozone, etc.) -- industrial carbon -- alkalines -- electrochemicals (metallic sodium, potassium and magnesium, chlorates, perchlorates, and peroxides) -- electrothermal products (artificial abrasive, calcium carbide) -- phosphorus and its compounds) -- nitrogenous compounds (cyanides, cyanamides, and other nitrogenous compounds) -- halogens and halogenated compounds (chlorine, fluorine, bromine and iodine) -- explosives (including industrial explosives and detonators and fuses)
No. 19	Insecticides, Fungicides, Herbicides, and other Pesticide Industries	
No. 20*	Synthetic Resins and Plastics	
No. 21	Manmade Fibre (Cellulosic and non-cellulosic) Industries	

Note *: expected operation in the IMT

Chapter 9

Operation and Management of IMT

Chapter 9 Operation and Management of IMT

9.1 Concept of Operation and Management Planning for the IMT

(1) Present situation of operation and management of the Industrial Estates in Gurgaon

The status of operation and management of the Industrial Estates in Gurgaon is as follows:

(a) The existing industrial estates in Gurgaon (about 800 ha) are managed by the public sector, being the Haryana State Industrial Development Corporation (HSIDC). In general, industrial estates in India are maintained and managed by the developer. For instance, the electrical of facilities are managed by the state-owned electric company, the Haryana State Electricity Board (HSEB), telecommunications are managed by the Department of Telecommunications (DOT) and the roads are managed by the Public Works Department (PWD).

(b) The HSIDC has so far maintained and managed the roads, water supply, waste water and sewage treatment, additional electrical facilities, drainage facilities, plantation, and horticulture in the industrial estates. 15 managers and 50 laborers are employed for this purpose in Gurgaon. HSIDC manages the existing industrial estates successfully.

(c) The HSIDC carried out sufficient management of the existing industrial estates in Gurgaon, although the management is relatively simple due to the fact that the infrastructural facilities on the industrial estates are primitive and do not require complicated operation and management. Except for periodically necessary maintenance, such as plantation supplementing (additional planting) and the removal of settled grit from water supply facilities, the repair and cleaning of facilities is only carried out each time a request is made by any of the located companies on the estates.

(d) The cost of maintenance and management is provided by the charges levied on the companies located in the industrial estates.

(e) Maintenance and management services are directly implemented by the HSIDC. No part of the management is entrusted to external companies; but maintenance and management can be entrusted in the future as is seen in developed countries.

(2) The level of management and operation in the industrial estates in Japan

The infrastructure in the industrial estates of developed countries, such as Japan, are often transferred to the local government. Maintenance and management are often undertaken by the local government and periodical maintenance and cleaning are implemented. Facilities and services to promote the activities of industries are often implemented.

The management of industrial estates by local government allows detailed and high quality services for those infrastructure items, which require high level management

capability, to be carried out.

As well as this, there are many cases where local governments introduce functions for the promotion of the local economy and industry, and provide support to located comapnies and joint enterprises.

(3) Policy of IMT management

The policy for the IMT estate management which will form the basis for the industrial estate operation and management plan is as follows:

(a) As one of the objectives of construction of the IMT is the promotion of direct investment from foreign corporations etc., it is vital that management of the IMT satisfies international standards. The IMT should provide a good physical and industrial environment, such as the constant supply of electricity and the treatment of drainage, so the industries can operate smoothly. High level skills and organized management are vital for the maintenance and management of such infrastructural facilities and the overall detailed and high level management, and it is also important to establish an organization and setup that can sufficiently handle the treatment of waste from the various companies and the checking of pollution regulations.

(b) The HSIDC, the agency that operates and manages the industrial estates of Gurgaon, has gained know-how and organizational skills in operation and management through its past achievements. It is therefore necessary to consider the effective utilization of this experience of the HSIDC for he operation and management of the IMT.

(c) As the operation and management of the IMT covers many aspects and requires high level skills, it is necessary to examine the implementation of management through the consigning of possible areas to bodies that possess specialist knowledge and skills. Moreover, care shall be taken to ensure that the maintenance and management organizations is slimmed down to enable efficient and rapid handling of affairs to be done.

9.2 The Operation and Management Organization

9.2.1 Possibility of an Operation and Management Agency

As in the case of the development agency, the operation and management agency of IMT may be one of the following three organizations:

① The existing organization, HSIDC

② A new organization consisting of a joint venture between the public and the private sectors

③ A new private sector organization

This list can further be subdivided into the case in which development and operation are integrated with the development agency evolving into the operation and management agency and the case in which the organization involves itself only in operation and management.

The merits and demerits of each of the above assuming the operation and management role are given below.

(1) HSIDC

The merits and demerits of HSIDC becoming the operation and management agency for IMT are as follows:

Merits:

① HSIDC will be able to employ its extensive experience in managing industrial estates in the IMT.

② IMT is expected to provide high quality service to companies through a single window service system and with HSIDC, providing services related to permits issued by the state government will be facilitated.

③ The maintenance and management of infrastructure outside IMT is the responsibility of relevant state government bureaus and cooperation with these bureaus will be facilitated.

Demerits:

① Because the HSIDC is a state agency, it is forecast that it will be constrained in the promotion of foreign investment and that it will not be able to conduct foreign investment invitations aggressively as other organizations may.

② It is doubtful whether HSIDC will be able to offer services in line with international standards.

(2) Third sector

The merits and demerits in the case of operation and management of the IMT by an organization that combines the public and private sectors are as follows:

Merits:

① With the involvement of overseas corporations, an active promotion program may be implemented.

② The merits listed under HSIDC can be realized as HSIDC will be part of the organization.

Demerits:

① As the state of Haryana has no experience in operation and management of industrial estates through a joint venture of the public and private sectors, forming such an organization with the attendant issues of structure and division of responsibilities between the public and private sectors, will require time.

② Close cooperation of the public sector with the private will be needed and there is concern about the time required for concluding budgetary issues.

(3) Private Sector

The merits and demerits of a new private sector organization assuming the role of the operation and management agency are as follows:

Merits:

① The dynamism in attracting overseas investment will be equal to or greater than in the case of the public/private joint venture.

② A slim and effective operation and management system can be expected.

Demerits:

① Although in developed countries, cost efficient and quick services are available, it is doubtful whether the state government can provide the various services needed for the operation of the industrial estate, because Hariyana is get to experience a case of industrial estate operation by the third sector.

② As a private corporation the operation and management agency will naturally set profit objectives which may be in conflict with the public nature of the facilities.

The three types of organizations all have their merits and demerits. Whichever format is chosen, the following needs to be considered.

In the event HSIDC is to assume the operation and management role, since the services required at IMT are outside the scope of HSIDC's previous experience, it will need to reinforce its organization in the fields of operation and management.

It will be necessary to reinforce HSIDC's operation capability through, perhaps, employment of a consultant on an international level. In the event a public/private sector joint venture is to assume the operation and management role, as this implies adding the expertise of the private sector to past HSIDC experience, feasibility is high. However, the new organization will be made up of the public and private sectors, each with different objectives. Since the operation and management services provided must continue long into the future as long as companies maintain facilities in the industrial

estate, the format should be carefully examined with a long term perspective in mind.

In the event the private sector is to assume the operation and management role, there is a problem as many of the facilities at IMT are not designed to produce profits and since the overall operation and management of IMT cannot be implemented without structuring these non-profit functions. There are facilities, however, that are designed to produce profits and for these, the format may work. However, here as well, accommodation with other public facilities and close cooperation with IMT's overall operation and management will have to be established.

In conclusion, operation and management by the third sector as a management body, which allows the mutual compensation of the demerits that exist in the cases of either public or private management, and which allows he merits to be obtained, is desirable.

9.2.2 Remarks on the Role of Operation and Management

(1) The infrastructure of IMT includes telephone systems and national highways, etc. that are operated and managed by bodies other than the development agency of IMT. Thus, the operation and management of these items shall not be examined in this chapter.

(2) Security precautions in the industrial estates are to be considered after the estates are in operation. Such software considerations will be the subject of discussion in a consultative agency to be organized by the companies located in the estates.

(3) The Promotion Center will be the main office of the IMT Promotion Center (IMTPC) and will be the central headquarters at which the operation and management functions of IMT will be conducted. The Promotion Center shall cover 20,000m^2 (four above ground floors, one underground floor, building area 5,000m^2, site area 20,000m^2)

9.2.3 Operational Planning for the IMTPC

(1) Setting up of an introduction function

When the IMT was established in the Master Plan its aim was described as the "Expansion of industrial production of manufactured goods for domestic demand," and the "Promotion of local industry by introducing advanced technology and management systems". Therefore, the IMT needs to raise India's industrial power and aim for a high standard in technology and management. From this point of view in the Master Plan the introduction of six promotional functions are intended. "7.3 Planning of Housing and Urban facilities" in the promotional F/S study indicates building the industrial Promotion Center in consideration of the functions to promote the IMT and to support business.

The five functions used in the operation and management of the IMT are as follows:

a. Investment Promotion Function
b. Business Supporting Function
c. Technology Supporting Function
d. Human Resource Education Function
e. Technology Exchange Supporting Function

(2) Outline of the facilities

The concrete facilities needed are the following five functions:

(a) Investment Promotion Function → Investment Promotion Facilities

It is necessary to have an information room (with library and data base facility) in order to provide information on an investment in India or to promote introduction of foreign capital by advertising the IMT. As for information, an independent section of one person in charge will be established because it needs reference and guidance for use.

(b) Business Supporting Function → Business Supporting Facilities

They supports the application procedure services, the management service for tenant companies, the capital raising intermediation service for tenant companies, consulting, and the introduction of subcontractors through intermediation between foreign companies and local companies. The information room (with library and data base function), conference, etc. are used as the facilities.

(c) Technology Supporting Function → Technology Supporting Facilities

The conference rooms, laboratory, the testing and analysis rooms are to guide the local companies (especially small sized) to use the test or analysis machines to meet international standard in the testing and checking of objects in the facilities. Concerning R&D facilities, as there is the existing R & D facilities in Gurgaon to intermediate their use to the companies, the facilities needed for the operation and management are conference rooms only.

(d) Human Resources Education Function → Human Resources Education Facilities

The training rooms and audio visual rooms where the tenant companies carry out small scale training are used as the facilities. Besides the training rooms in the Promotion Center, a large scale training center, are a seminar house are to be built harmonizing each facility with the service of the existing organization in Haryana state. The IMTPC will carry out desired services, making use of the facilities, intermediating to the agency of service.

(e) Technology Exchange Supporting Function → Technology Exchange Supporting Facilities

The conference rooms, the seminar rooms, the exchange rooms and the display rooms for promoting to exchange information, technology, and human resources among the companies, universities, and institutes in the IMT are used as the facilities to promote the transfer of technology.

As facilities for making operation and management of the IMT and making operation of the IMTPC, there are office floor, conference rooms, hall, etc., of every section.

(3) Operation of IMTPC

The IMTPC (Promotion Center) is very large and it is expected to expand the facilities in order to improve the convenience of conference rooms, halls, etc., with the needs of the tenant companies for the IMT. It is necessary to have a proper organization in order to maintain and operate the gradually improved facilities.

First, it is needed to form a necessary operation and management system and to implement the works related to the operation and management of the IMT. Besides, the Promotion Center needs a management room (or security room) to keep the safety.

The conference rooms and the hall, considered as a rental space, are checked, cleaned, improved on the interior and repaired as necessary. (The General Affairs Department of the IMTPC will manages and operates these facilities.)

9.3 Structure of Operation and Management

9.3.1 Scope of Work

The IMTPC, which shall operate and manage the IMT, shall be responsible for the smooth functioning of the industrial estates and the maintenance of equipment and buildings that will be improved through the infrastructure development. It is therefore necessary to build a system that takes this, and the fact that the IMTPC will take on affairs relating to the promotion of the estates, into consideration.

Implementation will be carried out by five departments being the Promoting Department to operate the facilities of the industrial estates, the Estates Management Department to manage the infrastructure of the industrial estates, the Housing Management Department to manage housing affairs and the facilities for the utility of the land, the Planning and Development Department to promote the use of the land and the General Affair Department to operate the organization.

The IMTPC shall of course be represented in the organization with an operation responsibility and deputy responsibility being exclusively placed within the IMT.

Furthermore, in order to carry out the regular works of the companies in the IMT more smoothly, a conference connecting each company which will be called the IMT Liaison Council, consisting of members of the located companies will be set up. The IMTPC will carry out the role of the secretariat.

(1) General Affairs Department

This department is in charge of the general business of the IMTPC, carries out the general affairs needed for the operation of the organization of the IMTPC, accounting for the operation, public information and the management of the buildings and facilities. The department consists of the general affair section, the accounting section and the business section. These three sections carry out business which the other departments or sections do not deal with.

(2) Planning and Development Department

This Department is in charge of the business concerning the development (the construction works, the equipment at each phase) of the investment by the first stage of the IMT, the planning of this business and the carrying out of the sales of the complete lots for the factories in the IMT. As the inside organization, this department consists of the planning and development section for the former and the sales promotion section for the latter. In case the lots in the IMT are sold out in the future, the planning and development section will be reduced or absorbed into another department.

(3) Promotion Department

This department is in charge of the promotion of additional functions for the IMT and carries out the promotion of investment, business support, technical support and the raising of human resources. Further, information of the economy, science and industry, are various additional functions which are needed in unifying the operation and management department. The department consists of the promotion of investment section, the business support section (in charge of the business support and exchange support), the technical support section (in charge of the technical support and the raising human resources) and the information room as an inside organization.

(4) Estates Management Department

This department is in charge of the management of the industrial estates at the IMT and carries out the operation and management of roads, park and green belt, water supply, drainage, electricity, treatment for industrial wastes and pollution control. The management carried out in the head organization as well as the spot management offices are set up in need.

Therefore, the inside organization unites the small section to prevent the enlargement of the organization and consists of the road management section, the park and green belt section, the water supply section, the drainage section, the electricity section, and the pollution control section. As for the spot offices, the road management office, the park management office, the water supply and drainage management office (in charge of water supply, drainage, treatment for industrial waste and pollution control), and the power station office will be set up.