

Fig. F.20 Dependency on Irrigation Canal in Sataon Area

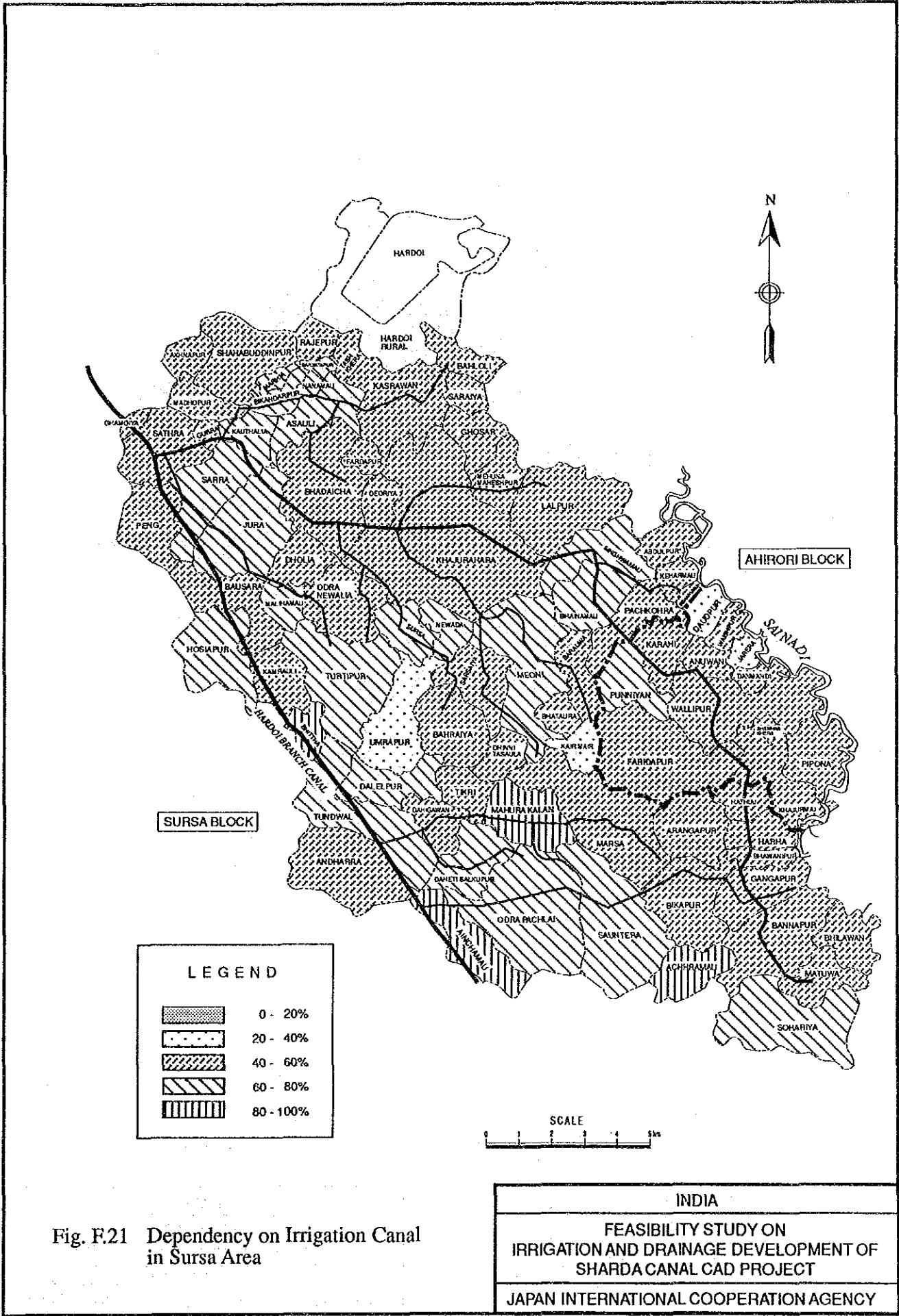


Fig. F.21 Dependency on Irrigation Canal in Sursa Area

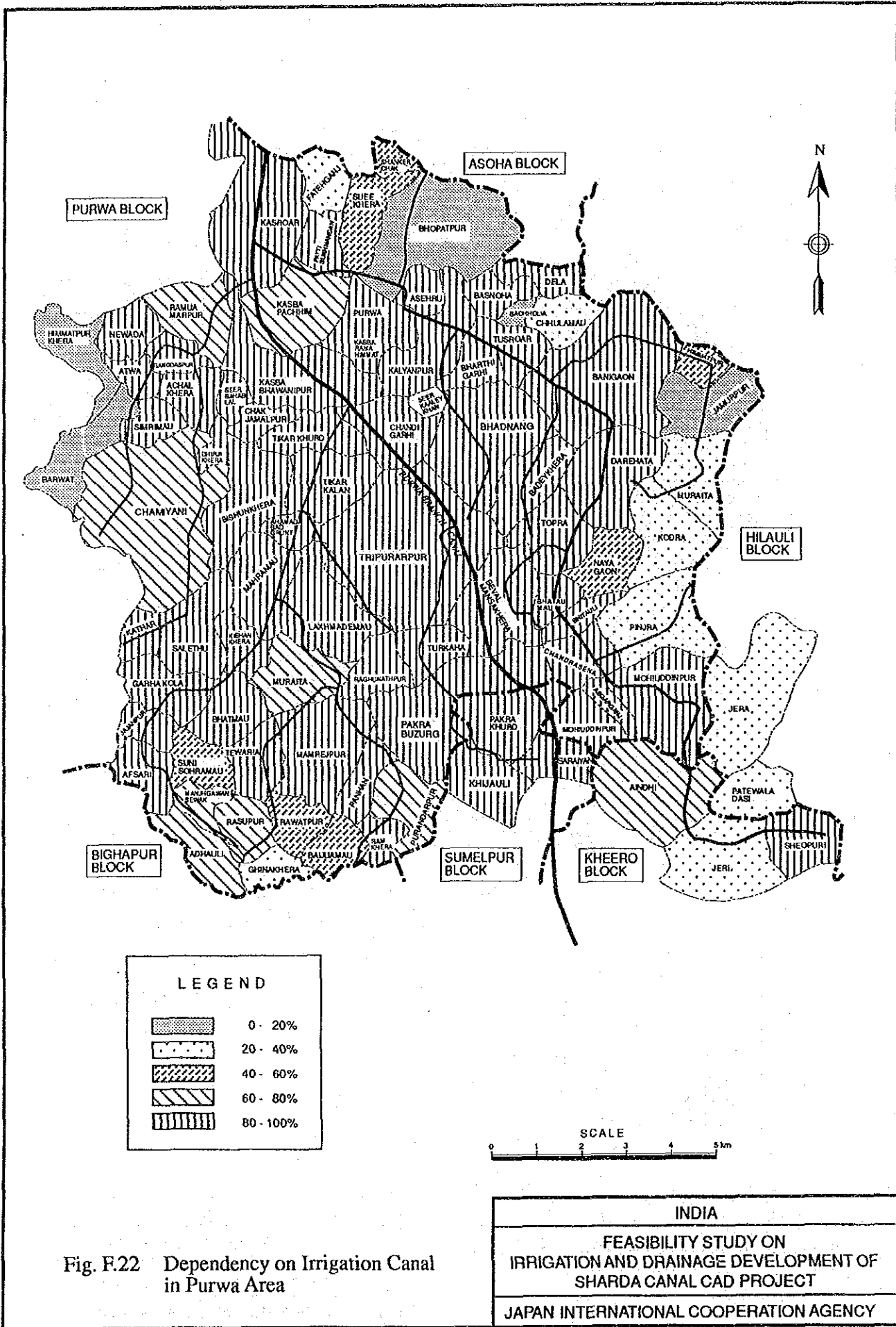
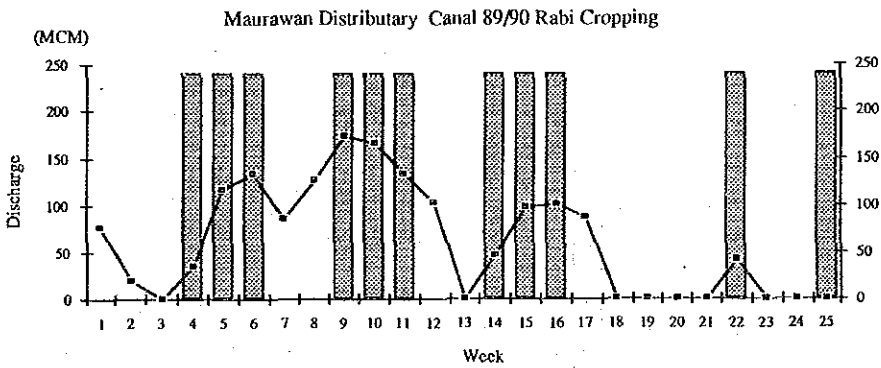
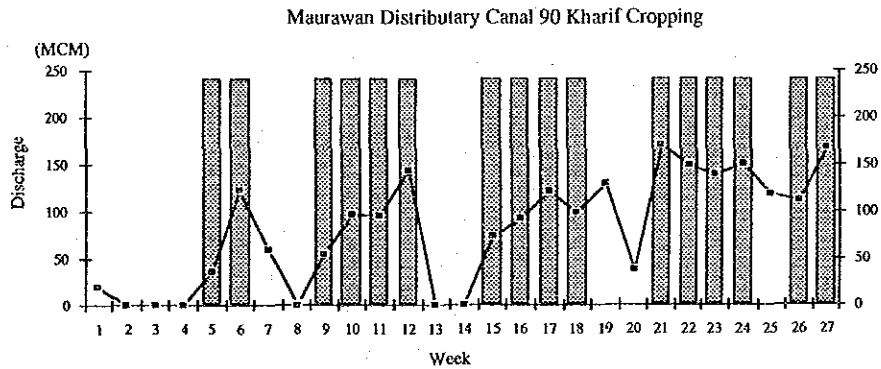
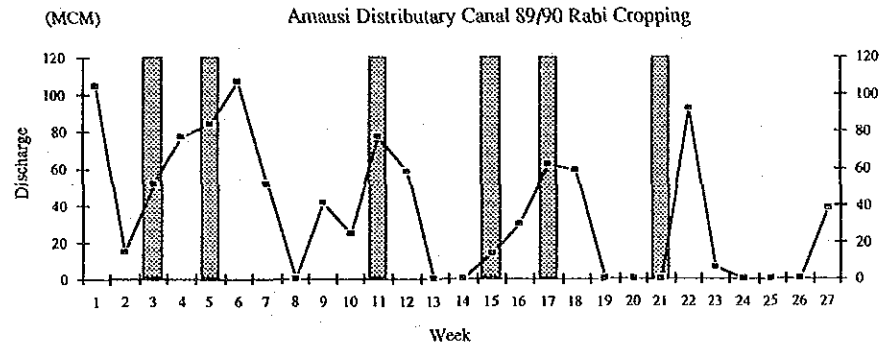
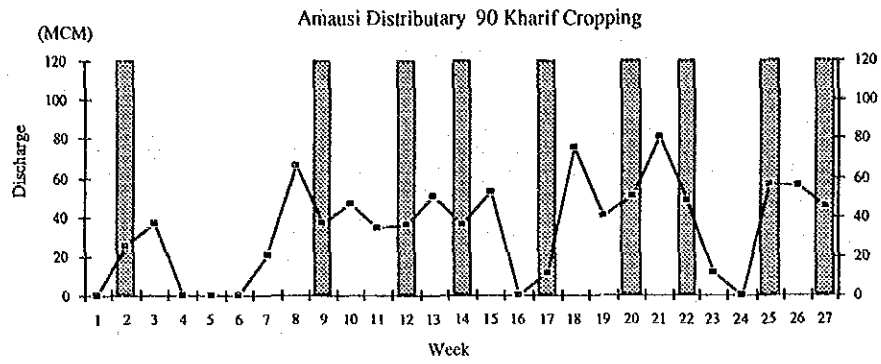


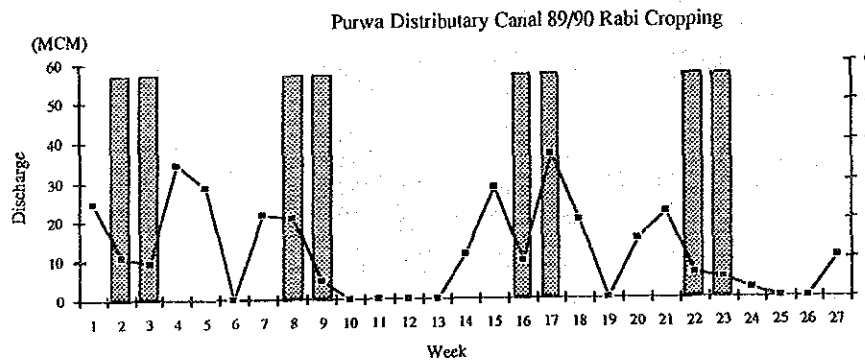
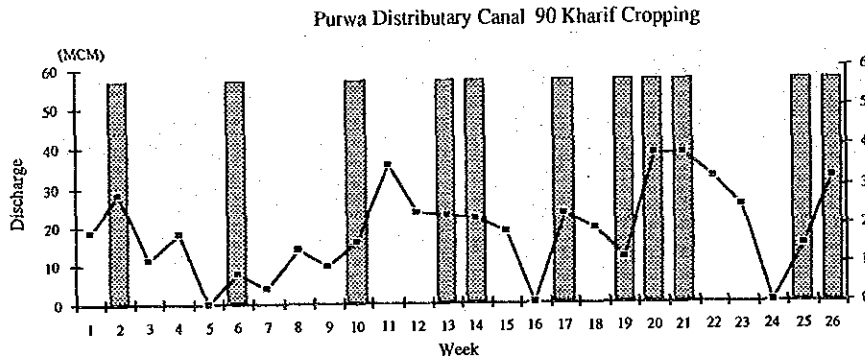
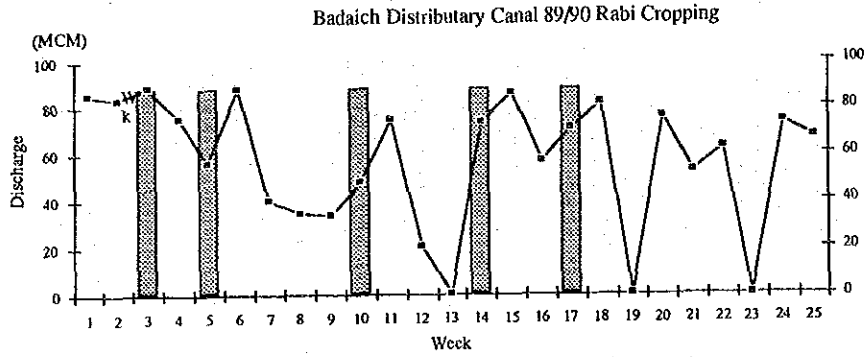
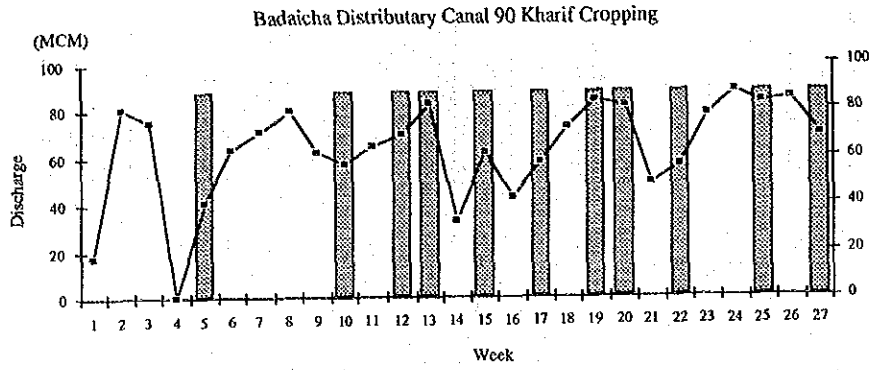
Fig. F.22 Dependency on Irrigation Canal in Purwa Area



Roster
 Actual

Fig. F.23 Comparison of Weekly Discharge between Schedule and Actual Supply in Representative Areas (1/2)

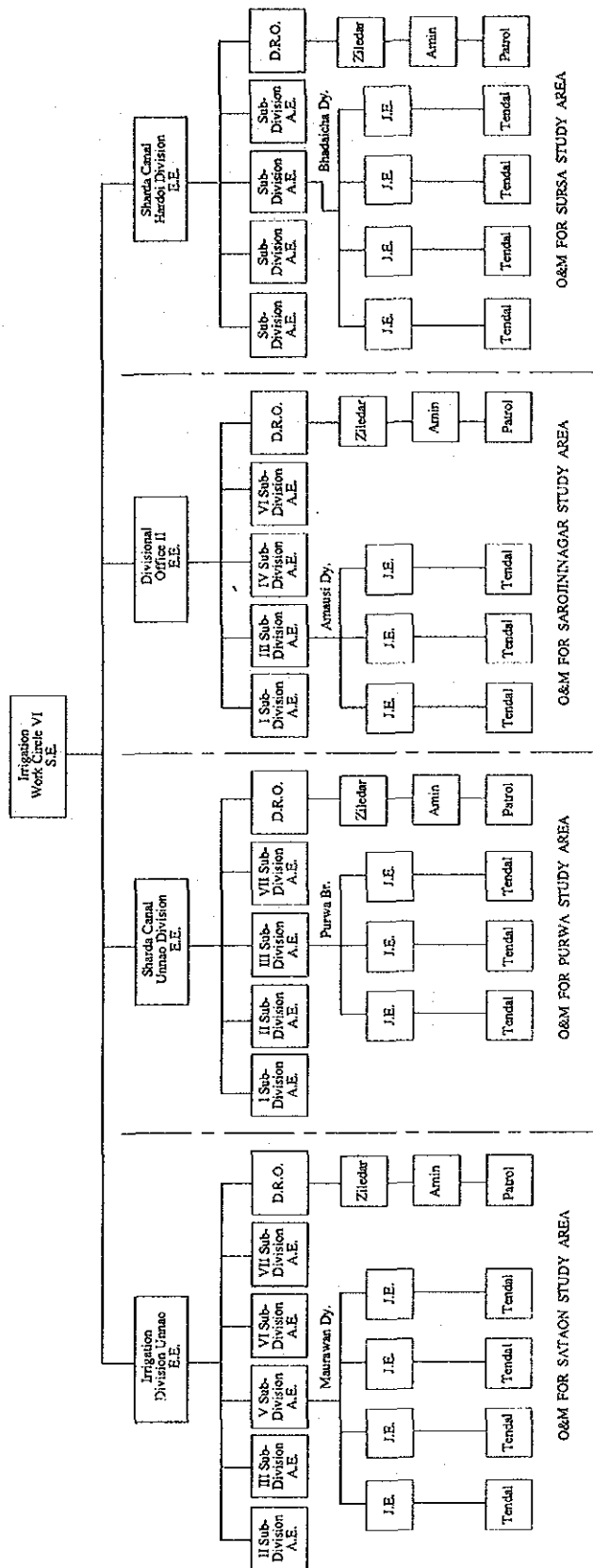
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█ Roster -■- Actual

Fig. F.23 Comparison of Weekly Discharge between Schedule and Actual Supply in Representative Areas (2/2)

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Note: S.E. : Superintending Engineer
 E.E. : Executive Engineer
 A.E. : Assistant Engineer
 D.R.O. : Deputy Revenue Officer
 J.E. : Junior Engineer

Fig. F.24 Organization on O&M of Sharda Canal System in the Representative Areas

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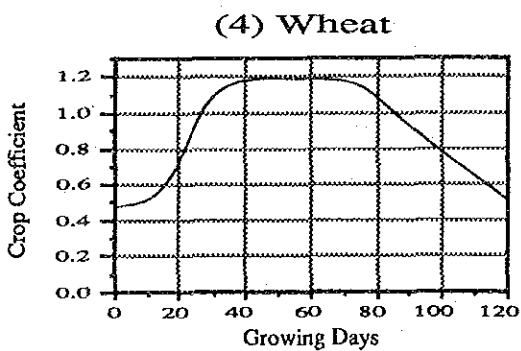
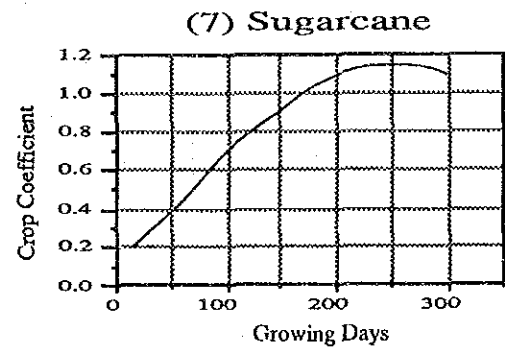
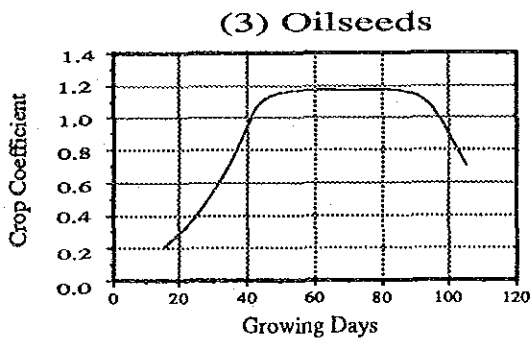
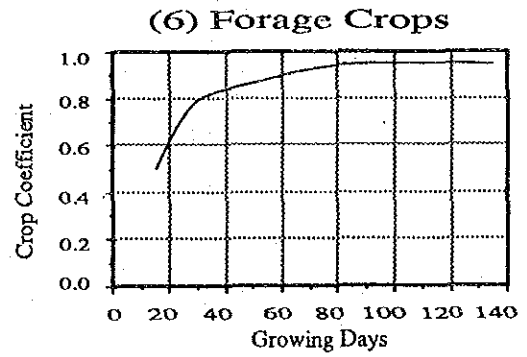
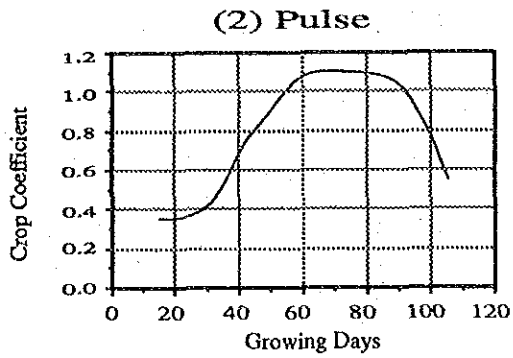
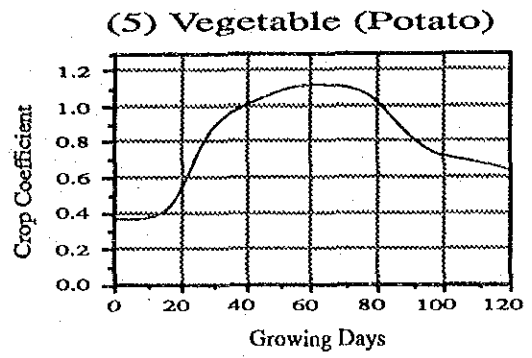
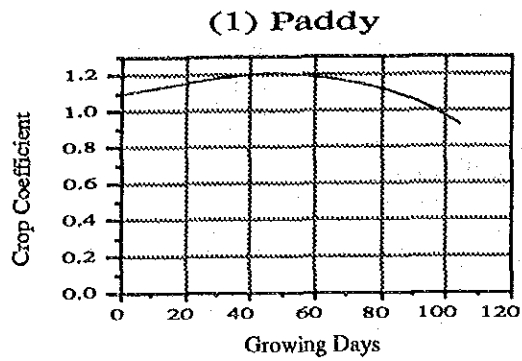


Fig. F.25 Crop Coefficients

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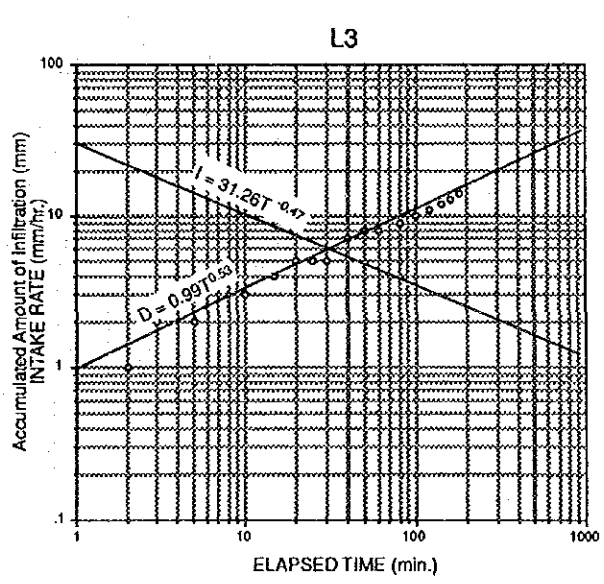
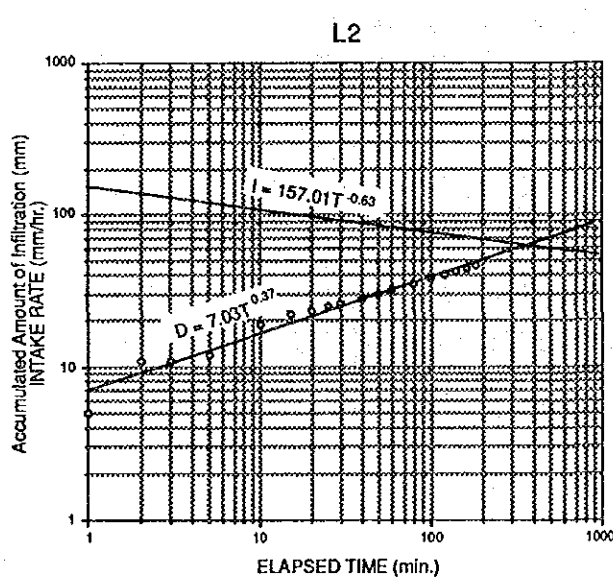
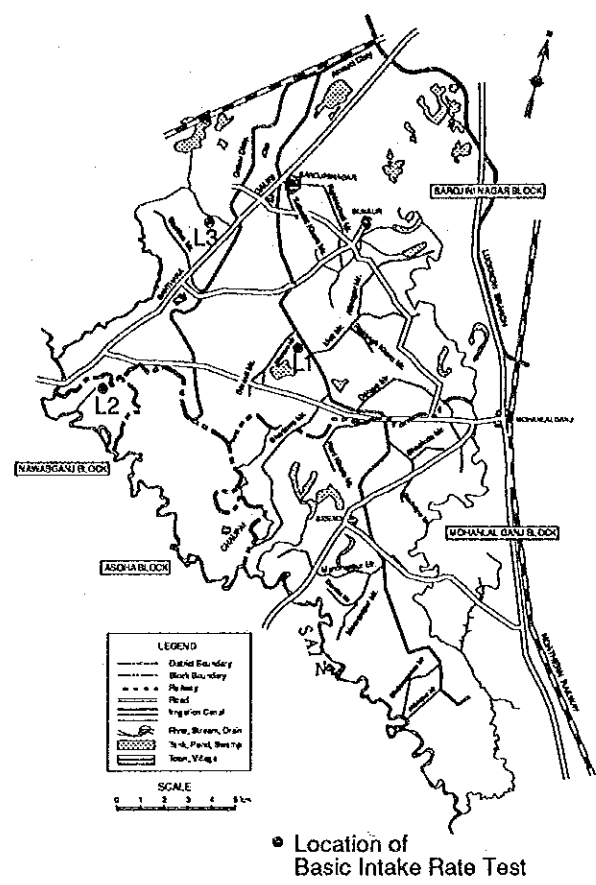
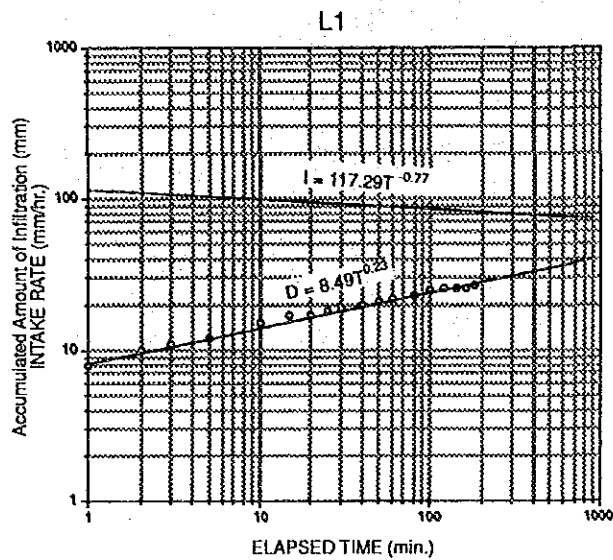


Fig. F.26 Intake Rate of Sarojini Nagar Area

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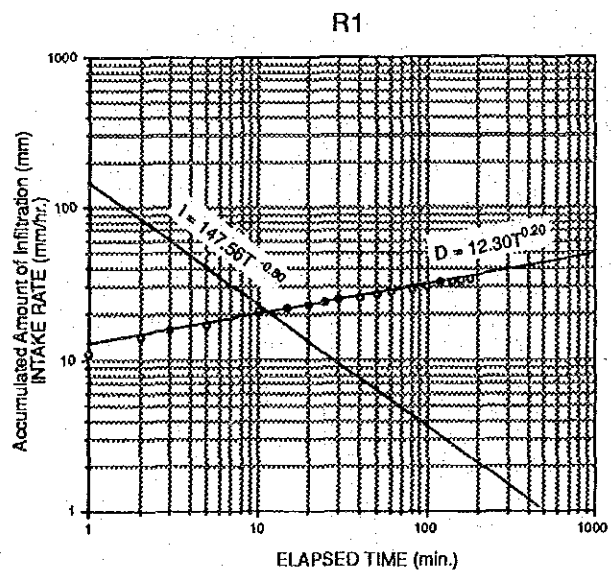
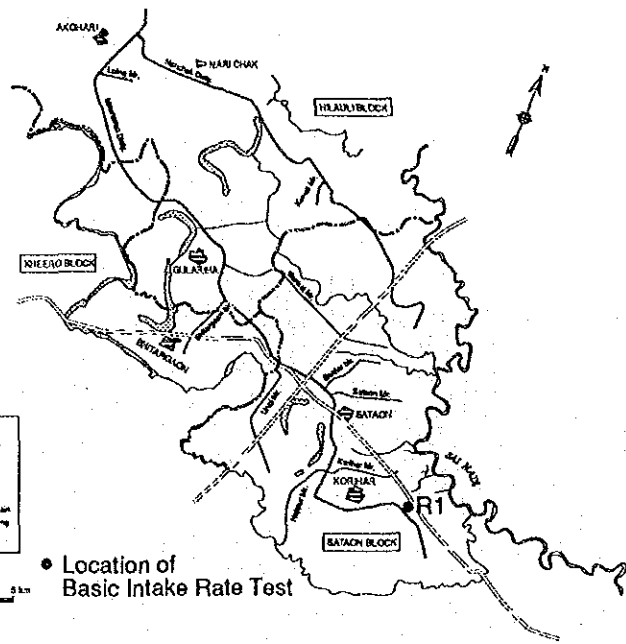


Fig. F.27 Intake Rate of Sataon Area

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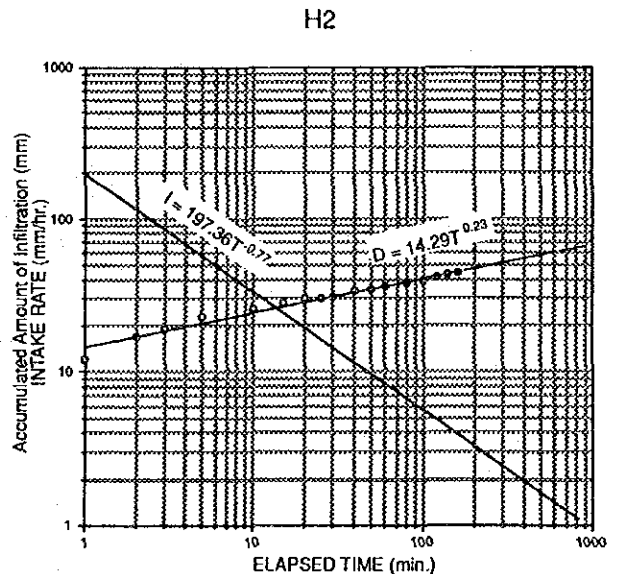
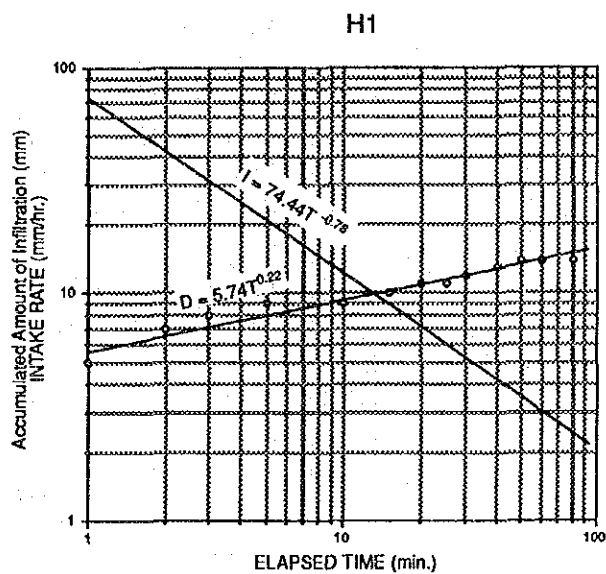
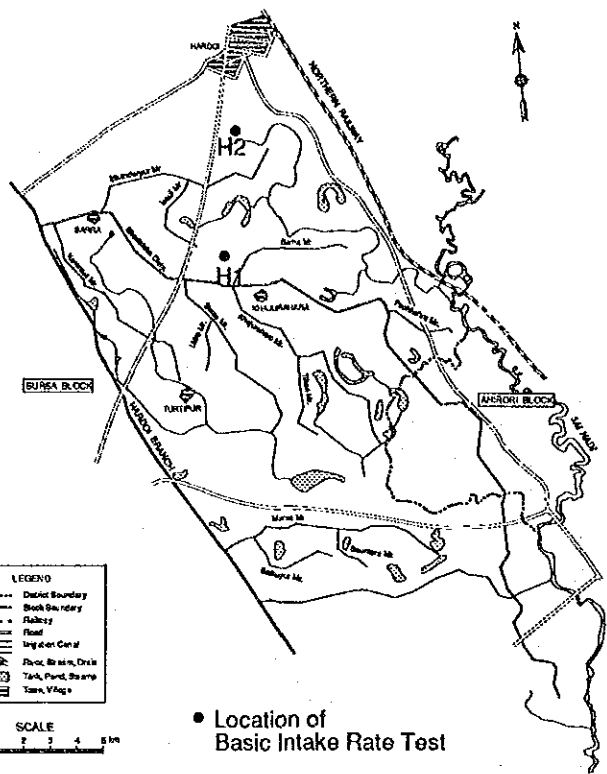


Fig. F.28 Intake Rate of Sursa Area

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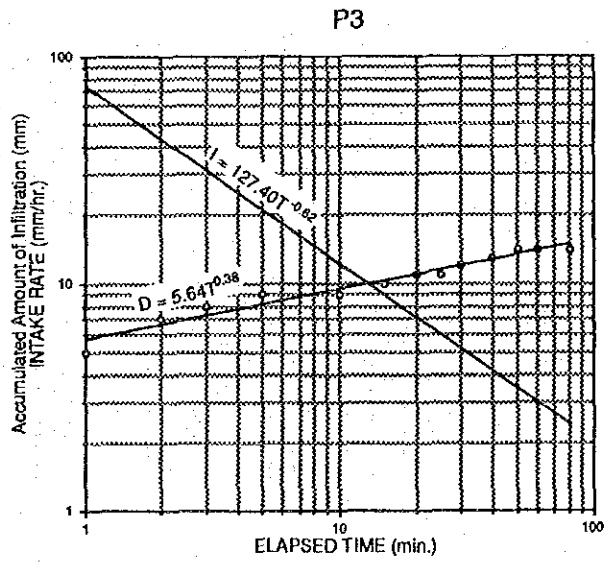
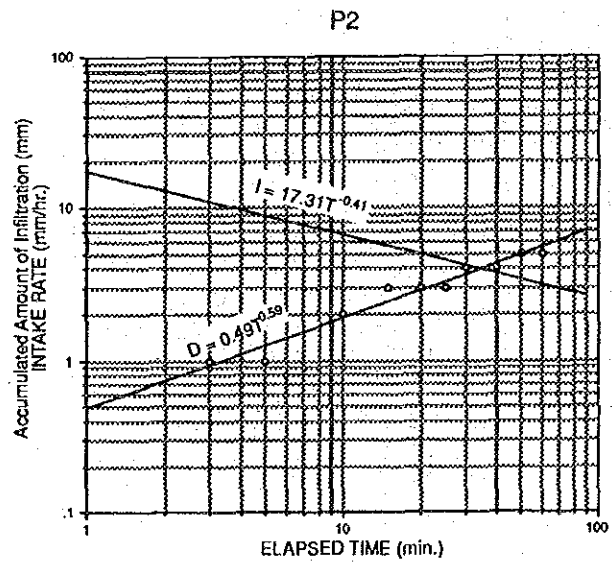
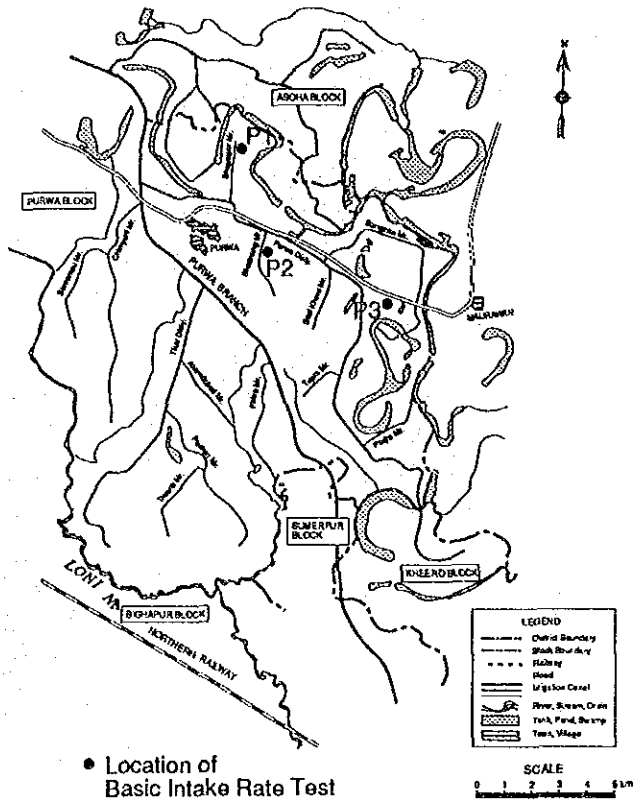
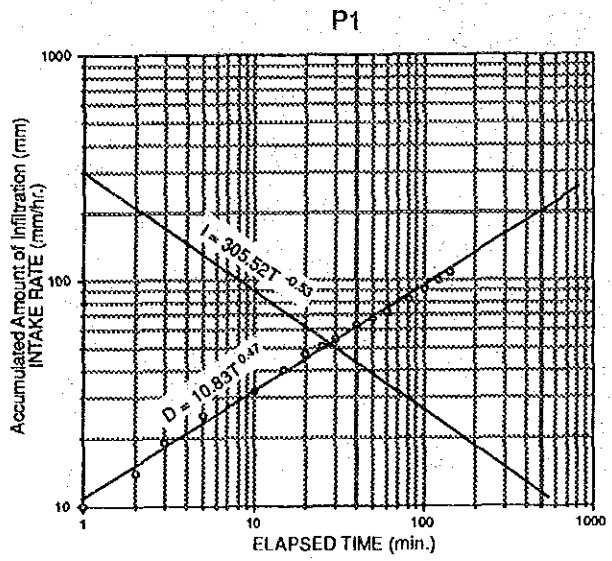
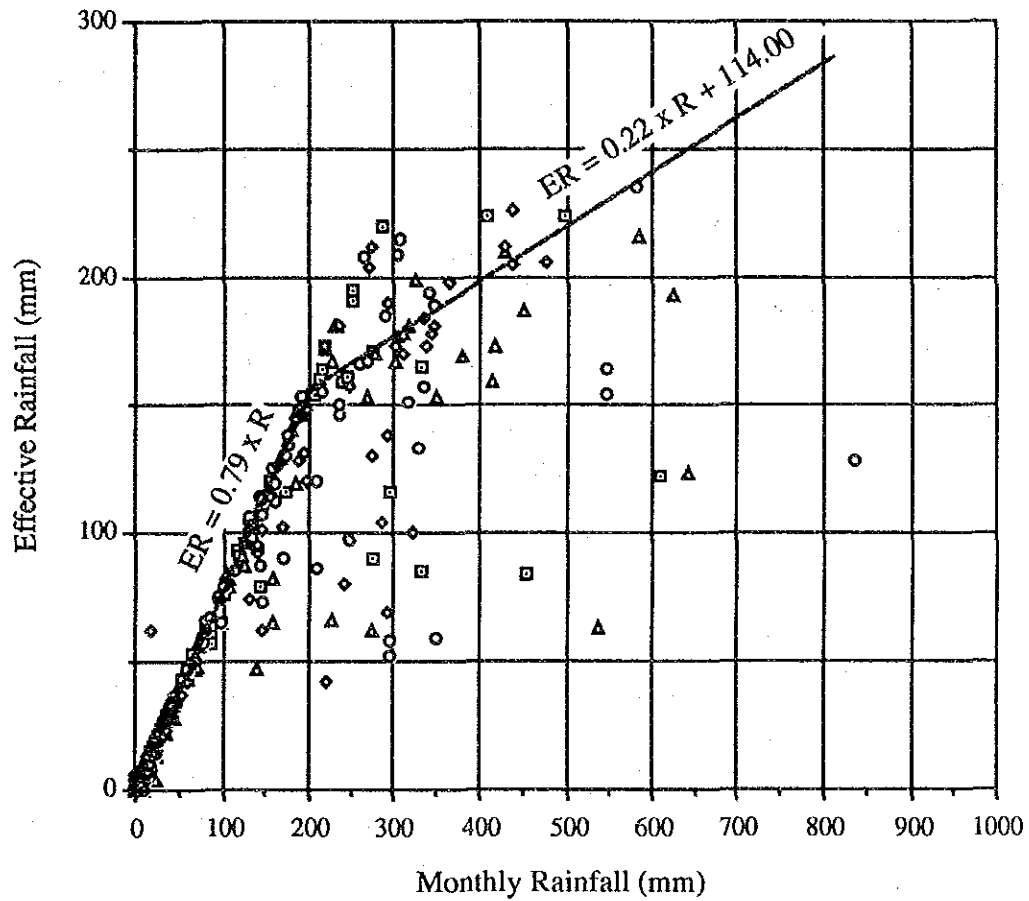


Fig. F.29 Intake Rate of Purwa Area

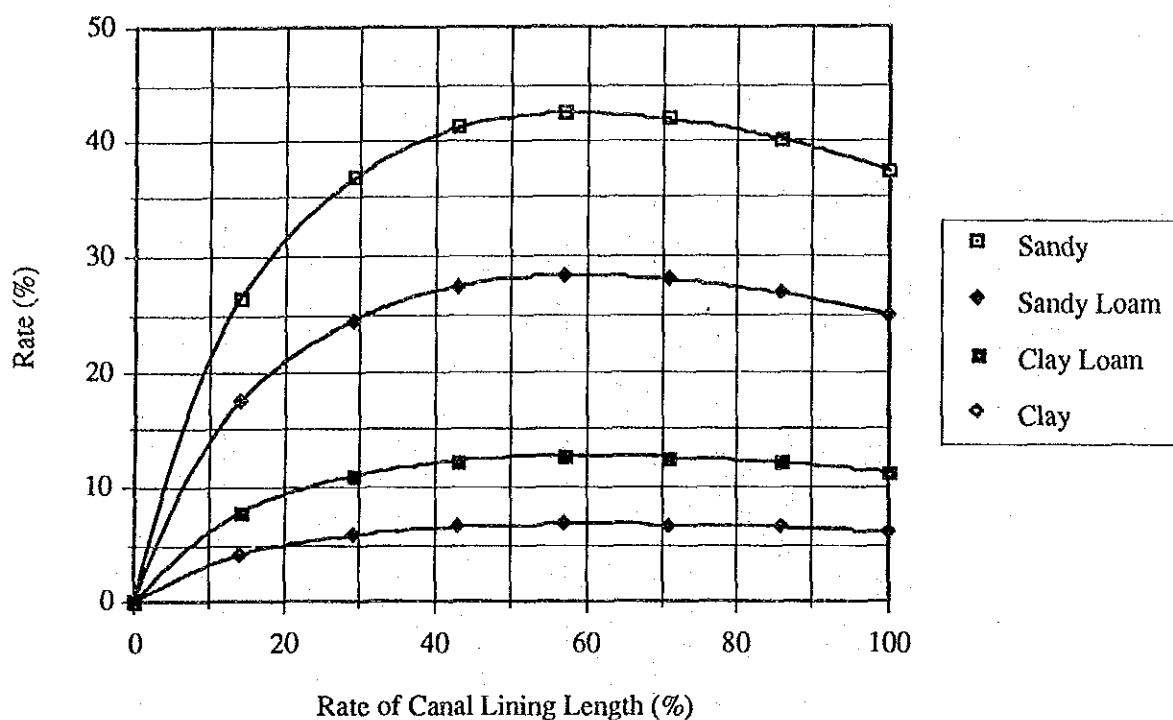
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LEGEND	
□	Sarojini Nagar Study Area
▲	Sataon Study Area
○	Sursa Study Area
◇	Purwa Study Area

Fig. F.30 Effective Rainfall

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Lining Length (m)	Lining Rate (%)	Sandy			Sandy Loam			Clay Loam			Clay		
		Cost (Rs.)	Benefit (Rs.)	Ratio (%)	Cost (Rs.)	Benefit (Rs.)	Ratio (%)	Cost (Rs.)	Benefit (Rs.)	Ratio (%)	Cost (Rs.)	Benefit (Rs.)	Ratio (%)
0	0	7,230	0	0.00	7,230	0	0.00	7,230	0	0.00	7,230	0	0.00
100	14	11,100	2,920	26.31	11,100	1,940	17.48	11,100	860	7.75	11,100	450	4.05
200	29	14,980	5,500	36.72	14,980	3,660	24.43	14,980	1,630	10.88	14,980	860	5.74
300	43	18,850	7,750	41.11	18,850	5,160	27.37	18,850	2,310	12.25	18,850	1,220	6.47
400	57	22,720	9,630	42.39	22,720	6,430	28.30	22,720	2,880	12.68	22,720	1,530	6.73
500	71	26,600	11,130	41.84	26,600	7,430	27.93	26,600	3,340	12.56	26,600	1,780	6.69
600	86	30,470	12,220	40.11	30,470	8,160	26.78	30,470	3,680	12.08	30,470	1,970	6.47
700	100	34,340	12,830	37.36	34,340	8,580	24.99	34,340	3,870	11.27	34,340	2,080	6.06

Note: Above values is estimated by the following conditions:

- Discharge: 14 liter/sec/ha for C.C.A. 40 ha
- Gradient: 1/1,200 for earth canal and 1/2,000 for lining canal
- Rotational Period: 7 days for 7 turnouts
- Total Canal Length: 700 m
- Cost: Rs. 41,770/100 m for lining canal
Rs. 3,920/100 m for earth canal
- Economic Life:

	Economic life	Capital recovery factor
Lining canal	20 years	0.1175
Earth canal	5 years	0.2638
- Incremental Benefit:

Paddy	0.66 Rs/1 m ³ of water	10 watering in one crop season
Wheat	0.93 Rs/1 m ³ of water	4 watering in one crop season

Fig. F.31 Economic Comparison of Lining Extent

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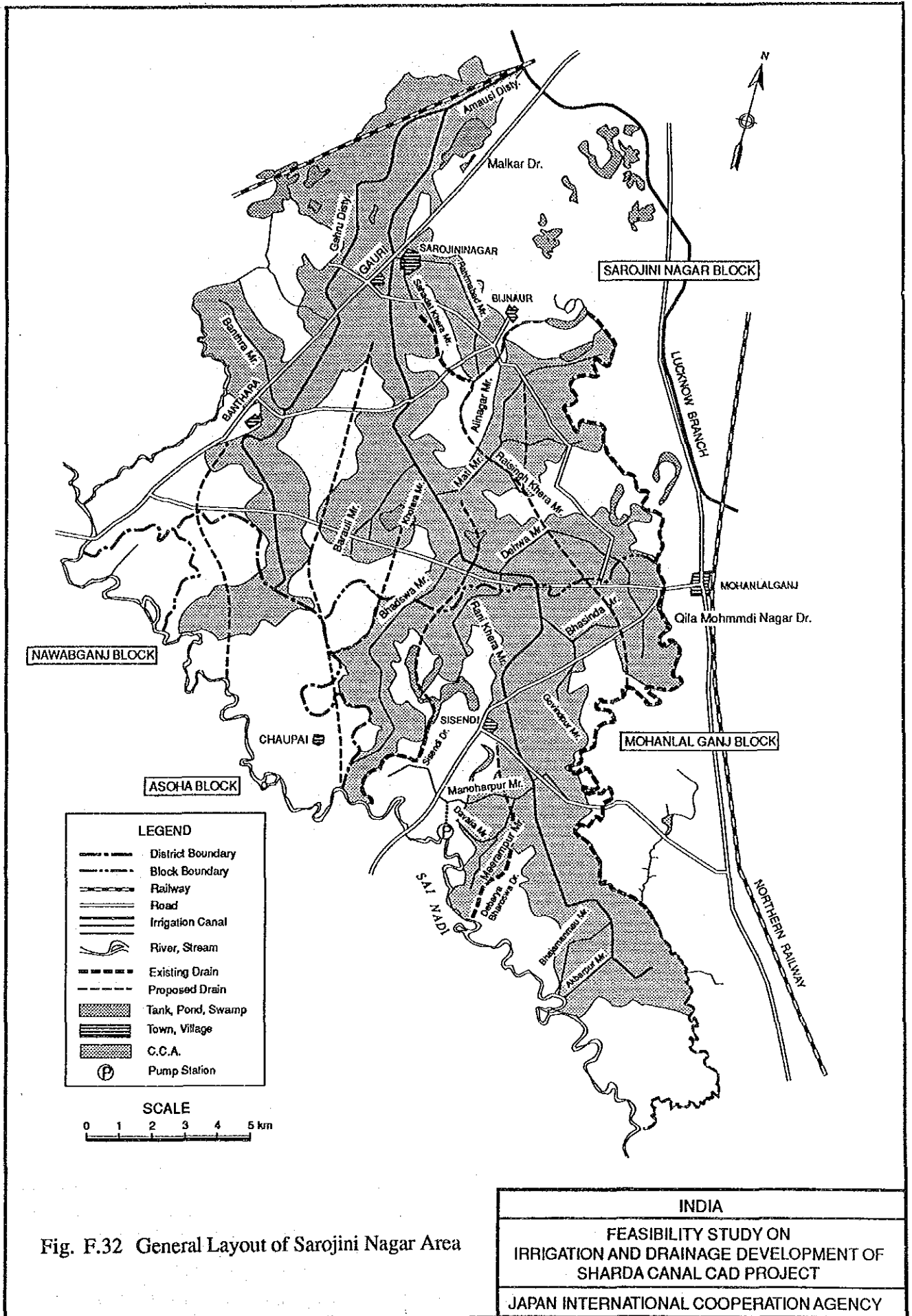


Fig. F.32 General Layout of Sarojini Nagar Area

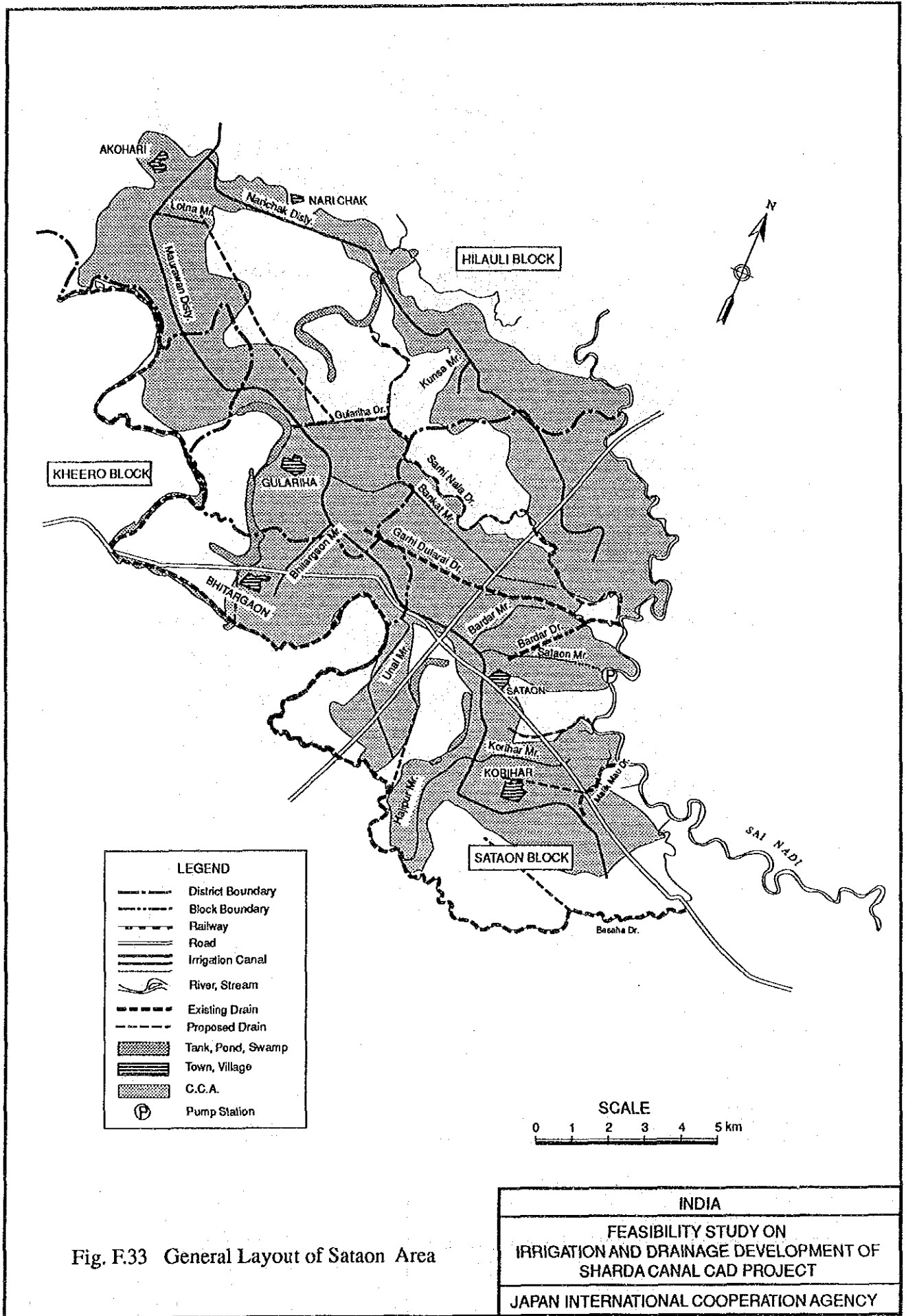


Fig. F.33 General Layout of Sataon Area

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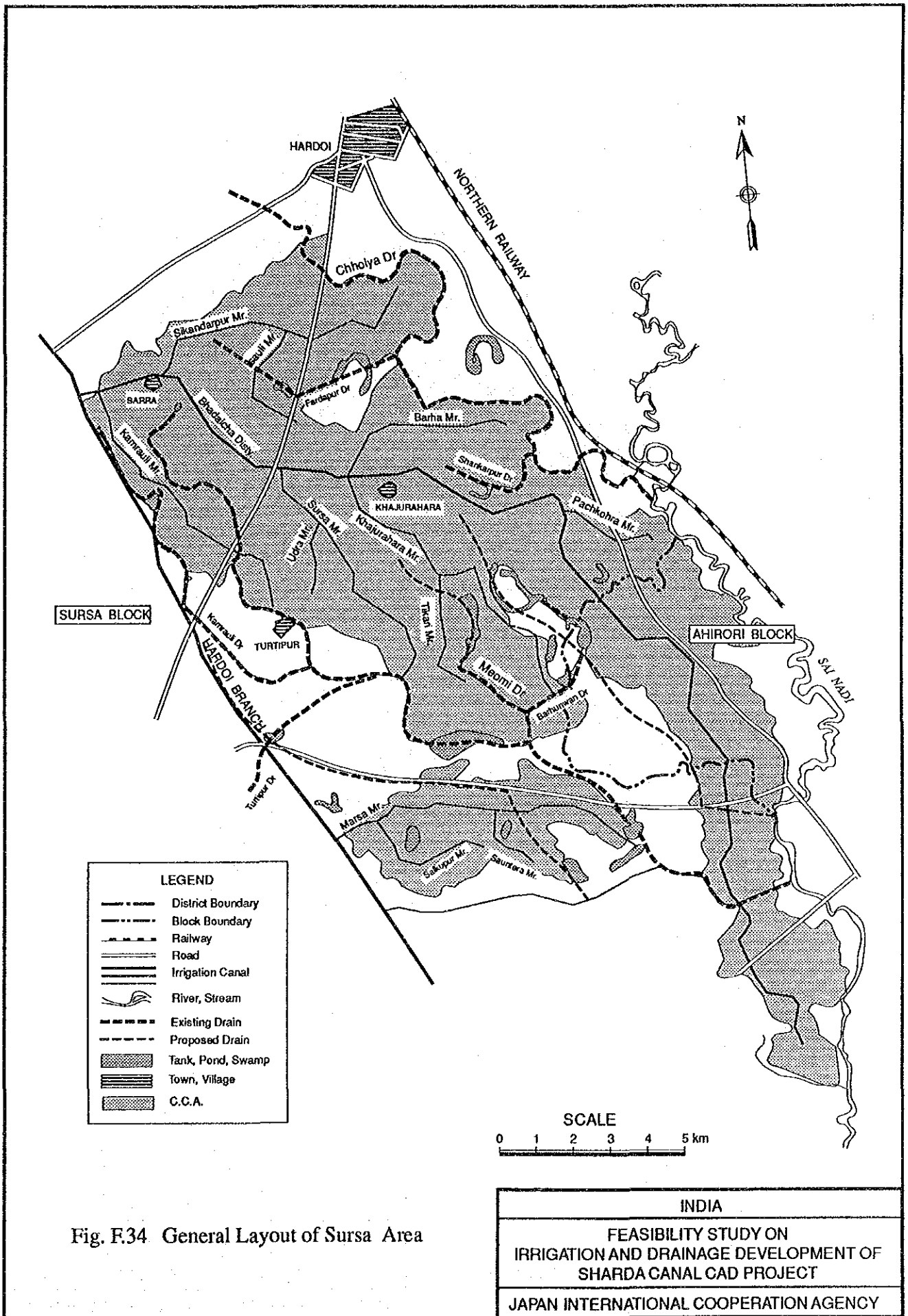


Fig. F.34 General Layout of Sursa Area

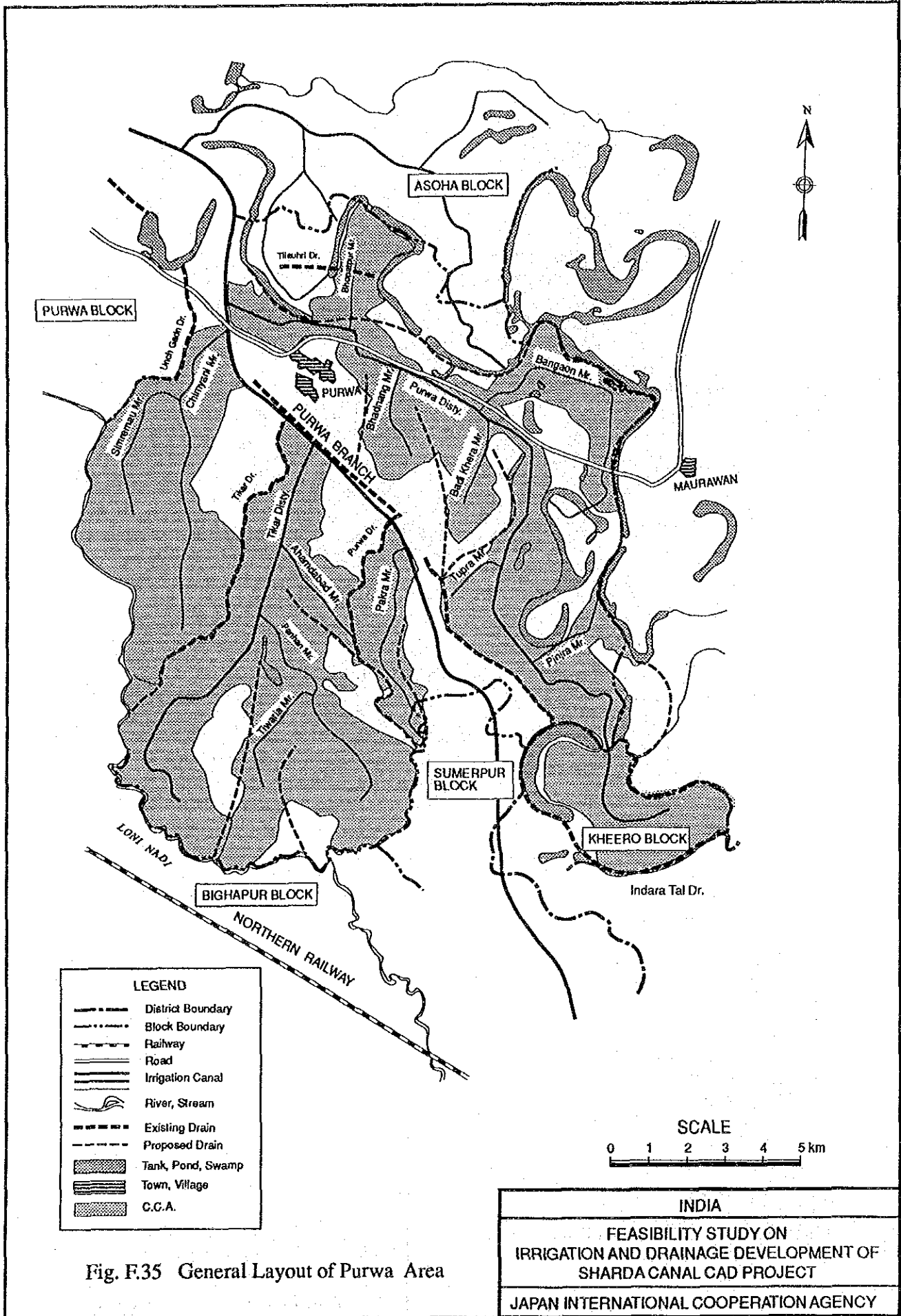


Fig. F.35 General Layout of Purwa Area

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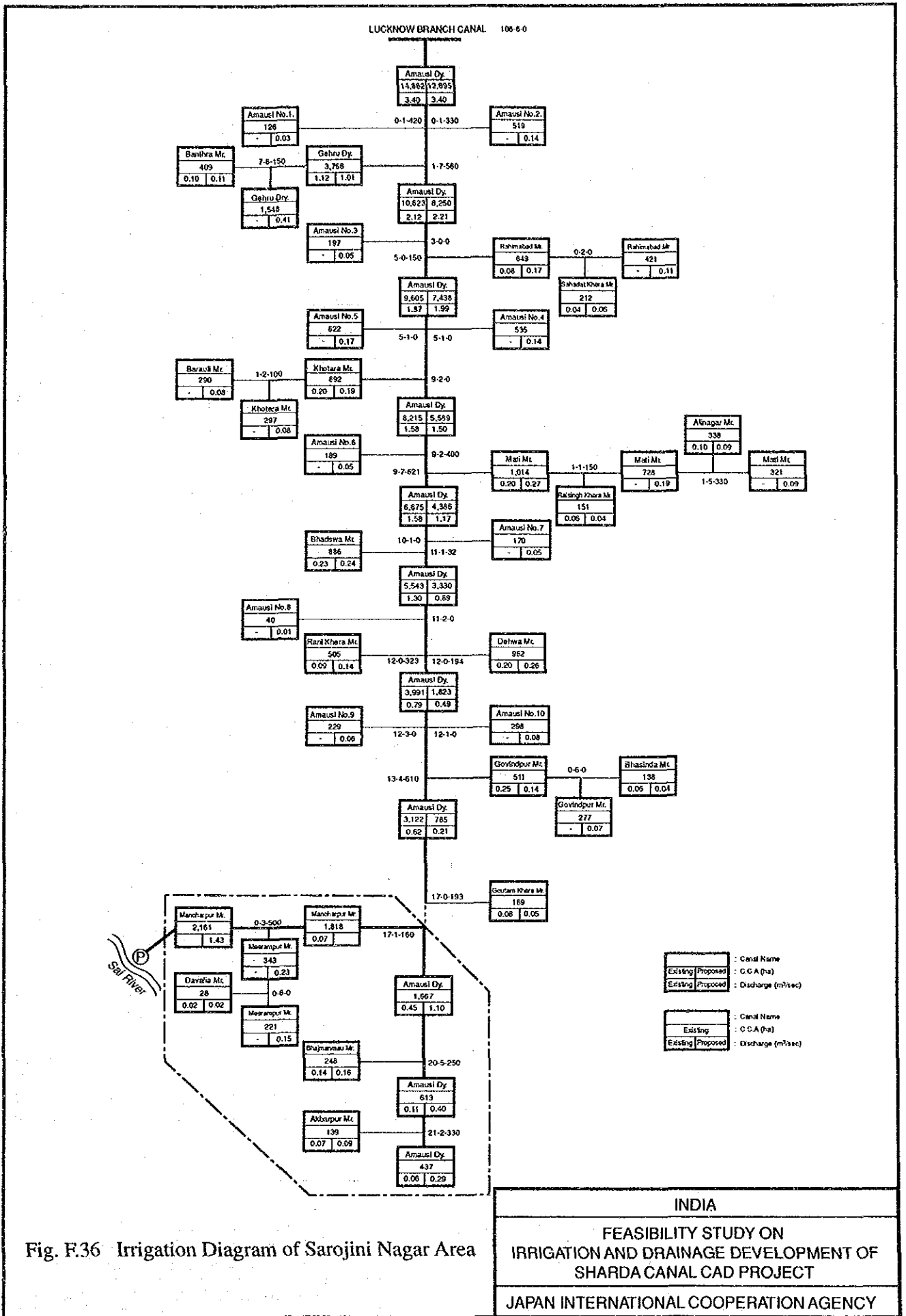


Fig. F.36 Irrigation Diagram of Sarojini Nagar Area

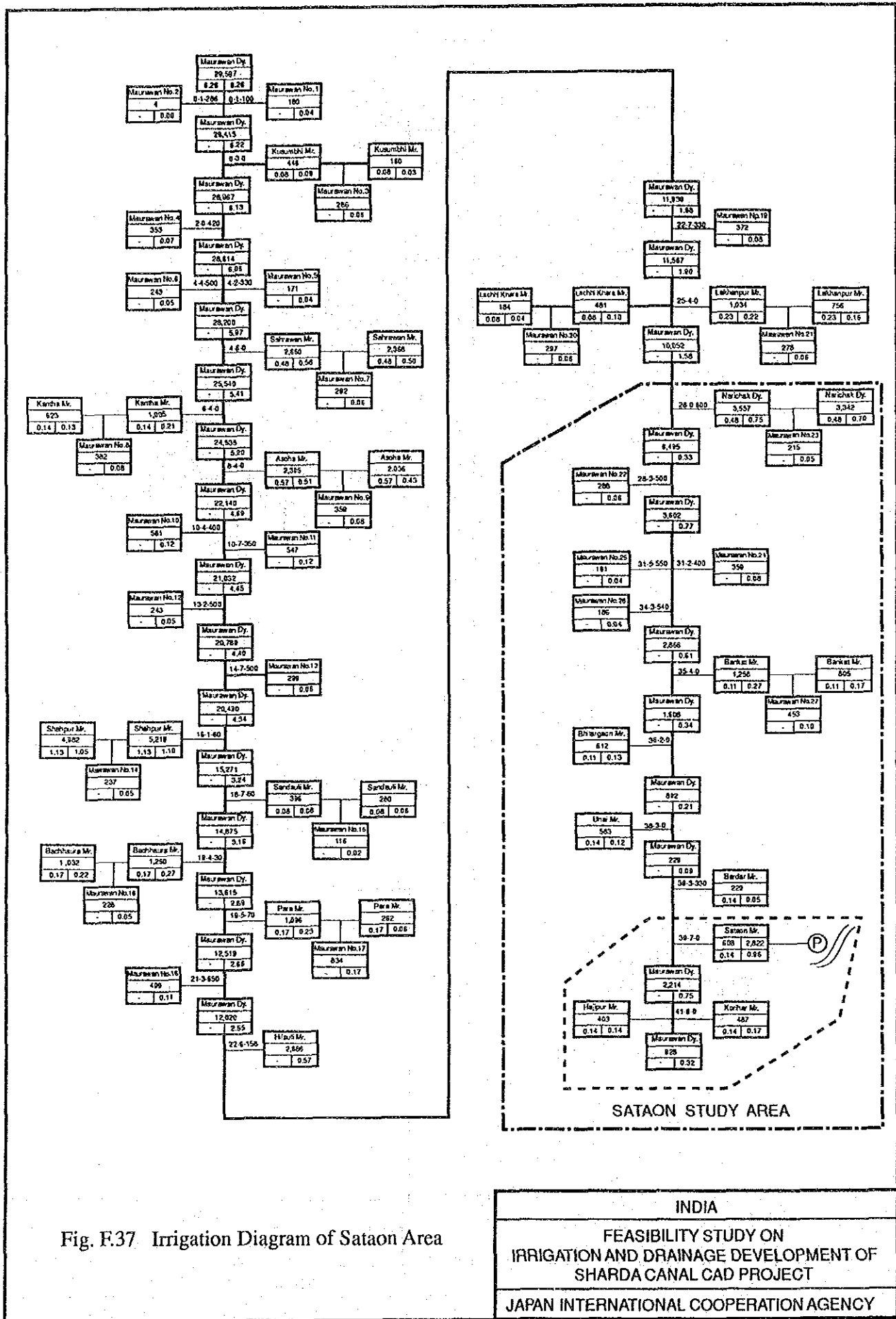


Fig. F.37 Irrigation Diagram of Sataon Area

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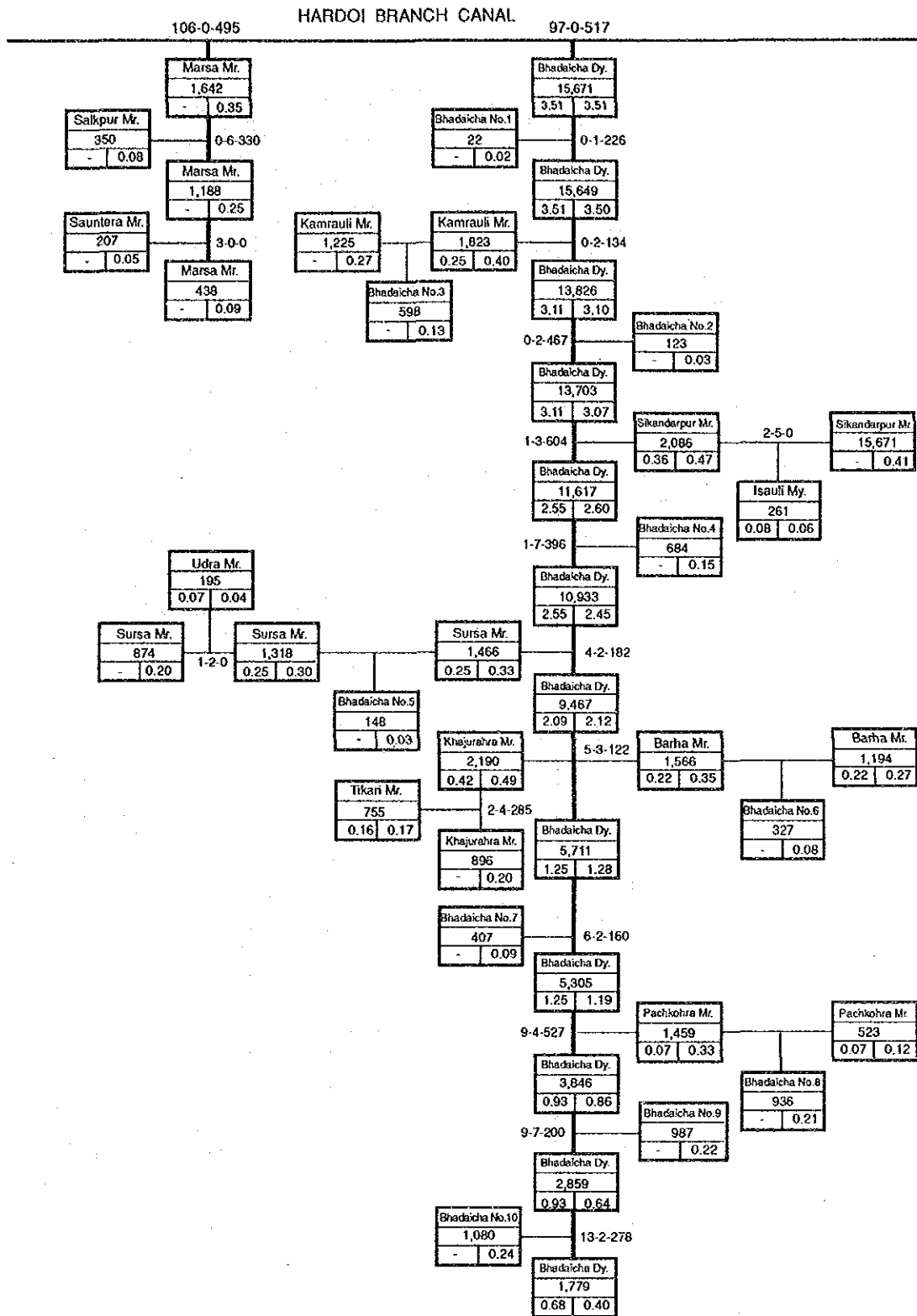


Fig. F.38 Irrigation Diagram of Sursa Area

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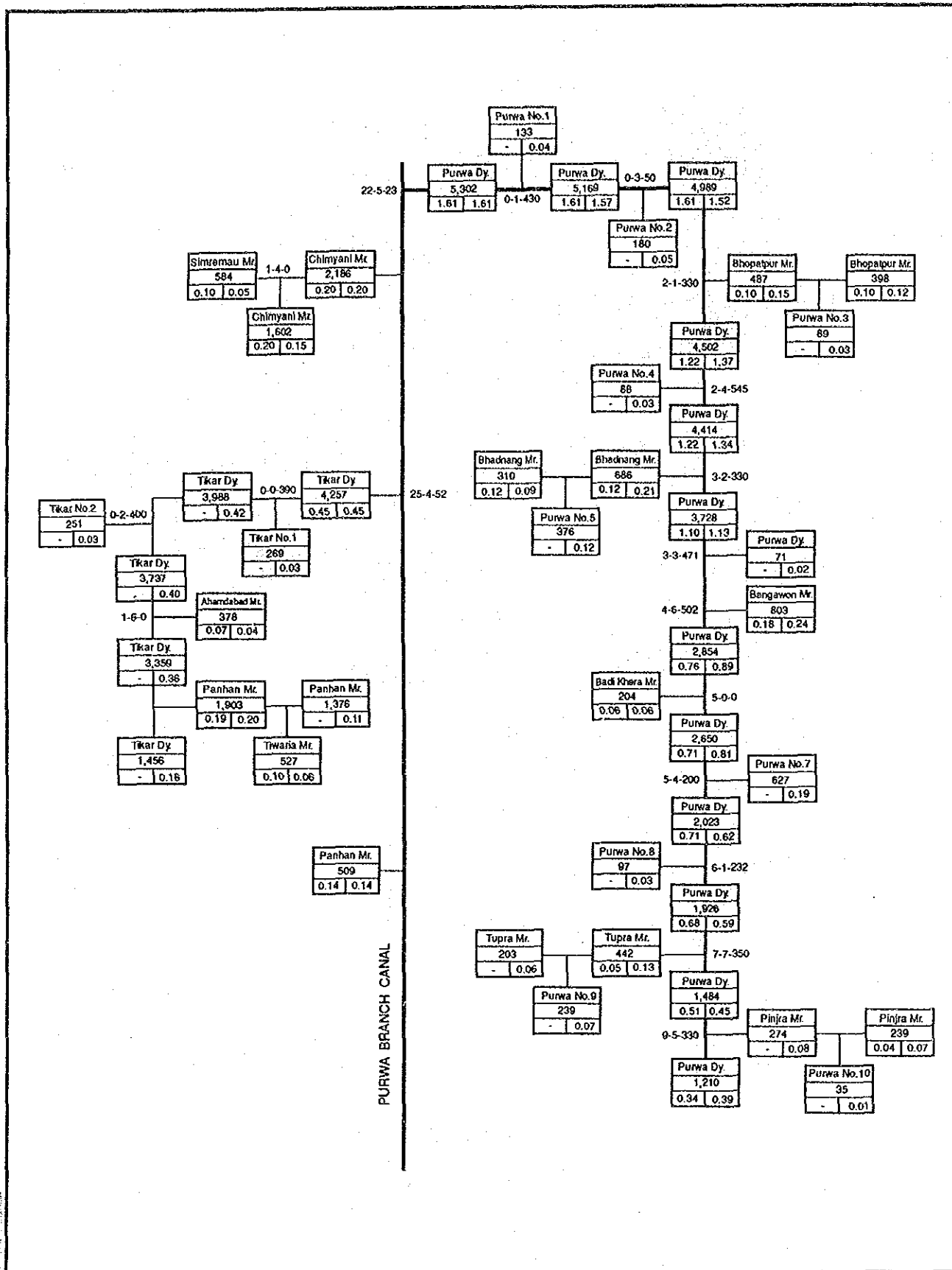


Fig. F.39 Irrigation Diagram of Purwa Area

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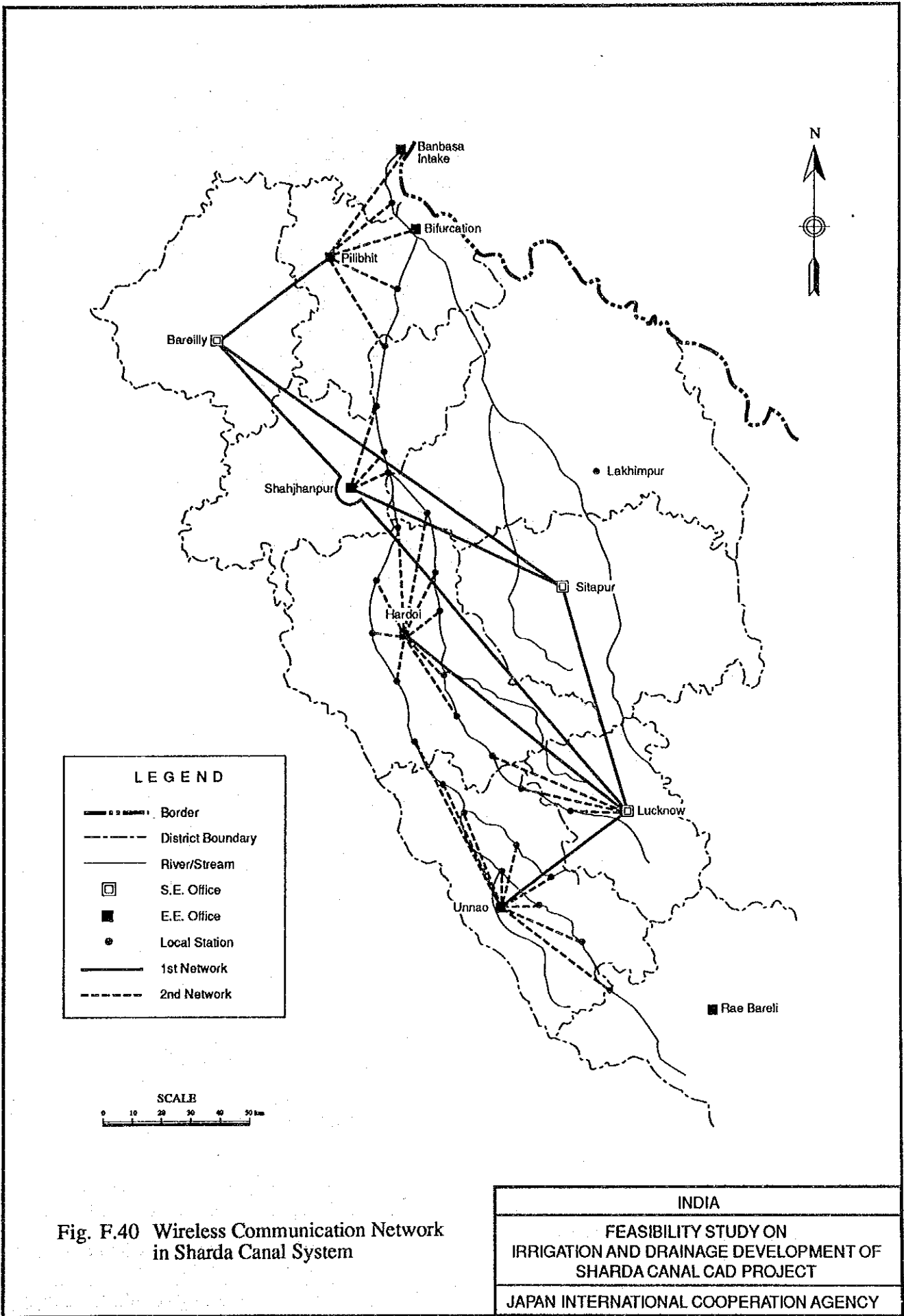
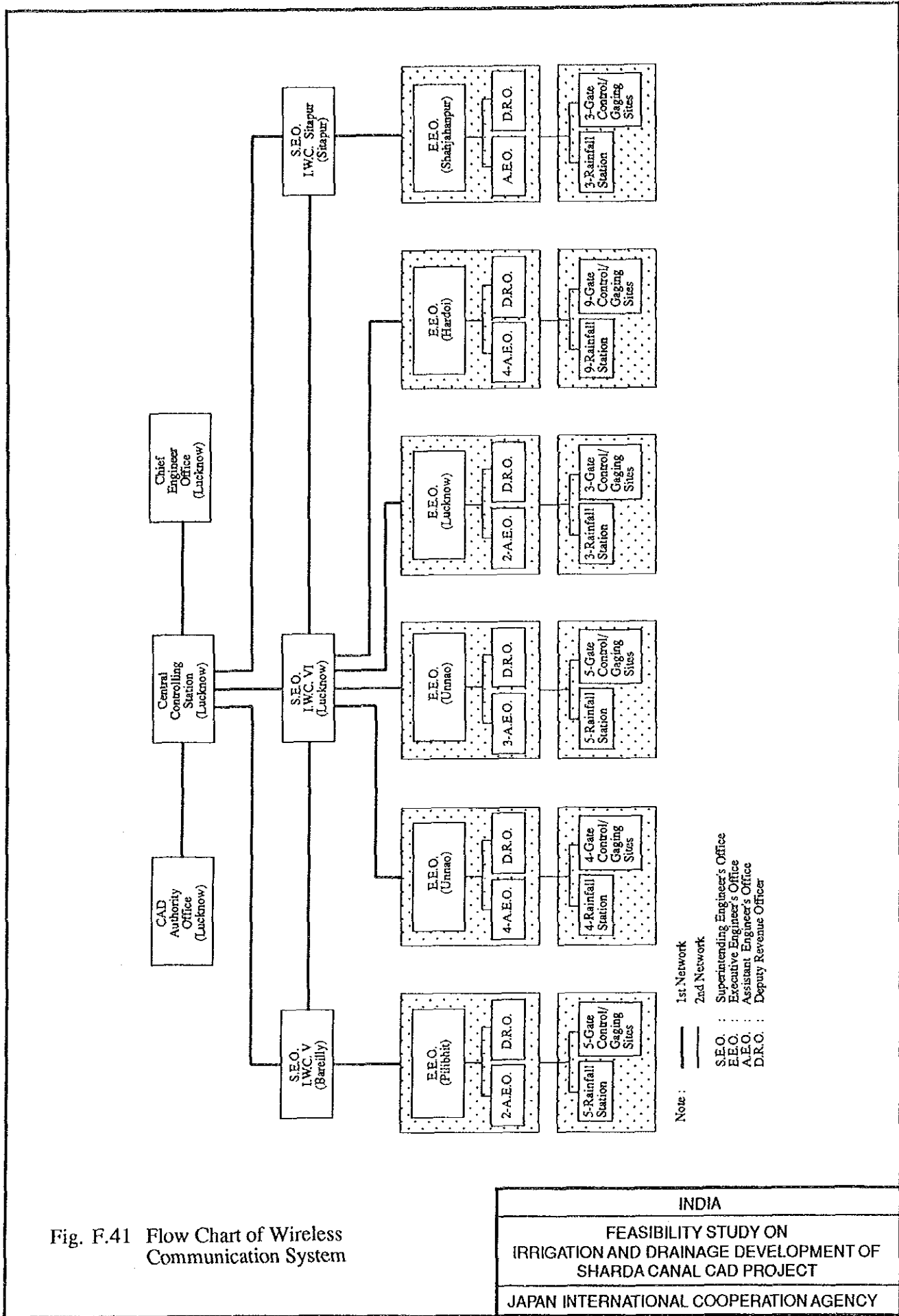


Fig. F.40 Wireless Communication Network in Sharda Canal System



ANNEX-G
DRAINAGE

FEASIBILITY STUDY ON
IRRIGATION AND DRAINAGE IMPROVEMENT OF
SHARDA CANAL CAD PROJECT

ANNEX - G
DRAINAGE

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ANNEX-G DRAINAGE

1. Drainage Condition of the Sharda Canal Command Area

Irrigation canals of the Sharda Canal Command Area run almost north-to-south. Major drainage rivers flow also north-to-south in parallel with major irrigation canals and join the Ganges River.

The Sharda Command Area extends in a vast alluvial plain with elevation of 100 m to 200 m above the Mean Sea Level (MSL) lying between the Ganges River and the Sharda River which flows down along the international boundary with Nepal. The geographical gradient is gentle from north-west to south-east. Surface water in the Area is drained by tributaries of these major rivers.

1.1 Existing Drainage Network

The drainage condition of the Sharda Canal Command Area which is composed of 11 districts, viz., Nainital, Pilibhit, Bareilly, Shahjahanpur, Sitapur, Kheri, Hardoi, Barabanki, Lucknow, Unnao and Rae Bareli. The status is described below.

(1) Poor drainage condition

Poor drainage condition is caused by flat topography to large extent and lack of proper drainage network, which allows precipitation and excessively irrigated water stagnate at tail. Such a condition raises ground water table, which follows waterlogged/marshy condition in the long term. These areas suffer from alkalinity or salinity due to high ground water table and vigorous evapotranspiration in dry season which brings about accumulation of salts on the ground surface. The extent of waterlogged/marshy area by District which is considered to be an index of alkalinity/salinity is reported by the State Government of U.P as shown in the next page.

The extent of salt-affected area, viz., area of alkaline/saline soil which is reported concerning in the Sharda Canal Command shows that District of Rae Bareli, Unnao and Lucknow have more than 10% salt-affected area to the total area. District of Hardoi and Barabanki have 6% salt-affected area as well. Thus drainage condition of downstream area is poorer than that of upstream area.

The above five districts where poor drainage areas are extensively distributed are located on the mid/downstream of the Sharda Canal Command Area. On the other hand, Nainital, Bareilly, Pilibhit, Shahjahanpur and Kheri are located on the upstream portion of the Area where excess water can be drained naturally benefited by desirable topography and soil characteristics.

Name of District	Geographical Area (km ²)	Waterlogged/Marshy Area		Land by Salinity/Alkalinity	
		(ha)	(%)	(ha)	(%)
Nainital	6,794	N.A	-	N.A	-
Pilibhit	3,499	N.A	-	N.A	-
Bareilly 4	,120	N.A	-	18,600	4.5
Shahjahanpur	4,575	N.A	-	21,800	4.8
Kheri	7,680	N.A	-	24,100	3.1
Hardoi	5,989	N.A	-	35,600	5.9
Barabanki	4,401	N.A	-	24,000	5.5
Sitapur	5,743	N.A	-	20,000	3.5
Lucknow	2,528	4,600	1.8	25,600	10.1
Unnao	4,558	12,800	2.8	48,700	10.7
Rae Bareli	4,609	6200	1.3	59,800	13.0

Source : By Remote Sensing Applications Center, U.P.
By Agriculture Department, U.P.

(2) Evaluation of existing drainage network

Density and length of drainage canal by District based on "Drainage Master Plan" by the Irrigation Department of UP are shown in Table G.1. As mentioned above, poor drainage area is distributed to a large extent in the Area, which explains the lack of proper drainage network covering whole Area at present. Comparing density of drainage canal, a tendency can be affirmed that four districts of Hardoi, Lucknow, Unnao and Rae Bareli have bigger density (2.9 m/ha to 1.4 m/ha) than those of other districts. Since extent of poor drainage area is larger in three Districts, it can be estimated that drainage improvement in those Areas has not been conducted successfully due to undesirable topography, ground water table and O&M condition.

1.2 Drainage Characteristics

Paying due consideration to the above-mentioned condition of poor drainage and evaluation of drainage improvement, 11 Districts of the Sharda Canal Command Area were classified approximately into three types as follows and as illustrated in Fig G.1:

Type	Geological Location	Drainage Characteristics	District
I. Upper Land	naturally drained high elevated and coarse soil texture		Nainital, Pilibhit Bareilly, Shahjahanpur, Kheri
II. Middle Land	ill drained, far from drainage canals, surrounded by high land		Sitapur, Hardoi Barabanki, Lucknow, Unnao, Rae Bareli
III. Lower Land	naturally drained, adjacent to river		Part of Unnao, Rae Bareli

Generally, Type II in the Sharda Canal Command Area has gentle gradient of 1/4,000 to 1/8,000, where lack of proper drainage network hampers eliminating excess water brought by irrigation and/or precipitation. This area suffers from serious poor drainage problem that overflow from small rivers and less permeable soil characteristics in conjunction with high ground water table result in expansion of waterlogged/marshy land, salt-affected land, occurrence of diseases, reduction of production, low quality of products, and difficulty of introducing double cropping or farm machinery for higher productivity.

Such poor drainage area should be improved so as to overcome the above-mentioned constraints as much as possible by the following countermeasures:

- improvement of major drainage facilities drainage system itself
- improvement of field drains
- rehabilitation of existing drainage canal

2. Drainage Condition of the Hardoi Branch Command Area

Districts in the Hardoi Branch Command Area which expands over 7 districts are mostly occupied by Type II where poor drainage condition is observed extensively. Drainage condition of the Area is classified as follows;

- Type I : Pilibhit, Shahjahanpur
- Type II : Hardoi, Barabanki, Lucknow, Unnao, Rae Bareli
- Type II : part of Hardoi, part of Unnao, part of Rae Bareli

2.1 Existing Drainage Network

(1) Drainage system

Waterlogged/marshy land where poor drainage condition is the most serious is scatteringly distributed in each District and/or Block. They are extensively distributed; i) on trail of perished river and around swamp, ii) in the area surrounded by irrigation canals, major roads and railways, and iii) along irrigation canal.

Major drainage facilities of the Area have not been arranged systematically and canal alignment does not follow topography as well. Drainage canals are simply connected to river or swamp, and drained water often loses its way to flow down at tail end, which brings about serious poor drainage, waterlogged/marshy land in the long term.

Alignment, length and density of non-artificial drains, existing drainage canals and proposed drainage canal by District/Block are tabulated in Table G.2. District of Hardoi, Lucknow and Rae Bareli where rate of waterlogged/marshy land is bigger have more Blocks with relatively high density of drains.

Existing related structures are composed of various works such as falls, railway crossing, road crossing, siphon, etc. Above all, road crossings malfunction due to silting and drained water often overflows along roads or onto farmland.

2.2 Drainage Characteristics

Most part of Hardoi Branch Command Area is located in the middle/downstream of the Sharda Canal Command Area. Topography is generally flat and drainability is low. Waterlogged/marshy land and salt-affected land are extensively distributed. The Area is divided into three portions viz. Upland (high, small hill), Midland (flatland) and Lowland. Drainage condition in accordance with topographical characteristics is written as follows:

(1) Poor drainage area

Upland is the area adjacent to river, or small hill formed in deposit of perished river, with gentle slope which makes surface drainage easier.

Midland lies in flatland between river, of which ground water table is high and soil permeability is medium. Some portion of Midland has physical constraints against effective

drainage because of long distance from major drainage river or location surrounded by high land. This is reason why waterlogged/marshy land and salt-affected land are distributed extensively in Midland and require proper drainage improvement.

Lowland lies adjacent to ponds and/or lakes surrounded by Midland and is subject to inundation. Here, flood-prone areas adjacent to river course which is included in "Miscellaneous" in land use classification are also regarded as Lowland.

Table G.3 shows; i) rate of Upland, Midland and Lowland to the total area by Block, and ii) rate of waterlogged/marshy land to Midland. Also rate of Midland and waterlogged/marshy land by District are tabulated below, which shows that District of Hardoi, Unnao and Lucknow have relatively high rate of Midland and waterlogged/marshy land. It is desirable to carry out drainage improvement in these three Districts prior to others.

Name of District	Geographical Area (ha)	Midland Area		Waterlogged/marshy Land Area	
		(ha)	(%)	(ha)	(%)
Pilibhit	121,574	75,599	62	794	1.1
Shahjahanpur	138,588	92,896	67	968	1.0
Kheri	47,370	34,100	72	504	1.5
Hardoi	525,500	390,879	74	14,153	3.6
Lucknow	178,058	135,649	76	3,584	2.6
Unnao	458,519	333,738	73	12,783	3.8
Rae Bareli	123,017	87,288	71	1,119	1.3

Furthermore, among the above three Districts, priority of implementation of drainage improvement should be set on Blocks where extent of waterlogged/marshy land in Midland is high. Judging from Table G.3, Blocks which should have high priority for drainage improvement are concentratedly distributed in Hardoi and Unnao District as shown below:

Hardoi	:	6 Blocks
Lucknow	:	1 Block
Unnao	:	4 Blocks

(2) Density of drainage canal in poor drainage area

Drainage canals are aligned in/around poor drainage area where waterlogged/marshy land or salt-affected land exist widely. Density of existing drainage canal in/around waterlogged/marshy land is shown in Table G.4. Density varies Block by Block and 22% of

50 blocks in 7 Districts have particularly low density, most of which have extensively distributed waterlogged/marshy land. Drainage improvement is required for these Blocks but topographical constraints hamper the implementation. On the contrary, Blocks with high density are considered to have high potential for drainage improvement by rehabilitation and/or construction of drainage network.

Name of District	Nos. of Block	Density of Drainage canal	
		(100m/ha<)	(<25m/ha)
Shahjahanpur	4	3 Blocks	-
Hardoi	17	6	5 Blocks
Lucknow	6	1	2
Unnao	16	5	3
Rae Bareli	5	4	1

3. Drainage Conditions of Four Representative Areas

3.1 Existing Drainage Network

Drainage system, schedule of development of catchment area and channel dimensions of drainage canal in Sarojini Nagar Study Area, Sataon Study Area, Sursa Study Area and Purwa Study Area are shown in Fig. G.2 to Fig. G.5 and Table G.5, respectively. Outline of existing drainage canals are as follows:

Study Area	Geographical Area (ha)	Nos. of Canal (Nos.)	Total Length (km)	Canal Density (m/ha)	Total Catchment Area (km ²)	Catchment Rate (%)
Sarojini Nagar	33,488	7	53.6	1.6	111.7	33
Sataon	25,763	6	69.0	2.7	141.6	55
Sursa	32,269	9	84.8	2.6	213.5	66
Purwa	20,828	6	44.2	2.2	99.1	48

Remarks: Density=Length as m/ha of Geographical Area
Catchment Rate=Catchment Area as % of Geographical Area

The above features show that drainage density of four Areas is low, and benefited area is only half of total area. Thus drainage system is not effectively distributed in the Study Area, which causes water logging/marshy condition, flood and usar problem.

Major drainage streams and drainage condition by Study Area are as follows:

(1) Major Drainage Stream

Major drainage streams for the Study Area are the Sai River and the Loni Nadi, which drain surface water outside the Area up to the Ganges River. Among four Study Areas, Sursa Study Area, Sarojini Nagar Study Area and Sataon Study Area are located from north to south in the Sai River Basin. Purwa Study Area is located in the Loni Nadi basin, and summary of the Sai River and the Loni Nadi are shown below.

1) Sai River

- a) Total length of river ; $L=760$ km
- b) Total catchment area ; $A=12,850$ km²
- c) Details of gauge discharge point

Location of point ; Unnao District, Orais Block

Catchment area ; $A=1,950$ km²

Bottom level of river ; $EL=117.51$ m

Maximum water level & discharge in last 5 years

1985	H.W.L=124.16 m,	$Q=182.00$ m ³ /s	(17.10.85)
1986	H.W.L=123.74 m,	$Q= 63.00$ m ³ /s	(21. 7.86)
1987	H.W.L=120.16 m,	$Q= 9.96$ m ³ /s	(6. 1.87)
1988	H.W.L=123.67 m,	$Q= 22.86$ m ³ /s	(16. 8.88)
1989	H.W.L=120.98 m,	$Q= 10.68$ m ³ /s	(20. 9.89)

2) Loni Nadi

- a) Total length of river ; $L=156$ Km
- b) Total catchment area ; $A=1,180$ km²
- c) Details of gauge discharge point

Location of point ; Rae Bareli District, Perialipur Block

Catchment area ; $A=1,114$ km²

Bottom level of river ; $EL=92.92$ m

Maximum water level & discharge in last 4 years

1986	H.W.L=100.20 m,	$Q=109.89$ m ³ /s	(20. 8.86)
1987	H.W.L= 96.16 m,	$Q= 15.99$ m ³ /s	(20.10.87)
1988	H.W.L= 99.30 m,	$Q=101.00$ m ³ /s	(15. 8.88)
1989	H.W.L= 97.74 m,	$Q= 68.44$ m ³ /s	(18. 9.89)

d) Planning of channelization in the Loni Nadi

The total length of Loni Nadi is 156 km. It starts from Makhi in District Unnao and it joins to the Ganges River in Rae Bareilly. Some parts of channelization were done by the Irrigation Department U.P. in 1956/57 and in 1984/85. A few years after completion, it was experienced that the drain was not functioning satisfactorily due to tight section below 94 km. Accordingly it was decided that natural drain should be further channelized from 94 km to 61 km in a length of 33 km.

Planning of channelization is composed of three-stage programme. This construction was supervised by Irrigation (Sharda) Division Unnao. The work started in the year of 1989 by stage and works on the third and the fourth stage were completed in the year of 1989/1990. The fifth stage under construction at present will be completed by June, 1991.

The channelization of this drain will relieve waterlogging and flood in the neighboring areas. This work will be done by manual labour.

It is assumed that channelization is not necessary below 61 km because of sufficient draining capacity of that section against designed discharge of 1,775 cusec.

(2) Sarojini Nagar Study Area

Sarojini Nagar Study Area is located in the north of the Sai River which flows from west to south of the Study Area. Artificial drains connected to the Sai River are few. There are seven artificial drains at present with total length of 53.6 km. Drainage network has not been improved yet. Particularly the middle portion and west portion of the Area suffer from poor drainage condition. Thus intruding water gathers nearby the Sai River and causes extensive flood.

In the east of the Area, Quila Mohammed Nagar, main drainage canal of the Area flows southward and joins the Sai River. Lower reach of the drain has not been improved by 12 km up to confluence to the Sai River.

(3) Sataon Study Area

Sataon Study Area is surrounded by the Sai River (north and east) and Basaha Drain (south and west). Intruding water flows down to the Sai River and Basaha Drain which is minor river flowing through Basaha Depression to the Sai River with total length of 77 km and catchment area of 479 km². Draining capacity of this drain has seriously deteriorated and flood prone area spreads over its catchment, i.e., west portion of the Area. Drainage improvement is under construction at present.

Existing six drains stretches 69.0 km in total, in which Basaha Drain occupies large extent. On the other hand, no branch drain is connected to Basaha Drain itself. This is considered to be the main reason of flooding and waterlogging and/or marshy condition in the middle and the west of the Study Area.

Existing drains which are connected to the Sai River generally cover small drainage area.

In this area Basaha Drain Plan has been executed. The total length of Basaha Drain is 137 km. Four Blocks, Hasanganj, Nawabganj, Asoha and part of Sataon Study Area lie in Basaha Depression and have been seriously affected every year by waterlogging. Accordingly, natural stream should be improved. The survey was done for 48 km of downstream stretch from the Sai River by Investigation and Planning Division of Irrigation Department, Lucknow. Construction was started in 1986 and will be completed by 1997. This work being done by few machines, length of only 3 km can be completed every year.

(4) Sursa Study Area

Hardoi Branch Canal runs southward in the west of the Area. The Sai River, main drainage of this Area flows southward too in the east boundary. Intruding water is drained up to the Sai River through two main drainage canals and Parchal Escape which is located in the down-most reach of the Study Area. Drainage system is distributed relatively well, and benefited area of drainage is large. Flood-prone area is not much due to sandy textured soils in the upper to middle reach. On the contrary in the middle to lower reach, particularly along Hardoi Branch and Marsa Distributary, waterlogging, usar and/or marshy area lie extensively, where intensive drainage system is required.

The total length of existing nine stretches of drains inclusive of Parchal Escape is 85 km. Main drains run to the Sai River along eastern and western edge of the Area catching

surface water from their branch drains. Drainage canals are systematically aligned except middle to lower reach where waterlogging/marshy and usar problem are serious. Capacity of drains along Hardoi Branch have deteriorated, which causes poor drainage and marshy condition.

(5) Purwa Study Area

Purwa Study Area is sandwiched by the Loni Nadi in the west and Basaha Depression in the east. Purwa Branch is the principal irrigation system of this Area. Intruding water to left bank of Purwa Branch flows down to the Loni Nadi and that of the right bank to Basaha Depression. Since drainage improvement has not been conducted properly, flood-prone area expands to large extent. Flooding water from Basaha Depression is drained through Basaha Drain which has insufficient capacity in rainy season, which results in inundation of lower Blocks viz., Sataon Study Area. Number of existing drains is six, of which total length is 44.2 km. Out of five lines of drains, three lines are connected to the Loni River of which lower portions have not been improved. Drains along Purwa Branch Canal is sandwiched by 5 km by maintenance road of the Branch and farm road, which hampers proper drainage. Also on the left bank of Purwa Branch, no drainage improvement has been done. Thus in this Area, poorly improved drainage system causes waterlogging and usar as well as flood-prone condition.

3.2 Waterlogging and Marshy Areas

Distribution of waterlogging/marshy area in four Study Areas is shown in Tables G.6 to G.10 and Figs. G.6 to G.9. Also condition of waterlogging/marshy by Block, and distribution of water logging/marshy land in the Study Areas are shown below.

Study Area	Geographical Area (ha)	Waterlogging/ Marshy Area(*1)		Waterlogging/ Marshy Area(*2)	
		(ha)	(%)	(ha)	(%)
Sarojini Nagar	33,488	1,169	3.50	2,268	6.8
Sataon	25,763	1,118	4.34	915	3.6
Sursa	32,269	1,204	3.73	1,991	6.2
Purwa	20,828	933	4.48	1,256	6.0

Source: *1: Milan Khasra (1986-1989)

*2: Remote Sensing Applications Center, U.P. (1991)

Rate of Waterlogging/Marshy Area by Village

Rate of W/M Area (%)	Sarojini Nagar		Sataon		Sursa		Purwa	
	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)
0 - 1	6	4.96	2	0.27	7	4.29	7	4.59
1 - 4	58	65.35	27	39.98	49	65.52	49	55.17
4 - 7	20	20.30	13	58.99	23	24.90	18	21.98
7 - 10	10	8.37	0	0.00	5	5.09	8	14.14
10 <	1	1.04	1	0.76	1	0.20	4	4.36
Total	95	100.00	43	100.00	85	100.00	86	100.00

Remarks: Rate=Area of Villages expressed in percentage to geographical area

Waterlogging/marshy area occupies 3.6 to 6.8% of geographical area. The percentage is higher in Sarojini Nagar Study Area. Village-wise data show that percentage of waterlogging/marshy area is mostly below 4% in each Study Area.

In Purwa Study Area, ground water table is shallow (about 2m) and consequently the percentage of such area is higher. Outline of the Study Areas is written below.

(1) Sarojini Nagar

Waterlogging/marshy areas occupy 6.8% of total area. They are distributed widely in the middle of the Area and along the Sai River. Extensive distribution of waterlogged/marshy areas is generally observed in area where drainage system is not improved.

(2) Sataon

Waterlogging/marshy areas are extensively distributed over 3.6% of total land. In upper portion of the Area and along the Sai River, not only waterlogging/marshy area but also salt affected land so called "usar" is predominant.

(3) Sursa

Comparing to Purwa and Sataon Area, waterlogging/marshy lands occupy a little bit less area, 6.2% of total area, but they are concentrated in following three areas;

- along Hardoi Branch Canal,

- middle portion of the Area, along lower reach of Khajurahra Minor and Tikar Minor, and
- lower portion along Marsa Distributary.

(4) Purwa Study Area

Waterlogging/marshy areas occupy 6.0% of total area, which is the highest value among the four Study Areas. This Area is characterized by extensive distribution of waterlogging/marshy area, which is caused by poorly improved drainage system and shallow water table based on clayey soil profile. Waterlogging/marshy area can be seen along Purwa Branch and in Basaha Depression which is located in the east of Purwa Branch. "Usar" is also found in these areas.

3.3 Drainage Characteristics

Distribution of flood-prone area and usar are shown in Tables G.11, G.12 and Figs. G.10 to G.17.

Condition of flooding, salt-affected area and usar are as follows.

Study Area	Geographical Area (ha)	Flooding(*1) Area		Salt Affected(*3) Area		Usar(*2) Area	
		(ha)	(%)	(ha)	(%)	(ha)	(%)
Sarojini Nagar	33,488	11,599	34.64	5,214	15.6	992	2.96
Sataon	25,763	16,413	63.70	1,423	5.5	640	2.48
Sursa	32,269	2,069	6.41	2,317	7.2	817	2.53
Purwa	20,828	15,990	76.77	3,080	14.8	669	3.21

Source: *1: Milan Khasra (1986-1989)

*2: Milan Khasra (1989)

*3: Remote Sensing Applications Center, U.P. (1991)

Rate of Flooding Area by Study Area

Rate of Flooding Area (%)	<u>Sarojini Nagar</u>		<u>Sataon</u>		<u>Sursa</u>		<u>Purwa</u>	
	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)
0-20	19	15.44	13	10.91	79	98.18	4	4.61
20-40	42	60.67	5	4.56	2	0.70	0	0.00
40-60	16	15.27	4	25.67	4	1.12	1	0.19
60-80	6	2.45	7	9.98	0	0.00	43	37.12
80-100	12	6.17	14	48.88	0	0.00	38	58.08
Total	95	100.00	43	100.00	85	100.00	86	100.00

Note: Rate=Area of villages expressed in percentage to geographical area

Rate of Usar Area by Study Area

Rate of Flooding Area (%)	<u>Sarojini Nagar</u>		<u>Sataon</u>		<u>Sursa</u>		<u>Purwa</u>	
	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)	Nos. of Village (Nos.)	Rate (%)
0 - 1	56	58.94	36	74.20	58	61.12	39	43.99
1 - 4	14	16.61	3	7.92	17	20.19	21	29.58
4 - 7	9	9.13	0	0.00	3	5.96	19	16.89
7 - 10	2	1.74	2	5.38	2	3.86	2	3.03
10 <	14	13.60	2	12.50	5	8.87	5	6.51
Total	95	100.00	43	100.00	85	100.00	86	100.00

Note: Rate=Area of villages expressed in percentage to geographical area

Extensive flooding areas are distributed in poor drainage area, they are;

- Entire Purwa Study Area,
- Middle and west portion of Sataon Study Area, and
- Along the Sai River close to Sarojini Nagar Study Area where intruding water gathers.

Percentage of flooding area in Sursa Study Area is 6.4% which is less than those of other Areas. In this Area, topographic condition is comparatively desirable for surface drainage and excessive surface water can be eliminated in short period through two main drains which are connected to the Sai River. Close correlation can be observed between distribution of waterlogging/marshy area, salt affected area and usar area. In terms of location, usar is distributed widely around waterlogging/marshy area, where drainage is not

improved well. Within the Study Area, salt affected area and usar are extensively distributed in;

- middle part of Sarojini Nagar Area,
- west part of Sataon Study Area
- along Hardoi Branch and southern part of Sursa, and
- northern and eastern part of Purwa Study Area where ground water table is shallow.

Outline of each Study Area is written below.

(1) Sarojini Nagar Area

In the center of the Area, main drainage channels joining the Sai River which flows along southern boundary of the area as the main drainage have not been constructed. Thus excessive surface water into the Area gathers and stagnates around depression near the Sai River, which brings about extensive flood-damaged areas. Also waterlogged/marshy area and salt-affected area widely spread in the center of the area, where "usar" is seen to large extent. The main constraint being lack of proper drainage system, these poor drainage lands in the CAD area will be drastically improved by arrangement of proper drainage facilities.

(2) Sataon Area

In the center and western part of the Area, flood-prone areas distribute widely by 64% of the whole Study Area due to lack of adequate drainage system and remaining water of flood, which brings about waterlogged/marshy and surrounding salt-affected area. "Usar" is widely observed in/around these area, but less distributed comparing to other three Areas benefited by high permeability of soils and low ground water table. Drainage network connected to the two main drains is required to be constructed for mitigating flood damage of this part. In the eastern part of the Area, excessive surface water is drained properly to the Sai River or the Basaha Drain, so drainage condition is comparatively good.

(3) Sursa Area

Flooding damaged area is less distributed to the extend of 6.4% of the Study Area benefited by flowing condition. i) topography, ii) flood water is drained in a short term to the Sai River through the two main drainage channels which run in this area from north to south, and iii) this Study Area is located near-by upper stream reach the Sai River.

Waterlogging/marshy and salt-affected area spread widely along middle to down stream of the Sai River and Hardoi Branch. "Usar" is distributed as extensively as other Area and in CAD area as well. Drainage is not constructed around the middle and down stream of the Sai River and drainage channels along the Hardoi Branch do not function well, which bring about poor drainage area. Drainage improvement by means of surface drains is not feasible judging from following reasons and improvement in conjunction with sub-surface drains and shallow tubewells is desirable.

- Waterlogged/marshy and salt-affected area are located in the area where ground water table is shallow by 2m or less and salt-affected area is estimated to increase.
- Countermeasure against seepage from Hardoi Branch.

(4) Purwa Area

Purwa Area is divided into two parts by Purwa Branch which runs in the center of the Area. Flood water is drained to Basaha Drain in the north-east part of the Area, while the Loni Nadi drains excessive water in the south-east part. However, existing drainage facilities have deteriorated and are not improved properly, which brings about flooding area of 77% of the geographical area.

Waterlogged/marshy area is distributed widely in the area of no drainage improvement, particularly in CAD area. Improvement of the Loni Nadi and Basaha Drain has been planned so far by Irrigation Department of UP and is under construction now. Flood damaged and waterlogged/marshy area in Kharif will be improved to large extend by this drainage improvement.

In this Study Area, area of shallow ground water table is widely spread and salt-affected area is supposed to expand more due to waterlogged/marshy condition. Consequently, drainage improvement plan should be proposed to introduce sub-surface drains aiming at prevention of salinity and soil amendment.

4. Improvement Drainage Plan

4.1 Basic Concept of Drainage Improvement

(1) Benefited area of drainage improvement

Improvement of present condition of poor drainage, salinity and crops productivity are expected much according to establishment of drainage system composed of construction and improvement of major drains and field drains.

Proposed area of drainage improvement is supposed to be the whole area of each Study Area, which aims at intensive drainage improvement in CCA.

Study Area	Geographical Area		Drainage Area		C.C.A		Waterlogged/ Marshy Area		Waterlogged/ Marshy Area in C.C.A	
	(ha)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	
Sarojini Nagar	33,488	25,552	76.3	14,862	58.2	2,286	8.9	1,213	53.1	
Sataon	25,763	19,687	76.4	12,824	65.1	278	1.4	181	65.1	
Sursa	32,269	25,062	77.7	17,313	69.1	2,053	8.2	859	41.8	
Purwa	20,828	22,485	108.0	12,252	54.5	1,140	5.1	745	65.4	

(2) Improvement Plan of Drainage River

Main drainage river in Study Areas are the Sai River (total length is 760 km, catchment area is 12,850 km²) and the Loni Nadi (total length is 156 km, catchment area is 1,180 km²), which flow into the Ganges River. Draining area of two rivers occupies 38% of Hardoi Branch Command, of which 39% of waterlogged/marshy area spreads in the basin of two rivers. Flooding area will be reduced much by improvement of the Sai River, the Loni Nadi and drainage system in the Areas, which will also reduce waterlogged/marshy areas.

Irrigation Department of UP proposed improvement plan for the two river. Construction for the Loni Nadi for the length of 33 km along which Purwa Study Area lies has been started. Maximum normal flow was estimated by non-uniform analysis using proposed cross-section of the two rivers. Judging from the result, improvement plan was determined as follows.

- Loni Nadi has enough capacity for 5-years flood discharge and excessive surface water from drainage channel can be drained to the Loni Nadi. Consequently, the improvement plan for the Loni Nadi is not required.
- The Sai River is the main drainage river for Sursa, Sarojini Nagar and Sataon Study Area with length of 760 km and meandering river course. Results of analysis show local overflow, accordingly smooth draining of flooding water within the Area will not be carried out. Improvement plan of this river will be proposed based upon in-depth flood analysis with proper data.

Thus drainage improvement plan should be proposed aiming at; i) avoiding waterlogged followed by salinity, ii) timely planting of Kharif crops, as well as iii) draining flooding water within the Area.

(3) Improvement Plan of Drainage Work

Purposed of drainage improvement is; i) establishment of drainage system which is connected to main drainage rivers to get rid of rain water and superfluous water smoothly, ii) reduction of waterlogged/marshy area, and iii) avoidance of salinity. Basic concept of drainage improvement plan is summarized as follows.

1) Main drainage Channels and Branch Improvement Plan

- Improvement or construction of main drainage channels.
- Improvement or construction of branch drain which connect field drain to main drainage channel.
- Enlargement of flow capacity of allied drain.
- Rehabilitation or Improvement of facilities under poor condition.

2) Sub-surface Drainage Plan

- Demonstration of drainage improvement by introduction of sub-surface drainage in the pilot farm aiming at soil amendment of poor drainage area and reclamation of waterlogged and saline area.
- Drainage improvement by means of sub-surface drains as a countermeasure against seepage from irrigation channel.
- Ground water development aiming at sufficient irrigation and improvement of waterlogged and saline area.

4.2 Flood Analysis of the Sai River and the Loni Nadi

(1) Flood in the Study Area

As shown in Fig.G.18, the main drainage river of the Study Area is the Sai River and the Loni Nadi through which surface water is drained up to the Ganges River. Flood in the Study Area mostly originates from these rivers during the period of intensive rainfall in Kharif season.

The Maximum flood of the Sai River recorded in the recent at Auras in Unnao District in October 1985 was 182 cumec, while that of the Loni Nadi was 109.9 cumec recorded at Perialipur in Rae Bareli District in August 1986. Return period of these floods is estimated 1 in 5 years.

Extent of waterlogged/marshy area is shown Table G.13. About 39% of waterlogged/marshy area is distributed in the basin of these two rivers, which suggests that construction and improvement of main drainage canals, the Sai River and the Loni Nadi will mitigate flood damage in the Area to large extent, followed by decrease of waterlogged.marshy area.

(2) Design Flood Discharge

Discharges are gauged for the Sai River and the Loni Nadi. The maximum discharges in the recent five years (1985-1990, shown in Table G.14 and Figs. G.19, G.20) which are equivalent to flood of 1 in 5 year were adopted as design flood discharges for estimating high water level of the river by non-uniform flow calculation.

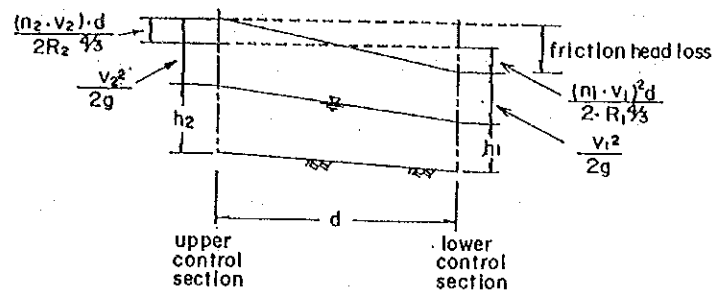
(3) Flood Analysis of the Sai River and the Loni Nadi

Flood analysis was conducted according to following procedure.

- Flood discharge (the maximum discharge in the recent five years)
- Flood routing (by non-uniform flow calculation)
- Check of the existing main drainage canals

Non-uniform flow calculation for estimating high water level was based upon following equation for computing energy of non-uniform flow. The calculations was carried out one by one from cross-section of downstream stretch.

$$h_1 + \frac{E_1 v_1^2}{2g} + \frac{(n \times v_1)d}{2 \times R_1^{4/3}} = h_2 + \frac{E_2 v_2^2}{2g} - \frac{(n \times v_2)^2 d}{2 \times R_2^{4/3}}$$



- h_1, h_2 ; water level (m)
 v_1, v_2 ; velocity (m/s)
 n ; coefficient of roughness
 R_1, R_2 ; hydraulic mean depth (m)
 d ; distance (m)
 E_1, E_2 ; coefficient of energy

(4) Results of Analysis

Results of flood analysis is shown in Table G.15, G.16 and Fig. G22 to G.25 and summarized as follows.

- The Loni Nadi has capacity of draining flood of 1 in 5 years and excessive water from existing and proposed drainage can be drained properly.
- Results show local overflow along river course of Sai. Flood analysis on the major drains and rivers to the Sai River shows that prompt drainage of flood water within the flood period can not be expected due to back water from the Sai River.

4.3 Surface Drainage

(1) Drainage Requirements

1) General

Proposed drainage areas of the Representative Area consist of paddy fields and upland fields. The drainage characteristics differ by respective area. Drainage

requirement of the paddy fields and upland fields were separately estimated below.

- Drainage systems for paddy fields were proposed on the assumption that 5-year, three day continuous rain storm would be drained from paddy fields within three day.
- Drainage water requirements for areas of upland fields were estimated on the basis of drainage characteristics of vegetation, soil and ground slope. The drainage system of upland fields was proposed aiming that 5-year, 24-hour continuous rain storm would be drained within 24 hours.

2) Criteria of Surface Run-off Analysis

For analysis surface run-off, following criteria have been set in this study.

a) Design storm

Rain storms of daily maximum, Two-day maximum and three-day maximum from 1965 to 1990 are shown in Table G.17. Using these data, probability analysis was carried out by Thomas Method, of which results are shown in Fig.G.26, G.27. One-day maximum and three-day maximum rainfall of 1 in 5 years probability are shown below.

District Station	Lucknow Mohanlalganj	Rae Bareli Rae Bareli	Hardoi Hardoi	Unnao Purwa
One-day	120	160	158	140
Three-day	207	270	250	220

b) Run-off Coefficient.

Run-off coefficient was determined as follows taking land use and topography into account.

Run-off coefficient of paddy field ----- 0.50

Run-off coefficient of upland field ----- 0.75

3) Drainage water requirement of paddy fields area

Drainage water requirement of paddy field areas is estimated by the following formula;

$$Q = q \times A$$

$$q = (C \times I \times 10^4) / (3 \times 24 \times 3600)$$

where, Q: Drainage discharge (l/sec)
 q: Drainage water requirement (l/sec/ha)
 I: Design rainfall
 5-year, three-day maximum rainfall
 C: Peak run-off coefficient of paddy field, 0.50
 A: Drainage area (ha)

Drainage requirement of Four Representative Areas are shown below.

Representative Area	Sarojini Nagar	Sataon	Sursa	Purwa
Three-day maximum rainfall (mm)	207	270	250	220
Drainage requirement (l/sec/ha)	3.99	5.21	4.82	4.24

4) Drainage water requirement of upland fields area

Drainage water requirement for upland field are estimated by using McMath formula as shown below.

$$Q = 2.3 \times C \times i \times S^{(1/5)} \times A^{(4/5)}$$

where, Q: Drainage discharge (l/sec)
 C: Coefficient representing the drainage area characteristics, 0.75
 i: Design rainfall intensity (mm/hr)
 S: Fall of drainage channel between the farthest contribution point and the point of concentration (m/Km)
 A: Drainage area (ha)

The design rainfall intensity is estimated as follows;

5 year 24 hour continuous rainfall:
 $i = R_{24}/24$ (mm/hr)

Based on the results of the drainage requirements of the Representative Areas and unit drainage requirements are obtained as shown in Fig.G.28.

(2) Drainage System Network

1) Schematic drainage Network

Proposed area of drainage improvement is equal to geographical area of the Representative Area aiming particularly at intensive drainage improvement and reduction of waterlogged/marshy areas within CCA. The Areas were divided into drainage blocks taking topographic condition, irrigation networks and existing drainage system into account.

The drainage blocks and proposed drainage system for each Representative Area are shown in Figs. G.29 to G.32.

2) Characteristics of each drainage block

Distribution of CCA and waterlogged/marshy area within drainage blocks is shown in Tables G.18 to G.21 and Figs.G.33 to G.36. Drainage improvement plan which is composed of construction and rehabilitation of major drains will be proposed giving priority to drainage blocks where CCA and waterlogged/marshy area occupy the area to a large extent.

(3) Drainage Facilities

1) Design discharge for drainage facilities

The discharge diagrams for respective drainage system in four Representative Areas were prepared on the basis of the design discharges derived from in Fig. G.28. The drainage diagrams are shown in Figs. G.37 to G.40.

2) Drainage Canal Capacity

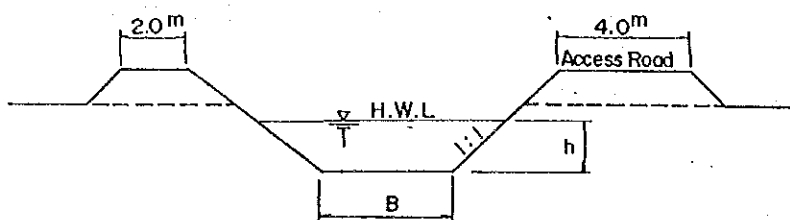
Dimensions of drainage facilities were determined based upon hydraulic calculation at the point of drainage blocks using Manning's Formula, of which results are shown in Tables G.22 to G.25.

- Manning's formula

$$V = 1/n \times R^{(2/3)} \times S^{(1/2)}$$

$$Q = A \times V$$

- where; V: Mean velocity (m/sec)
 R: Hydraulic mean depth (m)
 S: Gradient
 Q: Design discharge (m³/sec)
 A: Cross-sectional area of flow (m²)
 n: Coefficient of roughness -- 0.030



TYPICAL SECTION OF DRAINAGE CANAL

3) Required Drainage Facilities

General features of the drainage system in each Representative Area are summarized below.

Drainage facilities	Sarojini Nagar	Sataon	Sursa	Purwa
Main drainage Canal				
Length (km)	82.2	60.3	99.0	115.9
Nos.	9	10	10	13
Type	Trapezoidal earth canal			
Tertiary drainage canal				
Length (Km)	223	192	260	184
Type	Trapezoidal earth canal			
Related structures				
Road crossing (Nos.)	56	39	64	67

(4) Proposed Drainage Improvement Works

1) Drainage improvement works

Following types of drainage improvement works will be proposed aiming at ; i) prompt drainage of rain storm and excessive irrigation water by establishing drainage networks, ii) avoiding seepage from irrigation canals, iii) reduction of waterlogged/marshy area, and iv) control against salinity and alkalinity.

- Construction of drainage canals
- Improvement of existing drainage facilities
- Excavation for existing drains and streams

Location of the drainage improvement works are shown in Fig.G.33 to G.36.

2) Proposed drainage facilities

Proposed drainage facilities for the Study Areas are as follows.

Drainage facilities	Sarojini Nagar	Sataon	Sursa	Purwa
Main drainage canal (Nos.)	9	10	10	13
New construction (km)	49.5	30.6	51.0	36.7
Improvement (km)	32.7	29.7	48.07	9.7
Total (km)	82.2	60.3	99.0	115.9
Related structure				
Bridge (Nos.)	56	39	64	67

a) Sarojini Nagar Study Area

Main drain, Quila Mohammad Nagar Drain runs southward along the eastern boundary of the Area up to the Sai River. On the other hand drainage network within the Area has not been arranged well. Drainage network should be established particularly in order to improve waterlogged/marshy areas which are extensively distributed in the central part of the Area during Kharif season by means of construction and improvement of main drains and branch canals. Most of these drains will be newly constructed. Quila Mohammad Nagar Drain has sufficient capacity in the upstream stretch, but improvement will be required

because of its less capacity than design discharge in the downstream stretch. Main drainage works for the Area is summarized as follows:

- Construction of three lines of main drains up to the Sai River and allied branch drains.
- Construction of a line of main drain to Quila Mohammad Nagar Drain and its branch drains.
- Improvement of downstream portion of Quila Mohammad Nagar Drain.
- Construction of tertiary drains.

b) Sataon Study Area

Improvement plan of Basaha Drain has been proposed and conducted by Irrigation Department of U.P. Stretch between junction on the Sai River and SP.48 km point is under construction now, which will be completed in 1997. The Study Area being divided into two halves by Maurawan Distributary, drainage area in the Sataon Study Area is small. However, improvement of Basaha Drain should be proposed so as to establish drainage system for Purwa Study Area. Minor drains were temporarily arranged, but intensive improvement is required. Drainage network should be established by means of improvement of existing drains and streams aiming at prompt draining of rain storm and reduction of waterlogged/marshy area. Major drainage improvement works for the Sataon Area is summarized below;

- Improvement of two lines of main drains (existing drains and natural streams) up to the Sai River and construction or rehabilitation of their branch drains.
- Improvement and construction of branch canals connected to the Sai River and Basaha Drain in the lower reach of the Area
- Improvement of Basaha main drain
- Construction of tertiary drains

c) Sursa Study Area

Drainage network was comparatively well established with two lines of main drains and related drains most of which have deteriorated except Chhoiya Main Drain. Establishment of drainage network by improvement of existing drains, and construction of drains in the middle to lower reach where waterlogged/marshy areas are widely distributed will be proposed. Improvement

of existing drains and construction should be carried out to reclaim waterlogged/marshy area along Hardoi Branch along with sub-surface drains against seepage from Hardoi Branch. Following drainage works will be proposed for the Sursa Study Area.

- Improvement of two lines of main drains (existing drains and natural streams) up to the Sai River and construction or rehabilitation of their branch drains
- Construction of main drain to Parchar Escape
- Improvement of branch drains to Chhoiya Main drain
- Improvement of Parchar Escape
- Sub-surface drainage along Hardoi Branch
- Construction of tertiary drains

d) Purwa Study Area

Flood-prone area are spread over the Study Area but drainage condition is expected to be improved by rehabilitation of the Loni Nadi and Basaha Drain to large extent, for which establishment of drainage network within the Area is indispensable. Construction of drainage system will be proposed for improving existing drains in poor condition and reclamation of waterlogged/marshy areas. Rehabilitation of Basaha Drain will be also proposed. Following drainage works will be required for intensive drainage improvement.

- Improvement of three lines of main drains up to the Loni Nadi and construction of their branch drains
- Construction of branch drains to the Loni Nadi in lower reach.
- Improvement of Basaha Drain
- Improvement of a main drain up to Basaha Drain and construction of their branch drains
- Construction of tertiary drains

4.4 Sub-surface Drainage

Soils under poor drainage condition with low permeability has characteristics of alkaline soils in which layers with concretion or speckle of calcium carbonate are seen. pH of these soils is high and salts (mainly sodium) are accumulated to the surface by half (0.5) cm to three (3) cm in Rabi season. Soil amendment and/or leaching are required for improvement.

The subsurface drainage system is proposed aiming at soil amendment in poor drainage area under waterlogged/marshy and/or salt affected condition. Pilot farm demonstrating sub-surface drainage system will be applied in the Purwa Study Area where waterlogged/marshy condition followed by salinity is predominant due to widely distributed poor drainage areas. Sub-surface drainage will be introduced along Hardoi Branch against seepage from the Branch.

(1) Closed drains

1) Design discharge for closed drains

Design discharge for closed drains is determined based upon remaining rainfall on the surface, content of gravity water in the soil and allowable duration of inundation. In this Study, remaining rainfall in September when Rabi crops are harvested and Kharif crops are planted were used for calculating design discharge by following formulas.

$$q = (d \times 10^{(-3)} \times 10^4 \times 10 \times 3) / (N \times 86,400)$$

$$d = (Ra - Ev) / 31 \text{ days}$$

- where; q : Unit area drainage discharge (l/sec/ha)
d : Residual rainfall (mm/day)
N : Days of drainage (day)
Ra : Monthly rainfall (mm/month)
Ev : Monthly evapotranspiration (mm/month)

Representative Area	Ra mm/mon	Ev mm/mon	d mm/mon	d mm/day	q l/sec
Sarojini Nagar	195	138	57	1.9	0.22
Sataon	177	-	-	-	-
Sursa	167	129	38	1.3	0.15
Purwa	165	159	6	0.2	0.02
Maximum	-	-	57	1.9	0.22

2) Spacing of closed drains

Spacing of open drains and closed drains are determined taking due consideration on soil permeability and land use in the future. In case impermeable stratum exists near the ground surface, drainage improvement by closed drains should be carried out along with subsoiling so as to enhance productivity under proposed land use.

In the Study Area, Paddy fields are classified as follows:

- Paddy fields without drainage problems

These fields are located on Upland where no drainage problems exist because of its preferable ground slope and lower groundwater tables. Surface drainage is well achieved by plot-to-plot drainage.

- Paddy fields with drainage problems

These fields are distributed extensively in Midland and Lowland where sub-surface drainage is required as well as surface drainage due to higher groundwater table.

a) Hydraulic conductivity

Hydraulic conductivity was measured by auger-hole testing method at seven sites in the Study Areas. The results show that mean hydraulic conductivity is 1.0×10^{-3} to 8.0×10^{-4} cm/sec in the Study Areas.

The hydraulic conductivity can be computed by Ernst equation. For homogeneous soil with an impermeable stratum at a depth of $E > 1/2 \times J$, following equation is adopted.

$$K = (4000 \times r^2 \times h_0) / (J + 20 r)(2 - h_1 / J) \times h_1 \times t$$

where; K : hydraulic conductivity (m/day)

r : radius of the auger-hole (cm)

h_1 : the distance between the groundwater level and the average level of the water h in the hole for the interval t (cm)

J : the depth of hole below ground level (cm)

E : depth of impermeable layer below the bottom of the hole or the layer which has a permeability of about 1/10th or less than the permeability of the layer above (cm)

Hydraulic Conductivity

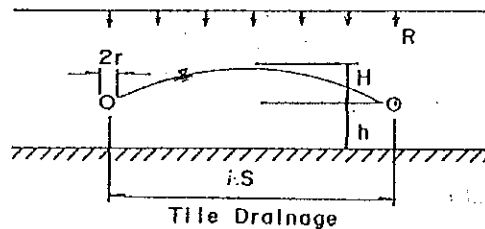
Study Area	K	Remarks
Sarojini Nagar (No.1 hole)	-	groundwater table was too low for measurement
Sataon (No.1 hole)	-	groundwater table was too low for measurement
Sataon (No.2 hole)	-	groundwater table was too low for measurement
Sursa (No.1 hole)	$8.5 \times 10^{(-4)}$ cm/sec	
Sursa (No.2 hole)	$7.6 \times 10^{(-4)}$ cm/sec	
Purwa (No.1 hole)	$3.1 \times 10^{(-4)}$ cm/sec	
Purwa (No.2 hole)	$1.8 \times 10^{(-3)}$ cm/sec	

b) Formulas for Drainage Spacing of drains

Spacing of drains was computed for open drains and closed drains for testing sites which are assumed to represent typical condition of the Area. Following two formulas were used for computation.

$$S^2 = (8 \times K \times H \times h + 4 \times K \times H^2) \times 1/R \text{ ----- [Hooghoudt]}$$

- where:
- S : space of drainage (m)
 - H : height of groundwater (m)
 - h : depth to impermeable layer (m)
 - K : hydraulic conductivity (m/day)
 - R : infiltration (m/day)



c) Infiltration

Groundwater table is raised by rainfall infiltration to the soil. Critical period for the crop cultivation occurs in December when heavy rainfall is observed. Infiltration is assumed to be 1.9 mm/day in that period.

$$\begin{aligned}
 \text{Infiltration} &= \text{Rainfall} - \text{Evapotranspiration} \\
 &= 195 \text{ mm/month} - 138 \text{ mm/month} \\
 &= 57 \text{ mm/month} \\
 &= 1.9 \text{ mm/day}
 \end{aligned}$$

where Rainfall : Average monthly rainfall at Sarojini Nagar in December.
 Evapotranspiration : Monthly evapotranspiration at Sarojini Nagar in December

d) Computation of spacing of drains

Under following drainage condition, spacing of closed drains was computed.

Items	Sursa Study Area		Purwa Study Area	
	No.1 Hole	No.2 Hole	No.1 Hole	No.2 Hole
K (m/day)	0.73	0.66	0.26	1.56
H (m)	0.4	0.4	0.4	0.4
h (m)	0.5	0.5	0.0	0.0
S (m)	29.3	27.9	9.4	22.9
Type of soil	Type-2	Type-2	Type-4	Type-3
Topography	Mid-upland	Mid-upland	Mid-lowland Lowland	Mid-upland Midland
Soil series	9,10	9,10	13,14,15	7,8,11,12
Drainage spacing (m)	30	30	10	25

3) Plan of closed drains

The sub-surface drainage system is proposed aiming at soil amendment in poor drainage area under waterlogged/marshy and/or salt affected condition. Pilot farm demonstrating sub-surface drainage system will be applied in the Purwa

Study Area where waterlogged/marshy condition followed by salinity is predominant due to widely distributed poor drainage areas.

a) Demonstration farm

- Proposed site; Unnao district, Purwa Study Area
- Field area; 42.7 ha
- Related irrigation canal; Purwa distributary canal
- Related drainage canal; Pur.No.6-2 proposed lateral canal
- Soil series; SITHAULI

b) Design

Four (4) testing plots were proposed in the pilot farm for examining drainability by arrangement of closed drains. As structures of closed drains, i) pipe drains, ii) brick drains with covering materials such as rice hulls which are available in the Areas were adopted.

Field block	Field area (ha)	Drainage spacing (m)	Structure of closed drain
A	9.8	25	Pipe drain
B	12.3	25	Brick particles with rice hulls
C	10.3	50	Pipe drain
D	10.3	50	Brick particles with rice hulls

(2) Countermeasure for seepage from Hardoi Branch Canal

Sub-surface drainage system is proposed for Sursa Study Area as a countermeasure against seepage from Hardoi Branch. Drained water will be collected through closed drains and will be pumped up to Minors so as to augment irrigation water.

1) Estimation of seepage water

Quantity of seepage water from Hardoi Branch is estimated as follows.

$$Q_1 = 2.3 \text{ m}^3/\text{mile.sq} = 0.89 \text{ m}^3/\text{km.sq} \\ = 8.9 \text{ l/sec/ha}$$

Source: by Fundamentals of Irrigation Engineering, INDIA

$$Q = Q1 \times A$$

$$= 8.9 \times 15.6 = 138.8 \text{ l/sec}$$

where: Q: Seepage water from Hardoi Branch (L=8.2km), (l/sec)

Q1: Seepage water of unit area (l/sec/ha)

A: Seepage area (ha)

2) Spacing of closed drains

spacing of drains were calculated by Hooghoudt Formula of which results are shown below;

$$S^2 = (8 \times K \times H \times h + 4 \times K \times H^2) \times 1/R$$

- Infiltration

$$R = (8.9 \times 10^{-3}) \times 86400 / (1 \times 10^4) = 0.077 \text{ m/day}$$

- Hydraulic conductivity

$$K = 4 \times 10^{-3} \text{ cm/sec} = 3.46 \text{ m/day (assumed value)}$$

- Height of groundwater

$$H = 2.0 \text{ m}$$

- Depth to impermeable layer

$$h = 0.5 \text{ m}$$

$$S^2 = (8 \times 3.46 \times 2.0 \times 0.5 + 4 \times 3.46 \times 2.0^2) / 0.077 = 1078$$

- Drainage spacing

$$S = 32.8 \text{ m} = \text{nearly } 30 \text{ m}$$

3) Design

a) Project area

- Proposed site; Hardoi district, Sursa Study Area
Along the Hardoi Branch Canal
(From 96 mile 2 furlong to 101 mile 3 furlong L=8.2km)
- Drainage area; 164ha (L=8.2km, B=200m)
- Related irrigation canal; Kamrauli minor
- Related drainage canal; Related Sur.No.5-1 proposed lateral canal

b) Dimension of structures

- Collecting pipe : RC D=200-400 mm, L=8,200 m
- Lateral drain pipe : PVC D=50 mm, L=65,600 m
- Sub-collecting drain pipe : PVC D=100 mm, L=8,200 m
- Pump station : 1 no.

TABLES

Table G.1 Present Nala/Drains and Proposed Drains by District

Name of District	Geographical Area (ha)	Present Nala Length (km)	Present Nala Density (%)	Present Drain Length (km)	Present Drain Density (%)	Present Nala/Drain Length (km)	Present Nala/Drain Density (%)	Proposed Drain Length (km)	Proposed Drain Density (%)
NAINITA	68.522	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
PILIBHIT	309.372	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
BAREILLY	260.465	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
SHAHJAHANPUL	396.539	89.0	0.22	175.0	0.44	264.0	0.66	N.A	N.A
KHERI	364.632	176.6	0.47	307.7	0.84	484.3	1.31	186.3	0.51
HARDOI	598.817	332.5	0.56	728.7	1.22	1,061.2	1.78	375.9	0.63
BARABANKI	30.074	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
SITAPUR	567.164	410.9	0.72	384.4	0.68	795.3	1.40	535.5	0.94
LUCKNOW	215.840	139.3	0.65	163.9	0.76	303.2	1.41	109.7	0.51
UNNAO	458.519	204.1	0.45	701.2	1.53	905.3	1.98	139.0	0.30
RAE BARELI	149.762	177.4	1.18	263.3	1.76	440.7	2.94	74.5	0.50

Remarks : Density -- Length as m/ha of Geographical Area
Data Source : Drainage Master Plan, Irrigation Department, U.P.

Table G.2 Present Nala/Drains and Proposed Drains by Block (1/2)

Sl No.	Name of Block	Geographical Area (ha)	Present Nala Length (km)	Present Nala Density (m/ha)	Present Drain Length (km)	Present Drain Density (m/ha)	Proposed Drain Length (km)	Proposed Drain Density (m/ha)
KHERI								
1.	BIJUA	59,083	-	-	4.0	0.07	90.5	1.53
2.	PHULBEHAR	40,504	4.9	0.12	7.7	0.19	71.0	1.75
3.	BANKAGANJ	33,852	3.0	0.09	63.7	1.88	-	-
4.	LAKHIMPUR	38,535	89.0	2.31	113.5	2.95	3.6	0.09
5.	BEHJAM	28,999	3.9	0.13	15.0	0.52	11.3	0.39
6.	MUHAMD	42,653	-	-	10.4	0.24	-	-
7.	KUMBHA	36,488	35.7	0.98	42.2	1.16	7.1	0.19
8.	MITAU	37,148	34.1	0.92	29.9	0.80	-	-
9.	PARAGAWAN	47,370	-	-	21.3	0.45	2.8	0.06
Total		364,632	170.6	0.47	307.7	0.84	186.3	0.51
HORDOI								
10.	PIHANI	33,685	40.6	1.21	41.2	1.22	44.7	1.33
11.	TODARPUR	30,621	37.6	1.23	54.2	1.77	65.6	2.14
12.	SHAHABAD	34,673	72.9	2.10	-	-	11.8	0.34
13.	BHARKAHANI	42,427	41.8	0.99	28.8	0.68	17.8	0.42
14.	HARIYAWAN	29,035	8.9	0.31	22.8	0.79	53.0	1.83
15.	TODIYAWAN	31,235	18.0	0.58	53.3	1.71	38.8	1.24
16.	BAWAN	32,827	-	-	46.9	1.43	12.4	0.38
17.	SANDI	31,575	-	-	-	-	5.1	0.16
18.	HARPARPUR	30,891	-	-	-	-	-	-
19.	AHIRAURI	37,703	-	-	38.0	1.01	16.5	0.44
20.	SURSA	33,628	34.2	1.02	119.1	3.54	24.1	0.72
21.	BILGRAM	33,839	-	-	6.3	0.19	12.7	0.38
22.	KOTHAWAN	29,485	-	-	52.0	1.76	8.9	0.30
23.	KACHHONA	24,864	-	-	31.7	1.27	6.3	0.25
24.	KADHOGANJ	28,916	26.6	0.92	24.1	0.83	2.5	0.09
25.	BHARAWAN	31,069	-	-	65.9	2.12	10.1	0.33
26.	SANDILA	31,362	32.9	1.05	43.1	1.37	13.9	0.44
27.	BEHDAR	27,842	19.0	0.68	68.4	2.46	15.2	0.55
28.	MALAWAN	23,140	-	-	32.9	1.42	16.5	0.71
Total		598,817	332.5	0.56	728.7	1.22	375.9	0.63
SITAPUR								
29.	BHATA	36,742	-	-	-	-	9.0	0.24
30.	HARGAON	27,603	11.6	0.42	31.3	1.13	10.2	0.37
31.	ALIA	26,713	9.6	0.36	46.3	1.73	41.2	1.54
32.	MAHOLI	23,277	20.0	0.86	38.2	1.64	15.1	0.65
33.	PISAWAN	39,780	36.0	0.90	69.1	1.74	10.3	0.26
34.	REOSA	43,868	-	-	-	-	12.0	0.27
35.	SAKRAN	30,764	-	-	-	-	-	-
36.	LAHARPUR	22,546	14.9	0.66	9.6	0.43	21.0	0.93
37.	PARSENDI	27,907	47.4	1.70	30.1	1.08	18.1	0.65
38.	KHAIIRABAD	23,526	-	-	14.6	0.62	40.5	1.72
39.	MISRICKH	30,430	31.2	1.03	18.1	0.59	6.0	0.20
40.	RAMPUR MATHURA	35,116	23.5	0.67	7.7	0.22	16.4	0.47
41.	MAHMUDABAD	23,431	21.1	0.90	-	-	62.4	2.66
42.	BISWAN	35,421	37.1	1.05	42.9	1.21	70.0	1.98
43.	MACHHARENTA	26,739	16.3	0.61	38.1	1.42	13.0	0.49
44.	PAHLA	27,532	63.0	2.29	-	-	68.7	2.50
45.	KASMANDA	27,468	44.8	1.63	21.3	0.78	49.5	1.80
46.	GONDLAMAU	32,718	16.0	0.49	7.0	0.21	22.9	0.70
47.	SIDHAULI	25,583	18.4	0.72	10.1	0.39	49.2	1.92
Total		567,164	410.9	0.72	384.4	0.68	535.5	0.94

Table G.2 Present Nala/Drains and Proposed Drains by Block (2/2)

Sl No.	Name of Block	Geographical Area (ha)	Present Nala		Present Drain		Proposed Density	
			Length (km)	Density (m/ha)	Length (km)	Density (m/ha)	Length (km)	Density (m/ha)
LUCKNOW								
48.	BAKSHIKA	37,782	8.9	0.24	28.6	0.76	5.7	0.15
49.	MAL	25,382	17.7	0.70	36.4	1.43	7.6	0.30
50.	MALIHABAD	21,092	25.3	1.20	33.1	1.57	20.4	0.97
51.	KAKORI	22,594	8.9	0.39	29.1	1.29	7.6	0.34
52.	SAROJINI NAGAR	38,435	29.1	0.76	21.5	0.56	6.3	0.16
53.	MOHAN LAL GANJ	35,903	24.1	0.67	15.2	0.42	24.1	0.67
54.	GOSAIGANJ	34,652	25.3	0.73	-	-	38.0	1.10
Total		215,840	139.3	0.65	163.9	0.76	109.7	0.51
UNNAO								
55.	AURAS	25,701	39.7	1.54	82.5	3.21	7.2	0.28
56.	GANJHURADABD	23,428	-	-	40.6	1.73	-	-
57.	BANGARMAU	27,990	3.2	0.11	26.1	0.93	23.6	0.84
58.	PATEHAPUR	27,996	-	-	35.2	1.26	8.0	0.29
59.	HASANGANJI	32,177	36.5	1.13	54.2	1.68	-	-
60.	MAYAGANJI	27,331	18.3	0.67	46.6	1.71	-	-
61.	SAFIPUR	25,683	-	-	26.4	1.03	20.2	0.79
62.	NAWABGANJI	27,803	43.6	1.57	63.9	2.30	-	-
63.	BICHHIYA	33,483	5.4	0.16	47.3	1.41	20.0	0.60
64.	SIKANDARPURSIROUSI	33,242	-	-	79.9	2.40	7.2	0.22
65.	SIKANDARPURKHAN	34,889	-	-	29.6	0.85	20.0	0.57
66.	ASOHA	28,893	37.4	1.29	29.1	1.01	3.2	0.11
67.	PURWA	23,527	16.0	0.68	37.0	1.57	14.4	0.61
68.	HILAULI	33,881	4.0	0.12	20.2	0.60	-	-
69.	BIGHAPUR	25,556	-	-	30.5	1.19	12.0	0.47
70.	SUMERPUR	26,939	-	-	52.3	1.94	3.2	0.12
Total		458,519	204.1	0.45	701.4	1.53	139.0	0.30
RABBARELI								
71.	SATAON	25,550	7.5	0.29	42.2	1.65	19.0	0.74
72.	KHEERO	23,204	7.3	0.31	14.9	0.64	26.3	1.13
73.	LALGANJ	22,276	21.2	0.95	14.2	0.64	3.6	0.16
74.	SARENI	25,511	14.4	0.56	6.4	0.25	10.3	0.40
75.	DALMAU	26,476	68.5	2.59	84.6	3.20	4.0	0.15
76.	JAGATPUR	26,745	58.5	2.19	101.0	3.78	11.3	0.42
Total		149,762	177.4	1.18	263.3	1.76	74.5	0.50

Remarks : Density = Length as m/ha of Geological Area
Date Source : Drainage Master Plan, Irrigation Department, U.P.

Table G.3 Drainage Characteristics by Topography in the Hardoi Branch Command Area

Sl No.	Name of Block	Name of District	(A) Geographical Area (ha)	(B) Upland (ha)	(C) (B/A) (%)	(D) Lowland (ha)	(E) (D/A) (%)	(F) Midland (ha)	(G) (F/A) (%)	(H) Waterlogged/ Marshy Area (ha)	(I) (H/A) (%)	(J) (I/F) (%)
1.	Puranpur	Pilibhit	121,574	38,863	32.0	7112	5.8	75,599	62.2	794	0.7	1.1
2.	Banda	Shahajhanpur	46,891	11,743	25.0	2986	6.4	32,162	68.6	154	0.3	0.5
3.	Pawayan	Shahajhanpur	30,601	9,516	31.1	632	2.1	20,453	66.8	162	0.5	0.8
4.	Sindhauli	Shahajhanpur	29,163	9,875	33.9	1039	3.6	18,254	62.6	266	0.9	1.5
5.	Bhawalkhara	Shahajhanpur	31,928	9,422	29.5	479	1.5	22,027	69.0	386	1.2	1.8
6.	Pasgan	Kheri	47,370	11,985	25.3	1285	2.7	34,100	72.0	504	1.1	1.5
7.	Pibani	Hardoi	33,685	8,343	24.8	481	1.4	24,861	73.8	350	1.0	1.4
8.	Todarapur	Hardoi	30,621	8,522	27.8	632	2.1	21,467	70.1	305	1.0	1.4
9.	Shahabad	Hardoi	34,673	9,146	26.4	521	1.5	25,006	72.1	614	1.8	2.5
10.	Hariyawan	Hardoi	29,035	5,962	20.5	491	1.7	22,582	77.8	656	2.3	2.9
11.	Tadiyawan	Hardoi	31,235	6,903	22.1	963	3.1	23,369	74.8	462	1.5	2.0
12.	Bawan	Hardoi	32,827	5,909	18.0	1014	3.1	25,904	78.9	502	1.5	1.9
13.	Sandi	Hardoi	31,576	8,497	26.9	5210	16.5	17,869	56.6	1,185	3.8	6.6
14.	Ahiraauri	Hardoi	37,703	6,941	18.4	336	0.9	30,426	80.7	111	0.3	0.4
15.	Sursa	Hardoi	33,628	4,255	12.7	596	1.8	28,777	85.6	897	2.7	3.1
16.	Bilgram	Hardoi	33,839	8,550	25.3	2204	6.5	23,085	68.2	1,192	3.5	5.2
17.	Kohawan	Hardoi	29,485	7,619	25.8	2413	8.2	19,453	66.0	557	1.9	2.9
18.	Kachhona	Hardoi	24,864	3,286	13.2	390	1.6	21,188	85.2	2,018	8.1	9.5
19.	Madhoganj	Hardoi	28,916	7,356	25.4	1267	4.4	20,293	70.2	549	1.9	2.7
20.	Bharawan	Hardoi	31,069	5,940	19.1	1232	4.0	23,897	76.9	417	1.3	1.7
21.	Sandila	Hardoi	31,362	8,269	26.4	317	1.0	22,776	72.6	2,195	7.0	9.6
22.	Behdar	Hardoi	27,842	6,243	22.4	379	1.4	21,220	76.2	2,188	7.9	10.3
23.	Malawan	Hardoi	23,140	5,126	22.2	508	2.2	17,506	75.7	1,155	5.0	6.6
24.	Mai	Lucknow	25,382	3,386	13.3	632	2.5	21,364	84.2	245	1.0	1.1
25.	Melihabad	Lucknow	21,092	6,998	33.2	314	1.5	13,780	65.3	539	2.6	3.9
26.	Kakori	Lucknow	22,594	4,207	18.6	339	1.5	18,048	79.9	646	2.9	3.6
27.	SarajiniNagar	Lucknow	38,435	8,959	23.3	1120	2.9	28,356	73.8	1,150	3.0	4.1
28.	Mohalalagani	Lucknow	35,903	6,827	19.0	647	1.8	28,429	79.2	201	0.6	0.7
29.	Gosalganj	Lucknow	34,652	7,972	23.0	1008	2.9	25,672	74.1	803	2.3	3.1
30.	Auras	Unnao	25,701	3,193	12.4	713	2.8	21,795	84.8	809	3.1	3.7
31.	Ganjauradabad	Unnao	23,428	3,923	16.7	1610	6.9	17,895	76.4	663	2.8	3.7
32.	Bangamau	Unnao	27,990	5,834	20.8	1130	4.0	21,026	75.1	1,302	4.7	6.2
33.	Patehapur	Unnao	27,996	5,558	19.9	1284	4.6	21,154	75.6	772	2.8	3.6
34.	Hasanganj	Unnao	32,177	3,479	10.8	853	2.7	27,845	86.5	524	1.6	1.9
35.	Mayaganj	Unnao	27,331	2,797	10.2	821	3.0	23,713	86.8	843	3.1	3.6
36.	Safipur	Unnao	25,683	6,740	26.2	5920	23.1	13,023	50.7	1,791	7.0	13.8
37.	Navabganj	Unnao	27,803	4,992	18.0	300	1.1	22,511	81.0	714	2.6	3.2
38.	Bichhiya	Unnao	33,483	2,194	6.6	126	0.4	31,163	93.1	972	2.9	3.1
39.	SikandarpurSirosi	Unnao	33,242	3,575	10.8	10800	32.5	18,867	56.8	726	2.2	3.8
40.	Sikandarpurkhan	Unnao	34,889	16,490	47.3	6270	18.0	12,129	34.8	647	1.9	5.3
41.	Asoha	Unnao	28,893	6,522	22.6	2075	7.2	20,296	70.2	1,081	3.7	5.3
42.	Purwa	Unnao	23,527	2,349	10.0	370	1.6	20,808	88.4	554	2.4	2.7
43.	Hilauli	Unnao	33,881	4,234	12.5	593	1.8	29,054	85.8	819	2.4	2.8
44.	Bighapur	Unnao	25,556	7,494	29.3	1340	5.2	16,725	65.4	189	0.7	1.1
45.	Sumerpur	Unnao	26,939	9,240	34.3	1965	7.3	15,734	58.4	377	1.4	2.4
46.	Sataon	Raebareli	25,550	5,288	20.7	480	1.9	19,782	77.4	85	0.3	0.4
47.	Khero	Raebareli	23,204	5,238	22.6	220	0.9	17,746	76.5	647	2.8	3.6
48.	Lalganj	Raebareli	22,276	8,050	36.1	990	4.4	13,236	59.4	71	0.3	0.5
49.	Sarani	Raebareli	25,511	6,528	25.6	1250	4.9	17,733	69.5	30	0.1	0.2
50.	Dalmau	Raebareli	26,476	7,565	28.6	120	0.5	18,791	71.0	286	1.1	1.5

Remarks : Upland, lowland, midland area by topographical classification

Data Source : Waterlogged/marshy land by Remote Sensing Applications Center, U.P.

Table G.4 Density of Drainage Canal in Poor Drainage Area in the Hardoi Branch Command

Sl No.	Name of Block	Name of District	(A) Geographical Area (ha)	(B) Midland Area (ha)	(C) Waterlogged/ Marshy Area (ha)	(D) Canal Length (km)	(E) Less Functioned Canal Length (km)	(F) Density of Drain (D/C) (m/ha)	(G) Rate (E/D) (%)
1.	Puranpur	Pilibhit	121,574	75,509	794	38.3	0.0	48.2	0.0
2.	Banda	Shahajhanpur	46,891	32,162	154	72.0	0.0	467.5	0.0
3.	Pawayan	Shahajhanpur	30,601	20,453	162	23.8	0.0	146.9	0.0
4.	Sindhauri	Shahajhanpur	29,168	18,254	266	34.2	0.0	128.6	0.0
5.	Bhawalkhera	Shahajhanpur	31,028	22,027	386	20.3	0.0	52.6	0.0
6.	Paswan	Kheri	47,370	34,100	504	21.3	0.0	42.3	0.0
7.	Pihani	Hardoi	33,685	24,861	350	41.2	0.0	117.7	0.0
8.	Todarpur	Hardoi	30,621	21,467	305	54.2	0.0	177.7	0.0
9.	Shahabad	Hardoi	34,673	25,006	614	0.0	0.0	0.0	0.0
10.	Hariyawan	Hardoi	29,035	22,582	656	22.8	0.0	34.8	0.0
11.	Tadiyawan	Hardoi	31,235	23,369	462	53.3	0.0	115.4	0.0
12.	Bawan	Hardoi	32,827	25,904	502	46.9	0.0	93.4	0.0
13.	Sandi	Hardoi	31,576	17,869	1,185	0.0	0.0	0.0	0.0
14.	Ahiraori	Hardoi	37,703	30,426	111	38.0	0.0	342.3	0.0
15.	Sursa	Hardoi	33,628	28,777	897	119.1	0.0	132.8	0.0
16.	Bilgram	Hardoi	33,839	23,085	1,192	6.3	0.0	5.3	0.0
17.	Kohawan	Hardoi	29,485	19,453	557	52.0	0.0	93.4	0.0
18.	Kachhona	Hardoi	24,864	21,688	2,018	31.7	0.0	15.7	0.0
19.	Madhoganj	Hardoi	28,916	20,293	549	24.1	0.0	43.9	0.0
20.	Bharawan	Hardoi	31,069	23,897	417	65.9	0.0	158.0	0.0
21.	Sandila	Hardoi	31,362	23,076	2,195	43.1	0.0	19.6	0.0
22.	Behdar	Hardoi	27,842	21,620	2,188	68.4	0.0	31.3	0.0
23.	Malawan	Hardoi	23,140	17,506	1,155	32.9	0.0	28.5	0.0
24.	Mal	Lucknow	25,382	21,364	245	36.4	0.0	148.6	0.0
25.	Malihabad	Lucknow	21,092	13,780	539	33.1	22.3	61.4	67.4
26.	Kakori	Lucknow	22,594	18,048	646	29.1	4.2	45.0	14.4
27.	SarajiniNagar	Lucknow	38,435	28,356	1,150	21.5	0.0	18.7	0.0
28.	Mohalalagani	Lucknow	35,903	28,429	201	15.2	0.0	75.6	0.0
29.	Gosaiganj	Lucknow	34,652	25,627	803	0.0	0.0	0.0	0.0
30.	Auras	Unnao	25,701	21,795	869	82.5	0.0	102.0	0.0
31.	Ganjmuradabad	Unnao	23,428	17,895	663	40.6	9.6	61.2	23.6
32.	Bangamau	Unnao	27,090	21,026	1,302	26.1	2.5	20.0	9.6
33.	Patehapur	Unnao	27,996	21,154	772	35.2	4.2	45.6	11.9
34.	Hasanganj	Unnao	32,177	27,845	524	54.2	0.0	103.4	0.0
35.	Mayaganj	Unnao	27,331	23,713	843	46.6	16.5	55.3	35.4
36.	Safipur	Unnao	25,683	13,023	1,791	26.4	0.0	14.7	0.0
37.	Navabganj	Unnao	27,803	22,511	714	63.9	22.6	89.5	35.4
38.	Bichhiya	Unnao	33,483	31,163	972	47.3	14.6	48.7	30.9
39.	SikandarpurSirosi	Unnao	33,242	18,867	726	79.7	13.1	109.8	16.4
40.	Sikandarpurkhan	Unnao	34,889	12,129	647	29.6	0.0	45.7	0.0
41.	Asoha	Unnao	28,893	20,296	1,081	29.1	5.3	26.9	18.2
42.	Purwa	Unnao	23,527	20,808	554	37.0	0.0	66.8	0.0
43.	Hilauli	Unnao	33,881	29,054	819	20.2	0.0	24.7	0.0
44.	Bighapur	Unnao	25,556	16,725	189	30.5	0.0	161.4	0.0
45.	Sumerpur	Unnao	26,939	15,734	377	52.3	0.0	138.7	0.0
46.	Sateon	Raebareli	25,550	19,782	85	42.2	0.0	496.5	0.0
47.	Khero	Raebareli	23,204	17,746	647	14.9	0.0	23.0	0.0
48.	Lalaganj	Raebareli	22,276	13,236	71	14.2	0.0	200.0	0.0
49.	Sarani	Raebareli	25,511	17,733	30	6.4	0.0	213.3	0.0
50.	Dalmau	Raebareli	26,476	18,791	286	84.6	0.0	295.8	0.0

Date Source : Waterlogged/marshy land by Remote Sensing Applications Center,U.P.
Drainage canal length by Irrigation Department,U.P.

Table G.5 Schedule of Catchment Area and Channel Dimensions

Sl. No.	Drainage Canal Name	Canal Length (km)	Catchment Area (km ²)	Design Discharge (cusec)	Water Depth (m)	Bed Width (m)	Bed Slope	Velocity (m/s)	Remarks
Sarojini Nagar Study Area									
1.	Qila Mohmmadi Nagar Dr.	37.2	76.3	73.6	1.68	7.01	1/5280	0.70	
2.	Debarya Bharoswa Dr.	3.2	4.7	36.0	0.78	1.83	1/600	0.56	
3.	Kunwar Khara Dr.	1.6	5.4	42.0	0.81	1.83	1/1650	-	
4.	Natkur Dr.	3.6	3.2	5.6	0.50	1.22	1/3300	-	
5.	Sisendi Dr.	4.8	17.6	68.0	0.76	4.88	1/2640	-	
6.	Airport Dr.	2.0	2.6	10.0	0.84	3.50	1/6000	-	
7.	Firangi Khara Dr.	1.2	1.9	7.5	0.49	0.91	1/2200	-	
Total		53.6	111.7						
Sataon Study Area									
1.	Basaha Dr.	48.0	108.0	1093.0	1.77	14.93	1/2640	-	
2.	Garhi Dularai Dr.	6.0	6.0	120.0	1.03	3.00	1/1100	0.97	
3.	Sataon Cut Dr.	3.8	2.4	18.6	0.46	2.44	1/2200	-	
4.	Malik Mau Dr.	3.1	6.5	53.0	0.68	3.00	1/1100	-	
5.	Bardar Dr.	1.0	3.2	7.5	0.47	3.05	1/2200	-	
6.	Gulariha Dr.	7.1	15.5	370.0	1.45	9.14	1/4400	-	
Total		69.0	141.6						
Sursa Study Area									
1.	Chholiya Dr.	46.4	278.6	537.7	1.46	15.25	1/5260	-	
2.	Fardapur Dr.	3.4	8.0	31.0	0.67	2.44	1/3300	0.46	
3.	Kanrauli Dr.	10.0	9.1	35.0	0.88	1.83	1/3300	-	
4.	Turtipur Dr.	27.7	111.9	216.0	1.22	7.32	1/3300	0.73	
5.	Shankarpur Dr.	1.9	7.8	15.0	0.64	1.52	1/4400	0.37	
6.	Brijljal Purwa Dr.	4.8	11.7	45.0	0.61	4.88	1/4400	-	
7.	Parchal Escape	8.2	-	500.0	1.83	7.32	1/3300	0.94	
Total		102.3	427.1						
Purwa Study Area									
1.	Purwa Dr.	10.1	28.8	55.7	0.88	2.44	1/2200	0.64	
2.	Tikar Dr.	8.9	32.5	126.0	1.22	5.79	1/2200	0.73	
3.	Tilauhri Dr.	2.8	3.1	25.0	0.61	2.44	1/3300	-	
4.	Mohannadpur Dr.	3.5	3.1	25.0	0.61	2.44	1/3300	0.43	
5.	Unch Gadn Dr.	7.6	18.6	35.9	0.85	2.44	1/5280	0.49	
6.	Indara Tal Dr.	11.3	13.0	50.0	0.61	4.57	1/3300	0.47	
Total		44.2	98.1						

Data Source : Irrigation Department, U.P.

Table G.6 Drainage Characteristics by Village-wise Data in Sarojini Nagar Study Area (1/2)

Sl. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
A. SAROJINI NAGAR BLOCK (LUCKNOW DISTRICT)												
1.	Khande Dev	521	112	21.50	21	4.03	0	0.00	8	1.54	29	5.57
2.	Kasarwara	176	32	18.18	4	2.27	6	3.41	2	1.14	6	3.41
9.	Paharpur	180	30	16.67	6	3.33	2	1.11	2	1.11	8	4.44
10.	Banthera	696	183	26.29	8	1.15	0	0.00	6	0.86	14	2.01
11.	Bani	181	31	17.13	6	3.31	21	11.60	2	1.10	8	4.42
22.	Sarai Shahzadi	250	38	15.20	4	1.60	29	11.60	3	1.20	7	2.80
1.	Kanlapur Ahmadpu	121	18	14.88	3	2.48	0	0.00	7	5.79	10	8.26
2.	Asraf Nagar	255	111	43.53	19	7.45	0	0.00	8	3.14	27	10.59
4.	Amausi	1,645	642	39.03	56	3.40	48	2.92	0	0.00	56	3.40
5.	Anaura	324	94	29.01	10	3.09	2	0.62	13	4.01	23	7.10
7.	Andhpur Dev	260	64	24.62	8	3.08	0	0.00	51	19.62	59	22.69
8.	Alinagar Sunnara	499	123	24.65	3	0.60	2	0.40	23	4.61	26	5.21
9.	Alinagar Khurd	126	68	53.97	12	9.52	0	0.00	20	15.87	32	25.40
11.	Aurawan	241	68	28.22	5	2.07	0	0.00	16	6.64	21	8.71
13.	Kurauni	719	208	28.93	16	2.23	0	0.00	74	10.29	90	12.52
14.	Kishanpur Kaudiy	149	43	28.86	2	1.34	10	6.71	30	20.13	32	21.48
17.	Khatola	464	157	33.84	8	1.72	0	0.00	21	4.53	29	6.25
20.	Gauri	337	89	26.41	10	2.97	0	0.00	0	0.00	10	2.97
21.	Gahru	619	211	34.09	13	2.10	0	0.00	0	0.00	13	2.10
23.	Chandraval	239	77	32.22	7	2.93	0	0.00	30	12.55	37	15.48
24.	Jahanabad	43	20	46.51	2	4.65	0	0.00	0	0.00	2	4.65
25.	Jaiti Khara	558	289	51.79	31	5.56	0	0.00	65	11.65	96	17.20
26.	Dhavaipur	111	28	25.23	10	9.01	4	3.60	0	0.00	10	9.01
27.	Natkur	661	219	33.13	29	4.39	0	0.00	0	0.00	29	4.39
28.	Nurnagar Bhadara	321	93	28.97	12	3.74	0	0.00	39	12.15	51	15.89
29.	Neevan	512	132	25.78	16	3.13	71	13.87	0	0.00	16	3.13
31.	Parvar Paschim	910	311	34.18	76	8.35	37	4.07	171	18.79	247	27.14
32.	Parvar Purab	515	103	20.00	13	2.52	0	0.00	0	0.00	13	2.52
35.	Farukhabad Chill	341	73	21.41	12	3.52	0	0.00	0	0.00	12	3.52
36.	Bijnaur	752	212	28.19	40	5.32	5	0.66	0	0.00	40	5.32
39.	Behtava	115	21	18.26	5	4.35	0	0.00	28	24.35	33	28.70
40.	Behsa	395	84	21.27	0	0.00	0	0.00	3	0.76	3	0.76
41.	Bibipur	289	73	25.26	13	4.50	11	3.81	21	7.27	34	11.76
42.	Bhagukhera	170	32	18.82	12	7.06	0	0.00	11	6.47	23	13.53
44.	Mati	1,187	673	56.70	15	1.26	0	0.00	0	0.00	15	1.26
46.	Hakidumpur Kaith	349	59	16.91	42	12.03	0	0.00	46	13.18	88	25.21
47.	Mesaura	360	63	17.50	6	1.67	0	0.00	36	10.00	42	11.67
50.	Keeranpur Pinwat	301	160	53.16	2	0.66	0	0.00	17	5.65	19	6.31
51.	Katauli	165	43	26.06	5	3.03	7	4.24	18	10.91	23	13.94
52.	Rahisabad	381	92	24.15	6	1.57	0	0.00	0	0.00	6	1.57
53.	Rasulpur Itthuri	130	26	20.00	8	6.15	0	0.00	0	0.00	8	6.15
55.	Shahpur Majhgawa	130	26	20.00	4	3.08	0	0.00	17	13.08	21	16.15
58.	Saraiya	154	29	18.83	8	5.19	13	8.44	25	16.23	33	21.43
Sub-Total		16,852	5,260	31.21	588	3.49	268	1.59	813	4.82	1401	8.31
B. MOHANLAL GANJ BLOCK (LUCKNOW DISTRICT)												
1.	Uttar Gaon	540	80	14.81	22	4.07	34	6.30	0	0.00	22	4.07
9.	Bhasanda	493	89	18.05	17	3.45	0	0.00	22	4.46	39	7.91
13.	Bhilampur	97	13	13.40	8	8.25	0	0.00	1	1.03	9	9.28
14.	Paraspur Thatha	343	48	13.99	7	2.04	0	0.00	1	0.29	8	2.33
18.	Jabrauli	1,000	200	20.00	66	6.60	0	0.00	31	3.10	97	9.70
22.	Sirs	522	182	34.87	9	1.72	0	0.00	2	0.38	11	2.11
24.	Bhaundari	682	203	29.77	12	1.76	0	0.00	0	0.00	12	1.76
25.	Gautamkhara	216	56	25.93	2	0.93	0	0.00	2	0.93	4	1.85
28.	Govindpur	650	110	16.92	10	1.54	0	0.00	12	1.85	22	3.38
37.	Dayalpur	730	152	20.82	17	2.33	34	4.66	2	0.27	19	2.60
39.	Rati	434	93	21.43	18	4.15	0	0.00	0	0.00	18	4.15
40.	Raghnath Khara	285	76	26.67	11	3.86	5	1.75	27	9.47	38	13.33
41.	Sisendi	754	184	24.40	54	7.16	0	0.00	0	0.00	54	7.16
42.	Salsamau	538	284	52.79	18	3.35	0	0.00	8	1.49	26	4.83
43.	Kusmaura	416	112	26.92	4	0.96	0	0.00	0	0.00	4	0.96
44.	Kodra Raipur	339	96	28.32	12	3.54	0	0.00	3	0.88	15	4.42
45.	Nadarikhara	90	16	17.78	4	4.44	1	1.11	0	0.00	4	4.44
46.	Mangtaiyya	439	232	52.85	17	3.87	0	0.00	1	0.23	18	4.10

Table G.6 Drainage Characteristics by Village-wise Data in Sarojini Nagar Study Area (2/2)

Sl. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
47.	Meenapur	287	147	51.22	18	6.27	1	0.35	1	0.35	19	6.62
48.	Heeranpur	216	109	50.46	13	6.02	0	0.00	0	0.00	13	6.02
50.	Akbar Deniganj	201	99	49.25	6	2.99	0	0.00	0	0.00	6	2.99
52.	Virsinghpur	313	69	22.04	17	5.43	0	0.00	1	0.32	18	5.75
53.	Baraulia	423	203	47.99	13	3.07	0	0.00	1	0.24	14	3.31
54.	Bhajanau	86	11	12.79	3	3.49	0	0.00	0	0.00	3	3.49
55.	Rhadeswa	643	189	29.39	19	2.95	17	2.64	11	1.71	30	4.67
56.	Devaria Bharosav	403	149	36.97	19	4.71	0	0.00	0	0.00	19	4.71
57.	Dhanuva Saand	444	68	15.32	15	3.38	0	0.00	23	5.18	38	8.56
80.	Dehava	370	48	12.97	10	2.70	0	0.00	7	1.89	17	4.59
103.	Gaura	1,055	273	25.88	22	2.09	0	0.00	5	0.47	27	2.56
Sub-Total		13,009	3,591	27.60	463	3.56	92	0.71	161	1.24	624	4.80
C. ASOHA BLOCK (UNNAO DISTRICT)												
65.	Vilaura	324	250	77.16	11	3.40	12	3.70	3	0.93	14	4.32
67.	Chaupai	533	498	93.43	16	3.00	55	10.32	8	1.50	24	4.50
68.	Chilauli	218	179	82.11	4	1.83	10	4.59	0	0.00	4	1.83
69.	Darehata Achli	89	80	89.89	2	2.25	0	0.00	0	0.00	2	2.25
70.	Darehata Mahant	73	65	89.04	2	2.74	0	0.00	0	0.00	2	2.74
71.	Dundiathar	162	143	88.27	4	2.47	2	1.23	0	0.00	4	2.47
72.	Gyanpur	139	120	86.33	4	2.88	0	0.00	0	0.00	4	2.88
74.	Gowapur	170	148	87.06	4	2.35	4	2.35	2	1.18	6	3.53
75.	Gondva	103	91	88.35	1	0.97	2	1.94	1	0.97	2	1.94
78.	Keslpur	70	56	80.00	4	5.71	2	2.85	0	0.00	4	5.71
80.	Lakshipur	159	136	85.53	5	3.14	0	0.00	0	0.00	5	3.14
81.	Majharia	142	123	86.62	11	7.75	0	0.00	0	0.00	11	7.75
82.	Gaddipur	65	44	67.69	1	1.54	0	0.00	0	0.00	1	1.54
83.	Makhdumpur	41	32	78.05	3	7.32	0	0.00	0	0.00	3	7.32
86.	Neentikar	164	128	78.05	5	3.05	0	0.00	1	0.61	6	3.66
87.	Paharpur	164	123	75.00	4	2.44	0	0.00	0	0.00	4	2.44
88.	Padmanpur	63	48	76.10	3	4.76	0	0.00	0	0.00	3	4.76
92.	Ograpur	209	173	82.78	4	1.91	0	0.00	2	0.96	6	2.87
Sub-Total		2,888	2,437	84.38	88	3.05	87	3.01	17	0.59	105	3.64
D. NAWABGANJ BLOCK (UNNAO DISTRICT)												
16.	Tendua Hirankud	198	79	39.90	15	7.58	3	1.52	0	0.00	15	7.58
23.	Paraura	103	49	47.57	4	3.88	0	0.00	0	0.00	4	3.88
30.	Balhesau	242	102	42.15	3	1.24	16	6.61	0	0.00	3	1.24
32.	Bendua	33	14	42.42	0	0.00	0	0.00	0	0.00	0	0.00
59.	Shekhpur	163	67	41.10	8	4.91	17	10.43	1	0.61	9	5.52
Sub-Total		739	311	42.08	30	4.06	36	4.87	1	0.14	31	4.19
Grand-Total		33,488	11,599	34.64	1169	3.49	483	1.44	992	2.86	2161	6.45

Data Source : Miran Khasara, Lucknow, Unnao District TEHSIL Concerned

Table G.7 Drainage Characteristics by Village-wise Data in Sataon Study Area

Sl. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
A. SATAON BLOCK (RAE BARELI DISTRICT)												
5.	Onai Paharpur	386	94	24.35	13	3.37	0	0.00	2	0.52	15	3.89
6.	Konsa	2,870	1,320	45.99	118	4.11	0	0.00	0	0.00	118	4.11
7.	Korihar	1,536	648	42.19	85	5.53	0	0.00	0	0.00	85	5.53
10.	Khusrupur	106	22	20.75	3	2.83	0	0.00	0	0.00	3	2.83
11.	Garhi Dula Rai	208	60	28.85	5	2.40	0	0.00	5	2.40	10	4.81
13.	Gambhipur	80	18	22.50	1	1.25	0	0.00	0	0.00	1	1.25
14.	Gauri Sataon	76	5	6.58	2	2.63	0	0.00	0	0.00	2	2.63
15.	Chaknasirpur	16	2	12.50	0	0.00	0	0.00	0	0.00	0	0.00
16.	Chandwal	117	9	7.69	4	3.42	0	0.00	0	0.00	4	3.42
29.	Domapur	198	10	5.05	4	2.02	0	0.00	0	0.00	4	2.02
33.	Nirashapur	130	24	18.46	3	2.31	0	0.00	0	0.00	3	2.31
38.	Purai	797	105	13.17	29	3.64	0	0.00	0	0.00	29	3.64
45.	Bardar	1,028	453	44.07	62	6.03	0	0.00	0	0.00	62	6.03
46.	Bankat	114	19	16.67	3	2.63	0	0.00	0	0.00	3	2.63
47.	Manpur	118	18	15.25	2	1.69	0	0.00	0	0.00	2	1.69
48.	Malikwau Chaubar	395	123	31.14	16	4.05	0	0.00	0	0.00	16	4.05
50.	Raula	202	11	5.45	8	3.96	0	0.00	0	0.00	8	3.96
56.	Shekhapur	123	12	9.76	4	3.25	0	0.00	0	0.00	4	3.25
58.	Sataon	1,180	647	54.83	39	3.31	0	0.00	9	0.76	48	4.07
68.	Husepur	65	8	12.31	3	4.62	0	0.00	0	0.00	3	4.62
69.	Hajipur	783	34	4.34	33	4.21	0	0.00	2	0.26	35	4.47
70.	Hardaurpur	72	10	13.89	2	2.78	0	0.00	0	0.00	2	2.78
Sub-Total		10,600	3,652	34.45	439	4.14	0	0.00	18	0.17	457	4.31
B. KHEDRO BLOCK (RAE BARELI DISTRICT)												
27.	Chandau	172	138	80.23	5	2.91	0	0.00	0	0.00	5	2.91
45.	Naugava	122	98	80.33	4	3.28	0	0.00	0	0.00	4	3.28
47.	Paho	866	693	80.02	39	4.50	0	0.00	62	7.16	101	11.66
52.	Baraula	195	156	80.00	27	13.85	3	1.54	0	0.00	27	13.85
57.	Basigava	224	179	79.91	3	1.34	0	0.00	0	0.00	3	1.34
60.	Bhitargaon	1,318	1,054	79.97	50	3.79	15	1.14	27	2.05	77	5.84
72.	Rampur Najara	139	111	79.86	2	1.44	5	3.60	0	0.00	2	1.44
Sub-Total		3,036	2,429	80.01	130	4.28	23	0.76	89	2.93	219	7.21
C. HILAULI BLOCK (UNNAO DISTRICT)												
1.	Ahesa	636	579	91.04	38	5.97	33	5.19	156	24.53	194	30.50
2.	Akohari	2,584	2,210	85.53	61	2.36	0	0.00	323	12.50	384	14.86
8.	Basari	496	402	81.05	30	6.05	4	0.81	0	0.00	30	6.05
11.	Gulariha	2,768	2,411	87.10	145	5.24	337	12.17	0	0.00	145	5.24
13.	Indaura	241	183	75.93	6	2.49	40	16.60	0	0.00	6	2.49
14.	Jaisinghkhara	272	219	80.51	10	3.68	3	1.10	0	0.00	10	3.68
19.	Lotna	526	458	87.07	30	5.70	0	0.00	0	0.00	30	5.70
23.	Mawai	2,708	2,312	85.38	172	6.35	77	2.84	0	0.00	172	6.35
25.	Nari Chak	521	453	86.95	23	4.41	73	14.01	41	7.87	64	12.28
50.	Chhibipur	53	41	77.36	0	0.00	0	0.00	0	0.00	0	0.00
56.	Galibpur	361	279	77.29	6	1.66	11	3.05	1	0.28	7	1.94
60.	Khanpur	211	183	86.73	4	1.90	0	0.00	2	0.95	6	2.84
65.	Rajwada	515	422	81.94	19	3.69	0	0.00	8	1.55	27	5.24
66.	Sarai Mubarak	235	180	76.60	5	2.13	0	0.00	2	0.85	7	2.98
Sub-Total		12,127	10,332	85.20	549	4.53	578	4.77	533	4.40	1082	8.92
Grand-Total		25,763	16,413	63.71	1118	4.34	601	2.33	640	2.48	1758	6.82

Data Source : Miran Khasara, Unnao, Rae Bareli District THESIL Concerned

Table G.8 Drainage Characteristics by Village-wise Data in Sursa Study Area (1/2)

S1. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
A. SURSA BLOCK (HARDOI DISTRICT)												
1.	Achhrawau	298	35	11.74	15	5.03	0	0.00	0	0.00	15	5.03
2.	Ancharra	693	70	10.10	15	2.16	0	0.00	116	16.74	131	18.90
3.	Umarapur	541	40	7.39	11	2.03	0	0.00	54	9.98	65	12.01
4.	Ainchawau	451	20	4.43	14	3.10	0	0.00	61	13.53	75	16.63
5.	Odra Pachlai	1,062	110	10.36	28	2.64	0	0.00	10	0.94	38	3.58
6.	Arangapur	346	20	5.78	17	4.91	0	0.00	6	1.73	23	6.65
7.	Kamrauli	249	17	6.83	17	6.83	0	0.00	6	2.41	23	9.24
8.	Tikri	270	19	7.04	4	1.48	0	0.00	3	1.11	7	2.59
9.	Dhinni Tasaula	378	19	5.03	30	7.94	0	0.00	2	0.53	32	8.47
10.	Turtipur	794	82	10.33	28	3.53	0	0.00	14	1.76	42	5.29
11.	Tundval	706	42	5.95	47	6.66	0	0.00	67	9.49	114	16.15
12.	Dahlgawan	219	22	10.05	5	2.74	0	0.00	4	1.83	10	4.57
13.	Dalolpur	427	18	4.22	10	2.34	0	0.00	103	24.12	113	26.46
14.	Nevada	150	21	14.00	2	1.33	0	0.00	0	0.00	2	1.33
17.	Dahoti Salkupur	381	18	4.72	10	2.62	0	0.00	22	5.77	32	8.40
18.	Barauva	278	12	4.32	23	8.27	0	0.00	1	0.36	24	8.63
19.	Bahrैया	271	11	4.06	5	1.85	0	0.00	3	1.11	8	2.95
21.	Bikapur	634	31	4.89	41	6.47	0	0.00	40	6.31	81	12.78
22.	Bausara	461	23	4.99	32	6.94	0	0.00	6	1.30	38	8.24
23.	Bhataura	138	9	6.52	3	2.17	0	0.00	0	0.00	3	2.17
24.	Bhittha	124	8	6.45	12	9.68	0	0.00	4	3.23	16	12.90
25.	Marsa	907	120	13.23	34	3.75	0	0.00	44	4.85	78	8.60
26.	Meoni	814	0	0.00	80	9.83	0	0.00	2	0.25	82	10.07
27.	Mahurakalan	365	19	5.21	12	3.29	0	0.00	54	14.79	66	18.08
31.	Sarsaiya	328	0	0.00	18	5.49	7	2.13	10	3.05	28	8.54
32.	Sauntera	927	52	5.61	53	5.72	3	0.32	97	10.46	150	16.18
33.	Hosiapur	562	31	5.52	29	5.16	22	3.91	4	0.71	33	5.87
36.	Dholia	256	14	5.47	2	0.78	0	0.00	0	0.00	2	0.78
37.	Deoria	128	0	0.00	1	0.78	0	0.00	0	0.00	1	0.78
38.	Nanamau	37	4	10.81	0	0.00	0	0.00	0	0.00	0	0.00
39.	Fardapur	110	11	10.00	3	2.73	0	0.00	0	0.00	3	2.73
40.	Asauli	381	19	4.99	9	2.36	0	0.00	0	0.00	9	2.36
41.	Odranevaliya	470	24	5.11	9	1.91	0	0.00	0	0.00	9	1.91
42.	Kasrawan	682	31	4.55	22	3.23	0	0.00	1	0.15	23	3.37
43.	Khajurabara	2,132	140	6.57	70	3.28	0	0.00	15	0.70	85	3.99
44.	Jura	708	0	0.00	26	3.67	2	0.28	11	1.55	37	5.23
45.	Bhadaicha	863	41	4.75	28	3.24	0	0.00	1	0.12	29	3.36
46.	Malihawau	753	36	4.78	4	0.53	0	0.00	1	0.13	5	0.66
47.	Madhopur	180	11	6.11	5	2.78	0	0.00	0	0.00	5	2.78
48.	Sursa	257	0	0.00	9	3.50	0	0.00	0	0.00	9	3.50
49.	Akhnapur	135	9	6.67	2	1.48	0	0.00	0	0.00	2	1.48
50.	Kauthalia	168	10	5.95	4	2.38	0	0.00	0	0.00	4	2.38
51.	Gurra	27	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
52.	Ghamolya	65	4	6.15	8	12.31	2	3.08	0	0.00	8	12.31
53.	Peng	368	21	5.71	15	4.08	2	0.54	4	1.09	19	5.16
54.	Marhia	48	4	8.33	4	8.33	0	0.00	0	0.00	4	8.33
55.	Shabuddinpur	646	43	6.66	25	3.87	21	3.25	4	0.62	29	4.49
56.	Sarra	590	0	0.00	19	3.22	0	0.00	3	0.51	22	3.73
57.	Sathra	518	36	6.95	35	6.76	10	1.83	2	0.39	37	7.14
58.	Sikandarapur	165	0	0.00	11	6.67	0	0.00	0	0.00	11	6.67
59.	Keharwau	150	11	7.33	3	2.00	0	0.00	0	0.00	3	2.00
61.	Gangapur	333	19	5.71	9	2.70	4	1.20	2	0.60	11	3.30
62.	Ghosar	279	0	0.00	19	6.81	0	0.00	0	0.00	19	6.81
63.	Pachkohra	331	19	5.74	14	4.23	0	0.00	1	0.30	15	4.53
64.	Bannapur	683	43	6.30	17	2.49	0	0.00	3	0.44	20	2.93
65.	Bahloli	185	0	0.00	9	4.62	1	0.51	0	0.00	9	4.62
66.	Bhawanipur	133	9	6.77	3	2.26	0	0.00	0	0.00	3	2.26
67.	Bhilawan	324	24	7.41	15	4.63	0	0.00	0	0.00	15	4.63
68.	Bhalnawau	430	41	9.53	13	3.02	0	0.00	0	0.00	13	3.02
69.	Mehuna Maheshpur	274	0	0.00	14	5.11	0	0.00	0	0.00	14	5.11
70.	Lalpur	576	0	0.00	23	3.99	1	0.17	0	0.00	23	3.99

Table G.8 Drainage Characteristics by Village-wise Data in Sursa Study Area (2/2)

Sl. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
71.	Sehramau	44	3	6.82	1	2.27	0	0.00	1	2.27	2	4.55
72.	Saraiya	150	0	0.00	4	2.57	8	5.33	1	0.67	5	3.33
73.	Singhwamau	340	0	0.00	8	2.35	2	0.59	4	1.18	12	3.53
74.	Sohariya	853	22	2.58	15	1.76	12	1.41	9	1.06	24	2.81
75.	Harha	217	25	11.52	9	4.15	0	0.00	0	0.00	9	4.15
76.	Hathiai	157	11	7.01	5	3.18	0	0.00	0	0.00	5	3.18
77.	Matuwa	269	14	5.20	4	1.49	0	0.00	7	2.60	11	4.09
78.	Abdulpur	168	12	7.14	10	5.95	0	0.00	0	0.00	10	5.95
79.	Tashkhora	123	10	8.13	1	0.81	0	0.00	0	0.00	1	0.81
80.	Barbatapur	48	3	6.25	2	4.17	0	0.00	0	0.00	2	4.17
81.	Rajepur	131	8	6.11	4	3.05	0	0.00	0	0.00	4	3.05
83.	Kairmair	177	9	5.08	5	2.82	7	3.95	2	1.13	7	3.95
Sub-Total		28,846	1,610	5.58	1114	3.86	104	0.36	805	2.79	1919	6.65
B. AHILOLI BLOCK (HARDOI DISTRICT)												
18.	Karahi	275	14	5.09	11	4.00	6	2.18	0	0.00	11	4.00
20.	Khajurwai	329	51	15.50	9	2.74	0	0.00	0	0.00	9	2.74
34.	Jarera	47	22	46.81	2	4.26	0	0.00	0	0.00	2	4.26
37.	Danwandi	132	61	46.21	2	1.52	0	0.00	4	3.03	6	4.55
50.	Punniyan	315	0	0.00	22	6.98	0	0.00	1	0.32	23	7.30
51.	Faridapur	802	0	0.00	11	1.37	21	2.62	0	0.00	11	1.37
60.	Wallipur	760	106	13.95	15	1.97	3	0.39	1	0.13	16	2.11
61.	Pipona	354	52	14.69	11	3.11	2	0.56	2	0.56	13	3.67
62.	Vaishpur	59	29	49.15	0	0.00	0	0.00	0	0.00	0	0.00
63.	Daudpur	125	63	50.40	4	3.20	0	0.00	4	3.20	8	6.40
65.	Bambna Khora	110	34	30.91	2	1.82	3	2.73	0	0.00	2	1.82
74.	Anuvan	115	27	23.48	3	2.61	0	0.00	0	0.00	3	2.61
Sub-Total		3,423	459	13.41	92	2.69	35	1.02	12	0.35	104	3.04
Grand-Total		32,269	2,069	6.41	1,206	3.74	139	0.43	817	2.53	2023	6.27

Data Source : Miran Khasara, Hardoi & Ahiloli District TEHSIL Concerned

Table G.9 Drainage Characteristics by Village-wise Data in Purwa Study Area (1/2)

Sl. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
A. PURWA BLOCK (UNNAO DISTRICT)												
1.	Beval Mansa Kher	308	258	83.77	0	0.00	0	0.00	51	16.56	51	16.56
2.	Bhatmau	230	198	86.09	8	3.48	0	0.00	8	3.48	16	6.96
3.	Chamlyani	1,075	874	81.30	25	2.33	40	3.72	27	2.51	52	4.84
4.	Garha Kola	171	114	66.67	3	1.75	0	0.00	7	4.09	10	5.85
5.	Janpur	96	72	75.00	2	2.08	0	0.00	1	1.04	3	3.13
6.	Kishan Khera	151	120	79.47	5	3.31	0	0.00	0	0.00	5	3.31
7.	Lakhmade Mau	328	278	84.76	12	3.66	0	0.00	0	0.00	12	3.66
8.	Mahra Man	289	211	73.01	13	4.50	0	0.00	0	0.00	13	4.50
9.	Majawan Sovak	113	83	73.45	5	4.42	4	3.54	7	6.19	12	10.62
10.	Muraita	246	181	73.58	15	6.10	19	7.72	0	0.00	15	6.10
11.	Rasupur	128	92	71.88	2	1.56	0	0.00	8	6.25	10	7.81
12.	Sijnisohra Mau	262	201	76.72	10	3.82	12	4.58	0	0.00	10	3.82
13.	Tewaria	150	114	76.00	5	3.33	5	3.33	0	0.00	5	3.33
14.	Salethu	345	271	78.55	8	2.32	0	0.00	0	0.00	8	2.32
16.	Barwat	163	114	69.94	6	3.68	0	0.00	9	5.52		0.00
35.	Achal Khera	145	0	0.00	5	3.45	0	0.00	1	0.69	6	4.14
36.	Soer Sahab Lal	11	7	63.64	1	9.09	0	0.00	0	0.00		0.00
37.	Ahamadabad Grunt	78	63	80.77	1	1.28	0	0.00	2	2.56	3	3.85
38.	Atwa	55	42	76.36	2	3.64	0	0.00	2	3.64	4	7.27
39.	Bodey Khera	190	161	84.74	3	1.58	0	0.00	26	13.68	29	15.26
40.	Banigaon	754	658	87.27	17	2.25	0	0.00	48	6.37	65	8.62
41.	Bhadnang	575	436	75.83	24	4.17	0	0.00	40	6.96	64	11.13
42.	Bishun Khera	362	298	82.32	5	1.38	0	0.00	25	6.91	30	8.29
43.	Chak Jamalpur	104	76	73.08	0	0.00	0	0.00	0	0.00	0	0.00
44.	Dhirji Khera	93	63	67.74	3	3.23	0	0.00	4	4.30	7	7.53
46.	Fatehganj	160	136	85.00	2	1.25	6	3.75	1	0.63	3	1.88
48.	Gangdaspur	100	78	78.00	1	1.00	0	0.00	6	6.00		0.00
49.	Himmatpur Khera	185	155	83.78	4	2.16	0	0.00	0	0.00		0.00
50.	Kasroar	556	478	85.97	54	9.71	3	0.54	17	3.06	71	12.77
53.	Nevada	171	141	82.46	2	1.17	0	0.00	15	8.77		0.00
54.	Kasba Pachhia	418	356	85.17	28	6.70	27	6.46	7	1.67	35	8.37
55.	Patti Sukhmandan	109	80	73.39	9	8.26	2	1.83	5	4.59	14	12.84
56.	Kasba Ramahimat	458	378	82.53	17	3.71	0	0.00	0	0.00	17	3.71
57.	Kasba Bhawanipur	362	283	78.18	6	1.66	0	0.00	17	4.70	23	6.35
58.	Chandigerhi	127	93	73.23	1	0.79	0	0.00	21	16.54	22	17.32
60.	Kalyanpur	59	43	72.88	1	1.69	0	0.00	0	0.00	1	1.69
61.	Bharthi Garhi	57	42	73.68	1	1.75	0	0.00	5	8.77	6	10.53
62.	Seer Kasley Khan	21	16	76.19	0	0.00	0	0.00	1	4.76	1	4.76
63.	Ramuanarpur	358	301	84.08	8	2.23	0	0.00	36	10.06		0.00
64.	Simri Mau	142	121	85.21	1	0.70	0	0.00	2	1.41	3	2.11
65.	Sues Khera	194	168	86.60	12	6.19	17	8.76	0	0.00		0.00
66.	Tikar Kalan	307	258	84.04	4	1.30	0	0.00	20	6.51	24	7.82
67.	Tikar Khurd	206	186	90.29	3	1.46	0	0.00	7	3.40	10	4.85
68.	Tripurarpur	1,059	858	81.02	83	7.84	21	1.98	0	0.00	83	7.84
69.	Tusroar	221	172	77.83	8	3.62	9	4.07	0	0.00	8	3.62
70.	Bachholia	39	22	56.41	6	15.38	3	7.69	0	0.00	6	15.38
72.	Asehru	291	204	70.10	14	4.81	0	0.00	0	0.00	14	4.81
75.	Bhopatpuk	491	386	78.62	14	2.85	80	16.29	15	3.05	29	5.91
76.	Shanker Chak	16	12	75.00	1	6.25	3	18.75	0	0.00	1	6.25
77.	Basnoha	135	104	77.04	5	3.70	9	6.67	2	1.48	7	5.19
78.	Chhulamau	169	114	67.46	11	6.51	5	2.96	0	0.00	11	6.51
79.	Dela	82	68	82.93	4	4.88	0	0.00	0	0.00	4	4.88
81.	Asgarganj	49	37	75.51	2	4.08	1	2.04	3	6.12	5	10.20
82.	Mohiuddinpur	471	387	82.17	44	9.34	14	2.97	18	3.82	62	13.16
83.	Bhatauma	105	82	78.10	1	0.95	0	0.00	6	5.71	7	6.67
84.	Bhitauli	177	148	83.62	8	4.52	0	0.00	2	1.13	10	5.65
85.	Chandrasena	144	121	84.03	14	9.72	7	4.86	6	4.17	20	13.89
86.	Darehata	372	299	80.38	35	9.41	0	0.00	42	11.29	77	20.70
87.	Himmatpur	85	71	83.53	3	3.53	10	11.76	0	0.00	3	3.53
88.	Kodra	284	211	74.30	58	20.42	62	21.83	0	0.00	58	20.42
89.	Muraita	237	187	78.90	13	5.49	14	5.91	13	5.49	26	10.97
90.	Naya Gaon	150	123	82.00	1	0.67	3	2.00	1	0.67	2	1.33

Table G.9 Drainage Characteristics by Village-wise Data in Purva Study Area (2/2)

Sl. No.	Village Name	Geographical Area (ha)	Flooding Area (ha)	Rate (%)	Waterlogged/Marshy Area (ha)	Rate (%)	Ponds & Lakes (ha)	Rate (%)	Usar Area (ha)	Rate (%)	Waterlogged/Marshy & Usar Area (ha)	Rate (%)
91.	Pinjra	334	278	83.23	21	6.29	39	11.68	23	6.89	44	13.17
92.	Topra	248	198	79.84	6	2.42	0	0.00	5	2.02	11	4.44
93.	Jampurpur	260	204	78.46	12	4.62	28	10.77	8	3.08	20	7.69
94.	Baijuaau	176	111	63.07	5	2.84	2	1.14	0	0.00	5	2.84
95.	Ghinakhara	123	94	76.42	2	1.63	0	0.00	0	0.00	2	1.63
96.	Mamrajpur	454	384	84.58	16	3.52	0	0.00	15	3.30	31	6.83
97.	Pakra Buzurg	458	386	84.28	13	2.84	0	0.00	0	0.00	13	2.84
98.	Panhan	92	78	84.78	3	3.26	0	0.00	3	3.26	6	6.52
99.	Purandarapur	198	164	82.83	7	3.54	0	0.00	0	0.00	7	3.54
100.	Raghunathpur	146	121	82.88	4	2.74	0	0.00	0	0.00	4	2.74
101.	Raw Khara	66	48	72.73	2	3.03	0	0.00	0	0.00	2	3.03
102.	Rawatpur	145	119	82.07	3	2.07	0	0.00	0	0.00	3	2.07
103.	Turkaha	118	93	78.81	3	2.54	0	0.00	0	0.00	3	2.54
104.	Afsari	151	131	86.75	5	3.31	0	0.00	1	0.66	6	3.97
105.	Adhauli	173	145	83.82	6	3.47	0	0.00	6	3.47	12	6.94
109.	Kathar	145	109	75.17	3	2.07	0	0.00	0	0.00	3	2.07
Sub-Total		18,276	14,567	79.71	770	4.21	445	2.43	595	3.26	1365	7.47
B. SUMELPUR BLOCK (UNNAO DISTRICT)												
4.	Khijauli	216	0	0.00	8	3.70		0.00	1	0.46	9	4.17
7.	Pakra Khurd	451	0	0.00	10	2.22		0.00	14	3.10	24	5.32
8.	Saraiyan	149	0	0.00	29	19.46		0.00	3	2.01	32	21.48
Sub-Total		816	0	0.00	47	5.76	0	0.00	18	2.21	65	7.97
C. HILAULI BLOCK (UNNAO DISTRICT)												
15.	Jera	518	452	87.26	28	5.41	60	11.58	44	8.49	72	13.90
28.	Patewala Dasi	204	160	78.43	14	6.86	0	0.00	8	3.92	22	10.78
Sub-Total		722	612	84.76	42	5.82	60	8.31	52	7.20	94	13.02
D. KHEERO BLOCK (RAE BARELI DISTRICT)												
7.	Aindhi	384	307	79.95	39	10.16	0	0.00	0	0.00	39	10.16
32.	Jari	407	326	80.10	18	4.42	35	8.60	4	0.98	22	5.41
79.	Sheopuri	223	178	79.82	17	7.62	11	4.93	0	0.00	17	7.62
Sub-Total		1,014	811	79.98	74	7.30	46	4.54	4	0.39	78	7.69
Grand-Total		20,828	15,990	76.77	933	4.48	551	2.65	669	3.21	1602	7.69

Data Source : Miran Khasara, Unnao & Rae Bareli District TEHSIL Concerned

Table G.10 Rate of Waterlogged/Marshy Area

Rate of W/M Area (%)	Sarojini Nagar Study Area			Sataon Study Area			Sursa Study Area			Purwa Study Area		
	Nos. of Village	Area (ha)	Rate of Vi. A/Ge. A (%)	Nos. of Village	Area (ha)	Rate of Vi. A/Ge. A (%)	Nos. of Village	Area (ha)	Rate of Vi. A/Ge. A (%)	Nos. of Village	Area (ha)	Rate of Vi. A/Ge. A (%)
0 - 1 %	6	1,662	4.96	2	63	0.27	7	1,383	4.29	7	957	4.59
1 - 2 %	15	6,376	19.04	6	1,133	4.40	11	4,222	13.08	14	2,474	11.88
2 - 3 %	20	7,025	20.98	11	4,136	16.05	21	6,754	20.93	15	5,191	24.92
3 - 4 %	23	8,470	25.29	10	5,032	19.53	17	10,168	31.51	20	3,826	18.37
(1 - 4 %)	58	21,871	65.31	27	10,301	39.98	49	21,144	65.52	49	11,491	55.17
4 - 5 %	10	3,279	9.79	6	5,500	21.35	9	2,151	6.67	9	2,243	10.77
5 - 6 %	5	1,847	5.52	4	5,466	21.22	6	2,557	7.92	2	755	3.62
6 - 7 %	5	1,676	5.00	3	4,232	16.43	8	3,327	10.31	7	1,581	7.59
(4 - 7 %)	20	6,802	20.31	13	15,198	58.99	23	8,035	24.90	18	4,579	21.98
7 - 8 %	6	1,560	4.66	0	0	0.00	1	378	1.17	2	1,282	6.16
8 - 9 %	2	1,007	3.01	0	0	0.00	2	326	1.01	1	109	0.52
9 - 10 %	2	237	0.71	0	0	0.00	2	938	2.91	5	1,554	7.46
(7 - 10 %)	10	2,804	8.37	0	0	0.00	5	1,642	5.09	8	2,945	14.14
10 % <	1	349	1.04	1	195	0.76	1	65	0.20	4	856	4.11
Total	95	33,488	100.00	43	25,763	100.00	85	32,269	100.00	86	20,828	100.00

Remarks : Rate of W/M ----- Waterlogged/Marshy Area as % of Geographical Area

Table G.11. Rate of Flooding Area

Rate of Flooding Area (%)	Sarojini Nagar Study Area			Sataon Study Area			Sursa Study Area			Purwa Study Area		
	Nos. of Village (Nos.)	Village Area (ha)	Rate of Vi.A/Ge.A (%)	Nos. of Village (Nos.)	Village Area (ha)	Rate of Vi.A/Ge.A (%)	Nos. of Village (Nos.)	Village Area (ha)	Rate of Vi.A/Ge.A (%)	Nos. of Village (Nos.)	Village Area (ha)	Rate of Vi.A/Ge.A (%)
0 - 10 %	0	0	0.00	6	1,499	5.82	66	25,751	79.80	4	961	4.61
10 - 20 %	19	5,169	15.44	7	1,312	5.09	13	5,930	18.38	0	0	0.00
(0 - 20 %)	19	5,169	15.44	13	2,811	10.91	79	31,681	98.18	4	961	4.61
20 - 30 %	33	14,655	43.76	4	780	3.03	1	115	0.36	0	0	0.00
30 - 40 %	9	5,661	16.90	1	395	1.53	1	110	0.34	0	0	0.00
(20 - 40 %)	42	20,316	60.67	5	1,175	4.56	2	225	0.70	0	0	0.00
40 - 50 %	8	1,463	4.37	3	5,434	21.09	3	238	0.74	0	0	0.00
50 - 60 %	8	3,652	10.91	1	1,180	4.58	1	125	0.39	1	39	0.19
(40 - 60 %)	16	5,115	15.27	4	6,614	25.67	4	363	1.12	1	39	0.19
60 - 70 %	1	65	0.19	0	0	0.00	0	0	0.00	7	883	4.24
70 - 80 %	5	756	2.26	7	2,571	9.98	0	0	0.00	36	6,849	32.88
(60 - 80 %)	6	821	2.45	7	2,571	9.98	0	0	0.00	43	7,732	37.12
80 - 90 %	11	1,534	4.58	13	11,956	46.41	0	0	0.00	37	11,890	57.09
90 - 100 %	1	533	1.59	1	636	2.47	0	0	0.00	1	206	0.99
(80 - 100 %)	12	2,067	6.17	14	12,592	48.88	0	0	0.00	38	12,096	58.08
Total	95	33,488	100.00	43	25,763	100.00	85	32,269	100.00	86	20,828	100.00

Remarks : Rate of Flooding Area as % of Geographical Area

Table G.12 Rate of Usar Area in Village-wise

Rate of W/M Area (%)	Sarojini Nagar Study Area			Sataon Study Area			Sursa Study Area			Purwa Study Area		
	Nos. of Village (Nos.)	Area (ha)	Rate of Vi.A/Ge.A (%)	Nos. of Village (Nos.)	Area (ha)	Rate of Vi.A/Ge.A (%)	Nos. of Village (Nos.)	Area (ha)	Rate of Vi.A/Ge.A (%)	Nos. of Village (Nos.)	Area (ha)	Rate of Vi.A/Ge.A (%)
0 - 1 %	56	19,738	58.94	36	19,115	74.20	58	19,722	61.12	39	9,163	48.99
1 - 2 %	12	4,309	12.87	1	515	2.00	11	4,807	14.90	5	968	4.65
2 - 3 %	0	0	0.00	2	1,526	5.92	3	562	1.74	4	1,550	7.44
3 - 4 %	2	1,255	3.75	0	0	0.00	3	1,146	3.55	12	3,643	17.49
(1 - 4 %)	14	5,564	16.61	3	2,041	7.92	17	6,515	20.19	21	6,161	29.58
4 - 5 %	4	1,780	5.32	0	0	0.00	1	907	2.81	6	900	4.32
5 - 6 %	3	866	2.59	0	0	0.00	1	381	1.18	3	505	2.42
6 - 7 %	2	411	1.23	0	0	0.00	1	634	1.96	10	2,112	10.14
(4 - 7 %)	9	3,057	9.13	0	0	0.00	3	1,922	5.96	19	3,517	16.89
7 - 8 %	1	289	0.86	2	1,387	5.38	0	0	0.00	0	0	0.00
8 - 9 %	0	0	0.00	0	0	0.00	0	0	0.00	2	632	3.03
9 - 10 %	1	285	0.85	0	0	0.00	2	1,247	3.86	0	0	0.00
(7 - 10 %)	2	574	1.71	2	1,387	5.38	2	1,247	3.86	2	632	3.03
10 - 11 %	3	1,244	3.71	0	0	0.00	1	927	2.87	1	358	1.72
11 - 12 %	1	558	1.67	0	0	0.00	0	0	0.00	1	372	1.79
12 - 13 %	2	560	1.67	1	2,584	10.03	0	0	0.00	0	0	0.00
13 - 14 %	2	479	1.43	0	0	0.00	1	451	1.40	1	190	0.91
14 - 15 %	0	0	0.00	0	0	0.00	1	365	1.13	0	0	0.00
15 - 16 %	1	126	0.38	0	0	0.00	0	0	0.00	0	0	0.00
16 - 17 %	1	154	0.46	0	0	0.00	1	693	2.15	2	435	2.09
17 - 18 %	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00
18 - 19 %	1	910	2.72	0	0	0.00	0	0	0.00	0	0	0.00
19 - 20 %	1	260	0.78	0	0	0.00	0	0	0.00	0	0	0.00
20 % <	2	264	0.79	1	636	2.47	1	427	1.32	0	0	0.00
(10 % <)	14	4,555	13.60	2	3,220	12.50	5	2,863	8.87	5	1,355	6.51
Total	95	33,488	100.00	43	25,763	100.00	85	32,269	100.00	86	20,828	100.00

Remarks : Rate of Usar Area as % of Geographical Area

Table G.13 Rate of Waterlogged/Marshy Area in Sai River Basin and Loni Nadi

Sl No.	Name of District	Name of Block	Hardoi Command Area		Sai River Basin		Loni Nadi Basin	
			Geographical Area (ha)	Waterlogged/Marshy Area (ha)	Geographical Area (ha)	Waterlogged/Marshy Area (ha)	Geographical Area (ha)	Waterlogged/Marshy Area (ha)
1	Pilibhit	Puranpur	121,574	794				
2	Shahajhanpur	Banda	46,891	154				
3	Shahajhanpur	Pawayan	30,601	162				
4	Shahajhanpur	Sindhauri	29,168	266				
5	Shahajhanpur	Bhawalkhera	31,928	386				
6	Kheri	Pasgan	47,370	504	11,843	126		
7	Hardoi	Pihani	33,685	350	20,211	210		
8	Hardoi	Todarpur	30,621	305	18,373	183		
9	Hardoi	Shahabad	34,673	614	3,467	61		
10	Hardoi	Hariyawan	29,035	656	14,518	328		
11	Hardoi	Tadiyawan	31,235	462	9,371	139		
12	Hardoi	Bawan	32,827	502	22,979	351		
13	Hardoi	Sandi	31,576	1,185				
14	Hardoi	Ahiraauri	37,703	111	7,541	22		
15	Hardoi	Sursa	33,628	897	26,902	718		
16	Hardoi	Bilgram	33,839	1,192				
17	Hardoi	Kohawan	29,485	557				
18	Hardoi	Kachhona	24,864	1,518	4,973	304		
19	Hardoi	Madhoganj	28,916	549	2,892	55		
20	Hardoi	Bharawan	31,069	417	9,321	125		
21	Hardoi	Sandila	31,362	1,895				
22	Hardoi	Behdar	27,842	1,788	16,705	1,073		
23	Hardoi	Malawan	23,140	1,155				
24	Lucknow	Mal	25,382	245				
25	Lucknow	Malihabad	21,092	539	1,055	27		
26	Lucknow	Kakori	22,594	646	9,038	258		
27	Lucknow	Sarojini Nagar	38,435	1,150	36,513	1,093		
28	Lucknow	Mohalalagani	35,903	201	17,952	101		
29	Lucknow	Gosaiganj	34,652	803				
30	Unnao	Auras	25,701	809	10,280	324		
31	Unnao	Ganjmuradabad	23,428	663	7,028	199		
32	Unnao	Bangawan	27,990	1,302	5,598	260		
33	Unnao	Patehapur	27,996	772	8,399	232		
34	Unnao	Hasanganj	32,177	524	32,177	524		
35	Unnao	Mayaganj	27,331	843	24,598	759	547	17
36	Unnao	Safipur	25,683	1,791	2,568	179		
37	Unnao	Nawaganj	27,803	714	27,803	714		
38	Unnao	Bichhiya	33,483	972	3,348	97	26,786	778
39	Unnao	Sikandarpur Siro	33,242	726			6,648	145
40	Unnao	Sikandarpur Khan	34,889	647			3,489	65
41	Unnao	Asoha	28,893	1,081	27,448	1,027		
42	Unnao	Purwa	23,527	554	9,411	222	14,116	332
43	Unnao	Hilauli	33,881	819	33,881	819		
44	Unnao	Bighapur	25,556	189			20,445	151
45	Unnao	Sumerpur	26,939	377			18,857	264
46	Rae Bareli	Sataon	25,550	85	25,550	85		
47	Rae Bareli	Khero	23,204	647	13,922	388	9,282	259
48	Rae Bareli	Lalaganj	22,276	71			17,821	57
49	Rae Bareli	Sarani	25,511	30			3,827	5
50	Rae Bareli	Dalmau	26,476	286	14,562	157		
Total			1,592,626	33,905	480,227 (30.2%)	11,160 (32.9%)	121,818 (7.6%)	2,073 (6.1%)

Table C.14 Daily Maximum Discharge of the Sai River and Loni Nadi

Sai River (Station:Orais)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des	Annual	
1985									35.00	155.60	182.00	50.50	14.50	182.00
1986	8.50	5.56	3.10	2.90	2.00	6.50	64.00	29.20	22.90	8.20	4.80	6.00	64.00	
1987	5.96	4.04	3.49	3.17	2.63	2.55	2.08	1.97	2.16	4.26	1.98	2.05	5.96	
1988	2.04	2.14	2.15	2.15	2.00	2.83	20.34	22.86	22.81	19.82	7.56	4.11	22.86	
1989	1.62	1.44	2.56	1.55	1.91	2.12	4.92	3.73	3.54	4.23	2.06	1.94	4.92	
1990	1.73	1.43	1.90	2.54	2.91	3.08	5.42	5.57					5.57	
Max	8.50	5.56	3.49	3.17	2.91	6.50	64.00	35.00	155.60	182.00	51.50	14.50		

Loni Nadi (Station:Pieralipur)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Des	Annual
1985													
1986													
1987	5.82	2.89	3.33	2.15	0.63	0.70	1.14	109.89	11.90	15.99	3.13	0.98	109.89
1988	3.05	3.13	1.57	0.90	0.43	8.70	38.66	101.00	15.41		4.25		101.00
1989			3.75	3.72	1.51	12.00	5.55	20.62	69.11	15.76	3.14	4.37	69.11
1990	3.58	7.58		3.65	0.72	12.94	54.29	83.46					83.46
Max	5.82	7.58	3.75	3.72	1.51	12.94	54.29	109.89	69.11	15.99	4.25	4.37	

Table G.15 Computation of Non-Uniform Flow in Sai River

St No.	Computational Point (Km)	Flood Stage (m)	Cross-sectional Area of Flow			Hydraulic Mean Depth			Coefficient of Roughness	Flood Discharge (m ³ /sec)
			Major Bed (m ²)	Minor Bed (m ²)	Total (m ²)	Major Bed (m)	Minor Bed (m)	Total (m)		
1.	145.00	87.707	450.9	740.2	1,191.1	1.16	6.71	4.26	0.0300	906.3
2.	150.00	88.104	324.9	741.9	1,066.9	0.61	6.71	4.42	0.0300	906.3
3.	155.00	88.482	1,213.9	741.7	1,955.6	1.24	6.75	2.98	0.0300	906.3
4.	160.00	88.742	802.4	730.7	1,533.1	1.05	6.54	3.29	0.0300	906.3
5.	165.00	89.127	145.6	731.2	876.7	0.61	6.52	5.28	0.0300	906.3
6.	170.00	89.607	459.6	741.2	1,200.8	0.95	6.68	4.09	0.0300	906.3
7.	175.00	90.036	74.7	747.1	821.8	0.61	6.58	5.88	0.0300	906.3
8.	180.00	90.540	50.5	759.5	810.0	0.52	6.72	6.21	0.0300	906.3
9.	185.00	91.006	198.2	768.1	966.3	1.14	6.90	5.48	0.0300	906.3
10.	190.00	91.408	226.0	770.3	996.2	1.30	6.99	5.46	0.0300	906.3
11.	195.00	91.812	121.8	773.7	895.5	0.71	6.87	5.81	0.0300	906.3
12.	205.00	92.608	310.4	777.3	1,087.7	1.61	7.14	5.31	0.0300	906.3
13.	210.00	92.955	405.6	775.0	1,180.6	0.98	6.95	4.51	0.0300	906.3
14.	230.00	94.251	0.0	753.6	753.6	0.00	6.55	6.56	0.0300	667.3
15.	240.00	94.844	0.0	737.9	737.9	0.00	6.43	6.44	0.0300	667.3
16.	245.00	95.156	0.0	731.1	731.1	0.00	6.38	6.38	0.0300	667.3
17.	247.00	95.283	18.9	728.8	747.8	0.18	6.40	6.19	0.0300	667.3
18.	250.00	95.475	0.0	725.0	725.0	0.00	6.33	6.34	0.0300	667.3
19.	255.00	95.771	691.8	717.6	1,409.4	0.58	6.36	3.02	0.0300	667.3
20.	260.00	96.041	0.0	706.6	706.6	0.00	6.19	6.20	0.0300	667.3
21.	265.00	96.396	0.0	704.1	704.1	0.00	6.17	6.18	0.0300	667.3
22.	270.00	96.755	0.0	702.0	702.0	0.00	6.16	6.16	0.0300	667.3
23.	275.00	97.116	0.0	701.1	701.1	0.00	6.15	6.15	0.0300	667.3
24.	280.00	97.479	0.0	699.4	699.4	0.00	6.14	6.14	0.0300	667.3
25.	285.00	97.844	0.0	697.9	697.9	0.00	6.12	6.13	0.0300	667.3
26.	290.00	98.211	0.0	697.6	697.6	0.00	6.12	6.13	0.0300	667.3
27.	295.00	98.580	0.0	696.5	696.5	0.00	6.11	6.12	0.0300	667.3
28.	300.00	98.950	0.0	695.5	695.5	0.00	6.11	6.11	0.0300	667.3
29.	305.00	99.320	0.0	695.5	695.5	0.00	6.11	6.11	0.0300	667.3
30.	310.00	99.691	0.0	694.6	694.6	0.00	6.10	6.10	0.0300	667.3
31.	315.00	100.075	0.0	680.0	680.0	0.00	5.99	5.99	0.0300	667.3
32.	322.00	100.654	0.0	662.9	662.9	0.00	5.85	5.86	0.0300	667.3
33.	330.00	101.525	0.0	531.2	531.2	0.00	5.69	5.70	0.0300	667.3
34.	340.00	103.291	85.4	366.8	452.2	1.26	6.15	5.06	0.0300	667.3
35.	350.00	105.380	56.9	417.8	474.7	0.25	6.33	5.36	0.0300	667.3
36.	357.00	106.350	868.4	429.3	1,297.6	1.46	6.83	2.94	0.0300	667.3
37.	371.00	107.401	763.4	406.8	1,170.2	0.76	6.39	2.29	0.0300	667.3
38.	380.00	108.210	950.6	399.2	1,349.8	0.88	6.32	2.14	0.0300	667.3
39.	390.00	109.192	339.7	394.9	734.5	1.35	6.54	3.82	0.0300	667.3
40.	400.00	110.247	0.0	394.1	394.1	0.00	5.99	6.00	0.0300	394.8
41.	410.00	111.008	144.8	378.6	523.4	1.42	6.15	4.63	0.0300	394.8
42.	420.00	111.846	51.4	354.1	405.4	0.51	5.61	4.79	0.0300	394.8
43.	430.00	112.990	0.0	344.2	344.2	0.00	5.40	5.40	0.0300	394.8
44.	440.00	113.973	248.5	326.9	575.4	2.39	5.71	4.16	0.0300	394.8
45.	450.00	115.057	0.0	314.1	314.1	0.00	5.02	5.02	0.0300	394.8
46.	460.00	116.626	0.0	326.1	326.1	0.00	5.17	5.18	0.0300	394.8
47.	470.00	118.060	13.6	330.8	344.3	0.17	5.27	4.99	0.0300	394.8
48.	480.00	119.414	168.6	265.6	434.2	1.63	5.32	3.73	0.0300	394.8
49.	490.00	120.456	283.6	262.4	546.0	2.69	5.58	3.99	0.0300	394.8
50.	500.00	121.172	321.7	246.3	568.0	3.03	5.40	4.01	0.0300	394.8
51.	510.00	121.849	59.9	228.1	288.0	0.59	4.55	3.54	0.0300	182.0
52.	520.00	122.518	106.3	210.1	316.5	1.04	4.35	3.07	0.0300	182.0
53.	530.00	123.361	44.1	199.0	243.2	0.44	4.07	3.24	0.0300	182.0
54.	540.00	124.477	0.0	198.9	198.9	0.00	3.98	3.98	0.0300	182.0
55.	550.00	125.674	112.1	151.5	263.6	1.10	4.02	2.63	0.0300	182.0
56.	560.00	126.670	172.5	147.8	320.3	1.67	4.06	2.69	0.0300	182.0
57.	570.00	127.814	81.4	148.2	229.6	0.80	3.88	2.62	0.0300	182.0
58.	580.00	129.233	92.1	157.1	249.2	0.90	4.07	2.73	0.0300	182.0
59.	590.00	130.524	66.1	162.3	228.4	0.69	4.16	2.97	0.0300	182.0
60.	600.00	131.631	139.6	161.9	301.4	1.36	4.31	2.81	0.0300	182.0
61.	610.00	132.415	174.9	151.8	326.7	1.69	4.15	2.74	0.0300	182.0
62.	620.00	133.209	167.9	142.0	309.9	1.63	3.94	2.60	0.0300	182.0
63.	630.00	134.089	176.4	134.5	310.9	1.70	3.80	2.54	0.0300	182.0
64.	640.00	135.052	164.9	129.8	294.7	1.60	3.68	2.45	0.0300	182.0
65.	650.00	136.070	175.2	126.7	301.9	1.69	3.63	2.45	0.0300	182.0
66.	660.00	137.014	194.4	121.5	315.9	1.87	3.56	2.48	0.0300	182.0
67.	670.00	138.535	56.4	136.2	192.6	0.64	3.64	2.60	0.0300	182.0
68.	680.00	140.062	178.7	151.1	329.8	1.73	4.16	2.76	0.0300	182.0
69.	690.00	140.683	234.0	139.1	373.1	2.25	4.08	2.89	0.0300	182.0
70.	700.00	141.540	139.2	133.9	273.2	1.36	3.72	2.42	0.0300	182.0
71.	710.00	142.476	225.9	131.1	357.0	2.17	3.85	2.75	0.0300	182.0
72.	720.00	143.268	177.8	124.0	301.8	1.72	3.61	2.45	0.0300	182.0
73.	730.00	144.112	224.9	121.7	346.7	2.15	3.63	2.65	0.0300	182.0
74.	740.00	145.063	171.5	112.4	283.9	1.66	3.31	2.27	0.0300	182.0
75.	750.00	146.502	148.9	101.9	250.8	1.45	3.02	2.04	0.0300	182.0
76.	760.00	149.922	40.9	40.4	81.3	0.41	1.27	0.80	0.0300	182.0

Table G.16 Computation of Non-Uniform Flow in Loni River

St. No.	Computational Point (Km)	Flood Stage (m)	Cross-sectional Area of Flow			Hydraulic Mean Depth			Coefficient of Roughness	Flood Discharge (m ³ /sec)
			Major Bed (m ²)	Minor Bed (m ²)	Total (m ²)	Major Bed (m)	Minor Bed (m)	Total (m)		
1.	0.00	97.371	6.0	129.2	135.2	0.82	2.89	2.78	0.0300	109.9
2.	3.00	97.845	0.9	130.4	131.3	0.26	2.76	2.74	0.0300	109.9
3.	6.00	98.333	3.2	125.6	128.8	0.61	2.91	2.84	0.0300	109.9
4.	9.00	98.873	1.3	115.1	116.3	0.31	2.84	2.80	0.0300	109.9
5.	12.00	99.446	5.7	116.8	122.5	0.77	3.02	2.90	0.0300	109.9
6.	15.00	99.948	0.0	133.6	133.6	0.00	2.81	2.81	0.0300	109.9
7.	18.00	100.501	0.7	106.6	107.3	0.18	2.91	2.89	0.0300	109.9
8.	21.00	101.122	1.3	114.7	115.9	0.30	3.13	3.09	0.0300	109.9
9.	24.00	101.641	4.4	116.3	120.7	0.70	3.22	3.11	0.0300	109.9
10.	27.00	102.113	2.3	124.2	126.5	0.49	3.23	3.17	0.0300	109.9
11.	30.00	102.592	0.0	117.5	117.6	0.04	3.05	3.05	0.0300	109.9
12.	33.00	103.110	1.1	115.9	117.0	0.24	3.23	3.20	0.0300	109.9
13.	36.00	103.622	4.1	107.4	111.5	0.64	3.45	3.32	0.0300	109.9
14.	39.00	104.159	1.6	108.2	109.8	0.36	3.37	3.31	0.0300	109.9
15.	42.00	104.694	0.0	113.5	113.5	0.00	3.30	3.31	0.0300	109.9
16.	44.00	105.156	4.5	119.0	123.6	0.64	3.68	3.54	0.0300	109.9
17.	47.00	105.590	1.2	114.5	115.7	0.25	3.41	3.37	0.0300	109.9
18.	50.00	106.021	5.8	123.4	129.2	0.79	3.70	3.54	0.0300	109.9
19.	53.00	106.444	0.0	114.2	114.2	0.00	3.33	3.33	0.0300	109.9
20.	56.00	106.975	0.0	108.7	108.7	0.00	3.26	3.26	0.0300	109.9
21.	59.00	107.540	0.0	112.7	112.7	0.00	3.16	3.17	0.0300	109.9
22.	62.00	108.084	2.4	108.3	110.7	0.46	3.37	3.30	0.0300	109.9
23.	65.00	108.665	6.2	99.8	106.0	0.64	3.33	3.14	0.0300	109.9
24.	66.00	108.885	11.4	82.5	94.0	1.12	3.47	3.14	0.0300	109.9
25.	69.00	109.667	11.0	84.1	95.1	1.06	3.57	3.23	0.0300	109.9
26.	72.00	110.224	7.4	76.1	83.5	0.81	3.36	3.09	0.0300	53.2
27.	75.00	110.517	0.0	73.2	73.3	0.01	2.84	2.84	0.0300	53.2
28.	78.00	110.903	0.0	68.6	68.6	0.00	2.72	2.72	0.0300	53.2
29.	82.00	111.493	3.6	62.6	66.2	0.57	2.85	2.70	0.0300	53.2
30.	85.00	111.956	5.7	62.0	67.7	0.78	2.84	2.64	0.0300	53.2
31.	88.00	112.468	5.2	56.8	62.0	0.70	2.72	2.52	0.0300	53.2
32.	90.00	112.851	3.5	59.1	62.6	0.56	2.69	2.55	0.0300	53.2
33.	93.00	113.484	0.0	57.5	57.5	0.00	2.41	2.41	0.0300	53.2
34.	96.00	114.226	0.9	54.1	55.0	0.20	2.46	2.41	0.0300	53.2
35.	99.00	114.953	5.8	51.7	57.5	0.84	2.76	2.54	0.0300	53.2
36.	102.00	115.678	1.1	54.1	55.2	0.24	2.45	2.39	0.0300	53.2
37.	105.00	116.429	3.8	52.7	56.5	0.66	2.63	2.47	0.0300	53.2
38.	108.00	117.183	1.5	53.1	54.6	0.32	2.48	2.40	0.0300	53.2

Table G.17 Daily Maximum Rainfall

District Station	Lucknow						Rae Bareilly						Hardoi						Unnao					
	Mohanlalganj			Rae Bareilly			Rae Bareilly			Hardoi			Hardoi			Purwa			Purwa					
	24hrs	48hrs	72hrs	24hrs	48hrs	72hrs	24hrs	48hrs	72hrs	24hrs	48hrs	72hrs	24hrs	48hrs	72hrs	24hrs	48hrs	72hrs						
1965	N.A	N.A	N.A	68.1	102.7	107.9	175.4	228.6	233.8	186.7	195.3	198.9												
1966	104.7	110.5	128	33	34	56.1	48	48	73.4	69	71	71												
1967	165.1	251	266.2	79	142	199	206	262	308	96	149.4	165.8												
1968	69	77.4	79.9	114.4	145.5	157.7	105.5	163	205	135	148.5	163.5												
1969	89.9	120.1	125.7	90	156.8	161.2	75	89	153	75	95.6	102.8												
1970	129.5	240	346.7	148.5	232	312	85	154	202	170	252.4	340.4												
1971	68.8	103.1	103.1	114	160.5	219	76	138	160	86	143	151												
1972	30.7	39.1	41.1	48.5	79	82	109.2	172.7	182.9	72	120	127												
1973	119.4	188	232.5	175.7	343.2	473.2	74.9	125.7	125.7	127	183.4	271.4												
1974	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1975	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1976	48.2	51.6	64.2	75	100	105	112	120	128	75	96.6	140.6												
1977	90.6	130	147.2	50	85	103	84	137	162	64	96	96												
1978	115.6	145.4	148.6	141	205	223	330	340	349	118	192.8	192.8												
1979	50.4	52.4	86	84	109	121	104	104	104	71	115	128.6												
1980	59.2	117.8	161	169.5	224.5	235.9	110	212	309	144	238.4	299.1												
1981	91.4	144.4	146.6	93.5	128	177.5	134	214	214	104.2	179.4	186.4												
1982	61.8	82.6	93.6	87.2	97.2	108.3	49	69	78	135	169	171												
1983	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1984	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1985	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1986	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1987	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1988	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A												
1989	114.2	114.2	114.2	118	174	174	65	44	111	111.8	141.3	141.3												
1990	102.4	118.2	154.4	220	255	273	96	117	151	86	94.2	118.2												

Table G.13 Drainage Benefit Area in Sarojini Nagar Study Area

Block No.	Geographical Drainage Area (ha)		C.C.A. Area (ha)		Waterlogged Area (ha)		Waterlogged Area in C.C.A. (ha)		Main Drainage Canal Construction Improvement (km)		Total (km)	Related Irrigation Canal
	A	B	C	(%) C/B	D	(%) D/B	E	(%) E	(km)	(km)		
D.A.1		2,088	1,998	95.7	0	0.0	0	-	-	-	-	Amausi Dy
D.A.2		839	292	34.8	0	0.0	0	-	-	-	-	Gehru Dy(R)
D.A.3		2,241	675	30.1	177	7.9	58	8.0	0.0	8.0	8.0	Gehru Dy(R)
D.A.4		4,374	2,085	47.7	441	10.1	294	14.5	0.0	14.5	14.5	Gehru Dy(R), Balauli(R) Khotara(R), Bhadswa(R)
D.A.5		1,288	746	58.0	132	10.2	65	3.0	2.5	5.5	5.5	Balauli(L), Khotara(L) Bhadswa(R)
D.A.6		1,801	1,176	65.3	197	11.0	122	7.1	4.8	11.9	11.9	Bhadswa (L), Ranikhera(R)
D.A.7		934	485	52.0	23	2.4	0	3.1	1.7	4.8	4.8	Ranikhera(L), Amausi Dy(R)
D.A.8		1,351	699	51.8	80	5.9	20	3.1	3.2	6.3	6.3	Amausi Dy(R), Manoharpur, Davalia, Meerampur
D.A.9		3,736	2,419	64.8	744	19.9	474	10.7	8.5	19.2	19.2	Amausi Dy(L), Mati, Raisingkhhera Dehwa(R), Bhasinda(L), Rahinabad
D.A.10		3,186	1,790	56.2	359	11.3	153	-	-	-	-	Alinagar, Dehwa(L)
D.A.11		2,627	1,841	70.1	114	4.3	27	0.0	12.0	12.0	12.0	Amausi Dy(L), Govindpur, Bhasinda(R)
D.A.12		1,087	654	60.2	0	0.0	0	-	-	-	-	Amausi Dy(R), Bhajmanmau Akbarpur
Total		33,488	25,552	76.3 (%)	14,862	8.9	1,213	49.5	32.7	82.2	82.2	

Data Source : Waterlogge Area : Remote Sensing Applications Center, U.P.
C.C.A : Longitudinal profile and Kulaba-wise data

Table G.19 Drainage Benefit Area in Sataon Study Area

Block No.	Geographical Drainage Area (ha)		C.C.A		Waterlogged Area		Waterlogged Area in C.C.A		Main Drainage Canal		Total (km)	Related Irrigation Canal
	A	B	C	(%) C/B	D	(%) D/B	E	(ha)	(km)	(km)		
D.A.1	7,043	3,554	50.5	228	3.2	131	9.4	20.8	30.2	Narichak Dy(R), Lotne, Kunsa, Maurawan Dy(L), Bankat(L)		
D.A.2	2,092	1,730	82.7	0	0.0	0	-	-	-	Narichak Dy(L)		
D.A.3	1,410	1,398	99.2	50	3.5	50	2.1	6.0	8.1	Bankat(R), Maurawan Dy(L), Bardar(L)		
D.A.4	807	552	68.3	0	0.0	0	5.0	0.0	5.0	Bhatargaon(R)		
D.A.5	1,183	1,048	88.6	0	0.0	0	-	-	-	Maurawan Dy(R)		
D.A.6	1,451	1,015	69.9	0	0.0	0	-	-	-	Bhatargaon(L)		
D.A.7	774	747	96.5	0	0.0	0	1.7	1.0	2.7	Bardar(R), Sataon		
D.A.8	557	384	68.9	0	0.0	0	2.8	0.0	2.8	Kaorihar(L)		
D.A.9	1,156	702	60.7	0	0.0	0	3.0	0.0	3.0	Maurawan Dy(R), Unai(L)		
D.A.10	724	724	100.0	0	0.0	0	2.6	1.9	4.5	Kaorihar(R), Maurawan Dy(L)		
D.A.11	1,279	644	50.4	0	0.0	0	4.0	0.0	4.0	Maurawan Dy(R), Hajipur(L)		
D.A.12	1,211	327	27.0	0	0.0	0	-	-	-	-		
Total	25,763	19,687	76.4 (%)	12,824	65.1	278	1.4	181	30.6	29.7	60.3	

Data Source : Waterlogge Area : Remote Sensing Applications Center, U.P.
C.C.A : Longitudinal profile and Kulaba-wise data

Table G.20 Drainage Benefit Area in Sursa Study Area

Block No.	Geographical Drainage Area (ha)		C.C.A		Waterlogged Area (ha)		Waterlogged Area in C.C.A		Main Drainage Canal Construction Improvement (km)		Tatol (km)	Related Irrigation Canal
	A	B	C	(%) C/B	D	(%) D/B	E	(ha) E	(km)	(km)		
D.A.1		2,380	1,371	57.6	150	6.3	27	3.1	1.5	4.6	Sikandarpur(L)	
D.A.2		2,070	1,828	88.3	81	3.9	77	2.9	3.4	6.3	Sikandarpur(R), Bhadaicha Dy(L), Isauli Barha(L)	
D.A.3		385	385	99.9	8	2.0	8	-	-	-		
D.A.4		909	909	100.0	24	2.7	25	2.3	1.9	4.2	Barha(R), Bhadaicha Dy(L)	
D.A.5		1,132	392	34.6	233	20.6	86	2.7	10.0	12.7	Hardoi Br(L), Kamrauli(R)	
D.A.6		5,250	3,500	66.7	456	8.7	131	0.0	28.2	28.2	Badaicha Dy(R), Kamrauli(L), Sursa(R), Udra, Marsa(L) Marsa, Salkupur(L), Sauntera	
D.A.7		2,237	934	41.7	297	13.3	123	15.1	0.0	15.1		
D.A.8		1,120	452	40.4	187	16.7	72	5.6	0.0	5.6	Hardoi Br(L), Salkupur(R)	
D.A.9		1,850	1,835	99.2	112	6.1	94	6.4	3.0	9.4	Sursa(L), Khajurahra(R), Tikari	
D.A.10		3,230	2,665	82.5	324	10.0	186	12.9	-	12.9	Badaicha Dy(R), Khajurahra(L)	
D.A.11		1,753	1,383	78.9	42	2.4	20	-	-	-	Badaicha Dy(L), Pachkohra	
D.A.12		1,205	587	48.7	77	6.4	10	-	-	-	Badaicha Dy(L)	
D.A.13		1,541	1,073	69.6	0	0.0	0	-	-	-	Badaicha Dy	
Total		32,269	25,062	77.7 (%)	17,313	69.1 (%)	1,991	859.0	51.0	48.0	99.0	

Data Source ; Waterloge Area : Remote Sensing Applications Center, U.P.
C.C.A : Longitudinal profile and Kulaba-wise data

Table G.21 Drainage Benefit Area in Purwa Study Area

Block No.	Geographical Drainage Area (ha)		C.C.A		Waterlogged Area		Waterlogged Area in C.C.A		Main Drainage Canal		Total (km)	Related Irrigation Canal
	A	B	C	C/B (%)	D	D/B (%)	E	(ha)	(%)	(km)		
D.A.1		2,059	171	8.3	0	0.0	0	0.0	0.0	5.8	5.8	Simreanu(R)
D.A.2		2,427	1519	62.6	86	3.5	32	0.0	0.0	17.0	17.0	Purwa Dy(L) Bhopatpur, Bangaon Simreanu(L), Chimyani
D.A.3		1,195	1161	97.2	0	0.0	0	4.0	4.0	0.0	4.0	Chimyani, Tikar Dy(R)
D.A.4		2,435	1790	73.5	116	4.8	43	3.5	3.5	9.7	13.2	Tikar Dy(L), Ahandabad Pakra, Panhan(L), Bhadnang(R) Tikar Dy(L), Tiwaria(R)
D.A.5		4,966	2230	44.9	369	7.4	201	10.6	10.6	19.4	30.0	Tiwaria(L), Panhan(R)
D.A.6		1,684	1326	78.7	166	9.9	111	4.5	4.5	1.0	5.5	Purwa Dy(R), Badikhera Tupra Purwa Dy(L), Pinjra
D.A.7		1,014	795	78.4	111	11.0	101	2.0	2.0	1.0	3.0	
D.A.8		4,010	2101	52.4	328	8.2	207	12.1	12.1	11.3	23.4	
D.A.9		2,695	1159	43.0	79	2.9	50	0.0	0.0	14.0	14.0	
Total	20,828	22,485	12,252	54.5	1256	5.6	745.0	36.7	36.7	79.2	115.9	
		108.0	(%)									

Data Source : Waterlogge Area : Remote Sensing Applications Center, U.P.
C.C.A : Longitudinal profile and Kulaba-wise data

Table G.22 Dimensions of Main Drainage Canal in Sarojini Nagar Study Area

Drainage Block No.	Drainage Canal	Reduced Distance	Drainage Area (ha)	Canal Length		L (km)	Discharge (cms)	Water Depth (m)	Bed Width (m)	Velocity (m/s)	Bed Slope	Bridges (places)	Remarks	
				L1 (km)	L2 (km)									
3.	Sar.No1	3.1	2.147	3.1	-	3.1	3.48	1.00	3.40	0.80	1/1100	3		
		5.7	1.458	2.6	-	2.6	2.55	1.00	3.10	0.69	1/1750	2		
		8.0	670	2.3	-	2.3	1.37	1.01	1.50	0.55	1/1800	4		
				8.0	-	8.0							8	
4.	Sar.No2	4.3	5.429	4.3	-	4.3	7.30	1.00	8.00	0.82	1/1300	4		
		8.6	3.043	4.3	-	4.3	4.59	1.00	5.40	0.73	1/1500	5		
		12.2	2.317	3.6	-	3.6	3.69	1.00	5.60	0.57	1/2500	4		
		14.5	911	2.3	-	2.3	1.75	1.00	2.50	0.50	1/2500	1		
				14.5	-	14.5						14		
5.	Sar.No2-1	4.1	1.259	1.6	2.5	4.1	2.27	0.99	3.00	0.58	1/2000	2	Natural Drain	
		5.5	493	1.4	-	1.4	1.07	0.99	1.50	0.44	1/2700	-		
				3.0	2.5	5.5							2	
6.	Sar.No3	3.2	2.707	-	3.2	3.2	4.18	1.00	4.90	0.72	1/1500	2	Sisedi Drain	
		6.5	1.558	1.7	1.6	3.3	2.69	0.99	3.80	0.57	1/2200	2	Sisedi Drain	
		9.0	811	2.5	-	2.5	1.60	0.99	2.30	0.50	1/2500	2		
		11.9	348	2.9	-	2.9	0.81	0.94	1.10	0.43	1/2500	-		
				7.1	4.8	11.9							6	
7.	Sar.No3-1	3.2	928	1.5	1.7	3.2	1.78	0.99	2.30	0.55	1/2000	4	Natural Drain	
		4.8	609	1.6	-	1.6	1.27	0.99	1.60	0.50	1/2200	1		
				3.1	1.7	4.8							5	
8.	Sar.No4	2.8	1.292	-	2.8	2.8	2.32	0.99	1.70	0.89	1/700	2	Debarya Bharoswa Drain	
		6.3	859	3.1	0.4	3.5	1.67	1.00	2.10	0.55	1/2000	3	Debarya Bharoswa Drain	
				3.1	3.2	6.3						5		
9.	Sar.No5	3.9	4.954	3.9	-	3.9	6.78	0.98	9.00	0.69	1/1300	3		
		9.0	4.201	5.1	-	5.1	5.95	1.01	8.00	0.66	1/2000	1		
		11.8	2.881	1.2	1.6	2.8	4.40	1.00	6.00	0.64	1/2000	2	Natural Drain	
		15.1	1.062	-	3.3	3.3	1.88	0.99	2.60	0.56	1/2000	1	Natural Drain	
				10.2	4.9	15.1						7		
9.	Sar.No5-1	4.1	901	0.5	3.6	4.1	1.74	1.01	2.20	0.54	1/2100	3	Nalkur Drain	
11.	Gila Mchmadi Nagar Drain	6.0	10.770	-	6.0	6.0	12.63	1.47	12.80	0.61	1/4000	2		
		12.0	10.075	-	6.0	6.0	11.97	1.50	12.00	0.60	1/4200	3		
				-	12.0	12.0							5	

Table G.23 Dimensions of Main Drainage Canal in Sataon Study Area

Drainage Block No.	Drainage Canal	Reduced Distance	Drainage Area (ha)	Canal Length		L (km)	Discharge (cms)	Water Depth (m)	Bed Width (m)	Velocity (m/s)	Bed Slope	Bridges (places)	Remarks
				L1 (km)	L2 (km)								
1.	Sat.No1	6.4	5,867	-	6.4	6.4	11.81	1.00	14.00	0.80	1/1500	4	Sarhi Nala
		11.6	6,324	-	5.2	5.2	11.05	1.01	14.00	0.73	1/1800	2	Sarhi Nala
		14.9	5,358	-	3.3	3.3	9.68	0.98	13.00	0.72	1/1800	3	Sarhi Nala
		17.9	1,531	-	3.0	3.0	3.55	0.99	5.50	0.56	1/2500	4	Sarhi Nala
		20.0	900	2.1	-	2.1	2.32	0.99	3.50	0.53	1/2500	3	
				2.1	17.9	20.0						16	
1.	Sat.No1-1	1.3	2,878	-	1.3	1.3	5.89	1.41	6.50	0.53	1/4300	1	Gulariha Drain
		2.9	995	-	1.6	1.6	2.52	1.39	2.60	0.46	1/4300	1	Gulariha Drain
				-	2.9	2.9						2	
1.	Sat.No1-2	3.0	1,747	3.0	-	3.0	3.95	1.00	6.00	0.57	1/2500	3	
		7.3	760	4.3	-	4.3	2.03	0.96	3.50	0.48	1/3000	3	
				7.3	-	7.3						6	
3.	Sat.No2	1.5	2,128	-	1.5	1.5	4.62	1.01	4.50	0.83	1/1100	-	Garhi Dularai Drain
		5.0	1,360	-	3.5	3.5	3.23	1.02	3.00	0.79	1/1100	2	Garhi Dularai Drain
		8.1	1,003	2.1	1.0	3.1	2.53	0.98	2.50	0.75	1/1100	2	Garhi Dularai Drain
				2.1	6.0	8.1						4	
7.	Sat.No2-1	2.7	615	1.7	1.0	2.7	1.71	1.00	2.20	0.54	1/2100	1	Bardar Drain
8.	Sat.No3	2.8	538	2.8	-	2.8	1.54	0.99	1.80	0.56	1/1800	3	
10.	Sat.No4	1.9	688	-	1.9	1.9	1.87	0.99	1.70	0.71	1/1100	1	Malik Mau drain
		4.5	495	2.6	-	2.6	1.44	0.99	1.50	0.59	1/1500	2	
				2.6	1.9	4.5						3	
11.	Sat.No5	1.2	1,296	1.2	-	1.2	3.11	1.01	5.50	0.48	1/3500	1	
		4.0	938	2.8	-	2.8	2.40	1.03	4.00	0.47	1/3500	-	
				4.0	-	4.0						1	
9.	Sat.No6	3.0	1,168	3.0	-	3.0	2.86	0.97	4.50	0.54	1/2500	1	
4.	Sat.No7	2.5	1,629	2.5	-	2.5	3.73	0.97	2.50	1.11	1/500	1	
		5.0	995	2.5	-	2.5	2.52	1.00	2.50	0.73	1/1200	1	
				5.0	-	5.0						2	

Table G. 24 Dimensions of Main Drainage Canal in Sursa Study Area

Drainage Block No.	Drainage Canal	Reduced Distance	Drainage Area (ha)	Canal Length L1 (km)	Canal Length L2 (km)	L (km)	Discharge (cms)	Water Depth (m)	Bed Width (m)	Velocity (m/s)	Bed Slope	Bridges (places)	Remarks	
1.	Sur.No1	2.1	1,631	0.6	1.5	2.1	3.68	1.01	5.00	0.51	1/2100	-	Natural Drain	
		4.6	927	2.5	-	2.5	2.34	0.89	3.50	0.53	1/2500	1		
				3.1	1.5	4.6							1	
2.	Sur.No2	3.1	2,375	-	3.1	3.1	4.97	1.02	6.50	0.65	1/2000	3	Fardapur Drain	
		6.3	1,385	2.9	0.3	3.2	3.25	1.10	4.30	0.62	1/2000	2	Fardapur Drain	
				2.9	3.4	6.3							5	
4.	Sur.No3	2.8	906	0.9	1.9	2.8	2.30	1.00	4.50	0.43	1/4200	2	Shankarpur Drain	
		4.2	421	1.4	-	1.4	1.25	1.02	2.20	0.38	1/4200	1		
				2.3	1.9	4.2							3	
10.	Sur.No4	2.7	3,737	2.7	-	2.7	7.15	1.01	10.00	0.65	1/2200	3		
		5.4	3,305	2.7	-	2.7	6.48	1.00	10.00	0.59	1/2600	3		
		8.2	2,236	3.8	-	3.8	4.74	0.99	8.00	0.54	1/3000	3		
		12.9	1,269	3.7	-	3.7	3.01	1.00	5.00	0.51	1/3000	2		
				12.9	-	12.9							11	
				4.3	11,872	-	4.3	17.41	1.02	24.00	0.69	1/2200	3	Turtipur Drain
				7.6	7,685	-	3.3	12.72	1.00	22.00	0.56	1/3200	2	Turtipur Drain
6.	Sur.No5	8.8	6,914	-	2.2	2.2	11.69	1.00	20.00	0.56	1/3200	-	Turtipur Drain	
		12.6	4,774	-	2.8	2.8	8.69	1.00	15.00	0.55	1/3200	1	Turtipur Drain	
		17.8	4,335	-	5.2	5.2	8.05	1.02	13.50	0.55	1/3200	4	Turtipur Drain	
		19.7	2,381	-	1.9	1.9	4.98	1.01	8.50	0.53	1/3200	1	Turtipur Drain	
		23.9	1,630	-	4.2	4.2	3.68	1.03	6.00	0.51	1/3200	6	Turtipur Drain	
		28.2	899	-	4.3	4.3	2.29	0.98	4.00	0.47	1/3200	3	Turtipur Drain	
				-	28.2	28.2							20	
				4.1	865	-	4.1	2.22	1.03	3.50	0.48	1/3200	4	Kamrauli Drain
				12.7	445	2.7	5.9	1.30	1.01	2.00	0.43	1/3200	3	Kamrauli Drain
						2.7	10.0	12.7					7	
		9.	Sur.No5-2	3.2	1,709	0.2	3.0	3.2	3.82	1.01	6.50	0.51	1/3200	4
9.4	1,233			6.2	-	6.2	2.94	1.03	5.00	0.48	1/3500	4		
				6.4	3.0	9.4							8	
7.	Sur.No6	3.7	2,685	3.7	-	3.7	5.49	0.89	8.00	0.63	1/2200	2		
		7.2	1,396	3.5	-	3.5	3.25	0.88	5.00	0.56	1/2500	3		
		15.1	843	7.9	-	7.9	2.17	1.02	3.20	0.51	1/2700	2		
				15.1	-	15.1							7	
8.	Sur.No7	5.6	622	5.6	-	5.6	1.70	1.02	2.70	0.46	1/3200	2		
-	Purchal Escape.	5.9	-	-	5.9	14.15	2.04	7.31	0.75	1/3300	-	Purchal Escape		
-		8.2	-	-	2.3	14.15	2.04	7.31	0.75	1/3300	-	Purchal Escape		
					8.2									

Table G. 25 Dimensions of Main Drainage Canal in Purwa Study Area

Drainage Block No.	Drainage Canal	Reduced Distance	Drainage Area (ha)	Canal Length		Drainage Discharge (cms)	Water Depth (m)	Bed Width (m)	Velocity (m/s)	Bed Slope	Bridges (places)	Remarks	
				L1 (km)	L2 (km)								
1.	Pur.No1	1.6	2,001	-	1.6	1.6	1.03	5.50	0.57	1/2500	1	Unch Gadh Drain	
		4.0	1,791	-	2.4	2.4	3.48	0.98	6.50	0.48	1/3600	2	Unch Gadh Drain
		5.8	1,309	-	5.8	5.8	2.71	1.02	5.00	0.45	1/4000	5	Unch Gadh Drain
3.	Pur.No2	2.4	716	2.4	-	2.4	1.00	2.00	0.55	1/1900	2		
		4.0	384	1.6	-	1.6	1.02	1.03	1.10	0.47	1/2300	3	
4.	Pur.No3	2.2	2,219	-	2.2	2.2	4.14	3.90	0.57	1/2000	1	Tikar Drain	
		4.7	1,900	-	2.5	2.5	3.66	1.16	4.10	0.58	1/2600	2	Tikar Drain
		6.4	1,516	-	1.7	1.7	3.05	1.10	3.80	0.56	1/2600	1	Tikar Drain
6.	Pur.No4	3.0	1,209	2.0	1.0	3.0	2.55	4.00	0.53	1/2500	3	Natural Drain	
		5.5	738	2.5	1.0	5.5	1.72	1.00	2.50	0.49	1/2600	5	
		1.3	809	0.3	1.0	1.3	1.85	0.99	2.70	0.51	1/2500	2	Natural Drain
7.	Pur.No5	3.0	532	1.7	1.7	3.0	1.32	2.00	0.48	1/2500	-		
		2.9	5,159	-	2.9	2.9	8.13	0.99	11.00	0.71	1/1800	-	Natural Drain
		7.0	3,655	-	2.0	2.0	6.17	0.99	8.50	0.66	1/2000	-	Natural Drain
8.	Pur.No6	10.8	2,683	-	3.8	3.8	4.82	7.00	0.83	1/2100	2	Purwa Drain	
		12.8	2,127	-	2.1	2.1	4.00	0.87	6.00	0.80	1/2200	2	Purwa Drain
		14.6	1,480	-	1.7	1.7	2.89	1.01	4.50	0.84	1/2600	2	Purwa Drain
5.	Pur.No6-1	4.4	717	3.2	1.2	4.4	1.68	2.30	0.52	1/2300	2	Natural Drain	
		2.3	670	2.3	-	2.3	1.59	0.97	2.20	0.52	1/2200	2	
		4.3	355	2.0	-	2.0	0.96	1.03	1.00	0.47	1/2200	1	
5.	Pur.No6-2	3.1	523	3.1	-	3.1	1.30	1.70	0.47	1/2600	3		
		3.8	3,914	-	3.8	3.8	6.52	1.02	13.00	0.43	1/4500	3	Indara Drain
		7.7	3,313	-	3.8	3.8	5.70	1.01	11.50	0.46	1/4500	2	Indara Drain
8.	Pur.No6-3	10.2	2,087	1.7	1.1	2.8	3.94	7.00	0.50	1/3300	1	Indara Drain	
		13.0	1,068	1.7	1.1	2.8	2.31	1.02	3.80	0.47	1/3300	1	Indara Drain
		15.9	838	2.9	-	2.9	1.90	1.00	3.00	0.48	1/2900	3	
8.	Basaha Drain	48.0	15,540	-	5.0	5.0	19.64	23.00	0.55	1/5400	1	Basaha Drain	
		60.0	12,850	-	7.0	7.0	16.88	1.51	21.00	0.50	1/5500	1	Basaha Drain
		64.0	10,360	-	4.0	4.0	14.20	1.49	18.00	0.49	1/5500	3	Basaha Drain
2. 8.	Basaha Drain	79.0	2,331	-	15.0	15.0	4.31	1.46	0.43	1/5500	7	Basaha Drain	
		17.8	482	2.0	2.0	31.0	1.22	1.03	1.60	0.46	1/2700	11	
		2.7	685	2.7	-	2.7	1.64	0.88	2.50	0.48	1/2700	2	
8.	Pur.No7-1	5.5	500	2.8	-	2.8	1.26	2.00	0.44	1/3000	3		
		5.5	500	5.5	-	5.5	1.26	0.98	2.00	0.44	1/3000	5	
		48.0	15,540	-	5.0	5.0	19.64	1.47	23.00	0.55	1/5400	1	Basaha Drain

FIGURES

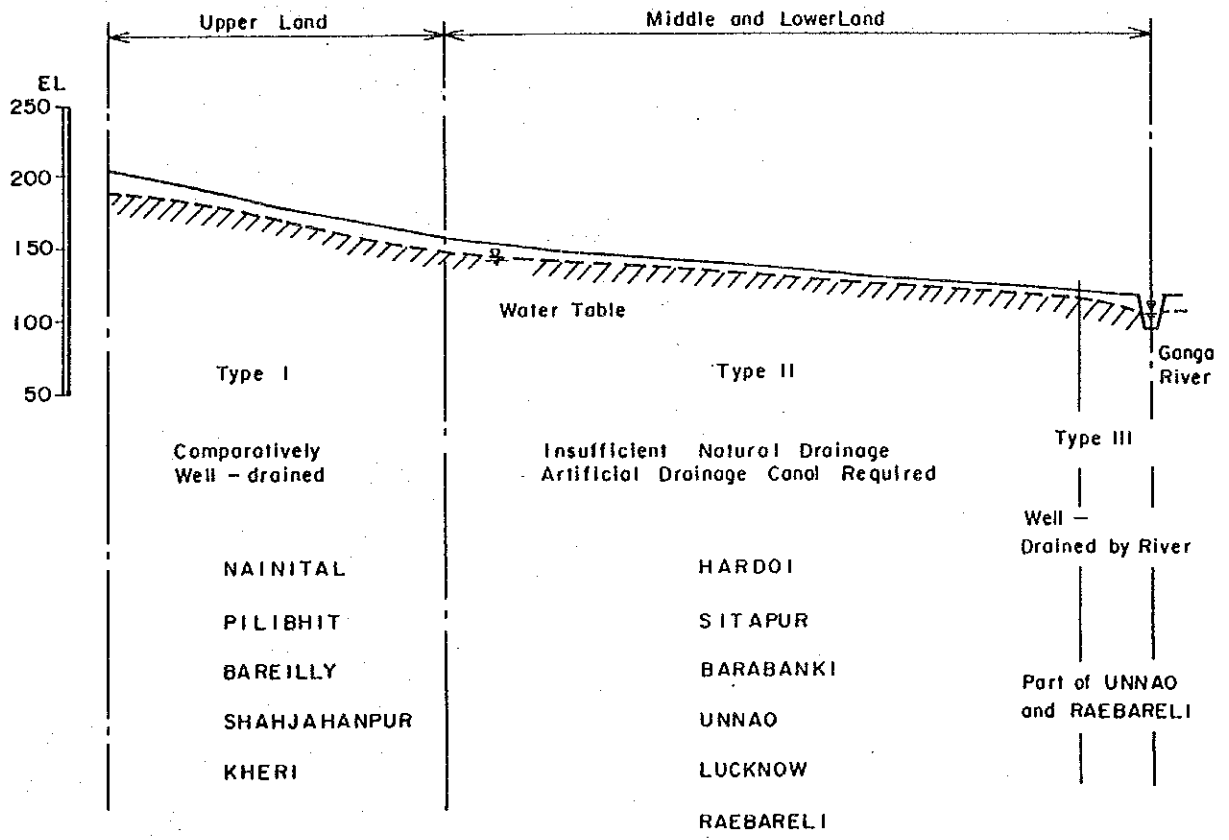
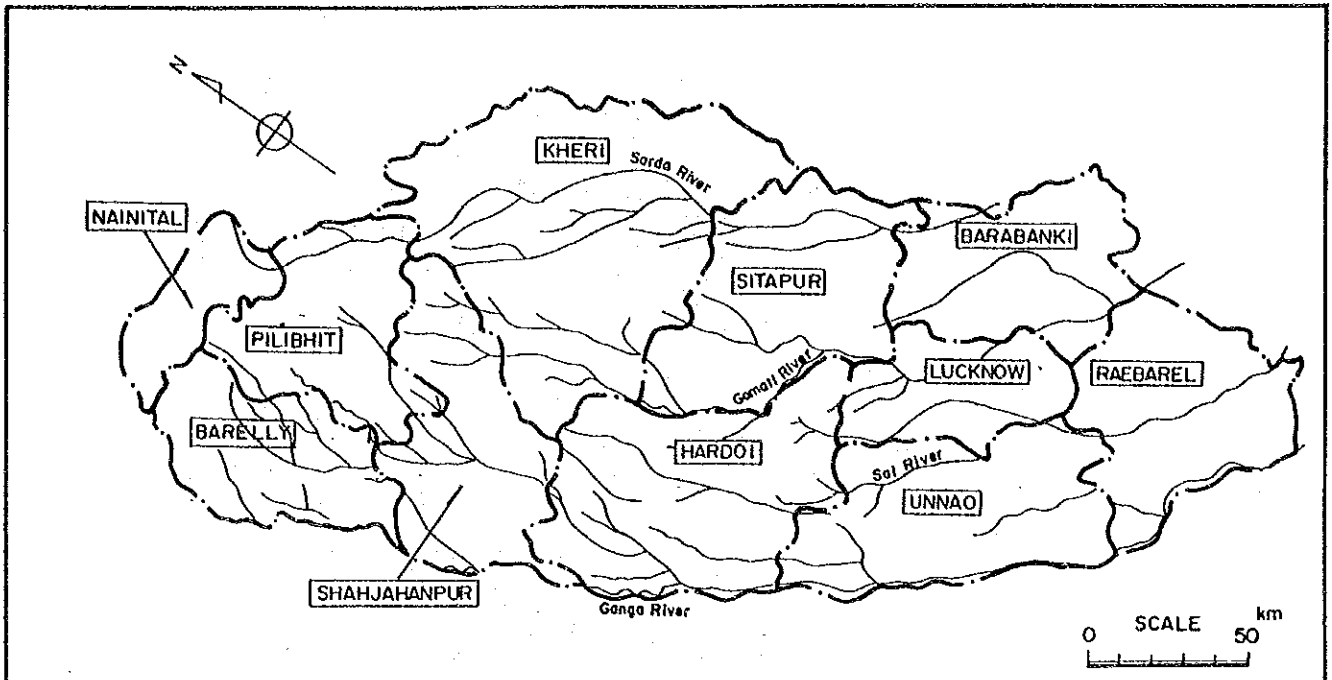


Fig.G.1 Drainage Condition in Sloping Strip Intersected

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