Appendix A

Table A1 Cost comparison of Alternatives II vs III

Pump costs	Rs/Kw	36000
Electrical charges	Rs/Kw	3.1
Land cost	Rs 10^6	4
Interest		5%
Project life	Years	30

Treatment Plants		II	III
Kakraha STP		UASB process	UASB process
Capacity	mld	520	345
Land area	ha	182.0	120.8
Land cost	Rs 10^6	728.0	483.0
Capital cost	Rs 10^6	1,560.0	1,035.0
Annual O&M cost (1)	Rs 10^6	67.6	44.9

Mastemau STP		UASB process	UASB process
Capacity	mld	130	305
Land area	ha	45.5	106.8
Land cost	Rs 10^6	182.0	427.0
Capital cost	Rs 10^6	390.0	915.0
Pump Station -civil	Rs 10^6	50.62	73.61
Pump Station - mechanical	Rs 10^6	37.01	80.09
sub-total		477.63	1,068.70
Annual O&M cost (1)	Rs 10^6	18.3	42.4
Pump station energy		4.2	9.76

Total Capital	Rs 10^6	**2,037.6**	**2,103.7**
Total Annual O&M Cost	Rs 10^6	**90.0**	**97.0**

(1) includes energy costs

(2) Annual O&M for pumping stations = 3% of total M&E, 1.5% of total civil, 0.25% of rising main

(3) NPV O&M includes replacement of mechanical equipment once in 30 years

(4) includes land costs, capital costs and NPV O&M

Table A1 Cost comparison of Alternatives II vs III

TGPS			II	III
Capacity		mld	51.0	51.0
Capital cost				
civil		Rs 10^6	25.40	25.40
mechanical		Rs 10^6	17.56	17.56
rising main to Kukrail		Rs 10^6	58.9	58.9
	sub-total		101.8	101.8
Annual O&M cost (2)		Rs 10^6	2.2	2.2
energy cost		Rs 10^6	2.6	2.6
	sub-total		4.7	4.7

Kukrail PS no.1				
Capacity		mld	285.0	234.0
Capital cost				
civil		Rs 10^6	71.78	66.47
mechanical		Rs 10^6	75.17	62.61
electrical service/transmission		Rs 10^6	228.00	187.20
rising main		Rs 10^6	166.1	166.1
	sub-total		541.1	482.4
Annual O&M cost (2)		Rs 10^6	6.2	6.1
energy cost		Rs 10^6	18.33	12.48
	sub-total		24.6	18.6

GH Canal				
Capacity		mld	125.0	125.0
Capital cost				
civil		Rs 10^6	49.56	-
mechanical		Rs 10^6	35.78	35.78
electrical service/transmission		Rs 10^6	100.00	100.00
rising main		Rs 10^6	75.3	50.8
	sub-total		260.6	186.5
Annual O&M cost (2)		Rs 10^6	3.1	1.6
energy cost		Rs 10^6	12.9	7.25
	sub-total		16.0	8.9

(1) includes energy costs

(2) Annual O&M for pumping stations = 3% of total M&E, 1.5% of total civil, 0.25% of rising main

(3) NPV O&M includes replacement of mechanical equipment once in 30 years

(4) includes land costs, capital costs and NPV O&M

Table A1 Cost comparison of Alternatives II vs III

Guari IPS			
Capacity	mld	498.0	323.0
Capital cost			
civil	Rs 10^6	86.83	75.16
mechanical	Rs 10^6	127.61	84.52
electrical service/transmission	Rs 10^6	398.40	258.40
rising main	Rs 10^6	288.4	294.3
sub-total		901.2	712.4
Annual O&M cost (2)	Rs 10^6	10.3	10.2
energy cost	Rs 10^6	36.0	21.4
sub-total		46.3	31.5

Marten Purwa IPS			
Capacity	mld	72.0	246.0
Capital cost pump station			
civil	Rs 10^6	34.69	67.81
mechanical	Rs 10^6	22.73	65.57
electrical service/transmission	Rs 107	57.60	196.80
rising main	Rs 10^6	14.6	45.2
relief sewer		165.4	150.5
outfall sewer to STP		526.7	952.6
sub-total		821.8	1,478.4
Annual O&M cost (2)	Rs 10^6	1.0	2.5
energy cost	Rs 10^6	2.3	4.1
sub-total		3.4	6.7

CGPS			
Capacity	mld	50.0	50.0
Capital cost			
civil	Rs 10^6	24.86	24.86
mechanical	Rs 10^6	17.31	17.31
rising main	Rs 10^6	16.6	30.3
sub-total		58.7	72.5
Annual O&M cost (2)	Rs 10^6	0.9	1.3
energy cost	Rs 10^6	3.0	1.59
sub-total		3.9	2.9

(1) includes energy costs

(2) Annual O&M for pumping stations = 3% of total M&E, 1.5% of total civil, 0.25% of rising main

(3) NPV O&M includes replacement of mechanical equipment once in 30 years

(4) includes land costs, capital costs and NPV O&M

Table A1 Cost comparison of Alternatives II vs III

Total Annual O&M Costs	Rs 10^6	188.93	170.41
Pump stations		98.88	73.38
Treatment plants		90.05	97.03

Total Present Value Cost

Land cost	Rs 10^6	910.0	910.0
Capital cost	Rs 10^6	4,722.9	5,137.8
treatment works		2,037.6	2,103.7
pumping stations		1,373.3	1,285.4
rising mains		619.9	645.6
trunk sewers		692.1	1,103.1
NPV O&M (3)	Rs 10^6	3,327.2	2,982.0
Total present value (4)	Rs 10^6	8,960.1	9,029.9

(1) includes energy costs

(2) Annual O&M for pumping stations = 3% of total M&E, 1.5% of total civil, 0.25% of rising main

(3) NPV O&M includes replacement of mechanical equipment once in 30 years

(4) includes land costs, capital costs and NPV O&M

Table A2 Kakraha STP: Comparison of cost for various treatment methods ALT II

Land cost	Rs. million	4
Interest		5%
Project life	years	30
Capacity	mld	520

Unit rates	WSP	AL	AL+	AS	AS +	UASB++
Land area Ha/mld	1.25	0.35	0.75	0.20	0.60	0.35
Capital costs (Rs.million/mld)	1.60	2.5	3.2	2.7	3.4	3.0
M&E cost (% of total)	2%	20%	20%	40%	40%	30%
Annual O&M (Rs.million/mld)	0.06	0.30	0.32	0.36	0.38	0.13
Capital Cost Component						Cost (Rs. million)
Land area for treatment process Ha	650	182	390	104	312	182
Land	**2,600**	**728**	**1,560**	**416**	**1,248**	**728**
Capital costs	**832**	**1,300**	**1,664**	**1,404**	**1,768**	**1,560**
Recurring Cost Component						Cost (Rs. million)
Replace M&E every 15 years	17	260	260	562	562	468
Annual O&M Cost (1)	31	156	166	187	198	68
Present value recurring cost	**488**	**2,523**	**2,683**	**3,148**	**3,308**	**1,264**
Total present value (2)	**3,920**	**4,551**	**5,907**	**4,968**	**6,324**	**3,552**

(1) includes energy costs
(2) includes land costs

WSP= waste stabilization pond
AL= aerated lagoon

AS=activated sludge
+ indicates maturation ponds

Table A3 Kakraha STP: Comparison of cost for various treatment methods ALT III

Land cost	Rs. million	4
Interest		5%
Project life	years	30
Capacity	mld	345

Unit rates	WSP	AL	AL+	AS	AS +	UASB+
Land area Ha/mld	1.25	0.35	0.75	0.20	0.60	0.35
Capital costs (Rs.million/mld)	1.60	2.5	3.2	2.7	3.4	3.0
M&E cost (% of total)	2%	20%	20%	40%	40%	30%
Annual O&M (Rs.million/mld)	0.06	0.30	0.32	0.36	0.38	0.13
Capital Cost Component						Cost (Rs. million)
Land area for treatment process Ha	431	121	259	69	207	121
Land	**1,725**	**483**	**1,035**	**276**	**828**	**483**
Capital costs	**552**	**863**	**1,104**	**932**	**1,173**	**1,035**
Recurring Cost Component						Cost (Rs. million)
Replace M&E every 15 years	11	173	173	373	373	311
Annual O&M Cost (1)	21	104	110	124	131	45
Present value recurring cost	**324**	**1,674**	**1,780**	**2,088**	**2,195**	**839**
Total present value (2)	**2,601**	**3,020**	**3,919**	**3,296**	**4,196**	**2,357**

(1) includes energy costs
(2) includes land costs

WSP= waste stabilization pond
AL= aerated lagoon

AS=activated sludge
+ indicates maturation ponds

Table A4 Mastemau STP: Comparison of cost for various treatment methods ALT II

Land cost	Rs. million	4
Interest		5%
Project life	years	30
Capacity	mld	130

Unit rates	WSP	AL	AL+	AS	AS +	UASB
Land area Ha/mld	1.25	0.35	0.75	0.20	0.60	0.35
Capital costs (Rs.million/mld)	1.60	2.5	3.2	2.7	3.4	3.0
M&E cost (% of total)	2%	20%	20%	40%	40%	30%
Annual O&M (Rs.million/mld)	0.06	0.30	0.32	0.36	0.38	0.13
Capital Cost Component						Cost (Rs. million)
Land area for treatment process Ha	163	46	98	26	78	46
Land	**650**	**182**	**390**	**104**	**312**	**182**
Capital costs	**208**	**325**	**416**	**351**	**442**	**390**
Recurring Cost Component						Cost (Rs. million)
Replace M&E every 15 years	4	65	65	140	140	117
Annual O&M Cost (1)	8	39	42	47	49	17
Present value recurring cost	**122**	**631**	**671**	**787**	**827**	**316**
Total present value (2)	**980**	**1,138**	**1,477**	**1,242**	**1,581**	**888**

(1) includes energy costs
(2) includes land costs

WSP= waste stabilization pond
AL= aerated lagoon

AS=activated sludge
+ indicates maturation ponds

Table A5 Mastemau STP: Comparison of cost for various treatment methods ALT III

Land cost	Rs. million	4
Interest		5%
Project life	years	30
Capacity	mld	305

Unit rates	WSP	AL	AL+	AS	AS +	UASB++
Land area Ha/mld	1.25	0.35	0.75	0.20	0.60	0.35
Capital costs (Rs.million/mld)	1.60	2.5	3.2	2.7	3.4	3.0
M&E cost (% of total)	2%	20%	20%	40%	40%	30%
Annual O&M (Rs.million/mld)	0.06	0.30	0.32	0.36	0.38	0.13
Capital Cost Component						Cost (Rs. million)
Land area for treatment process Ha	381	107	229	61	183	107
Land	**1,525**	**427**	**915**	**244**	**732**	**427**
Capital costs	**488**	**763**	**976**	**824**	**1,037**	**915**
Recurring Cost Component						Cost (Rs. million)
Replace M&E every 15 years	10	153	153	329	329	275
Annual O&M Cost (1)	18	92	98	110	116	40
Present value recurring cost	**286**	**1,480**	**1,574**	**1,846**	**1,940**	**742**
Total present value (2)	**2,299**	**2,669**	**3,465**	**2,914**	**3,709**	**2,084**

(1) includes energy costs
(2) includes land costs

WSP= waste stabilization pond
AL= aerated lagoon

AS=activated sludge
+ indicates maturation ponds

Table A6 Kwajapur STP: Comparison of cost for various treatment methods

Land cost	Rs. million	4
Interest		5%
Project life	years	30
Capacity	mld	135

Unit rates	WSP	AL	AL+	AS	AS +	UASB++
Land area Ha/mld	1.25	0.35	0.75	0.20	0.60	0.35
Capital costs (Rs.million/mld)	1.60	2.5	3.2	2.7	3.4	3.0
M&E cost (% of total)	2%	20%	20%	40%	40%	30%
Annual O&M (Rs.million/mld)	0.06	0.30	0.32	0.36	0.38	0.13
Capital Cost Component						Cost (Rs. million)
Land area for treatment process Ha	169	47	101	27	81	47
Land	**675**	**189**	**405**	**108**	**324**	**189**
Capital costs	**216**	**338**	**432**	**365**	**459**	**405**
Recurring Cost Component						Cost (Rs. million)
Replace M&E every 15 years	4	68	68	146	146	122
Annual O&M Cost (1)	8	41	43	49	51	18
Present value recurring cost	**127**	**655**	**697**	**817**	**859**	**328**
Total present value (2)	**1,018**	**1,182**	**1,534**	**1,290**	**1,642**	**922**

(1) includes energy costs
(2) includes land costs

WSP= waste stabilization pond
AL= aerated lagoon

AS=activated sludge
+ indicates maturation ponds

Table A7 Daulatganj STP: Comparison of cost for various treatment methods

Land cost	Rs. million	4
Interest		5%
Project life	years	30
Capacity	mld	56

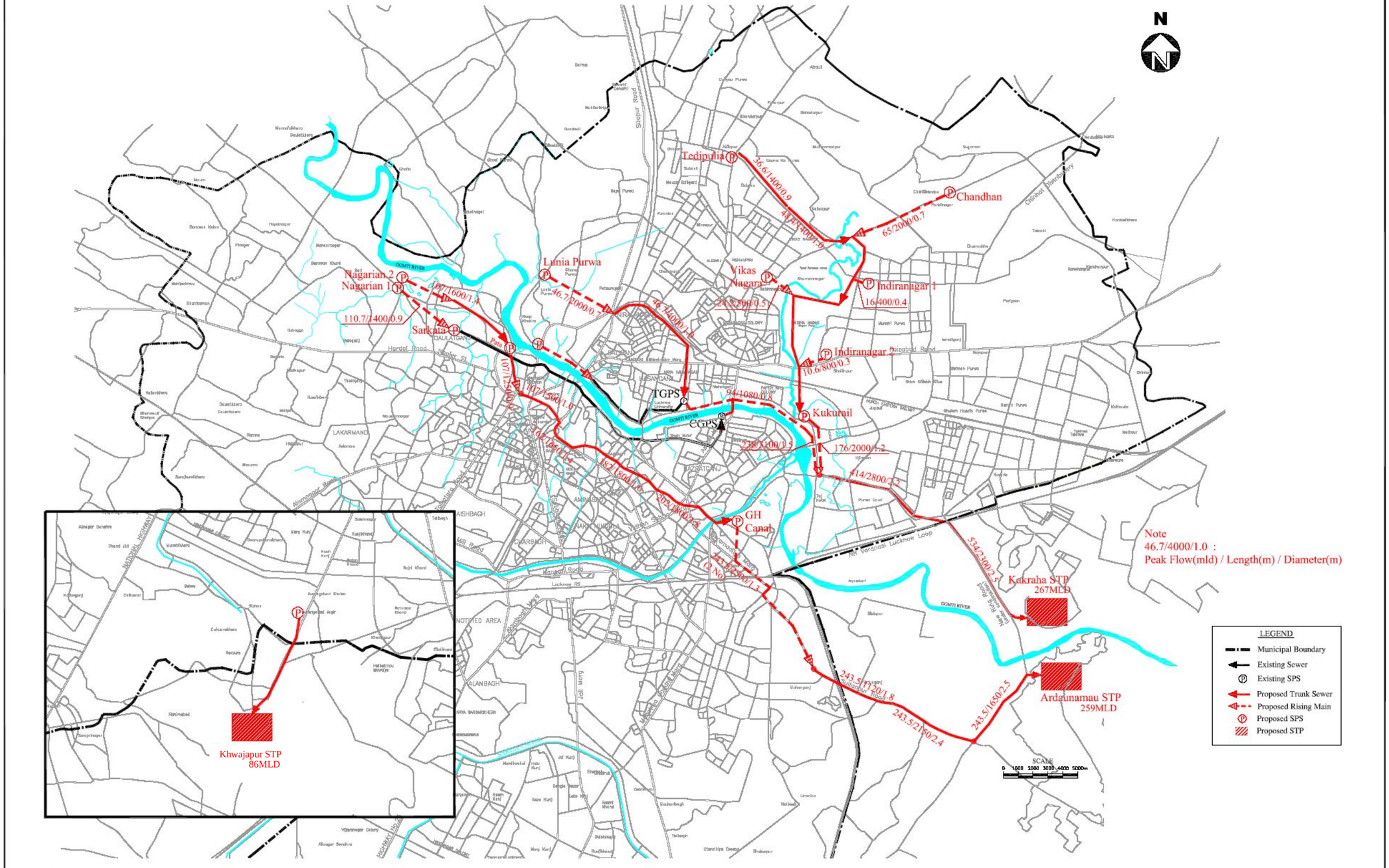
Unit rates	WSP	AL	AL+	AS	AS +	FAB
Land area Ha/mld	1.25	0.35	0.75	0.20	0.60	0.06
Capital costs (Rs.million/mld)	1.60	2.5	3.2	2.7	3.4	4.6
M&E cost (% of total)	2%	20%	20%	40%	40%	60%
Annual O&M (Rs.million/mld)	0.06	0.30	0.32	0.36	0.38	0.59
Capital Cost Component						Cost (Rs. million)
Land area for treatment process Ha	70	20	42	11	34	3
Land	**280**	**78**	**168**	**45**	**134**	**13**
Capital costs	**90**	**140**	**179**	**151**	**190**	**258**
Recurring Cost Component						Cost (Rs. million)
Replace M&E every 15 years	2	28	28	60	60	155
Annual O&M Cost (1)	3	17	18	20	21	33
Present value recurring cost	**53**	**272**	**289**	**339**	**356**	**582**
Total present value (2)	**422**	**490**	**636**	**535**	**681**	**853**

(1) includes energy costs
(2) includes land costs

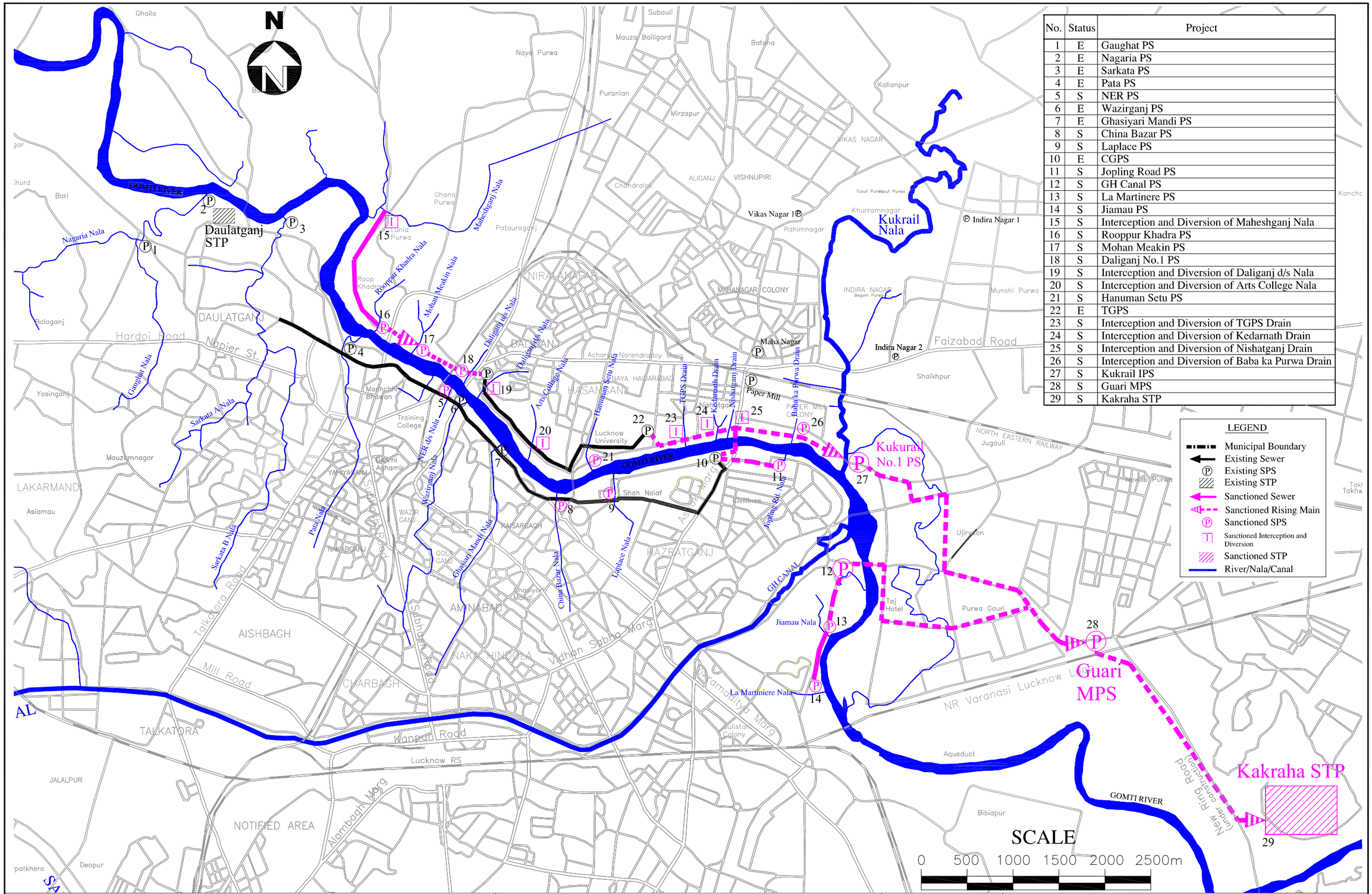
WSP= waste stabilization pond
AL= aerated lagoon

AS=activated sludge
+ indicates maturation ponds

Appendix B



JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO ENGINEERING CONSULTANTS CO., LTD. CTI ENGINEERING INTERNATIONAL CO., LTD.	PROJECT THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	LOCATION LUCKNOW CITY	DRAWING B1 1996 SEWERAGE MASTER PLAN



No.	Status	Project
1	E	Gaughat PS
2	E	Nagaria PS
3	E	Sarkata PS
4	E	Pata PS
5	S	NER PS
6	E	Wazirganj PS
7	E	Ghasiyari Mandi PS
8	S	China Bazar PS
9	S	Laplace PS
10	E	CGPS
11	S	Jopling Road PS
12	S	GH Canal PS
13	S	La Martinere PS
14	S	Jiamau PS
15	S	Interception and Diversion of Maheshganj Nala
16	S	Rooppur Khadra PS
17	S	Mohan Meakin PS
18	S	Daliganj No.1 PS
19	S	Interception and Diversion of Daliganj d/s Nala
20	S	Interception and Diversion of Arts College Nala
21	S	Hanuman Setu PS
22	E	TGPS
23	S	Interception and Diversion of TGPS Drain
24	S	Interception and Diversion of Kedarnath Drain
25	S	Interception and Diversion of Nishatganj Drain
26	S	Interception and Diversion of Baba ka Purwa Drain
27	S	Kukrail IPS
28	S	Guari MPS
29	S	Kakraha STP

LEGEND
- Municipal Boundary
- Existing Sewer
- Existing SPS
- Existing STP
- Sanctioned Sewer
- Sanctioned Rising Main
- Sanctioned SPS
- Sanctioned Interception and Diversion
- Sanctioned STP
- River/Nala/Canal

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO ENGINEERING CONSULTANTS CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.

PROJECT	LOCATION	DRAWING B2
THE STUDY ON WATER QUALITY MANAGEMENT PLAN FOR GANGA RIVER IN THE REPUBLIC OF INDIA	LUCKNOW CITY	SEWERAGE FACILITY MAP EXISTING & PROPOSED BY GoAP