Design concept for Watershed Management of RCF-RBL at Lalganj, Raibareilly

Problems & constraints

Storm water

1. Watershed lies in catchment of rain drain flowing from South/ South East to North West passing through the said watershed, Land has slope towards drain due to erosion from storm water runoff.
   Natural Storm drain has bed level from 94.8 to 94.25near end of RCF area
   Highest Flood Level, HFL reported is 1.2 M (level 94.8) at culvert of Lalganj, Raibareli Road. Culvert size 3 x 4.2 (photo attached)

   Maximum flow rate through weir at road culvert, considering 250 mm of water head, is 40 KL/min

2. It has been planned to realign & hydraulic re design the natural drain for safe disposal of rain water from factory area.

3. Preferred levels for formation are 98.3 for shed and 97.8 for roads. Since minimum cutting and filling is required at 98.3 for FFL of working shed & 97.8 FFL of road, thus these levels have been frozen by Management of M/s. IRCON International Ltd.

4. Natural Storm water drainage is to be redesigned to have minimal possible HFL at 150% of present estimated discharge, so as outfall of internal storm water drains falls more than 1 m above from HFL.

Water supply

5. Water supply for RCF-RBL should meet the requirements of 7500 person, in absence of final figures (demand & quantity at various utility areas) from M/s. IRCON International Ltd. following distribution is considered for calculation of water supply:
   a. 1000 person in administrative building
   b. 2000 person each in all remain 3 sheds
   c. 500 persons at various locations

6. Total demand required by the RCF-RBL, as documented at site is 6 lac lts /day which in not matching with the standards laid for 7500 persons strong work force at site, thus needs further probing.

7. One overhead tank is under construction with 20M staging and 3 Lac Litres storage capacity.

8. One bore well has been constructed at the site with depth of nearly 500m from NGL to supply 2000 LPM (as per Jal Nigam design)

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Sewer and its disposal

9. It is found in layout that area of maximum discharge is on one side of roads, i.e. in shed area and near administration block.

10. M/s. IRCON international Ltd. management is looking for treated waste water disposal for irrigation area and if excess it is required to disposed into the realigned drain.

DESIGN BASIS

1.0 The following objectives are set for designing of services for RCF-RBL at Lalganj:

1. Defining the final Formation levels for working sheds and roads,(freeze levels for formation are 98.3 for shed and 97.8 for roads.)
2. Designing of storm water disposal systems.
3. Calculation of hydraulics and designing of realigned natural storm water drain.
4. Layout and designing water supply system.
5. Design and Layout of sewer& water disposal system, with identification of possible recommended technologies.

2.0 The Information provided by the IRCON is as under:

1. The soft copy of Topographical survey plan.
2. Soil test report of Workshop as provided by the railways.
3. Bore log and detailed provided by UP Jal Nigam.
4. No. of workers – 7500 for 12 hrs.
5. Water supply requirement for RAF is 337500Lts per day, One over head tank of 50000 Lts required capacity is being constructed at site.

3.0 Parameter selected for the services designing as per the NBC and, CPHEEO, Ministry of urban development. (Clause 5.2.51 table No 10 part 9 of NBC)**:**

1. No of WC will be counted as
    a) For men over 200 person 6 +2.5% of targeted population
    b) For women over 200 person 6 +4% of targeted population
2. No of Urinal seat will be counted as
    a) For men over 200 person 6 +2.5% of targeted population
    b) For women over 200 person 6 +4% of targeted population
3. Water requirement will be 900 Lt/WC & 350 Lt/ urinal seat.
4. Total water supply to factory will be computed on the basis of 45 Liter per head.
5. Rain intensity for runoff calculation – 20mm/ hr to 50 mm/hr.. (as per guidelines in manual on sewerage & sewage treatment, second edition, CPHEEO, Ministry of urban development.)
6. Velocity of water in storm water drain will be equal or more than 0.8 m/s but not more than 2 m/s.
7. Velocity in sewer drain shall be more than 0.7 @ half full but not more than 2m/s., minimum pipe size 150 mm,
8. Velocity in drinking water lines at peak should reach 0.65 M/s.
9. For Runoff calculation / modeling, Dynamic **Wave** as the flow routing method will be used, with time delay, as watershed and ridgeline is beyond the boundaries of RCF.(Wave method of routing flows through drainage system can be used. This is an efficient but simplified approach that cannot deal with such phenomena as backwater effects, pressurized flow, flow reversal, and non-dendritic layouts, Dynamic Wave routing can represent these conditions in modeling)
10. Water Conduit, shall be only circular pipes and covered.
11. Storm water management will sub divided into micro zones as per the site plan, excess runoff after rainwater harvesting, will be transport to next micro

zone till it reach to natural or realigned storm zone. There shall be escape plan for disposal of storm water without ground water recharging.

12. Disposal of storm water shall be primarily to ground water aquifers, only excess water will be sent to storm water drainage.
13. Natural storm water drain will be aligned as per the requirement of RCF, with provision of creating structures for backwater landscape near admin building.
14. Water supply will be via single overhead tank of required staging & as per guidelines of CPHEEO, Ministry of urban development.
15. Water supply shall be of grid & loop type
16. Sewer lines will design as per NBC and CPHEEO.

Design calculations for drain:

1. Since drain has HFL of 1.2 m from bed of culvert, section of 3 m, considering head of 250 mm at weir Maximum discharge is 40KL/min
2. To attain the maximum velocity and at given drop and minimum possible sections & HFL (design) following V= .712 m/s

Outcome is

Width of drain	= 10000	mm
Left bank	= 1000	mm
Right bank	=1000	mm
Depth of water	=300	mm
Wetted perimeter	=10632	mm

Maximum flood level @ 50% increment of runoff due to possible runoff increment in catchment area =95.2

Total drop in drain = 457 mm

Thus invert level of internal storm water drains from watershed, at discharge point should be higher than 96.7

Design of drain (internal)

Option -1 – all drain will carry water to discharge point without rain water recharging

Maximum length of drain is	950 M
Initial water flow at start point	11 KL/min
Velocity required	1 m/s
Increment of water flow per 24 m of shed	3 KL/min

(24x40x.02x 0.9) = 3 KL/Min

At all insertion zone thus it is recommended to change slope at 24 m to minimize the size and maximize the flow rate to achieve minimum drop in invert section of drains attached herewith

Maximum drop is 96.19, which is safe is as per requirement.

For detailed analysis please refer to attached Annexure 1

Option -2 – storm water design with rain water harvesting

In this system total watershed is divided in zones and each zone has its own water recharge system of desired capacity, in case of rain density more than designed rainfall, overflows from RWH system, will move to next zone leading of realigned drain and removed to downstream flood zone in natural drain catchment.

Concept
Since area between shed and road is lower by 500 mm thus in case of flooding water will not enter in the working floors or roads rather it will move towards storm water drain flowing over the surface in green area. Design consideration for above is a minimum of 50% of runoff should move out of the system without entering to Rain water harvesting (RWH) of next zone through weir point.

Drinking water
As all the water supply required (as per layout) on one side of road
A single loop / grid system is designed. Please refer to attached drawing & section / with provision for garden hydrant.

Sewer line
As the case of water supply waste water will be generated the same bank thus sewer is also planned on the same side (please refer to attached drawing and section)

- To make system more flexible for maintenance it is recommended to have cleanout manhole at maximum distance of 30 m
- System is designed for minimum velocity of 0.7 m/s in SWR pipe. System is designed @ ½ full for dia less than 300 mm and 2/3 @ more than 300 mm
- Maximum sewer life in system is 0.5 hr. which well below the required requirement for India.

Annexure 1

Analyses of rain drain Option1:

segment No.	initial flow		addition		Total discharge	pipe size		slope	initial LVL		Length of segment		Final LVL ref NGL	LVL
	11.5	Kl/m			11.5	500	mm	0.00222	-700	mm	0	m	-700.00	95.9000
sg1	11.5	Kl/m	3	Kl/min	14.5	600	mm	0.001754	-700	mm	24	m	-700.04	95.9000
sg2	14.5	Kl/m	3	Kl/min	17.5	600	mm	0.002192	-700.042	mm	24	m	-700.09	95.8999
sg3	17.5	Kl/m	3	Kl/min	20.5	700	mm	0.001508	-700.095	mm	24	m	-800.13	95.7999
sg4	20.5	Kl/m	3	Kl/min	23.5	700	mm	0.001508	-800.131	mm	24	m	-800.17	95.7998
sg5	23.5	Kl/m	3	Kl/min	26.5	700	mm	0.001638	-800.167	mm	24	m	-800.21	95.7998
sg6	26.5	Kl/m	3	Kl/min	29.5	700	mm	0.001638	-800.206	mm	24	m	-800.25	95.7998
sg7	29.5	Kl/m	3	Kl/min	32.5	800	mm	0.001638	-800.246	mm	24	m	-900.29	95.6997
sg8	32.5	Kl/m	3	Kl/min	35.5	800	mm	0.001638	-900.285	mm	24	m	-900.32	95.6997
sg9	35.5	Kl/m	3	Kl/min	38.5	800	mm	0.002229	-900.324	mm	24	m	-900.38	95.6996
sg10	38.5	Kl/m	3	Kl/min	41.5	800	mm	0.002229	-900.378	mm	24	m	-900.43	95.6996
sg11	41.5	Kl/m	3	Kl/min	44.5	800	mm	0.0028	-900.431	mm	24	m	-900.50	95.6995
sg12	44.5	Kl/m	3	Kl/min	47.5	1000	mm	0.000892	-900.499	mm	24	m	-1100.52	95.4995
sg13	47.5	Kl/m	3	Kl/min	50.5	1000	mm	0.001062	-1100.52	mm	24	m	-1100.55	95.4995
sg14	50.5	Kl/m	3	Kl/min	53.5	1000	mm	0.001538	-1100.55	mm	24	m	-1100.58	95.4994
sg15	53.5	Kl/m	3	Kl/min	56.5	1000	mm	0.001538	-1100.58	mm	24	m	-1100.62	95.4994
sg16	56.5	Kl/m	3	Kl/min	59.5	1000	mm	0.001538	-1100.62	mm	24	m	-1100.66	95.4993
sg17	59.5	Kl/m	3	Kl/min	62.5	1200	mm	0.000683	-1100.66	mm	24	m	-1300.67	95.2993
sg18	62.5	Kl/m	3	Kl/min	65.5	1200	mm	0.000683	-1300.67	mm	24	m	-1300.69	95.2993
sg19	65.5	Kl/m	3	Kl/min	68.5	1200	mm	0.000683	-1300.69	mm	24	m	-1300.71	95.2993
sg20	68.5	Kl/m	3	Kl/min	71.5	1200	mm	0.001579	-1300.71	mm	24	m	-1300.74	95.2993
sg21	71.5	Kl/m	3	Kl/min	74.5	1200	mm	0.001579	-1300.74	mm	24	m	-1300.78	95.2992

sg22	74.5	Kl/m	3	Kl/min	77.5	1200	mm	0.001579	-1300.78	mm	24	m	-1300.82	95.2992
sg23	77.5	Kl/m	3	Kl/min	80.5	1200	mm	0.001579	-1300.82	mm	24	m	-1300.86	95.2991
sg24	80.5	Kl/m	3	Kl/min	83.5	1200	mm	0.001579	-1300.86	mm	24	m	-1300.89	95.2991
sg25	83.5	Kl/m	3	Kl/min	86.5	1200	mm	0.001579	-1300.89	mm	24	m	-1300.93	95.2991
sg26	86.5	Kl/m	3	Kl/min	89.5	1200	mm	0.001579	-1300.93	mm	24	m	-1300.97	95.2990
sg27	89.5	Kl/m	3	Kl/min	92.5	1200	mm	0.001579	-1300.97	mm	24	m	-1301.01	95.2990
sg28	92.5	Kl/m	3	Kl/min	95.5	1200	mm	0.001579	-1301.01	mm	24	m	-1301.05	95.2990
sg29	95.5	Kl/m	3	Kl/min	98.5	1200	mm	0.001579	-1301.05	mm	24	m	-1301.08	95.2989
sg30	98.5	Kl/m	3	Kl/min	102	1200	mm	0.001579	-1301.08	mm	24	m	-1301.12	95.2989
sg31	102	Kl/m	3	Kl/min	105	1200	mm	0.001579	-1301.12	mm	24	m	-1301.16	95.2988
sg32	105	Kl/m	3	Kl/min	108	1200	mm	0.002683	-1301.16	mm	24	m	-1301.22	95.2988
sg33	108	Kl/m	3	Kl/min	111	1200	mm	0.002683	-1301.22	mm	24	m	-1301.29	95.2987
sg34	111	Kl/m	3	Kl/min	114	1200	mm	0.002683	-1301.29	mm	24	m	-1301.35	95.2986
sg35	114	Kl/m	3	Kl/min	117	1200	mm	0.002683	-1301.35	mm	24	m	-1301.42	95.2986
sg36	117	Kl/m	3	Kl/min	120	1200	mm	0.002683	-1301.42	mm	24	m	-1301.48	95.2985
sg37	120	Kl/m	3	Kl/min	123	1200	mm	0.002683	-1301.48	mm	24	m	-1301.55	95.2985

Annexure 2

Analyses of rain drain Option 2:

segment No.	initial flow	Unit	addition	Unit	Total discharge	pipe size		slope	initial LVL	Unit	Length of segment	Unit	Final LVL ref NGL	LVL
	5.75	Kl/min			5.75	500	mm	0.005612	-910	mm	0	m	-910.00	96.8900
sg1	5.75	Kl/min	3	Kl/min	8.75	500	mm	0.001687	-910	mm	24	m	-910.04	96.8900
sg2	8.75	Kl/min	3	Kl/min	11.75	500	mm	0.002192	-910.04	mm	24	m	-910.09	96.8899
sg3	11.75	Kl/min	3	Kl/min	14.75	500	mm	0.003838	-910.093	mm	24	m	-910.19	96.8898
sg4	14.75	Kl/min	3	Kl/min	17.75	500	mm	0.005792	-910.185	mm	24	m	-910.32	96.8897
sg5	17.75	Kl/min	3	Kl/min	20.75	500	mm	0.005792	-910.324	mm	24	m	-910.46	96.8895
sg6	20.75	Kl/min	3	Kl/min	23.75	500	mm	0.007608	-910.463	mm	24	m	-910.65	96.8894
sg7	23.75	Kl/min	3	Kl/min	26.75	500	mm	0.015229	-910.646	mm	24	m	-911.01	96.8890
sg8	26.75	Kl/min	3	Kl/min	29.75	500	mm	0.015229	-911.011	mm	24	m	-911.38	96.8886
sg9	29.75	Kl/min	3	Kl/min	32.75	500	mm	0.015229	-911.377	mm	24	m	-911.74	96.8883
sg10	32.75	Kl/min	3	Kl/min	35.75	600	mm	0.010262	-911.742	mm	24	m	-1011.99	96.7880
sg11	35.75	Kl/min	3	Kl/min	38.75	600	mm	0.010262	-1011.99	mm	24	m	-1012.23	96.7878
sg12	38.75	Kl/min	3	Kl/min	41.75	600	mm	0.010262	-1012.23	mm	24	m	-1012.48	96.7875
RWH-2														
Weir point level														**96.8900**
sg13	20.875	Kl/min	3	Kl/min	23.875	500	mm	0.001062	-910	mm	24	m	-810.03	96.9900
sg14	23.875	Kl/min	3	Kl/min	26.875	500	mm	0.001062	-810.025	mm	24	m	-810.05	96.9899
sg15	26.875	Kl/min	3	Kl/min	29.875	500	mm	0.001062	-810.051	mm	24	m	-810.08	96.9899
sg16	29.875	Kl/min	3	Kl/min	32.875	500	mm	0.001062	-810.076	mm	24	m	-810.10	96.9899
sg17	32.875	Kl/min	3	Kl/min	35.875	600	mm	0.010262	-810.102	mm	24	m	-910.35	96.8897
sg18	35.875	Kl/min	3	Kl/min	38.875	600	mm	0.010262	-910.348	mm	24	m	-910.59	96.8894

sg19	38.875	Kl/min	3	Kl/min	41.875	600	mm	0.000683	-910.595	mm	24	m	-910.61	96.8894
sg20	41.875	Kl/min	3	Kl/min	44.875	700	mm	0.008067	-910.611	mm	24	m	-1010.80	96.7892
sg21	44.875	Kl/min	3	Kl/min	47.875	700	mm	0.008067	-1010.8	mm	24	m	-1011.00	96.7890
sg22	47.875	Kl/min	3	Kl/min	50.875	700	mm	0.008067	-1011	mm	24	m	-1011.19	96.7888
sg23	50.875	Kl/min	3	Kl/min	53.875	700	mm	0.008067	-1011.19	mm	24	m	-1011.39	96.7886
RWH-3														
Weir point level														**96.8900**
sg24	26.938	Kl/min	3	Kl/min	29.938	600	mm	0.000683	-910	mm	24	m	-810.02	96.9900
sg25	29.938	Kl/min	3	Kl/min	32.938	600	mm	0.000683	-810.016	mm	24	m	-810.03	96.9900
sg26	32.938	Kl/min	3	Kl/min	35.938	700	mm	0.008067	-810.033	mm	24	m	-910.23	96.8898
sg27	35.938	Kl/min	3	Kl/min	38.938	700	mm	0.008067	-910.226	mm	24	m	-910.42	96.8896
sg28	38.938	Kl/min	3	Kl/min	41.938	700	mm	0.008067	-910.42	mm	24	m	-910.61	96.8894
sg29	41.938	Kl/min	3	Kl/min	44.938	700	mm	0.008067	-910.614	mm	24	m	-910.81	96.8892
sg30	44.938	Kl/min	3	Kl/min	47.938	700	mm	0.008067	-910.807	mm	24	m	-911.00	96.8890
sg31	47.938	Kl/min	3	Kl/min	50.938	700	mm	0.008067	-911.001	mm	24	m	-911.19	96.8888
sg32	50.938	Kl/min	3	Kl/min	53.938	700	mm	0.008067	-911.194	mm	24	m	-911.39	96.8886
sg33	53.938	Kl/min	3	Kl/min	56.938	700	mm	0.008067	-911.388	mm	24	m	-911.58	96.8884
RWH-4														
Weir point level														**96.8900**
sg34	28.469	Kl/min	3	Kl/min	31.469	700	mm	0.008067	-910	mm	24	m	-910.19	96.8898
sg35	31.469	Kl/min	3	Kl/min	34.469	700	mm	0.008067	-910.194	mm	24	m	-910.39	96.8896
sg36	34.469	Kl/min	3	Kl/min	37.469	700	mm	0.008067	-910.387	mm	24	m	-910.58	96.8894
sg37	37.469	Kl/min	3	Kl/min	40.469	700	mm	0.008067	-910.581	mm	24	m	-910.77	96.8892

Annexure 3

Analysis of storm water runoff:

Client name		M/s. IRCON INTERNATIONAL LTD.		
Address		SAKET, NEW DELHI		
Premises		LALGUNJ, RAEBAREILY ROAD		
		RAEBAREILY		
PROJECT		RCF - RBL		
CALCULATION FOR RAIN WATER				
Area of watershed	A		40000	Sq. M
average rain fall	F		0.76	M/ yr.
Paved area open (roads)	Apopn		8000	Sq. M
Paved	Aproof		12000	Sq. M
Paved area open (semi paved)	Aproof1		8000	Sq. M
Un paved area [park]	Au		12000	Sq. M
Area Covered by Plantation	Apl		0	Sq. M
Soil				
Sand				
sandy Soil				
Clay		Silty Clay		Yes
Loam				
rocks				
Expected water quantity			30400	Cu.M /Yr.
Total harvestable Water quantity			15352	Cu M/ yr.
Maximum harvestable Water quantity /day			5454	Cu M/ yr.
Discharge quantity @ 300 mm/day			545.4	Cu.M/Hr.
Recommended mode of discharge	from paved area:	Direct injection after proper sedimentation.		
	from un paved area:	sand piling		

Annexure 4

Analysis of Sedimentation tank:

Client name	M/s. IRCON INTERNATIONAL LTD.
Address	SAKET, NEW DELHI
Premises	LALGUNJ, RAEBAREILY ROAD RAEBAREILY
PROJECT	RCF - RBL

SEDIMENTATION TANK DIMENSIONING

FLOW THROUGH TUBE SETTLER CUM/HR; **Q**	600		
SEDIMENTATION VELOCITY OF SETTLABLE SOLIDS; **VS**	1		
TUBE HEIGHT	0.5	M	
FACTOR OF SAFETY; FS	1		
SEDIMENTATION AREA REQUIRED ; AS	600	SQ. M	
SETTLING AREA AT 55	14	SQ. M / CUM	
VOLUME OF TUBE DECK REQUIRED	42.85714	CUM	
PLAN AREA OF CLARIFIER	85.71429		
PROVIDED PLAN AREA OF MEDIA	9.258201	X	9.258201
OVERALL SURFACE LOADING RATE	7		CUM / SQM / HR
QUANTITY OF MEDIA	42.85714		
WEIR LOADING RATE	64.80741		CUM/M/DAY
QUANTITY OF MEDIA WITH ANGLE CORRECTION	**39.85714**		CUM

Thus settling area of 85.7 Sq M or grater can be employed as per the site conditions