ON-CHANNEL RECHARGE ON NAJAFGARH DRAIN IN DELHI

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1.0 INTRODUCTION

Najafgarh Block, which constitutes the Delhi catchment of Najafgarh Drain basin, is characterized by declining ground water table and rising demand for water from growing urban and rural populations. The availability of raw water in this Block, to meet the norms laid down in the MPD-2001, through conventional means is a remote possibility because of a lack of upstream water storage on River Yamuna. Further, this Block, being at the tail end of the water supply system of Delhi, is at a disadvantage with respect to the sharing of available raw water. The Block being mainly agricultural till recently and located at the periphery of the Delhi urban area has received little consideration with regard to piped water supply. This has led to considerable exploitation of groundwater and an alarming decline of the water table.

The problem has further compounded through an emphasis on drainage. The Najafgarh Drain, traversing through this Block of the NCT of Delhi, constitutes the main line of drainage for West and South-West Delhi and also serves catchment areas of the Sahibi Nadi in Rajasthan as well as of Drain No. 8 in Haryana. The development of the Drain and its subsequent remodelling has aimed at providing efficient drainage to its catchment areas including the Najafgarh Jheel both of flood waters as well as of rainfall.

The study project deals with the stretch of the Najafgarh drain starting from Dhansa regulator to Kakraula regulator, a relatively unspoiled and unpolluted stretch of approximately 30 kms. Length. The project research establishes possibilities of modifying and using the drain for on-channel storage of water for recharge of ground water which is also used for other purposes.

The conceptual scheme envisages increasing the storage capacity of the channel by desilting upto the designed bed level and deepening the channel, filling the enhanced capacity through storage of flood waters and runoff from the local catchment basin and in years of exceptionally lean average rainfall to divert a calculated fraction of Delhi's monsoon season allocation of Yamuna waters (which currently run waste due to lack of storage) via the existing drainage/canal network passing through Haryana state upto Dhansa Bund in NCT Delhi and thereon to the Najafgarh Drain. The waters would be stored on the drain and prevented from flowing away by the closure of the Kakraula regulator. A series of shallow tubewells along the drain would extract the sub-soil water and the vacated strata would continuously be recharged by the stored waters in the channel.

2.0 WATER DEMAND AND SUPPLY SCENARIO IN THE NAJAFGARH BLOCK

Najafgarh block of NCT of Delhi covers an area of 302.77 sq. km. It presently consists of 72 villages, 4 census towns and Najafgarh town. The Block is facing substantial urbanization both natural and induced. Dhansa, Mitraon, Gummanhera, Chawala, Jharoda Kalan villages have been earmarked as growth centres in Mini-Master plan for Rural Delhi. Dwarka sub-city, an upcoming urban extension project of DDA, is also located in this block. Presently, rural water demand is worked at a rate of 67.5 lpcd whilst, the water supply requirements of the urban population is worked at a rate of 225 lpcd. However, in view of increasing standard of living as also growth of demand from other sectors the water supply requirements for the future are projected at 100 lpcd for rural population and 363 lpcd for urban population in keeping with DDA norms. In view of urbanization in the block the extent of cultivated area will decline and therefore the requirement of water for irrigation may marginally come down in the future.

While DWS & SDU (Delhi Water Supply and Sewage Disposal Undertaking) is supplying treated water in this area from the river and groundwater from tubewells, the demand-supply gap is being met mainly by the extraction of groundwater through private tubewells. The groundwater availability is also affected by the extraction of groundwater for irrigation both by I & FC Department tubewells as well as private tubewells. However, in view of increasing area under urbanization, the cropped acreage has shown a declining trend which should result in a decline in consumption in the irrigation sector.

3.0 SUPPLY SITUATION

According to Delhi Jal Board the present availability of potable safe drinking water in this area is 12 MGD from Haiderpur water treatment plant (raw water source being Western Yamuna Canal) and about 9 MGD from 180 tubewells in this area i.e. a total of 21 MGD. However, the output performance of tubewells has shown a declining trend. Another 10 MGD water is earmarked for Dwarka area from Haiderpur plant (again from River Yamuna) as and when the infrastructure is completed by Delhi Development Authority. In order to meet the future requirements of this area, additional water treatment plants have been proposed for this area as follows :

a. 40 MGD water treatment plant at Nangloi (estimated cost Rs. 58.5 crores): this work is completed. There is no assured source of raw water for this plant. The only possible source of raw water is the Delhi Tail distributory of the Western Yamuna Canal under the control of Haryana Govt.

b. 100 MGD water treatment plant for Dwarka near village Bakarwala. There is no source of raw water in the near future for this plant also.

Irrigation needs of the area are fulfilled mainly by private tubewells, government tubewells and canals (Dhansa Minor and Surakhpur Minor). There are 7818 private tubewells and 92 government tubewells for irrigation in the Najafgarh Block according to the information supplied by the Block Development Officer and I&FC Dept.

Supply side planning for raw water availability is mainly based on the anticipated development of three major upstream Himalayan reservoirs viz. Kishau, Renuka and Tehri dam and the transfer of water from the same to Delhi.

In such areas there is need for artificial recharge of groundwater by augmenting the natural infiltration of precipitation or surface water by some methods such as water spreading, recharge through pits, excavations, wells, shafts etc. The choice of a particular method is governed by local topography, geological and soil conditions, quantity of water to be recharged and the quality of water available for the recharge and the techno-economic viability of such schemes.

The most widely practiced methods of artificial recharge of groundwater employ different techniques of increasing the contact area and resistant time of surface water with the soil so that maximum quality of water can infiltrate and augment the water storage. **On-Channel Spreading** is one of the methods of direct artificial recharge method.

4.0 ALTERNATIVE PROPOSAL

The major drainage channel is examined in the following manner :

- Enhance on- channel storage capacity
- Enhance on-channel ground water recharge
- Examine conjunctive extraction of ground water.

Enhancing storage capacity to approximately 25 MCM in the Najafgarh Drain at full supply level (210.74 m) would also lead to submergence of vast tracts of land in the Jheel stretch. The water available at a 75% level of runoff probability and a 75% level of flood discharge dependability amounts to 58.22 MCM. Thus it is logical to modify the storage capacity of the Drain to hold yet larger volumes of water out of those available. Various scenarios unfold themselves each having a different storage capacity, a different combination of engineering works, expenditure, implementation schedule and limitations. It is, however, obvious that each scenario requires enclosure by embankment of the right bank in the Jheel stretch and the precise location of this embankment will determine the storage capacity within the system. The scenarios are outlined below with each successive scenario giving the cumulative storage capacity.

These have been at the planning stage for the past three decades and are not expected to materialize in the immediate future. As is evident from table no 1 & 2 the demand from the domestic sector is set to rise steeply. In view of the absence of any further augmentation in the raw water supply in the near future ground water will be exploited to meet the demand supply gap of 59.06 MGD. Thus in 2001 the demand- supply gap is expected to be 47 MGD excluding irrigation demand in Najafgarh block. The emerging scenario is that the unsustainable ground water extraction in the absence of any other source of water.

Table 1 : Water Demand & Supply Projections : Najafgarh Block

Supply (MGD)	1981	1991	2001 (Projected)			Demand 2001			
	Population			Rate (lpcd)	LPD	MGD	MCM/Day	1991	2001
Rural	131804	215146	350000	100	35000000	9.25	0.035	-	
Census Towns(5)	80401	128641	205820	100	20582000	5.45	0.020	-	-
Najafgarh	-	45211	80000	265	21200000	5.60	0.021	-	-
Urban (Dwarka)	-	-	600000	363	217800000	57.61	0.217	-	-
TOTAL Najafgarh Block	212205	388998	1235820	-	294582000	77.91	0.293	11.34	31.0 (0.124 MCM)

Table 2 : Total Demand Supply Scenario (Irrigation+Domestic) MGD/MCMD

Sector (MGD)		Demand		Supply		Gap (Demand-Supply	
		1991	2001	1991	2001	1991	2001
DOMESTIC							
Najafgarh town + Dwarka	MGD	3.95	63.20	2.7	12.7	1.25	50.50
	MCM	0.016	0.253	0.011	0.051	0.005	0.202
Rural (including census towns)	MGD	9.09	14.7	6.14	6.14	2.95	8.56
	MCM	0.037	0.058	0.025	0.025	0.012	0.035
IRRIGATION	MGD	2.5	2.2	2.5	2.2	-	-
	MCM	0.01	0.009	0.01	0.009	-	-
TOTAL	MGD	15.54	80.10	11.34	20.04	4.20	59.06
	MCM	0.062	0.320	0.045	0.080	0.0168	0.236

5.0 SCENARIO ALPHA

Under this scenario the gates of the Kakraula Regulator would be closed at the beginning of the monsoon season. The water inflow would be stored up to the FSL (210.74M) at Kakraula. This would result in on-channel water storage which would have the following implication:

The Jheel stretch would be filled up and water storage upto the FSL 210.74 m. This would result in the extensive submergence of Hayrana land. Normally the submergence of the Haryana side is upto contour level 209m and in average rainfall years this land gradually emerges from the water by December to enable sowing of late cropping varieties. Haryana may therefore, have objection to the scheme and objection can be met in the following manner:

(i) Delhi may build the right bank bandh in the Jheel stretch along the defined channel from RD 5800 to RD10500 and the volume stored would be 9.9 MCM from 1 km upstream of Dhansa to Kakraula Regulator. The submerged lands on Haryana side could be evacuated by lift-pumping the water from the embanked Jheel. In order to enable the flood moderating effect of the Jheel to come into play two spillways would be provided in the proposed bundh at RD6000 and RD10000 with the crest level of the spillways being at level 210.74. The construction of the right bank bundh in the Jheel stretch is constrained owing to a lack of space due to the interstate boundary being coincident with the right bank in this stretch. This may require some realignment of the Najafgarh drain in the Jheel stretch to the north of its present course by about 20m in case Scenario Beta is not executed.

(ii) Under this scenario it is proposed to add to the on-channel volumetric capacity created under Scenario Alpha (I) by removing the silt deposits in the channel above the designed bed level (DBL) as also envisaged in the recommendations stated in the "Master Plan for Storm Water Drainage in the Union Territory of Delhi (1977)". This would create an additional on-channel storage capacity of 3.15 MCM over and above the capacity created in Scenario Alpha (I). The details of the desilting exercise are available in Annexure-iv. The cumulative storage capacity amounts to 13.05 MCM.

(iii) Under this scenario it is proposed to deepen the channel by excavating 1m below the DBL. It would be logical to see this exercise as an extension of the work in Scenario Alpha (ii) and execute both the scenarios simultaneously. The additional on-channel storage capacity over and above Scenario Alpha (ii) thus created would be 2.73 MCM. The cumulative storage capacity amounts to 15.78 MCM.

(iv) Another sub-scenario which can be immediately achieved is by having two regulators at the end of parallel channel at RD 5700m. Taking into account the lowering of bed by 1.0m as recommended above a storage capacity of 2.5 MCM upto the FSL would be created in this stretch.

6.0 SCENARIO BETA

As described above the spread of the Jheel used to be over an area of as much as 225.sq. kms. Now a days, normally the submergence of the Haryana side is upto contour level 209m and in average rainfall years this land gradually emerges from the water by December to enable sowing of late cropping varieties. Thus it is proposed to consider two further scenarios for increasing the storage capacity of the system by submerging the Jheel depression as follows :

(i) Delhi and Haryana may agree to construct the right bank bundh along the 208m contour level upto a height of RL 212 m (as FSL is 210.74m) on Haryana's side of the boundary. Thus an additional bundh of length 3.2 kms (i.e. in addition to bundh made along the Drain stretch) would be required to be made and an area of 98 ha may be submerged in the Jheel area. The volume of additional water stored would be 3.17 MCM and the cumulative capacity created would be 18.95 MCM. Haryana, too, would be a beneficiary by being able to utilize a proportionate volume of water for Gurgaon. Submerged lands on the Haryana side of the bundh could be evacuated by lift-pumping the water into the Jheel.

(ii) Delhi and Haryana may agree to construct the right bank bundh along the 209m contour level upto a height of RL 212 m (as FSL is 210.74 m) on Haryana's side of the boundary. Thus an additional bundh of length 7.3 kms (i.e. in additional to bundh made along the Drain stretch) would be required to be made and an area of 340 ha may be submerged in the Jheel area. The volume of additional water stored would be 6.146 MCM and the cumulative capacity created would be 25.09 MCM. Haryana, too, would be a beneficiary by being able to utilize a proportionate volume of water for Gurgaon. Submerged lands on the Haryana side of the bandh could be evacuated by lift-pumping the water into the Jheel or through regulated inlets.

The spread of waters in the Najafgarh Jheel as shown in scenarios beta (i) and (ii) is desirable but being an inter-state matter requires an agreement between Delhi and Haryana at a higher level.

Thus, the cumulative total storage capacity available on the channel, if Scenarios Beta (ii) is executed, would be 25.09 MCM.

Table 3 : Water Volume Stored Under Different Scenarios

Scenario	Volume Stored (MCM)	Volume Stored in Addition to previous Scenario (MCM)	Length of Embankment Required in Addition to Previous Scenario (M)	Jheel Area Submerged (Ha)
Alpha (i)	9.9	-	4700	-
Alpha (ii)	13.05	3.15	-	-
Alpha (iii)	15.78	2.73	-	-
Beta (i)	18.95	3.17	3200	98
Beta (ii)	25.09	6.146	4100	340

7.0 COST-BENEFIT ANALYSIS

The cost of providing water at a given place from a given source at a given point of time and under known technical conditions can be easily calculated, the benefits, although inumerable in qualitative terms, are not so readily quantifiable in monetary terms. A few benefits, in the case of this project, may range as follows :

(a) Enabling sustainable urbanisation and development to take place.

(b) Preventing the further decline of the ground water table.

(c) Enabling sustained agricultural productivity.

(d) Augmentation of rural water supply preventing the regular lowering of tubewell depths thereby causing savings in equipment and energy consumption.

(e) Improvement in micro-climate, ecology and bio-mass generation.

(f) Improvement in the overall regional water regime.

(g) Recreational facilities.

Thus, instead of performing a cost-benefit exercise it is more suitable to carry out an exercise demonstrating the cost effectiveness of providing water via this method as compared to obtaining water from distant sources. The capital cost of executing Scenario Beta (ii) along with appurtenant works like tubewells etc. is calculated as shown in Table 4 below :

Table 4 : Capital Investment for Raw Water Supply from the Najafgarh Drain

Sl. No.	WORK	DETAILS	RATE	CAPITAL COST (Rs. Crores)
1.	Desilting the channel upto D.B.L. (from RD 0m to 30, 125m)	The quantity of silt to be removed = 30,83,562 cu.m.	Rs. 50/cu.m.	15.41
2.	Deepening the channel 1m below D.B.L. (from RD 0m to 30, 125m)	The quantity earth to be removed = 25,28,414 cu.m.	Rs. 60/cu.m.	15.17
3.	Construction of right embankment (from RD 5800m to 10500m, along 209m contour i.e. 7040m)	The quantity of earth required = 1,90,080 cu.m. (obtained from desilting)	Rs. 40/Cu.m.	0.76
4.	Construction of pipeline to WTP	Within 1000m of Kakraula Regulator		1.00
5.	Installation of tubewells	Boring, pumping station, pumpsets, pipelines, energization		20.46
6.	Strengthening of embankment			0.80
7.	5% overheads			2.68
Revenue (-)				
1. Royalty on excavated earth		Surplus excavated earth 54,21,896 cu.m.	Rs.8/cu.m.	(-) 4.33
Net Capital Cost : (Gross Capital Cost – Total Revenue) **51.95**				(Say 52.0)

Source :Estimates on the basis of prevailing prices in 1996-97

Thus the cost of supply of an average 20 MGD works out to be Rs. 52.00 Crores or Rs. 2.60 crores / MGD. As against this the cost of augmentation of water supply for Delhi from various upstream reservoirs in the Himalayas i.e. Rs. 4.46 crores /MGD (Tehri Dam).

The overall project could be implemented in a phased manner over 3 years. The works involved are mainly earthworks in desilting and excavation for increasing the volumetric capacity of the drain. The technique employed would be to use mechanical excavators on the dry bed of the drain. For this purpose the waters upstream of Kakraula regulators would have to be removed during the exercise by lowering the crest level of the old regulator or abandoning this regulator and building a fresh regulator with the desired crest level.

8.0 CONCLUDING REMARKS

The project has been accepted by Delhi Government and is in the process of implementation. It has established the possibility and practicability of on-channel storage of flood waters and rain water runoff and the related ground water recharge on the Najafgarh Drain. Raw waters could thus be obtained for Delhi in the shortest possible time and in the most cost-effective manner as compared to any other source or method. Under various scenarios the water stored range from 9.9 MCM to a maximum of 25.09 MCM. However the higher level of storages are possible only with interstate cooperation with Haryana. As the various scenarios are incremental in nature therefore in the short run those scenarios not having interstate implications may be implemented. The study report has also brought out the related benefits, i.e., imparting sustainability to ground water extraction, increase in green cover, recreational possibilities and uniquely a navigable inland waterway.

The study also reveals the possibility of extending the on-channel storage and recharge concept on a number of other major storm water drains in the Najafgarh basin such as Mungeshpur and Palam drains, the proposed supplementary Najafgarh Drain and also approximately 3 kms. Downstream of Kakraula before the start of the highly polluted downstream stretch of the Najafgarh drain. In due course with the isolation/diversion of sewage in the downstream stretch the system could be extended upto the tail reach of the Najafgarh Drain.

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Note : The paper presents the findings of a Techno-Feasibility study undertaken by INTACH in 1997-98 (the author was the Project Co-ordinator) for Irrigation & Flood Control Department Govt. of NCT Delhi. The report has been accepted/appreciated at the highest levels of decision making process and Govt. of Delhi is taking up the project report for implementation.