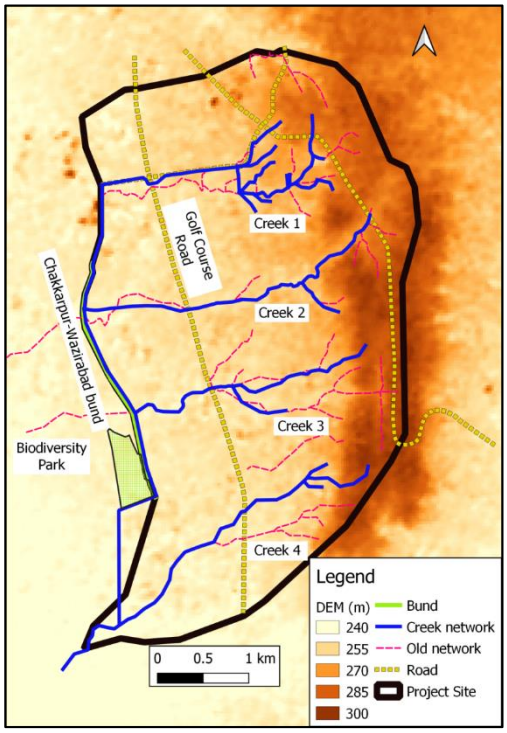
Blue Green interventions for addressing flooding along Golf Course Road and Neighbouring Sectors in Gurugram

Executive Summary

The TERI School of Advanced Studies (TERI SAS) conducted a three-month long study to investigate the causes of frequent flooding along Golf Course Road and the neighbouring sectors (26-56) in the city of Gurugram in Haryana. The aim of the study was to propose blue green interventions for sustainable flood management. The study area has four Creeks, many segments of which has either been disconnected or buried in the garb of urbanisation. The Chakarpur-Wazirabad bundh is a prominent and successful self-sustaining green public space located within the study area. Preservation of green infrastructure may have a positive influence on the residents about the commitment of local government to sustainable development. The upstream of each creek is a hilly region that can be preserved for water conservation and runoff control during heavy rains. The old (pink dotted) and the present (Blue) creek network and the elevation of the site are shown in figure alongside.



The Golf Course Road is at an average elevation of 250m, while the bund at 245m and Paras hospital and Sheeba apartment are at 240m. Hence, being low-lying spots, these form the chronic flooding spots.

Key Recommendations

1. **Non concretized creek segments to be kept Kaccha (Stream Daylighting):** The DPR has proposed RCC drains in the creek network except in the hilly areas and other alternative sustainable green solutions. Approximately 10% of the total creek length of 30222m has already been concretised. As the status of the boxed drains is not known, we suggest that at least 15000m and preferably all of the remaining part of creeks can be kaccha (natural/sustainable with green corridor) channels.

   It is to be noted that creating box drain drastically reduces the cross section and carrying capacity of the erstwhile channels, and also prevents groundwater recharge. This also adversely affects the natural greenery and biodiversity in the surrounding area of the channels. The box culvert proposed has fixed carrying capacity of 12.4 m^3/sec at maximum and it is supposed to flow at 80% capacity as per its design guidelines. Here, the natural/kaccha channels may have varying capacity and allow for overflow to sides and ready absorption in soil. Due to varying/variable cross section, it is

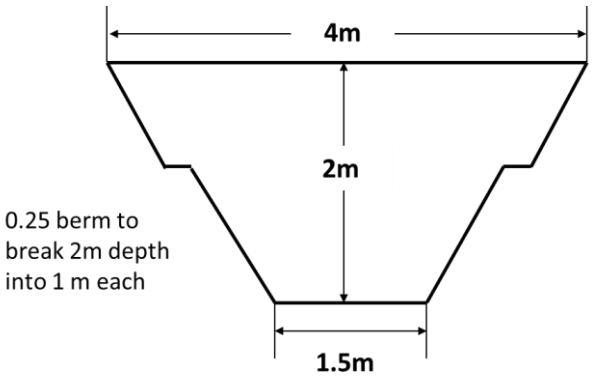
possible to provide flexible design, and also increase cross section if required, while the hard box drain does not leave us with any such option.

2. **Catchment basins:** All the eight catchment basins (pondage) proposed in the DPR may be built. They will help reduce storm runoff volume by 50% from the upper green catchment. Cities in Europe and USA have benefitted from adopting sustainable urban storm water design by preserving the urban blue green spaces.

3. **Role of roads in channelizing storm water; channel it to the creeks:** The roads connecting the Gurgaon Faridabad highway and the Golf course road also act as water channels during high rainfall events. Gentle breakers & gradients and discharge pipes may be used to ensure that this flow is blocked and diverted to the green belts and creeks.

4. **Restoration of the Hydrological Channel and removal of bottlenecks:** The ecological restoration of the channels is required for all four creeks.

    - For all creeks, dimensions may be considered as top width 4m, bottom width 1.5m, depth 2m. Hence, the cross-sectional area on an average for all creeks will be higher than a box drain with size 3mx1.8m or 5.4m^2. Restoring them will allow groundwater recharge in the area. The runoff velocity can be slowed down by ensuring infiltration at the rate of 25mm/h by enhancing the soil properties.



    - ***Ecological restoration works on creek 2 have enhanced the infiltration capacity of the green area on the slopes of the channel and the berm above.*** The creek 2 eventually joins the main Chakkarpur-Wazirabad bund. The Wazirabad bund has capacity to carry storm water and the sand and silt at its bottom section allow seepage of water to the ground below and laterally. This shall also allow the recharge wells proposed along the bund to receive water. The side slopes of the bund can be strengthened by plantations. Unlike the popular belief, they do not reduce the carrying capacity of the bund which is at 5m height. The high flood level in the bund will be at best at 2.5m level and if green slopes are maintained, there will be less erosion on the slopes as well. The silt and sand accumulated in the bund channel increases absorption capacity of the channel and desilting is not suggested for this portion. Likewise, no disturbance to the existing greenery in the area is recommended as the roots of the plants act as water carriers to deeper levels and slow

down the movement of water in the channel which allows more water to be stored within the green corridor of the bund and catchment.

- Certain portions of the creeks face bottlenecks for various reasons, which constrain the passage of water. These bottlenecks should be identified and expanded.

- For the kaccha channel flowing along the Chakkarpur-Wazirabad bundh – a small box drain has been constructed along the initial portion of the drain with rather low cross section, and in practice water flows over the top of it. Beyond the box drain - there is a long portion which is still kaccha and has a fairly large cross section and good natural vegetation has also come up on its sides. This may be kept largely as it is. If possible, the unboxing of the boxed drains may be considered in due course to increase the carrying and absorption capacities.

- Ecological restoration and plantation of native wetland species should be continued to create sub-surface water flow channels. Especially during rainfall period, it will naturally help absorption and speed reduction of water flow.

5. **Gabion Structures:** Gabion steps of 1m height and 0.5m thickness may be constructed within the creek cross section to reduce runoff velocity and thereby allow groundwater recharge within the creek catchment**.** Construction debris may be used in place of RCC for building these structures.

6. **Green corridor:** Green corridors act as water repositories.

    - Since the north side of the creek 1 catchment has large open green spaces and rejuvenation of these open green spaces is being carried out, laying of the green corridor (and or sub surface storm water drains, wrapped geotextiles) is suggested.

    - Creek 2 is open till the DLF project (where it is buried under two pipes) and then again after Golf course (GC) road till the Bund (with a concrete/pucca bottom and natural side slopes). Widening and ecological restoration work here to be continued using native species to grow on the side slopes and adjacent green corridor. This will create sub surface water flow channels which during rainfall episodes will naturally help absorb more rainwater and create a slower water flow path. The pucca bottom can be removed.

    - Creation of green corridor with infiltration trench adjacent to the creek 2 along the road will mitigate accumulation of water at the Golf Course road and underpass. A sunken green corridor, 5-10m wide and >250m long, along the road side is suggested for creek 2 in this portion at a lower elevation than the road level to allow water from the road to be drained in these green corridors which will act as water retention/natural recharge belts.

    - The GC road after the creek 3 crossing has a depression on GC road which continues till junction of GC road with creek 4. Parallel green corridor on both sides of the road at an elevation lower than the GC road elevation in this stretch will help in diverting storm runoff from the road and maintain a green corridor (with or without shallow infiltration trenches).

- Green corridor can also be maintained along the creek between the catchment basin 8 and Smriti van.

7. **Rain Garden and Infiltration trenches:** These help in arresting large volumes of runoff as well as in groundwater recharge.
    - Rain gardens are suggested in the catchment of all the four creeks. The dimensions may be flexible. As they are in the lowest elevation in the sub catchments, so runoff may be collected with ease. However, necessary channels will have to be constructed to divert water to these rain gardens from the nearby catchment within 250-400m radius.
    - Rain gardens are suggested within the Ansal university campus.
    - Rain gardens and infiltration trenches are recommended within the Smriti Van catchment.
    - Subsurface flow in the recharge areas can be generated through the infiltration trenches along the creeks and connected to the recharge wells.
    - Parks and green belts should be reviewed and lowered in height by 0.15m to 0.5m, as much as possible, so that they can act as distributed water holding areas.
    - Laying of tiles/concretizing of green belts should be avoided.

8. **Wetlands /Lake rejuvenation/Pond**

    - Creation of a wetland is proposed adjacent to golf course road upstream of creek 3. Ensuring rainwater flow to the wetland will result in reduction in water accumulation at the GC road junction.

    - In Creek 3, the downstream of GC road junction is still in natural condition and enters the lake near Parvsnath exotica (Wazirabad Jheel) which can be rejuvenated as it currently faces eutrophication. This jheel can act as a large holding pond for rain runoff from the GC road. The creek carries sewage after crossing the GC road which is evident from the eutrophication of the Jheel.

    - Culverts near Sheeba Apart should be provided to carry the excess runoff to the open green space adjacent to it. Creation of sunken green area /green pond may also be considered in the open area along with shallow rainwater harvesting borewells.

    Create nature-based/ natural catchment areas at localized low points- Use parks, greenbelts, vacant lands, natural ground, and all open spaces to retain surplus rainwater and recharge groundwater in urbanized and undeveloped areas. Low points can be natural or created to temporarily store water. Subsurface capacity to enhance holding capacity where feasible through recharge pits, gravel basins etc. Non- concretized/ structured catchment basins will enhance water collection and percolation into the ground. And reduce pressure downstream. This includes bio-swales, rain gardens, retention and detention ponds, constructed wetlands, recharge wells and tanks.

9. **Recharge Wells**

   - Recharge wells along the 245m elevation, parallel to the **Chakkarpur-Wazirabad Main Bund**, is suggested, with infiltration galleries (so that water reaches these wells). These recharge wells can be at points where the creeks join the Bund (fresh sand may be deposited to provide for increased infiltration). The groundwater recharge may increase by 20% depending upon the surface area accessible to receive runoff and flow to the recharge wells. The diameter of recharge wells may be 1m-2m, depth 5m and filled with gravel and a permeable soil bottom.

   - On creek 4, near **Ansal University** and **Smriti Van**, recharge wells of 1m-2m diameter are suggested because of presence of thick soil layer which can allow retention (increase in hydraulic conductivity-0.002m/day, recharge is possible for 20mm/h infiltration rate, on days of regular rainfall and good vegetation cover). The roots of existing plants help in acting as water carriers to the soil below and renew recharge capacities.

   - Creek cleaning at all existing locations is suggested (to remove construction debris and plastic waste), so that water may be stored in them and slow infiltration will happen and will reduce flood flow and attenuate the flood levels in the creek and bund channel. Sub surface flow can be induced due to gradient and new green corridor parallel to the creek, which may contribute further to recharge wells.

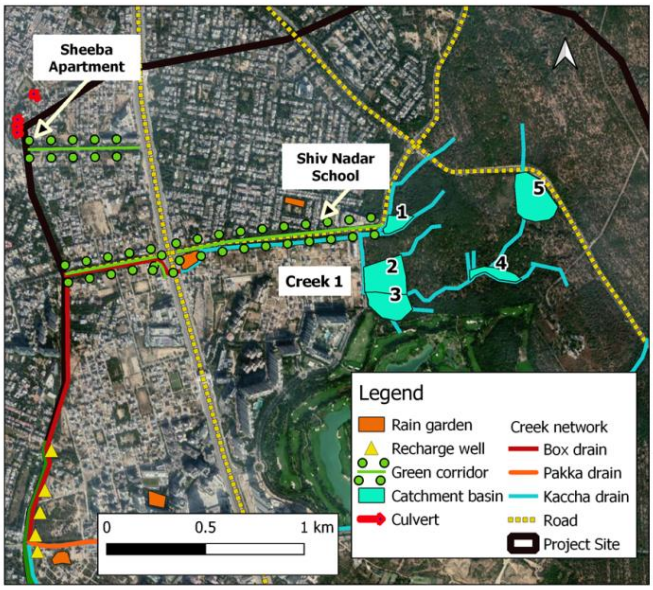
10. **Sewage Infrastructure:** The sewage generated in the city must be channelised to municipal sewers and not discharged in the stormwater drains and creeks. At present, 20-30% of the channel capacity is used to carry all weather sewage flow. Dismantling of sewage disposal outfalls in the stormwater channels may start from the upstream and proceed downstream in a sequential manner. Keeping channels open helps in identifying sewage outfalls. This is a critical issue not addressed at the city level. To ensure sustainability and low requirement for servicing and maintenance, treatment is required so that external water outfalls are not contaminated. The authorities may consider mapping this network and correcting the lapses as the first step.

11. **Rainwater Harvesting:** Each residential neighbourhood or gated complex must work on the principle of absorbing the water it is generating as run off. Presently, the rainwater from the residential area also flows to the GC Road as it is at a lower elevation than the surrounding residential apartments and colonies. Given the increase in rainfall variability and increasing extreme events that are happening, the minimum storm water holding capacity of the projects/colonies should be reviewed and enhanced. It should be made mandatory for all the residential/commercial buildings along the GC Road to conduct a rainwater holding capacity and recharge audit of their premises, and based on the findings, to increase the capacity to hold/arrest the rainwater within their premises through **rainwater retention and recharge/harvesting options**. This shall ease the rainwater flow to the golf course road.

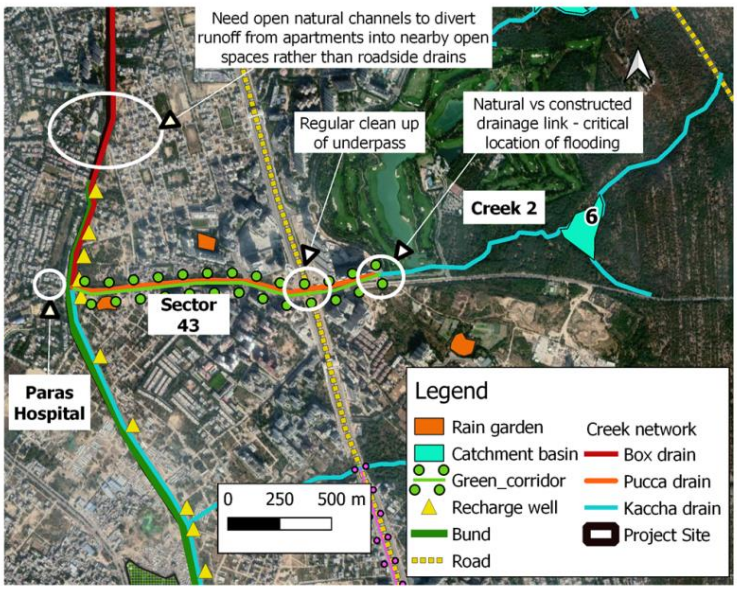
12. **Protection of the Aravallis upstream of the Golf Course road.** Gurgaon is highly concretized. This is especially true along the GC road, where the green belts have been sacrificed for road expansion and the projects along the GC road have high level of paved areas which generate higher levels of

runoff. The Aravalli hills above the GC road are an important groundwater recharge area and green zone for the city. These should be earmarked as a forest and recharge zone where no construction is allowed, as any further construction and concretization in the Aravallis upstream will increase the storm water runoff and increase the flood risk downstream.

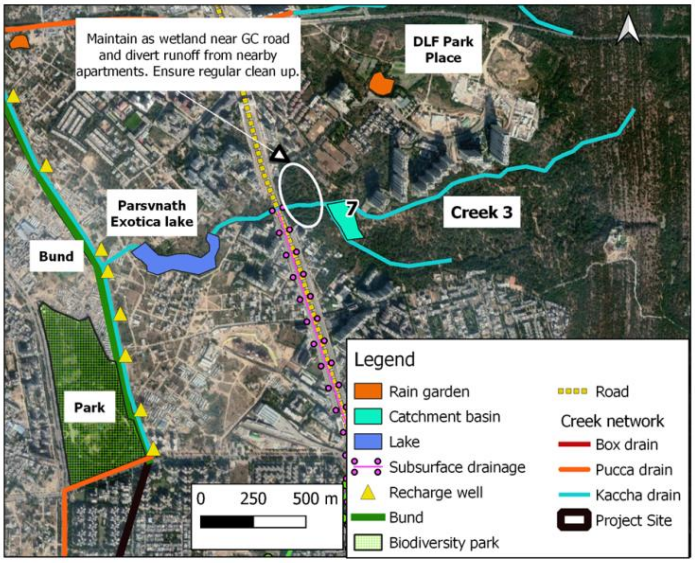
Locations of interventions in the Map for four creeks



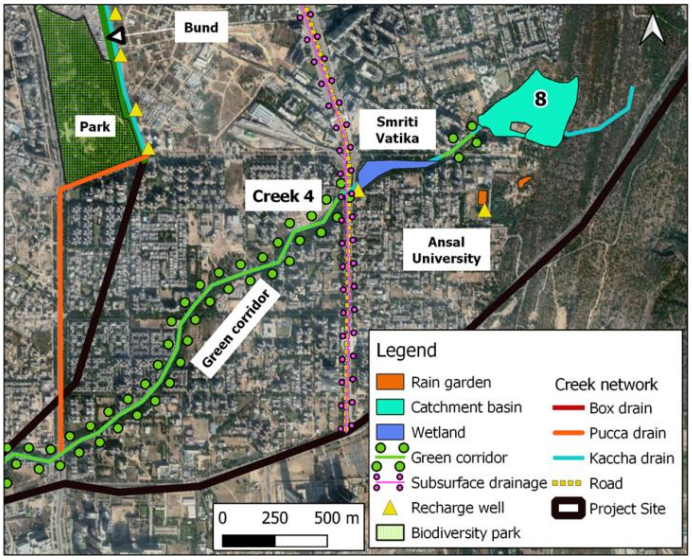
Creek 1



Creek 2



Creek 3



Creek 4

Prepared By:
Ms. Ranjana Ray Chaudhuri, TERI SAS
Dr Sherly M A, TERI SAS
Dr Fawzia Tarannum, TERI SAS

Sponsored By:
I Am Gurgaon