

CHAPTER V

DRAINAGE SYSTEM IN CHENNAI METROPOLITAN AREA

Pappan channel, Tambaram



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5.1 Flood protection works

The National Water Policy recommends that water resource development and management has to be done for a hydrological unit such as a drainage basin as a whole, or for a sub-basin. The approach needs to address not only irrigation but other requirements such as, domestic, industrial, energy, recreational and other uses as well. The importance of planning any project within broad framework of river basin master plan has been, therefore, amply emphasised. Improvements to macro and micro drainages¹ are, therefore, vital to address the challenges of flooding.

The macro drainage works are executed by Water Resources Department (WRD) and the micro drainage works are executed by Greater Chennai Corporation (GCC) and respective local bodies.

With a view to mitigate flooding in Chennai city due to frequent heavy rains, after the floods of 2005, WRD proposed to carryout flood protection works under the centrally sponsored scheme of JNNURM. As JNNURM works were related to urban areas, the preparation of Detailed Project Report (DPR) was entrusted to GCC to provide solution for the inundation problems of Chennai city. The DPRs were prepared in 2008-09.

GoTN accorded (October 2009) administrative sanction for improvement to macro drainages maintained by WRD in the four basins² of Chennai at a cost of ₹ 633.03 crore using JNNURM funds (35 *per cent*) and State funds (65 *per cent*). The works were to be executed in 10 packages. The works in seven packages were awarded between June 2010 and April 2011 to various contractors. The C&AG's Audit Report on GoTN (Economic Sector) for the year ended 2012-13 had pointed out that these works were not completed due to improper planning, non-acquisition of land, lack of co-ordination with other departments, and non-eviction of encroachments. We observed that these issues continued to persist and consequently, the works were getting delayed as discussed in the following paragraphs. Works in three other packages were not commenced due to non-removal of encroachments in waterways by WRD, where such works were required to be carried out.

¹ Rivers and canals, under the control of WRD, constitute macro drainages and storm water drains under the control of GCC, constitute micro drainages

² Northern Basin (Ambattur, Kathirvedu, Korattur and Otteri); Central Basin (Arumbakkam, Koyambedu, Maduravoil and Virugambakkam); Eastern Basin (Adyar, Ice House, Mandaveli, Muttukadu, Mylapore, Triplicane and Wall Tax Road) and Southern Basin (Manapakkam, Pallikaranai, Porur, Ram Nagar, Taramani and Velachery)

While implementing the seven packages awarded in 2010-11, WRD faced constraints in the DPR prepared in 2008-09 such as low soil bearing capacity of the work site, need for changing the construction methodology, non-availability of land due to encroachments, non-feasibility of the proposed alignment, etc. Therefore, WRD prepared (September 2012) a revised DPR for executing the work in all the ten packages including in the seven packages which were awarded, but faced various constraints in implementation. The revised DPR was approved by GoI, Ministry of Urban Development in December 2012.

After approval of the DPR by GoI in December 2012, and subsequent approval by Technical Advisory Committee and Tender Award Committee, GoTN accorded (September 2014) Revised Administrative Sanction for the ten packages at a total cost of ₹ 699.86 crore.

We observed from the fact that the works could not be carried out based on the DPR of 2008-09, which indicated that the DPR was defective, warranting a revised DPR and the consequent delay in implementation of the works.

As of March 2016, three out of the ten packages were successfully completed. Deficiencies in the execution of the remaining packages, contributing to non-achievement of objectives of these works despite incurring an expenditure of ₹ 274.05 crore, are discussed in **Paragraphs 5.1.1 to 5.1.8**.

Northern Basin

5.1.1 Work not completed due to non-completion of land acquisition despite directive by the Hon'ble Supreme Court to acquire remaining land

GoTN sanctioned (October 2009) construction of a diversion channel for carrying 300 cusec of surplus water from Kolathur Tank to Madhavaram Tank to reduce inundation in adjoining areas due to overflowing of Kolathur Tank's surplus course. The work of creation of the channel for 1,830 m out of 3,150 m was completed by incurring an expenditure of ₹ 13.92 crore. The balance work of creation of channel for 1,320 m was not executed due to legal proceedings in the acquisition of land and the partly executed work was closed by WRD (July 2015).

We observed that the legal appeal filed by the land owners was disposed of (September 2014) by the Hon'ble Supreme Court of India with direction to GoTN to start land acquisition process afresh. But, WRD without taking any initiative to acquire the land, closed the work in July 2015, ten months after the Hon'ble Supreme Court's direction. This lackadaisical approach of WRD had resulted in non-achievement of the objective of constructing diversion channel from Kolathur Tank to Madhavaram Tank and thus, the expenditure of ₹ 13.92 crore incurred on the partial work proved unfruitful. Non-completion of the channel resulted in inundation of nearby areas of Thanikachalam Nagar of Kolathur during the December 2015 floods.

GoTN replied (February 2017) that efforts would be made to complete the land acquisition. The reply was not tenable as GoTN had not initiated any action even after a lapse of three years since the judgement of the Hon'ble Supreme Court allowing fresh land acquisition. Thus, there is need for GoTN to complete the work after ensuring acquisition of remaining land as per directives of the Hon'ble Supreme Court for achieving the intended objective of the work.

5.1.2 Failure to create additional vent resulted in afflux of water

GoTN sanctioned (October 2009) the work of improvements to Ambattur Tank surplus drainage channel to mitigate inundation in Ambattur industrial area of North Chennai by discharging 1,830 cusec of surplus water from Ambattur Tank to Korattur Tank. The works included construction of weirs at left and right flank, flood protection walls, bridge etc.

We had observed³ that the work could not be fully completed even after incurring an expenditure of ₹ 18.68 crore due to non-receipt of permission for provision of additional vent for transferring 570 cusec under the Railway track considering the safety of the tracks.

We also observed from the scrutiny of records that no efforts were made by WRD for redesigning the vents in accordance with the safety requirements of the Railways but pre-closed the execution of work (March 2015). This resulted in non-achievement of the objective of transferring 570 cusec of water and continued inundation and flooding in Ambattur and SIDCO industrial areas.

Thus, failure of WRD to commence the work after obtaining necessary permissions or to initiate efforts for redesigning the vents in accordance with the requirement of railways resulted in non-achievement of desired objective, besides unfruitful expenditure of ₹ 18.68 crore.

5.1.3 Unfruitful expenditure on partially executed surplus channel work

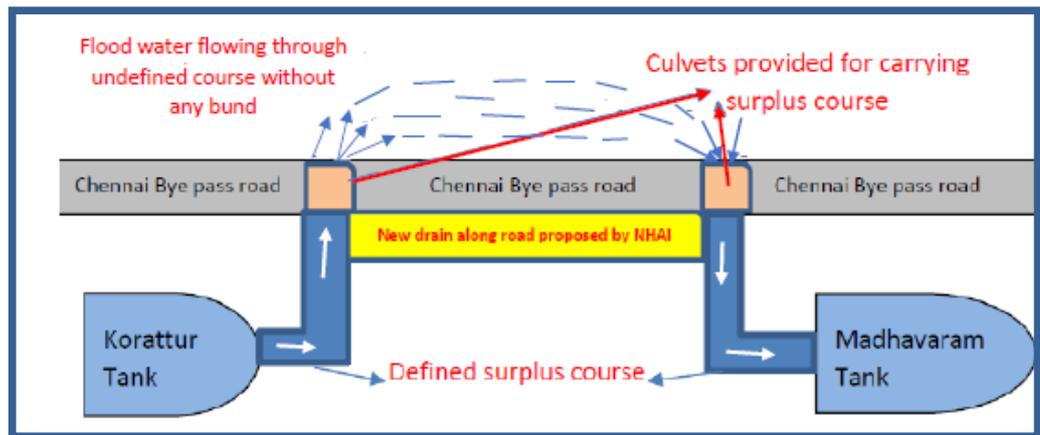
Para 100 of Public Works Department (PWD) Code envisaged that no estimates should be prepared for any work except on the basis of a detailed investigation on the site. Para 180 also stipulated that no work should be started on land which was not duly handed over.

(A) Korattur Tank having capacity of 0.236 TMC is situated in Ambattur taluk, Tiruvallur District. The tank had a defined surplus course only for a length of 1,750 m. Thereafter, it spreads over and takes a natural course for a length of 1,290 m., passing through *patta* lands before falling into Madhavaram Tank. In 2010, the National Highways Authority of India (NHAI) proposed construction of Chennai bypass road, with its alignment cutting across the surplus course of Korattur Tank. During commencement of the work on the bypass road, NHAI had proposed (February 2010) for

³ Paragraph 2.13.4 of C&AG's Audit Report (Economic Sector), GoTN for the year 2012-13

construction of a drain along the service road for taking the Korattur Tank's surplus water to Madhavaram Tank (**Exhibit 5.1**). The proposal was discussed by NHAI and WRD authorities, and it was suggested by WRD for construction of box culverts at two locations to carry surplus water across the road to its natural drains. WRD had not agreed to the NHAI proposal of construction of a drain along service road. NHAI had completed (2011) Chennai Bypass road and service road with box culverts at two locations as suggested by WRD.

Exhibit 5.1: Illustrative sketch showing existing and proposed alignment of Korattur Tank's surplus course



Not to scale

The bypass road work was completed with box culvert underneath the road to carry the surplus water of Korattur Tank, instead of constructing a drain along the service road as was suggested by NHAI. After crossing the bypass road through box culverts, the surplus water took natural course over the *patta* lands, thereby contributing to inundation in adjoining areas. The failure of WRD to agree to the proposal of NHAI resulted in continued flow of the surplus water through thickly populated areas contributing to the inundation in the adjoining areas.

(B) Subsequent to the construction of Chennai Bypass, the work of improvements to diversion channel to Korattur Tank surplus course to carry 600 cusec water was approved (December 2012) in the Revised DPR. The work involved creation of regulatory arrangement to the existing weirs, construction of cut and cover type surplus channel for 850 m along the service road of NHAI and construction of flood protection wall to the surplus channel.

Based on the approval (July 2013) of the Technical Advisory Committee of GoTN, Technical Sanction was accorded (December 2013) by CE, WRD for execution of the work at a cost of ₹ 27.76 crore. The work was awarded (February 2014) for ₹ 27.67 crore to the lowest bidder for completion in nine months.

WRD requested (June 2014) permission from NHAI for construction of cut and cover type surplus channel along the service road. NHAI refused (October 2014) permission citing non-availability of sufficient land for

execution of work in the service road and such construction would also disturb the embankment of the existing NHAI bridge. WRD engaged the services of a consultant from IIT, Madras to assess the possibility of undertaking cut and cover type surplus channel and the consultant opined that excavation of the service road for box type surplus channel would weaken the embankment of the bridge. The contractor completed the other items of the work at a cost of ₹ 17.94 crore and requested for foreclosure of the work citing non-availability of work front and the work was foreclosed (May 2015).

We observed that despite non-initiation of proceedings seeking permission from NHAI and without ensuring work front for execution of work, WRD had prematurely finalised the contract and commenced other components of the work. This resulted in pre-closure of the work after incurring an expenditure of ₹ 17.94 crore. Thus, absence of proper planning in management of macro drains in diversion of surplus waters, finalisation of alignment without proper feasibility study, commencement of work without ensuring the availability of work front and in contravention of the codal provisions resulted in unfruitful expenditure of ₹ 17.94 crore on the partially executed work besides non-achievement of the envisaged objective. Partial execution of the work was of no use as the surplus course of 600 cusec from Korattur Tank could not be linked to the downstream Madhavaram Tank, thus, defeating the very objective of the project.

Thus, (a) the injudicious decision of WRD in 2010 to construct box culvert instead of drain along the service road and (b) the resultant failure in executing the drain work sanctioned in 2013 due to refusal of permission by NHAI as it would damage the existing bridge, had contributed to huge inundation and loss of property in the residential areas of INTUC Nagar, Collector Nagar and Ambedkar Nagar of Kathirvedu village during 2015.

Government replied (March 2017) that efforts were being made to commence the work in the service road without damaging the embankment of highway. The reply was not tenable as WRD should have done a proper feasibility study as the alignment of the channel along the service road was not at all feasible with the present design.

Southern basin

5.1.4 Incorrect assessment of field conditions in the DPR resulted in non-achievement of objective and unfruitful expenditure

During the floods in 2005, Velachery and its adjoining areas were one of the worst affected areas which faced massive inundation, the reasons for which may be primarily attributed to poor drainage system and non-existence of diversion channel from Velachery Tank to South Buckingham Canal. As such, GoTN sanctioned (October 2009) the work of providing a short cut diversion drainage channel for a length of 4,100 m to carry surplus water from Velachery Tank to South Buckingham Canal near TIDEL Park at a cost of ₹ 58.15 crore, which was subsequently revised to ₹ 88.34 crore. The work was subsequently awarded (June 2010) to a contractor for completion in

18 months. WRD handed over the site to the contractor in May 2011 after a delay of 12 months due to defects in the DPR, which are as follows:

- As no field study was conducted during the preparation of DPR, WRD could not ascertain that Grade separator piers of Highways Department were lying, which were overlapping the alignment of the proposed channel work in one stretch (LS 0-220 m), resulting in delayed execution of work.
- The DPR failed to assess that routine traffic was required to be diverted for execution of the work in a stretch of 60 m (4,040 – 4,100 m), for which prior permission from Police Department was required to be obtained. No such field study was conducted, which again contributed to delayed execution of the work.

We further observed that the DPR had even failed to assess that the conventional construction method would not be feasible for a length of 2,690 m out of the total length of 4,100 m as there were 23 road crossings including a major crossing near Velachery Bus Stand. As a result, the entire stretch of work, which should have been completed by the stipulated period i.e. November 2012, was not completed till date (May 2017).

Thus, incorrect preparation of DPR without assessing the field conditions, delayed handing over of work front and absence of co-ordination for finalisation of alignment resulted in unfruitful expenditure of ₹ 72.42 crore besides non-achievement of flood mitigation in the areas. This led to inundation in the Velachery area during the December 2015 floods.

Government stated (March 2017) that presence of heavy traffic in the stretch and necessity of required permission from various agencies delayed the completion of work. The fact however remains that WRD failed to ensure the correctness of methodology suggested in the DPR while according Technical Sanction for the work which resulted in non-achievement of the objective even after five years despite being pointed out in the earlier Audit Report.

5.1.5 Non-commencement of diversion channel work resulting in inundation

GoTN sanctioned (January 2010) two works, viz., (i) improvements to South Buckingham Canal from Okkiyum Maduvu to Muttukadu backwater to carry 9,000 cusec of flood waters and provide relief from inundation of Velachery and (ii) a short cut diversion channel from Buckingham Canal (near confluence of Okkiyum Maduvu) to the Bay of Bengal to carry 3,500 cusec of flood waters for effective draining of flood waters from the Pallikarnai marshland at a total cost of ₹ 131.90 crore.

WRD completed (December 2014) the first component of the work of improvements to south Buckingham Canal to carry 9,000 cusec of flood water from Okkiyum Maduvu to Muttukadu backwater. But, while preparing the revised DPR in 2012, WRD proposed to drop the second component of the work of constructing short cut diversion channel from Buckingham Canal to

the Bay of Bengal as the proposed alignment was to pass through ‘VGP Golden Beach’, a popular sea shore resort cum amusement park, citing land acquisition cost of ₹ 100 crore. The Central Public Health Environmental Engineering Organisation (CPHEEO) of GoI, Ministry of Urban Development, while appraising the revised DPR did not agree to the proposal of WRD to drop the diversion channel work and instructed that the decision was required to be reviewed by GoTN keeping in view the importance of the component. Despite strong recommendation of CPHEEO, GoTN dropped the work after incurring an expenditure of ₹ 90.34 crore. We had observed⁴ that the work of short cut diversion channel from Buckingham Canal to Bay of Bengal, was not commenced due to the involvement of acquisition of private lands costing about ₹ 100 crore. GoTN finally dropped (October 2014) the project citing land acquisition problems.

We observed that absence of short cut diversion channel led to increased discharge of 12,500 cusec of flood waters into the Buckingham Canal, designed to carry 9,000 cusec, resulting in inundation of Velachery and adjacent areas.

Thus, the action of the Government in not considering alternative options and deciding to drop the project citing land acquisition cost, indicated lack of seriousness in fulfilling the objective of providing a permanent solution to the inundation problems of the thickly populated Velachery area.

5.1.6 Unfruitful expenditure on partially completed surplus course

Porur Tank situated in the city limits of Chennai was catering to the drinking water needs of the residents of the city. The tank did not possess a defined surplus course or regulatory arrangement. The tank discharged 600 cusec of surplus water through weirs which passed through *patta* lands causing inundation during monsoon.

WRD proposed (August 2009) for providing a defined surplus course to connect the Porur Tank to the existing Manapakkam drain for final discharge into Adyar River. Accordingly, GoTN sanctioned (October 2009) ₹ 26.96 crore for improvements to Porur Tank surplus drainage by weir reconstruction, widening and deepening canal and widening of existing bridges.

We had observed⁵ that the work could not be commenced due to inability of WRD to acquire the required land for the project.

WRD revised the alignment of the surplus course for length of 1,165 m and for provision of cut and cover canal with pre-cast concrete in the service road of NHAI to an extent of 745 m, at a cost of ₹ 49.92 crore and CE accorded (January 2014) revised Technical Sanction. The work was awarded to the

⁴ Paragraph 2.13.1 of C&AG’s Audit Report (Economic Sector), GoTN for the year 2012-13

⁵ Paragraph 2.13.4 of C&AG’s Audit Report (Economic Sector), GoTN for the year 2012-13

lowest bidder for ₹ 45.53 crore for completion in 15 months from February 2014. WRD forwarded (June 2014) a proposal seeking permission from NHAI to undertake the work in the service road for a length of 745 m. NHAI returned (December 2014) the proposal stating that the drawing indicated the total width of canal as 5.9 m and considering the width of service road (5.5 m), execution of the work would damage drain along the main carriage way.

Despite notice from NHAI (February 2015) directing not to commence the work without approval, WRD commenced construction work and partially executed 495 m of the canal work. The work was stopped after the matter was taken up by NHAI with GoTN indicating that the continuance of work by WRD without permission amounted to trespassing and illegal activity under the provisions of National Highways Act, 1956. The work was stopped (March 2016) after incurring an expenditure of ₹ 45.03 crore.

We observed as under from the scrutiny of records:

- WRD failed to undertake proper field investigation and to determine the adequate width of the canal in consonance with the width of the service road resulting in non-receipt of required permission from NHAI.
- Commencement of work on the service road without permission resulted in illegal activity by WRD contravening the provisions of National Highways Act which calls for fixing of responsibility on the officials concerned.
- The work was pre-closed without completing 250 m, which was in the initial stretches of the surplus canal, which resulted in unfruitful expenditure of ₹ 45.03 crore incurred on the canal in subsequent stretches due to its non-utilisation besides inundation in the nearby areas.

Thus, the failure of WRD to undertake proper field investigation and to determine the adequate width of the canal resulted in unfruitful expenditure on the partially completed work besides non-achievement of the envisaged objective despite being pointed out in the earlier Audit Report.

In the Exit conference (February 2017) with the Secretary to Government, PWD, WRD officers informed that the work would be completed after obtaining necessary permission from NHAI. The reply did not address the Audit observation that the work was commenced without following the due process leading to stoppage of work and non-achievement of the objective.

Central basin

5.1.7 Abandoning of work due to absence of feasibility study

GoTN accorded (October 2009) administrative sanction for ₹ 17.52 crore for improvements and construction of diversion channel from Maduravoyal Tank to Cooum River for discharging 962 cusec of surplus flood water.

We had observed⁶ that the work awarded (June 2010) to the contractor was not commenced due to existence of multi-storeyed tenements of Tamil Nadu Slum Clearance Board and heavy encroachments at work site. In order to overcome the issues posed by encroachments, WRD, without initiating any measure to evict the encroachers, proposed an alternative alignment.

The proposed alternative alignment required obtaining of permission from other agencies like Highways, TNEB, BSNL, CMWSSB and NHAI for execution of the project. The Tender Award Committee decided (September 2013) to execute the work by calling for fresh tenders after obtaining clearances from these agencies. GoTN accorded (September 2014) revised administrative sanction for ₹ 32.59 crore for construction of straight cut diversion channel in the alternate alignment for discharge of surplus flood water. We observed that WRD failed to obtain necessary permission from the agencies concerned, resulting in non-commencement of the work even as of January 2017.

Government replied (March 2017) that delay in obtaining necessary permissions from the agencies concerned delayed the commencement of the project. The reply was not tenable as other than writing letters to the agencies concerned, WRD did not make any serious efforts to obtain permission from them.

Thus, the failure of WRD to evict encroachments at the site of the original alignment and the absence of effective co-ordination to obtain necessary permission from various agencies for execution of work in the alternative alignment, resulted in non-commencement of diversion channel to discharge 962 cusec of surplus flood waters into Cooum River. This had also led to inundation in Maduravoyal area and its adjacent areas during 2015 floods.

Eastern Basin

5.1.8 Non-completion of improvement works to Central Buckingham Canal due to encroachment

Non-commencement of the work of improvements to Central Buckingham Canal sanctioned in October 2009 for ₹ 68.62 crore was pointed out in C&AG's Report on GoTN (Economic Sector), 2013.

National Disaster Management Guidelines, 2008 envisaged provision of embankment in the existing course of rivers for preventing overflowing of water over the banks. It was also envisaged that concrete or masonry flood walls may be constructed where adequate space was not available in developed areas for provision of embankments.

GoTN accorded (October 2009) administrative sanction for improvement to Central Buckingham Canal for ₹ 68.62 crore to mitigate the inundation in the residential areas of Triplicane, Ice House, etc., due to overflowing of the canal

⁶ Paragraph 2.13.3 (a) of C&AG's Audit Report (Economic Sector), GoTN for the year 2012-13

during monsoon seasons. Technical Sanction was accorded by CE, Chennai Region for the work including construction of flood protection wall on both banks of the canal, having total length of 14,200 m (7,100 m on either side) besides widening of two bridges viz., Ice House road bridge and Kutchery Road bridge which had vents with width of 5 to 6 m as against the required 15 to 17 m.

We had observed⁷ that the work could not be commenced due to incorrect adoption of soil conditions in the DPR (December 2008) and encroachment of the canal area by slum dwellers.

WRD revised (January 2014) the scope of the work for adoption of pile foundation instead of open foundation and reduced construction of flood protection wall to a length of 1,115 m due to the failure of the WRD to evict the encroachments by slum dwellers who demanded alternative residential accommodation in nearby areas. The work was awarded (February 2014) to the lowest bidder for ₹ 16.18 crore for completion in 12 months. The work commenced in March 2014 was completed in March 2015 incurring an expenditure of ₹ 15.72 crore except for important sub component, viz., construction of additional vent facilities to two bridges for the reason that the additional work would weaken the existing structure.

We observed from the scrutiny of records as under:

- WRD failed to ensure the correctness of the soil condition at the time of according Technical Sanction, resulting in revision of scope of work of construction of flood protection wall from open foundation to pile foundation.
- Failure of WRD to evict the slum dwellers from the banks of the canal forced the department to reduce the scope of the work of flood protection wall to 1,115 m. as against 14,200 m. We also observed that the encroachers were provided with electricity connection, voter identification cards, ration cards and well laid roads in violation of GoTN's own statutes, orders etc. All these indicated lack of seriousness on the part of GoTN to mitigate the hardships due to inundation and loss of property in the nearby areas.
- Non-commencement of important sub components of providing additional vent facilities under two bridges indicated inadequate field investigation by the departmental officials while sanctioning Technical Sanction.
- Without exploring alternative ways for creation of additional vent facilities, WRD pre-closed the work resulting in flow of water in a width of 5 to 6 m as against the required 15 to 17 m, which contributed to flooding in the adjoining areas during December 2015.

Government replied (March 2017) that the encroachments could not be evicted due to stiff resistance from the encroachers and efforts were being made to

⁷ Paragraph 2.13.4 of C&AG's Report on Economic Sector, GoTN for 2012-13

evict them in stages. The reply was not acceptable as it was GoTN's duty not to allow any encroachments as per its own law and orders.

Thus, failure of the WRD to ensure the correctness of soil conditions and stability of the existing structure and to take stern action for removal of encroachments resulted in reduction in scope of work and non-achievement of the objective of mitigating the inundation of residential areas despite incurring an expenditure of ₹ 15.72 crore. The failure of the GoTN to remove encroachments clearly demonstrated its lack of seriousness to handle serious issues affecting the life and property of the people of Chennai city.

Recommendation No. 15: We recommend that GoTN should take effective steps to complete all the above eight flood prevention works, approved way back in 2009 under JNNURM, by evicting encroachments, facilitating acquisition of land, finding alternative alignments and instructing WRD to redesign the construction methodology, wherever required, so that the threat of inundation is reduced.

5.2 Micro drainage system

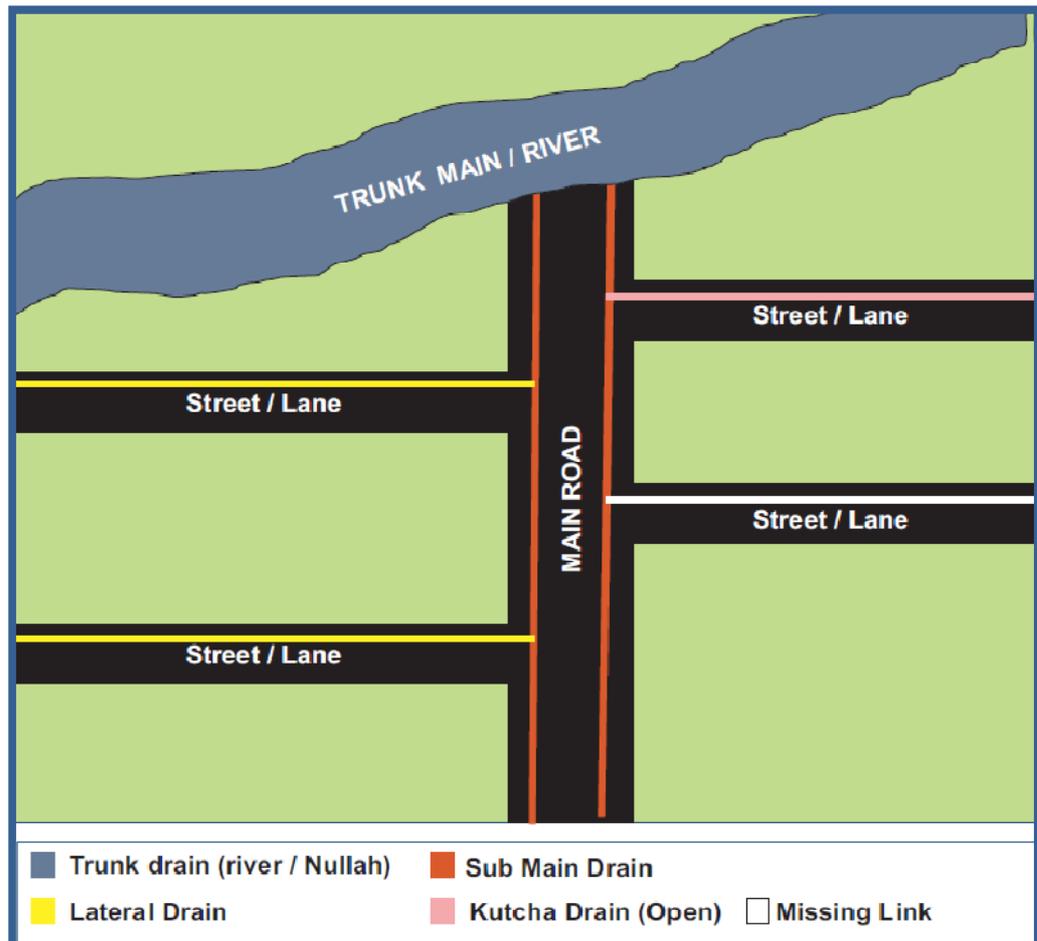
Storm water drains (SWD) are intended to collect surface rain water from the streets and discharge into water courses. An efficient, well designed and well maintained storm water drainage system would minimise the level of water logging and damage and therefore play an important role in flood management.

Indian Roads Congress (IRC) Guidelines of 1999 and 2013 provide that urban drainage system has to be designed in such a way that it captures the rainwater runoff from the road surface and infiltrate and takes it into the ground closest to the source. In case of lack of space, it should be conveyed along the road to the receiving body, in addition to infiltrate it into below ground at designated locations only.

SWD networks comprise of lateral drains, sub-mains and trunk or main drains. Rain water gets collected in the lateral drains along road margins. The lateral drains join to make sub-main drain and finally joins trunk or main drain.

As per the existing system and as envisaged in the SMP, the local bodies are responsible for management of micro drainage system within their jurisdiction. In GCC areas, as against the road length of 7,303 km, SWDs were provided only for a length of 1,894 km which formed only 26 *per cent* of the total road length. Scrutiny of records of sampled zones revealed that SWD network was not adequate, as discussed in succeeding paragraph. A sketch depicting, macro drain, sub-mains, lateral drains and missing links in SWD network in Ward 127 of Kodambakkam Zone is shown in **Exhibit 5.2**.

Exhibit 5.2: Illustrative sketch depicting SWD network



Not to scale

(Source : Storm water network in GCC)

5.2.1 Non-preparation of master plan for Storm Water Drains

The guidelines issued (1999/2013) by IRC envisaged preparation of comprehensive master plan to manage storm water. The master plan was to be based on watershed⁸-based planning, focusing on retaining and recharging the rain water locally. It also envisaged Geographical Information System (GIS) - based analysis of drainage patterns, hydrological mapping, topography and open spaces of the city.

We noticed that GCC did not prepare any master plan for SWDs. Though a Department headed by a Superintending Engineer had been functioning to deal with construction of SWDs, no attempt was ever made by GCC to prepare a master plan for SWDs to approach the issue in a systematic manner. Lack of a master plan with a timeline had resulted in poor coverage of SWDs and unidentified missing links⁹ in the network. During monsoon 2014, GCC identified (November 2014) 52 missing links of SWDs in road margins and sub-mains which were not connected to SWD network, which ultimately

⁸ The area that drains into a single river is the watershed for that river

⁹ SWDs not connected with the network. These SWDs empty the rain water in undesignated areas

caused inundation during floods of 2015. The details of missing links are given in **Appendix 5.1**. Subsequent to the floods, remedial measures for connecting the missing links were carried out in 42 links and works were in progress in 10 links (November 2016). Out of 52 missing links, 24 links were in the test checked zones, which reported inundation during December 2015. Government stated that (April 2017) a Master Plan was prepared (2009) by a Consultant appointed in 2008. The reply was incorrect as the DPR for JNNURM work, prepared in 2009 could not be equated to a Master Plan as it dealt with only the works proposed to be carried out and it did not have any plan for covering the whole area of the city.

We observed that non-preparation of comprehensive master plan for SWD as envisaged in IRC guidelines had resulted in poor coverage of SWDs in CMA and non-completion of the work of correcting the missing links in the network prior to floods of 2015.

Recommendation No. 16: We recommend preparation of a Master Plan on watershed basis to guide a time-bound strategy for construction of SWDs on all required roads for ensuring flow of storm water to the sea/destination/at its disposal point.

5.2.2 Wrong designing of storm water drains due to incorrect adoption of rainfall intensity

(i) IRC guidelines (1999) envisaged that rainfall intensity¹⁰ was to be considered for designing SWDs. Other parameters to be considered for designing SWDs are the catchment area, land pattern and location of disposal point. CMDA appointed (1993) a Consultant to recommend a programme of works for the alleviation of flooding in the city and CMA. The Consultant viz., Matt MacDonald arrived (1994) at a rainfall intensity of 48.63 mm per hour using Gumbel's extreme value distribution method¹¹ to be adopted for designing SWDs. National Institute of Hydrology, Roorkee, which evaluated the World Bank - aided Hydrology Project II¹² (Project 2006) also arrived at a rain fall intensity of 48.89 mm per hour using the same method. We observed that both Matt MacDonald and National Institute of Hydrology, Roorkee had adopted the same method to calculate rain fall intensity. The negligible variation in the rainfall intensity calculated by the Consultants was due to adoption of different base years for calculation.

In June 2008, GCC engaged a Consultant for preparation of DPR for improvement of SWDs under JNNURM Project. While preparing (2009) the DPR for SWDs, the Consultant had considered two methods for arriving at the rainfall intensity based on which the size of SWDs were to be designed. The

¹⁰ Rainfall intensity is defined as the ratio of the total amount of rain falling during a given period to the duration of the period. It is expressed in mm per hour (mm/h)

¹¹ In probability theory and statistics, the Gumbel distribution is used to model the distribution of the maximum or the minimum. This theory is used by CMDA as well and the workings were vetted by the Consultant appointed by Audit

¹² Project executed by PWD during 2006 to 2014 for storm water management in Cooum River

Consultant arrived at a rainfall intensity of 31.39 mm per hour under one method (hourly rainfall data obtained by interpolation of data of rain fall for periods less than 60 minutes) and 49 mm per hour under another method (recurrence interval method). GCC adopted the rainfall intensity of 31.39 mm per hour and constructed SWDs for a length of 345 km at a cost of ₹ 610.55 crore under JNNURM project during 2011-14 with design based on lesser rainfall intensity. We observed that adoption of lesser rainfall intensity had resulted in construction of SWDs of lower rain water carrying capacity which was one of the findings of Anna University in respect of SWDs available in 2009.

On being pointed out during audit, GCC justified adoption of lesser rainfall intensity citing approval given by Central Public Health and Environmental Engineering Organisation (CPHEEO), a body under GoI, Ministry of Urban Development. We observed that GCC could not source the required data from India Meteorological Department (IMD) as required under CPHEEO guidelines and went in for interpolation of available data to arrive at the rainfall intensity of 31.39 mm per hour. Rather than interpolating the data, GCC could have adopted the method as suggested in SMP.

We noticed that the second value of rainfall intensity as worked out by GCC's own Consultant for the JNNURM project and the values worked out by CMDA's Consultant Matt MacDonald and the National Institute of Hydrology, Roorkee, ranged between 48.63 mm and 49 mm. This clearly established that the rainfall intensity adopted by GCC for designing SWDs was incorrect leading to construction of lower capacity SWDs which contributed to the floods of 2015.

To substantiate the argument for adoption of the recurrence interval method, the Report on Functional Plan on Drainage for National Capital Region, under the Ministry of Urban Development, GoI, had also emphasised that the design of SWD should be on the basis of recurrence interval method. This Report further stated that CPHEEO Manual was not applicable to cities like Chennai, where rainfall intensity is more than 20 mm per hour and executing SWD works based on the method suggested by CPHEEO may cause severe floods.

Recommendation No. 17: We recommend adoption of the correct rainfall intensity for designing SWDs in future.

(ii) In the aftermath of 2005 Floods, the GoTN had entrusted the work of flood risk mapping for CMA to Anna University, Chennai using Airborne Laser Terrain Mapping (ALTM) and Geo Information System at a cost of ₹ 2.17 crore with partial financial support from GoI (Department of Science and Technology).

The University submitted its report in 2012 containing recommendations by experts group proposing flood mitigation works with site plans and also conducted workshops for dissemination of knowledge in which officials from GCC, Revenue Department, WRD and other Departments participated. The Report attributed the flooding in Chennai and its suburbs to reduction in

capacity of the waterways due to encroachment, construction of roads and bridges across water bodies, inadequate size of drains, obstructions in the drains, obstructions in rivers' mouth due to sand bars, etc.

The recommendations of Anna University, *inter alia*, included inter-linking of SWDs with temple tanks¹³ which were not taken up seriously by GCC as discussed below:

Based on lithological studies on recharge capabilities, the Report classified areas of Chennai city and its suburbs into seven zones based on their geo locations which were intended to recharge coastal and river sands (aquifer zone), parks, open spaces, play grounds, temple tanks and institutions. The Report recommended intensive artificial recharge by redesigning SWDs, by providing recharging bore holes at potential recharge locations and by connecting SWDs to temple tanks to divert the flood water and to minimise surface run off.

As per GCC's norms, rain water harvesting structures were to be provided in SWDs at 30 m intervals along the roads. However, GCC did not construct rain water harvesting structures in SWDs as required. In respect of temple tanks, GCC identified 17 tanks for rejuvenation and inter-linking of them with SWDs. Out of this, GCC took up (2016) two tanks on pilot basis and completed at a cost of ₹ 0.40 crore.

GoTN stated (April 2017) that a total of 9,113 rain water harvesting structures were constructed in the SWD network of GCC. We observed that as per GCC's own plan, rain water harvesting structures were to be provided at 30 metre intervals along the roads. Considering the SWD length of 1,894 km, 63,133 rain water harvesting structures were required. While appreciating the efforts of GCC to start providing rain water harvesting structures in SWDs, we observed that the achievement was only 14.43 *per cent*, indicating a need for greater thrust.

We observed that non-adoption of the recommendations of Anna University and improper design in construction of drains with incorrect capacity also contributed to the floods during 2015.

5.3 Storm Water Drain network of Greater Chennai Corporation

GCC had taken up improvement of SWD network under Centrally Sponsored JNNURM and World Bank-aided TN Sustainable Urban Development Programme (TNSUDP).

(i) Under JNNURM, SWD works for Chennai City were approved (April 2009) for a length of 533.32 kms at a cost of ₹ 814.88 crore. The project comprising of 1,203 works was to be carried out in four basins *viz.*, North, Central, East and South.

¹³ Tanks located in temple complex which are used for temple ceremonies, poojas, etc.

A Performance Audit on the implementation of JNNURM was conducted and audit findings were included in C&AG's Report (Local bodies) – GoTN for the year ended March 2011. The Report highlighted delays in execution of SWD works. The present position of execution of SWD works under JNNURM by GCC as of December 2016 has been given in **Table 5.1** below.

Table 5.1: Projects under JNNURM in respect of SWD by GCC

Name of the basin	Revised Plan		Completed		Number of works dropped
	Number of works	Length of SWD (km)	Number of works	Length of SWD (km)	
North	329	118.91	329	117.73	0
Central	328	144.32	245*	82.92	83
East	244	91.48	195	86.38	49
South	131	65.19	116	57.97	15
Total	1,032	419.90	885	345.00	147

* includes a canal work partially completed
(Source: Details furnished by GCC)

As against revised plan to execute 1,032 works for a length of 419.90 km, GCC executed 885 works for a length of 345 km during June 2012 to June 2015 and dropped the remaining 147 works due to reasons such as commencement of works for Metro Rail project, narrow roads, service lines, heavy traffic, good condition of SWD and public objection. Audit scrutiny in sample Zones revealed that areas in Adyar and Kodambakkam zones, where works under JNNURM were dropped, were affected during floods, since no alternative measures were proposed to mitigate the flood in these areas.

(ii) Under TNSUDP, GoTN accorded (January 2015) administrative approval for provision of SWDs in newly added areas¹⁴ of GCC at a cost of ₹ 2,212.89 crore. As per the conditions of World Bank relating to such works, tenders were to be finalised only after resettlement of families living along the canals. GCC invited (April 2015) tenders for providing SWDs in the basins of Adyar and Cooum Rivers under 39 packages.

Audit scrutiny of the records of GCC disclosed that work orders were issued (January-February 2016) for 35 packages. There were delays in issue of work orders by GCC, ranging from two to five months. Further, the milestones, as provided in the agreement (20 per cent of work in six months period), were not achieved in 25 packages and achievement was less than 10 per cent in ten packages, as of August 2016 (**Appendix 5.2**).

The remaining four packages, which were to be executed in Nandambakkam, Padikuppam, Ambattur SIDCO and Nolambur Canals, were not taken up due to non-clearance of encroachments. Subsequent to 2015 floods, GCC

¹⁴ Alandur, Ambattur, Perungudi and Valasaravakkam zones, which were added (2011) to Chennai Corporation as part of additional eight zones

prepared (July and August 2016) Resettlement Action Plan to motivate voluntary resettlement of encroachers. Based on the action plans prepared for three of the four canals, TNSCB rehabilitated the encroachers of Nandambakkam Canal area and action was being taken to rehabilitate the encroachers dwelling in Ambattur SIDCO, Nolambur and Padi kuppam Canals.

Despite eviction of encroachers from one canal and progress made in respect of other canals, GCC had not initiated action for commencing work in these four packages. However, the works for construction of SWDs in the streets, which had disposal points in these canals, were awarded (January 2016) and were being executed.

The delays in execution of SWD works delayed accrual of the benefits. We observed that construction of SWDs without execution of works in canals would not mitigate the floods.

5.3.1 Construction and maintenance of Storm Water Drains

Expenditure on construction and maintenance of SWDs, as a percentage of total expenditure of GCC, during 2011-12 to 2015-16 is given in **Table 5.2**.

Table 5.2: SWD in GCC

Year	Total expenditure			Expenditure on SWD			Percentage of SWD expenditure to total expenditure
	Revenue	Capital	Total	Revenue	Capital	Total	
2011-12	924.66	269.55	1,194.21	0.41	77.90	78.31	7
2012-13	1,413.78	732.72	2,146.50	1.13	162.76	163.89	8
2013-14	1,973.15	1,392.63	3,365.78	1.02	236.01	237.03	7
2014-15	2,222.67	1,923.91	4,146.58	7.90	198.31	206.21	5
2015-16	2,536.01	1,742.79	4,278.80	11.81	158.55	170.36	4
Total	9,070.27	6,061.60	15,131.87	22.27	833.53	855.80	6

(Source: Details furnished by GCC)

The percentage of expenditure on SWD to the total expenditure of GCC during 2011-16 ranged from four to eight *per cent*. The financial outlay for SWD was found to be inadequate in the face of the huge shortfall in the coverage of SWDs in GCC area, leading to inundation of areas, as discussed in the succeeding paragraphs.

5.3.2 Non-achievement of targets due to poor outlay

Achievement of targets, as of August 2016, against the targets set (April 2006) under City Development Plan for provision of SWD in City and other urban areas by 2011/2016 is given in **Table 5.3**.

Table 5.3: SWD - Targets and achievements

Zone	Length of road (in kms.)	Target for SWD achievement as per City Development Plan (in per cent)		Length of SWD provided (in kms.)	Actual achievement Percentage (as of August 2016)
		2011	2016		
Adyar	411.52	100	100	136.33	33
Alandur	231.84	40	60	86.17	37
Ambattur	496.51	40	60	29.97	6
Kodambakkam	456.36	100	100	189.60	42
Perungudi	455.47	40	60	55.94	12

(Source: Details furnished by zonal offices)

We observed that even the targets fixed for 2011 were not achieved as of August 2016 in any of the sampled Zones and the GCC had a long way to go to achieve 2016 target. From the above, it could be observed that the length of SWD in the selected zones was 6 to 42 *per cent* of the total length of the roads. In terms of number of streets, scrutiny of records revealed that SWDs were not provided in 4,854¹⁵ out of 9,225 streets in four¹⁶ of the five sampled Zones (53 *per cent*).

While conceding to the low coverage of SWDs, GoTN stated (April 2017) that in respect of Ambattur Zone, works were in progress to provide SWDs under the World bank aided TNSUDP. Further, GoTN stated that the natural topography of Adyar zone was sloping towards water body, requiring lesser coverage of SWD network. The reply was untenable as Adyar was one of the worst affected areas during floods of 2015. The fact of vulnerability of Adyar area to inundation was indicated by the fact that according to a micro level study conducted by GCC in 2014, the Adyar Zone had 21 out of 52 water stagnant 'hot spots' in the city, requiring attention. This proved that the contention of GoTN that Adyar required lesser coverage of SWD in view of its topography was incorrect.

5.3.3 Poor maintenance of Storm Water Drains

As per the Disaster Management Plan prepared (2014) by GCC, zonal offices should complete the pre-monsoon activities, which *inter-alia* included cleaning of SWDs, before the onset of monsoons.

Scrutiny of records in the test checked zones revealed that cleaning of SWDs was not done in 163 out of 614 streets with drains in Kodambakkam zone during 2013-16 and in all 898 streets with drains in Perungudi zone during 2015-16. Further, work orders for cleaning of SWDs in four Divisions of Kodambakkam zone were issued in October 2015 after the onset of the

¹⁵ Alandur: 397, Ambattur: 780, Kodambakkam: 1,776 and Perungudi: 1,901

¹⁶ Except Adyar zone for which details were not furnished

monsoons and the works were completed in December 2015 and January 2016. Non-cleaning of SWDs contributed to inundation of these areas.

GoTN, in their reply (April 2017) reasoned that the ban on manual scavenging imposed by the Hon'ble Madras High Court caused difficulties in cleaning SWDs. We noticed that only because of the 233 illegal sewer lines linked to SWDs (October 2016), cleaning of SWDs became an issue. We observed that GCC failed to effectively prevent sewage entering SWDs, leading to non-cleaning and consequent flooding due to overload and clogging of these SWDs.

5.4 Storm Water Drain network in suburban areas

Scrutiny of records of Tambaram, Sembakkam and Pallavapuram Municipalities and Perungalathur, Peerkankaranai and Thiruneermalai Town Panchayats and joint inspection of sites alongwith the local bodies' officials revealed the following regarding maintenance of SWDs:

5.4.1 Inadequate funds for Storm Water Drain

The details of total expenditure of the selected local bodies and the expenditure incurred by them on SWDs during 2011-16 were as under (Table 5.4).

Table 5.4: Expenditure on SWD

Name of Municipality/ Town Panchayat	Total expenditure (₹ in crore)						Expenditure on SWD (₹ in crore)						Percentage
	2011-12	2012-13	2013-14	2014-15	2015-16	Total	2011-12	2012-13	2013-14	2014-15	2015-16	Total	
Pallavapuram	25.13	33.41	37.18	40.25	49.80	185.77	0.49	1.37	2.11	1.44	2.93	8.34	4
Peerkankaranai	2.50	2.78	3.10	3.91	5.51	17.80	0.22	0.73	0.99	0.96	1.18	4.08	23
Perungalathur	4.95	5.09	6.89	5.82	11.10	33.85	0.08	0.10	1.07	0.21	0.76	2.22	7
Sembakkam	4.76	5.30	8.30	8.67	11.67	38.70	0.15	0.72	1.51	2.81	2.81	8.00	21
Tambaram	24.56	30.45	41.28	47.85	58.80	202.94	3.66	8.03	8.27	8.33	12.86	41.15	20
Thiruneermalai	4.06	4.24	6.19	5.04	5.00	24.53	0.15	0.55	0.86	0.33	0.37	2.26	9

(Source: Details furnished by the respective local bodies)

As seen from the above, the percentage of expenditure incurred for provision and maintenance of SWDs, with reference to total expenditure, ranged from 4 to 23 *per cent* during 2011-16. The poor outlay had resulted in non-provision of SWDs leading to inundation of areas in the selected local bodies during floods, the details of which are given in **Appendix 5.3**.

Government stated (April 2017) that lesser percentage of expenditure for SWD was due to paucity of funds and the need to incur expenditure on unavoidable and more essential works. The reply was incorrect as these local

bodies had accumulated surplus¹⁷ as of March 2016 and hence there was no paucity for funds. We observed that the local bodies were not making serious efforts to provide SWDs which had contributed to flooding causing huge loss to life and property.

5.4.2 Inadequate/non-provision of Storm Water Drains by local bodies

According to the service level benchmark for SWDs, stipulated by GoI, Ministry of Urban Development, only 'covered pucca drains' are to be considered for the purpose of calculation of achievement of SWD coverage. *Kutcha* drains are unreliable as they are constructed without scientific design and get clogged by filth entering them as they are not covered. The length of SWDs provided by selected local bodies, as of March 2016, was as under (Table 5.5).

Table 5.5: SWD in suburban local bodies

Municipality/ Town Panchayat	Length of road (in kms.)	Length of SWD provided (in km.)		Percentage	
		Kutcha	Pucca	Kutcha	Pucca
Pallavapuram	242.00	172.00	3.00	71	1
Peerkankaranai	41.65	26.60	0	64	0
Perungalathur	83.56	40.18	0	48	0
Sembakkam	100.42	0	85.35	0	85
Tamparam	164.75	0	142.75	0	87
Thiruneermalai	39.36	32.86	0	83	0

(Source: Details furnished by the local bodies)

It is evident from the table above that without constructing pucca drains as per service level benchmark for SWDs, four out of six local bodies had mostly constructed *kutcha* drains. Therefore, *kutcha* drains constructed without proper scientific design with cover were not considered as proper SWDs.

We observed that in four out of six local bodies test checked, construction of pucca SWDs with reference to total length of the roads was almost nil while in two local bodies, it ranged from 85 to 87 *per cent*. Pallavapuram Municipality and Peerkankaranai, Perungalathur, and Thiruneermalai Town Panchayats did not achieve coverage of SWD in 321¹⁸ streets as against the target of 50 *per cent* set out in the City Development Plan to be achieved by 2016.

We, therefore, observed that lack of a Master Plan as envisaged in IRC and non-attachment of adequate importance for SWD works resulted in poor coverage of SWDs in suburban areas leading to inundation.

¹⁷ Pallavaram Municipality - ₹ 43.16 crore; Sembakkam Municipality - ₹ 20.45 crore; Tamparam Municipality - ₹ 48.41 crore; Peerkankaranai TP - ₹ 9.55 crore; Perungalathur TP - ₹ 32.93 crore and Thiruneermalai TP - ₹ 12.51 crore

¹⁸ Pallavapuram: 206, Peerkankaranai: 5, Perungalathur: 103 and Thiruneermalai: 7

Government stated (April 2017) that adequate funds would be provided to construct SWD in left out streets. The reply was not tenable as even with the available funds the local bodies had spent on *kutchra* drains instead of pucca drains as per the service level benchmark for SWDs, thereby defeating the very objective of constructing SWDs.

5.4.3 Non-implementation of consultant's recommendations on improving Storm Water Drains in Tambaram

In 2011, GoTN appointed a consultant for preparation of a DPR for construction of SWDs in six Municipalities, including Tambaram in CMA. In Zone 5 and Zone 9 of Tambaram Municipality, 14 Wards¹⁹ were identified as priority areas for SWDs at a cost of ₹ 17.24 crore, which were to be taken up in the first phase of four months.

We observed that despite a lapse of three years the Municipality did not take up any of the proposed works in the priority areas as suggested in the DPR as GoTN had not yet issued Administrative Sanction for taking up SWD works in the six Municipalities based on the DPR of March 2014. Major flooding had occurred during 2015 in the areas identified in the DPR as flood prone and priority areas, leading to damages including to roads, which were estimated to cost ₹ 25 crore for repairing.

GoTN replied (April 2017) that SWDs were constructed in 2 of the 14 prioritised wards. We noticed that even in the two wards mentioned by GoTN, SWDs were constructed only in few streets, and no work was approved in the remaining 12 wards. Thus, the DPR proposal to construct SWDs on priority basis in 12 out of the 14 wards, which required urgent action, did not materialise even after a lapse of three years, contributing to flooding in these areas during 2015.

5.4.4 Inadequate provision of Storm Water Drain on State Highways

Inside Tambaram Municipal area, 9.7 km of roads were owned and maintained by State Highways Department. Scrutiny of records of Highways Department revealed that SWDs were provided in a scattered manner for a length of 3.47 km on left side and 3.26 kms on right side without linkage and continuity. To an Audit query on non-construction of SWDs for the full length of the roads, the Assistant Divisional Engineer (Construction and Maintenance), Highways Sub Division, Tambaram and Government stated (June 2016/April 2017) that due to non-availability of land, SWDs were provided only in the locations, wherever the land was available. We observed that construction of SWDs in a sporadic manner, citing non-availability of land, indicated that the Highways Department had worked in an unprofessional manner without draining the rain water from the roads. On scrutiny of records pertaining to flood affected areas of Tambaram Municipality, we noticed that rain water stagnated in the areas abutting the highways during 2015.

¹⁹ Ward numbers 11, 12, 13, 14, 17, 18, 20, 22, 28, 29, 30, 31, 32 and 38

Thus, failure of the Highways Department in not constructing the SWDs for full length of the roads resulted in wasteful expenditure on sporadic construction of SWDs without linkage, and consequent inundation of the areas abutting Highways in Tambaram Municipality.

5.4.5 Partial execution of Storm Water Drain works

SWDs in internal streets (small lanes and by lanes) were to be designed in such a way that they collected rain water, seamlessly connected with sub-main and discharged the water into the main drain. However, scrutiny of records of Pallavapuram Municipality revealed that SWDs were constructed in bits and pieces, without seamless connectivity in the streets (**Appendix 5.4**), as against the provisions made in the respective estimates. When pointed out by Audit (June 2016), the Municipal Commissioner stated that the works were stopped due to public objection.

We observed that non-provision of SWDs to the full length in the streets, despite sanction of funds, defeated the objective of creating comprehensive drainage facilities, which contributed to inundation of these areas during floods of 2015. Government stated (April 2017) that the work of connectivity would be taken up during 2017-18 as the public had come forward for construction of SWD.

We observed that executing SWD works in bits and pieces was indicative of an unprofessional style of functioning of Pallavapuram Municipality. Stoppage of the SWD works, which were to benefit the public citing public objection, indicated that the Municipality failed to authoritatively negotiate with public to overcome the objection.

5.5 Clogging of storm water drains due to unauthorised entry of sewage

Underground sewerage system (UGSS) scheme was intended to carry sewage from households, commercial establishments and industries to treatment plants. UGSS is helpful to mitigate health issues arising due to open sewers. The untreated sewage carried by UGSS are treated by sewage treatment plants before being led into major drains. In places where the UGSS were either not available or not functioning, sewage got discharged into SWDs, which were constructed to carry rain water. The illegal action of allowing untreated sewage to enter SWDs caused clogging of the drains thereby blocking the flow of rain water through the existing SWD system.

The position in sample local bodies is discussed below:

5.5.1 Non-completion of underground Sewage Scheme in Tambaram Municipality

GoTN accorded (May 2009) administrative approval for implementing UGSS at a cost of ₹ 160.97 crore in Tambaram Municipal area through CMWSSB. The project was to be completed by August 2014. Out of four packages of works included in the project, one package entrusted (September 2009) by the CMWSSB to a contractor was terminated (June 2014) due to slow progress. The execution of the package was taken over by the Municipality in June 2014, but entrusted to a contractor only in March 2016 due to poor response to first three tender calls. The three other packages executed by CMWSSB were also not completed due to slow progress of work.

The project scheduled to be completed by August 2014 was not completed even as of March 2017 and the sullage from houses in many parts of the town continued to flow into SWDs and clogged them leading to inundation in Tambaram Municipal area.

5.5.2 Non-implementation of Project in other selected local bodies

GoTN accorded (December 2009) administrative sanction for implementing UGSS in the areas of Perungalathur, Peerkankaranai and Sembakkam local bodies at a cost of ₹ 130.72 crore, funded equally by JNNURM (50 per cent) and loan (50 per cent).

While the preliminary works were underway, the GoTN cancelled (September 2010) the implementation on the ground that these local bodies were not financially sound to repay the loan proposed to be taken for implementation of this scheme.

After six years, Sembakkam Municipal Council (January 2016) decided to implement UGSS in its area and sought approval of Commissioner of Municipal Administration for preparation of Detailed Project Report, which was awaited (March 2017).

We observed that rather than finding source of funds, GoTN took a wrong decision to drop an approved project to provide UGSS to three suburban areas of CMA. This clearly indicated bad governance, contributing to sullage being let out into SWDs. We observed that clogging of SWDs also contributed to the inundation in the suburban areas of Pallavapuram, Peerkankaranai, Perungalathur, Sembakkam, Tambaram and Thiruneermalai.

5.6 Pre-monsoon preparedness work

The rivers and drains in CMA are seasonal in nature with water flow only during monsoon. The rivers and drains get dried up in the non-monsoon period, except for the sewage unauthorisedly entering them. Misuse of dried rivers/drains for dumping solid waste and debris and growth of vegetation hinders free flow of water in the monsoon months. Therefore, every year, CE, WRD initiates action before the onset of North East monsoon for removal of silt, floating materials, vegetation and other obstructions to ensure free flow of

water. These pre-monsoon works also include continuous cleaning of vulnerable points during monsoon also.

5.6.1 Delay in release of funds for pre-monsoon works

Paragraph 4.12.2 of the National Disaster Management guidelines for urban flooding envisaged that desilting of drains is a major activity in flood management. Unauthorised disposal of untreated sewage, garbage, bio-degraded solid waste and growth of vegetation causes siltation of major and micro drains.

Commissioner of Revenue Administration (CRA) in their circular for disaster preparedness for the North East Monsoon also instructed (August 2015) that all water courses had to be desilted well before the onset of North East Monsoon.

The pre-monsoon work involving removal of silt, slush, debris, weeds, desilting and reforming the bund of the drains maintained by WRD was proposed for execution every year. North East Monsoon in the State is from October to December and hence the pre-monsoon works were required to be executed prior to onset of monsoon for effective clearance of debris from the water bodies.

The details of the pre-monsoon works proposed, sanctioned, executed in Kosasthalaiyar Basin, Lower Palar Basin and Araniyar Basin Divisions along with the expenditure and the dates of onset of monsoon are given in the **Table 5.6**.

Table 5.6: Details of execution of pre-monsoon works

Year	Date of Administrative Sanction	No. of works proposed	No. of works sanctioned and executed	Expenditure (₹ in crore)	Date of onset of monsoon	Date of commencement of pre-monsoon works	Date of completion of pre-monsoon work
2011	30/08/2011	58	58	3.59	24/10/2011	02/09/2011 to 27/09/2011	21/09/2011 to 15/12/2011
2012	18/09/2012	71	63	3.59	19/10/2012	25/09/2012 to 01/10/2012	17/10/2012 to 31/12/2012
2013	06/09/2013	68	58	3.57	21/10/2013	27/09/2013 to 03/10/2013	23/10/2013 to 30/12/2013
2014	13/10/2014	54	43	3.60	18/10/2014	16/10/2014 to 02/12/2014	31/10/2014 to 31/12/2014
2015	29/10/2015	52	41	3.59	28/10/2015	06/11/2015 to 01/12/2015	15/11/2015 to 31/12/2015

(Source: Details furnished by WRD)

From the details illustrated in the table, we observed as follows:

- GoTN did not sanction all the proposals received for undertaking pre-monsoon works, except during 2011.
- As sanction of funds during the five year period of 2011 to 2015 was almost the same, the number of pre-monsoon works sanctioned was in the decreasing trend during 2012 to 2015.

- GoTN belatedly released funds for pre-monsoon works during 2014 and 2015, leading to commencement and execution of 84 works after the onset of the monsoon. The execution of work after the commencement of monsoon hindered the free flow of flood water
- Though pre-monsoon works for the year 2013 were sanctioned by GoTN prior to monsoon, the works were not completed before the onset of monsoon.

Thus, the GoTN did not provide adequate funds on the basis of the proposals received from WRD, and failed to release funds prior to the onset of the monsoon in the year 2014 and 2015, leading to ineffective execution of pre-monsoon works, contributing to floodings.

Government replied (March 2017) that the pre-monsoon works were commenced prior to monsoon and continued during the monsoon period for clearance of debris, etc. The reply was not acceptable as the works which were required to be carried prior to the onset of monsoon were not completed before onset of monsoon in 2013, 2014 and 2015.

5.6.2 Non-desilting of canals by GCC

As per extant Rules, water bodies catering to 40 hectare or more of agricultural land were to be maintained by WRD and other than those were to be maintained by the respective local bodies. The details of water bodies maintained by GCC and WRD in the selected zones, Municipalities and Town Panchayats are given in **Appendix 5.5**.

During joint inspection (August to October 2016) of water bodies in GCC area by Audit and GCC officials, it was noticed that GCC failed to undertake any desilting works in the three out of four canals in Kodambakkam Zone and six out of eight canals in Ambattur Zone during 2011-16, which contributed to inundation in respective areas during floods of 2015. Further, Veerangal Odai (Alandur Zone) intended for draining excess water from the Adambakkam Lake, which finally drains out in Pallikaranai marsh, was also not maintained by WRD to facilitate free flow of flood water, leading to flooding in Adambakkam area.

5.7 Non-adherence to instructions on supervising desilting of water bodies

The CRA issued circulars prior to North East Monsoon 2014 and 2015 to all the Collectors to oversee the cleaning/desilting of natural water courses, clearance of encroachment etc.

We noticed that the District Collector, Chennai had not done any supervision of pre-monsoon works. To an audit query, the District Collector, Chennai replied (June 2016) that the pre-monsoon works were being carried out by the GCC and WRD. The reply was not tenable as the District Collector was responsible for overseeing the work by WRD. The District Collector, Tiruvallur inspected the pre-monsoon works only after the monsoon. The

District Collector, Kancheepuram inspected the works carried out only in 4 out of 12 Taluks.

Thus, the instructions of the CRA were not followed by the respective Collectors in overseeing pre-monsoon works which also contributed to flooding.

5.8 Flood mitigation measures in Adyar River

Adyar River course starts from Adanur Tank in Kancheepuram District and flows through Chennai city before draining into Bay of Bengal. The width of the river was not uniform in the entire stretch and it ranged between 30 m and 200 m. As per WRD records, 222 tanks with storage capacity of 7.41 TMC, influence the flow of water in Adyar River. The surplus course of a major tank Chembarambakkam with storage capacity of 3.645 TMC flows into the Adyar River near Thiruneermalai. The maximum flood carrying capacity of Adyar River in Chennai city as of October 2013, determined based on 100-year discharge ranged between 30,229 cusec and 49,652 cusec.

Historically, flooding in Chennai city was caused by overflow of flood water in Adyar River. Floods in Adyar River had caused inundation in Chennai and suburban areas in 1976, 1985, 1996 and 2005. The river with a carrying capacity ranging from 30,229 to 49,652 cusec, recorded a flow of 1.34 lakh cusec²⁰ on 1 December 2015 due to incessant rains and discharge of surplus water from Chembarambakkam Tank and several other unregulated tanks.

The recommendations made for mitigation of flood in Chennai city and its suburbs by various agencies nominated by GoTN and GoI were as detailed below:

- Nucleus Cell formed in CMDA to suggest measures for flood problems recommended (1980) creation of two new tanks above Chembarambakkam Tank and diversion channel from Perungalathur/Tambaram to transfer 10,000-15,000 cusec of surplus water from Adyar River to Covelong backwaters of Bay of Bengal.
- Report on Dam Safety Procedures issued by Central Water Commission, GoI (July 1986) envisaged preparation of Inundation map as the first input for planning an effective emergency preparedness. It was also envisaged to analyse the inundation history of the past 25 years and 50 years to assess safe carrying capacity of the downstream channel and the vulnerability of different areas through which the surplus water from the dam passed through. These inundation maps were to facilitate in prioritising structural measures to prevent floods.
- Report on Dam Safety Procedures issued by Central Water Commission, GoI (July 1986) envisaged that the flood carrying

²⁰ Estimated by Indian Institute of Science, Bengaluru adopting simulated hydrologic model

capacity of the river channels downstream of the dam shall be reviewed at intervals of five years.

- National Disaster Management Authority (NDMA) in their Guidelines (January 2008) recommended the State Governments to identify the locations and to take up channel improvement works like embankments, flood protection walls, etc., to increase the velocity or area of flow and reduce flood level in the river depending upon site-specific conditions and techno-economic considerations.
- Anna University, Chennai, engaged²¹ (2010) to prepare flood mapping of Chennai city and its suburbs by using Air-borne Laser Terrain Mapper (ALTM) technology, recommended (March 2012) for establishment of Automatic Weather Stations for development of an Early Warning and Decision Support System for Urban Flood Management in addition to IMD predictions.
- The National Water Policy 2012 envisaged installation of real time data acquisition system for flood forecasting and flood preparedness.
- An Expert Committee constituted by GoTN to suggest measures to minimise flood hazard and to optimise utilisation of monsoon rains recommended (October 2012) for construction of two check dams at Varadharajapuram and Anakaputhur villages to harness the surplus flow of flood waters through Adyar River.

We observed that these recommendations were not given due importance by GoTN to mitigate the floods arising due to North East Monsoon which resulted in unprecedented floods in Chennai and its suburbs during December 2015, as detailed below:

5.8.1 Creation of new reservoirs

Non-construction of two tanks in the upstream of Chembarambakkam Tank, as per Nucleus Cell's recommendations, and dropping of the proposal to construct a reservoir across Adyar River at Thiruneermalai have already been commented in **Paragraph 3.1.1**. Failures of WRD in execution of other structural measures suggested by the Nucleus Cell and the Expert Committee (2012) are discussed hereunder:

- GoTN did not consider the recommendation of the Nucleus Cell for construction of diversion channel from Perungalathur/Tambaram to transfer 10,000-15,000 cusec of surplus water from Adyar River to Covelong backwaters. We observed that the diversion channel proposed by the Nucleus Cell could have diverted a substantial flood load from Adyar River so that the flow in the river gets reduced. We also observed that GoTN neither made any attempt for acquiring land to construct the diversion channel nor made any provision in the SMP to earmark land for the channel by restricting development in the area.

²¹ By GoI, Ministry of Science & Technology and GoTN at a cost of ₹ 2.47 crore

- GoTN did not consider construction of two check dams at Varadharajapuram and Anakaputhur villages to minimise flood hazard and to harness the surplus flow of flood waters through Adyar River despite it being recommended by the Expert Committee on North East Monsoon rains. On the contrary, it allowed the Airports Authority of India to demolish a check dam constructed across Adyar River as discussed in **Paragraph 4.5(v)**. We observed that construction of the suggested check dams could have accommodated flood and to that extent the flow in Adyar River would have been reduced.

Thus, GoTN failed not only to create new reservoirs and check dams to mitigate the flood hazard due to monsoon rains, but also did not take any action to divert flood water from Adyar River despite recommendation by Nucleus Cell and Expert Committee resulting in inundations due to floods during December 2015 rains.

GoTN stated (May 2017) that the proposed and sanctioned reservoirs could not be taken up due to non-acquisition of land and urbanisation of the city. The issues like non-acquisition of land and urbanisation cited as reasons for not creating new reservoir by the GoTN were well in its capability and authority as brought out in this Report in the light of the benchmarks mentioned in the FMP and SMP.

5.8.2 Non-creation of flood protection wall

The NDM guidelines, 2008 recommended to carry out river channel improvement works as a measure to reduce the flood level in the river. Taking into the account the flood vulnerability near Nandambakkam bridge on Adyar River, GoTN sent (July 2008) to GoI, a detailed proposal for flood protection works on left bank of Adyar River for execution under centrally sponsored Flood Management Programme (2007-12). The proposal was withdrawn (March 2012) by the WRD on the plea that an amount of ₹ 1.06 crore would be required for acquisition of 0.69 ha of agricultural and residential land, which in fact was a very meagre amount. Thus, the injudicious decision of the WRD for deletion of the proposal resulted in non-execution of flood protection work as envisaged in the NDM guidelines which led to huge inundation in adjoining areas.

Thus, the failure of WRD in acquiring the meagre area of land by way of paying compensation had led to non-creation of important component of river improvement work by constructing flood protection wall. This was one of the failures, which contributed to inundation in the adjoining areas. The issue of failure of WRD in acquiring meager area of land requires to be investigated by GoTN, which entailed serious consequences.

Furthermore, this failure of WRD had also contributed to the inundation at MIOT Hospital, where critical patients were admitted and no help could be extended during the time of flooding.

5.8.3 Non-desilting of Adyar River

Report on Dam Safety Procedures issued by Central Water Commission, GoI (July 1986) envisaged that the flood carrying capacity of the river channels downstream of the dam shall be reviewed after every five years. Watershed Management Division of WRD, Pollachi, was responsible to conduct sedimentation survey to identify the extent of siltation in the tanks and rivers.

We observed that in terms of CWC guidelines, the Watershed Management Division of WRD did not conduct any survey to assess the extent of siltation in the Adyar River during the years 2011-12 to 2015-16 enabling WRD to carryout desiltation works to enhance the flood carrying capacity in violation of CWC guidelines. It was pertinent to note that the flood mapping of Chennai city and its suburbs by using ALTM technology conducted by Anna University had also recommended desilting the river courses as an immediate flood mitigation measure in CMA. Non-desilting of Adyar River resulted in overflowing of surplus water over the banks of the river at many points and resultant inundation in the residential areas of Chennai and its suburban areas.

WRD replied (October 2016) that no periodicity for conducting sedimentation studies had been fixed in the Departmental Manuals and survey would be conducted on priority basis. The reply was not acceptable as the CWC guidelines are quite clear about reviewing the carrying capacity of river channels after every five years.

The reply is also indicative of the fact that Manuals are outdated and need to be updated soon. Furthermore, needless to mention that desiltation is a very significant work of flood mitigation, WRD had not even bothered to carry out the work despite knowing the fact that CMA had witnessed several catastrophic floods even in the past. Instead of according seriousness to the desiltation work in the river, WRD cited non-provision of periodicity in Manual, which indicated lack of interest shown by the WRD towards flood mitigation measures.

5.8.4 Absence of Early Warning System for flood management

The Adyar River carried the surplus water from four major unregulated tanks²² besides surplus discharge of Chembarambakkam Tank joining in the midcourse before passing through Chennai and its suburbs for discharging water into Bay of Bengal. Despite recommendations for installation of Automatic Weather Stations for development of an Early Warning and Decision Support System for Urban Flood Management in addition to IMD predictions by Anna University and National Water Policy, WRD did not initiate efforts for installation of Early Warning System. This resulted in non-regulation of the flow of surplus water in the river after obtaining inputs from the controlling officers of various Tanks and overflowing of water over its banks causing inundation.

²² Adanur, Mannivakkam, Nandhivaram and Urappakkam

WRD in the Exit Conference stated that efforts were being made to complete installation of Early Warning System.

5.8.5 Flood Management of Chembarambakkam Tank influencing Adyar River

Report on Dam Safety Procedures issued (July 1986) by CWC, GoI envisaged that the aim of reservoir operation is to reduce the risk of man-made floods to the area on the downstream through carefully prepared reservoir regulation schedules, release procedure and gate operation schedules aided by an accurate and reliable flood forecasting and warning system.

Paragraph 8.1.2 of the guidelines also stipulated that floods disaster would be considered natural if the quantum of outflow from the dam is equal to the inflow flood. If, however, due to very existence of a dam, the outflow exceeds the inflow, the disaster can be logically classified as man-made. Paragraph 8.2.1, further stipulated that outflow in excess of inflow can be taken care of by developing operation rules with built-in factor of safety and adequate and efficient warning system.

Paragraph 8.8.1 of the guidelines envisaged that an efficient communication system with wireless communication facility should be in place for the success of emergency preparedness plan. Emergency Action Plan (EAP) for Dams, 2006 formulated by CWC, GoI recommended the requirement of inflow forecasting arrangements for better flood management.

Chembarambakkam Tank is one of the largest tanks with a capacity to store 3.645 TMC of water. The original surplus arrangement with three weirs²³ was converted into regulated arrangement by constructing five vented regulators with discharge capacity of 20,410 cusec and subsequently enhanced to 33,060 cusec by constructing (July 1993) 19 vented regulators.

The Rules for Flood Regulations of Chembarambakkam Tank, forming part of Compendium of Rules of Regulations (COR) issued by PWD in October 1984, provided for release of surplus water through three weirs without regulating arrangements. The Rules also provided for estimating the inflows into the tank and promptly intimating the flood discharges to the Chief Engineer, District Collector, Commissioner of Police and Commissioner of Chennai Corporation.

We observed from the scrutiny of records as follows:

Despite stipulations in the CWC guidelines for preparation of reservoir regulation schedules, the COR for Chembarambakkam Tank was not revised by WRD taking into account the regulated discharge of surplus water and enhancement of the height of the tank to 24 feet.

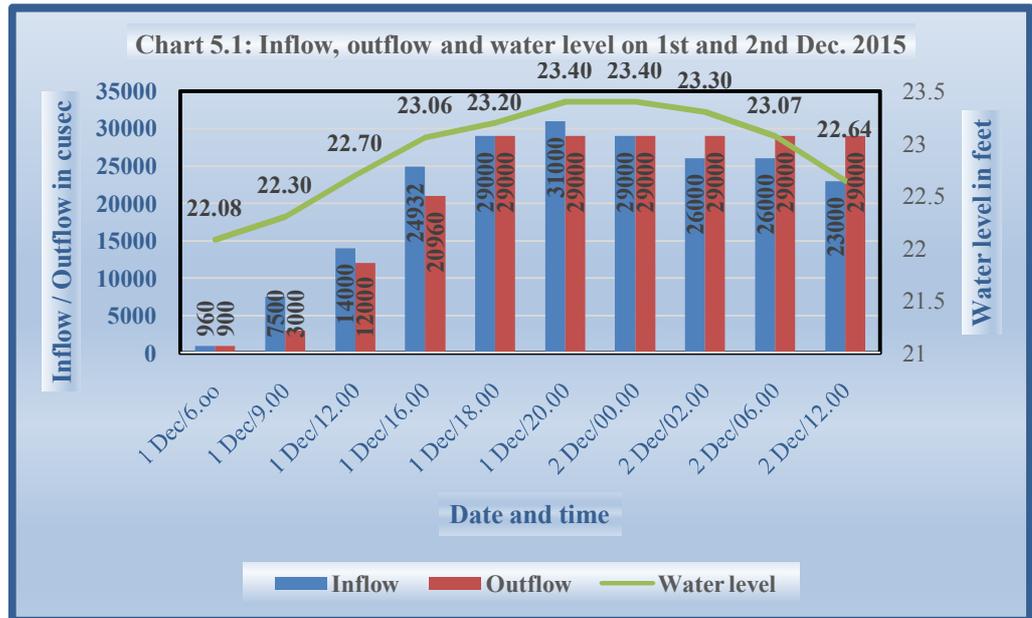
²³ Weirs are structures provided in tanks for surplus water to pass through

A comparison between COR for Poondi reservoir and the unrevised COR for Chembarambakkam Tank revealed the following:

Subject	As per COR for Poondi reservoir	As per COR for Chembarambakkam Tank	Applying the regulated COR of Poondi Reservoir to Chembarambakkam Tank	
			Required	Actuals
(1)	(2)	(3)	(4)	(5)
Declaration of state of Extra-ordinary Emergency	As soon as the reservoir level reaches three feet below Full Reservoir Level.	No such emergency declared. Information to other Departments when the weirs are likely to surplus and water level crosses 25 m.	Extra-ordinary Emergency should have been declared when the depth of water reached 21 feet (It reached 21 feet on 16/11/2015 (12 noon) and the water was maintained above that level till 02/12/2015).	Extra-ordinary Emergency was not declared. District Collector and Police officials were informed on 01/12/2015 when depth of water in the tank was 22.5 feet and flood warnings were issued.
Rainfall and discharge details of upstream tank	During emergency, the details of rainfall, duration, intensity, discharge particulars of upstream tanks were to be obtained.	No reference to emergency. The details of rainfall, inflow and outflow of upstream tanks were required to be collected.	Duration and intensity of the rainfall in the upstream tank were to be collected.	We observed that surplus from Sriperumpudur and Nemam Tanks discharged to Chembarambakkam Tank and there were only two rain gauges to measure the rainfall in its catchment and upstream tanks measuring 357 sq.km. We also observed that the duration and intensity of discharge of upstream tanks was not recorded.
Opening of regulator shutters	The gates should not be opened suddenly. They should be lifted giving time to allow the water level to rise gradually.	No provision as the COR was based on unregulated arrangement.	Gradual opening of gates and release of water.	We observed that the release of water was not gradual as detailed in the succeeding paragraph.

The surplus course of Chembarambakkam Tank joined Adyar River at Thiruneermalai. In the absence of gauges, the inflow into the tank from catchment areas was to be measured based on the increase in the height of water in the tank.

The details of inflow, outflow and water levels of Chembarambakkam Tank for the period from 16/11/2015 to 17/11/2015 and 01/12/2015 to 02/12/2015 are indicated in **Appendix 5.6**. The inflow, outflow and water levels pertaining to the crucial days of 1 and 2 December 2015 are shown in **Chart 5.1**.



(Source: Chart prepared based on data provided by WRD)

We analysed the discharge with reference to the extant rules and observed as under:

Imprudent and injudicious release of water causing massive flood

As per the COR for Regulated Tanks, WRD should store water at the Full Reservoir Level in the month of December, as the monsoon starts receding. The COR also does not allow presence of private *patta* land inside water spread area. As such, the *patta* land was required to be acquired for ensuring storage of water till the full capacity of the reservoir. We observed that the full tank capacity of Chembarambakkam was 3.645 TMC at a storage depth of 24 ft. However, the same was not achieved on any of the days during the receding monsoon of 2015. Even on the days of maximum inflow (01/12/2015 and 02/12/2015), water was stored only up to a maximum of 3.481 TMC, leaving 0.164 TMC of remaining capacity unutilised. We observed that the WRD did not maintain Full Reservoir Level to avoid possible submergence of the *patta* land on foreshore area, which was in absolute violation to the compendium of rules of regulations.

The Department had, therefore, failed to acquire *patta* land to operate the tank to its full capacity. GoTN stated (May 2017) that considering the cost of acquisition of *patta* land, a proposal to enhance the bunds in the foreshore of the tank was in pipeline, the documentary evidence for which was not made available to Audit. Had WRD acquired the *patta* land, the storage capacity could have been maintained to its fullest and magnitude of flooding could have been reduced as more water could have been stored in the reservoir.

The following observation substantiate that maintaining the storage capacity to the maximum, could have reduced the magnitude of the disaster:

- On 01 December 2015, at 2 pm, when the storage stood at 3.377 TMC, which was 0.268 TMC less than the total capacity of the tank, the discharge of water was abruptly increased from 12,000 cusec to 20,960 cusec. Again at 5 pm, the discharge was increased to

25,000 cusec and from 6 pm to 29,000 cusec. Considering the opportunity to store another 0.268 TMC, we firmly hold the view that the discharge could have been maintained at 12,000 cusec for another six hours²⁴, by which an additional quantity of 0.266 TMC could have been stored and yet the storage level would not have reached to the brim. We further observed that this indiscriminate water discharge was made to happen also because of the fact that *patta* land, which was allowed in the foreshore area, was to be saved from submergence. The tank-in-charge, therefore, had not maintained the tank capacity upto the maximum level and consequently, abrupt and un-sustained release of water was done. This was a serious failure in operation of the reservoir, thus, contributing to the massive disaster. Such imprudent and injudicious action by the Tank-in-charge as well as WRD warrants detailed enquiry.

- The discharge of water at 29,000 cusec continuously for 21 hours from 01/12/2015 - 18.00 hrs to 02/12/2015 - 15.00 hrs into the Adyar River coupled with surplus water from the upstream tanks and catchment area, caused huge flow of flood waters into Adyar River. Non-taking up of the desiltation work in Adyar River for increasing the flood water storage capacity along with other flood protection works in Adyar River and the injudicious decision to indiscriminately increase the discharge of water from 12,000 cusec to 29,000 cusec had proved that the disaster that had happened in November-December 2015 was not a natural disaster but was indeed a man-made catastrophe as per CWC norms, for which GoTN was responsible.
- According to CWC norms on Dam Safety, the surplus water released from the tank should be based on the actual inflow only. In the absence of Emergency Action Plan and due to GoTN's failure to update its system/manuals as per CWC guidelines, the water was released in an un-sustained manner. We also observed that the outflow of surplus water was more than inflow into the tank for 13 hours on 02/12/2015 (2.00 hrs to 15.00 hrs; Inflow 23,000 to 26,000 cusec – outflow 29,000 cusec) during the period of rain and despite non-storing of water to its full capacity, in contravention of the Guidelines of CWC prescribing the procedure for Dam safety, resulting in increased flow of water to the already swelling Adyar River.
- We observed that a total quantity of 8.7 TMC of water, which was more than 75 per cent of the total capacity of four reservoirs in CMA put together, was discharged from Chembarambakkam into the sea during 17 November to 10 December 2015. As Chembarambakkam Tank plays a very significant role in catering to the water supply needs

²⁴ Additional discharge of 8,960 cusec for three hours, over and above 2 pm discharge of 12,000 cusec between 2 pm to 5 pm would have increased storage by 96.768 mcft $(8,960 \times 60 \times 60 \times 3 / 10,00,000)$ + Additional discharge of 13,000 cusec for one hour, over and above 12,000 cusec between 5 pm to 6 pm would have increased storage by 46.80 mcft $(13,000 \times 60 \times 60 \times 1 / 10,00,000)$ + Additional discharge of 17,000 cusec for two hours, over and above 12,000 cusec between 6 pm and 8 pm would have increased the storage by 122.40 mcft $(17,000 \times 60 \times 60 \times 2 / 10,00,000)$

of Chennai city, the upstream reservoirs, if constructed, as was proposed by the Nucleus Cell, would have helped in storing at least 1.57 TMC and the issue of catering to the drinking water needs could have been addressed to that extent, besides reducing the load on Chembarambakkam.

Absence of scientific real-time flood forecasting and communication facility

- No real-time flood forecast and scientific assessment of inflow, as envisaged in the guidelines of CWC and Anna University (2012) was carried out. As regards inflow, WRD did not have any scientifically proven inflow forecast system and depended only on IMD for weather forecast and reverse mechanism method²⁵ based on the actual increase in the water level of the water spread area. As a result, the actual assessment of inflow could not be ensured and the total outflow exceeded the actual inflow for 13 hours during 02/12/2015 from 2.00 am to 3.00 pm, leading to the massive flooding.
- A scrutiny of periodical Inspection Report on safety of Chembarambakkam dam conducted and submitted to Dam Safety Directorate of the State revealed that the wireless communication facility was not functioning for more than six months before December 2015 floods, indicating that WRD did not possess adequate emergency preparedness plan as envisaged in the Dam Safety Procedure. As a result, on 01 December 2015, when the inflow was more, necessary communications could not be made using the wireless communication devices as was also evident from the fact that no records were made available to audit for ascertaining the fact that communication from the tank-in-charge was actually made with the Government/Departmental authorities on the incoming flood.

Absence of monitoring in release of water from Chembarambakkam Tank

- CWC guidelines on Release Procedure states that the aim of reservoir operation is to reduce the risk of man-made floods through careful preparation of reservoir regulation schedule, release procedure and gate operation schedules with accurate and reliable flood forecasting and warning system. The discharge of water from the Chembarambakkam Tank was monitored and executed by a Section Officer (SO) who was the in-charge of the tank. In absence of any gate opening schedule as prescribed under CWC norms, the decision to release water from the tank vests with the SO in-charge of the tank. As no record was made available to Audit on any communication made by the SO with the Departmental/Government authorities, we observed from the data that on 01 December 2015, when there was a huge discharge of 29,000 cusec of water, the imprudent decision was made by the in-charge of the tank. The Department had stated that there was telephonic communication made by the in-charge of the tank and the Chief Engineer, PWD was personally monitoring the entire activity;

²⁵ Assessment of inflow is made with reference to the rise in the water level of the tank

documentation of the telephonic conversation was though not found on record to ascertain the veracity of the claim made by WRD. The fact, however, remains that even if it was accepted on basis of the reply that supervision and monitoring at Chief Engineer level was in place, the actual inflow and outflow was, nevertheless, not regulated as per CWC norms. Consequently, indiscriminate discharge of water in excess of inflow took place which had further reduced the water level in the tank, as a result of which, burden on Adyar River was more, leading to massive flood in Chennai and in its suburban areas. Thus, though a watchful supervision was in place, as was claimed by WRD, it could not be even ensured that total outflow from Chembarambakkam Tank did not exceed the inflow for 13 hours, as no schedule for gate opening was available. This implies that due to non-ensuring of discharge of water in sustained manner, the catastrophe that had happened during North East Monsoon 2015 may be categorised as a man-made disaster as per CWC Guidelines.

Thus, Department failed to consider the Report on procedures for Dam safety issued by CWC by updating the COR of Chembarambakkam Tank taking into account the regulated surplus arrangement, non-maintenance of full capacity of the tank, non-release of surplus water in a sustained manner, release of surplus water in excess of inflow of water into the tank and to formulate EAP for determination of the actual inflow and management of the tank resulting in un-planned release of water in excess of the carrying capacity of the Adyar River causing huge floods in the residential areas of Chennai and its suburbs during December 2015 rains.

Government replied (March 2017) that the release of water was based on the existing Compendium of Rules of Regulations and revision of Compendium and formulation of EAP were under progress. The reply was not tenable as WRD failed to revise the Compendium even after a lapse of 23 years from the date of installation of regulated arrangement to the tank and no lessons were learnt from the damages caused to life and property in the floods of 2005.

Recommendation No. 18: We recommend immediate updation of the Compendium of Rules of Regulations of Chembarambakkam Tank and fixing responsibility on officials for their failure to follow CWC's guidelines on Dam safety.

5.8.6 Inundation at Thiruneermalai confluence point due to afflux of water and encroachment by local body

The surplus course of Chembarambakkam was constructed in such a way that it joins the Adyar River at Thiruneermalai confluence point on a perpendicular line. Owing to the existence of perpendicular line of meeting design, water flowing from Chembarambakkam surplus course collided with water flowing from Adanur and other Tanks causing afflux action and consequent inundation in the upstream areas during 2015. Besides, the river portion of the confluence point had been encroached by the compound wall of solid waste management unit operated by Thiruneermalai Town Panchayat increasing the afflux action.

Thus, due to heavy discharge of 29,000 cusec of water for continuous 21 hours on 01/12/2015 and 02/12/2015 from Chembarambakkam Tank, the discharged water could not smoothly pass through the confluence point causing immense inundation in the nearby areas. GoTN replied (March 2017) that under the project 'Rehabilitation and Restoration of Floods-damaged Adyar', Administrative Sanction had already been issued (October 2016) for various works including construction of a meeting point curve at Thiruneermalai confluence point where Chembarambakkam surplus water meets the surplus water from Adanur and other tanks. The belated action of GoTN in planning for corrective measures at the confluence point also contributed to flooding.

5.9 Inundations in suburban areas of Chennai

The inundations in various locations of Chennai and its suburbs due to overflowing of flood waters in Adyar River and the major factors contributing to the inundations are discussed in the subsequent paragraphs.

5.9.1 Inundation due to non-desilting of tanks

Report on Dam Safety Procedures issued by Central Water Commission, GoI (July 1986) envisaged that reservoir silt survey should be undertaken at regular intervals and the area capacity of the curve need to be revised accordingly. Watershed Management Division of WRD, Pollachi, was responsible to conduct sedimentation survey to identify the extent of siltation in the tanks.

We observed that no sedimentation survey was conducted in any of the tanks in Chennai, Kancheepuram and Tiruvallur districts except Poondi reservoir (2010). Check of five tanks²⁶ influencing Adyar River by Anna University also revealed that the storage capacity had reduced by 30 *per cent*, i.e. from 0.780 TMC to 0.576 TMC, due to siltation. Shrinkage of original capacity of 222 tanks led to overflow of water triggering the flooding in Adyar River and non-harnessing of rain waters to an extent of 2.2 TMC²⁷. We also noticed that four tanks *viz.*, Mannivakkam, Nandhivaram, Urappakkam and Adanur, which

²⁶ Manimangalam, Nemam, Pillaipakkam, Porur and Sriperumpudur

²⁷ Capacity of 222 tanks was 7.412 TMC; siltation of 30 *per cent* worked out to 2.2 TMC

influence Adyar River, breached during the rains. We also observed that due to non-desilting of these tanks, flood waters could not be accommodated to the full tank capacity resulting into heavy inflow of flood waters in Adyar River.

WRD replied (October 2016) that no periodicity for conducting sedimentation studies had been fixed in the Departmental manuals and survey would be conducted on priority basis. The reply was not acceptable because such studies were required to be conducted as per CWC guidelines and their departmental manuals required updation in tune with CWC guidelines.

Recommendation No. 19: We recommend for conduct of sedimentation survey of the tanks in Chennai and its suburbs for taking effective action in removal of the silt and maintaining the original capacity of the tanks.

5.9.2 Inundation due to abrupt ending of channel

Pappan Channel in the southern part of the city, carried surplus water from nearby uncontrolled tanks to Adyar River. The channel passed through a defined course²⁸ on Government land and along road sides, before spreading over private *patta* land and emptying into Adyar River.

We noticed that developments including construction of culverts and foot paths by local bodies and a small bridge and retaining wall constructed by Highways Department, without obtaining NOC from WRD reduced the width of the Channel. Downstream, the channel ended abruptly as residential buildings had come up on the *patta* land near confluence with Adyar River, thus causing inundation in Tambaram, Mudichur, Mannivakam and Perungalathur areas. Joint inspection also showed that a major residential colony was developed on the end point of the Pappan Channel. CMDA stated that the residential area was developed on a *patta* land. The reply was not tenable as the role of CMDA was also to ensure protection of waterways through proper planning. Due to the abrupt ending of the channel, WRD provided a diversion channel after the floods.

During floods of 2015, surplus water from Peerkankaranai and Irumbuliyur Lakes caused heavy floods in the Pappan Channel. Due to its limited carrying capacity, the channel could not drain the surplus water received from the lakes quickly into Adyar River and could not negotiate with the Adyar River, which was already in floods, thereby causing heavy inundation in these areas, shown in **Exhibit 5.3**.

²⁸ Defined course is a channel with earthen or concrete bund, as against an undefined or natural course of channel which does not have any structure like a bund to carry the flood through a definite path

Exhibit 5.3: Heavy inundation in the areas of Ward 32 of Tambaram Municipality



(Source: Tambaram Municipality)

Thus, the failure of CMDA in allowing constructions of residential buildings without preserving water course and WRD's failure in protecting the channel under its jurisdiction resulted in inundation of adjoining areas.

Recommendation No. 20: We recommend the GoTN to conduct investigation in the matter of establishment of colonies and constructions in the water bodies in violation of the SMP and CWC guidelines and allowing facilities like power, water connections, roads and other community works.

5.10 Analysis

Though Chennai and its suburban areas witness high intensity rainfall during a short span of two to three months every year, Government and its agencies failed to keep the mitigation machinery in full preparedness. Even the stipulated annual desilting of micro and macro drains was largely not carried out or started after the onset of monsoon.

Allowing *patta* lands in the foreshore area of the tanks and inability to acquire lands for flood protection walls indicate the helplessness of GoTN in ensuring safety to its people against disaster.

Improvements to macro drains did not fructify due to encroachment and pending clearance from other agencies. No system existed for real-time flood forecast for releasing of surplus water with due regard to the water carrying capacity of waterways. SWDs were not scientifically designed and lacked seamless connectivity to trunk mains/rivers. Lapses in implementing Underground Sewage Schemes by local bodies led to continued outflow of sewage into SWD and consequent clogging of drains.

We observed failure of GoTN in carrying out the recommendations of various experts/committees on creation of additional storage capacity in the upstream of Chembarambakkam Tank, construction of diversion channel to Adyar River and construction of two check dams across the river. Moreover, the GoTN did not ensure desilting of the channels and tanks feeding Adyar River besides non-execution of flood protection works, non-adherence to CWC's guidelines on dam safety and release procedures and non-clearance of structural hindrances in the river. Due to all these factors, we conclude that the flooding was man-made in terms of the CWC guidelines.