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A Study on Current Status of Municipal Solid Waste Management Practices in Cuddalore Municipality, India

B. Abraham Lingan and G. Poyyamoli

Department of Ecology and Environmental Sciences,
Pondicherry University, Pondicherry, PIN-605014, India

Abstracts: Management of Municipal Solid Wastes (MSW) continues to remain one of the most neglected major issues in Indian cities due to the rapid urbanization, urban population growth and industrialization. Most of local administrations are directly dumping MSW without any segregation and treatment to the open dumping site, this manner of inappropriate disposal of MSW is become a major threat to the environments and public health in developing countries like India. The study area Cuddalore is a class I city and historical coastal town having a population of about 1.5 lakh and situated 160 km from the capital city of Chennai, Tamil Nadu, India. Frequent field visits were conducted to collect the primary data and to understand the MSW management systems in the city, including interaction and interviews with the various officials and workers of the municipality responsible for MSW Management and residents of the city. As like other Indian cities an effective, appropriate, systematic and sustainable waste management system is still non-existent in Cuddalore due to lack of infrastructure, resources and proper management plan. The existing MSW management system in the city is found to be highly ineffective. The city administration is only practicing collection, transportation and open dumping as MSW management activities at present in the city. The aims of this paper to assess current status of municipal waste management scenario and highlighted some suggestions for the efficient, appropriate MSW management which can help any urban local administration responsible for MSW management.

Key words: MSW management · Municipality · Solid waste · Landfill · Composting · Cuddalore

INTRODUCTION

The problem of municipal solid waste management (MSWM) has become a global challenge from a local, regional, national environmental and public health issue, due to the rapid population, urbanization and industrialization. This is due to the improper management of MSW as reported by several researchers in different cities of developing countries. 90% of the MSW generated in India is directly disposed on land in an unsatisfactory manner. Uncollected MSW can also forming of stagnant water bodies resulting the breeding ground of water born diseases that include malaria, dengue, filariasis, typhoid, dysentery. Direct dumping of untreated waste in rivers, seas and lakes lead to the bio-accumulation of toxic substances in the food chain through the plants and animals that feed on it. Hence, realizing the need for proper and scientific management of MSW, the Ministry of Environment & Forests notified the Municipal Solid Waste (Management & Handling) Rules, 2000 (Gazette of India,2000) [1]. The objective of these rules was to make every municipal authority responsible for the implementation of various provisions of the rules within its territorial area in terms of collection, storage, segregation, transportation, processing and disposal of MSW. The present study aims was to analyze the current status of MSW management practices and issues associated with collection, segregation, transportation and disposal practices in Cuddalore municipal area.

Waste management system in India: The success of the municipal authorities in managing waste is based on the availability of financial resources, manpower, good governance and awareness of environmental aspects, (Ahmadia M. *et al*., 2013; Kabbashi N., *et al*., 2013) [2-3].

Corresponding Author: B. Abraham Lingan, Department of Ecology & Environmental Sciences, Pondicherry University, Pondicherry, PIN-605 014, India. Mob: +91 8883830835.

Traditionally in most of developing countries is only involves removing MSW from sources of generation and transport to the open lanfill sites for final disposal, it is common practice in most of municipal authorities in India due to shortage of desired level as the systems adopted are out-dated and ineffective, management weakness, deficiency of human and financial resources, improper selection of technology, inadequate coverage and lack of long term planning. A typical MSW management system consists of source reduction, segregation, composting, recycling and landfilling (Tchobanoglous, *et al.* 1993) [4]. In India, 400 plus Class I city (Urban Local Bodies) with populations of greater than 0.1 million each generating about 72 % of the MSW in the country (Zhu, *et al.* 2008) [5]. The daily per capita generation of municipal solid waste in India ranges from about 100 g in small towns to 500 g in large towns and per capita MSW generated is annually estimated to increase at a rate of 1% - 1.33% while the estimated urban population growth is around 3.5% per annum (Shekdar, 1999) [6]. In this condition more than 25% of the MSW is not collected at all and 70% of the Indian cities are doing improper MSW management due to lack proper facilities to collection, transport and Scientific landfills (NEERI 1999) [7]. Improper management of MSW has been reported by several researchers in different cities of developing countries leads to several problems that impair health and ultimately result in economic, environmental and biological losses (Sharholy, *et al*. 2008; Imam *et al*., 2008; Chung *et al*., 2008) [8-10]. Visvanathan (2002) [11] has intensively examined Solid Waste Management issues in Asian Perspectives. Hence, the municipal administrations in India therefore face the challenge of strengthen their available infrastructure, financial and human resources for effective management and scientific disposal of MSW.

Background Information about the City: Cuddalore Town (Fig. 1) is the Headquarters of the Cuddalore Taluk and the Cuddalore District. It is located at the estuary of rivers Gadilam and Pennayar on Bay of Bengal. The town is at a distance of 200 Kms from South of Chennai, 23 Km South of Puducherry and 44 Kms North of Chidambaram. The latitude and longitude are 11.75°N and 79.75°E respectively. As per 2011 censes the town had population of 173,361 and floating Population of about 20,000. The Cuddalore town covers a total area of 27.69 km^2 and is divided in to 8 sanitary division and 45 political wards. The urbanization and industrialization has made rapid changes and expanding residential areas. The lack of adequate collection and treatment of MSW by Cuddalore Municipality Corporation (CMC) has created greater challenges for waste management in the rapidly expanding town. The MSW problem has become very acute in Cuddalore town, where the disposal facilities available are inadequate in comparison to the generated quantity of MSW, which is typical of any expanding city in India.

MATERIALS AND METHODS

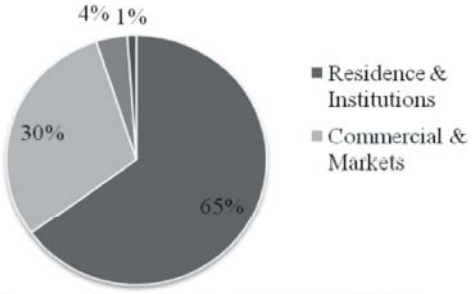
The Primary data to assess the current status of MSW management in Cuddalore municipality was collected using different methods such as direct filed observation, taking photography, informal and semi-structured interviews with responsible persons and focus group discussions were conducted and data collected over the period of one year between 2008 -2010.

RESULTS AND DISCUSSION

Municipal Solid Waste Generation and Quantity in Cuddalore: Managing Municipal Solid waste in Cuddalore city is handled by Cuddalore Municipal Corporation as similar in other Indian towns and cities. The major sources of waste include waste from Residence, Commercial establishments, Institutions, Markets and health care centers, the detailed of MSW generation from different sources with percentage is presented in Fig. 1. The majority of daily waste is produced from the residential sector (65%) and the rest of the sources like, Institutional, Industrial, Commercial, Construction and demolition and Street cleaning have contributed to 45 %.

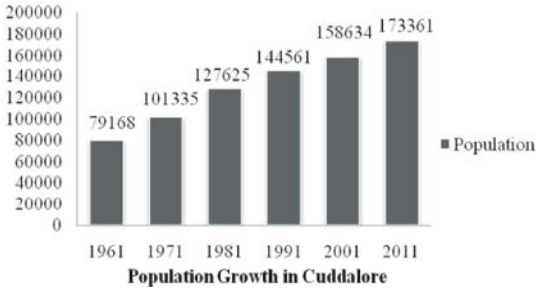
The quantity of the MSW generation in Cuddalore municipality rapidly increased in last few decades, according to the National Institute of Urban Affairs, New Delhi, The CMC generated 65 MT per day with average per capita generation of 401gms pc/day in 1999, it was estimated 75 MT/day in during 2001 and 100.5 MT/day during 2011 with the population 158634 and 173,361 respectively. Hence from 2001 to 2011 the total municipal solid waste generated has increased by 50 % and the population growth of 9.28 % in the same period. The per capita MSW generation in class I cities ranges from 0.1 to 0.929 kg/day and the average per capita generation is 0.376 kg/person/day (CPCB, 2013) [12].

History of the Cuddalore Municipal Corporation: The municipality of Cuddalore was constituted under the Towns Improvement Act X during the year of 1865 (Georgia, 1996) [13] comprising a revenue village. It has been upgraded Special Grade Municipality with effect



Sources of MSW generation in Cuddalore

Fig. 1:



Population Growth in Cuddalore

Fig. 2:

from 9th May 1993 as per the G.O.No.651 and has been again upgraded as a Special Grade Municipality with effect from December 2008 as per the G.O.No.237. Initially Cuddalore was practically divided into four parts viz. Cuddalore Old Town, New town or Tiruppapuliyur, Manjakuppam and Fort St. David. Now it has 11 division viz. Varadharajan Nagar (ward 1,2,3,4), Pennaiyar Road (ward 5,6,7,8), Pillukattu Lane (ward 9,10,11,12,13), Kalaiyarangam (ward 19,20), Pudupalayam Market (ward 14,15,16,17,18), Banbari Market (ward 22,23,24,25), Reddi chatiram (ward 26,27,28,29), Vandipalayam (ward 30,31,32,33), Sivanandapuram (ward 34,35,36,37), Municipal Dispensary, Williton Street (ward 38,39,40,41) and Sunnambukara street (ward 42,43,44,45).

The MSW management is handled by the Health and Engineering departments of the CMC. The Health department was in charge for day-to-day waste collection, transportation and disposal while the Engineering department was given the task to main the vehicles, managing and setting up new plants for segregation and proper disposal.

The Department Public Health: The Department of Public Health of the CMC is headed by Health officers, who control six sanitary inspectors, 20 sanitary supervisors, 12 sanitary inspectors, 10 Drivers and 371 sanitary workers. The major activities of the department are providing health care facilities within the municipal limit that include prevention and control of communicable diseases, monitoring and prevention of food adulteration, controlling mosquitoes, family welfare, registration of births and deaths and MSW management.

Frequency MSW Collection: The waste cleaning of streets and road was carried out once in a day from Monday to Saturday, with the working hours between 6.00 a.m. to 11.00 a.m. in the morning and 2.00 p.m. to 5.00 p.m. in the evening. This existing workers time schedule is subject to change in respective of Municipal authority. MSW from the main market (Panpari Market), bus stand and Uzavar Santhai (Farmer's market) were regularly collected by private sectors, Municipality was placed 42 metal dustbins in the city and used to transport by dumper plasa once overflow the bin. The road sweeping was concentrated only in commercial and institutional areas, while the slum and semi urban fishermen colonies did not get frequent collection services and hence many temporary secondary disposal sites were used for dumping the non segregated MSW in the public spaces like roads, drains, river side and railway tracks.

Population Growth: The population growth in Cuddalore Municipality from 1961 to 2011 along with the growth rate is given in the Table 1 and Fig. 2. The average decadal population growth in CMC area from 1961 -2011 is 17.24 %. The density of population has increased rapidly, it was 2857.01/sq.km in 1961 and it has increased to 6256.26/sq.km in 2011. The estimated growth rate by 2021 would be 24.9 percentages.

Current Waste Management Practice in Cuddalore Municipality: Cuddalore municipality has large number of households, shops and commercial establishments. Generally local communities do not practice waste segregation at source and the municipality consists of 45 wards and these wards are divided in to 11 sanitation divisions for better management of waste and other services to the citizen. Each sanitary division has a sanitary supervisor. CMC was given independent contracts for carrying out daily cleaning, sweeping and disposal activities in 8 wards including Bus stand, market and Uzavar santhai.

Some initiatives have been made by municipality and NGOs for segregation of municipal waste in Cuddalore Municipal area and compost making. A zero waste management program and conversion of garbage to manure unit was started by Cuddalore municipality at

Table 1: Population changes in Cuddalore Municipality area

Year	1961	1971	1981	1991	2001	2011	2021
Households	13073	16172	21665	28311	33989	NA	-
Population	79168	101335	127625	144561	158634	173361	216576
Decadal growth (%)	NA	27.99	25.94	13.27	9.73	9.28	24.92
Population density (sq.km)	2857.01	3646.45	4605.73	5216.92	5724.79	6256.26	-

Source: Census 2011 and Cuddalore Municipality. NA-Not available

Gundusalai in collaboration with local NGO in 2007, but this initiatives were unsuccessful due to improper management and lack of cooperation from citizen.

Collection and Transportation of Solid Waste: Primary collection of MSW is the duty of the health department of concerned Municipality, who are also responsible for control and preventive measures of epidemic diseases, healthcare administration and food control. The health department also acts as additional inspectors of factories in their respective zones. The Cuddalore Municipality is divided in eleven sanitation division for better waste management and each division consists of 3 to 5 wards and headed by a sanitary inspector.

Primary Collection: About 381 sweepers were employed in CMC for primary waste collection - street sweeping from households and various street collection points from open storage points, concrete cylindrical bins and steal dustbins. Each sweeper is responsible for the daily cleansing of a fixed area, (length range) usually at both sides of street lanes. Their working period is six hours starting between 6 a.m. and 12 a.m. The municipal administration is adapting several methods to clean the city such as door to door collection, street sweeping, mopping and drain cleaning. However, street sweeping is the most common method adopted in India for primary collection of wastes deposited in the streets. Most of household mixed solid waste is usually thrown on the streets or the nearest open temporary storage point or in plastic bags from where sweepers collect it and dumped into heaps by using a handcart or tricycle.

Each sweeper is given a broom stick and a scraper to sweep the roads, lanes and by-lanes in allotted area and the collected waste is loaded it into the handcart and transfer to a secondary collection point from where the waste is loaded in to vehicle for final disposal in open dumping ground and this usually happens in the first half of the day. In the afternoon, either street sweepers generally are deployed to other areas for group sweeping or they return to the same place to repeat their sweeping.

There are 120 hand push carts and 51 tri-cycles used by Cuddalore municipality workers for street and roadside collection. The market waste is directly collected from large heaps accumulated in front of the all markets and transported to the dumping ground without segregation.

Secondary Collection and Transportation: Transportation and secondary collection of MSW from the various collection points to disposal sites in Cuddalore municipality is commonly done by Municipal workers using hand push carts, tri-cycles, mini lorry, lorry, Hydraulic Dumper Plaza, tractor and trailer, depending on their availability and the nature/quantity of the MSW. CMC is operating 15 vehicles for waste transportation including 2 Lorry with each 6 MT capacities, 4 Mini Lorries with each 4 MT capacities, a Tumber placer (hydraulic vehicle to shift steal dustbins) with 10 MT capacities, 3 Tractors and Trailers with each 3 MT capacity, a Sludge tanker lorry with 9000 L capacity and an Earth mover.

There are 45 box placer steel dustbins with volume of 2.5 m^3 and 600 concrete cement cylindrical bins with volume of 500 l scattered all over in Cuddalore city. The box type of steel dustbins has lifting provision and directly transported by Hydraulic dumper placer to the dumping site and cement bins are manually emptied and transferred to vehicle by the municipal workers for final disposal. On an average, each garbage collection vehicle made two or three trips per day, whereas dumper placers make three to five trips. Officially, the municipality has a six-day working in a week with Sunday as a holiday but cleaning workers will work even on Sundays and other holidays due to public demand and political reasons. The municipality workers have not been provided with even the protective gears such as hand gloves, shoes and masks. Hence, they are directly exposed to the waste, exposing them potential health risks. This is very common in other Indian cities too.

Equipment and Machinery: Cuddalore municipality has been operating 12 motorized vehicles for solid waste collection and 121 non-motorized vehicles for transportation of the waste. Some of the vehicles used include earth mover, Hydraulic dumper placer are used occasionally due to poor maintenance. The Cuddalore municipality does not operate its own workshop and generally the vehicle repair is outsourced.

Table 2: Vehicle data

S.No	Vehicles	Nos.	Capacity per vehicle
1	Ashok Leyland	2	6 MT
2	Medium Ashok Leyland	2	4 MT
3	Medium TATA 709	4	4 MT
4	Dumper Plaza	2	5 MT
5	Hunter	2	3 MT
6	Tractor & Trailer	2	3 MT
7	Sludge tanker lorry	1	9000 Lit
8	Dozer	1	-
9	JCP	1	-

Source: CMC

Waste Collection by Private Sectors: In Cuddalore, solid waste is collected by the private sector as well. South Arcot Agro Society, a Cuddalore based company has undertaken garbage collection at 8 wards including Main bustard, Thirppuapuliyur main Market and commercial areas from October 2004 on contract basis. The municipality is paying Rs.800 per metric ton of collected waste and the agency collects approximately 30 metric ton per day. The agency is responsible to collect and transport solid waste to the nearest dumping sites.

Vehicles Used in the Municipal Solid Waste Management: The details of the vehicles currently operating by Cuddalore Municipality for waste transportation purpose are given in the Table 2.

The MSW collected from the dustbins and secondary collection points is transported to the open disposal sites using a verity of vehicles. According to the CMC 17 Vehicles were operating for the SWM in the Municipality area. Due to the lack of sufficient number of vehicles, all vehicles have to carry and transport the MSW more number of times. According to CMC all trucks, Tractor and Trailer and other dust bin carry and earth moving vehicles have to perform at least 2 rounds in the morning and one round in the evening.

Monitoring: The efficiency of collection, transportation and disposal are monitored by the Sanitary Supervisor in charge of supervision of primary collection work at street and ward level. Supervision, enforcement, control of primary collection work in street and ward level has been monitored by sanitary inspector. The municipal authority not only has to monitor their own staff activities but also the operations carried out by the private waste colleting organizations.

Disposal of Waste: At present open dumping is only disposal practice in CMC as like many of other cities in India. Citizens dumping waste in many places like street corner, low-lying areas, river side etc., which are within or outside the town limit. As per Cuddalore municipal record there are three disposal sites in the Cuddalore area - Kammiyampettai, Semmandalam and Pachankuppam of which Semmandalam landfill is not operated as open dumping or composting at present due to its very close proximity to government employees residential area in Semmandalam. Since Cuddalore does not have proper sanitary landfill or any other controlled waste disposal facility, all collected waste reach the two dumping sites without any kind of segregation and processing. The majority of waste is dumped in Kammiyampettai landfill located approximately 3 km from Cuddalore bus stand. It is the largest landfill site in Cuddalore municipality and it is operating since 1985. The landfill has 6.10 acres and still receives majority of municipal waste. Another dumpsite is located in Pachankuppam area on the South Cuddalore, the landfill covers 1.90 acre and is operating for nearly 15 years. This dumping site receives waste from Cuddalore old town market.

There is no systematic environmental monitoring to prevent possible pollution sources like emission, leachate migration and leachate gas from landfill operations. According to the MSW Management and handling rules 2000, the landfill site shall be away from habitation clusters and water bodies and monuments but the existing landfills are located very close to human settlements (within 100m) and Kammiyampettai landfill is located very close to river Pennaiyar (500m).

Physical Characterization of MSW: Municipal waste characterization and composition vary not only from city to city but even within the city, as it depends on various factors such as the nature of local activities, food habits, culture and traditions, socio-economic factors, climatic conditions and seasons. Variation of physical composition and chemical characteristics of MSW in Cuddalore were investigated according to the collection program of MSW from November 2008–June 2009.

The characterization and quantity of MSW generated depends on the way which the particular municipal administration managing the waste in terms of planning, designing and operation. Several studies have been conducted to estimate the characterization of MSW in Indian cities, as it is an important factor in choosing the suitable method of MSW management (Ramachandra, T.V. *et, al*. 2006) [14]. Generally the organic fraction tends be highest in low and lowest income countries, in India the fraction of organic waste varying from 40 - 75 %

Table 3: Composition of MSW characteristics in Cuddalore %

Organic fraction (Food, market waste, animal excrements, garden waste)	58.50
Paper & cardboard (office paper, bills, paper box, cardboard, newspaper, magazine and mixed paper)	9.14
Plastics & rubber (PET, HDPE, PVC, LDPE, PP, PS containers)	3.57
Metals (ferrous, non ferrous, aluminum cans)	2.74
Glass or ceramics	2.80
Bio-resistant (cloths, leather, napkin)	2.54
Inert (stone, brick, earthen wares)	11.50
Fine earth (ash, dust, soil)	8.60
Others (wooden substances, bone, coal, Batteries)	0.61
Total	100

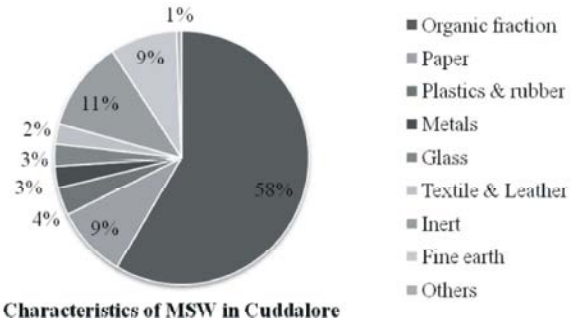


Fig. 3:

(NEERI, 1996) [15]. Studies have stated that the composition of solid waste varying based of the lifestyle and living standard of the region's (Chandrappa, R. *et al*., 2012) [16].

The results obtained characterization analyses are presented in Table 3 and Fig. 3. The organic fraction of waste is occupied by 58.50 %, followed by inert materials 11.50 %, paper 9.14 %, fine earth 8.6 %, plastic 3.57 %, glass 2.80%, cloths 2.54 % and others 0.61%. These major organic fractions of waste include food, market waste, garden waste which is from daily market and residence of the city.

The Ministry of Environment and Forest has notified the Municipal Solid Waste (Management & Handling) Rule, 2000 under the Environment (Protection) Act, according to this rule (Schedule-I) was setting up of waste processing and disposal facilities should be implemented by December 2003 but at present generated MSW in a city directly dumping to the open landfill without any process. Processing of Municipal Solid Wastes, the Municipal authorities shall adopt suitable technology such as compositing, vermin composting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes.

Recommendations:

- The CMC shall create awareness among the public to encourage waste segregation and recycling behavior at source and the local authorities should involve and get support from various resident welfare associations and non-governmental organizations on waste management program.
- Waste to energy potential: Waste to energy consider as one of the suitable resource recovery option, the MSW landfills are major sources of greenhouse gases (GHGs) which are contributor for global warming, if the methane recovered from landfill, unpleasant odour and environmental impacts will be minimized. In addition, clean energy will be produced that will offset the polluting fossil fuel. Since the amount of organic waste is highest in Cuddalore, energy could be recovered by thermal process. The thermal treatment process of MSW results energy recovery of 500 to 600 Kwh electricity from one ton of combusted MSW, similar project implemented by several local authorities with support of Ministry of New and Renewable Energy (MNRE) Govt.of India. Hence, this kind of energy recovery plan needs a proper technical and fusibility study for sustainable energy recovery from Cuddalore municipal landfill.
- Waste reduction at source: The households are the major source of MSW generation; it may useful to focusing on improving household waste management behavior and segregation at household level can help to reduce volume of waste being generated. The municipal authority have to provide separate waste collection bins to collecting bio and non bio-degradable waste to each residents, it can be distribute through the NGO and Resident's Associations. The Corporation also should allot particular day and time to each zone for door to door collection.

- Community Based Management: Another important point drawn from this study is lack of community participation on waste management, that community organizations, municipal administration should focus their attention on developing grass root enterprises for waste collection, segregation and composting. The community groups can get Payment for the service may be direct from the household in the case of household waste collection and through the association for street sweeping.
- Composting: Composting is tradition practice rural areas and considering environmentally sound option to reduce organic waste going to landfill, the composted fertilizer and other products has good economic and environmental values and composting with involvement of community is one of the best sustainable way to manage local waste (Alexandar, R. *et al*. 2010) [17]. Hence, the CMC can be adapted ward wide for better MSW management option to reduce organic residues.
- Sanitary Landfilling: The existing open dumping is causes contamination of water, air and soil quality and it creating unhygienic health condition to the public. Municipal authority need to setup sanitary Landfills with lachate and gas collecting facility.

CONCLUSION

Urbanization and rapid population growth increases overall waste generation in Cuddalore, at present the status of MSW management in terms of collection, storage, transportation and disposal practices are poor in the Cuddalore municipal area, the discarded waste on streets many places of the city clearly shows about the poor environmental health of the city. The city generating 110 metric tons of solid waste per day, but the current solid waste collection system is not fully coved to the slums, fishermen colonies and semi urban areas. There is many vehicles are older and urgent need to upgrade waste collection vehicles, dumping pins etc., The municipality urgently needs to improve public awareness on MSW generation especially the concept of 4r's such as Refuse, Reuse, Recycle and Reduce at all levels of society and need to get involvement of women self help groups on MSW management. The informal waste pickers and recyclers are ignored and In order to develop effective MSW management the local authorities need to integrate private sector, waste pickers, community organization and NGOs in the MSW management sector. Waste reduction at source, effective recycling and re-use of materials and long term plan for MSW management can help CMC to have sustainable MSW management options.

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