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INVESTIGATION OF PHYSIOCHEMICAL CONTAMINATION OF GROUNDWATER IN AND AROUND BHOPAL CITY WITH SPECIAL REFERENCE TO ASSESS THE IMPACT OF LANDFILL SITE ON WATER QUALITY

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Investigation of Physiochemical Contamination of Groundwater In and Around Bhopal City with Special Reference to Assess the Impact of Landfill Site on Water Quality

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Abstract – Solid waste generation has become an increasing environmental and public health problem all over the India. Landfills site is identified as one of the major source of polluting the groundwater resources. The study examined groundwater contamination in and around municipal landfill site in Bhanpura, Bhopal. Groundwater samples were collected from 24 sampling stations in and around the landfill and were analyzed in laboratory, stored at 4^0C and analyzed the same day. The result showed that the concentration of physio-chemical properties of water is higher around the landfill site are compare with other stations in Bhopal city.

Keywords: Groundwater, physio-chemical parameters, landfill, Bhopal, Seasons.

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INTRODUCTION

Bhopal, the capital city of central Indian state of Madhya Pradesh, with an area of over 550 km^2 and a population of 1.4 million, is a city still expanding.

The landfill is located at the extreme north-east area of metropolitan Bhopal aperated by Bhopal Management authority. The proposed work involves generation of primary Physico-chemical data on the groundwater from city and peripheral areas of Bhopal which embraces some large industrial house (BHEL, Railway Coach factory, Mandideep industrial Growth centre , Govindpura Industrial area) and numerous small scale industrial (Saw mill, Oil mills, printing presses and dairy industries) Besides these the city has around 75 acres of area for solid waste disposal site at Bhanpura village, at a distance of 16 kms from the city. The municipal waste generated in the city is disposed at thin landfill site without proper segregation.

According to the latest available estimates, it produces over 1,200 metric tons of municipal and post-consumer solid waste on a daily basis (ESR 2006). The exponential growth in the Bhopal city during the last decade (in terms of area industry population and living standards) has put immense pressures on solid waste management system of the local municipal body. As a common waste disposal practices in many developing countries, trucks from different parts of Bhopal city collect and bring solid wastes to the nearly site and unload in an irregular fraction there wastes predominantly contain domestic waste that is house hold waste, Street letter, municipal park sweeping waste, garden waste, commercial waste from shops and trading centers, kitchen wastes etc..

The site under review was previously an abandoned stone quarry, which later braved as a dumping site for MSW, with improper leached collection system. Presently, it looks like a hillock (15-20 m height) with even increasing heap of MSWs. The general composition of waste is as follows : Organic matter 63% proper 7 % plastic, rubber, leather, and synthetic 8 %, metal 5 % inert matter 9 % and glass 8 % (BMC 2003 year), out of which organic matter produces large amount of leachates. Consequently, the leachate production is high organically complex in nature and continuously growing. The instant effects of MSW decomposition are a foul and stinking smell felt from a distance and breeding of houseflies, vermin and pathogens besides a very unpleasant sprawl " Pur Bhanpura and Rasal kheri are the two villages in this area severely affected due to leachate contamination in soil and ground water, unhygienic drinking water and garbage induced diseases, like dysentery, cholera, and hepatitis, are frequently reported in their villages during monsoon season. Therefore, the present work on the geochemistry of leachate as well as groundwater from the study area was conducted.

IMPORTANCE OF PROPER MSW MANAGEMENT

The out dated, inefficient, institutional weakness shortage of working man-power, inadequate financial resources, improper choice of technologies, inadequate coverage of area and poor short and long term waste management planning are few of the reasons why the MSW management system in India is lacking to desired level. The city Bhopal is also facing there deficiencies in varying degrees and there is a need to make substantial improvement in the MSW practices prevailing in the city to raise the standards of health, sanitation and urban environment keeping pace with the rapid urbanisation and growing population.

The adverse effects on environment due to unscientific management of waste disposal are well known, there are as follow ;

- Ground and surface water pollution.
- Air pollution due to bad odour of the waste
- Greenhouse gases i.e. CO_2.
- Harmful effects of rats, stray animals, flies mosquitoes, germs and other insects.
- Increase in acidity of soil near the garbage heaps.
- Probability of diseases and epidemics.
- Health related problems for rag pickers.

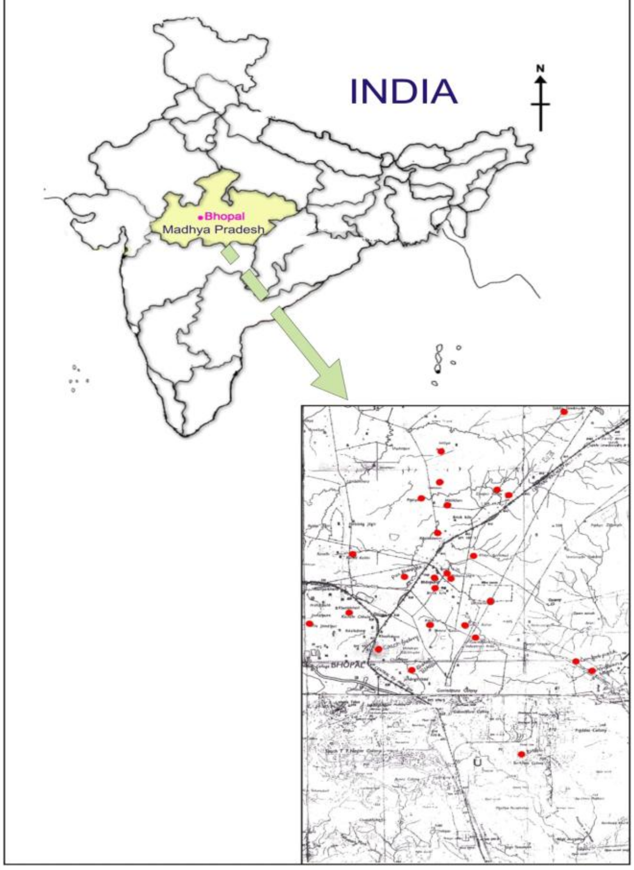
In the view of above, studies were taken up to assess the contamination status in and around the dumpsites of the city. Physico-chemical parameters and trace elements in ground water monitoring was carried out and samples were analysed at Govt. Motilal Vigyan Maha Vidyalaya, Bhopal and Madhya Pradesh Pollution control Board, Laboratory (MPPCB) Bhopal.

MATERIAL & METHODS:

Study Area:

The study area lies between latitude 23°10'-23°22'N and longitude 77°15'-77°30' E on the survey of India Toposheet Nos 55E/7and 55E/8 covering an area of about 550 Km^2. The study area is occupied by Vindhyan forming hill ranges and the Deccan Traps occupying the valley. A number of hills surround the upper Lake, out of which singarcholi hill, near Lal Ghati is highest an elevation of 625 m above mean sea level (MSL) Climate in this area is semi-arid with an average annual rainfall of 240 mm. June to September in the period of rainy season with occasional heavy rainfall events. This leads to depression of leachates in the surrounding low lying areas. The total area available for MSW dumping site is about 75 acre. The present work involves generation of primary physical chemical data on the groundwater from city and peripheral areas Bhopal which embraces some large industrial houses (BHEL, Railway Coach factory, mandideep industrial Growth centre Govindpura Industrial area) and numerous small scale industrial (Saw mill, Oil mills, printing presses and dairy industries) Besides these the city has around 75 acres of area for solid waste disposal site at Bhanpura village, at a distance of 16 kms from the city. The municipal waste generated in the city is disposed at thin landfill site without proper segregation. The organic contents of the wastes generate large amounts of leachate which percolates and pollutes the subsurface aqueous environment. Two season groundwater chemistry data will be obtained for Based on the chemical data, zones with excessive pollution within the groundwater system and their linkages with surface polluting sources will be identified. The chemical attributes of water will be analyzed and interpreted using various statistical tools. Suitable measures will be suggested to restrain the intensity of pollution and to upgrade the solid waste management practices in the city.

MAP 1 : MAP OF THE STUDY AREA



GROUNDWATER QUALITY

The ground water in study area is mainly used for drinking and irrigation purpose. Table no 1 (pre monsoon 2012) and Table No. 2(post monsoon 2012) depict the seasonal variations in the different parameters of groundwater in the study area. It is evident from the tables that the ground water in the close vinicity of dumping site are the worse affected due to leachate percolation despite a less permeable basaltic terrain.

Physio-chemical properties of groundwater samples :

The pH value (Table 1, physio-chemical data) for all groundwater samples are within the range of WHO (2002) standards. EC is the indicator of dissolved inorganic ions of groundwater, the wells having highest values (GW1, GW2, GW3, GW4, GW5 And GW6) during both the seasons are in the close vinicity of dumping site demonstrating the effect of leachate on groundwater. Higher EC values during pre-monsoon possibly show the effect of evaporation as well as impact of leachate.

Cations : The values of sodium varies from. 99 to 281 mg/l in premonsoon and 102 to 200 mg/l in post monsoon season. The value of potassium varies from 3.29 to 10.86 mg/l in premonsoon and from 1.46 to 9.99 mg/l in post monsoon seasons. The values of calcium varies from 208.19 to 431.01 mg/l in pre monsoon and from 101.34 to 386.00 in post monsoon seasons. The values of Mg varies from 43.00 to 100.00 in premonsoon and from 34.00 to 99.01 in post monsoon seasons. Almost all cations show high concentrations during pre-monsoon possibly due to higher evaporation effect under semi-arid climatic setup.

Similar to physico-chemical parameters discussed above , all bore-wells and dug-wells around the dumping site exhibit exceedingly higher values for major cations analyzed (Table no 1&3) with GW1, GW2, GW3, GW4, GW5 and GW6 showing highest values. The high concentration for sodium around the landfill site indicates impact of leachate. The high concentration of Na+, K+ may pose a risk to person suffering from cardiac, renal and circulatory diseases (Mor *et al*. 2006).

Dispite few impacts from agricultural activities, the high concentration of K^+ has been reported to be an indication of the leachate effect (Eillar 1980)

Anions : Higher concentration of chlorides are observed in dugwells and borewells close to dumpsite (GW1, GW2, GW3, GW4, GW5 and GW6) during both seasons the high chloride content in groundwater is from pollution sources such as domestic effluents, fertilizer, septic tanks and leachates (Mor *et al*. 2006). Increase in chloride level is injurious to people suffering from diseases of heart and kidney (WHO 2002). The high alkalinity imparts water an unpleasant taste and may be deleterious to human health along with the high pH, TDS and TH.

Agriculture fertilizer and leachate are the main source of sulphate in ground water the (SO_4^{2-}) Sulphate concentration in groundwater in within WHO Standard (2002) for both seasons. Still the values are considerably high in (GW1, GW2, GW3, GW4, GW5 and GW6), due to the effect of leachate on groundwater. The value of nitrate are higher in all the wells surrounding the dumping site.

Table 1 : Physico chemical analysis of sampling station in premonsoon 2011

S. No		Carbonate	Bicarbonate	Ca Hardness	Mg Hardness	Cl	Sodium	pH	Elec. Cond.	Potassium	Sulphate	Flouride	Nitrate
1	GW1	294.0	259.86	232.00	43.00	91.43	300	7.2	1.22	11.00	5.05	0.02	21.01
2	GW2	200.19	231.86	431.01	60.13	81.03	189	7.0	1.20	10.00	5.05	0.02	15
3	GW3	186.01	243.81	431.12	64.89	98.11	299	7.4	0.80	9.00	6.05	0.02	18
4	GW4	199.49	232.81	334.10	59.16	89.42	150	7.5	1.76	10.00	6.01	ND	18
5	GW5	249.86	261.11	401.13	100.00	86.43	280	7.2	1.12	8.18	7.02	ND	21
6	GW6	200.84	276.43	329.16	59.16	89.16	312	6.9	0.99	8.06	7.02	0.02	21.02
7	GW7	261.86	244.23	314.19	56.04	63.14	154	7.2	1.26	4.89	7.02	0.02	21.06
8	GW8	243.84	212.31	306.18	52.19	62.16	160	7.3	1.76	3.29	5.03	ND	19.08
9	GW9	232.16	211.11	401.13	56.18	70.54	180	7.3	0.61	4.86	4.03	ND	15.06
10	GW10	233.89	231.01	293.18	54.16	73.16	200	7.0	1.23	6.69	5.02	0.02	14.03
11	GW11	213.06	236.43	208.19	59.13	74.18	181	7.1	1.49	5.86	5.02	0.02	12.03
12	GW12	216.89	212.01	254.10	60.10	79.86	200	7.9	0.69	4.86	5.02	0.02	15.08
13	GW13	232.19	232.02	231.19	59.43	74.00	114	7.2	0.92	5.86	6.02	0.02	20.06
14	GW14	254.16	246.03	237.18	56.01	60.00	174	7.0	1.28	4.81	6.02	0.02	19.08
15	GW15	232.19	241.01	256.13	62.11	69.86	184	7.8	1.43	5.86	6.02	ND	17.06
16	GW16	249.16	210.42	231.19	63.04	67.00	190	7.6	1.10	4.16	8.02	ND	15.04
17	GW17	269.89	222.01	261.89	61.56	68.01	211	7.4	1.22	5.86	8.02	ND	13.02
18	GW18	274.88	234.43	232.16	62.04	69.02	221	7.2	1.68	5.17	5.03	0.01	18.01
19	GW19	294.87	254.01	279.18	60.13	63.89	180	7.1	0.76	4.89	5.03	0.02	19.01
20	GW20	216.86	263.07	281.16	60.40	64.79	160	7.4	0.88	3.81	5.02	0.02	20.01
21	GW21	231.00	278.08	291.81	62.14	70.86	150	7.2	0.99	4.42	5.03	0.02	20.01
22	GW22	243.89	291.03	271.89	64.00	74.01	140	7.0	1.12	4.32	5.02	0.02	19.01
23	GW23	261.81	281.06	293.16	67.14	78.59	150	7.4	1.98	6.16	4.03	0.02	20.01
24	GW24	291.00	254.81	270.11	68.00	78.06	112	7.5	0.86	3.46	4.08	0.02	20.02

All values are in mg/l except pH, E.C.

Table 2 : Physico chemical analysis of sampling station in postmonsoon 2011

S. No		Carbonate	Bicarbonate	Ca Hardness	Mg Hardness	Cl	Sodium	pH	Elec. Cond.	Potassium	Sulphate	Flouride	Nitrate
1	GW1	101.02	132.66	101.34	35.43	63.43	180	6.0	1.20	1.46	4.04	0.01	20
2	GW2	103.14	143.89	136.00	40.15	60.11	150	6.5	1.23	3.49	4.02	0.01	15
3	GW3	115.06	254.01	200.00	50.55	60.14	160	6.0	1.38	4.41	5.01	0.01	14
4	GW4	169.89	231.43	182.00	60.06	62.00	120	6.5	1.89	3.26	5.00	ND	13.03
5	GW5	207.09	186.02	156.00	49.06	63.00	150	7.0	1.70	2.19	5.04	ND	15.06
6	GW6	139.16	167.03	166.00	43.00	46.00	120	7.5	0.82	3.16	5.02	0.01	18.04
7	GW7	169.18	156.04	134.00	99.01	59.00	120	7.6	0.99	4.76	4.02	0.01	19.02
8	GW8	143.06	164.84	154.00	56.11	54.00	205	7.2	0.49	3.23	5.01	ND	15.01
9	GW9	161.03	205.01	144.56	61.01	60.00	200	6.0	1.22	4.11	4.02	ND	14.01
10	GW10	196.04	136.43	132.44	53.11	57.00	180	6.5	1.77	3.66	3.06	0.01	13.02
11	GW11	198.09	201.86	185.66	52.01	51.00	160	6.0	1.69	3.99	4.06	0.01	13.01
12	GW12	197.08	206.11	163.44	50.16	52.00	150	6.4	1.89	4.12	4.06	0.01	10.01
13	GW13	186.09	201.19	167.00	52.11	53.00	140	7.2	1.73	4.13	4.03	0.01	12.012
14	GW14	191.08	189.01	182.00	49.13	51.00	120	6.0	3.43	5.16	5.01	0.01	18.001
15	GW15	178.06	199.14	180.00	36.10	60.00	110	6.5	4.49	6.16	5.04	ND	15.03
16	GW16	145.86	186.13	172.00	34.00	54.00	102	6.4	1.76	7.82	5.00	ND	10.09
17	GW17	132.87	199.13	206.99	44.16	47.00	108	6.3	1.89	9.99	5.03	ND	11.01
18	GW18	159.89	198.13	281.00	54.00	48.00	110	6.2	1.78	8.77	5.09	0.01	12.06
19	GW19	189.76	250.14	283.00	43.15	50.00	150	7.0	1.89	4.03	5.03	0.01	18.01
20	GW20	196.86	250.00	386.00	42.18	52.00	140	7.5	3.80	3.03	4.00	0.01	18.05
21	GW21	134.86	194.13	296.00	49.00	54.00	120	6.0	4.88	4.03	3.01	0.01	18.05
22	GW22	134.87	149.01	300.01	53.00	56.00	112	6.5	0.99	2.13	3.00	0.01	17.06
23	GW23	169.86	132.49	311.43	52.00	57.00	114	6.9	0.66	3.32	3.02	0.01	18.01
24	GW24	136.89	149.50	326.00	54.00	59.00	110	6.8	0.76	4.13	2.01	0.01	17.09

All values are in mg/l except pH,E.C.

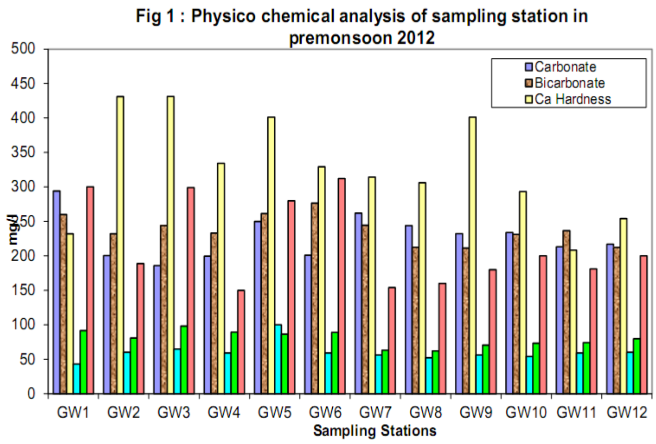


Fig 1 : Physico chemical analysis of sampling station in premonsoon 2012

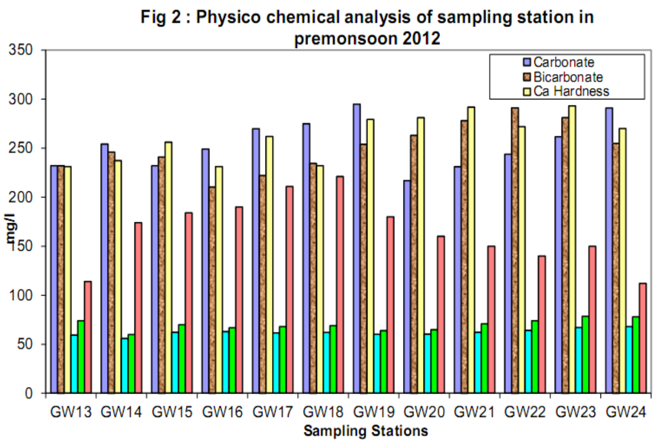


Fig 2 : Physico chemical analysis of sampling station in premonsoon 2012

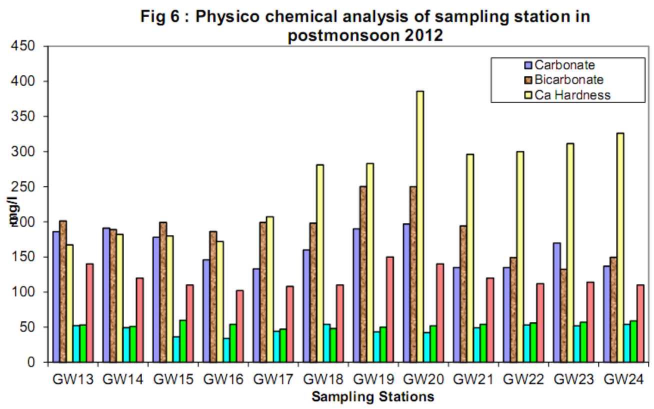


Fig 6 : Physico chemical analysis of sampling station in postmonsoon 2012

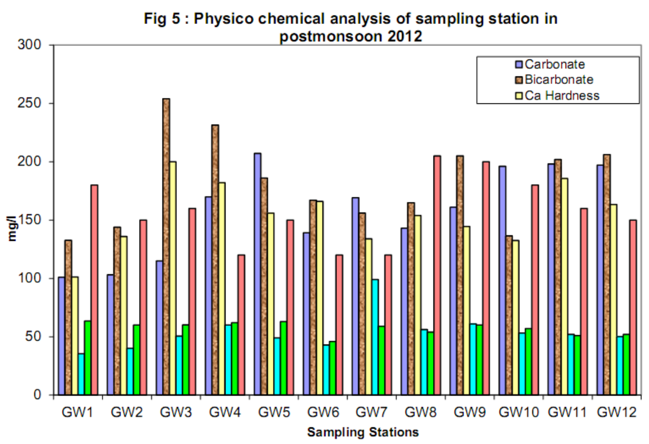


Fig 5 : Physico chemical analysis of sampling station in postmonsoon 2012

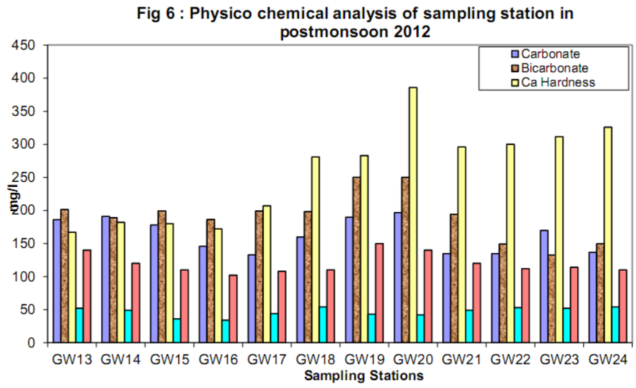
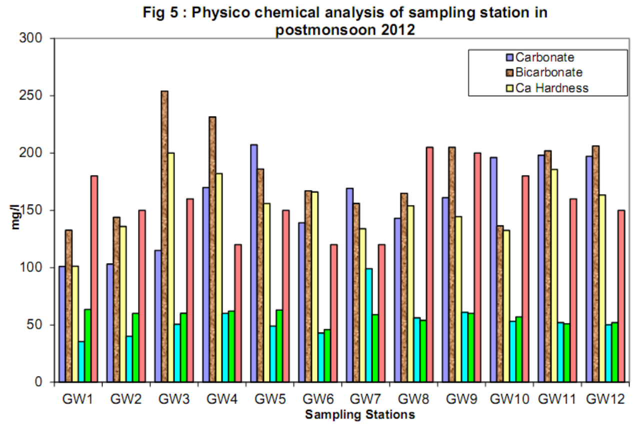


Fig 6 : Physico chemical analysis of sampling station in postmonsoon 2012



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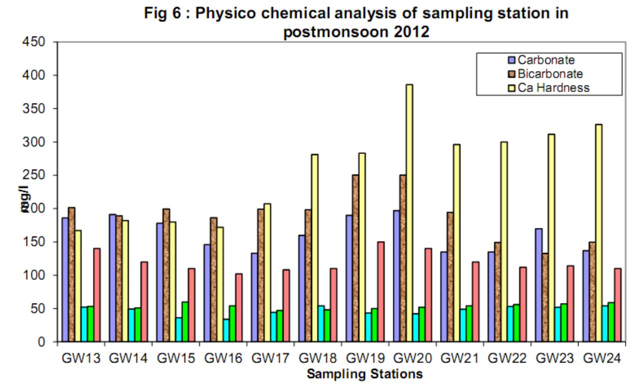

Fig 6 : Physico chemical analysis of sampling station in postmonsoon 2012

CONCLUSION:

The present study has indicated that the quality of water especially around the landfill site has the higher concentration compared to the others locations of Bhopal city.Thus the water of this area is not fit for the drinking purpose as wel as the agriculture practices. The various diseases are found in the localized people who are living in this area. The overall implication of this study call for the management of water Resources to check these waste management practices as to circumvent the discharge of its pollutants in to surrounding ecosystems that may pose associated health risks and hazards.

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