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Studies of groundwater quality for irrigation suitability from Muktainagar region, dist. Jalgaon, Maharashtra

Tiwari M. Y.

Department of Engg. Science, Shri Sant Gadge Baba College of Engg. &Technology, Bhusawal, Dist Jalgaon (India)

ABSTRACT

The study area under investigation, Muktainagar is located towards eastern part of Jalgaon district in Maharashtra state. The area is lying between 21°03'08" North latitude 76°03'18"East longitudes. This area is facing a problem of water scarcity. In India the water availability, quality and quantity differs. The chemical quality of water is of great importance as it determines the suitability for specific use whether it is for drinking, domestic or for agriculture use. To study the hydrochemical nature of the water used for drinking purpose, a collective 51 samples of ground water were collected during May 2012. Analytical reports were compared with World Health Organization. Ground water from this area is very hard in nature. The qualities of ground water were found to be deteriorated predominantly due to overexploitation and anthropogenic activities. The outcome of this work will be helpful for the local population to understand the qualitative behavior for specific use to create a healthy eco friendly environment among themselves.

Keywords: Groundwater, hydrogeochemical facies, Piper diagram; pollution.

INTRODUCTION

Water plays a central role for the survival of human beings as it is needed for all the aspects of life (Manoj .k et.al..2013)[1] . Not only quantity plays a vital role but quality also matters subjected to the suitability needed for various purposes. Water quality analysis is an important issue in the ground water studies (T. Subramani et. al ..2005)[2]. Ground water variation in an particular area determines the physical and chemical parameters are greatly influenced by geological formations and anthropogenic activities. Sujatha and Rajeswara Reddy (2003)[3] studied ground water and its suitability for irrigation in south India part in Andra Pradesh . Sayyed et. al.. (2013)[4] studied the water quality aspects of Pune. Patil S. N et.al [5]studied the impact of ground water on agricultural aspects of Yawal (2011)[6] .Studies shows that increase in water quality contaminated is due to lack of sanitation , improper waste disposal, faulty well construction and lack of water sources management (S. N. Patil 2010)[5] . Even irrigation done by poor quality of water shows improper seed germination, retardation of the crops affecting the yield. As we done scientifically changes with the help of new technologies in agricultural, industrial and in domestic field. Thus the is an urgent need to assess the potability of water before consumption by human beings. Therefore , in the present study area , an attempt was made to evaluate the chemical characteristics of ground water in Muktainagar taluka, Jalgaon district, Maharashtra.

II. Description of the study area:-

Muktainagar taluka is situated towards the eastern part of Jalgaon city of Maharashtra State , India. The area of Muktainagar is found to be of 63,392 hectares. It is located at 21°03'08"North latitude and 76°03'18"East longitude.

The average annual rainfall is 750 mm / per annum. Rainfall of the study area is predominant in the monsoon season from June to September. The study area consists of alluvial plain of Tapti valley associated with Purna river flowing from north to south. The study area is rural in nature. The climate of the study area is characterized by hot summer and general dry throughout the year. The mean minimum and maximum temperature lies between 10.8°C and 42.2°C.

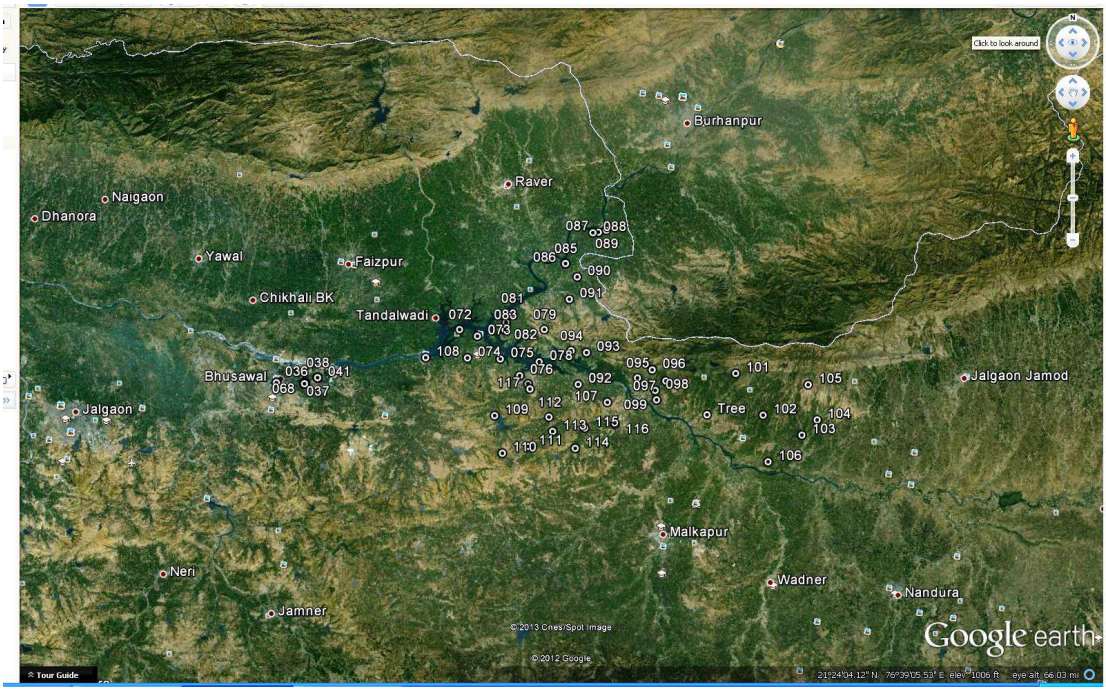

Fig 1: Map of the study area

The study area is covered by deep black soil which is very productive is nature. The soil has the property of getting swell when it is wet and develops cracks when it is dry in nature. Fig 1 shows the position of 51 sampling stations with their longitude and latitude.

MATERIALS AND METHODS

Ground water was collected from 51 sample stations during May 2012 from Muktainagar area Jalgaon district. The water samples were collected in pre-cleaned polyethylene one litre bottles. The sample bottles were labeled, sealed and transported to the laboratory for further hydro chemical analysis. The analytical procedure and techniques followed by APHA (1995)[9].

Estimation of pH , EC and TDS were measured digitally. The sodium and potassium were determined by using Flame photometer and titration methods was used for calcium, chloride, total alkalinity , carbonate, bicarbonate, total hardness while sulphate, phosphate, nitrate were analysis by Spectrophotometer . The results were obtained in ppm, Further based on the physicochemical analysis, irrigation quality parameters like sodium absorption ratio (SAR), Kelley's ratio (KR), sodium percentage (Na%), residual sodium carbonate (RSC), Magnesium ratio(Mg%), corrosivity ratio, chloro alkaline indices is calculated. The correlation of the analytical data has been attempted by plotting different graphical representation such Piper trilinear diagram (1994), Wilcox diagram (1970), US Salinity diagram was used to study the classification and suitability of groundwater.

RESULTS AND DISCUSSION

From table 1, we can easily understand the suitability of water for drinking, domestic and irrigation uses. In present study area, pH value ranges from 7.0 to 8.2. The entire ground water sample are alkaline and within limits.

Electrical conductivity values varies from 500 µS/cm to 3300 µS/cm. Highest value was recorded in sample station 13and lowest value was recorded in sample station 9. According to BIS , the desirable limit is 1400 which was found 33% of samples to exceed the limit.

TDS value ranged between 305 to 2244ppm. Lower value was recorded in sample station 10 and highest value was recorded in sample station 21.As per BIS , only two samples exceeds the permissible limit (2000ppm) and found to be unfit for drinking and agriculture. Classification of TDS value on the nature of salinity by Rabinove et.al. (1958)[8] showed that 72% samples were of non-saline nature (>1000ppm) and 27% samples were slightly saline nature (1000- 3000ppm).

Total alkalinity fluctuated between 17.2 to 1208ppm; highest value was recorded in sample station 15 and lowest value was recorded in sample station 5. Nearly 4 samples have crossed the permissible limit of BIS (600ppm). If we see carbonate it varies from 0.0 to 99.8ppm and bicarbonate varies from 56.0 to 1194 ppm. Thus total alkalinity is majorly contributed by bicarbonates. Maximum bicarbonate was seen in sample station 15. Carbonate was recorded maximum in sample station 14.

Natural hardness of water depends upon the geological nature of the drainage basin and mineral level in natural water (Patil S. N.2010)[5]. The total hardness ranges from 81 to 2267.05ppm. Highest hardness was seen in sample station 32.WHO (1993) standards shows 500 ppm and ISI (1983) standards show 600 ppm as maximum permissible hardness limit for drinking water. The principal sources of calcium and magnesium in ground water is the silicate mineral groups like plagioclase , pyroxene and amphibole among igneous rocks (Patil S. N, 2010)[5]. The calcium value ranges from 8 to 84.8ppm. The magnesium value was observed in the range of 1.2 to 227ppm. Maximum Ca and Mg were recorded in sample station 13 and 16 respectively. Ca and Mg allocation can be due use excessive phosphate fertilizers of Ca and Mg.

Sodium bearing minerals like albite and other members of plagioclase feldspars etc. are not as wide spread or abundant as the calcium and magnesium releases primarily soluble sodium products (Patil S. N. 2010)[5]. In agriculture and human pathology concentration of sodium plays an important role. Soil permeability can be disturbed by high sodium concentration. Sodium varies from 10.6 to 378ppm. (Sample station 28 and 16 respectively).

Table1. Statistical data of 51 ground water samples collected from Muktainagar taluka during May 2012

	Maximum	Minimum	Average	STDEV	median	mode
pH	8.2	7.0	7.4	0.3	7.4	7.3
EC (µS/cm)	3300.0	500.0	1247.5	657.3	1060.0	600
TDS (ppm)	2244.0	305.0	811.5	465.6	650.0	585
Total hardness	2267.5	81.0	651.0	565.7	365.0	1232.3
Total alkalinity	1208.0	17.2	367.4	224.4	334.0	404
Turbidity	8.6	0.1	1.1	1.8	0.4	0.1
Ca^{2+}	84.8	8.0	30.9	15.3	29.6	32.8
Mg^{2+}	227.7	1.2	45.2	43.6	35.4	24.9
Na^{+}	378.0	10.6	85.0	82.3	59.7	26.8
K^{+}	158.4	0.1	4.3	22.0	0.9	1.1
Cl^{-}	483.6	1.2	130.9	127.4	100.6	42.6
SO_4^{2-}	88.3	5.0	37.5	22.4	34.0	45.5
CO_3^{2-}	99.8	0.0	36.9	25.6	34.3	0
HCO_3^{-}	1194.0	56.0	372.1	215.4	366.7	489
NO_3^{-}	102.2	13.2	41.1	21.9	37.7	49.8
Phosphate	10.5	0.0	1.1	1.8	0.6	0

(all the parameters are expressed in ppm. Except EC in µs/cm and pH. Here N= number of ground water samples.)

Two factors are responsible for the scarcity of potassium in ground water. One being the resistance of potassium mineral in decomposition by weathering and the other is fixation of potassium in clay (Patil S. N. 2010)[5]. Potassium varied from 0.1 to 158ppm (in sample station 24 and 32 respectively).

The chloride level in the samples ranged from 1.2 to 483.6 ppm. The highest value was recorded in sample station 21 and lowest value recorded in sample station 8. Sulphate varies from 5 to 88.3ppm. Nitrate ranges from 13.2 to 102.2ppm. Phosphate varies from 0.0 to 10.5ppm. Maximum sulphate, nitrate and phosphate were recorded in sample station 39, 4, 32 respectively.

Hydrochemical Facies :-

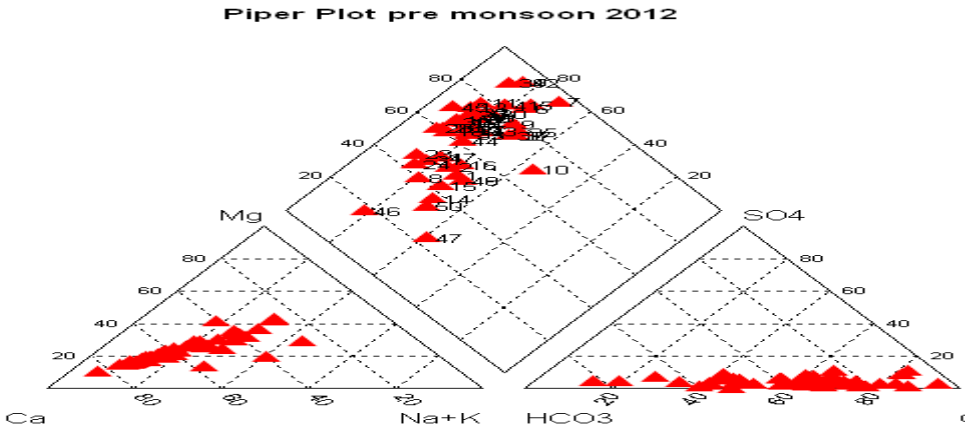

Fig.2 Piper trilinear diagram showing chemical Facies of May 2012

The geochemical evolution of ground water can be understood by plotting the major cations and anions in the piper (1953) trilinear diagram. Fig 2 shows the plot, where most of the ground water sample analyzed during May 2012 falls under Ca-Cl_2 category, some samples also falls under mixed Ca-Mg-Cl and a very few falls under Ca-HCO_3 type. From the plot, alkaline earths (Ca^{2+} and Mg^{2+}) significantly exceeds (Na^{+} and K^{+}) and strong acids (Cl^{-} and SO_4^{2-}) exceeds the weak (HCO_3^{-} and CO_3^{2-}).

Water analysis obtained from the present study area was utilized to analyze the suitability of water for agricultural uses. The various parameters such as Sodium Absorption ratio (SAR), Residual sodium carbonate (RSC), Kelly's ratio (K.R.), Sodium percentage (Na %), Soluble sodium percentage (SSP) helps us to identify the quality of water for irrigation (U.S.D.A…1954). The value are tabularized in table 2 . The SAR value varies from 1.8 to 17.7. The average Kelly's ratio is nearly 1. And average Na% is 123. SSP helps us to determine the sodium hazard. 31% of water samples are having their soluble sodium % higher than 50 (USDA.1954).

The typical ionic concentration ratios are shown in table 2. The Na/Ca ratio ranges from7.6 to 1008.3. The Ca/Mg ratio ranges from 0.1 to 12.5, which is considered to be indicative of precipitation of $CaCO_3$ on evaporation and concentration of salts in water. The Cl/HCO_3 ratio helps us to determine the contamination degree (Todd, 1980)[11] and it ranges from 0.0 to 9.9. Thus indicating the chloride being conservative element gets concentrated in the water, which further increases the salinity concentration. The Cl/SO_4 ratio varies from 0.2 to 17.7. The lower value suggests that the source of contamination is due to overuse of fertilizers in the study area.

The ratio of salinity can be easily studied by plotting the SAR versus electrical conductivity in Wilcox diagram (Kumaresan and Riyazuddin et. al 2006)[10].

According to Wilcox (fig 3), most of the sample shows high salinity with low sodium hazards (C_3S_1). Whereas 4 samples shows medium salinity and low sodium content (C_2S_1) and 4 -5 samples shows very high salinity and low sodium content (C_4S_1).

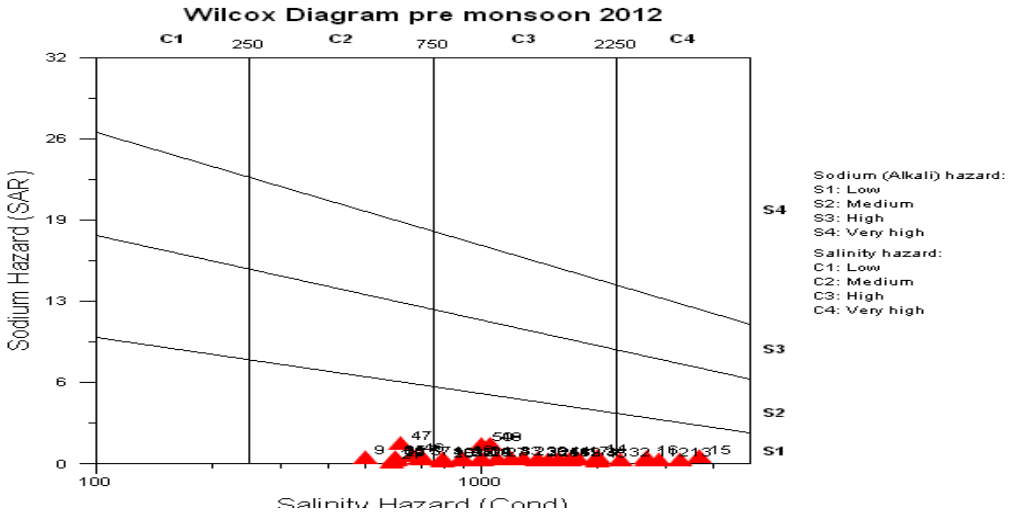

Fig 3 . Wilcox Diagram of May 2012 from the present study area

Correlation of physicochemical parameters of ground water:-Correlation coefficient is used to determine the relation of one variable with another variable (Kurumbein and Graybill 1965)[12]. The correlation matrices for 16 variables were prepared from 51 samples of May 2012 (pre2012).

From the table3 it is clear that ph shows negative correlation with Ca, Mg, sulphate, carbonate and nitrate. Total hardness shows negative with sodium, carbonate and nitrate where as total alkalinity with Ca, Cl with bicarbonate, nitrate & Ca with Na, carbonate, bicarbonate, nitrate and phosphate.

Table3 . Correlation of physicochemical parameters of ground water of May 2012

	pH	EC	TDS	T H	TA	Turb	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	SO_4^{2-}	CO_3^{2-}	HCO_3^{-}	NO_3^{-}	PO_4
pH	1															
EC	0.07	1														
TDS	0.09	0.78	1													
T H	0.13	0.27	0.21	1												
TA	0.14	0.55	0.35	0.02	1											
Turb	-0.09	0.00	-0.04	-0.17	0.04	1										
Ca^{2+}	-0.16	0.29	0.27	0.45	-0.12	-0.30	1									
Mg^{2+}	-0.28	0.48	0.33	0.30	0.27	-0.02	0.31	1								
Na^{+}	0.11	0.53	0.49	-0.03	0.47	0.07	-0.11	0.11	1							
K^{+}	0.08	0.23	0.21	0.41	0.07	-0.03	0.16	0.03	0.04	1						
Cl^{-}	0.06	0.56	0.61	0.45	0.07	0.00	0.30	0.41	0.52	0.36	1					
SO_4^{2-}	-0.11	0.61	0.57	0.29	0.00	-0.07	0.33	0.31	0.37	0.05	0.61	1				
CO_3^{2-}	-0.06	0.41	0.28	-0.38	0.55	0.26	-0.17	0.14	0.44	0.17	0.04	0.02	1			
HCO_3^{-}	0.13	0.52	0.36	0.04	0.85	-0.02	-0.02	0.21	0.35	0.11	-0.02	0.06	0.46	1		
NO_3^{-}	-0.25	0.21	0.28	-0.34	0.14	0.23	-0.19	0.05	0.27	0.02	-0.05	0.08	0.51	0.03	1	
PO_4	0.10	0.32	0.26	0.19	0.34	0.04	-0.07	0.00	0.28	0.76	0.34	-0.04	0.36	0.19	0.24	1

Table 2 . Characteristic ratio and indices of ground water from the study area

S. No	SAR	RSC	K.R.	Na %	SSP	Na/Ca	Ca/Mg	Cl/SO_4	Cl/HCO_3
1	1.19	8.79	0.21	21.46	48.7	0.32	1.98	12.84	0.94
2	1.15	12.56	0.25	25.16	11.3	0.42	1.52	7.33	0.92
3	1.37	23.43	0.16	15.98	26.5	0.21	3.41	15.23	2.96
4	1.22	9.96	0.23	22.61	52.7	0.33	2.14	15.80	1.02
5	1.16	34.13	0.22	22.45	56.9	0.34	1.88	76.73	7.89
6	1.20	23.53	0.22	22.27	41.3	0.33	2.02	27.93	6.27
7	1.01	31.07	0.39	38.89	83.4	0.48	4.25	33.51	24.65
8	1.18	9.02	0.25	24.74	61.9	0.39	1.72	24.65	0.66
9	1.03	16.96	0.33	32.92	68.0	0.62	1.12	69.69	3.68
10	1.02	14.69	0.37	36.82	59.4	0.77	0.91	62.91	2.24
11	1.60	13.02	0.12	11.60	34.4	0.14	4.76	16.31	3.39
12	1.55	20.00	0.11	11.32	11.4	0.14	4.32	9.14	2.61
13	1.58	17.40	0.12	11.77	28.8	0.14	4.41	9.39	1.87
14	1.00	15.72	0.41	40.82	91.2	0.86	0.90	8.63	0.54
15	1.06	32.72	0.37	37.34	85.1	0.69	1.16	17.26	0.72
16	1.10	32.07	0.33	33.09	83.6	0.61	1.21	15.93	1.11
17	1.35	18.15	0.18	17.97	79.2	0.24	2.98	8.70	0.98
18	1.42	13.12	0.14	13.96	61.8	0.18	3.46	8.75	1.44
19	1.37	9.21	0.15	15.34	63.8	0.20	3.48	7.29	1.91
20	1.24	12.91	0.19	19.23	35.0	0.27	2.49	5.88	2.84
21	1.36	10.08	0.16	16.31	69.3	0.19	6.34	8.28	7.84
22	1.36	12.55	0.15	15.35	15.9	0.20	3.36	25.08	2.11
23	1.40	7.03	0.14	13.61	17.0	0.17	3.71	7.59	0.80
24	1.34	9.85	0.17	16.76	26.5	0.22	3.08	12.16	0.72
25	1.56	14.92	0.11	11.05	20.2	0.13	5.03	15.25	1.51
26	1.46	20.81	0.13	13.46	31.7	0.17	3.90	20.86	2.47
27	1.33	18.03	0.18	17.88	32.8	0.24	2.91	25.28	1.99
28	1.54	9.57	0.10	9.90	7.5	0.12	5.28	22.38	1.45
29	1.27	18.21	0.16	16.19	16.5	0.22	3.02	13.63	2.36
30	1.55	17.53	0.11	11.05	25.3	0.13	4.65	16.88	1.84
31	1.24	20.98	0.18	18.33	41.9	0.26	2.37	104.29	0.91
32	1.56	23.49	0.12	11.68	75.8	0.14	4.40	20.46	2.60
33	1.30	17.61	0.19	18.90	30.8	0.26	2.60	17.71	1.78
34	1.25	18.72	0.20	20.19	34.0	0.28	2.55	30.48	1.87
35	1.08	17.08	0.31	31.48	29.9	0.57	1.21	51.00	3.47
36	1.30	15.80	0.18	17.61	30.1	0.24	2.86	29.15	1.92
37	1.06	15.42	0.29	28.90	30.7	0.53	1.21	29.30	3.06
38	1.11	12.55	0.27	26.76	13.8	0.45	1.45	8.89	2.62
39	1.52	16.60	0.12	12.49	78.9	0.15	4.67	9.48	9.01
40	1.25	12.13	0.17	17.47	17.8	0.24	2.63	15.95	2.53
41	1.38	13.97	0.16	16.04	25.4	0.21	3.32	26.69	4.71
42	1.42	11.08	0.15	15.32	74.5	0.19	4.06	7.47	13.56
43	1.19	20.37	0.24	24.00	45.3	0.37	1.82	26.57	2.18
44	1.13	18.12	0.22	22.30	20.6	0.35	1.80	8.89	1.48
45	1.84	14.79	0.06	6.10	16.6	0.07	7.84	8.24	2.11
46	2.45	1.45	0.22	22.41	18.4	0.45	0.97	2.91	0.16
47	3.10	2.74	0.68	68.02	40.9	1.02	2.02	3.97	0.25
48	4.33	3.89	0.46	45.81	31.7	1.18	0.63	4.59	0.82
49	4.33	3.89	0.46	45.81	31.7	1.18	0.63	4.59	0.82
50	4.31	2.57	0.44	44.40	31.4	1.17	0.61	3.63	0.40
51	2.69	1.25	0.15	15.18	13.4	0.39	0.64	4.24	0.13

CONCLUSION

Based on the above data, it is clear that most of the ground water samples collected for the study area is suitable for agricultural purposes. The concentration of abundant cations and anions were employed to describe and assess the ground water quality through data collection and graphical presentation from the study area. The concentration of Mg and Na is very high. The ground water is very hard due to high salt concentration. The hardness ranges from 81 to 2267 ppm. WHO (1993) standards show 500ppm and ISI (1983) standards show 600 ppm as the maximum permissible hardness limit for drinking water. Thus there is growing need to correlate the chemical content in drinking water with long term health hazards.

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