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Impact Assesment of Municipal Solid Waste on Ground Water Quality in and around Kapulauppada Dumpyard in GVMC using Remote Sensing and GIS Techniques

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***Abstract*—** The improper dumping of the municipal solid waste in the Kapulauppada area of Greater Visakhapatnam Municipal Corporation (GVMC) leads to serious pollution threat to the ground water of the study area. Thus, the present study deals with the physio-chemical parameters of the ground water in the dumping yard of Kapulauppada area which is occupying about 100 acres of the area. The investigation involves the detailed field survey and collection of data and analysis and displaying the results. In the study area, 21 different ground water samples have been collected in and around Kapulauppada. The analysis of the physio-chemical parameters of ground water like pH, total hardness, total alkalinity, chlorides, total dissolved solids, calcium, magnesium, turbidity and electrical conductivity are studied. The results are compared with Bureau of Indian Standards (BIS). Based on the standard calculation methods, the standard parameters such as Water Quality Index (WQI) is calculated for each sample location. The results show that 66.66 % of water is poor for drinking purpose, 23.8% of water is good water and 9.5% of water is excellent for drinking purpose. So improper dumping of municipal solid waste is leading to the pollution of the ground water in the Kapulauppada area.

***Keywords*—**Groundwater, Pollution, Water Quality Index, Remote Sensing, GIS

I. INTRODUCTION

Visakhapatnam is one of the fast growing cities in India industrial development accelerating urbanization and increasing population. Increasing population accelerating directly or indirectly resource utilization that leads to increase solid and liquid waste as well as air emissions [1]. Improper management of solid waste management contributes large quantities of pollutants percolated into the ground water table that have been continuously introduced into ecosystems. The contaminating Physical and chemical parameters in the ground water is a major concern because of their toxicity and threat to human life and the environment. Physical and Chemical parameters such as PH, TH, TA, Cl, F, TDS, Ca, Mg, EC, Turbidity were potential water pollutants. Physical and Chemical parameters are necessary to evaluate groundwater contamination. Water Quality Index method is useful to indentified the water quality in and around the Kapulauppada area [2].

II. STUDY AREA

The study area of Kapulauppada village is occupied about 67.61 sq. km. The study area is lies between the $83^0 5'0''$to $83^0 2'0''$ East Longitude and $17^0 32'0''$ to $17^0 54'0''$ North Latitude, respectively and the location map has shown in Figure.1. Kapulauppada is located in sub-locality of Visakhapatnam city, Vishakhapatnam District, Andhra Pradesh. Unofficial activity and Encroachments led to tapering of major drains, diversion of geddas, indiscriminate disposal of waste and debris led to inundation of low lying areas during rainy sessions.

Figure1: Location Map of the Study Area

The broad objective of this thesis work is to assess the Ground water quality in and around the Kapulauppada surrounding areas, Visakhapatnam District, AP. The properties create spatial digital database consisting of base map, drainage network map, Slope map, physiographic map, land use/land cover map, and other derivative maps using Survey of India topographic sheets No. 65 0/1, 65 0/2 & 0/3, 65 0/5, 65 0/6, scale 1:50,000. , SENTINEL - 2A (Figure. 2) and ASTER DEM data, ground data and collateral data with the help of Arc GIS 10.3, Mobile Data Collection App. The ground water quality status of the study area based on Physical - Chemical characteristics is used to evaluate the ground water quality [3].Water quality Index Map is used by integrating spatial and attribute database on Arc GIS 10.3, Mobile Data Collection App.

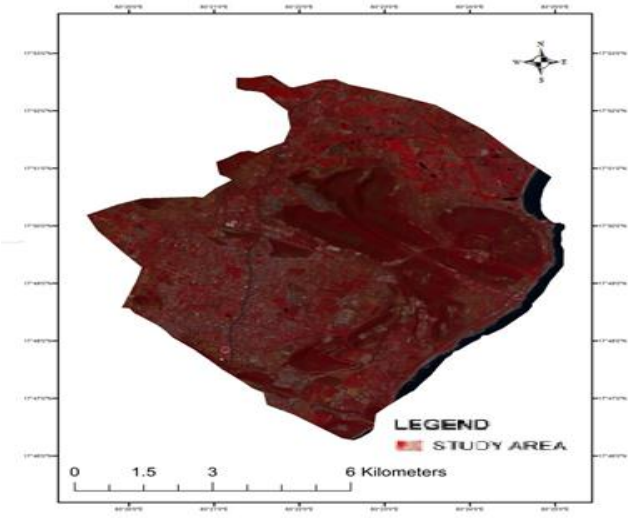

Figure 2: Sentinel-2A Satellite Sensor data of the Study Area

III. METHODOLOGY

Mobile Data collection App is used to capture the latitude and longitudinal values for each sample collection in the study area. The data has been recognizing features such as Agriculture, forests, land-use, land-cover changes. In this study, about 21 water samples has collected around Kapulauppada region in the year during 2017 To analyze chemical parameters in the laboratory guidelines of American Public Health Association (2005) has been adapted. The present work is carried out to determination of the water quality analysed for the physical and chemical parameters. Trace elements are used for the identification of the pollution in near Kapulauppada area in Greater Visakhapatnam Municipal Corporation (GVMC). The concentration of physical and chemical parameters in ground water samples are compared with the Bureau of Indian Standards (BIS) Water quality Method is used for to determination of the quality of water. Flow chart of methodology has shown in figure.3.

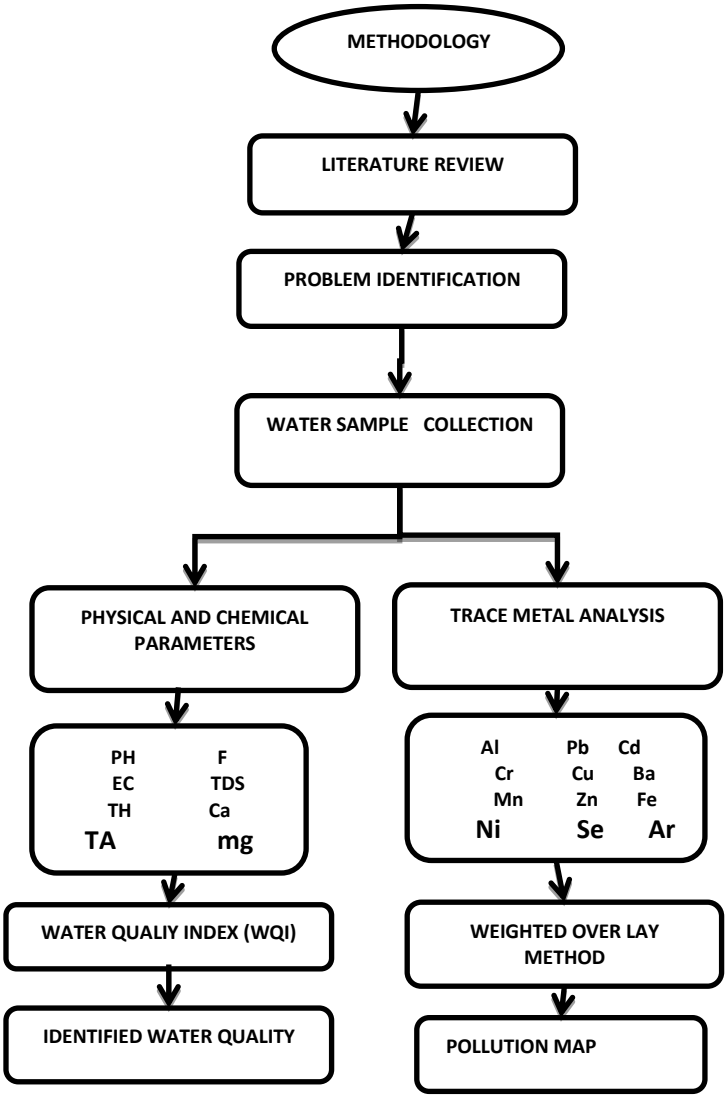

Figure: 3 Methodology used for the study area

3.1.1 Land use/Land cover

land use / land cover features have been precisely captured through onscreen visual interpretation based on basic image characteristics such as size, shape, shadow, location, association, texture, tone/colour, pattern and various related features were considered. In this analysis, only Rabi season (April) data have been used to decipher land use and land cover of the area [12]. In fact, this analysis requires two seasons data, however, double crop has been interpreted where Kharif, and Rabi practiced. In this, analysis level-1, and level-2 categories have been identified as per the guidelines given by the NRSC (2012). The land use/ land cover map of the area is shown in Figure. 4.

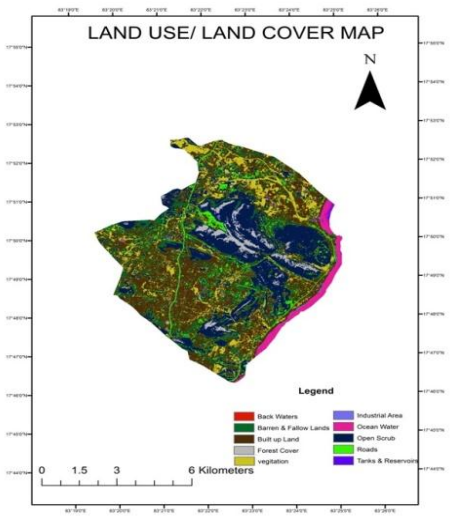

Figure 4: Land Use/ Land cover map of the Study Area.

3.1.2 Slope

The Slope is the most important parameter in Natural Resource Studies. Delineation of slope classes in an appropriate manner is very essential in ground water recharge zones because slope is the main factor that indicates major runoff produced.

3.1.3 Drainage

It has been an attempt to classify stream systems on the basis of branching or bifurcation. In this system of stream orders, the largest most branched, main stream is usually designated as and smaller tributary streams of increasingly higher orders. The smallest un-branched finger trip tributaries are given the highest order although these streams are similar in characteristics in different drainage basins, they are designed as different orders. As shown in fig.5the study area has five order streams, which has been extracted from the toposheets of the study area.The drainage map of the area is shown in the Figure 5.

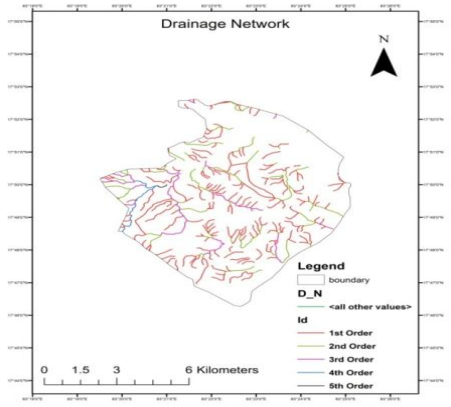

Figure 5: Drainage Map of the Study Area.

3.2 Water collection

The groundwater samples have been collected from 20 Borewells and 1 Openwell in the surroundings of Kapulauppada dumping yard to understand the water quality strategy. The water samples were collected by using one liter sterilized plastic containers as per standards. During water sample collection, Mobile Data Collection (MDC) App is used to identify the locations of sample collection based on latitude and longitude. The sample locations with its coordinates are shown in Table 1. The ground water sample collection of the area is shown in Figure. 6.

Table: 1 Ground Water Sample Collection

S.NO	SOURCES OF WATER	LATITUDE	LONGITUDE
1	Borewell	17.84511	83.36523
2	Borewell	17.84466	83.36574
3	Borewell	17.84497	83.36571
4	Borewell	17.84435	83.36585
5	Borewell	17.84419	83.36606
6	Borewell	17.84437	83.36667
7	Borewell	17.84474	83.36841
8	Borewell	17.84491	83.3672
9	Borewell	17.84447	83.36563
10	Borewell	17.87073	83.3622
11	Borewell	17.87225	83.35911
12	Borewell	17.87442	83.35547
13	Borewell	17.85449	83.3858
14	Borewell	17.85382	83.3824
15	Borewell	17.8531	83.37421
16	Borewell	17.85505	83.36779
17	Borewell	17.84998	83.35941
18	Borewell	17.85785	83.36575
19	Borewell	17.85727	83.36685
20	Borewell	17.84671	83.3643
21	Borewell	17.84198	83.36136

3.2.1 Laboratory analysis

Collected water samples have been analyzed in laboratory to identify their various Physical and Chemical characters as per standard procedures [4]. In this analysis process 21 ground water samples in 10parameters were considered for this research, such as pH, Total Dissolved Solids (TDS), Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Calcium (Ca), Magnesium (Mg), Chloride (Cl), Fluoride (F) ,Turbidity. The test results of each ground water sample were compared with BIS 2012 standard values; and the results shows that majority of samples values are below the permissible limits as per standards.

IV. RESULTS AND DISCUSSION

The individual water quality of each collected groundwater sample is identified by using WQI based on BIS (2012) standards for drinking water. The weight (wi) was assigned in the range between 1 to 5 according to the importance in overall quality of water. The relative weight (Wi) is calculated based on the Weighted Arithmetic Index Method and Quality Rating Scale (Qi) is obtained for each sample by dividing its respective standard and then multiplied by 100. By using Water Quality Index (WQI) concept, the groundwater quality is assessed. Standards with weights assigned and calculated relative weight are shown in Table.3. Sub Index Parameter (SI) is obtained by multiplying the Wi and Qi. Finally the overall WQI is obtained by adding all the sub index values. The average value of WQI is obtained for the study area is 224.18. The WQI for the Collected Water Samples are ranging from 41.26 and 179.66. Statistical Data Analysis has been suggested to identify the groundwater quality parameter correlation [8].

Table.2 Standard Weight (wi) and Calculated Relative Weight (Wi)

Parameters	Standards	Recommended Agency	Weight (wi)	Relative weight (Wi)
Ph	6.5-8.5	WHO/BIS	1	0.04
EC	1000	BIS	1	0.04
TH	300	WHO/BIS	4	0.15
TA	200	BIS	4	0.15
Cl	250	WHO/BIS	2	0.07
F	1.5	WHO	2	0.07
TDS	500	WHO/BIS	5	0.19
Ca	75	WHO/BIS	2	0.07
Mg	50	WHO	2	0.07
Turbidity	300	BIS	4	0.15
		TOTAL	27	1

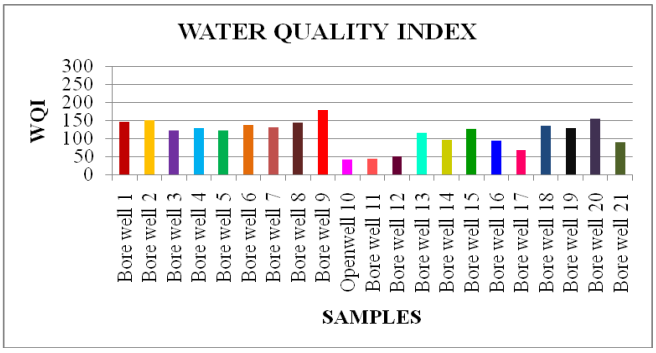

Figure: 7 Graphical Representation of WQIAs per standard method of classification the collected Ground Water Sample is classified from excellent to unfit for drinking.

Nowadays the groundwater quality problem has become severe [8].The number of samples in each category and water quality percentage of each collected location is shown in Table. 5. By using Water Quality Index (WQI) concept groundwater quality is assessed [9].

Table.3 Water Quality Index (WQI) percentages

WQI Value Range	Water Quality	No. of Station	Percentage of WQI
<50	Excellent	2	9.5
50-100	Good Water	5	23.80
100-200	Poor Water	14	66.66
200-300	Very Poor Water	NIL	NIL
>300	Unfit for Use	NIL	NIL

Under the excellent classification 2 locations are found in Borewells 10, 11. In good water classification 5 locations are found Borewell 12, 14, 16, 17, 21. In poor classification 14 locations are found in Borewells 1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 15, 18, 19, 20. In very poor classification not identified. No location is identified under unfit for drinking purposes the WQI value is 114.98 which is the highest in the collected samples. The direct use of contaminated groundwater due to leachate may be a serious threat to human health leachate [10].

V. CONCLUSION

The analysis results of two parameters from the collected twenty one samples in the surroundings of Kapulauppada Dump Yard in Visakhapatnam are as follows:

PH: The parameter pH should in the range of 6.5 to 8.5 in groundwater as per Bureau of Indian Standards IS 10500 (2012). The pH values obtained for all the samples tested ranges from 6.99 to 7.46, it is within permissible range.

EC: The parameter Electrical Conductivity (EC) should in the range of 1000 to 2000 in groundwater as per Bureau of Indian Standards IS 10500 (2012). The EC values obtained for all the samples tested range from 384.1 to 2955.6, it is exceeding permissible range.

TDS: The parameter Total Dissolved Solids (TDS) should in the range of 500 to 2000 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The TDS content obtained for all the samples tested ranges from 212 to 1595 mg/L, of which 15 have reached maximum permissible range.

TH: The parameter Total Hardness (TH) should in the range of 200 to 600 mg/L in groundwater as per Bureau of Indian

Standards IS 10500 (2012). The TH content obtained for all the samples tested ranges from 96 to 496 mg/L, of which 18 have reached maximum permissible range.

Ca: The parameter Calcium (Ca) should in the range of 75 to 200 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The Ca content obtained for all the samples tested ranges from 35.2 to 160.8 mg/L, of which 17 have reached maximum permissible range.

Mg: The parameter Magnesium (Mg) should be in the range of 30 to 100 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The Mg content obtained for all the samples tested ranges from 0.48 to 49.44 mg/L, of which 16 are below the minimum permissible limit.

F: The parameter Fluoride (F) should be in the range of 1.0 to 1.5 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The Fluoride content obtained for all the samples tested ranges from 0.2 to 0.7 mg/L, all the samples fall below the permissible range.

Cl: The parameter Chloride (Cl) should be in the range of 250 to 1000 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The Cl content obtained for all the samples tested ranges from 84 to 402 mg/L, of which 16 have reached maximum permissible range.

TA: The parameter Total Alkalinity (TA) should be in the range of 200 to 600 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The TA content obtained for all the samples tested ranges from 142 to 584 mg/L, of which 19 have reached maximum permissible range.

Turbidity: The parameter Turbidity should in the range of 1-5 mg/L in groundwater as per Bureau of Indian Standards IS 10500 (2012). The Turbidity content obtained for all the samples tested ranges from 0.4-2.5 mg/L, all the samples fall below the permissible range.

The unpolluted portion of the map ground water indicates that the trace elements concentrations are below the harmful range. The groundwater in the polluted portion of the map indicates that the trace metals concentrations are about to reach the harmful range.

The analysis result of 10 parameters from the collected 21 samples surroundings to the kapulauppada dump yard in Visakhapatnam municipality only 66.66% of ground water are in poor condition for drinking purpose. In many parts of the world, landfills and open dumps are the cheapest and a common municipal solid waste management practice. The test results indicate only 34.34%of the groundwater is only fit for drinking purpose. The correlation coefficient shows the connection between the tested parameters. For a healthy life, it is mandatory to drink the groundwater under the prescribed limit as per Bureau of Indian Standards IS 10500 (2012). Toxic solid waste must be treated before disposal this may lead to serious health threat to human beings. Trace elements concentration results are obtained from the lab analysis. These results are used to prepare interpolation maps using ArcMap.10.3 for each element showing the spread of concentration of each element in groundwater within study area. Trace element pollution map is generated using weighted overlay tool in ArcMap.10.3. This map is classified into two zones: Unpolluted and Polluted.

As per lab analysis report and trace elements pollution it can be inferred that the study area is presently safe in terms of trace element pollution, but there is chances of pollution in near future if no proper preventive measures are implemented.

The results of physical, chemical parameters and trace elements of groundwater have been compared with the Bureau of Indian Standards IS 10500 (2012). So far, no major studies have been carried out on solid waste interaction with groundwater. In this study, it is observed that the groundwater regime is being polluted due to improper dumping of solid waste in unlined sewage drains, besides geological causes. Toxic Solid Waste must be treated before disposal. This may lead to serious health threat to human beings [11].

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REFERENCES

[1] T. B. Reddy, C. V. Ramana, C. Bhaskar, P. J. Chandrababu, "Assessment of heavy metal study on ground water in and around Kapulauppada MSW site, Visakhapatnam, AP.", International Journal of Science and Nature, Vol.3, pp.468-471, 2012.

[2] T. J. R. Kumar, C. Dushiyanthan, B. Thiruneelakandan, R. Suresh, S. V. Raja, M. Senthilkumar, "Major and trace element characterization of shallow groundwater in coastal alluvium of Chidambaram Town, Cuddalore District, South India.", Journal of Geoscience and Environment Protection, Vol.4, Issue.01, pp.64, 2015.

[3] S. Mor, K. Ravindra, , R. P. Dahiya, A. Chandra, "Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site", Environmental monitoring and assessment, Vol.118, Issue.1-3, pp. 435-456, 2006.

[4] A. Farooqi, H. Masuda and N. Firdous., "Toxic fluoride and arsenic contaminated groundwater in the Lahore and Kasur districts, Punjab, Pakistan and possible contaminant sources." Environ. Pollution, Vol.145: pp.839-849, 2007.

[5] S. Devi, P R. Premkumar, "Physicochemical Analysis of Ground water samples near Industrial Area Cuddalore district, Tamil Nadu, India", International Journal of Chem Tech Research, Vol.4, Issue.1,pp. 29-34, 2012.

[6] K. Hadjibiros , D. Dermatas, C.S. Laspidou," Municipal solid waste management and landfill site selection in Greece: irrationality versus efficiency", Journal of Global NEST,Vol. 13, Issue.2, pp. 150-161, 2011.

[7] Prasoon Kumar Singh, BinayPrakash Panigrahy, Ashwani Kumar Tiwari, Bijendra Kumar, PoornimaVerma, "A statistical evaluation

for the groundwater quality of Jharia coalfield, India", International Journal of ChemTech Research, Vol.7, Issue.4, pp 1880-1888. 2014-2015

[8] S. Gupta , G. Dutta , D. Mondal , "Mechanism of Fluoride Mobilization in an Alluvial Aquifer: a Kinetic Approach", International Journal of ChemTech Research, Vol.9, Issue.4, pp 270-278, 2016.

[9] S. Kalaivani., K. Ramesh, "Groundwater Quality Assessment using WQI In South Coimbatore, Tamil Nadu, India", International Journal of ChemTech Research, Vol.7, Issue.1, pp .316-322, 2014-2015

[10] N. Rajkumar, T. Subramani, L. Elango, "Groundwater contamination due to municipal solid waste disposal – A GIS based study in erode city". International Journal of Environmental Sciences, Vol.1, Issue.4, pp. 39-55, 2010.

N. Kumar, D.K. Sinha , "Drinking water quality management through correlation studies among various physic- chemical parameters". International Journal of Environmental Sciences, Vol.1, Issue.2, pp. 253-259,2010.

[11] M. Sunandana Reddy, L. Harish Kumar, "GIS based Land Information System for Medchal Mandal of R.R. District", International Journal of Computer Sciences and Engineering, Vol.6, Issue.8, pp.43-49, 2018.

[12] Suraj Kumar Singh, Vikash Kumar, Shruti Kanga, "Land Use/Land Cover Change Dynamics and River Water Quality Assessment Using Geospatial Technique: a case study of Harmu River, Ranchi (India)", International Journal of Scientific Research in Computer Science and Engineering, Vol.5, Issue.3, pp.17-24, 2017.

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Killana Dileep pursued Bachelor of Engineering from Andhra University, Visakhapatnam. in 1998 and Master of Technical from Andhra University in year 2008. He is currently pursuing Ph.D. and working as a Deputy Executive Engineer in GVMC, Visakhapatnam- Department of Civil Engineering and Public works. He is a member of MIE since 2010, a life member of the Rotartary Club since 2013. He has also received more than 10 best Engineer's Awards from State and district level and organisation. His main research work focuses on Quality of Ground water using remote sensing and GIS Algorithms. He has 15 years of technical experience and in his supervision ie. Flyover Bridge, BRTS Roads, Indore Stadium, Disposal of Waste Water Project for Gangavaram port at Steel Plant in Visakhapatnam and 5 years of Research Experience.

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