UWR Rainwater Offset Unit Standard

(UWR RoU Standard)

Concept & Design: Universal Water Registry

www.uwaterregistry.io

Project Name: Rainwater Harvesting Ponds in Gondwali by Trimula Industries Limited.

UWR RoU Scope: RoU Scope 2

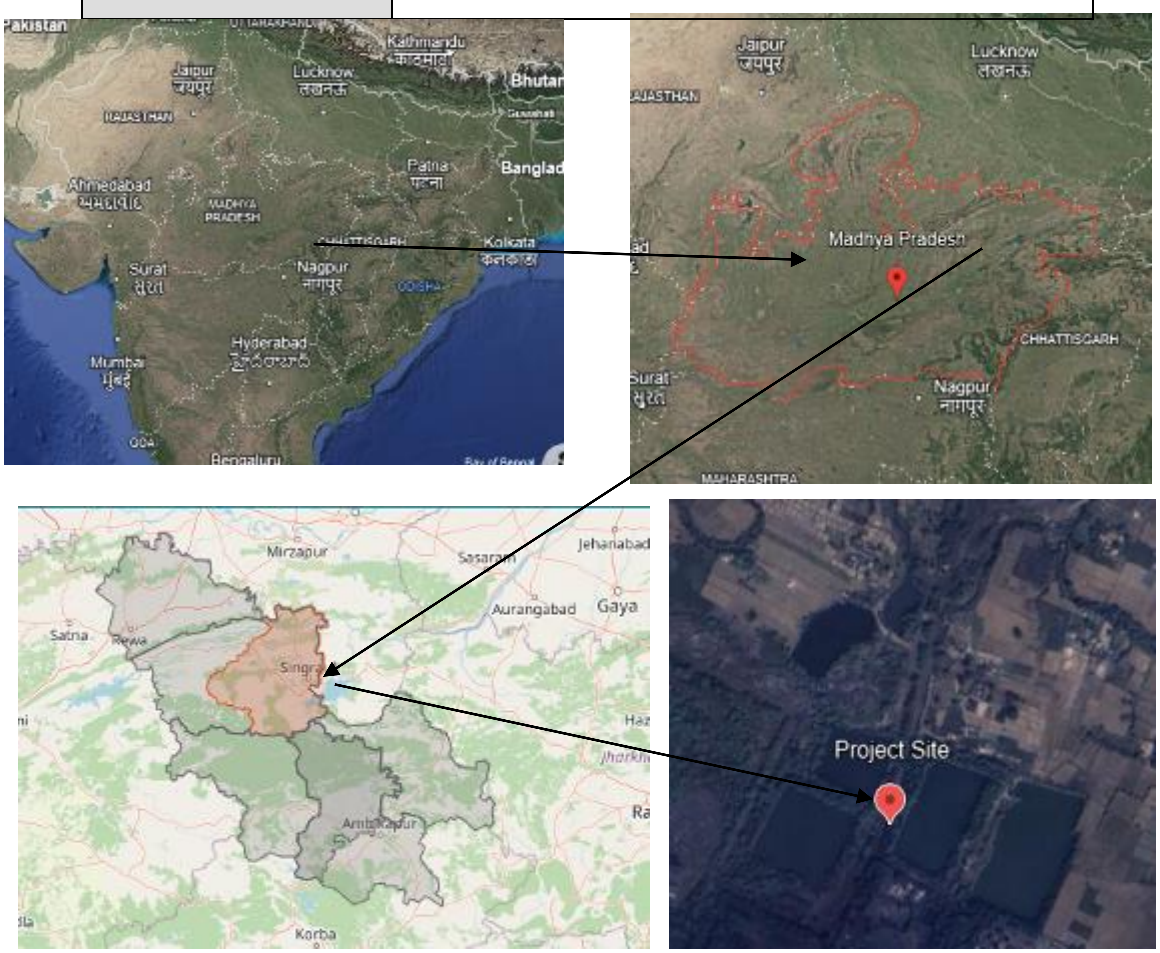
Monitoring Period: 01/01/2014-31/12/2023

Crediting Period: 2014-2023

UNDP Human Development Indicator: 2(India)

A.1 Location of Project Activity

Address of the Project Activity	Trimula Industries Limited (TIL), Village & PO- Gondwali, Tehsil-Deosar, District- Singrauli, State: Madhya Pradesh, 486892
Project Proponent	Innovators Infratech LLP
State	Madhya Pradesh
District	Singrauli
Block Basin/Sub Basin/Watershed	Lower Ganga Basin
Lat. & Longitude	24.207919°, 82.529147°
Area Extent	Groundwater Surface



A.2. Project owner information, key roles and responsibilities

Innovators Infratech LLP (Project Proponent or PP) is the authorizer of Trimula Industries Limited. Trimula Industries Limited is a structural steel manufacturer, has implemented a dedicated rainwater harvesting system to address its significant water needs **for operations such as cooling, power generation, and steel production**. Due to the absence of a nearby water source, the company constructed a series of catchment ponds on-site to capture and utilize rainwater, reducing reliance on groundwater and river resources (i.e. Bikul River). As the PP oversees the project activity, ensuring effective rainwater runoff harvesting and proper maintenance of the catchment area during the monsoon season. The PP also manages the necessary permits and documentation for water harvesting and conservation activities, ensuring compliance and sustainability in its operations.

The increasing pace of ground water extraction in agricultural, industrial and domestic sectors during the past four decades has led to problems of continuously declining ground water levels and deterioration of groundwater quality in many areas of Madhya Pradesh. This has threatened the sustainability of many dug wells and tube wells. Depending heavily on agriculture-based economy, the State requires assured irrigation for sustainable agricultural productivity. Groundwater is the major source of irrigation, and also the sole source of drinking water. But the development of ground water is constrained due to heterogeneity of the formations, non-uniformity in degree and nature of the weathered and fractured zones of the aquifers. It is observed that there is heavy surface run-off in many areas during the monsoon period often resulting in floods, yet these very same areas face crisis of water during the summer. This flood- drought syndrome is basically resultant of improper management of available water resources.

As ground water is an annually replenishable but limited resource, augmentation of the recharge to ground water by the PP is the only option left for ensuring its sustainability.

This type of artificial recharge project activity helps to arrest the depletion of ground water resources on the one hand and create additional resources to cater to the domestic, agricultural and industrial needs in the State.

A.2.1 Project RoU Scope

PROJECT NAME	Rainwater Harvesting Ponds in Gondwali by Trimula Industries Limited
UWR Scope	RoU Scope 2**:** Measures for conservation and storage of excess surface water for future requirement
Project Aggregator	Yojan Solutions Pvt. Ltd.

<table>
<tr><td>Project Aggregator Address</td><td>17-18, Nilamber Bliss, Gotri Sevasi Road, Vadodara 390021, Gujarat, India</td></tr>
<tr><td>Date PCNMR Prepared</td><td>22/10/2024</td></tr>
<tr><td>Catchment Area</td><td>
<table>
<tr><td>Pond 1: L-125m
B-115m
D-6m</td><td>Pond 2: L-100m
B-75m
D-6m</td></tr>
<tr><td>Pond 3: L-175m
B-85m
D-6m</td><td>Pond 4: L-199m
B-104m
D-9m</td></tr>
<tr><td>Pond 5: L-34m
B-28m
D-5m</td><td>Pond 6: L-113m
B-60m
D-9m</td></tr>
</table>
</td></tr>
<tr><td>Total catchment Capacity Area (m^2)</td><td>
<table>
<tr><th>Name</th><th>m^2</th></tr>
<tr><td>Pond 1</td><td>14375</td></tr>
<tr><td>Pond 2</td><td>7500</td></tr>
<tr><td>Pond 3</td><td>14875</td></tr>
<tr><td>Pond 4</td><td>20696</td></tr>
<tr><td>Pond 5</td><td>952</td></tr>
<tr><td>Pond 6</td><td>6780</td></tr>
<tr><td>Total</td><td>65178</td></tr>
</table>
</td></tr>
<tr><td>Type of structure</td><td>Six (6) Rectangular Shaped Rainwater Harvesting and Recharge Ponds</td></tr>
<tr><td>Year of Construction/Year of Commissioning</td><td>
<table>
<tr><th>Name</th><th>Year</th></tr>
<tr><td>Pond 1</td><td>2007</td></tr>
<tr><td>Pond 2</td><td>2007</td></tr>
<tr><td>Pond 3</td><td>2008</td></tr>
<tr><td>Pond 4</td><td>2010</td></tr>
<tr><td>Pond 5</td><td>2010</td></tr>
<tr><td>Pond 6</td><td>2011</td></tr>
</table>
</td></tr>
<tr><td>Average Rainfall</td><td>1117mm</td></tr>
</table>

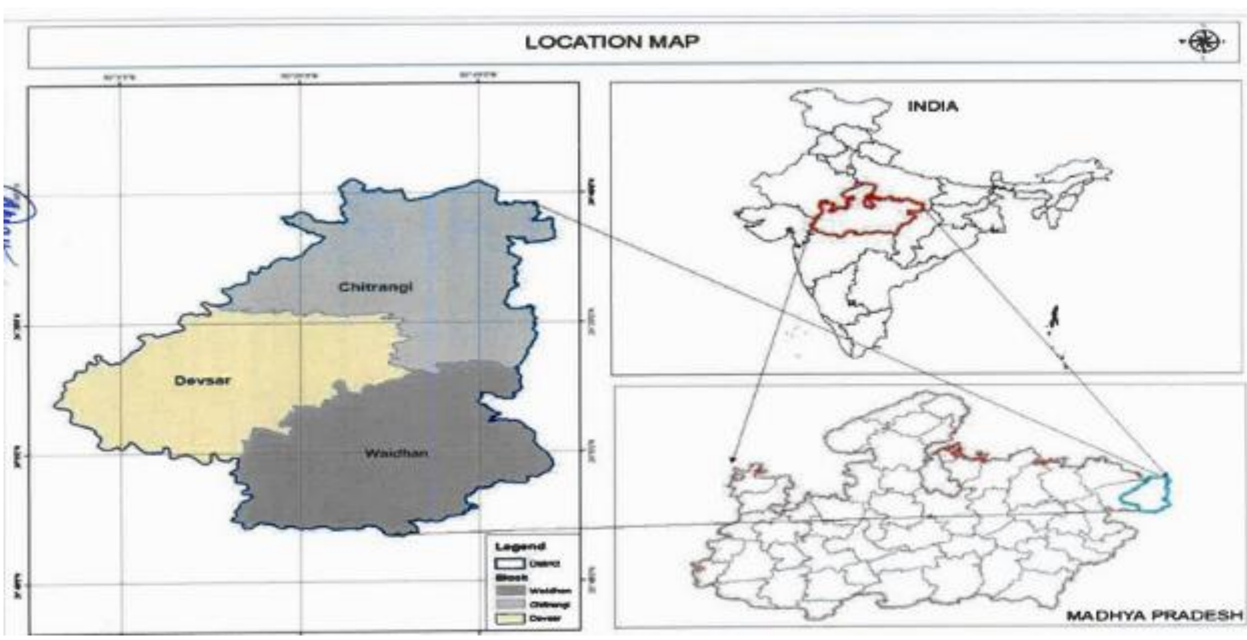
Run off Coefficient	0.3
Evaporation and absorption losses	24%
RoU Crediting Period	2014-2023
Total RoUs Generated For the Crediting Period	**166001 RoUs**

The project activity **Rainwater Harvesting Ponds in Gondwali by Trimula Industries Limited (TIL)** is a cluster of six (6) man-made ponds each having a large catchment area that conserves and stores rainwater for future use in the different manufacturing process of the PP in Madhya Pradesh, India.

A.3. Land use and Drainage Pattern

A3.1 Urban and rural Residential

A3.1.1 Introduction



The Singrauli district is located in the north eastern part of Madhya Pradesh having a geographical area of 567200 ha and extended by North latitudes 230 49’ and 24’42’ and east longitude. 810 18’ to 820 48’.

The district is bounded in the North by Rewa and Sidhi district in the east by Uttar Pradesh,in the south by Sarguja and West by Shahdol district. The district is divided into 3 Tehsil - Deosar, Chitrangi and Singrauli. There are 3 development blocks Deosar, Chitangi and Waidhan. other towns and 746 villages in the district. The administrative divisions of Singrauli district are shown in figure I.

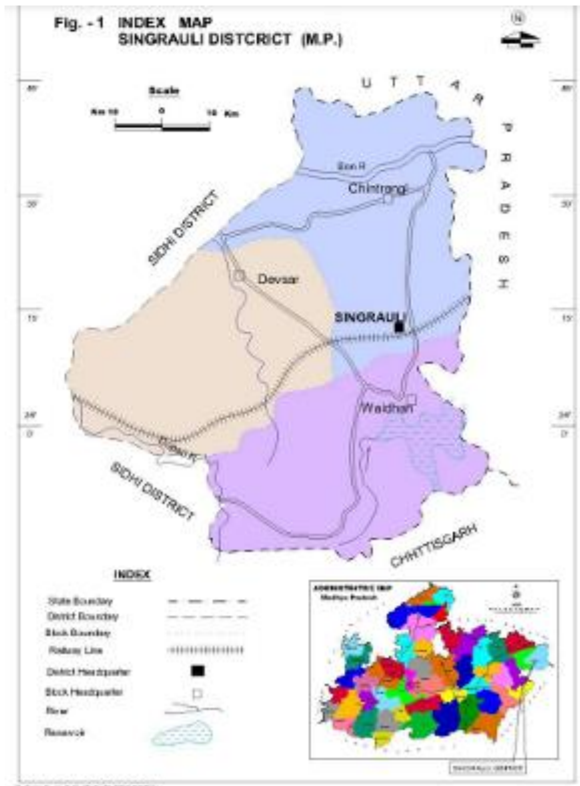


Figure: Singrauli District Map

SOIL CHARACTERISTICS: The Singrauli District is generally covered with Alluvial soil, red Sandy soil and yellow loamy Sandy soil, laterite soil and red loam soil. The district comprises sedimentary, crystalline and metamorphic rocks, weather into red soil. Similarly the red colour of the laterite soil is more due to diffusion of Iron compounds rather than due to high proportion of Iron oxides. The alluvial soil is mostly restricted by along the banks of major rivers, whose thickness varies from few meters to 25 meters.

A3.1.2 Physiography

The district is divided into three physiographic divisions: -

(i) Kaimur hilly ranges (ii) The Central part hilly ranges and (iii) Southern hilly ranges.

In the district three main river flows along with several tributaries rivers the major rivers are the son, Gopal and Rihand. The Kaimur range stretching from NE and SW direction and covered most part of the district. The central part of the district forms a series of hill ranges. The Southern part of district the elevation of hills ranges varies between 365 and 488m above MSL. The general slope of the area is towards Northeast.

The entire district drained by the above mentioned 3 major rivers and their tributaries for us the Ganges drainage System. The pattern of drainage is dendrite in hectare excepting the localized radial pattern in the hilly terrain.

A3.1.2 Geology

The geology of the district reveals that the occurrence of various work formation as old as granites of Achaean age to the Alluvium of Recent age. The other important formations Outcropping in the district are Deccan trap of cretaceous – Eocene, Gondwanas of Paleozoic to Mesozoic Sandstone and other ranks of Vindhayans and Phyllites. Quartzites, Schist Gneisses and Granites of Archeans age. The Geology of the district is shown in the Hydrogeogical Map. The general Stratigraphical Succession obtained in the district is given as under: -

Period	Series/stage	Lithology	
Recent Pleislocene	Allvium	Allvium and soil cap comprising clay, sand gravel etc.	
Cretaceous to Eocene	Deccan Traps	Basaltic Lava flows	
Permian to up carboniferous	Gondwanas	Upper Gondwana formation Ranging formation Talchir formation	Sandstone Shale eval conglometrate and glouconite
Cambrian	Vindhyans	Kaimur Series Semri Series	Porcellinite sandstone Orthoquortzite and conglometry
Pre Cambrian	Archeans	Phyite, Quartzites, Granite, Schist, gneisses metabasic sedimentary and inhusives	

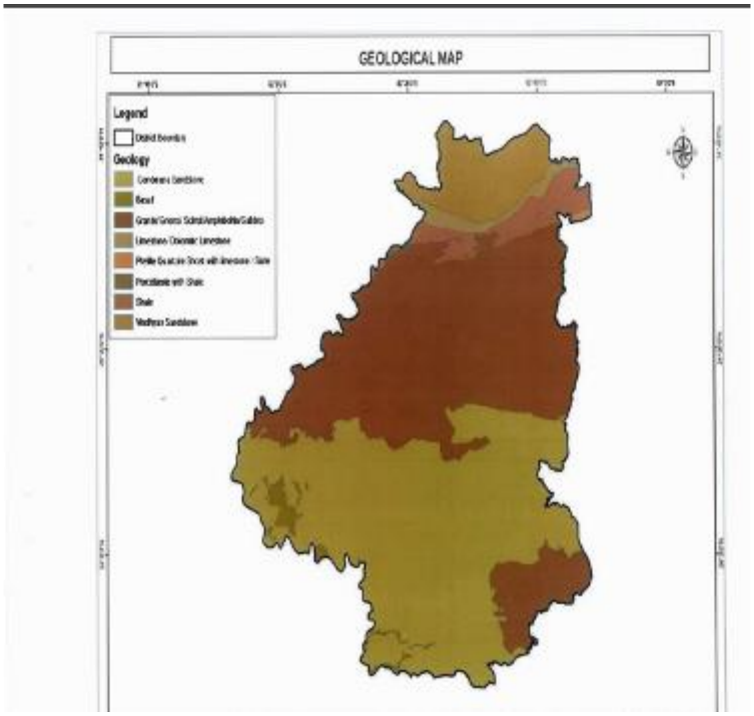


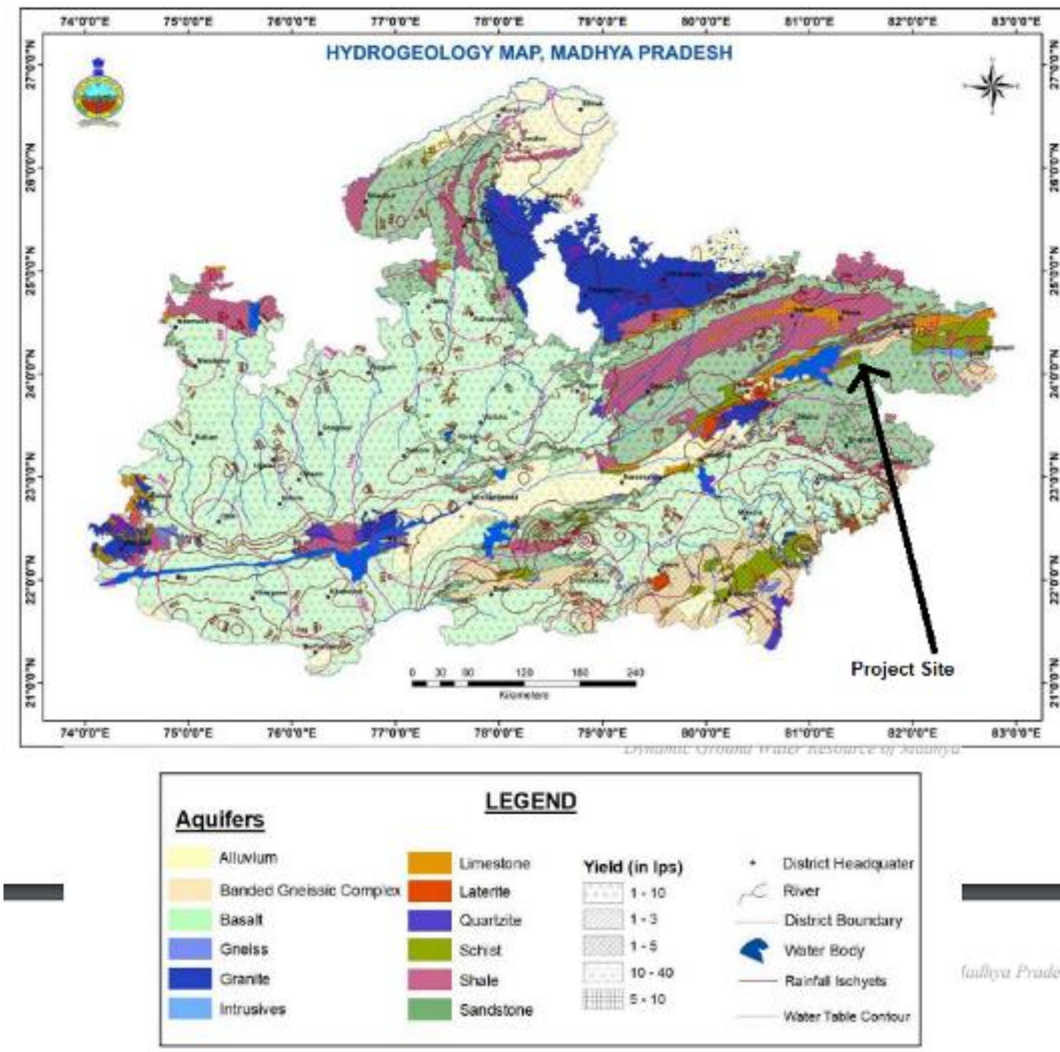
Figure: Geological map of Singrauli District

https://mpseiaa.nic.in/DSR/Singrauli/DSR_Singrauli_OTS.pdf

A3.1.3 Hydrogeology

Groundwater in the Singrauli district is primarily used for irrigation and occurs in various geological formations, including Archean rocks, Vindhyan sandstone, limestone, Gondwana formations, and alluvium. The Archean rocks, composed mainly of granites, schists, and gneisses, store groundwater in weathered and fractured zones, where well depths range from 3 to 21 meters below ground level (mbgl). Vindhyan sandstone and limestone also yield groundwater through well-developed joints, with well depths varying between 6 and 24 mbgl. The Gondwana formations, mainly sandstone and clays, are found in hilly terrain and offer significant water yields. In alluvial areas near rivers, groundwater is available under water table conditions, with well depths between 10 and 25 meters.

S. No.	Assessment Unit	Sub-unit Command/ Non-Command/	Net Annual Ground water Availability (ham)	Existing Gross Ground water Draft for Irrigation (ham)	Existing Gross Ground water Draft for Domestic & Industrial water Supply (ham)	Existing Gross Ground water Draft for All uses (ham)	Provision for domestic, and industrial requirement supply to next 25 year (2033) (ham)	Net Ground water Availability for future irrigation d development (ham)	Stage of Ground water Development (%)	Category
1	Chitrangi	Command								
		Non-Command	8591	1677	723	2400	997	5917	28	Safe
		Block Total	**8591**	**1677**	**723**	**2400**	**997**	**5917**	**28**	**safe**
2	Deosar	Command	199	12	60	73	122	65	36	Safe
		Non-Command	12382	3350	607	3957	917	8115	32	Safe
		Block Total	**12581**	**3362**	**667**	**4029**	**1039**	**8181**	**32**	**Safe**
3	Waidhan	Command	716	56	101	157	207	453	22	Safe



Conclusion

The Singrauli district exhibits diverse geological formations that significantly influence its hydrogeological characteristics. The district is divided into three physiographic regions, with major rivers like the Son, Gopal, and Rihand playing a key role in drainage. Groundwater is found in multiple formations, from Archean rocks to alluvium, with varying depths and water yields. The Archean formations, Vindhyan sandstones, Gondwana rocks, and alluvial deposits each offer unique groundwater storage capacities, making the district a valuable resource for irrigation. The area's hydrogeology, shaped by its complex geology, supports sustainable water management for agricultural and other purposes.

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

A3.2 Land Use

Singrauli district in Madhya Pradesh has a complex and diverse land use pattern that reflects both its natural resources and industrial significance. The district features extensive forest cover, spanning approximately 239,689 hectares, which plays a critical role in maintaining the region's ecological health. However, this forested area faces increasing pressure from coal mining and industrial expansion. Agriculture is another key component of land use in Singrauli, with about 240,670 hectares of net sown land supporting the cultivation of staple crops like paddy and wheat. A portion of this agricultural land, around 61,928 hectares, is double cropped, highlighting its productivity. The district's land is also heavily utilized for industrial purposes, particularly coal mining, which has significantly impacted both the natural landscape and water resources. Groundwater levels and quality have been affected by these industrial activities, making the management of water resources a growing concern. Overall, Singrauli's land use reflects a delicate balance between preserving its natural resources and supporting economic development.

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

The statistical dates of caned use, Irrigation and cropping pattern of Singrauli district has been extracted bone the district statistical Booklet, 2008 issued by the statistical Department. Total geographical area cultivated and non-cultivated area, area under forest, fallow land, area under double crop, total cropped area and area suitable for agriculture of Singrauli district are tabulated in Table 1 & 2, area irrigated by canals, tube wells, dugwells and tanks of Singrauli district are tabulated in Table 3.

Table: Land Use and Land Cover classification of shingrauli District

Table – 1, Blockwise land use in District Singrauli

S.No.	District Block	Geographical Area In Hact.	Forest area In Hact.	Land not available for cultivation In Hact.	Total Cultivable area In Hact.
1.	Deosar	184559	78102	13952	55333
2.	Chitrangi	192290	77614	14755	67465
3.	Waidhan	190424	83973	11446	55944
	Total District	**567273**	**239689**	**40153**	**178742**

Table – 2 Blockwise land use in District Singrauli

S.No.	District Block	Followup	Net Shown Area	Double Cropped area	Gross shown area Total cropped area
1.	Deosar	16272	72497	17164	89661
2.	Chitrangi	10779	89930	22465	112395
3.	Waidhan	27982	78243	22299	100542
	Total Area	**55033**	**240670**	**61928**	**302598**

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

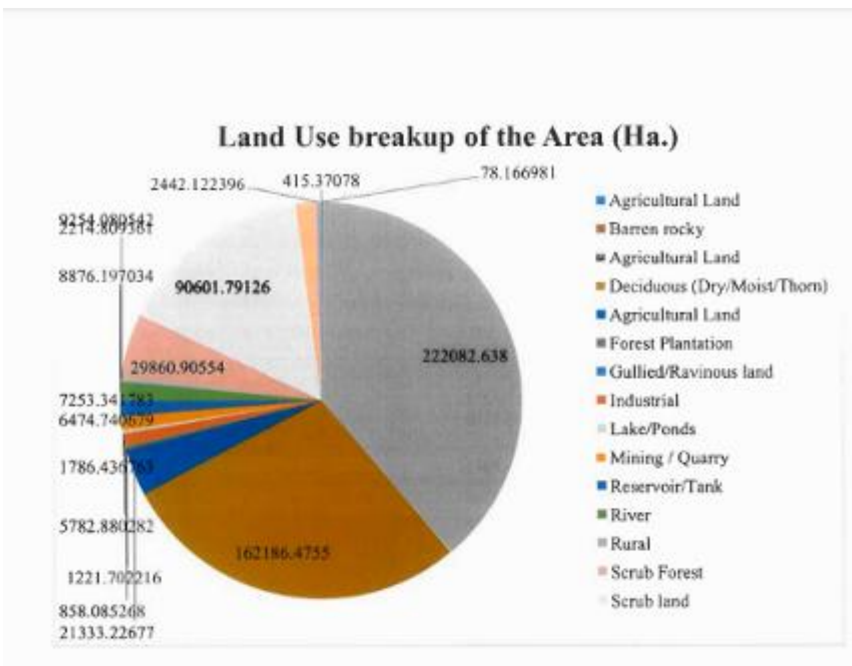
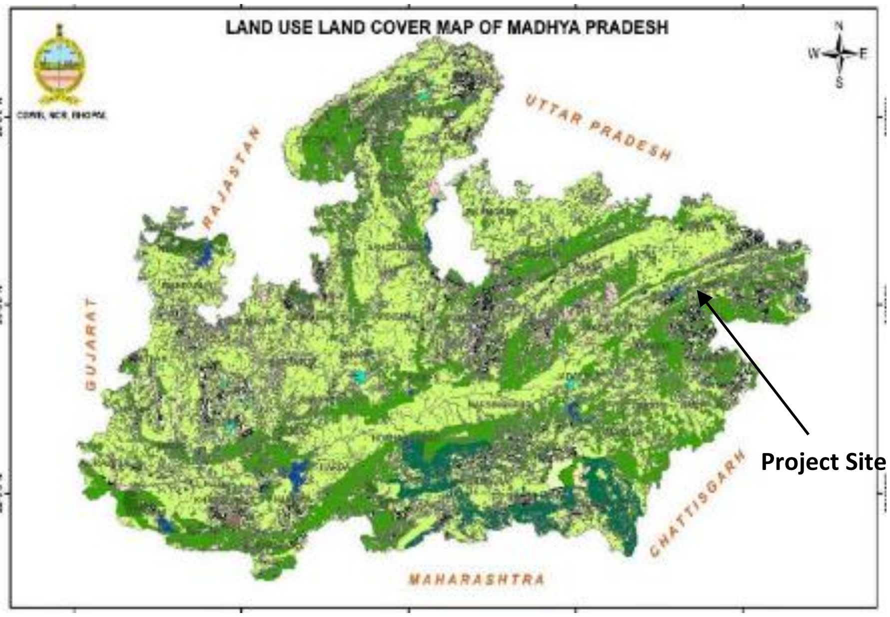


Figure: Land Use and Land Cover of Singrauli District

https://mpseiaa.nic.in/DSR/Singrauli/DSR_Singrauli_OTS.pdf



Conclusion

In conclusion, Singrauli district's land use is characterized by a delicate balance between its rich natural resources and significant industrial activities. While the extensive forest cover and agricultural land play a critical role in sustaining the region's ecological and economic systems, coal mining and other industrial operations have placed considerable strain on both the environment and water resources. Groundwater levels and quality are particularly affected, raising concerns for sustainable water management. Therefore, strategic planning is essential to reconcile the region's economic development with long-term ecological conservation.

A3.3 Drainage

In this district three main river flows along with several tributaries rivers are the son, Gopal and Rihand. The Kaimur range stretching from From NE and SW direction and covered most part of the district.

The Central part of the district forms a series of hill ranges. The southern part of the district the elevation of hills range varies between 365 and 488m above MSL. The general slope of the area is towards the Northeast. The entire district drained by the above mentioned 3 major rivers and their tributaries for us the Ganga drainage system. The pattern of drainage in hectare excepting the localized radial pattern in the hilly terrain.

The main drainage system of the area is the Gopad river, which is a tributary river of Son river, situated on the south-western side of the block but out of the concerned area. 4.4 The westerly flowing Sukhiya nala is passing through the north-western part of the block and eventually drains into the Gopad river along with Hardul Nala. 4.5 Other seasonal nala contributing in to the Sukhiya nala is present within the block creating a dendritic type drainage pattern.

https://nmet.gov.in/upload/project_registration/63b810daa71bd17%20Gurwani%20block_Coal_MP.pdf

https://pmksy.gov.in/mis/Uploads/2017/20170504011501842-1.pdf

Blocks	No of Water Bodies	Total Area (in Ha)
Waidhan	4051	12020.43
Deosar	4486	9821.6
Chitarangi	6445	8919
Total	**14982**	**30761.03**

https://indiawris.gov.in/wiki/doku.php?id=river_basins
https://indiawris.gov.in/downloads/Ganga%20Basin.pdf

A3.4 River Basin

Madhya Pradesh has six major river basins that contribute to India's river systems, including the **Ganga Basin** (subdivided into the Yamuna, Tons, and Sone sub-basins), the **Narmada Basin**, the **Godavari Basin**, the **Tapti Basin**, the **Mahi Basin**, and the **Mahanadi Basin**. The Vindhya range separates the northern Ganga basin from the southern river systems. The Ganga basin supports fertile agricultural land, while the southern basins feature dense forests, including teak and bamboo in the upper Mahanadi catchment.

Singrauli is traversed by several rivers, with the most significant being the **Rihand River** (locally known as Rhed), which originates from the Matiranga hills and flows northward through the region before entering Uttar Pradesh and joining the **Son River**. The Son River, originating from the Amarkantak block in Anuppur district, is the primary river of Singrauli, eventually merging with the Ganga River. The **Singrauli Coalfield** is divided into two basins: the **Moher sub-basin** (312 km^2), largely in the Sidhi district of Madhya Pradesh, and the **Singrauli Main basin** (1,890 km^2), which remains largely unexplored in the western part of the coalfield. Current coal mining activities, primarily concentrated in the Moher sub-basin, focus on lignite extraction and are supported by Heavy Earth Moving Machinery (HEMM).

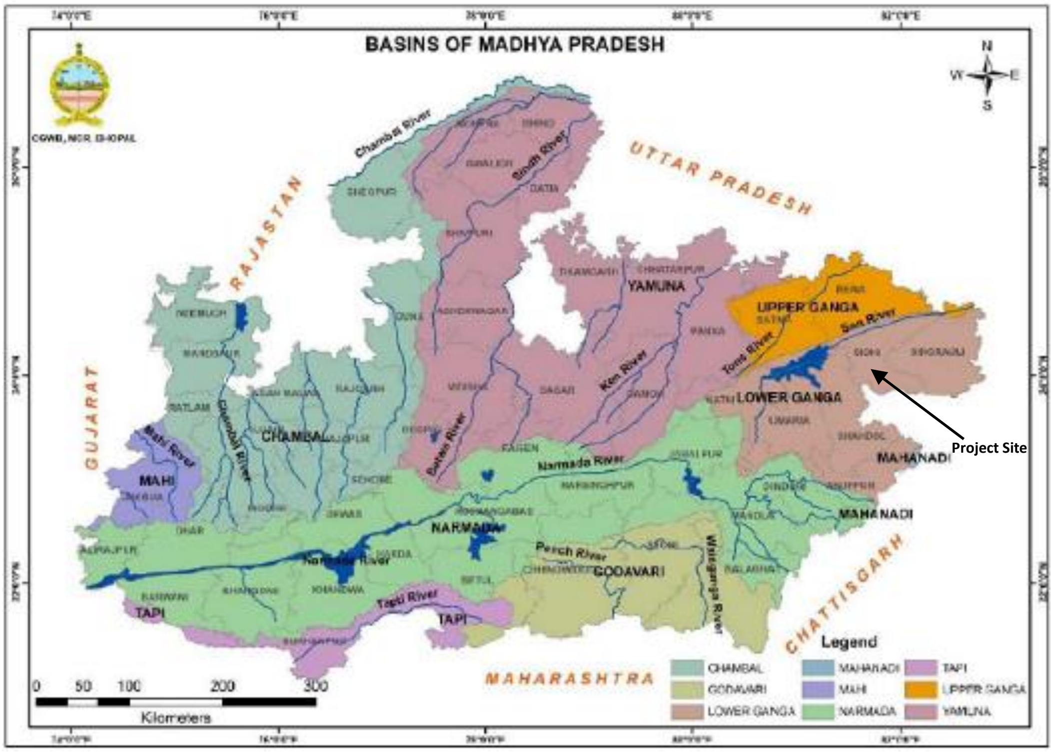


Figure : River Basin of MP

Blocks	No of Water Bodies	Total Area (in Ha)
Waidhan	4051	12020.43
Deosar	4486	9821.6
Chitarangi	6445	8919
Total	**14982**	**30761.03**

https://pmksy.gov.in/mis/Uploads/2017/20170504011501842-1.pdf

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A3.5 Description of River System

Madhya Pradesh, centrally located in India, serves as a crucial catchment area for several interstate rivers that significantly impact the region's hydrology and ecology. Key rivers, such as the Chambal, Sindh, Betwa, and Ken, flow northward to join the Yamuna, while the Sone River (Swarna Nadi), a principal right bank tributary of the Ganga, originates in the Maikala Range at an elevation of 600 m in the Amarkantak Plateau. The Sone sub-basin covers an area of 65,110 sq. km, and about 500 km of the

Sone River runs through Madhya Pradesh before joining the Ganga around 16 km upstream of Dinapur in Bihar. The Sone flows for 784 km, initially moving northwest before changing course to the northeast and merging with the Ganga near Arrah in Bihar. Its wide bed is filled by important rivers like the Mahanadi, Banas, Gopat, Rihand, Kanhar, and North Koel. The Chambal River, rises from the Vindhya Range near Mhow, flowing northward until it reaches the Madhya Pradesh-Rajasthan border and receiving tributaries like Kali Sindh and Kural from Madhya Pradesh. This river, which mainly relies on rain, is crucial for the state's farming and water supply. However, extensive industrial activities, particularly coal mining in regions like Singrauli, place significant pressure on the river system, raising concerns about water quality and the overall health of the ecosystem.

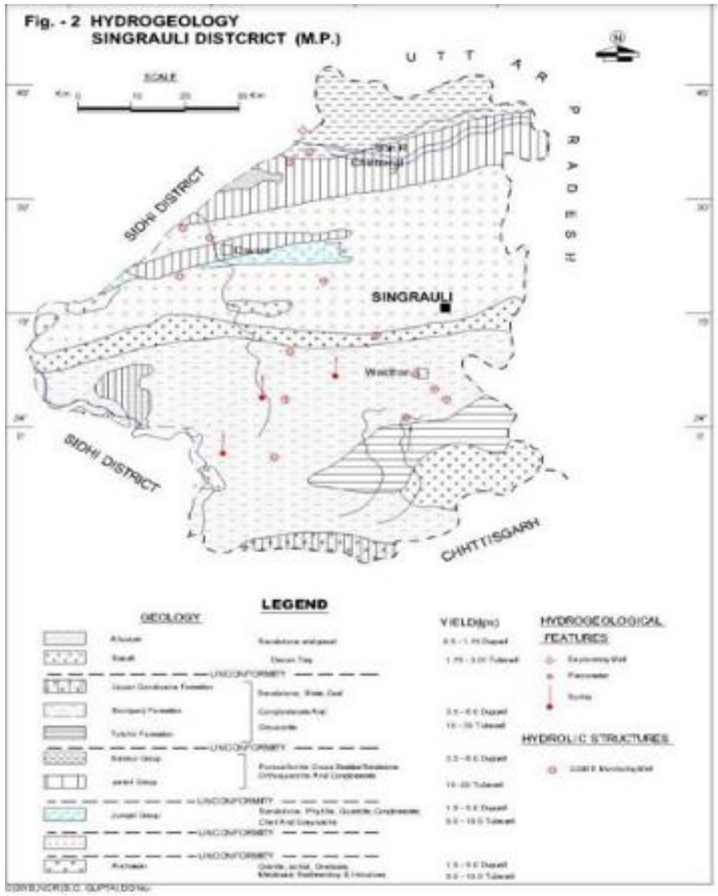
1708417155190435308file.pdf

https://indiawris.gov.in/downloads/Ganga%20Basin.pdf

Watershed Code	
Sub-Basin Name	**Watershed Code**
Chambal Lower	C2ACHL01 to 14

Watershed Code	
Sub-Basin Name	**Watershed Code**
Son	C2ASON01 to 83

Figure : Singrauli District Watershed Code



A.4. Climate

(ι) Type of Climate

The climate of Singrauli district is characterized by four distinct seasons: winter, hot weather, southwest monsoon, and post-monsoon. Winter lasts from the end of November to early March, with January being the coldest month, where temperatures range from a maximum of 24.3°C to a minimum of 8.1°C. The hot weather spans from March to mid-June, peaking in May with mean maximum temperatures reaching 42.0°C and individual days soaring to 44-45°C. The southwest monsoon arrives in mid-June, bringing a significant drop in temperature and increased humidity, which can reach up to 85% in August. The humidity is lowest in April at about 35%, with the annual mean humidity around 60%. Wind velocities are higher during the pre-monsoon period, peaking at 6.35 km/hr in June, and dropping to 1.6 km/hr in December, resulting in an annual mean wind velocity of 3.94 km/hr. Singrauli receives an average annual rainfall of 1120.7 mm, with 89% occurring during the monsoon season (June to September) and July being the wettest month; only 11% of the rainfall takes place from October to May.

Normal Climatologically PARA METERS of (Singrauli District) -

Parameters	Jan	Feb	Mar.	April	May	June	July	Aug	Sep.	Oct.	Nov.	Dec.	Annual
Max. Temp.	24.3	27.6	33.4	39.1	42.0	39.2	32.9	31.7	32.3	32.6	29.5	25.3	32.5
Min. Temp.	8.1	10.8	15.5	21.5	25.8	27.5	25.1	24.6	23.8	19.4	13.0	8.3	18.6
R.H. %	76	68	51	38	35	58	83	85	82	73	69	74	66
W. Speed in Km/hr.	2.1	2.7	3.3	4.5	5.1	6.5	5.3	4.5	3.9	2.4	1.8	1.6	3.6
Rainfall in m.m.	27.0	18.4	13.2	3.4	8.8	133.5	338.2	325.3	211.8	33.4	12.1	7.7	1132.7

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

A.5. Rainfall

The normal rainfall of the Madhya Pradesh State is 977.5 mm. The normal monsoon rainfall and normal post monsoon rainfall is 940.6 mm and 53.7mm respectively. Rainfall is the sole source of natural recharge to ground water regime and rainfall pattern has an important impact on groundwater level in the phreatic aquifer. Rainfall in the state occurs during south-west monsoon season (mid June to September) and sometimes during winter(November to February). Most of the rainfall (more than 90%) occurs during the south-west monsoon season. Monsoon rainfall within ± 19% of the normal monsoon rainfall is considered normal. Monsoon rainfall between 20 per cent and 59 per cent of the normal monsoon rainfall is considered excess and above 60 % is considered as large excess. Monsoon rainfall less than-20% and more than -59% of the normal monsoon rainfall is considered deficit and if the monsoon rainfall is lesser than -60% of the normal monsoon rainfall, it is considered large deficient. The normal monsoon rainfall and normal post monsoon rainfall of the Madhya Pradesh State is 940.6 mm and 53.7 mm respectively. During monsoon season state has received 945.2mm, 0% departure from monsoon normal and in the post monsoon season 72.1 mm, 34%abovepost monsoon normal.

The rainfall pattern in Singrauli district is predominantly influenced by the southwest monsoon, with the district receiving an average annual rainfall of 1132.7 mm. Approximately 89% of this rainfall occurs during the monsoon season, which lasts from June to September. July is the wettest month of the year, contributing significantly to the overall rainfall. The onset of the monsoon in mid-June brings heavy precipitation, which continues through July and August, gradually decreasing by the end of September. During this period, humidity levels peak at around 85%, and the weather becomes cooler and more humid.

In contrast, the post-monsoon months of October and November witness only a minimal amount of rainfall. As the monsoon retreats, there is a brief increase in daytime temperatures, but overall, the weather remains dry. The months from October to May, which form the dry season, receive only about 11% of the annual rainfall. Rainfall during these months is sporadic and generally insignificant. April and May, in particular, experience the driest conditions, with relative humidity levels dropping to about 35%.

This seasonal variation in rainfall, with the bulk occurring during the monsoon months and a prolonged dry period for the rest of the year, plays a crucial role in shaping the district's climate and impacts both agricultural and water resource management. Understanding this distribution is essential for ensuring proper planning and sustainable development in the region.

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

Singrauli District Rainfall Data - IMD Data	
Year	**Rainfall (mm)**
2014	698.3
2015	799.6
2016	1298.3
2017	866.9
2018	999.4
2019	1395
2020	1294.9
2021	1440.5
2022	939
2023	1440.5

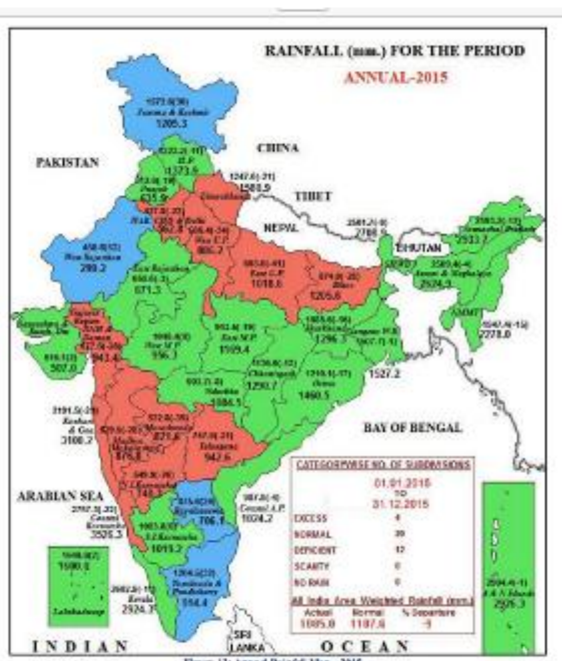


Figure 13: Annual Rainfall Map – 2015

Figure 24: Annual Rainfall Map – 2016

Figure 13: Annual Rainfall Map – 2017

Figure 13: Annual Rainfall Map – 2018

Figure 13: Annual Rainfall Map

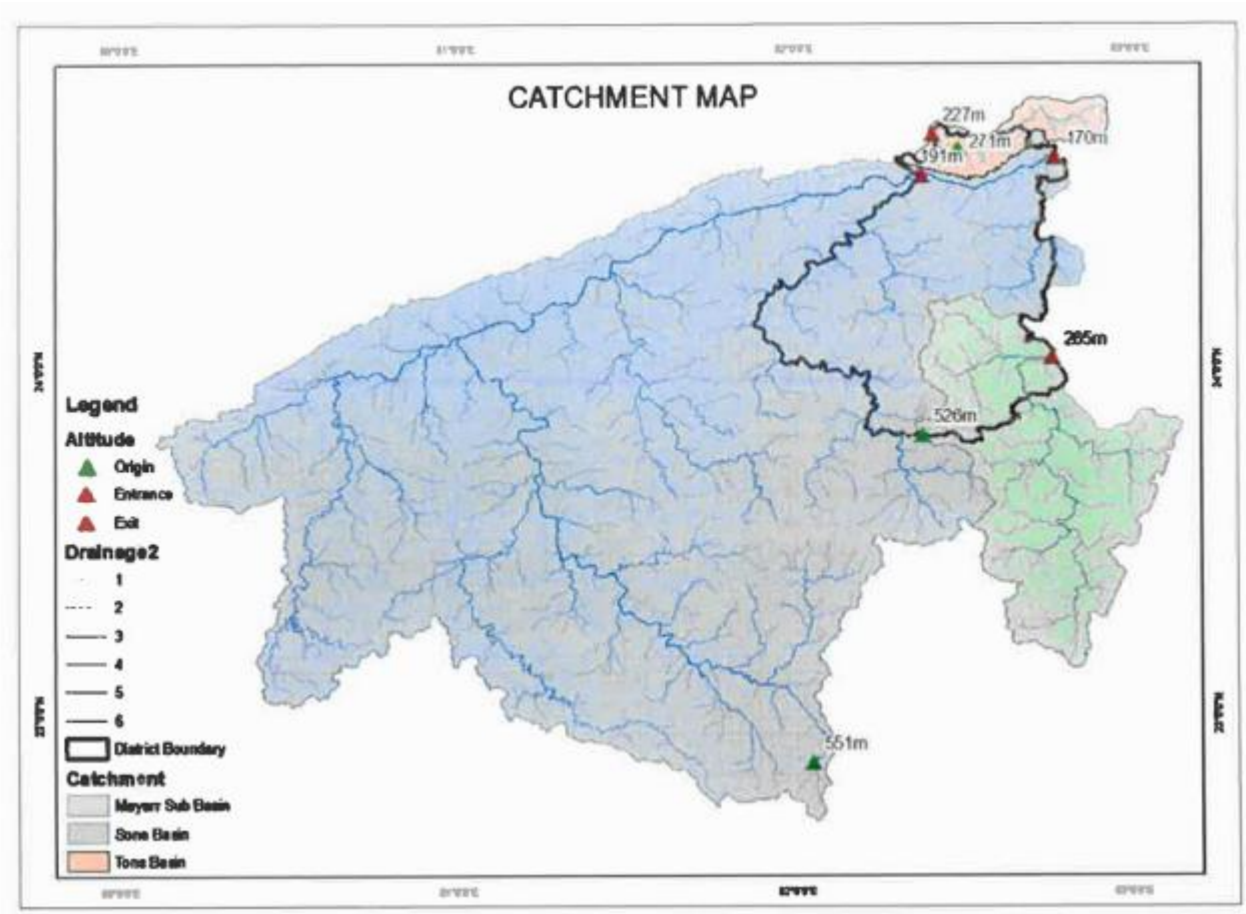
Figure 12: Annual Rainfall Map

Figure 12: Annual Rainfall Map

Figure 13: Annual Rainfall Map

https://environicsindia.in/wp-content/uploads/2018/09/Rainfall-Statistics-of-India-2014.pdf

Year	Rainfall (in mm)	Source
2023	1440.5	https://www.cgwb.gov.in/cgwbpnm/public/uploads/documents/17084171551904353 08file.pdf



Catchment Map of District

A.6. Ground Water

Ground Water is found beneath the earth's surface and is an important source of water in most of the Districts in the State. Ground Water is withdrawn for Agriculture, Municipal and industrial use. The depth at which the ground water occurs is called Ground water Table.

In the latest 2023 assessment, the total annual ground water recharge has been assessed as 35.47 Billion Cubic Meter (bcm). Keeping an allocation for natural discharge, the annual extractable ground water resource works out as 32.85 bcm. The total annual ground water extraction (as in 2023) has been assessed as 19.30 bcm. The average stage of ground water extraction for the state as a whole works out to be about 58.75%. The extraction of ground water for different parts of the state is not uniform. Out of the total 317 assessment units (Blocks/ Urban areas) in the state, 26 units (8%) have been categorized as ‘Over-Exploited’ indicating groundwater extraction exceeding the total annual extractable resources. A total of 5 (2%) assessment units have been categorized as ‘Critical’, where the stage of ground water extraction is between 90-100 % of annual extractable resources available. There are 60 ’Semi-Critical’ units (19%), where the stage of ground water extraction is between 70 % and 90 % and 226 (71%) assessment units have been categorized as ‘Safe ‘, where the stage of Ground water extraction is less than 70 %.

Out of 32853.75 million cubic meters (mcm) of total annual extractable resources of the state, 3424.26 mcm (10.42 %) are under ‘Over Exploited’, 537.1 mcm (1.63 %) are under ‘Critical’, 6119.62 mcm (18.63 %) are under ’Semi-Critical’, 22772.77 mcm (69.32 %) are under ‘Safe’ category assessment units.

Out of 269333.27 Sq Km of “recharge” worthy area of the state, 22554.86 Sq Km (8.37 %) are under ‘Over-Exploited’, 4249.07 Sq Km (1.58 %) are under ‘Critical’, 51803.76 Sq Km (19.23 %) are under ’Semi-Critical’, 190725.58 Sq Km (70.81%) are under ‘Safe’ category assessment units.

The total annual ground water recharge has increased from 35.24 to 35.47 bcm. The rise in groundwater recharge can be attributed to increased rainfall recharge and the implementation of water conservation structures. Accordingly, the annual extractable resource of Ground Water Resource Assessment, 2023 on comparison Ground Water Resource Assessment, 2022 shows an increase from 32.58 to 32.85 bcm. The groundwater extraction has increased from 19.25 to 19.30 bcm and the changes are attributed mainly to due to increase in the abstraction structures and increase in population. The overall stage of groundwater extraction has increased from 59.10% to 58.75%. Almost all over-exploited assessment units falling in western part of Madhya Pradesh, which is known as “MALWA AREA” where ground water extraction has increased many folds during past decades. **District wise analysis of data of annual extractable resource and annual ground water extraction indicate that four districts namely Indore, Mandsaur, Neemuch, Ratlam and Shajapur are districts where stage of ground water extraction is more than 100% as a whole**

Ground water is the principal source of irrigation in the district. The district area is underlain by hard rock as well as alluvium. The occurrence and movement of ground Water in different formations varies with rock type. The weathered and fractured zones occurring at shallow depths provide scope of ground water storage and movement. Ground water in Archaean rocks moves in joint and fracture plane and in the weathered zones mostly under the water table conditions occurrence and movement of ground water is controlled by the extended size and interconnection of joints and the degree of weathering which varies specially areas having a fairly high degree of fracturing and weathering can sustain tube wells. The pre-monsoon depth to water level in the district ranges between 4.13 m bgl and 18.50m bgl. Major part of the district have water level in the range of 8- 12m bgl during the pre-monsoon. During post-monsoon period, water level varies from 2.94m bgl to 15.17m bgl. In major part of the district, water level lies between 5 & 10 m bgl. Analyses of Groundwater level data of pre-monsoon period indicate that there is declining trend in the range of 0.0018 - 0.27 m/yr.

Ground Water Exploration by CGWB	
Exploration well	EW-5,OW-1, Pz-5
Depth	83 – 302 M bgl
Static Water level	3.1 – 26 M bgl
Discharge	0.69 – 5.88 lps.
Ground Water Quality	EC-160-775, nitrate-6.7-17, F-0.04-1.2
Ground Water Resources (2009)	
i) Net Annual Ground Water Availability	36653 ham
ii) Existing Gross Ground Water Draft	11225 ham
iii)Projected Demand for Domestic and Industrial uses upto 25 years	3380 ham
iv) Stage of Ground Water Development	31%
Ground Water Quality	
	EC-160-775, nitrate-6.7-17, F-0.04-1.2

Dynamic Ground Water Resource of Madhya Pradesh - 2023

S N	Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
	Narwar	5787.07	0.00	576.87	6363.94	623.84	2048.23	75.23	semi_critical
	Pichhore	5053.19	0.00	577.58	5630.77	624.61	1633.73	77.01	semi_critical
	Pohari	5650.17	0.00	663.88	6314.05	717.94	6320.02	49.76	safe
	Shivpuri	5922.63	4.66	522.35	6449.66	564.88	5448.74	54.01	safe
	DISTRICT TOTAL	**48288.67**	**42.99**	**4668.71**	**53000.39**	**5048.85**	**24939.43**	**67.67**	
47	**SIDHI**								
	Kusmi	1723.68	0.00	227.33	1951.01	246.81	6011.03	24.44	safe
	Majholi	1520.64	0.00	428.76	1949.40	465.49	3512.52	35.45	safe
	Rampur Naikin	1575.08	87.92	657.25	2320.27	713.55	4499.65	33.74	safe
	Sidhi	2061.29	0.34	838.43	2900.05	910.25	1312.22	67.69	safe
	Sihawal	671.72	0.00	756.61	1428.32	821.42	3078.66	31.24	safe
	DISTRICT TOTAL	**7552.41**	**88.26**	**2908.38**	**10549.05**	**3157.52**	**18414.08**	**36.11**	
48	**SINGRAULI**								
	Chitrangi	1744.20	622.00	1010.76	3376.97	1118.73	4606.24	41.74	safe
	Deosar	2747.25	150.54	931.34	3829.13	1035.43	8338.24	31.20	safe
	Waidhan	4488.31	1447.15	715.19	6650.67	791.59	8367.44	44.06	safe
	DISTRICT TOTAL	**8979.76**	**2219.69**	**2657.30**	**13856.77**	**2945.75**	**21311.92**	**39.08**	
49	**TIKAMGARH**								
	Baldeogarh	5778.65	0.00	579.69	6358.33	703.73	2069.71	74.35	semi_critical
	Jatara	8723.26	0.00	830.15	9553.40	956.48	1247.28	87.43	semi_critical
	Palera	4747.60	0.00	794.29	5541.90	922.50	1095.86	81.91	semi_critical

Surface Water

The general slope of the area is towards North east. The entire district drained by the above mentioned 3 major rivers and their tributaries for us the Ganges drainage System. The pattern of drainage is dendritic in hectare excepting the localized radial pattern in the hilly terrain.

(i) **Description of aquifer:**

The aquifers in Singrauli district, located in northeastern Madhya Pradesh, primarily consist of unconfined shallow aquifers formed from alluvial deposits at depths of less than 50 meters. These aquifers are crucial for the region, which has significant industrial activities, including coal mining and power generation. Groundwater quality is a concern due to contamination from heavy metals and nitrates resulting from these activities and agricultural runoff. Regular monitoring of water quality parameters like pH, TDS, and conductivity is essential to assess safety for drinking and irrigation. Sustainable management practices, including community awareness and regulatory measures, are necessary to protect and preserve these vital water resources.

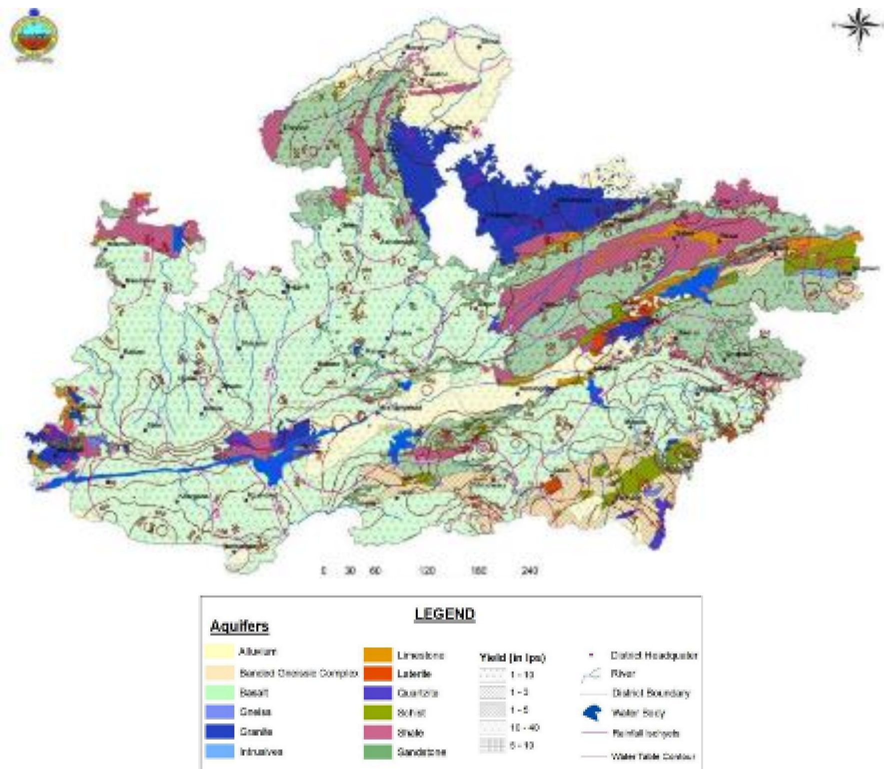


Figure: Hydrogeology Map, Madhya Pradesh

(ii) **Unconfined Aquifers:**

Unconfined aquifers in Singrauli district, Madhya Pradesh, are primarily composed of alluvial sediments and are located at shallow depths of less than 50 meters. These aquifers recharge through rainfall and surface water infiltration but are highly susceptible to fluctuations in the water table due to seasonal changes and industrial extraction. Water quality is a significant concern, as contaminants like heavy metals from industrial activities and nitrates from agricultural runoff can compromise safety for drinking and irrigation. Sustainable management practices, including regular monitoring and community education, are essential to protect and preserve these vital groundwater resources amid ongoing industrial pressures.

(iii) any special quality problem, (Seawater intrusion, pollution, high fluoride etc.).

As of the latest reports from the Central Ground Water Board (CGWB), Singrauli District in Madhya Pradesh faces several water quality issues, including:

- **Heavy Metal Contamination:** Heavy metal contamination in groundwater is primarily due to industrial activities such as mining and power generation, where harmful metals like lead, cadmium, arsenic, and mercury can leach into the water supply. Prolonged exposure to these contaminants poses significant health risks, including neurological disorders and increased cancer susceptibility.
- **High Nitrate Levels:** Elevated nitrate levels are largely attributed to the overuse of nitrogen-based fertilizers in agriculture, leading to runoff that carries nitrates into groundwater. High concentrations of nitrates in drinking water can cause methemoglobinemia, especially in infants, and contribute to environmental issues like harmful algal blooms in nearby water bodies.
- **Elevated Fluoride Concentrations:** Fluoride can naturally occur in groundwater, but industrial discharges and agricultural practices can increase its levels significantly. While fluoride is beneficial for dental health in small amounts, excessive exposure can result in dental and skeletal fluorosis, leading to serious health complications such as pain and mobility issues.
- **Industrial Pollution:** The presence of numerous industrial facilities in Singrauli contributes to groundwater pollution through the discharge of untreated or inadequately treated wastewater. This pollution not only introduces harmful contaminants into groundwater but also disrupts the natural ecosystem, potentially leading to long-term environmental damage.
- **Over-Extraction of Groundwater:** The rising demand for groundwater, driven by population growth and agricultural and industrial activities, has resulted in significant over-extraction of this vital resource. This overuse leads to declining water tables, which heightens the risk of contamination as pollutants can more easily infiltrate groundwater supplies.

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

Dynamic Ground Water Resource of Madhya Pradesh - 2023

S N	Assessment Unit	Recharge from Canals (in Ham)	Recharge from Surface Water Irrigation (in Ham)	Recharge from Ground Water Irrigation (in Ham)	Recharge due to Tanks and Ponds (in Ham)	Recharge due to Water Conservation Structures (in Ham)	Recharge due to Pipelines (in Ham)	Total Recharge from Other Sources (in Ham)
	Shivpuri	82.75	224.64	1480.65	227.68	73.694	0	2089.41
	DISTRICT TOTAL	**1941.44**	**2851.83**	**12072.17**	**1377.97**	**642.496**	**0**	**18885.91**
47	**SIDHI**							
	Kusmi	0	0	430.92	22.58	56.308	0	509.81
	Majholi	0	0	380.16	14.53	67.202	0	461.89
	Rampur Naikin	540.54	23.96	393.77	72.06	60.9	0	1091.23
	Sidhi	69.65	23.96	515.33	145.3	74.61	0	828.85
	Sihawal	398.46	23.96	167.93	85.51	68.882	0	744.74
	DISTRICT TOTAL	**1008.65**	**71.88**	**1888.11**	**339.98**	**327.902**	**0**	**3636.52**
48	**SINGRAULI**							
	Chitrangi	0	0	436.05	107.27	142.86	0	686.18
	Deosar	45.36	41.94	686.81	45.32	151.132	0	970.56
	Waidhan	75.41	96.35	1122.08	203.19	204.33	0	1701.36
	DISTRICT TOTAL	**120.77**	**138.29**	**2244.94**	**355.78**	**498.322**	**0**	**3358.10**

A.7. Alternate methods

DYNAMIC GROUND WATER RESOURCES OF MADHYA PRADESH, 2023

AT A GLANCE

1. Total Annual Ground Water Recharge (BCM)	: 35.47
2. Annual Extractable Ground Water Resource (BCM)	: 32.85
3. Annual Ground Water Extraction (BCM)	: 19.30
4. Stage of Ground Water Extraction (%)	: 58.75

CATEGORISATION OF ASSESSMENT UNITS

(Blocks/ Urban Areas)

S. N.	Category	Assessment Units		Annual Extractable Ground Water Resource		Recharge Worthy Area	
		Number	%	MCM	%	Sq KM	%
1	Safe	226	71.29	22773	69.32	190726	70.81
2	Semi-Critical	60	18.93	6120	18.63	51804	19.23
3	Critical	5	1.58	537	1.63	4249	1.58
4	Over-Exploited	26	8.20	3424	10.42	22555	8.37
5	Saline	0	0	0	0	0	0
	Total	**317**		**32854**		**269334**	

Dynamic Ground Water Resource of Madhya Pradesh - 2023

S.N.	Assessment Unit	Recharge from Rainfall-Monsoon Season (Ham)	Recharge from Other Sources-Monsoon Season (Ham)	Recharge from Rainfall-Non Monsoon Season (Ham)	Recharge from Other Sources- Non Monsoon Season (Ham)	Total Annual Ground Water Recharge (Ham)	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)
	Deosar	11946.75	246.05	0	724.52	12917.32	645.86	12271.46
	Waidhan	14187.6	380.24	0	1321.12	15888.96	794.45	15094.51

Most of the groundwater recharge techniques, including tubewell recharging, percolation pits and rooftop-water harvesting techniques have been known to restore groundwater levels in the state.

For the Singrauli District, water management methods need to be tailored to local conditions such as topography, rainfall, hydrogeology, and land source water availability. Current methods are likely chosen based on these factors, with a focus on sustainability and feasibility. For high rainfall areas, rainwater harvesting and check dams are effective, while recharge pits and watershed management are beneficial for addressing groundwater depletion. In coastal regions facing saline intrusion, desalination and coastal aquifer management can be alternative solutions. A comprehensive approach considering these methods can enhance water resource management in Singrauli.

Table: Water Management Methods for Singrauli District

Condition	Recommended Methods	Rationale
High Rainfall Areas	-Rainwater Harvesting - Check Dams	Captures and stores excess rainfall for dry periods.
Groundwater Depletion	-Recharge Pits - Watershed Management	Enhances groundwater recharge and manages resources holistically.
Coastal Areas with Saline Intrusion	-Desalination -Coastal Aquifer Management	Mitigates the impact of saline water on freshwater resources.

https://www.cgwb.gov.in/old_website/District_Profile/MP/Singrauli.pdf

The Dewas Model is also known for groundwater recharge in MP. Villages in MP, once living a parched reality, are now lined with pucca roads and thousands of tube wells, all thanks to the Dewas groundwater recharge model. Now there are more than 16,000 ponds spread across 60-80 acres of land in Dewas, MP.

Dynamic Ground Water Resource of Madhya Pradesh - 2023

Assessment Unit	Total Geographical Area (ha)				
	Recharge Worthy Area (ha)			Hilly Area	Total
	Command Area	Non Command Area	Total		
SINGRAULI					
CHITRANGI	0	171250	171250	23350	194600
DEOSAR	2150	137960	140110	42090	182200
WAIDHAN	4452	135448	139900	50500	190400
DISTRICT TOTAL	**6602**	**444658**	**451260**	**115940**	**567200**

A.8. Design Specifications

Trimula Industries Limited has developed and constructed a series of six interconnected ponds in sequential order, demonstrating strategic water management expertise. Pond No. 01 is a large-scale facility, measuring 125m x 115m x 6m, with a capacity of 86.25 million liters. It is followed by Pond No. 02, a medium-scale structure with dimensions of 100m x 75m x 6m, capable of holding 45 million liters. Pond No. 03 is constructed at 175m x 85m x 6m, containing 89.25 million liters. The largest installation, Pond No. 04, stands out with measurements of 199m x 104m x 9m, offering an impressive capacity of 186.26 million liters. Pond No. 05 is the smallest in the sequence, with dimensions of 34m x 28m x 5m and a capacity of 4.76 million liters. The series concludes with Pond No. 06, a deep storage facility measuring 113m x 60m x 9m, holding 61.02 million liters. This comprehensive pond system, engineered by Trimula Industries Limited, showcases their expertise in large-scale water management solutions with varying pond depths from 5 to 9 meters and a total combined capacity of 472.54 million liters.

Figure : PP's Pond Layout

The PP has also implemented phased developments to reduce reliance on groundwater by capturing and utilizing rainwater for manufacturing processes. The six ponds are connected to the facility's power plants via 100 mm diameter underground pipelines, ensuring a continuous supply of reasonably good-quality water for operational needs. The unlined pond beds allow water to seep into the ground, positively contributing to the rise of the local water table.

Overall water consumption across all six ponds amounts to 900 KLD, with the power plant consuming between 400 and 420 KLD (using a pump flow rate of 35,000 LPH for 12 hours). The DRI plant uses 250 KLD from a 600,000 L overhead tank operating for approximately 6 hours at a flow rate of 40,000 L/h, while the steel melting shop consumes 250 KLD from a 1,200,000 L overhead tank operating for about 5 hours at a flow rate of 48,000 L/h. This strategy not only highlights the significance of rainwater harvesting but also underscores the PP's commitment to operational efficiency and environmental sustainability.

Even though the data on the field studies for computing recharge from Water Conservation Structures are very limited, it is recommended that the Recharge from the water conservation structures is 40% of the Gross Storage based on the field studies by Non-Government Organizations. Hence, the norm recommended by GEC-2015 for the seepage from Water Conservation Structures is 40% of gross storage during a year which means 20% during monsoon season and 20% during non- monsoon Season.

A.9. Implementation Benefits to Water Security

The PP, a structural steel manufacturer with integrated facilities, has successfully implemented a dedicated rainwater harvesting system by constructing a series of catchment ponds on its premises. This initiative not only mitigates operational challenges related to water scarcity but also provides numerous benefits across various activities within the facility:

- **Cooling for DRI Finished Material**: The harvested rainwater is effectively utilized to cool Direct Reduced Iron (DRI) finished materials, ensuring optimal temperature during production processes, which enhances product quality and energy efficiency.
- **Cleaning**: Pond water serves as a resource for cleaning various surfaces and equipment within the facility, maintaining hygiene and operational efficiency while reducing water costs associated with external sources.
- **Dust Suppression**: The water from the ponds is employed for dust suppression, helping to minimize airborne particulate matter. This practice not only improves air quality within the facility but also contributes to a safer working environment for employees.
- **Coal Fire Management**: During the summer season, pond water is used to extinguish coal fires, significantly enhancing safety and operational stability by reducing the risk of fire-related incidents.
- **DM Water for Power Plant**: After proper treatment, the pond water can be converted into Demineralized (DM) water, which is crucial for the efficient operation of the power plant, ensuring optimal performance and reducing the need for additional water sourcing.
- **Firefighting and Temperature Control**: The pond water is also readily available for firefighting efforts, providing an essential resource for emergency response. Additionally, it can be used for temperature control in various processes, adding an extra layer of safety to facility operations.

- **Sustainability and Resource Conservation**: By utilizing harvested rainwater, PP reduces its reliance on groundwater resources, contributing to sustainable water management practices and conserving valuable natural resources.
- **Operational Resilience**: The availability of pond water enhances the facility's resilience against seasonal water shortages, ensuring continuous operations in cooling, power generation, and *steel manufacturing.*

A9.1 Objectives vs Outcomes

Objectives of the Project Activity:

Objective	Explanation
Enhance Water Security	Implementing a rainwater harvesting and pond water management system increases the accessibility of water for local communities, ensuring consistent access to this essential resource.
Boost Agricultural Productivity	Elevating underground water levels facilitates improved irrigation techniques, resulting in higher crop yields and benefiting farming communities reliant on water resources.
Improve Socioeconomic Status	Increasing water availability bolsters local farmers' livelihoods, leading to enhanced agricultural output and greater income for those who depend on farming for their income.
Implement Dust Control Measures	Applying harvested pond water for dust suppression on nearby roads enhances air quality, alleviating respiratory problems for residents and reducing environmental degradation.
Promote Local Greenery	Offering a sustainable irrigation source for local flora boosts biodiversity, fostering a greener environment and enhancing the aesthetic and ecological value of the community.
Reduce Pollution	Supporting vegetation growth decreases the need for mowing, which lowers emissions and noise, contributing to a healthier ecosystem and improving the overall quality of life for residents.
Foster Sustainable Development	Integrating sustainable practices into industrial operations ensures that PP' activities positively impact both the environment and local communities, showcasing responsible corporate behavior.

Outcome of the Post-Project Activities:

Outcome	Definition
Improved Water Access	Increased availability of water resources for local communities, ensuring consistent access for both domestic and agricultural needs, thereby mitigating water scarcity issues.
Higher Agricultural Yields	Enhanced crop production resulting from improved irrigation practices, leading to greater food security and economic stability for farming communities.
Increased Farmer Income	Boosted income levels for local farmers due to higher agricultural output, contributing to better living standards and improved quality of life within the community.
Enhanced Air Quality	Improved environmental conditions due to effective dust suppression measures, resulting in reduced respiratory issues and a healthier living environment for residents.
Increased Biodiversity	Promotion of diverse plant and animal life in the area, contributing to a healthier ecosystem and enhancing the ecological balance within the community.
Reduced Emissions and Noise	Decreased pollution levels from reduced mowing activities and increased vegetation, leading to a cleaner environment and improved overall quality of life for residents.
Positive Community Relations	Strengthened relationships between PP and the local community through responsible practices and engagement, fostering a sense of trust and collaboration.
Sustainable Industrial Practices	Adoption of environmentally friendly practices within the industrial operations of PP, demonstrating a commitment to long-term sustainability and ecological stewardship.

Conclusion:

The project activity by the PP has significantly enhanced water security and agricultural productivity in the local community. By increasing water availability, the initiative has improved farmers' livelihoods, leading to higher crop yields and incomes. Additionally, the use of harvested pond water for dust suppression has enhanced air quality and public health. The project has also promoted biodiversity and reduced pollution, contributing to a greener environment and better quality of life. Overall, these outcomes demonstrate PP' commitment to sustainable practices and responsible corporate behavior, fostering positive relationships with the community and creating lasting environmental and socio-economic benefits.

A9.2 Interventions by Project Owner / Proponent / Seller

PP has undertaken several strategic interventions to enhance sustainability and resource management. The company constructed six interconnected rainwater harvesting ponds with a total capacity of 472.54 million liters, reducing reliance on groundwater while also recharging the local water table through unlined pond beds. Energy efficiency initiatives include utilizing byproducts from steel production for power generation and recovering waste heat for additional energy. The company prioritizes community engagement by employing 60% of its workforce from local villages and allocating 2% of its profits to CSR activities, focusing on education, healthcare, and infrastructure development. Additionally, PP ensures environmental compliance through continuous monitoring of air, water, and noise levels to minimize its ecological impact.

A.10. Feasibility Evaluation

The feasibility evaluation of PPs rainwater harvesting and pond water management system reveals a strong alignment of technical, economic, environmental, and social factors that support the project's success. The existing infrastructure of six interconnected ponds demonstrates solid technical foundations, while effective water management practices, including unlined pond beds for groundwater recharge and underground pipelines, ensure sustainability and resilience against water shortages. Economically, the initial investment is likely to be offset by reduced operational costs and increased local economic activity due to enhanced agricultural productivity and farmer incomes. Environmentally, the project promotes biodiversity, improves air quality, and complies with regulatory standards, contributing to a healthier ecosystem. Socially, the initiative enhances water security and livelihoods for local farmers, fostering positive relationships with the community and improving public health outcomes. While operational and financial risks exist, effective management strategies can mitigate these challenges. Overall, the project presents a viable opportunity to create lasting benefits for both PP and the surrounding community, ensuring sustainable water management and socio-economic improvements in the region.

A.11. Ecological Aspects & Sustainable Development Goals (SDGs):

The ecological aspects of the project activity highlight its significant positive impact on the environment. By establishing interconnected ponds, the initiative fosters biodiversity by creating diverse habitats that support various plant and animal species. The unlined pond beds facilitate natural groundwater recharge, ensuring a sustainable water supply for surrounding ecosystems. Utilizing harvested rainwater for dust suppression and irrigation reduces pollution and enhances soil health, leading to improved agricultural practices. Furthermore, increased vegetation growth contributes to better air quality and enhances carbon sequestration, bolstering climate resilience in the region.

Overall, this initiative not only supports vital ecosystem services but also underscores PPs commitment to ecological stewardship and the well-being of the local community.

The pond groundwater recharge activities of PP in Singrauli, Madhya Pradesh, align with sustainability goals.

Sustainable Development Goal (SDG)	***Compliance Activities***
SDG 2: Zero Hunger	By improving agricultural productivity through better irrigation, the project supports food security for local farmers and enhances crop yields, addressing hunger and malnutrition.
SDG 3: Good Health and Well-being	Improved air quality from dust suppression measures enhances public health outcomes for nearby residents, reducing respiratory issues and promoting overall well-being.
SDG 6: Clean Water and Sanitation	The pond system enhances water security by collecting and storing rainwater, improving accessibility to clean water for local communities, and promoting sustainable water management practices.
SDG 8: Decent Work and Economic Growth	The project creates economic opportunities for local farmers by improving their livelihoods through enhanced agricultural productivity, contributing to inclusive economic growth.

SDG 12: Responsible Consumption and Production	The use of harvested rainwater for various operational needs reduces dependence on groundwater and promotes efficient water use in industrial processes.
SDG 13: Climate Action	The project contributes to climate resilience by improving groundwater levels and promoting sustainable land use practices, which help mitigate the impacts of climate change, such as droughts.
SDG 15: Life on Land	The ponds create diverse ecosystems, enhancing local biodiversity and providing habitats for various species, thus contributing to the conservation of terrestrial ecosystems.
SDG 17: Partnerships for the Goals	Engaging with local communities and stakeholders fosters collaboration, strengthening partnerships that are essential for achieving sustainable development.

Conclusion

Trimula Industries Limited's Pond activities align with multiple Sustainable Development Goals, reflecting a commitment to environmental sustainability, social responsibility, and economic development. By promoting clean water access, enhancing biodiversity, supporting agricultural productivity, and improving public health, these initiatives contribute to a holistic approach to sustainable development in the region.

A.12. Recharge Aspects :

A.12.1 Solving for Recharge

Ultimately, the volume of groundwater recharge benefit to the subbasin is the most critical aspect for such MAR activities. Groundwater recharge is quantified as the deep percolation of surface water applied during project implementation. Using a field-scale water budget, deep percolation can be calculated as the difference between all other inflows and outflows, per the equation below, with each other inflow and outflow being quantified:

Recharge = Rainfall + Surface Inflow – Evapotranspiration – Surface Outflow – Change in Storage

Evapotranspiration & Other Data: https://datameet-pune.github.io/open-water-data/docs/open-water-data-paper.pdf (or available under Documents Section- Water Data Guide)

Root Zone = The root zone is comprised of the upper portion of the soil where water extraction by roots occurs, above the depth at which water infiltrates to the groundwater system. The depth to the bottom of the root zone varies by crop, but typically extends up to seven feet.

Surface Inflow= Surface inflows can be either directly measured or calculated from measured values. In fields directly served by metered lift pumps or metered gates, the volume of surface inflows to the field can be directly measured or calculated from totalized measurements. Typical accuracies of pipe flow measurements range from 1-12 percent. In fields that are indirectly supplied with surface water, surface inflows may need to be calculated from upstream and downstream flow measurements, or through theoretical or empirical equations relating available data to field surface inflows. For example, fields served from canals measured using weirs, or fields served from canals that deliver water to multiple locations downstream of a measurement device may require site-specific calculations to quantify surface inflows to a specific field. Low-cost in-field measurements can also be made by setting up flashboards at the measurement location and correlating the “runup” of an unsubmerged weir overflow on a flat weir stick to the flow rate using standardized equations. Typical accuracies of “runup” or indirect flow measurements may exceed 10 percent, depending on site conditions and the accuracy of measurement data.

To monitor surface inflows, project owners may record flow data, maintain irrigation logs, and maintain logs of any other parameters required to calculate field deliveries, depending on the unique conditions of their field. Project owners may also consider using mobile flow monitoring equipment to measure or verify surface inflows.

Surface Outflows: To monitor surface outflows, users may record flow data or water level data and maintain logs of any other parameters required to calculate outflows, depending on the unique conditions of their project activity. Pressure transducers and dataloggers may be used to automatically monitor water levels, or users may install wooden stakes to manually monitor water depths.

Change in Storage = The change in surface storage, or average ponded water depth, can be calculated from measured and observed changes in water surface levels at points throughout the project field. Over the annual project implementation period, **<u>the total change in surface storage is typically zero</u>**, provided that the surface of a field is dry and free of ponded water at the start and end of the project.

While the uncertainty of each inflow and outflow will vary based on field conditions and measurement devices, typical uncertainties associated with each water budget component are summarized in the table below. The uncertainty of deep percolation (i.e., recharge) can then be calculated from these other uncertainties, for example following the process described by Clemmens and Burt (1997). Users can use the following table to eliminate uncertainty from their estimates.

Water Budget Component	**Typical Estimated Uncertainty (%)**	**Description**
Surface Inflow	5%	Typical range of accuracy from meters to minimum delivery accuracy requirements of delivery and diversion measurement devices.
Precipitation	2%	Typical range of accuracy from field-level rain gauges to extrapolation of local weather station data
Surface Outflow	5%	Typical range of accuracy from meters to estimated outflow relationships
Evapotranspiration	10.00%	Clemmens and Burt, 1997; typical accuracy based on free water surface evaporation coefficient.
Deep Percolation	2%	Typical range of calculated accuracy from field-scale water budget results (fields ranging from 56 to 125 acres)
Total	**24%**	

A.13. Quantification Tools

The baseline scenario is the situation where, in the absence of the project activity, unutilized rainwater flows uncollected into drains or is not conserved and harvested within the project boundary and hence remains unutilized. Baseline scenario, if not directly measurable, is calculated by using the UWR Standard. The PP has selected the following method from UWR standard

Harvesting potential or Volume of water utilized (liters) = Area of Catchment/Roof/Collection Zone (m^2) X Amount of rainfall (mm) X Runoff coefficient*uncertainty Factor (1-0.24= 0.76)

As per UCR Standard

Surface area	Runoff Coefficient (K)
Ground Surface Covering Soil and Slope less than 10%	0.3

Area of Catchment:

Annual Rainwater harvesting Potential

Annual rainwater harvesting potential is given by V = K × I× A

Where, V=Volume of water that can be harvested annually in liters.

K = Runoff coefficient

I = Annual rainfall in (mm)

A = Catchment area in (m^2)

Quantification of RoUs:

Year	Crediting Period	RoUs (1000 Liters)/Year						
		Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6	Total
2014	01/01/2014-31/12/2014	2288	1194	2368	3295	151	1079	**10375**
2015	01/01/2015-31/12/2015	2620	1367	2711	3773	173	1236	**11880**
2016	01/01/2016-31/12/2016	4255	2220	4403	6126	281	2006	**19291**
2017	01/01/2017-31/12/2017	2841	1482	2940	4090	188	1340	**12881**
2018	01/01/2018-31/12/2018	3275	1708	3389	4715	216	1544	**14847**
2019	01/01/2019-31/12/2019	4572	2385	4731	6582	302	2156	**20728**
2020	01/01/2020-31/12/2020	4244	2214	4391	6110	281	2001	**19241**
2021	01/01/2021-31/12/2021	4721	2463	4885	6797	312	2226	**21404**
2022	01/01/2022-31/12/2022	3077	1605	3184	4430	203	1451	**13950**
2023	01/01/2023-31/12/2023	4721	2463	4885	6797	312	2226	**21404**
Total		**36614**	**19101**	**37887**	**52715**	**2419**	**17265**	**166001**

A.14. UWR Rainwater Offset Do No Net Harm Principles

The project activities undertaken by the PP effectively address critical water management goals in Gondwali, Tehsil Deosar, District Singrauli, Madhya Pradesh. Below is a detailed description of how these activities accomplish the specified objectives:

1. Increase Sustainable Water Yield in Areas Where Over-Development Has Depleted the Aquifer

PP has constructed six (6) catchment ponds as part of its rainwater harvesting system, significantly increasing sustainable water yield in an area where over-extraction has depleted local aquifers. With a total storage capacity of **472,544 cubic meters**, these ponds capture rainwater during monsoon seasons, helping to recharge groundwater levels and ensuring a reliable water supply for both industrial operations and local communities.

2. Collect Unutilized Water or Rainwater from Going into Storm Drains or Sewers

The rainwater harvesting system effectively collects unutilized rainwater that would otherwise flow into storm drains or sewers. By directing runoff into the constructed ponds—Pond 1 (Storage capacity 86,250 m^3), Pond 2 (45,000 m^3), Pond 3 (89,250 m^3), Pond 4 (186,264 m^3), Pond 5 (4,760 m^3), and Pond 6 (61,020 m^3)—the project maximizes water conservation and reduces pollution associated with stormwater runoff.

3. Conserve and Store Excess Water for Future Use

The catchment ponds serve as reservoirs that conserve and store excess rainwater for future use. With an overall consumption of **920 KLD** drawn from these ponds, the PP ensures a reliable water supply for various operational needs such as cooling processes in the DRI plant and steel melting shop. This stored water is critical during dry periods when other sources may be insufficient.

4. Enhance Local Women's Participation and Professional Development

While specific programs for women's participation are still developing, PP recognizes the importance of involving local women in water management initiatives. Efforts are being made to provide training opportunities that empower women with skills related to water conservation and management.

A.15. Scaling Projects-Lessons Learned-Restarting Projects

The water crisis in Madhya Pradesh's Vindhya region is reaching alarming levels, particularly affecting Gondwali in Tehsil Deosar. The local administration has officially declared the area a "water-scarce" zone, as the Tamas River, a vital water source for many communities, has nearly dried up. Reports indicate that groundwater levels have significantly declined, leading to acute shortages for residents in nearby Maihar and Satna districts.

Local residents have expressed their frustration over the inadequate water supply. Many villages rely on government hand pumps, but most have become ineffective due to over-extraction and insufficient rainfall. In some areas, households receive only a few cans of water per day from tankers, making it nearly impossible to meet basic needs. For example, one resident noted that while they previously faced only one day without water last year, this year they have gone 15 days without any supply. The District Collector has initiated comprehensive testing of local water sources to explore alternative supply options and address these shortages. However, the situation remains dire for both rural and urban communities, highlighting the urgent need for sustainable water management solutions in the region.

To effectively scale projects like those undertaken by PP, it's essential to integrate existing practices and identify areas of duplication that can enhance water and urban management. The following outlines key strategies for scaling such initiatives:

PP is playing a pivotal role in addressing some of the water scarcity challenges faced by Gondwali and its surrounding areas. The company has implemented several initiatives that not only support its operations but also contribute positively to local water management:

1. **Rainwater Harvesting Systems**: PP has constructed multiple catchment ponds to collect and store rainwater. This initiative helps replenish groundwater levels and provides an additional water source for both industrial and community use during dry spells.

2. **Community Engagement**: By involving local communities in the maintenance of these rainwater harvesting systems, PP fosters a sense of ownership among residents, ensuring that these resources are managed sustainably. Educational programs on effective water use and conservation practices empower locals to adopt similar strategies at home.

3. **Job Creation and Economic Development**: The expansion of PP's operations leads to job creation in the region. As new facilities are developed, there is an increased demand for local labor, which contributes to economic upliftment in the area.

4. **Infrastructure Improvements**: The presence of PP encourages improvements in local infrastructure, including better roads and utilities that benefit both the company and the community. This development can enhance access to essential services such as healthcare and education.

5. **Model for Replication**: The successful implementation of sustainable practices by PP serves as a model that can be replicated in other parts of Madhya Pradesh facing similar challenges. By demonstrating effective rainwater harvesting and community involvement strategies, other industries can adopt these methods to alleviate water scarcity issues.

By implementing these strategies, projects like those at PP not only enhance operational efficiency but also contribute significantly to alleviating the water scarcity challenges faced by communities in Gondwali and surrounding areas. Such initiatives are crucial for promoting sustainable urban management practices that prioritize environmental health and community welfare while providing a template for future projects aimed at addressing water crises across Madhya Pradesh.

The information regarding the ongoing water crisis in Madhya Pradesh's Vindhya region was sourced from The Mooknayak.

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