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Groundwater Drilling in the Deccan Plateau: A Three-Year Analytical Study of Trends, Depths, and Performance in Telangana and Andhra Pradesh (2022–2024)

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Highlights:
- Groundwater drilling doubled in Telangana from 2022 to 2024
- Andhra Pradesh saw 282% rise in drilling depth from 2022 to 2023
- Revathi T60H rig showed high efficiency across different terrains

Abstract: This study analyzes groundwater drilling activities in Telangana and Andhra Pradesh from 2022 to 2024 using monthly data. Telangana showed substantial growth, with the number of wells drilled increasing from 109 in 2022 to 261 in 2023 (139.45% growth) and further to 565 in 2024 (116.48% growth), while total drilling depth grew from 2605.35 meters to 8502.55 meters (226.35% growth) and then to 13020.73 meters (53.14% growth), with indications of seasonal variations. In contrast, Andhra Pradesh also saw significant growth, with wells drilled increasing from 231 in 2022 to 453 in 2023 (96.10% growth) and further to 901 in 2024 (98.89% growth), while total drilling depth increased from 3558.90 meters to 13587.40 meters (281.76% growth) and then to 22699.50 meters (67.06% growth), followed by additional year-on-year growth. These distinct growth trajectories, characterized by varying magnitudes of change, highlight the dynamic nature of groundwater extraction across the two states, providing crucial information for regional water management strategies.
Keywords: Rotary Drilling, DTH, Groundwater Extraction, Drilling Wells, Telangana, Andhra Pradesh

I. INTRODUCTION

Groundwater extraction in semi-arid regions like the Deccan Plateau, encompassing Telangana and Andhra Pradesh, relies heavily on efficient drilling technologies. This research analyzes the trends in groundwater drilling activities within these states from 2022 to 2024, utilizing official monthly data on well numbers and drilling depths to understand resource exploitation patterns. The effectiveness of these operations is intrinsically linked to the drilling methodologies and equipment employed. Rotary drilling, suitable for unconsolidated to medium-hard formations, utilizes drill strings typically ranging from 3 to 12 inches in diameter, driven by top-head or rotary table mechanisms with varying torque capacities. The choice of rotary drill bits, such as tricone bits with tungsten carbide inserts for harder formations or drag bits for softer materials, depends on the geological strata. For the prevalent hard rock formations, down-the-hole (DTH) hammer drilling is common. DTH hammer bits, ranging from 4 to over 12 inches in diameter, are powered by high-pressure compressor units delivering air volumes typically between 500 to 1500 CFM (cubic feet per minute) at pressures of 150 to 350 PSI (pounds per square inch), optimizing percussive fracturing. The compressor's working principle often involves positive displacement (e.g., reciprocating or screw types) to generate the required compressed air. The structural integrity of boreholes is maintained by drill rods, typically steel pipes with diameters matching the drill string, and casing pipes, often ranging from 4 to 10 inches in diameter depending on well design, joined on-site using welding units (e.g., arc welding) to ensure a continuous and stable well structure. While this paper primarily focuses on the quantitative analysis of drilling output, this introduction provides a technical context by outlining common drilling technologies and their general specifications, underscoring their influence on groundwater extraction efficiency. The subsequent sections will analyze the statistical trends in drilling activities, revealing regional disparities and temporal patterns of groundwater resource utilization.

Telangana, situated on the northern Deccan Plateau, primarily features ancient crystalline rocks such as granite, gneiss, and quartzite across much of its terrain, with occurrences of basaltic formations, particularly related to the Deccan Traps, found in areas like the northwestern districts including Adilabad, Nirmal, and parts of Nizamabad.

Andhra Pradesh, located on the eastern part of the plateau, also comprises similar Archaean crystalline rocks, dominant in its western and central regions, including areas like the Rayalaseema districts (Kurnool, Anantapur, Kadapa, Chittoor) and parts of the interior coastal districts. However, moving towards the east, particularly in the coastal districts encompassing regions like the Godavari and Krishna deltas (East Godavari, West Godavari, Krishna districts), and extending south along the coast (Guntur, Prakasam, SPSR Nellore districts), the geological composition transitions to sedimentary formations, including sandstones and shales belonging to the Gondwana and Kurnool systems.

This geological variation not only influences drilling equipment selection and operational strategy but also affects the success rate, cost, and sustainability of groundwater extraction in different districts. Understanding these dynamics is crucial for optimizing resource management and guiding future groundwater development policies.

II. METHODOLOGY

This study adopts a descriptive approach to delineate the typical operational sequence and technical considerations inherent in water well drilling utilizing the Revathi T60H rig. The methodology is structured based on the rig's technical specifications and established industry protocols. The subsequent steps outline a generalized process that may be adapted according to specific subsurface geological conditions and project demands.

A. Preliminary Site Assessment and Preparation

1) *Activity:* It is presupposed that a comprehensive geological and hydrogeological survey has been conducted before rig mobilization to pinpoint potential aquifer locations and understand subsurface stratigraphy. This initial phase guides the selection of appropriate drilling methodologies and anticipated drilling depths, within the rig's "Drilling Depth" capability of up to 200 meters (660 ft).
2) *Rig Relevance:* The "Mounting" configuration of the rig, available as either a single (6×4) or two (4×2) truck carrier, dictates the accessibility requirements of the intended drilling location. Adequate clearing and leveling of the site are essential to accommodate the rig's operational footprint and ensure stability, a process facilitated by the deployment of the "Leveling Jacks" (two at the rear, two at the front).

B. Rig Deployment and Operational Setup

1) *Activity:* The Revathi T60H rig is transported to the prepared drilling site. Accurate positioning over the planned borehole location is paramount. Subsequently, the "Leveling Jacks" are engaged to establish a stable and horizontal base for drilling operations, ensuring the vertical alignment of the borehole.
2) *Rig Relevance:* The truck-mounted design of the rig offers relative ease of transport. The stability provided by the leveling jacks is crucial for safe and precise drilling, particularly when utilizing the "Heavy Duty Structural Steel" mast.

C. Initial Borehole Drilling and Surface Casing (Conceptual)

1) *Activity:* Although the rig specifications do not explicitly detail surface casing procedures, it is a common practice in water well construction. An initial, larger diameter pilot borehole is typically drilled to a shallow depth through unconsolidated upper layers. Following this, a temporary or permanent surface casing is installed and often cemented to stabilize the upper borehole and prevent formation collapse. This initial drilling phase would utilize the "Rotary Head" with its "Torque" of 345 Kg.m (30,000 Lb. inch) and adjustable "Speed" ranging from 0 to 100 RPM, in conjunction with the "Feed System" providing controlled "Pull down" force of 4,530 Kgs (10,000 Lbs).

D. Main Drilling Operations

1) *Activity:* The Revathi T60H offers versatility with both Down-The-Hole (DTH) and Rotary drilling capabilities, allowing adaptation to varying subsurface conditions ("Hole Size (DTH / Rotary)" ranging from 152 to 203 mm / 6" to 8").
2) *DTH Drilling (Competent Formations):* High-pressure air generated by the "Air Compressor" ("Capacity" of 21 m3/min / 750 cfm and "Pressure" of 10/17 kg/cm2 / 150/250 psi) powers a downhole hammer that impacts and rotates the drill bit. Drill cuttings are removed from the borehole by the expelled compressed air.

3) *Rotary Drilling (Less Competent Formations):* The "Rotary Head" directly imparts rotational force to the drill bit. Drilling fluid, typically water supplied by the "Water Injection" system ("Capacity" of 30 LPM / 8 US CPM, driven by a hydraulic motor), is circulated to cool the drill bit and transport cuttings to the surface.
4) *Rig Relevance:* The "Twin hydraulic motors thru gearbox" of the rotary head facilitate efficient torque delivery. The "Single Hydraulic Cylinder with chain" feed mechanism ensures controlled downward pressure. Drill pipes with a "Length" of 6.10 meters (20 ft) and a "dia" of 114 mm (4 1/2″), managed by the "Single pipe" "Pipe Loader," are added sequentially to achieve the intended "Drilling Depth." The "Pull Up" capacity of 6,350 Kgs (14,000 Lbs) is essential for retracting the drill string.

E. Well Completion (Conceptual)

1) *Activity:* Upon reaching the targeted aquifer, well completion involves the installation of a well screen across the water-bearing zone and solid casing through impermeable layers to prevent contamination from other strata. A gravel pack may be placed around the screen to enhance filtration and well efficiency.
2) *Rig Relevance:* The rig's maximum drilling depth of 200 meters allows access to various potential aquifer depths. The availability of "Optional Equipment" such as a "Mud Pump" would be pertinent if more complex drilling fluid management and well development techniques are employed.

F. Well Development and Evaluation (Conceptual)

1) *Activity:* Following completion, the well requires development to remove fine sediments from the aquifer surrounding the screen and optimize water flow into the well. Common methods include surging, jetting, or pumping. Subsequently, the well's water yield and quality are assessed.
2) *Rig Relevance:* The rig's "Power Unit" ("Off (or) by a separate deck mounted Diesel Engine / Truck engine through Power Take Off") provides the necessary power to operate auxiliary equipment, such as pumps, during the development and testing phases (although a dedicated pump unit is typically utilized).

G. Rig Demobilization and Site Restoration

1) *Activity:* Once drilling and well completion activities are concluded, the Revathi T60H rig is dismantled, and all associated equipment is removed from the drilling site. The area is then restored to its original or a mutually agreed-upon condition.

H. Controls and Operational Considerations

The "Compact control console grouping the controls within easy reach of operator" is fundamental to the efficient and safe operation of the rig throughout these procedures. It enables the driller to manage critical drilling parameters, hydraulic systems, air compression, and other operational functions effectively.

This methodological framework elucidates the typical sequence of operations when utilizing the Revathi T60H rig for water well drilling, directly referencing its technical specifications and established industry practices relevant to this application. Further research could explore specific case studies, analyze the rig's performance under diverse geological conditions, and evaluate the efficiency of its various features.

Specification	Details	Values
Drilling Capacity	Hole Size (DTH/Rotary)	152 to 203mm (6” to 8”)
	Drilling Depth	660 ft (200mts)
Mounting	-	Single(6X4) or Two(4X2)
Mast	Construction	Heavy Duty Structural Steel
	Drill Pipe Length	6.10mts(20ft)
Feed	Feed System	Single Hydraulic Cylinder with Chain
	Pull Down	10,000 Lbs (4530 kg)
	Pull Up	14000 Lbs (6350 kg)
Rotary Head	System	Twin Hydraulic motors through gearbox
	Torque	30000 Lb inch (345 kg.m)
	Speed	0-100 RPM

Table 1. Drilling, Structural, and Mechanical Specifications

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Specification	Detail	Value
Air Compressor	Type	Single or two stage oil flooded Screw type
	Capacity	$21m^3$/min (750 cfm)
	Pressure	10/17 kg/cm^2 (150/250 psi)
Power Unit	Prime Mover	Off or by a separate desk mounted Diesel engine/ Truck Engine through Power take off
Levelling Jacks	Rear End	Two Nos.
	Front End	Two Nos.
Water Injection	Capacity	8 US CPM (30 LPM)
	Drive	Hyd Motor Driven
Drill Pipe Handling	Pipe Loader	Single Pipe
	Pipe Dia	4 ½ (114 mm)
	Pipe Length	20ft (6.10 mts)
Control		Compact control console
Optional equipment		Mud Pump, Hydraulic welder etc

Table 2. Power, Fluid, and Auxiliary Systems

Fig 1. Drilling Rig at CGWB Hyderabad DIV 9

III. FUTURE DIRECTIONS

As groundwater extraction continues to play a critical role in sustaining agriculture, industry, and domestic water supply in Telangana and Andhra Pradesh, future strategies must focus on integrating advanced drilling technologies with sustainable water management practices. The following directions are proposed to enhance the efficiency, equity, and resilience of groundwater resource development:

A. Adoption of Smart Drilling Technologies

The integration of advanced features such as drill rod automation, hammer opening setup, and remote-operated hammer choking systems marks a significant leap in drilling efficiency and safety. Moving forward, it is recommended to standardize these technologies across all operational rig units to ensure uniformity in performance. Further advancements could focus on integrating real-time telemetry and AI-based drilling diagnostics**.**

B. Geological Information System (GIS)-Based Planning

Developing a centralized GIS platform that consolidates geological, hydrogeological, and drilling data at the village or block level will allow for better planning and targeting of drilling operations. This can minimize redundant borewell drilling and encourage aquifer-specific groundwater development.

C. Customized Rig Design for Diverse Terrains

Given the stark geological contrasts—from hard crystalline formations to porous sedimentary layers—there is a need for modular rig systems that can be tailored for specific terrains. Rigs with interchangeable rotary and DTH configurations, variable torque settings, and adaptable feed systems would provide greater flexibility and efficiency.

D. Groundwater Recharge and Managed Aquifer Replenishment

Drilling activities should be complemented by initiatives focused on artificial recharge and aquifer restoration, particularly in overexploited zones. Monitoring the impacts of drilling through periodic assessments of groundwater levels and quality will help ensure long-term sustainability.

E. Policy Support and Training Programs

Government policies should incentivize sustainable drilling practices and mandate proper registration and monitoring of borewells. Additionally, capacity-building programs for drilling operators and groundwater professionals are essential to improve technical skills and ensure compliance with regulatory frameworks.

IV. CONCLUSION

The analysis of groundwater drilling activities in Telangana and Andhra Pradesh between 2022 and 2024 reveals a significant and sustained increase in both the number of wells drilled and the total drilling depth across both states.

A. Telangana

Demonstrated substantial year-on-year growth in well drilling. The number of wells more than doubled between 2022 and 2023 (139.45% increase) and continued to rise significantly between 2023 and 2024 (116.48% increase). Similarly, the total drilling depth in Telangana experienced a dramatic increase of 226.35% from 2022 to 2023, followed by a further increase of 53.14% from 2023 to 2024. This indicates a consistent and accelerating trend in groundwater extraction efforts within the state.

B. Andhra Pradesh

Also exhibited significant growth in groundwater drilling activities during the study period. The number of wells nearly doubled between 2022 and 2023 (96.10% increase) and continued to grow robustly between 2023 and 2024 (98.89% increase). The total drilling depth in Andhra Pradesh showed an even more pronounced initial increase of 281.76% from 2022 to 2023, followed by a further substantial increase of 67.06% from 2023 to 2024. This highlights a strong and persistent drive towards increased groundwater utilization in Andhra Pradesh.

C. Comparative Trends

While both states show a clear upward trend in groundwater drilling, the magnitude of the initial increase (2022-2023) in total drilling depth was notably higher in Andhra Pradesh compared to Telangana. However, Telangana demonstrated a higher percentage growth in the number of wells drilled during the same period. In the subsequent year (2023-2024), both states continued

D. Implications

These distinct growth trajectories in groundwater drilling activities across Telangana and Andhra Pradesh underscore the increasing reliance on groundwater resources in the region. The significant year-on-year increases in both the number of wells and the total drilling depth have important implications for regional water management strategies, potentially indicating increasing water demand, changes in agricultural practices, or responses to climatic variability. Further research is needed to explore the underlying drivers of these trends and their long-term sustainability.

Category	State	2022	2023	2024	YOY Growth 2022-2023(%)	YOY Growth 2023-2024(%)
Number of wells	Telangana	109	261	565	139.45	116.48
	Andra Pradesh	231	453	901	96.10	98.89
Total Drilling Depth	Telangana	2605.35	8502.55	13020.73	226.35	53.14
	Andra Pradesh	3558.90	13587.50	22699.50	281.76	67.06

Table 3. Drilling Comparison for two states

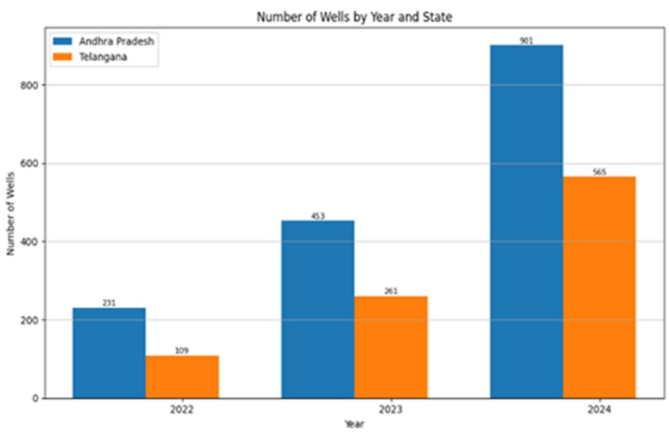

Fig 2(a). No of wells comparison

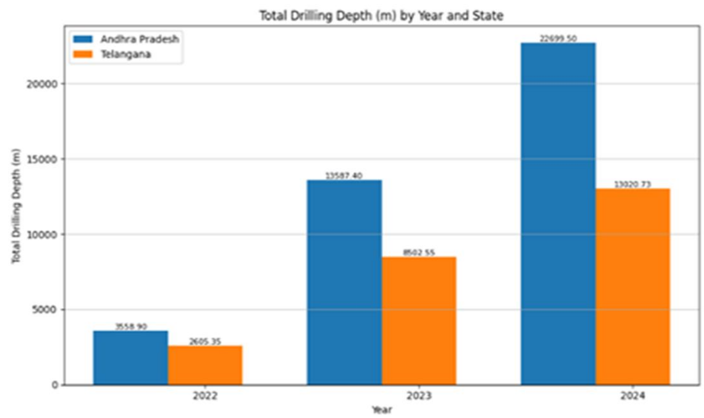

Fig 2(b). Drilling Depth Comparison

E. Cost Estimation Report

The Annual Action Plan (AAP) drilling budgets from 2022–23 to 2025–26 reflect evolving priorities and operational scaling in groundwater exploration across the region. In 2022–23, the total estimated cost was ₹371.89 lakhs, supporting the drilling of 85 wells. This year recorded the highest number of wells, with all five rigs actively engaged and a balanced distribution of Exploratory Wells (EW), Observation Wells (OW), and Piezometers (PZ). In 2023–24, the budget slightly declined to ₹336.62 lakhs, covering 76 wells. This year was characterized by uniform deployment across Rigs I, II, III, and V, each allocated 14 wells, reflecting operational consistency and optimization of costs.

The 2024–25 plan saw a further drop in estimated expenditure to ₹270.64 lakhs, the lowest in the four-year span. With only 60 wells planned, the reduction in drilling activity likely indicates either site saturation or a temporary scale-down in operations. Despite this, core rigs continued functioning steadily, with Rig IV retaining its full PZ program of 20 wells. Looking ahead, 2025–26 marks a significant strategic expansion, with the highest projected budget of ₹397.31 lakhs. A major part of this cost is driven by the introduction of a new rig unit (MMR-2025) under Rig I, which alone accounts for ₹163.02 lakhs for 26 wells. Rig II also receives a high allocation of ₹151.20 lakhs for 28 wells.

Sl. No.	Rig Unit	EW	OW	PZ	Total Wells	Total Cost
1	DTH/RMT-77/54	6	3	6	15	75,45,000
2	DTH/LMP-87/80	6	3	6	15	69,44,000
3	DTH/RECP-88/92	6	3	6	15	74,05,000
4	DTH/KLR-12/121	-	-	25	25	71,04,000
5	DTH/DEL-15/129	10	3	2	15	81,91,000
6	Total	28	12	45	85	3,71,89,000

Table 4(a). Expenditure and Estimated well counts 2022-23

Sl. No.	Rig Unit	EW	OW	PZ	Total Wells	Total Cost
1	DTH/RMT-77/54	7	3	4	14	72,13,000
2	DTH/LMP-87/80	7	3	4	14	65,29,000
3	DTH/RECP-88/92	7	3	4	14	72,90,000
4	DTH/KLR-12/121	-	-	20	20	56,51,000
5	DTH/DEL-15/129	7	3	4	14	69,79,000
6	Total	28	12	36	76	3,36,62,000

Table 4(b). Expenditure and Estimated well counts 2023-24

Sl. No.	Rig Unit	EW	OW	PZ	Total Wells	Total Cost
1	DTH/RMT-77/54	5	3	3	11	58,82,000
2	DTH/LMP-87/80	6	3	-	9	45,20,000
3	DTH/RECP-88/92	6	3	-	9	49,69,000
4	DTH/KLR-12/121	-	-	20	20	58,01,000
5	DTH/DEL-15/129	5	3	3	11	58,92,000
6	Total	22	12	26	60	2,70,64,000

Table 4(c). Expenditure and Estimated well counts 2024-25

Sl. No.	Rig Unit	EW	OW	PZ	Total Wells	Total Cost
1	DTH/LMP-87/80(MMR-2025)	20	3	3	26	1,63,02,000
2	DTH/RECP-88/92	15	6	6	28	1,51,20,000
3	DTH/KLR-12/121	-	-	20	20	1,30,99,000
4	DTH/REL-15/129	3	1	-	4	25,07,000
5	Rig V InterShifting	-	-	-	-	4,53,600
6	Total	39	10	29	78	3,97,31,600

Table 4(d). Expenditure and Estimated well counts 2025-26

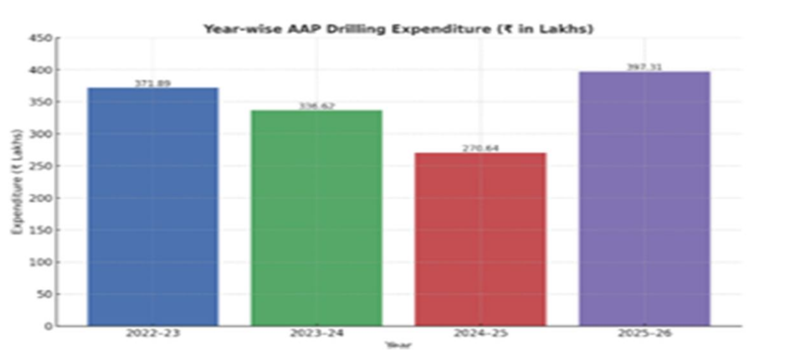

Fig 3. Expenditure Comparison over years

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