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GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD

PLAN ON ARTIFICIAL RECHARGE TO GROUNDWATER AND WATER CONSERVATION IN NINDRA MANDAL, CHITTOOR DISTRICT, ANDHRA PRADESH

SOUTHERN REGION
HYDERABAD
AUGUST-2016

PLAN ON
ARTIFICIAL RECHARGE TO GROUNDWATER AND WATER CONSERVATION IN NINDRA MANDAL, CHITTOOR DISTRICT, ANDHRA PRADESH

CONTENTS

AT A GLANCE

Name of the Mandal	NINDRA
District	CHITTOOR
State	ANDHRA PRADESH
Total Area(sq. km)	99
Area suitable for Artificial Recharge (sq.km.)	97.5
Latitude and Longitude	13.285630 to 13.440860 and 79.622830 to 79.766610.
Average Annual Rainfall (mm)	1091
Geology	BGC
Average Depth To Water Level (Decadal) (Pre Monsoon)	6.43
Average Depth To Water Level (Decadal) (Post Monsoon)	3.2
Ground Water Resources (2011)	
Annual Replenishable Ground Water Resources (MCM/yr)	13.42
Net Annual Ground Water Availability(MCM)/yr	12.08
Net Annual Ground Water Draft(MCM)/yr	17.81
Projected Demand for Domestic and Industrial Use(MCM)/yr	1.07
Stage of Ground Water Development (%)	147
Surface runoff available (MCM)/yr	33.16
Total Storage Created in the Mandal by Various Agencies (MCM)/yr	0.81
Artificial Recharge/Conservation Measures	
Recharge Structures Proposed (No.s)	Percolation Tanks: 32, Check Dams: 30 Farm ponds: 420, Recharge Shafts: 58
Improving Water use Efficiency	Micro Irrigation System: 2100 ha
Tentative Total Cost in Lakhs (Rs.)	2162
Expected Recharge/Savings (MCM)/yr	10.0

1. INTRODUCTION

Nindra Mandal is one of over-exploited Mandal in Chittoor district, Andhra Pradesh State, which is economically backward and chronically drought affected. The Mandal has 14 inhabited villages, 1 uninhabited village and with 21 gram panchayats.

2. LOCATION

The Mandal lies between north latitudes 13.285630 to 13.440860 and between east longitudes 79.622830 to 79.766610. The Mandal occupies the Eastern part of the Chittoor district and is bounded on the north by KVB Puram Mandal, on the east by Pichatur Mandal, on the south by Vijayapuram Mandal and west by Nagari Mandal. (Fig.1) The geographical area of the Mandal is 99 sq.km.

3. PHYSIOGRAPHY AND DRAINAGE:

The area is drained by streams which are tributaries of Palar River. The streams are mostly ephemeral in nature. The drainage pattern is dendritic, rectangular to sub rectangular due to the influence of geological structures. (Fig.2)

4. RAINFALL

The average rainfall in the Mandal is 1091 mm. The rainfall during the South-west monsoon season i.e., June-September accounts for about 85% of the total rainfall.

5. LAND USE PATTERN

Out of the total geographical area of 99 sq.kms, the area covered by forest is 8.27 sq.km and the net area sown is 26.93 sq.km. Barren and uncultivable land is 15.13 sq.kms. The land for non agricultural use accounts for 13.61 sq.km. (Fig.3)

6. HYDROGEOLOGY

The area is underlain by granites and granitic gneisses of Archaean age (Fig.4). Ground water occurs in weathered and fractured zones under water table and semi- confined conditions. The weathered zone thickness as per the GEC report is 10 m. The weathered zone has been extensively tapped by dug and dug cum bore wells upto20 m depth, which are mostly dry now. Ground water occurrs in the fractured granites upto 200 m bgl. However, the potential fractures are encountered between 50-100 m bgl. The cumulative yield varies from 2-5 lps.

7. GROUND WATER LEVEL SCENARIO

The depth to water level during the pre-monsoon and post-monsoon varies from 5 to 10 m. The Decadal mean water level trend during post monsoon is depicted in the Fig-5.

8. DYNAMIC GROUND WATER RESOURCES

The Ground water availability, Utilization and stage of Development in Nindra Mandal, Chittoor District is given in Table-1.

Table-1: Ground water resources of Nindra Mandal, Chittoor District.

Annual Replenishable Ground water resources (MCM)	13.42
Net Annual Ground Water Availability(MCM)/yr	12.08
Net Annual Ground Water Draft(MCM)/yr	17.81
Projected Demand for Domestic and Industrial use up to 2025. (MCM)	1.07
Stage of Ground water development (%).	147
Whether notified or not with year of notification.	No

9. NEED FOR ARTIFICIAL RECHARGE AND CONSERVATION METHODS

The ground water withdrawal is more than the recharge with a stage of development above hundred percent. The long term water level trend mostly shows a declining trend and the water levels are very deep ranging upto15 m. The sustainability of bore wells has become questionable as many bore wells are either drying up or have recorded reduced yields. There is no surface water irrigation facility in the area. All these factors indicate that there is an urgent need for artificial recharge and water conservation in the Mandal.

10. JUSTIFICATION OF THE ARTIFICIAL RECHARGE PROJECT

Nindra Mandal falls under high stage of ground water development i.e., 147 % and with sufficient amount of uncommitted surface runoff. The area is completely dependent on ground water for domestic, industrial and irrigation purposes. During the monsoons runoff quickly flows out of the area without natural recharge to ground water. It is necessary to apply artificial recharge techniques to allow more and more recharge through check dams, PTs, MPTs, farm ponds, recharge shafts to cope up with the withdrawal pattern and also to improve ground water situation through various interventions including on farm activities and micro irrigation systems (Sprinkler-Drip-HDPE).

11. AVAILABILITY OF SURPLUS, SURFACE WATER FOR ARTIFICIAL RECAHRGE OR CONSERVATION

The runoff was calculated by taking into account of normal rainfall of the mandal and corresponding runoff yield from Strangers table. The existing storage created by various artificial recharge structures constructed by the State Government, if any, was deducted for calculating the runoff yield to recommend new AR structures.

Total Geographical area (Sq.kms)	99
Hilly Area (Sq.kms)	1.5
Area suitable for Artificial Recharge (sq.km.)	97.5
Runoff Yield in MCM/yr.	33.16
Existing No. of Check Dams	25
Storage created MCM/yr.	0.177
Existing No. of Percolation Tanks	90
Storage created MCM/yr.	0.64
Total Existing Storage Created	0.81

12. FEASIBLE ARTIFICIAL RECHARGE STRUCTURES

Since the mandal is categorized as over exploited, there is an immediate need for improving ground water scenario and to ensure sustainability of ground water sources. It is also suggested to create additional storage capacity of surface water bodies which would result in supplementing irrigation thereby reducing the ground water draft. The run off available in the mandal has been assessed as 32.35 MCM/yr, which could be considered for further planning of artificial recharge. However, the number of artificial recharge structures feasible has been recommended in areas, by considering the utilizable yield, number of existing structures, land use, drainage pattern and also where the post monsoon water levels (decadal mean) are more than 5 m bgl., and or decadal trends are either falling or showing insignificant raising trend.

A) Check dams and Percolation Tanks

The area is covered by seasonal nalas – drains, which carry discharge during monsoon period debauched into the water bodies within a short duration. It is proposed to identify such nalas for construction of check dams/Percolation tank with recharge shafts, so as to harness ground water and to increase soil moisture content.

- The site selected for check dam/Percolation Tank should have sufficient thickness of permeable soils or weathered material to facilitate recharge of stored water within a short span of time. The water stored in these structures is mostly confined to the stream course and height is normally less than 2m.
- These are designed based on stream width and excess water is allowed to flow over the crest wall. In order to avoid scouring from excess runoff water cushions are provided on the downstream side. To harness maximum runoff in the stream, a series of such check dams can be constructed to have recharge on a regional scale.
- Considering the annual monsoon rainfall of 1091 mm, sufficient rain water can be harnessed. This will improve ground water regime as well as delaying the instant flow into the main river.
- The flow in these seasonal rivers can be sustained up to about 2 to 3 months after monsoon.

- Recharge trenches can also be constructed along upstream side of the check dam/Percolation Tank in the impoundment area for enhancing the ground water recharge rate.

Thus, a total of 30 **Check dams and 32 Percolation tanks** are recommended.

B). Recharge Shafts

The existing check dams and percolation tanks lose their storage capacity as well as recharge capacity due to siltation. Hence, Recharge shafts are recommended in the existing Check dams and Percolation tanks to enhance the ground water recharge. During the heavy downpours, there will be sufficient accumulation of runoff, which can also effectively be utilized for recharge by constructing recharge shafts. Hence, it is proposed to construct 13 and 45 recharge shafts of 165 mm dia with 30 m depth in the existing check dams and percolation tanks respectively.

C). Farm Ponds

A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rain water and stores it for future use. It has an inlet to regulate inflow and an outlet to discharge excess water. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. The size and depth depend on the amount of land available; the type of soil water from the farm pond is conveyed to the fields manually, by pumping, or by both methods.

Advantages of Farm Ponds

- They provide water to start growing crops, without waiting for rain to fall.
- They provide irrigation water during dry spells between rainfalls. This increases the yield, the number of crops in one year, and the diversity of crops that can be grown.
- Bunds can be used to raise vegetables and fruit trees, thus supplying the farm household with an additional source of income and of nutritious food.
- Farmers are able to apply adequate farm inputs and perform farming operations at the appropriate time, thus increasing their productivity and their confidence in farming.
- They check soil erosion and minimize siltation of waterways and reservoirs.
- They supplies water for domestic purposes and livestock.
- They promote fish rearing.
- They recharge the ground water.
- They improve drainage.

- The excavated earth has a very high value and can be used to enrich soil in the fields, levelling land, and constructing farm roads.

As per the Land use classification, majority of the area is covered by the agricultural field. Hence, it is proposed to construct 420 farm ponds in 21 villages of the Mandal @ 20 farm ponds in each village.

D). Micro Irrigation System (Sprinkler /drip/HDPE pipes)

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line. In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant. While through drip & sprinkler irrigation wastages of irrigational water could be minimized. The studies on different crops, has revealed that irrigation water is saved drastically. The conveyance losses (mainly seepage & evaporation) can be saved up to 25 to 40% through utilization of HDPE pipes. Initially the scheme is proposed to be implemented in worst affected areas showing deepest water levels and significant declining trends. It is proposed to take up micro irrigation system in 2100 ha @ 100 ha per village.

13. TENTATIVE COST ESTIMATES (NINDRA MANDAL)

S.No.	Feasible Artificial Recharge & Water Conservation structures/	No. of Structures/ Quantity	Total Volume (MCM)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs Lakh)	Expected Annual GW recharge/savings (MCM)
1	Proposed Masonry Check dams Crest Length -10-15 m, Height-1-2 m) (0.007 MCM*4 fillings)	30	0.84	5	150	0.63
2	Recharge shaft in Check dam (50% of the existing Check dams)	13	0.143	0.5	6.5	0.143
3	Proposed Percolation Tanks (100*100*2.5)* 4 fillings)	32	3.2	15	480	2.4
4	Renovation Desilting, Repairs and installation of Recharge Shafts in existing PTS (50% of the existing PTS)	45	0.495	1	45	0.495
5	Proposed Farm Pond (6 filling) 5*5*1.5 dimension @ 20 farm ponds per each village	420	0.06048	0.25	105	0.054432
6	Proposed Sprinkler/drip/HDPE pipes for 100 ha in each village	2100	12.6	0.6	1260	6.3
7	Proposed Piezometers up to 50 mbgl @ one PZ per Village	21	0	0.6	12.6	0
8 (i)	Total (No. of AR Structures)	561	4.74		799.1	3.722
8 (ii)	Total (ha)	2100			1260	6.3
	Total (8(i) + 8 (ii))				**2059.1**	**10.022**
9	Impact Assessment & O & M -5 % of Total cost of the Scheme				**102.955**	
	Grand Total				**2162.055**	

*(Expected annual GW Recharge/Savings MCM - CDS& PTS: 75%, Farm ponds - 90%, Sprinklers-50%, Recharge shafts in existing CDS and PTS-100%)

Note: The type, number and cost of structure may vary according to site, after the ground truth verification.

14. TIME SCHEDULE

Steps	Quarters							
	1st	2nd	3rd	4th	5th	6th	7th	8th
Identification of line department/implementing agency and preparation of DPR								
Approval of Scheme and releases of sanction of funds								
Implementation of ARS								

Phase = one quarter or 3 months or equivalent to financial quarter

A). Operation and Maintenance

In all projects impact assessment has to be carried out to ensure that project is economically viable, socially equitable and environmentally sustainable by inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Accordingly it is proposed to have impact assessment as well as operation & Maintenance at the rate of 5% of the total cost of the project for 5 years from the completion of artificial recharge project.

B). Expected Benefits

The benefits of the project are:

1. The implementation of the project would result in additional recharge/Ground water savings to the tune of 10.0 MCM.
2. Ground water recharge will help in arresting the rapid decline in ground water resources and will also ensure improvement in quality of ground water by dilution.
3. Proposed structures and measures will also enhance the ground water potential and would ensure sustainability of ground water resources. It is estimated that the stage of ground water development may likely to be reduced from the present 147% to 80% (67%)
4. It will also help in controlling soil erosion.

Acknowledgements

The data received from the Director Ground Water Department Andhra Pradesh in respect of the basic inputs is duly acknowledged. The information on existing Artificial Recharge Structures have been taken from the EMUSTER, Department of Rural Development, Government of AP.

EXISTING ARTIFICIAL RECHARGE STRUCTURES
NINDRA MANDAL, CHITTOOR DISTRICT, AP

S.no	Gram Panchayat	Habitation	Structure Type	Longitude	Latitude	Scheme
1	M.s.v.m. puram	M.S.V.M. Puram	Check Dam	79.6709	13.3953	NREGS
2	M.s.v.m. puram	M.S.V.M. Puram	Check Dam	79.6723	13.3938	NREGS
3	M.s.v.m. puram	M.S.V.M. Puram	Check Dam	79.6759	13.3951	NREGS
4	M.s.v.m. puram	M.S.V.M. Puram	Check Dam	79.6763	13.3968	NREGS
5	Ururupeta	UruruPeta	Check Dam	79.7416	13.3399	NREGS
6	Ururupeta	UruruPeta	Check Dam	79.7404	13.3394	NREGS
7	Ururupeta	UruruPetaMadiga Wada	Check Dam	79.7427	13.3434	NREGS
8	Agaram	Agaram H.W	Check Dam	79.5851	13.3229	NREGS
9	Agaram	Agaram H.W	Check Dam	79.7250	13.3594	NREGS
10	Agaram	DevadarakodiamBedu	Check Dam	79.7273	13.3696	NREGS
11	Athuru	Athuru H/W	Check Dam	79.7347	13.3360	NREGS
12	Nindra	Mitta Yanadi Colony	Check Dam	79.7040	13.3652	NREGS
13	G.n. kandriga	B.G. Kandriga	Check Dam	79.6378	13.3423	NREGS
14	G.n. kandriga	B.G. Kandriga	Check Dam	79.6403	13.3441	NREGS
15	Iruguvai	Iruguvai	Check Dam	79.6233	13.3446	NREGS
16	Iruguvai	Iruguvai H.W	Check Dam	79.6235	13.3434	NREGS
17	Iruguvai	P.R. PuramYc	Check Dam	79.6142	13.3494	NREGS
18	Iruguvai	P.R. PuramYc	Check Dam	79.6115	13.3554	NREGS
19	Iruguvai	P.R. PuramYc	Check Dam	79.6146	13.3479	NREGS
20	Iruguvai	P.R. PuramYc	Check Dam	79.6136	13.3509	NREGS
21	Iruguvai	P.R. PuramYc	Check Dam	79.6112	13.3577	NREGS
22	Iruguvai	P.R. PuramYc	Check Dam	79.6113	13.3602	NREGS
23	Iruguvai	P.R. PuramYc	Check Dam	79.6118	13.3606	NREGS
24	G.n. kandriga	B.G. Kandriga	Check Wall	79.6406	13.3437	NREGS
25	G.n. kandriga	G. N. Kandriga	Check Wall	79.6331	13.3417	NREGS
26	Kacharavedu	Kacharavedu H.W	MPT	79.6974	13.3609	NREGS
27	Keelambakam	Thippaapuram	MPT	79.6803	13.3669	NREGS
28	Keelambakam	Thippaapuram	MPT	79.6810	13.3670	NREGS
29	Keelambakam	Thippaapuram	MPT	79.6909	13.3729	NREGS
30	Keelambakam	Thippaapuram	MPT	79.6900	13.3730	NREGS
31	Kaipakam	Kaipakam	MPT	79.6639	13.3418	NREGS
32	Chavarambakam	Chavaram Mitta H.W	MPT	79.6788	13.3533	NREGS
33	Chavarambakam	Chavarambakam	MPT	79.6793	13.3630	NREGS
34	Chavarambakam	Chavarambakam H.W	MPT	79.6862	13.3679	NREGS
35	Kunamarajupalem	KunamRajuPalem	MPT	79.6781	13.3376	NREGS
36	Netteri	Netteri	MPT	79.6736	13.3467	NREGS
37	Agaram	Agaram	MPT	79.7134	13.3587	NREGS
38	Agaram	Agaram	MPT	79.7207	13.3555	NREGS
39	Agaram	Agaram H.W	MPT	79.7234	13.3589	NREGS
40	Agaram	AgaramPeta And Sc Colony	MPT	79.7255	13.3540	NREGS

41	Agaram	DevadarakodiamBedu	MPT	79.7274	13.3636	NREGS
42	Athuru	Athuru	MPT	79.7277	13.3328	NREGS
43	Athuru	M.G. KandrigaHw	MPT	79.7421	13.3489	NREGS
44	Athuru	MangalagiriKandriga	MPT	79.7373	13.3432	NREGS
45	Padiri	Padiri	MPT	79.6685	13.3221	NREGS
46	Nindra	Mitta Yanadi Colony	MPT	79.7042	13.3619	NREGS
47	Nindra	Nindra	MPT	79.7071	13.3842	NREGS
48	Nindra	Nindra	MPT	79.7036	13.3679	NREGS
49	Nindra	Nindra H/W	MPT	79.7107	13.3827	NREGS
50	G.n. kandriga	G. N. Kandriga	MPT	79.6333	13.3357	NREGS
51	Iruguvai	Iruguvai	MPT	79.6282	13.3472	NREGS
52	Iruguvai	Iruguvai H.W	MPT	79.6255	13.3444	NREGS
53	Iruguvai	IruguvaiYc	MPT	79.6230	13.3486	NREGS
54	Iruguvai	IruguvaiYc	MPT	79.6243	13.3480	NREGS
55	Iruguvai	ParvathaRajuPuram	MPT	79.6195	13.3432	NREGS
56	Iruguvai	ParvathaRajuPuram	MPT	79.6214	13.3460	NREGS
57	I.r. kandriga	I.R. Kandriga	PT	79.6674	13.3998	NREGS
58	I.r. kandriga	I.R. Kandriga	PT	79.6613	13.3931	NREGS
59	I.r. kandriga	I.R. Kandriga	PT	79.6673	13.3947	NREGS
60	I.r. kandriga	I.R. Kandriga	PT	79.6733	13.4005	NREGS
61	Kacharavedu	Kacharavedu	PT	79.6954	13.3593	NREGS
62	M.s.v.m. puram	M.S.V.M. Puram	PT	79.6729	13.3868	NREGS
63	Melambakam	KannikapuramYc	PT	79.6699	13.3662	NREGS
64	Melambakam	KannikapuramYc	PT	79.6684	13.3664	NREGS
65	Melambakam	KannikapuramYc	PT	79.6694	13.3654	NREGS
66	Kaipakam	Kaipakam	PT	79.6685	13.3426	NREGS
67	Kaipakam	Kaipakam H.W	PT	79.6659	13.3429	NREGS
68	Ururupeta	UruruPeta H.W	PT	79.7474	13.3339	NREGS
69	Ururupeta	UruruPeta H.W	PT	79.7485	13.3365	NREGS
70	Ururupeta	UruruPeta H.W	PT	79.7475	13.3352	NREGS
71	Kunamarajupalem	KunamRajuPalem	PT	79.6813	13.3377	NREGS
72	Kunamarajupalem	KunamRajuPalem	PT	79.6803	13.3376	NREGS
73	Kavanuru	Kavanuru	PT	79.7004	13.4292	NREGS
74	Kavanuru	Kavanuru H.W	PT	79.6913	13.4376	NREGS
75	Kavanuru	Kavanuru H.W	PT	79.6960	13.4357	NREGS
76	Kavanuru	Kavanuru H.W	PT	79.6976	13.4356	NREGS
77	Kavanuru	Kavanuru H.W	PT	79.6960	13.4341	NREGS
78	Koppedu	Koppedu H.W	PT	79.6887	13.4038	NREGS
79	Koppedu	Koppedu H.W	PT	79.6907	13.3948	NREGS
80	Koppedu	Koppedu H.W	PT	79.7017	13.3946	NREGS
81	Koppedu	Koppedu H.W	PT	79.7057	13.3966	NREGS
82	Netteri	Netteri H.W	PT	79.6764	13.3519	NREGS
83	Elakatur	Elakatur	PT	79.6803	13.3710	NREGS

84	Elakatur	Elakatur H.W	PT	79.6715	13.3704	NREGS
85	Elakatur	M. PaparajuKandriga	PT	79.6914	13.3832	NREGS
86	Aruru	Aruru	PT	79.6589	13.3416	NREGS
87	Aruru	Aruru	PT	79.6528	13.3410	NREGS
88	Aruru	Aruru H.W	PT	79.6497	13.3503	NREGS
89	Aruru	Aruru H.W	PT	79.6580	13.3415	NREGS
90	Aruru	KothaAruru	PT	79.6552	13.3421	NREGS
91	Aruru	Yanadi Colony	PT	79.6489	13.3536	NREGS
92	Padiri	Padiri	PT	79.6687	13.3229	NREGS
93	Padiri	Padiri	PT	79.6677	13.3238	NREGS
94	Padiri	Padiri	PT	79.6678	13.3256	NREGS
95	Padiri	Padiri East Hw	PT	79.6690	13.3223	NREGS
96	Padiri	PadiriOddiIndlu	PT	79.6705	13.3213	NREGS
97	Padiri	PadiriOddiIndlu	PT	79.6754	13.3229	NREGS
98	Sri ramapuram	Sri Ramapuram	PT	79.7086	13.4199	NREGS
99	Sri ramapuram	Sri Ramapuram	PT	79.7066	13.4211	NREGS
100	Sri ramapuram	Sri Ramapuram	PT	79.7056	13.4175	NREGS
101	Nindra	Mitta Kandriga	PT	79.7028	13.3608	NREGS
102	Nindra	Nindra	PT	79.7065	13.3849	NREGS
103	Nindra	Nindra	PT	79.7034	13.3802	NREGS
104	Nindra	Nindra	PT	79.7061	13.3794	NREGS
105	Nindra	Nindra	PT	79.7053	13.3769	NREGS
106	Nindra	Nindra	PT	79.7035	13.3704	NREGS
107	G.n. kandriga	B.G. Kandriga	PT	79.6434	13.3480	NREGS
108	G.n. kandriga	G. N. Kandriga	PT	79.6410	13.3449	NREGS
109	G.n. kandriga	G. N. Kandriga	PT	79.6384	13.3425	NREGS
110	G.n. kandriga	G. N. Kandriga	PT	79.6454	13.3485	NREGS
111	G.n. kandriga	G. N. Kandriga	PT	79.6464	13.3511	NREGS
112	Iruguvai	Iruguvai	PT	79.6277	13.3478	NREGS
113	Iruguvai	Iruguvai H.W	PT	79.6265	13.3408	NREGS
114	Iruguvai	Iruguvai H.W	PT	79.6234	13.3440	NREGS
115	Iruguvai	J.P. Kandriga	PT	79.6237	13.3399	NREGS

PROPOSED ARTIFICIAL RECHARGE STRUCTURES
NINDRA MANDAL, CHITTOOR DISTRICT, AP

S.No.	Mandal	Lattitude	Longitude	Structure_Type
1	Nindra	13.3916	79.6739	Check Dam
2	Nindra	13.3805	79.6693	Check Dam
3	Nindra	13.3557	79.6591	Check Dam
4	Nindra	13.3426	79.7335	Check Dam
5	Nindra	13.3445	79.7205	Check Dam
6	Nindra	13.3168	79.7432	Check Dam
7	Nindra	13.3160	79.7462	Check Dam
8	Nindra	13.3078	79.7544	Check Dam
9	Nindra	13.3081	79.7574	Check Dam
10	Nindra	13.3159	79.7557	Check Dam
11	Nindra	13.3235	79.7372	Check Dam
12	Nindra	13.3325	79.7330	Check Dam
13	Nindra	13.3399	79.7475	Check Dam
14	Nindra	13.3423	79.6826	Check Dam
15	Nindra	13.3556	79.6321	Check Dam
16	Nindra	13.3519	79.6235	Check Dam
17	Nindra	13.3405	79.6136	Check Dam
18	Nindra	13.3424	79.6160	Check Dam
19	Nindra	13.3560	79.6402	Check Dam
20	Nindra	13.3597	79.6550	Check Dam
21	Nindra	13.3807	79.6859	Check Dam
22	Nindra	13.3654	79.7130	Check Dam
23	Nindra	13.3529	79.6969	Check Dam
24	Nindra	13.3367	79.6661	Check Dam
25	Nindra	13.4014	79.6987	Check Dam
26	Nindra	13.4096	79.6726	Check Dam
27	Nindra	13.4151	79.6976	Check Dam
28	Nindra	13.4333	79.6766	Check Dam
29	Nindra	13.4371	79.6766	Check Dam
30	Nindra	13.4388	79.7083	Check Dam
31	Nindra	13.3504	79.6579	Percolation Tank
32	Nindra	13.3554	79.6540	Percolation Tank
33	Nindra	13.3481	79.6644	Percolation Tank
34	Nindra	13.3564	79.6890	Percolation Tank
35	Nindra	13.3763	79.6859	Percolation Tank
36	Nindra	13.3907	79.6839	Percolation Tank
37	Nindra	13.3726	79.7153	Percolation Tank
38	Nindra	13.3682	79.7119	Percolation Tank
39	Nindra	13.3491	79.7278	Percolation Tank
40	Nindra	13.3486	79.7153	Percolation Tank

41	Nindra	13.3391	79.7310	Percolation Tank
42	Nindra	13.3436	79.7288	Percolation Tank
43	Nindra	13.3747	79.7094	Percolation Tank
44	Nindra	13.3722	79.7208	Percolation Tank
45	Nindra	13.4000	79.6830	Percolation Tank
46	Nindra	13.4103	79.6862	Percolation Tank
47	Nindra	13.4313	79.7072	Percolation Tank
48	Nindra	13.4394	79.7023	Percolation Tank
49	Nindra	13.4381	79.6867	Percolation Tank
50	Nindra	13.4308	79.6794	Percolation Tank
51	Nindra	13.4198	79.6833	Percolation Tank
52	Nindra	13.4106	79.7018	Percolation Tank
53	Nindra	13.3872	79.6994	Percolation Tank
54	Nindra	13.3851	79.6872	Percolation Tank
55	Nindra	13.4330	79.6849	Percolation Tank
56	Nindra	13.4180	79.6921	Percolation Tank
57	Nindra	13.4044	79.6961	Percolation Tank
58	Nindra	13.4062	79.6594	Percolation Tank
59	Nindra	13.3564	79.7080	Percolation Tank
60	Nindra	13.3464	79.6804	Percolation Tank
61	Nindra	13.3330	79.6708	Percolation Tank
62	Nindra	13.3292	79.6794	Percolation Tank

Fig.1

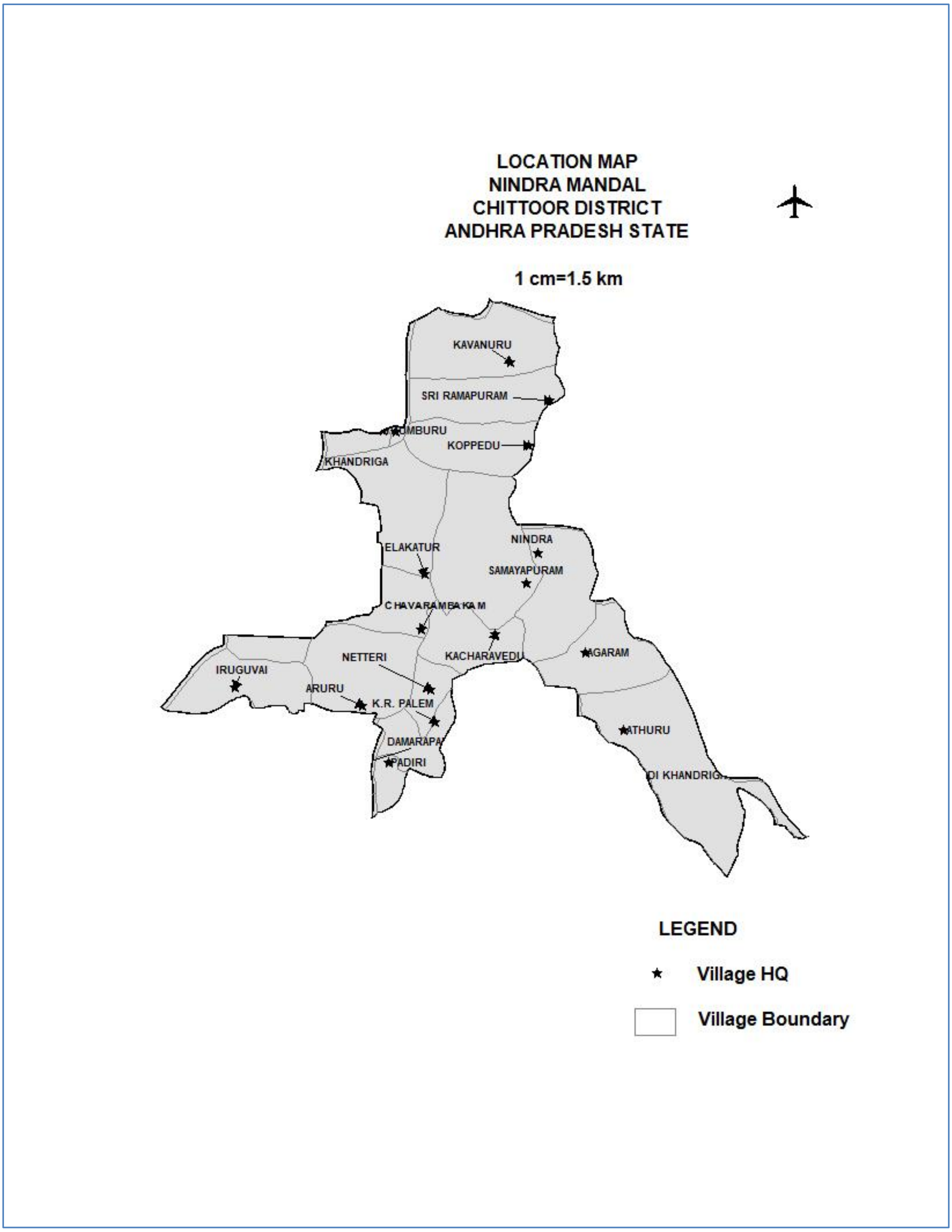

LOCATION MAP
NINDRA MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
1 cm=1.5 km
KAVANURU
SRI RAMAPURAM
KOPPEDU
KHANDRIGA
ELAKATUR
NINDRA
SAMAYAPURAM
CHAVARAMBAKAM
NETTERI
KACHARAVEDU
IRUGUVAI
ARURU
K.R. PALEM
DAMARAPA
PADIRI
ATHURU
LEGEND
Village HQ
Village Boundary

Fig.2

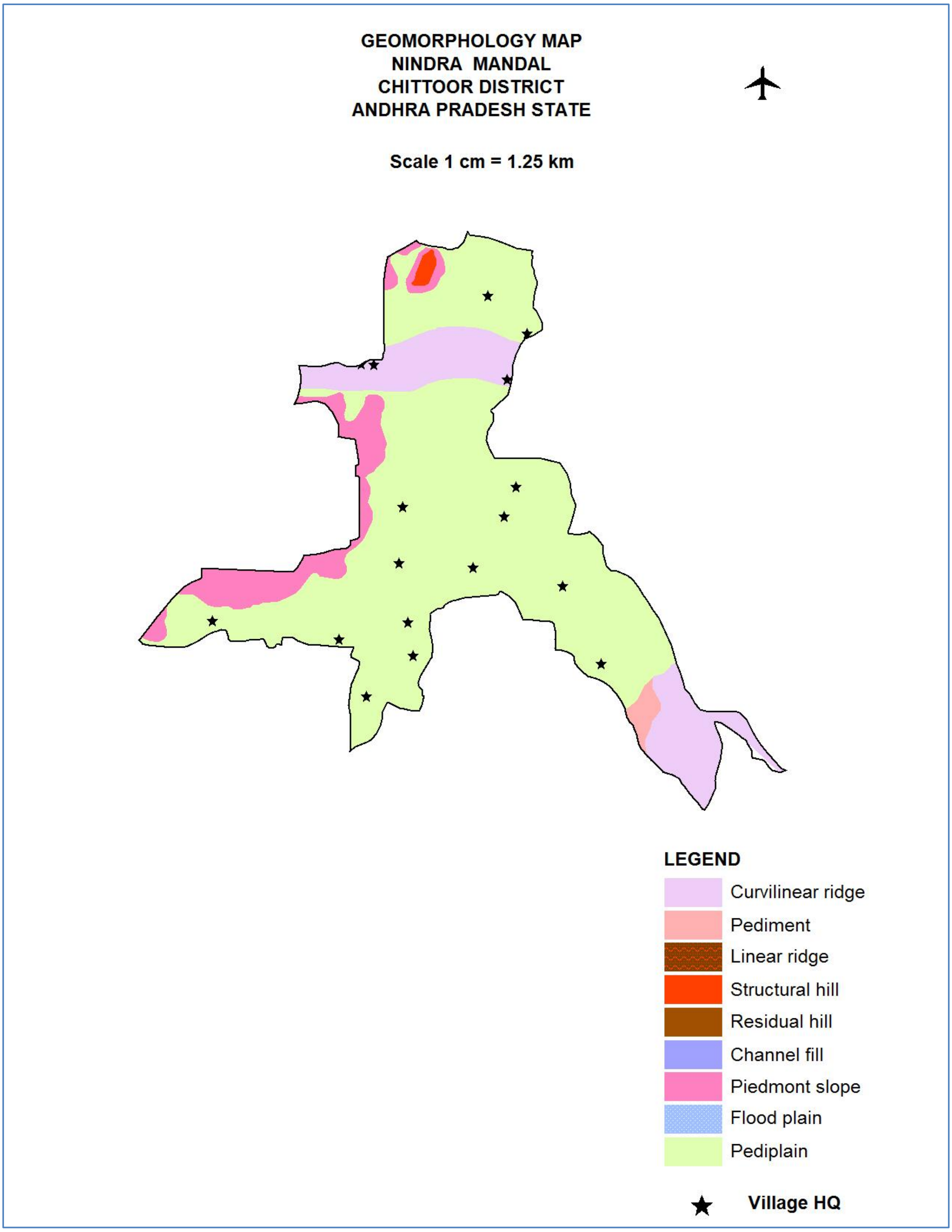

GEOMORPHOLOGY MAP
NINDRA MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
Scale 1 cm = 1.25 km
LEGEND
Curvilinear ridge
Pediment
Linear ridge
Structural hill
Residual hill
Channel fill
Piedmont slope
Flood plain
Pediplain
Village HQ

Fig.3

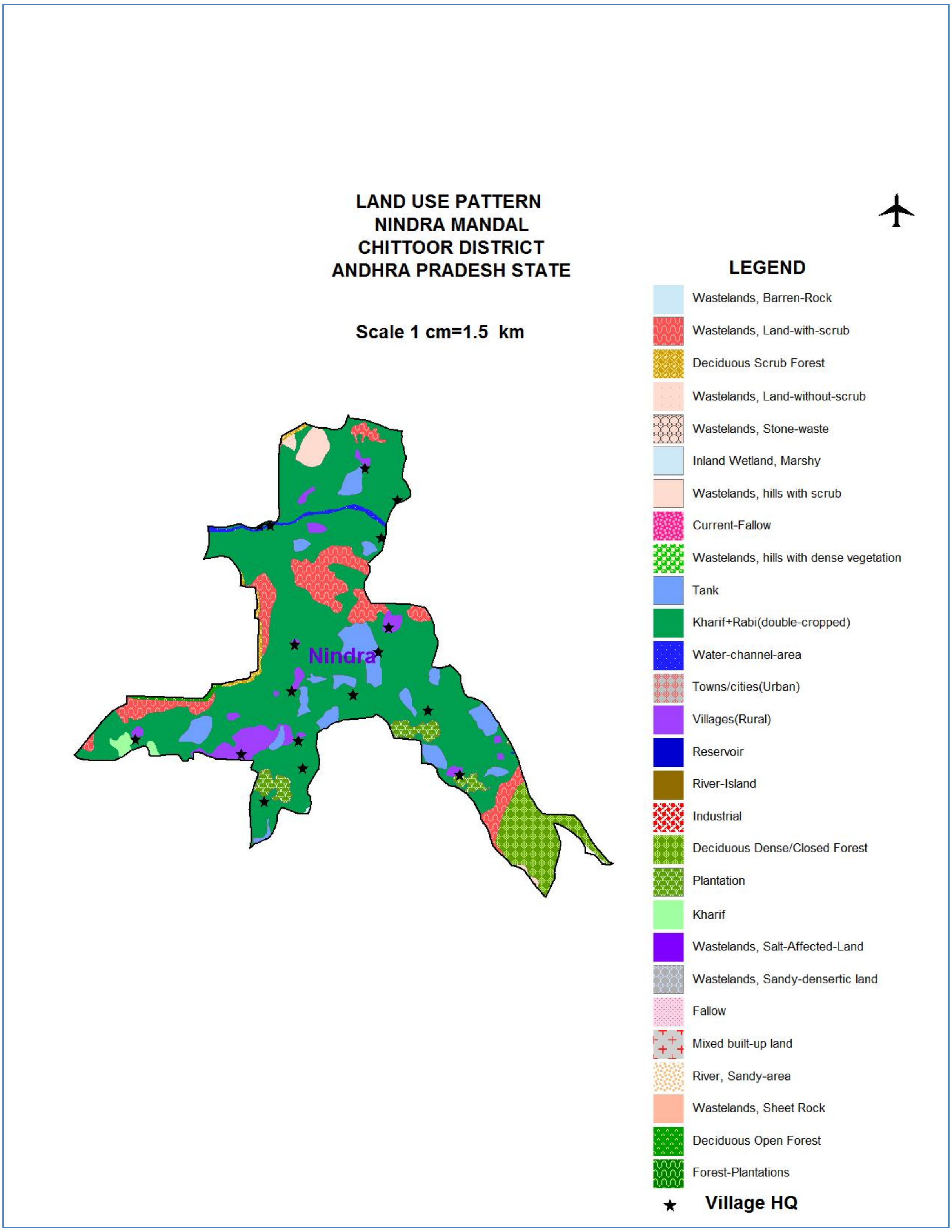

LAND USE PATTERN
NINDRA MANDAL
CHITTOOR DISTRICT
ANDHRA PRADESH STATE
Scale 1 cm=1.5 km
Nindra
LEGEND
Wastelands, Barren-Rock
Wastelands, Land-with-scrub
Deciduous Scrub Forest
Wastelands, Land-without-scrub
Wastelands, Stone-waste
Inland Wetland, Marshy
Wastelands, hills with scrub
Current-Fallow
Wastelands, hills with dense vegetation
Tank
Kharif+Rabi(double-cropped)
Water-channel-area
Towns/cities(Urban)
Villages(Rural)
Reservoir
River-Island
Industrial
Deciduous Dense/Closed Forest
Plantation
Kharif
Wastelands, Salt-Affected-Land
Wastelands, Sandy-densertic land
Fallow
Mixed built-up land
River, Sandy-area
Wastelands, Sheet Rock
Deciduous Open Forest
Forest-Plantations
Village HQ

Fig.4

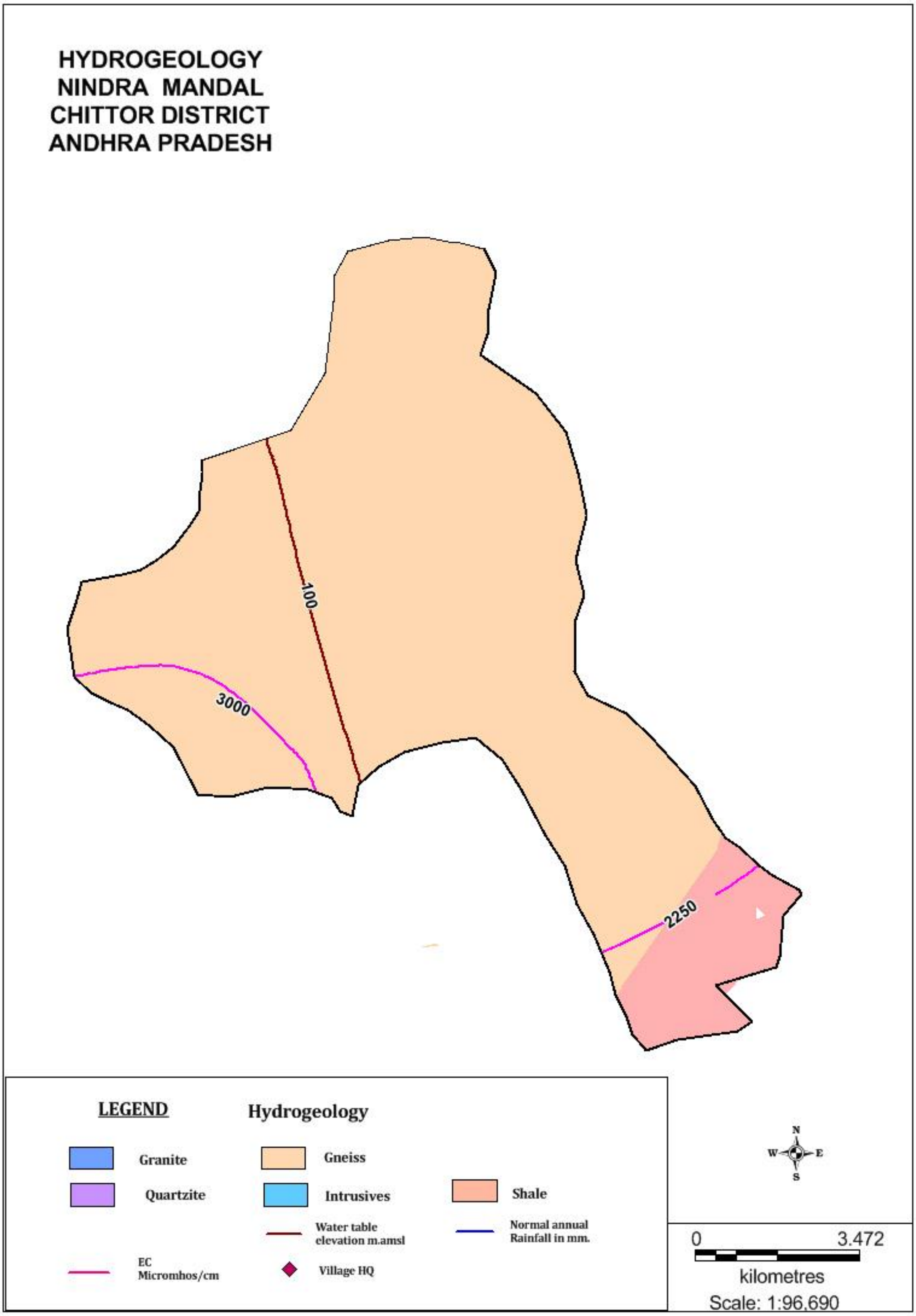
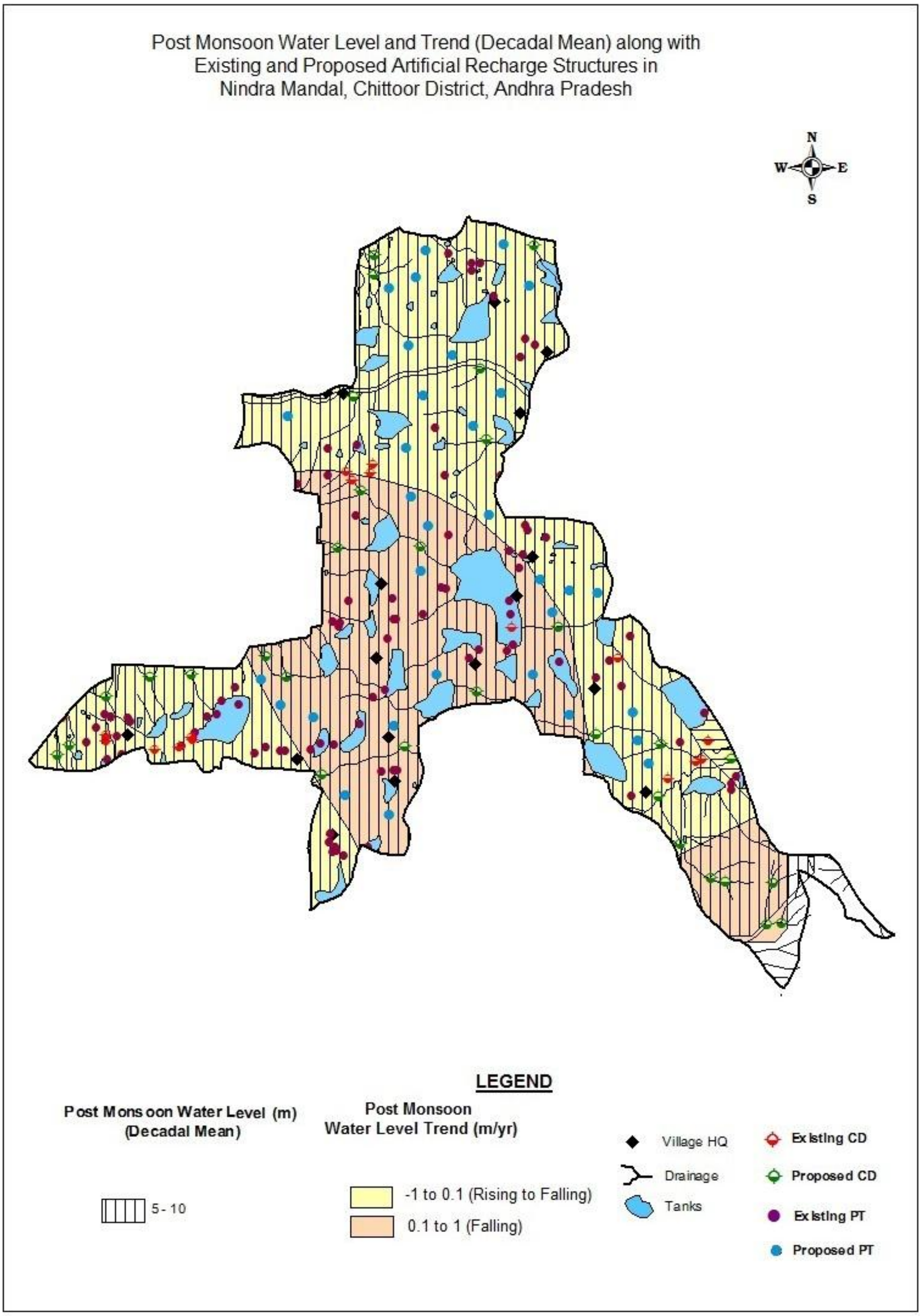

HYDROGEOLOGY
NINDRA MANDAL
CHITTOR DISTRICT
ANDHRA PRADESH
100
3000
2250
LEGEND
Hydrogeology
Granite
Gneiss
Quartzite
Intrusives
Shale
Water table elevation m.amsl
Normal annual Rainfall in mm.
EC Micromhos/cm
Village HQ
N
W
E
S
0
3.472
kilometres
Scale: 1:96,690

Fig.5


Post Monsoon Water Level and Trend (Decadal Mean) along with
Existing and Proposed Artificial Recharge Structures in
Nindra Mandal, Chittoor District, Andhra Pradesh
N
W
E
S
LEGEND
Post Monsoon Water Level (m)
(Decadal Mean)
5 - 10
Post Monsoon
Water Level Trend (m/yr)
-1 to 0.1 (Rising to Falling)
0.1 to 1 (Falling)
Village HQ
Drainage
Tanks
Existing CD
Proposed CD
Existing PT
Proposed PT