Watershed Interventions for Kurlod and Botoshi

Phase II

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1 Introduction

The Kurlod-Botoshi watershed project is planned as a joint collaboration between Aroehan, Siemens CSR, and the Technology and Development Solutions Cell (TDSC) at IIT Bombay. Kurlod and Botoshi are neighboring tribal villages in Mokhada block, Palghar district, that face severe water scarcity, particularly in the summer months of February, March, April, May and June. The aim of this project is to increase water availability in the area for both drinking and livelihood purposes, and is planned to be implemented in two phases, over two years. This report presents the watershed interventions proposed for Phase II which aims at providing livelihood water.

The report begins with a short background on Kurlod and Botoshi and the water stress levels in each habitation. Next, is the summary of interventions from phase I of the project and the progress in implementation. The main section of the report presents detailed analysis of each village-wise intervention as part of Phase II. The report concludes with a summary of all Phase II proposed interventions and an annexure with technical and design details of specific interventions.

1.1 Kurlod and Botoshi

Kurlod and Botoshi have a combined population of approximately 2600 souls, split over 13 habitations with individual populations ranging from 15 to 450. Kurlod is approximately 158 km from Mumbai (typically a 5 hour drive), and 55 km from Kasara (typically a 2-3 hour drive). Botoshi is closer to Kasara by an hour.

Figure 1 Map showing geographical location of Kurlod village.

The habitations are all either close to the Pinjal River, seen in the image below, or by a stream that drains into the river.

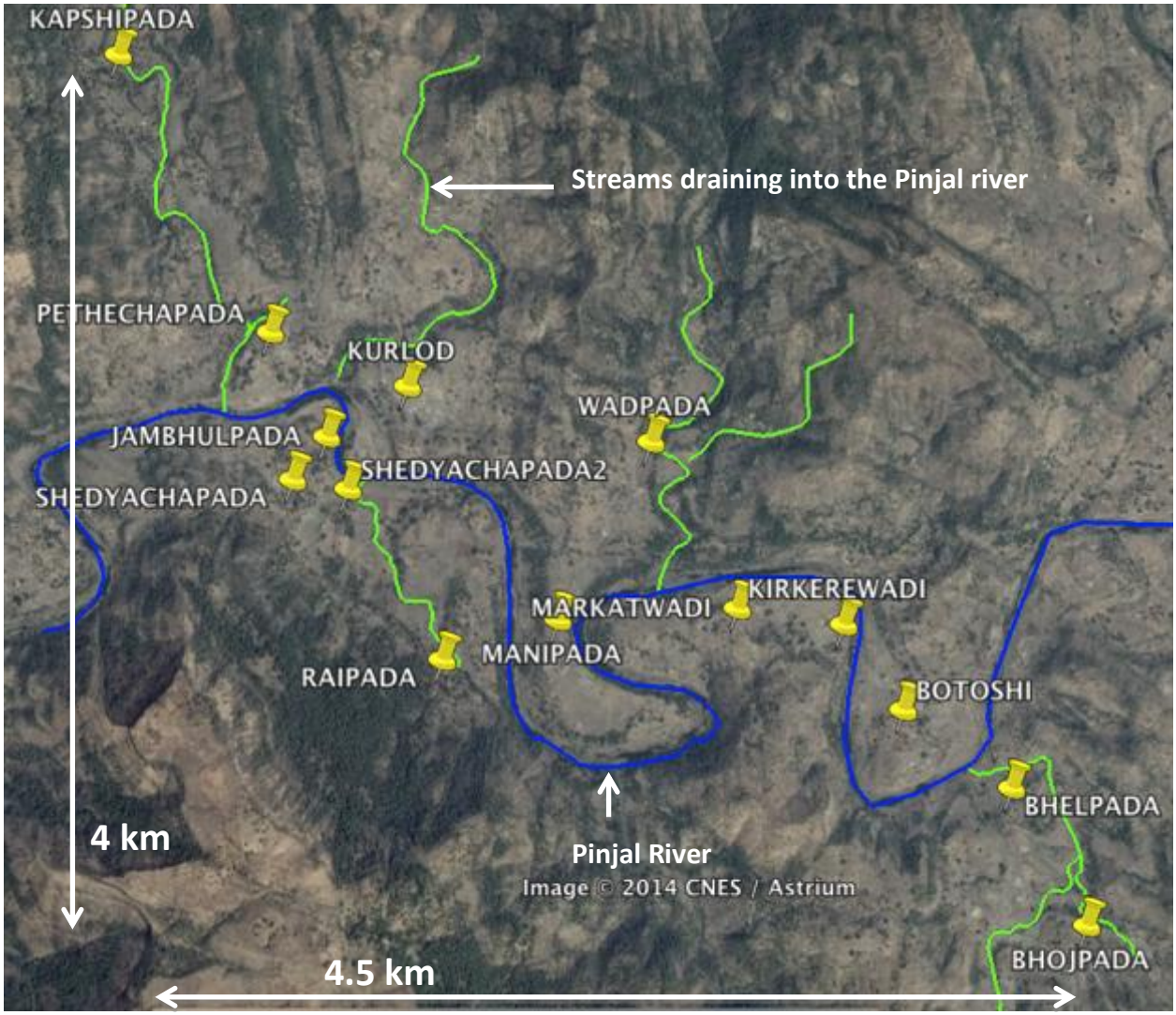

Figure 2 Google Earth image showing layout of habitations in Kurlod and Botoshi.

The total agricultural area in Kurlod and Botoshi are 13,74,400 m^2 and 9,49,742 m^2, respectively. All the agricultural area is rain-fed and hence only one crop is cultivated in monsoon season (Kharif crop). It has been observed that proper water management can provide additional water for the second crop (Rabbi crop).

1.2 Brief Summery for Past projects

1.2.1 Water stress assessment

From May-July 2014, Mohit Singhal and Mukul Kaushik, two students from IIT Roorkee, conducted a status assessment of the drinking water stress in the 13 habitations of Kurlod and Botoshi[1]. Their findings were verified and updated during field visits by TDSC between September and December 2014. The table below indicates specific challenges of drinking water security for each habitation.

[1] The complete water stress assessment report can be found along with other project-related outputs at http://www.ctara.iitb.ac.in/tdsc/kurlodbotoshi

Habitation	Pop.	Primary well lasts until…	Problems of water quality in primary well	Problems of accessibility to water sources
Kurlod	400	May		
Pethechapada	450	December		Difficult access to potential primary well
Jambhulpada and Shedyachapada	150	Year round	Quality problem due to tree overhanging the well	
Raipada	80	Year round	Major quality problem post-monsoons	
Manipada	60	October		Difficult access to potential primary well
Wadpada	100	March		One of the two wells is at a much lower elevation than the habitation
Botoshi	400	May		
Kirkirewadi	40	Year round	Quality problem in the summer months	Primarily well gets submerged during monsoons
Bhelpada	450	June		
Markatwadi	150	November		Steep 30 m drop to reach water source from habitation
Bhojpada	340	Year round		Primary well get cut off by stream during the monsoons
Kapshipada	15	Year round		

Table 1 Water stress assessment based on 2014 study

1.2.2 Watershed Interventions for Kurlod and Botoshi Phase I

TDSC in Phase I of the project proposed various interventions mainly to address drinking water scarcity in the 13 habitations. The interventions include repair of well, construction of new wells, installation of pumps and filters, and contour trenching. Table below summaries the list of interventions:

Habitation	Interventions for Phase I	Expected Impact after Phase I	Pumping system	Status
Kurlod	Bund repair for well recharge; well platform and drain construction	Longer duration of water in well, and improved sanitation around well	Pumping system with filters	Well work completed
Pethechapada	Well repair	Protection of well from siltation in monsoons	Pumping system with filters	Well work completed
Jambhulpada and Shedyachapada	Installation of netted cover for well	Protection of well from leaves and debris		
Raipada	Reconstruction of buried well	Creation of an additional drinking water source		Well construction completed

Manipada	Well repair	Protection of well from siltation	Pumping system	Well work completed
Wadpada	No interventions planned	--		
Botoshi	Contour trenches for well recharge; well platform and drain construction	Well recharge and improvement in soil moisture, and improved sanitation around well	Pumping system with filters	
Kirkeriwadi	Well repair and de-siltation	Protection of well from siltation in monsoons		
Bhelpada	No interventions planned	--		
Markatwadi	New well; contour trenches for well recharge	Creation of an additional drinking water source, well recharge and improvement in soil moisture		Well work completed
Bhojpada	Well repair and de-siltation; new bund construction for irrigation storage	Protection of well from siltation, creation of surface water storage for irrigation	Pumping system with filters	Well work completed

Table 2 Planned Phase I interventions for each habitation

Sample images of the completed Phase I work:

Figure 3 Well lining repair and drainage construction at Kurlod well

Figure 4 New well construction at Raipada

2 Methodology

2.1 Agricultural area calculation

Firstly, agricultural area (AA) is identified using Google Earth and crosschecked with villagers, Upsarpanch, Sarpancha and Mr. Ramesh for Aroehan. Different areas are identified in each habitation and are marked as AA1, AA2, AA3 and so on. Example as given below:

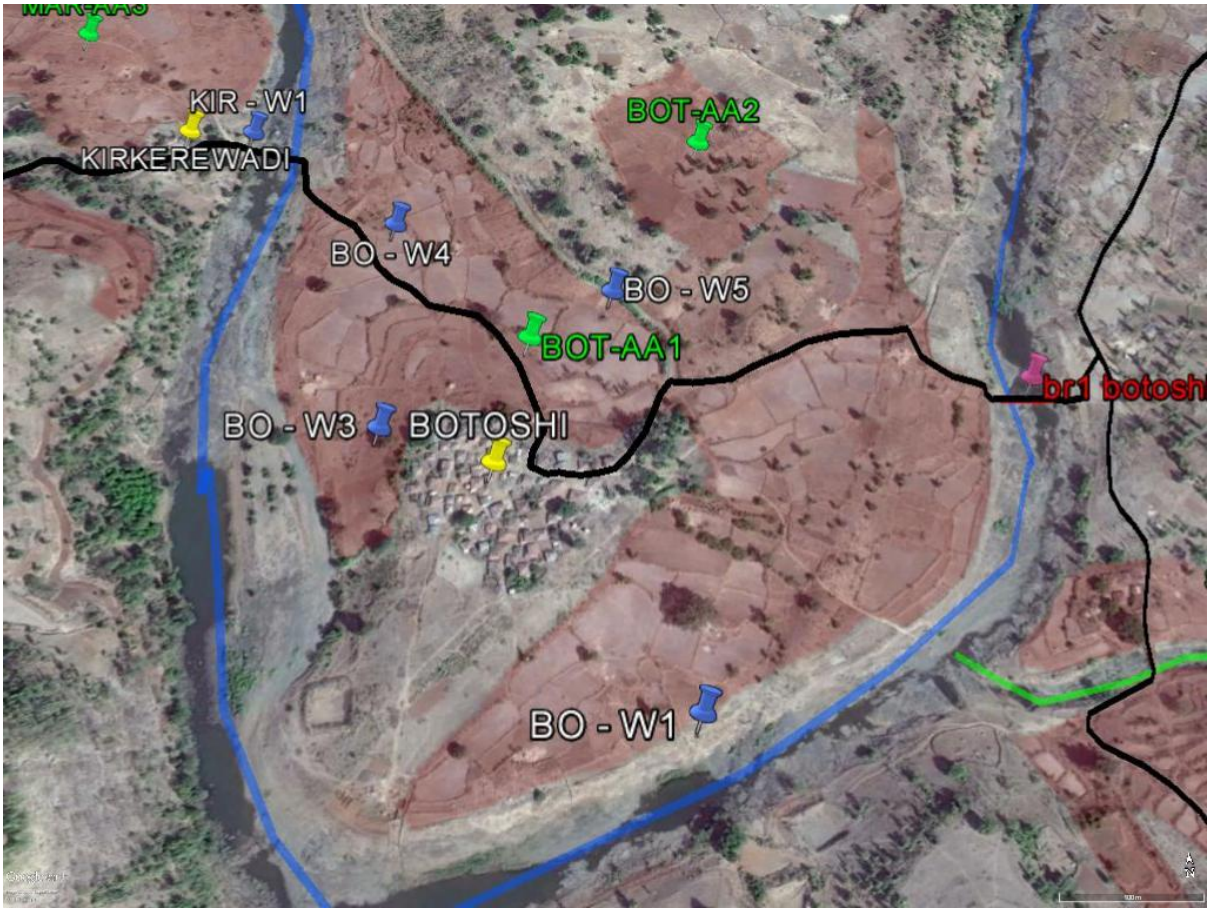

Figure 5 Agricultural area of Botoshi

Each area is discussed with villagers for their ownership and type of agriculture. All the areas were covered during site visit to check for deviation from Google Earth.

2.2 Bund storage calculation

Bund storage is calculated based on following formula:

$$Volume = 0.5 * (B * H) * L * k$$

Here, B is length of the backwater, H is height of the bund, L is length of the bund and k is factor of safety. Backwater length is calculated using a Dumpy level in the manner demonstrated in the figure below:

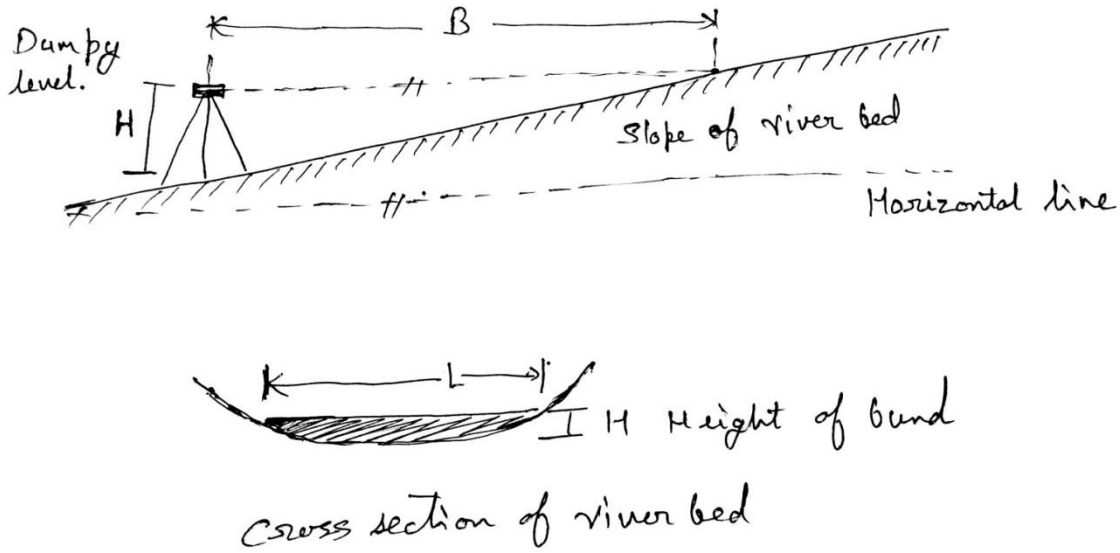

Figure 6 Slope calculation of river bed

Height of the agricultural area from the bund is measures using a scale of 5 meters. The factor of safety, k, is taken between 0.4 to 0.6 based on the local conditions of storage area of the bund.

2.3 Water demand calculation

Water demand for the crops of chilly and vegetables is calculated using data from Handbook for Agricultural by Indian Council of Agriculture Research (ICAR). Total water demand for flood irrigation for crop, i.e. delta, of chilly is taken as 50 cm and for vegetables is taken as 30 cm. Duration of crops in both cases is taken as 90 days with watering on every alternate days for calculation of maximum cultivable area. Total cultivable area based on water storage capacity of the bund is calculated for four scenarios as following:

1. Area cultivable under flood irrigation for chilly
2. Area cultivable under drip irrigation for chilly
3. Area cultivable under flood irrigation for vegetables
4. Area cultivable under drip irrigation for vegetables

Water demand in case of drip irrigation is taken as one third of flood irrigation of the same crop.

2.4 Pump selection

Duty parameters for pumps i.e. required head and flow are calculated using on the Hazen–Williams equation and daily water requirements respectively. Pumps are selected from online available catalogs of agricultural pumps by Kirloskar (attached in appendix).

3 Interventions

3.1 Kurlod habitation: Current scenario and proposed interventions

Kurlod habitation has four wells and a bund, shown in the map below. It has large agricultural area which needs to be irrigated in rabbi season to improve the livelihood. Following are the details of agricultural area in Kurlod village.

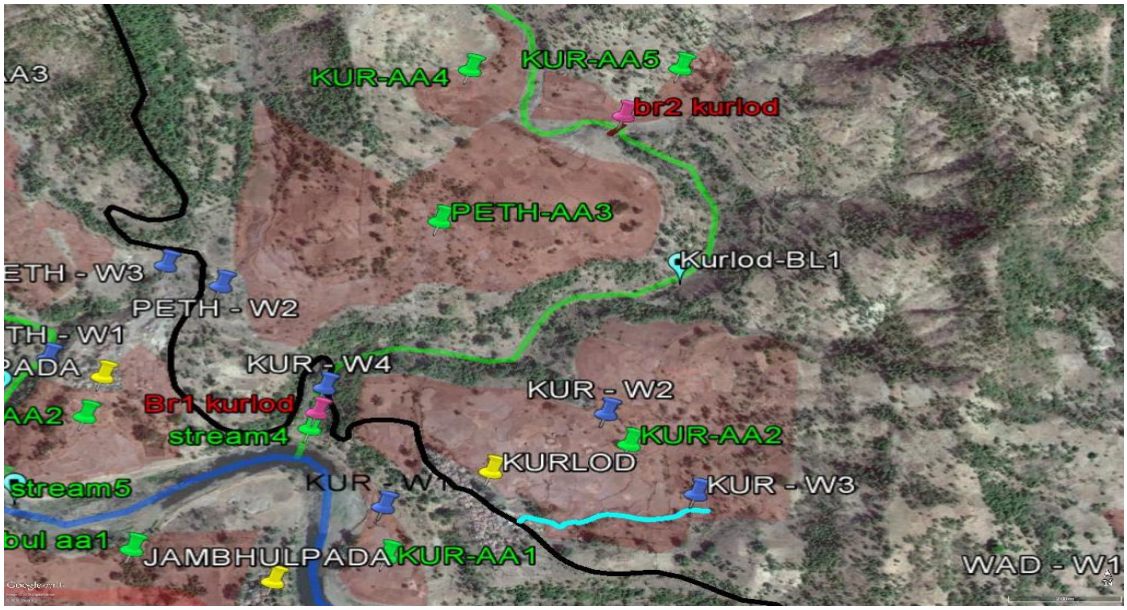

Figure 7 Agriculture areas of Kurlod village.

Following table shows total agricultural area in Kurlod village.

NAME	Area(m^2)	Area in Acre
AA1	25,816	6
AA2	1,91,168	47
AA4	28,897	7
AA5	30,953	7
Total	2,76,834	68

Table 3 Agricultural area in Kurlod village.

3.1.1 Current status of bund (BR1):

Kurlod's existing bund stands on a stream that flows into the Pinjal River. The bund has a significant leakage problem; by the end of November virtually all the water stored leaks out. Large cavities and cracks can be seen at the base and in the body of the bund. AA2 agricultural area can be irrigated which is at elevation of 23m (right side of upstream). **However, as this bund will support the primary drinking water well 4 (W4), it is advisable to not use this bund for agricultural purpose.** Latitude and longitude of this bund is 19°48'46.40"N and 73°18'31.93"E.

Following are the details of broken bund (BR1).

Name	Height (m)	Back water Length (m)	Length of bund (m)	Volume (m^3)
BR1	2.4	110	19.2	1267

Table 4 Details of broken bund(BR1) in Kurlod

Figure 8 Current status of broken bund (BR1) in Kurlod

Figure 9 Current status of Kurlod well (W4) after repair

3.1.2 Proposed bund (BL1)

For fulfillment of water requirement for irrigation new bund is suggested at location 19°48'56.52"N and 73°18'54.54"E.

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BL1	1.65	97	17	884
	2	117	17	1299
	2.5	147	17	2030
	3	176	17	2923

Table 5 Detail of proposed bund (BL1) in Kurlod.

3.1.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly(m^2)	Drip Irrigated area of chilly(m^2)	Flood Irrigated area of vegetable(m^2)	Drip Irrigated area of vegetable(m^2)
Proposed	5846	17538	9743	29230
Broken	756	2268	1260	3780
River	8093	24280	13488	40467

Table 6 Irrigation Detail of Kurlod

3.2 Pethechapada: Current scenario and proposed interventions

Pethechapada agriculture AA3 can be provided water from BR2 of Kurlod and areas AA2 and AA1 can be irrigated either by BL1 or river bund. The agricultural area identified around Pethechapada is shown in the map below.

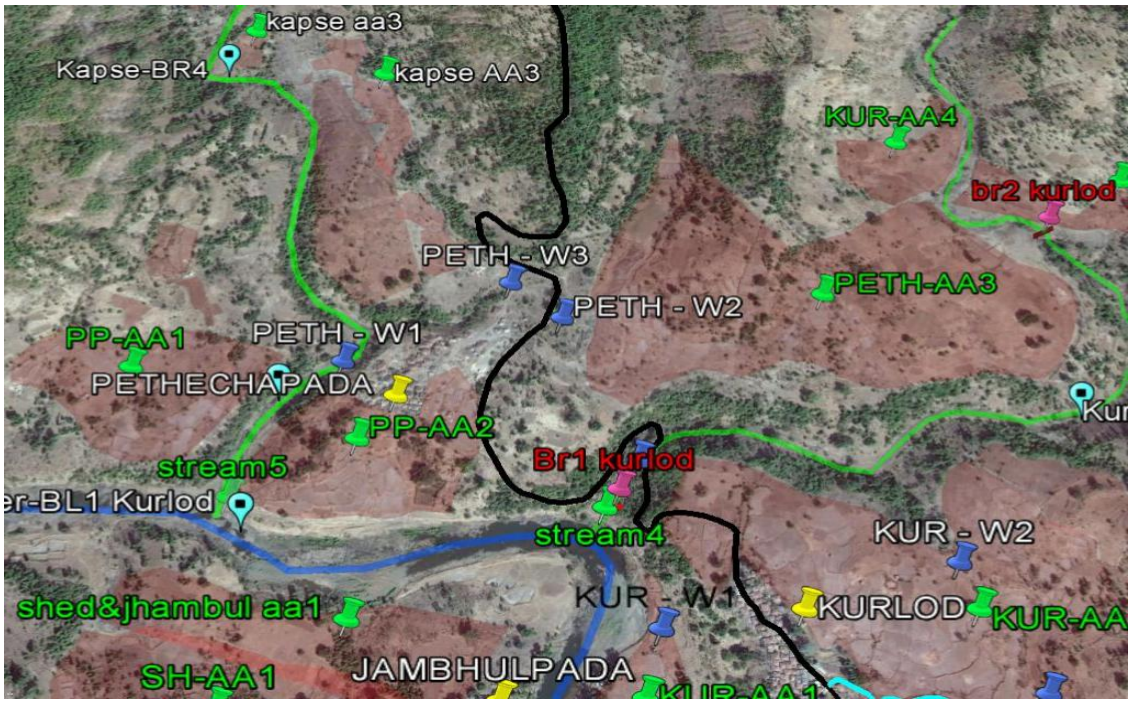

Figure 10 Agriculture areas of Pethechapada

Following are details of agricultural area in Pethechapada:

Name	Area(m^2)	Area in acre
AA1	71,312	18
AA2	70,546	17
AA3	2,58,737	64
Total	4,00,595	99

Table 7 Detail of Pethechapada agricultural area

3.2.1 Current status

The following work has been completed in Pethechapada as part of Phase I: Repair of Well 1 wall and lining to prevent silt from entering, plugging of hole in the well to prevent muddy surface water from entering it during the monsoons, construction of drainage line and de-silting of the well. Siltation problem has been solved after repair of well (W1). It will be used by villagers for domestic purpose.

3.2.2 Proposed bund (BL1)

Bund (BL1) will recharge well (W1) and irrigate (AA1 & AA2). AA2 and AA1 farm land is at elevation of 12 m and 15 m respectively. Latitude and Longitude of proposed bund is 19°48'49.35"N and 73°18'13.47"E.

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BL1 (near well)	1.6	81	20	842
	2	101	20	1316
	2.5	126	20	2056

Table 8 Details of proposed bund location in Pethechapada.

Note: Irrigational area (AA3) can be irrigated by proposed Kurlod bund BL1.

3.2.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly(m^2)	Drip Irrigated area of chilly(m^2)	Flood Irrigated area of vegetable(m^2)	Drip Irrigated area of chilly(m^2)
River bund at Kurlod	12,140	36,420	20,233	60,700

Table 9 Detail of irrigated area in Pethechapada

3.3 Shedyachapada & Jambhulpada: Current scenario and proposed interventions

Shedyachapada and Jambhulpada are two small neighbouring habitations with a combined population of 150. There are two wells in the vicinity of the habitations, this area belongs to low stress zone. One stream was found near Shedyachapada recently known as Ambechapada. Volumetric calculations show that irrigational demand cannot be satisfied with construction of bund in Ambechapada.

Figure 11 Agriculture areas of Shedyachapada and Jambhulpada.

Following are details of agricultural area in Shedyachapada & Jambhulpada

Name	Area(m^2)	Area in acre
AA1	1,36,783	51
AA2	1,72,200	43
Total	3,08,983	94

Table 10 Detail of Shedyachapada agricultural area.

3.3.1 Current Status:

In Shedyachapada and Jambhulpada there is a need for a river bund which can solve the irrigation problem of Shedyachapada, Jambhulpada and Kurlod. Currently there is no bund either on stream or river to solve this problem.

3.3.2 PROPOSED RIVER BUND LOCATION (BL -1)

River Bund (BL-1) can irrigate the area of Shedyachapada, Jambhulpada and some parts of Kurlod, Pethechapada. Farm land of Shedyachapada and Jambhulpada are at 8 m and 20 m respectively. (Right side of upstream)

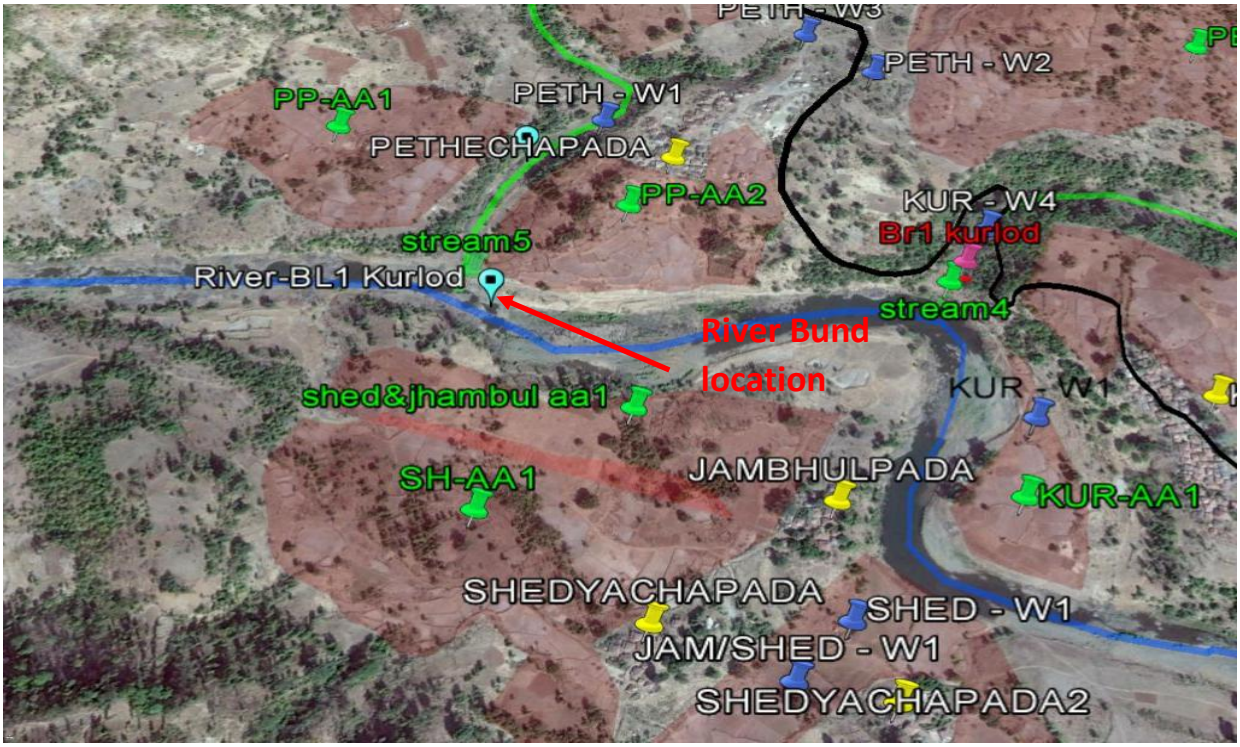

Figure 12 River Bund location (BL1)

Following are details of River Bund:

Name	Back water length(m)	Height(m)	Length of bund(m)	volume(m^3)
River Bund	800*	2	60	31,200*

Table 11 Detail of river bund in Kurlod.

*Calculation is done based on slope calculation of Manipada bund

3.3.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly(m^2)	Drip Irrigated area of chilly(m^2)	Flood Irrigated area of vegetable(m^2)	Drip Irrigated area of vegetable(m^2)
River bund	42,166	1,26,498	70,276	2,10,830

Table 12 Irrigated area in Shedyachapada and Jambhulpada

River bund in Kurlod will be beneficial for several villages which include Shedechyapada, Jambhulpada, Pethechapada and Kurlod.

3.3.4 Proposed Bund: Ambechapada (BL1)

Ambechapada bund (BL1) can partially solve the problem of Shedyachapada. Topography of area shows that bund height cannot be increase beyond 1.5m.Latitude and longitude of proposed bund is 19°48'23.54"N,73°18'37.59"E

Figure 13 Topography of Ambechapada Bund (BL1) location.

Following are the details of Ambechapada Bund

Name	Height (m)	Back water Length (m)	Length of bund (m)	Volume (m^3)
Ambechapada (BL1)	1.5	68	7.5	188

Table 13 Detail of proposed bund in Ambechapada (BL1).

Note: If river bund in Kurlod is constructed there is no need of Ambechapada Bund (BL1).

3.4 Raipada: Current scenario and proposed interventions

Raipada has a population of 80 and currently has one well (Well 1) that lasts through the year but that had a major water quality problem just after the monsoons, in October. TDSC collected a water sample in November suspecting a high concentration of iron, but did not find exceptionally high concentrations of iron. There is a bund within the fields (BL1 in image below), about 250 m from the habitation, which has minor leakage and holds water until February. There is an additional bund (BR1) that is broken from the middle, holds no water. The bund BR1 requires minor repair work and a gate in order to be functional again.

Figure 14 Agriculture areas of Raipada.

Following are the details of agricultural area

Name	Area (m^2)	Area in acre
AA1	55,206	13.6
AA2	52,141	19.3
Total	1,07,347	33

Table 14 Detail of Raipada agricultural area.

3.4.1 Current Status of well (W1)

Raipada belongs to medium stress zone, and the construction of the new well is complete.

Following are the details of well (W1)

Name	latitude	Longitude	Diameter (m)	depth
well W1	19°48'6.21"N	73°18'47.56"E	3	4.5

Table 15 Well detail of Raipada.

Figure 15 Repair of old primary well (w1) in progress.

3.4.2 Current Status of bund (BL1)

Raipada's existing bund (see photos below) holds water until February, and was built with the intention of providing water for irrigation. Physical details about the bund are in the table below. The bund has minor leaks in a few places: if they are repaired the bund would retain water beyond February, and a pumping system can be installed in the future to pump water to the fields for a second crop. Siltation has been observed during our visit.

Intervention details:

Agricultural area AA2 can be irrigated with minor repair of bund (BL1). The fields are at elevations of 8 m and 4 m, from the left and right side of upstream, respectively. De-siltation is needed to maximize the capacity of bund. Latitude and longitude of bund is 19°48'11.98"N and 73°18'43.40"E

Figure 16 Raipada Bund condition in 1st week of June

Following are the details of Raipada Bund:

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BL1	2	78	28	983

Table 16 Details of Raipada bund

3.4.3 Current Status of Broken bund (BR1)

There is an additional bund in that is broken from the middle, holds no water and has little scope for repair. Repair of this bund would irrigate partial area of AA-2 which is almost at ground level. Latitude and longitude of bund is 19°48'9.90"N and 73°18'46.80"E

Figure 17 Broken bund (BR1) of Raipada

Following are the details of broken Bund (BR1)

Name	Height (m)	Backwater length(m)	Length of bund(m)	volume(m^3)
BR1	1.7	70	14.2	253

Table 17 Details of broken bund (BR1) in Raipada

3.4.4 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly(m^2)	Drip Irrigated area of chilly(m^2)	Flood Irrigated area of vegetable(m^2)	Drip Irrigated area of vegetable(m^2)
Constructed	1965.6	5896.8	3276	9828
Broken	506.94	1520.82	844.9	2534.7

Table 18 Detail of irrigated area in Raipada

3.5 Manipada: Current scenario and proposed interventions

Manipada has a population of 60 and two wells, one that holds water through the year (Well 2) and one that dries in October (Well 1). Repair of well (W2) was completed during our visit. A partially complete river bund (BR1) was also completed. The river bund can alone meet the irrigational demand of the habitation and also recharge the primary well (W2).

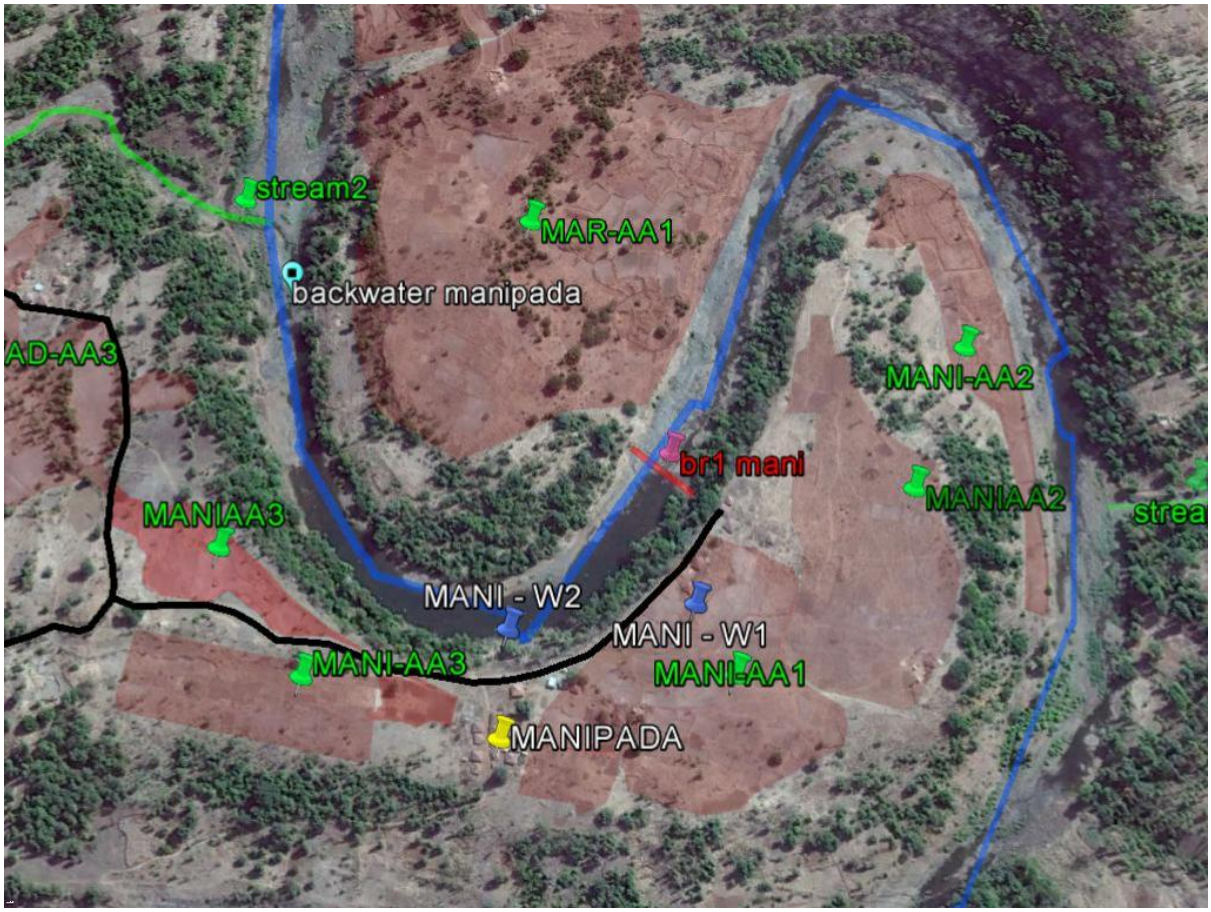

Figure 18 Agriculture areas of Manipada.

Following are the details of agricultural area in Manipada:

Name	Area (m^2)	Area in Acres
AA1	48644	13
AA2	26525	17
AA3	16068	9
Total	91237	48

Table 19 details of agricultural area in Manipada

3.5.1 CURRENT STATUS:

The repair work of Well 2 (W2), consisting of a new platform and repair to the damaged well wall, was completed during our visit period. The problem of well accessibility remains, however.

Figure 19 Present condition of well (w2)

3.5.2 Current status of river bund (BR1):

Manipada river bund was completed during our visit period. River bund alone can meet the irrigational demand of agricultural area (AA1, AA2, and AA3). Farm land of Manipada is at a elevation of 35 m (left side of upstream). Latitude and longitude of bund is19°48'0.91"N and 73°19'17.13"E.

Proposed intervention for Manipada: Manipada irrigational area water requirement can be satisfied with River bund (BR1).There is no need of other bund for irrigation purposes
Following are the details of Manipada Bund:

Name	Height (m)	Back water length (m)	Length of bund (m)	Volume (m^3)
River Bund	1.5*	640	70	20160*
	3	1280	70	80640

Table 20 Details of Manipada river bund

*Volumetric calculation for 1.5 meters of height corresponds to water level of 1st week of June.

Figure 20 Backwater of Manipada (670 m from Manipada river bund)

3.5.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly (m^2)	Drip Irrigated area of chilly (m^2)	Flood Irrigated area of vegetable (m^2)	Drip Irrigated area of vegetable (m^2)
River	20,160	60,480	33,600	1,00,800

Table 21 Irrigated area of Manipada

3.6 Wadpada: Current scenario and proposed interventions:

Wadpada has a population of 100, and 2 wells shown in the image below. Well 1 dries in October, while Well 2 dries in March, after which villagers rely on the Pinjal River for all purposes. This area belong to high stress zone, there is not a single bund in this area to satisfy irrigational demand and for recharge of well.

Figure 21 Agriculture areas of Wadpada

Following are the details of agricultural area in Wadpada:

Name	Area(m2)	Area in Acre
AA1	63093	6.41
AA2	20558	8.1
AA3	23417	19.6
Total	85968	34

Table 22 agricultural area in Wadpada

3.6.1 Proposed Bund (BL1)

This bund is essential as it can recharge well W2, water will be available throughout the year. Well was totally dry in June. Bund (BL1) can also meet the irrigational demand of area AA2 and some parts of AA1. Bund height cannot be increased beyond 1.5 m as topography does not permit and also there are chances agricultural area submergence. Agricultural area AA1 is at elevation of 7 m. Latitude and longitude of bund is 9°48'31.27"N and 73°19'27.84"E.

Following are the details of Wadpada Bund (BL1):

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
Proposed (BL1)	1.35	65	17	410

Table 23 Details of Wadpada bund (BL1)

3.6.2 Proposed Bund (BL2):

Bund (BL2) is necessary to satisfy irrigational demand of area (AA1 and AA2). Farm land AA1 and AA2 must be irrigated to improve the livelihood of people. Bund height cannot be increased beyond 1.35 m as topography of area does not permit. AA2 is at an elevation of 12 m (left side of upstream). Latitude and longitude of bund is 19°48'38.81"N and 73°19'27.26"E.

Following are the details of Wadpada Bund (BL2):

Name	Height (m)	Back water length (m)	Length of bund (m)	Volume (m^3)
Proposed (BL2)	1.35	63	16	374.22

Table 24 Details of Wadpada Bund (BL2)

Irrigational demand for AA3:

Manipada backwater can easily meet the irrigational demand of agricultural area (AA3). Agricultural area (AA3) is at an elevation of 23m from Pinjal river. Depth of water was almost 10-12 feet in month of June.

3.6.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly (m^2)	Drip Irrigated area of chilly (m^2)	Flood Irrigated area of vegetable (m^2)	Drip Irrigated area of vegetable (m^2)
Proposed	748	2245	1247	3742

Table 25 Irrigated area in Wadpada

3.7 Kapsepada: Current scenario and proposed interventions

Kapsepada belongs to low stress zone and it has got five (5) wells. Well 5 have water throughout the year generally used for domestic purpose. Kapsepada's existing bund stands on a stream that flows into the Pinjal River. The bund has a significant leakage problem; by the end of November virtually all the water stored leaks out. Large cavities and cracks can be seen at the base and in the body of the bund.

Figure 22 Agriculture areas of Kapsepada

Following are the detail of Kapsepada agricultural area

Name	Area(m^2)	Area in acre
AA1	18045	4.5
AA2	19704	4.9
AA3	44586	11
Total	82335	20.5

Table 26 Detail of Kapsepada agricultural area

3.7.1 Broken Bund (BR4)

Latitude and longitude of bund is19°49'11.66"N, 73°18'3.19"E

Figure 23 Current status of Kapsepada bund (BL4)

Following are the details of broken bund:

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BR4	2.1	160	28	2822

Table 27 details of broken bund (BL4)

Proposed suggestion:

Repair of broken bund (BR4) is essential as it has a large volumetric storage of water. Area AA3 can be easily irrigated. It can also solve the drinking water problem of Kapsepada.

3.7.2 Proposed Bund (BL2):

Bund construction at location 2 (BL2) is difficult task as it requires skilled labour and machinery due to hard rock bed. Storage of the bund is also very less. AA2 can be irrigated by this bund. AA2 is at an elevation of 15 m and 5 m on left and right side of upstream, respectively. Latitude and longitude of bund is 19°49'27.08"N and 73°18'3.63"E.

Figure 24 Hard bed rock at BL2 in Kapsepada

Following are the details of proposed bund (BL2):

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BL2	1.65	97	12	384

Table 28 Details of proposed bund (BL-2) in Kapsepada

3.7.3 Proposed Bund (BL3):

Kapsepada bund location (BL3) is an ideal place for bund construction as there is agricultural area nearby. Irrigational area AA1 can be irrigated by bund at location BL3. The height of the bund cannot be increased beyond 1.5 m as there are chances of submergences of agricultural area. Agricultural area AA1 is at an elevation of 17 m and 8 m left and right side of upstream, respectively. The highest elevation of farm is considered on both sides. Latitude and longitude of bund is19°49'38.69"N and 73°17'56.77"E.

Following are the details of Bund (BL3)

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BL3	1.4	94	16	632

Table 29 Details of proposed bund (BL-3) in Kapsepada

Priority should be given to bund location BR4 and BL3.

3.7.4 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly(m^2)	Drip Irrigated area of chilly(m^2)	Flood Irrigated area of vegetable(m^2)	Drip Irrigated area of vegetable(m^2)
Proposed	1263	3790	2105	6316
Broken	5645	16934	9408	28224

Table 30 Irrigated area in Kapsepada

3.8 Botoshi habitation: Current scenario and proposed interventions

Botoshi has a population of 400 and 5 wells, four of which dry in October and one that lasts until May (W5 in the image below). W5 is the primary well with good water quality which last till summers, during summer season villagers rely on river pits. Repair of well (W1) was in progress during our visit. There is a broken bund (BR 1 in image below), which is on the Pinjal River. During the monsoons, water flows several feet over the broken sections of the bund, making it unsafe to cross the river and cutting the habitation off from the road.

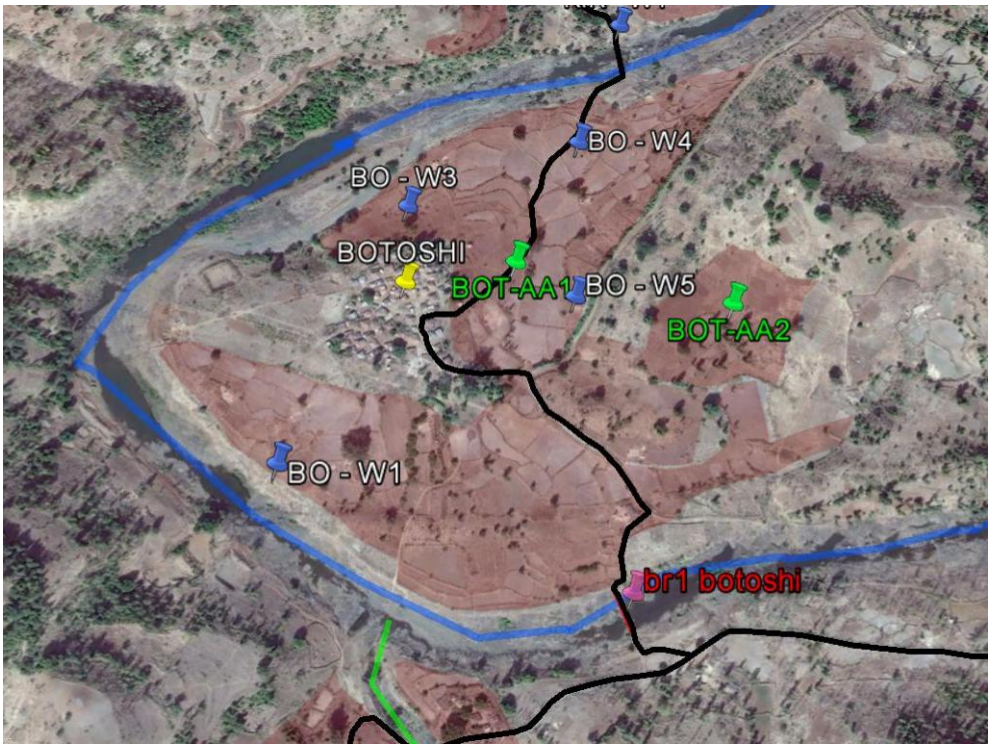

Figure 25 Agriculture areas of Botoshi

Details of agricultural area in Botoshi

Name	Area (m^2)	Area in Acre
AA1	2,02,343	50
AA2	50,008	12
Total	2,52,351	62

Table 31 Details of agricultural area in Botoshi

3.8.1 Current status: broken bund (BR1)

Currently Botoshi does not have any river bund or stream bund. Construction of Broken bund (BR1) is essential as it can irrigate area (AA2 and some parts of AA1). To irrigate other part of AA1 pump needs to be installed. Proper design of this bund can solve the accessibility problem of Botoshi.

Figure 26 Present condition of broken bund (BR-1)

Proposed intervention: there is an urgent need of bund (BR1) to be constructed as it can solve both the irrigational and accessibility problem of Botoshi. Construction of this bund can store huge amount of water, enough to serve the irrigational purposes of Botoshi in any season. Base of broken bund was considered as datum and volume was calculated. Agricultural area AA1 and AA2 is at an elevation of 12 m on left side of upstream. Latitude and longitude of bund is 19°47'54.05" and 73°20'18.69"E.

Following are the details of broken Bund (BR1)

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
River bund	0.76	135	53	1767
	2	700	53	24,115
	2.5	875	53	37,679
	3	1050	53	54,258

Table 32 details of broken bund in Botoshi (BR1)

3.8.2 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly (m^2)	Drip Irrigated area of chilly (m^2)	Flood Irrigated area of vegetable (m^2)	Drip Irrigated area of vegetable (m^2)
river	48,230	1,44,690	80,383	2,41,150

Table 33 Irrigated area in Botoshi

River bund cum bridge design must be provided as Botoshi faces accessibility problem in rainy season.

Figure 27 Accessibility problem of Botoshi.

3.9 Markatwadi & Kirkirewadi: Current scenario and proposed interventions

3.9.1 Current status of Markatwadi:

Markatwadi has a population of 150 and has three wells, shown in figure below. None of the three wells can be used the whole year but Manipada backwater will recharge Well (W2 & W3). Markatwadi has got large agricultural area. Previously no bund was constructed in this region due to absences of stream in nearby area.

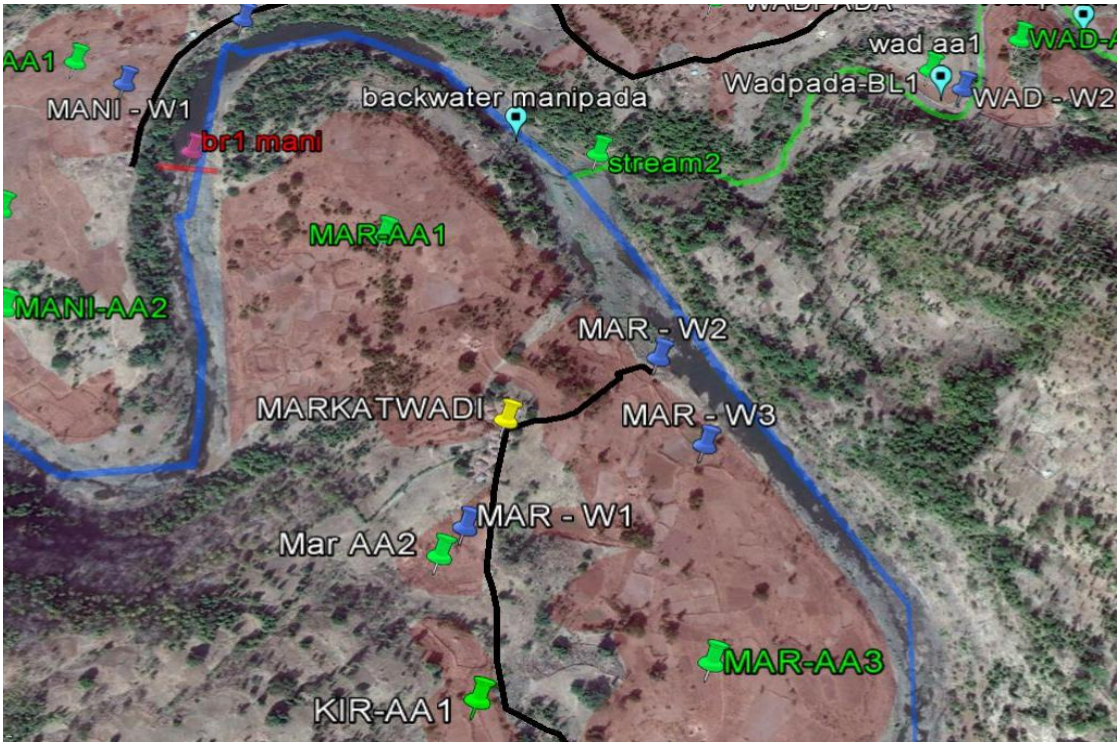

Figure 28 Agriculture areas of Markatwadi and Kirkirewadi

Following are the details of agricultural area in Markatwadi &Kirkirewadi

Name	Area (m^2)	Area in acre
AA1	1,58,636	39.2
AA2	9064	2.24
KAA2	22,500	5.56
AA3	1,62,683	40.2
Total	3,52,880	87

Table 34 Agricultural area in Markatwadi & Kirkirewadi

3.9.2 Current status of Kirkirewadi:

Kirkirewadi is a small habitation with a population of 40. It has a single well (W1 in image above) which lasts through the year but whose water quality deteriorates from April-May, after which villagers shift to using river water. The well gets submerged during the monsoons by at least 1 meter. Well (W1) repair was in progress during visit, this would probably solve the problem of submergence and drinking water problem.

3.9.3 Proposed solution of Markatwadi:

Markatwadi has got large agricultural area which can be easily irrigated with help of Manipada river bund. Agricultural area (AA1) is at an elevation of 23 m from river bund (right side of upstream).Pump needs to be installed for irrigational purpose.

Agricultural area AA3 can also be irrigated with the help of Manipada back water which is at elevation of 7 m from river.

3.9.4 Proposed solution of Kirkirewadi:

Kirkirewadi has got small agricultural area which can be irrigated by **Manipada backwater**, but pump of high capacity needs to be installed. Single pump can irrigate Kirkirewadi area along with Markatwadi area (AA3).

3.10Bhelpada: Current scenario and proposed interventions

3.10.1Current scenario

Bhelpada is the largest habitation in Botoshi with a population of 450. It has one well that lasts until June, after which villagers rely on the river. There is a broken bund approximately 500 m from the habitation. Broken bund (BL1) is at perfect location as it covers maximum agricultural area .Bund (BL1) is in totally damaged condition

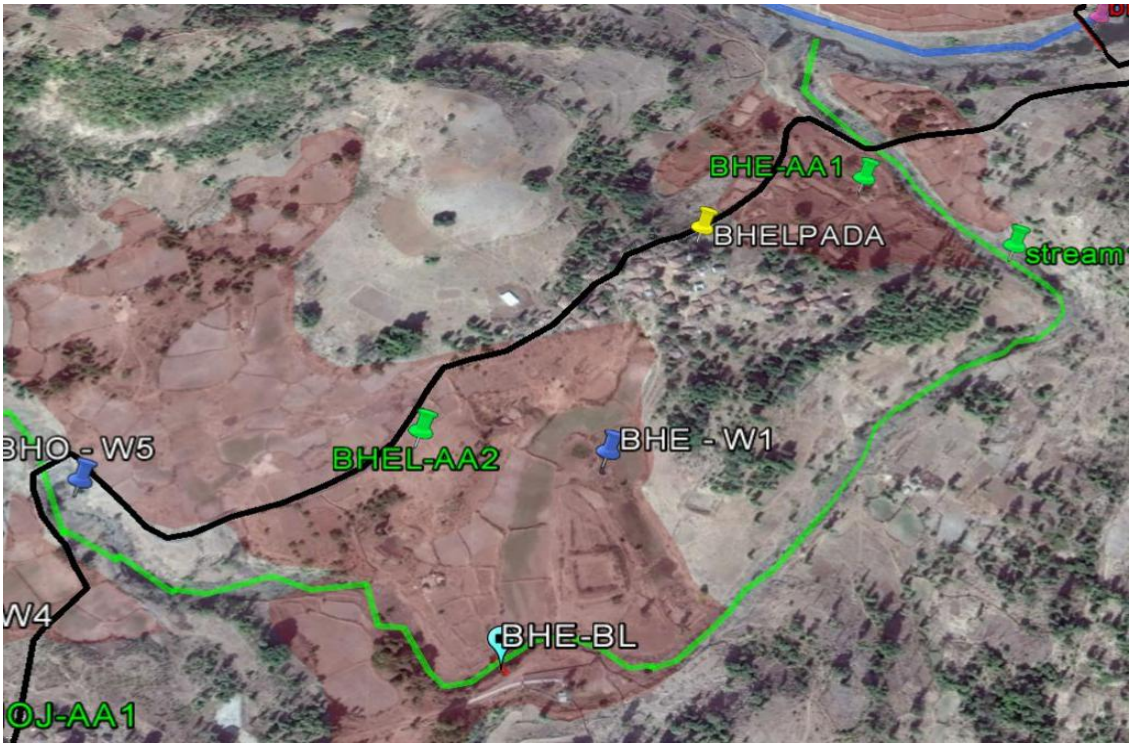

Figure 29 Agriculture areas of Bhelpada.

Following are the details of Bhelpada agricultural area:

Name	Area (m^2)	Area in acre
AA1	43,301	10
AA2	1,74,237	43
Total	2,17,538	54

Table 35 Details of Bhelpada agricultural area

3.10.2 Possible suggestion:

Bhelpada has large agricultural area. Repair of bund is required to improve the livelihood of villagers. Currently there exists a bund which is totally in damaged condition. Agricultural

area AA2 can be irrigated with the help of this bund which is at an elevation of 5m (right side of upstream). Latitude and longitude of bund is 19°47'28.92"N and 73°20'31.93"E.

Figure 30 Present condition of Bhelpada Broken bund (BR1)

Following are the details of broken Bund (BR1)

Name	Height (m)	Backwater length (m)	Length of bund (m)	Volume (m^3)
BR1	1.8	64	12.2	316

Table 36 Details of broken bund in Bhelpada (BR1)

3.10.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly (m^2)	Drip Irrigated area of chilly (m^2)	Flood Irrigated area of vegetable (m^2)	Drip Irrigated area of vegetable (m^2)
Broken	632	1896	1053	3160

Table 37 Irrigated area of Bhelpada

3.11Bhojpada: Current scenario and proposed interventions

Current status:

Bhojpada has a population of 340 and has five wells, two of which hold water all year round (Well 1 and 1b). The Google Earth image below shows the locations of all five wells. Well 1 and 1b are the primary wells, and lie adjacent to each other and on the bank of a stream that leads to the Pinjal River.

Bhojpada also has two bunds (BL1 and BR1 in image below). Bund (BR1) is almost silted and entirely broken from the middle and cannot be repaired. Bund (BL1) is leaking but can be greatly enhanced by repairing the structure.

Figure 31 Agriculture areas of Bhojpada

Following are the details of Bhojpada Agricultural area:

Name	Area (m^2)	Area in Acre
AA1	28,409	7
AA2	18,026	6.8
AA3	80,532	19.9
Total	1,26,967	34

Table 38 Details of Bhojpada agricultural area

3.11.1 Current Status of bund (BL1):

Bund (BL1) has minor leakage problem, but water is available till December. Its main purpose is to recharge the well (W1 & W1b), water is available though out the year in these two well. Agricultural area nearby to this bund is very less. Minor repair work can be done here to prevent leakage from the bottom. Latitude and longitude of bund is 19°47'22.62"N and 73°20'36.14"E.

Figure 32 Present Condition of Bhojpada Bund (BL1).

Following are the details of broken Bund (BL-1)

Name	Height (m)	Back water length (m)	Length of bund (m)	Volume (m^3)
BL 1	1.8	82	21.8	756

Table 39 Details of Bhojpada bund (BL-1)

3.11.2 Current Status of bund (BR1):

Bhojpada has got another bund which is completely silted and completely broken from middle; repair of this bund is a difficult task. Bund BR1 has got perfect location as majority of agricultural area is nearby to this bund.

Proposed intervention: Agricultural area (AA2& AA3) can be irrigated with the help of this bund .DE siltation is needed to increase the storage of water as the area has been completely silted. Repair of this bund is not possible due to complete damage. There is a need of other bund at the same location due to topographical advantages. Siltation is major problem in this region so while designing gate or pipe must be provided at bottom. Latitude and longitude of proposed bund is 19°47'13.49"N and 73°20'19.64"E.

Following are the details of broken Bund (BR-1)

Name	length(m)	height(m)	width(m)	volume(m^3)
broken bund	-	-	29.8	as it was silted

Table 40 Details of broken bund in Bhojpada (BR1)

Figure 33 Present condition of broken bund (BR1)

3.11.3 Cultivable area

Considering water requirement for chilly and vegetable, calculation are worked out for 2 meter of bund height. The flood irrigation water requirement, delta, of Chilly and vegetable is 50 cm and 30 cm respectively. The water requirement for drip irrigation is assumed to be 1/3rd of delta.

Name	Flood Irrigated area of chilly(m^2)	Drip Irrigated area of chilly(m^2)	Flood Irrigated area of vegetable(m^2)	Drip Irrigated area of vegetable(m^2)
BR1	1512	4536	2520	7560

Table 41 Irrigated area in Bhojpada

*Volume of broken bund (BR1) is not considered as it was completely silted.

4 Summary

4.1 Size of pumps

Village	Discharge (lps)	Daily Pumping Hour	Pump model	Power
Bhojpada	1.17	4	KU4-1505 T	1
Bhelpada	0.49	4	KU4-1505 T	1
Botoshi	4.96	5	KS7A-1003	7.5
Wadpada				
AA2	0.58	4	KU4-1505 T	1
AA3	6.22	5	KS7A-1003	7.5
Manipada	6.22	5	KS8P-1304	12.5
Markatwadi & Kirkirewadi	12.44	5	KS7A-1505	11
Raipada				
AA2	1.52	4	KU4-1505 T	1
AA2	0.39	4	KU4-1504 T	0.75
Shedyachapada and Jambhulpada	13.01	5	KS8P-1304	12.5
Kurlod				
AA2	1.80	5	KS6F-0503	5
AA4	0.58	4	KU4-1504 T	0.75
AA1	2.50	5	KS6F-0503	5
Pethechapada				
AA3	3.75	5	KS6F-0604	6
Kapsepada				
AA1	0.97	4	KU4-1505 T	1
AA3	1.74	5	KS6D-0504	5

Table 42 Pump at different habitat

4.2 Summary of cultivable areas

Village	Flood irrigated area for Chilly (m^2)	Drip irrigated area for Chilly (m^2)	Flood irrigated area for vegetable (m^2)	Drip irrigated area for vegetable (m^2)
Bhojpada	1,512	4,536	2,520	7,560
Bhelpada	632	1,896	1,053	3,160
Botoshi	48,230	1,44,690	80,383	2,41,150
Wadpada				
AA2	748	2,245	1,247	3,742
AA3	20,160	60,480	33,600	1,00,800
Manipada	20,160	60,480	33,600	1,00,800
Markatwadi and Kirkirewadi	1,20,960	3,62,880	2,01,600	6,04,800
Raipada				
AA2	1,966	5,897	3,276	9,828
AA2	507	1,521	845	2,535
Shedyachapada and Jambhulpada	42,166	1,26,498	70,277	2,10,830
Kurlod				
AA2	5,846	17,538	9,743	29,230
AA4	756	2,268	1,260	3,780
AA1	8,093	24,280	13,489	40,467
Pethechapada				
AA3	12,140	36,420	20,233	60,700
Kapsepada				
AA1	1,263	3,790	2,106	6,317
AA3	5,645	16,934	9,408	28,224
Total	2,90,785	8,72,354	4,84,641	14,53,923
Area in acre	72	216	120	359
Percentage of area that can be irrigated	12	38	21	63

Table 43 Irrigated area at different habitat