Project Preparation Technical Assistance

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FINAL REPORT

for the

Karnataka Integrated and Sustainable Water Resources Management Investment Program

Volume 4: Annexure - 2
Initial Environmental Evaluation, Gondhi Anicut

Prepared for the State Government of Karnataka and the Asian Development Bank

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By

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Abbreviations

AC-IWRM	Advanced Centre - Integrated Water Resource Management
ADB	Asian Development Bank
AEE	Assistant Executive Engineer
BGL	Below ground level
CADA	Command Area Development Authority
CE	Chief Engineer
CPCB	Central Pollution Control Board
DoEF	Department of Environment and Forests, Government of Karnataka
EARF	Environmental Assessment and Review Framework
EE	Executive Engineer
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA, 1986	Environmental Protection Act, 1986
GoI	Government of India
GoK	Government of Karnataka
HA	Hectors
HWHAMA	Hampi World Heritage Area Management Authority
IEE	Initial Environmental Evaluation
IWRM	Integrated Water Resources Management
KISWRMIP	Karnataka Integrated and Sustainable Water Resources Management Investment Program
KSPCB	Karnataka State Pollution Control Board
MAB	Man and Biosphere
MFF	Multitranche Financing Facility
MoEF	Ministry of Environment and Forests, India
MW	Megawatts
NABET	National Accreditation Board of Education and Training
O&M	Operation and Management
PMU	Project Management Unit
RSPM	Respiratable Suspended Particulate Matter
SE	Superintending Engineer
TA	Technical Assistance
QCI	Quality Council of India
UNESCO	United Nations Educational, Scientific and Cultural Organisation

EXECUTIVE SUMMARY

1. The SGOK has requested financing from the Asian Development Bank (ADB) to enhance water security in selected basins where there is increasing water stress due to rapid economic growth and future competing needs for water supply and industry. Based upon an agreement between Government of India, SGOK and ADB agreed to prepare the Karnataka Integrated and Sustainable Water Resources Management Investment Program (KISWRMIP). This is to be financed through a Multi-tranche Financing Facility (MFF) to enable flexibility in investment decisions and timing based on the needs and constraints of the project, instead of a precise definition of investments up front as conventionally required.

2. There are three outputs for the project. These are, Output 1: AC-IWRM Strengthened to Support State and Basin Level IWRM Institutions and Policies. Output 2: Management of Irrigation Schemes with IWRM Principles. Output 3: Efficient Program Management Systems Operational. Output 2 of the project involves modernisation the irrigation schemes for the canal systems of Tunghabhadra Left Bank Canal, Vijayanagara Channels, Gondi Anicut and the Bhadra Canal system. Of these only Gondi Anicut and Bhadra are to be in Tranche 1 and are the focus of this Initial Environmental Evaluation (IEE).

3. The project is located in the Bhadrawati Taluk of Shivamogga District. Part of this district comes under the Western Ghats. Shivamogga also has a few sensitive areas such as the Bhadra Tiger Reserve. However, Bhadrawati Taluk does not fall in any of the wildlife reserve areas. From the available information and plans it unlikely that there will be any major adverse environmental impacts from the project. Considering the limited impact of the project, this project has been categorized as Category B project. Therefore, an IEE has been conducted for it.

4. There are also likely to be a number of positive impacts from project activities such as improved drainage resulting in better soil health, increased agricultural productivity and reduced habitat for certain disease vectors. There are discussed in greater detail in the impact assessment section.

5. Most adverse impacts are likely to be during the construction phase – when the canal lining and other structures (eg. outlet structures, bridge replacements, command area works, etc) are to be put in place, agricultural intensification taking place spontaneously and as part of the project design, the increased efficiency of water use and potentially a small expansion of agriculture. The major construction related activities of concern are the procurement of material, transport routes, and the various sites. These sites include quarries and borrow pits, material storage, labour camps and construction areas. The major concerns related to construction activities are (i) safety of the workers and local population, (ii) waste disposal, (iii) impact to local ecosystems due to degradation or destruction, (iv) reduced access to the local population dependent upon the sites, (v) long term degradation of sites such as erosion or waterlogging due to inadequate rehabilitation, (vi) damage to local infrastructure, and (vii) health risks from poor site management or safety and labour management such as waterborne diseases due to inadequate provision of sanitation facilities.

6. Tanks, currently linked to the canal system and which collect catchment runoff, overland flow from an upstream irrigation area and water from the canal system may be separated and then regulated to improve functioning and water management of the canal system. This will affect, to some extent, tank functions as ephemeral wetlands and result in longer term and less variable water levels. This could have some impact on the local ecosystem; however this is not likely to be a major concern.

7. Agricultural interventions and intensification is likely to result in higher use of agrichemicals[1]. This is expected to create greater toxicity to the environment impacting human health and the ecosystem adversely as these chemicals enter the environment. Furthermore, the disposal of

1 Household survey and anecdotal experience indicates that the use of fertilisers is already high and exceeding recommendations levels. The project intervention is to reduce this to recommended levels.

agrichemical waste will also become an issue considering that at present there is no system for its disposal. While some waste is burnt or buried other, such as plastic containers are reused, entering the human food chain directly. Furthermore, any expansion of irrigated agriculture, although not planned may result in increased waterlogging, that may have an adverse impact on soil health and agriculture productivity. Increased waterlogging may also result in an increase in vector-borne diseases like malaria, or waterborne diseases due to existing low levels of sanitation.

8. Increased irrigation efficiency is another possible concern for the environment. While increased irrigation efficiency in some areas would result in reduced waterlogging, it may also result in reduced return flows to the river. This is likely to impact existing ecosystems and downstream users adversely.

9. Agricultural intensification and assured irrigation could result in increased hydraulic loading of soils not previously fully irrigated. This could result in waterlogging, increase the toxicity to the environment and may also create vector habitats.

10. However, most of these impacts are likely to be managed with appropriate interventions which are to be included in the project design, or in the case of construction related activities though appropriate contract clauses. The EMPs of all activities need to be monitored, as should the overall implementation of the project to ensure both appropriate implementation of the EMP and also inclusion of any unforeseen impacts during implementation.

11. In the case of construction related activities, good site management, consultative processes to ensure local populations are not adversely impacted, rehabilitation of sites, and safety measures at all sites are the major management actions required. Safety needs should not only include appropriate signage and warnings, but also safety equipment for workers and first aid in case of any accident until the injured are taken to appropriate medical centres.

12. To ensure agriculture interventions do not have an adverse impact on human or ecosystem health a good service to provide both information and support for farmers would be needed. This could include the better management, storage and disposal of agrichemical waste; Integrated Pest and Nutrition Management knowledge; and access to resources to prepare and implement identified farm management strategies including for the management of soil health (waterlogging, salinity, nutrition, organic matter, soil structure etc).

13. The maintenance of environmental flows and land use changes and patterns are beyond the immediate implementation actions of this intervention however Output 1 is to address river basin water resource planning including environmental requirements. Much of this can be more appropriately addressed in the overall IWRM framework of the KISWRMIP and the river basin management activities. Local land use changes and environmental risks – such as conversion of tanks that function as ephemeral wetlands into semi-permanent and more stable water retention structures, and other reclamation processes, may be reduced though the project's farm level education and communication process which would also address improved on-farm land, water and agriculture management. As well, guidelines for the operation of tanks that are integrated into the water distribution system would ensure increased multiple benefits (environment and socio-economic).

1. PROJECT DESCRIPTION

1. The Gondhi Anicut is built across river Bhadra, near Gondhi village which is 11.56 Km from Bhadravathy Town, Bhadravathy Taluk, Shivamogga District. It is situated at a latitude 13°46' N & longitude 75° 41' E. Gondhi anicut is located at 14.50 km downstream of Bhadra Reservoir. The construction of the anicut was started during 1916 and completed during 1926 with an estimated cost of Rs.16.00 lakhs. The right bank canal was commissioned during 1926-27. The work of left bank canal started during 1951 and completed during 1953-54.

2. There are two main canals originating from Gondhi anicut both from Left Bank and Right Bank. Left bank canal is 14.5 km long with 20 DPOs for an atchkat of 212 Ha and full potential is created under this canal. The discharge required in the canal is 0.56 cumecs (20 cusecs). Right bank canal is 74.40 Km long with 16 distributaries and 130 DPOs to cater an atchkat of 4388 Ha. The Discharge required in the canal is 7.50 cumecs (265 cusecs) in unlined condition. The Gondhi Anicut canal system is unlined.

3. The Gross Command Area (GCA) is 5060 Ha, Cultivable Command Area (CCA) is 4600 Ha and sanctioned atchkat is 4465 Ha.

1.1 Canal Modernisation Activities

4. The following interventions are envisaged to upgrade the system and these and the following summary are described more fully in the main report and its attachments:

- Repairs to the Gondhi anicut and canal head works.
- Improvement of main canals and distributaries including provision of concrete canal lining to suit future water delivery requirements and upgrading of canal access roads. Lining may be a combination of slip formed channel and large precast units in order to minimize the duration of canal closures.
- Repair / replacement of all canal structures including bridges and crossings, drainage inlets and relieving weirs, pipe outlets and provision of new structures such as cross regulators where necessary to support the future operational objectives. Ramps into canals for laundry and animal drinking will be provided.
- Possible modification of current on-line storage (tanks) where feasible to become actively managed off-line storage and enhancement of existing off-line tanks for more pro-active management. Modification options and impacts will be assessed during detailed planning and design.
- Command area development works comprising lined channels, low pressure gravity-supplied pipe distribution where technically feasible and drainage where required.
- Provision of electronic flow measurement with telemetry at about 20 locations on the main canal and drainage system and flow measurement with recorders at all outlets.
- Capacity development of system operations staff and water users to enable them to effectively use the flow measurement system and provide a more efficient and equitable water distribution service more closely aligned with farmers' needs.
- Agricultural extension and on-farm water management training to equip the farmers with the skills to use water more efficiently.

5. It is also envisaged to develop managed conjunctive use of canal water, water stored in tanks and pumped groundwater and undertake small pilots of pressurised irrigation using gravity supply from the main canal with possible interlinking to existing drip irrigation that uses groundwater.

Construction Activities:

6. In summary, and in relation to environmental implications, the main construction activities are expected to involve:

- Clearance of vegetation along the canal rights of way to provide access and working space for the construction activities.
- Excavation where necessary within the existing canals. Suitable excavated material may be re-used within the construction works and unsuitable material (too silty) may be placed on fields to improve soil quality. The total excavation volume is estimated to be about 250,000m³.
- Filling of about 350,000m³ to restore the canal cross section and access track. Fill material will either be suitable material from the excavation or from borrow areas.
- Gravel surfacing of canal roads using material from suitable quarries or borrow areas.
- Concrete lining either using mechanised paving equipment, precast concrete units or hand-placed concrete. Concrete for paving equipment would be supplied by ready-mixed concrete but concrete for hand-placed lining will probably be mixed on site. Precast units would be stockpiled on site for a brief period before installation.
- Reconstruction of canal structures using reinforced concrete. Most structures will be cast in place although some works may use precast concrete. Rebuilding of larger structures may take a month or more and will probably follow after the lining works.
- Provision of either concrete field channels or pipes within the command area which will require temporary access over fields.
- The logistics associated with the construction work include:
- Extensive movement of trucks carrying soil, gravel for roads and either ready-mixed concrete or materials for concrete. Potentially there could be about 100,000 round trip truck movements depending on the truck size.
- It is not currently envisaged that there will be work camps in the field as the construction sites are close to Bhadravati.
- The canals under modernisation do not pass through or immediately adjoin forest. The Gondhi Anicut and Gondhi left bank canal at the anicut is within 1 km of a minor forest (sandalwood plantation) and 6 km of a reserved forest (and wildlife reserve) on the left side of the Bhadra reservoir, with the Bhadra Left Bank canal and settlements in-between. The Gondhi Anicut and Right Bank Canal near the anicut are 2 km from a minor/State forest with settlements in between. It is 11 to 12 km from the Wildlife and Tiger Reserve with the Bhadra Right Bank canal and settlements in-between. Elsewhere the canal is more than 2.5 km from reserved forest with the Bhadra Right Bank canal and settlements in-between
- Modernisation works for each site will occur just the once and activity at any one location will only be for a few days in total. Passing traffic will increase for most of that closure period. Overall modernisation is expected to take place in 1 or 2 canal closure periods each year (mid May – mid July or December) when the canals are normally empty.
- It is expected that about 213,000 m³ of material will be excavated from the canal. Where possible it will be used for construction purposes. However, discussions with farmers have also identified that farmers consider the material to be nutritive and therefore may also be interested in using it on their fields. According to existing estimates about 357,000 m³ will be need for filling. Some of this, as found suitable will be from the excavated material. The material unsuitable for filling can be disposed in farmer fields, after discussions with them.

Improved In-scheme Storage

7. Gondhi irrigation system contains at least 20 tanks. Some of these are along the main canal and were formed where the canal cuts across small side valleys. Others are within the command area. One of these tanks, Koppa Dodakere, commands about 60ha and has gated outlets to enable active management of supply to its command area. The tanks along the main canal are on-line, which mean that their water levels fluctuate with the main canal. As such, they reduce the responsiveness of the system to flow changes. These tanks will therefore be modified to enable active management of the stored water. Once the tanks along the canals are modified so that they can be separated from the canal flows, they are likely to reduce in level and dry out more than they do currently in the dry (Rabi) season and possible increase in storage in and immediately following the wet (Kharif) season.

Night Storage Reservoirs

8. Night storage reservoirs are to be considered. These would be located downstream of outlets so that, although water can flow continuously through the outlets, irrigation in the command area would be only undertaken in day-time, when water can be managed more efficiently, safely and wastage reduced. Such reservoirs, however, will require land which will need the support of the beneficiaries which may not be immediately forthcoming. If water becomes scarcer in future years then such reservoirs can only be incorporated if the downstream system has been designed for the increased flows resulting from 12-hour irrigation.

Command Area Development

9. To realise the overall objective of improved water use efficiency it is necessary to improve the entire distribution system between head works and the crops. This involves improving the distribution system in the command area and, if necessary, supporting measures such as land levelling and drainage. There is considerable potential to upgrade the command area distribution system in Gondhi. It is recommended that this distribution system includes piped distribution where feasible using uPVC or HDPE pipes. Final distribution of water from the fixed pipe outlets could be undertaken using flexible hose. A piped system will provide several benefits including: (i) negligible land take; (ii) negligible conveyance losses; (iii) reduced opportunity for water to be drawn from points between the agreed outlets; (iv) a clearly defined rotation system for sharing the use of the pipe outlets.

Gravity-Fed Pressure Irrigation

10. Part of the command area has slopes greater than 1% with land more than 10m below main canal level. This provides opportunity to mobilise sufficient pressure for micro sprinklers or drip irrigation with associated increase in water use efficiency. There may be potential for interlinking of the pressure supply from the canal system with the drip irrigation systems provided for some arecanut plantations to enable conservation of groundwater supplies for periods when insufficient surface water is available.

Reuse of Drainage Flows

11. At present the Gondhi main canals intercept drainage flows (both runoff from rainfall and excess flow from irrigation) from the Bhadra canal command areas. However, with better water management within the Bhadra system this source of water is expected to diminish. Within the Gondhi command area there is also potential to intercept runoff for re-use further downslope (the tanks within the command area probably do this) which raises the water use efficiency within the system. The existing situation needs to be mapped and further potential for water reuse identified.

Conjunctive Use

12. Opportunities should be identified for conjunctive use of surface water (canal supplies, water stored in tanks and pumping of surface water during canal closures) and groundwater, particularly to sustain perennial crops during canal closures. The potential groundwater storage and the likely abstraction should be estimated and compared with expected recharge from rainfall and irrigation percolation losses, while taking account of the tendency for groundwater to migrate downslope.

Flow Measurement

13. Improved flow measurement will provide information to support better operation of the irrigation system both in terms of day-to-day flow management and quantification of flow volumes supplied. Main canal flow measurement will use electronic flow measurement devices with telemetry to enable real time data acquisition to guide system operation. Likely measurement points are at boundaries of WUCSs, at major inflows and possibly at selected command area outflow points. In addition, flow measurement using flumes with water level and flow volume recorders is proposed for all outlets so that water provided to each WUCS can be quantified.

14. The construction work will take place over a period of 3 years and will correspond to the closure period of the canal. This will be from May to June, a one month period and again November to December, a two month period. The scope of activities for all major construction work is given in the table below.

	Left Bank Area	Right Bank Area	Total	Scope
CCA (ha)	220	4380	4600	
Main canal length (km)	14.7	74.4	89.1	Lining
Distributaries	0	16 No. / 34km	16	Lining
Cart bridges	20	86	106	Replace
DPOs on main canal	20	130	150	Replace
DPOs on distributaries		52	52	Replace
Drainage inlets	2	51	53	Improve
Relieving weirs	3	22	25	Improve
Escape sluices	0	6	6	Improve
Aqueducts	0	3	3	Repair
Tanks	0	20	20	Improve

Support to System Operation

15. Capacity building of the WUCSs is required to enable them to be sustainable and undertake operation and maintenance of the irrigation distribution system. Specific training of system operations staff will be provided to enable them to benefit from the flow measurement system to provide efficient and efficient operation with minimal wastage.

1.2 Agriculture Related Activities

16. The major agriculture related activities planned under the project are,

- Crop diversification by introducing short duration and market value added crops such as vegetables, flower cultivation.

- Introduction and increase in the area under System of Rice Intensification (SRI) Paddy cultivation which will increase yields and significantly reduce water use.
- 100% coverage of the area in capacity building of Water User Cooperative Societies in sustainable agriculture including soil testing, balanced fertilizers and use of micro nutrients, Integrated Pest Management, management of agri-chemicals and waste management including container disposal (including health and safety aspects). This should at least offset any increase in agrichemical use and it should reduce from the current levels. It should reduce the current applications of fertilisers which are said to exceed recommended levels.
- Adoption of rice (Kharif) following pulses (Rabi) cultivation
- Increase in area of crops under micro irrigation which will reduce water runoff and recharge of groundwater in the Rabi season
- Increase of area under horticultural crops with special focus on Arecanut, tissue cultured Banana
- Improved extension and training through WUCS to farmers to increase water saving, agricultural production, farmer profitability and environmental sustainability

1.3 Land and Water Use and the Environment Conditions

17. At the height of the irrigation season (Rabi), it is believed that, other than for urban water supply, little water is released into the rivers and all the inflows are diverted through the main canal off-takes for irrigation. As a result flows in rivers are extremely low for a considerable part of the year[2].

18. Currently water is supplied to the Gondhi system from the Gondhi Anicut. For the lower Gondhi canal beyond about chainage 45 km, irrigation water is received as tail water from the Bhadra system. Tailwater from the Gondhi system, as well as rainfall runoff from both, flows through to the Bhadra river. Return flows during the Rabi season are thought to be used further downstream by irrigation systems. Return flows are also considered to be a source of non point source pollution with elevated nutrients in particular for the river.

19. Once the project is implemented, the Gondhi DPR indicates that the current water irrigation supply water usage for the Gondhi system will be reduced by 0.5 TMC (14.12 Mm^3)[3]. The saved water will be transferred to new irrigation developments in the Upper Bhadra catchment. As a result of this and a major reduction of flows entering the Gondhi system once the Bhadra system is being operated optimally, Tailwater, as well as non point source pollution leaving the Gondhi system and entering the Bhadra river is expected to be much reduced. Within the Gondhi area, the recharge of groundwater during the Rabi season should also be much reduced as the area of paddy is replaced with SRI rice and other annual and perennial crops.

20. The land in the command area is currently fully cropped based on satellite interpretation and so there is little likelihood that the area of irrigated land will expand especially given the planned reduction in the supply of water. A greater intensity of use is likely however and this is likely to involve greater use of agrichemicals although the use of N:P:K is said to already exceed recommended levels. An agricultural extension effort is to be implemented to reduce these inputs and to introduce IPM and INM.

2 CDTA Report (2010) Component 2: Sub-Basin Framework Plans for Efficient and Sustainable Water Resources Management. Integrated Water Resource Management and Sustainable Water Service Delivery in Karnataka (ADB TA No. 7418-Ind)

3 Modernisation of Left Bank Canal and Right Bank Canal of Gondhi Anicut in Bhadravati Taluk, Shimoga District. Detailed Project Report September 2012, 3G Consultants. p30.

2. POLICY, LEGISLATIVE AND INSTITUTIONAL ARRANGEMENTS

2.1 Policy

21. There are a number of acts and rules of the State and National Government that may be of important to the project. While some of these could define activities to be done and location of the project, there are others that may be supported by project activities. This section discusses these regulations and their implications.

2.1.1 National and State Legislation

Environmental (Protection) Act, 1986, Environmental Impact Assessment Notification, 1994 and recent amendment of 2006, and rules

22. This act vests power in the Central Government to take necessary action to protect the environment and in the prevention of environmental pollution. Under this act, standards for pollution and the discharge of effluents, as specified under the various pollution control acts are made. Under this act procedures and safeguards for handling hazardous substances are also laid down. All projects and activities are broadly categorized into two - Category A and Category B, based on the spatial extent of potential impacts and potential impacts on human health and natural and man made resources.

23. According to notification of 2006 under sub-rule (3) of rule 5 of the EPA, 1986, powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986, read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 construction of new projects or activities or the expansion or modernization of existing projects or activities listed in the Schedule to the notification entailing capacity addition with change in process and or technology will only be undertaken after the prior environmental clearance from the Central Government or as the case may be, by the State Level Environment Impact Assessment Authority.

24. The Schedule includes in 1(c) River valley projects, including irrigation projects. The table below gives details of what is mentioned under 1(c) of the Schedule.

Project or Activity		Category with threshold limit		Conditions if any
		A	B	
1(c)	River Valley projects	(i) ³ 50 MW hydroelectric power generation; (ii) ³ 10,000 ha. of culturable command area	(i) < 50 MW ³ 25 MW hydroelectric power generation; (ii) < 10,000 ha. of culturable command area	General Condition shall apply

25. Any project or activity specified in Category 'B' will be treated as category 'A', if located in whole or in part within 10 km from the boundary of: (i) Protected Areas notified under the Wild Life (Protection) Act, 1972, (ii) Critically Polluted areas as identified by the Central Pollution Control Board from time to time, (iii) Notified Eco-sensitive areas, and (iv) inter-State boundaries.

26. Based upon the above criteria and available information it has been identified that the project is within 10 km of the Bhadra Wildlife Sanctuary (Figure 1). The Gondhi Anicut is the closest project point to the reserve and is approximately 4.7 km and 9.2 km by the marked lines.

27. Also, the project is within the 10 km zone of a critically polluted area, Bhadrawati. Therefore, this project would be considered a category A/B project requiring a clearance from the central government.

Figure 1: Distance from Project to Bhadra Wildlife Sanctuary (Source Google Earth)

28. For any project that requires an environmental clearance under Government of India's EPA, 1986 there will be a need for an accredited consultant registered with the Ministry of Environment and Forests to undertake the EIA and obtain a clearance from it, as has been stated in the Office Memorandum: Accreditation of the EIA Consultants with Quality Council of India (QCI)/ National Accreditation Board of Education and Training (NABET) Dated 9th December, 2009 and available at the ministry's website.

The Biological Diversity Act, 2002

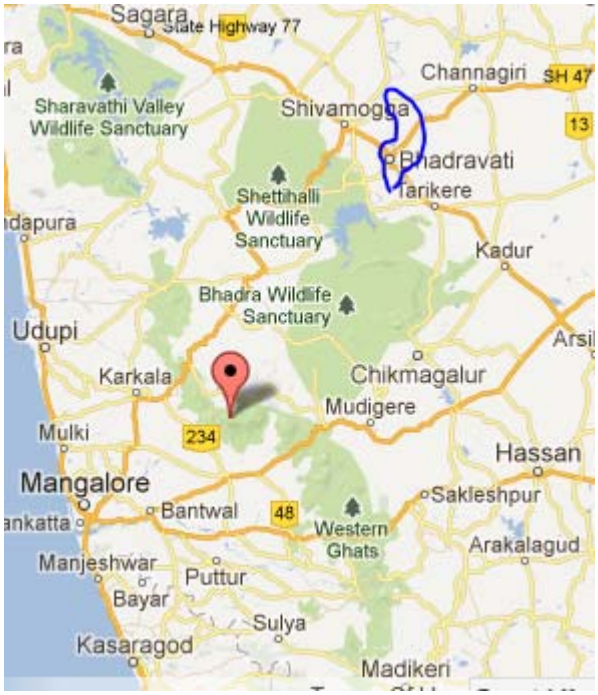
29. According to this act, where the Central Government has reasons to believe that an area rich in biological diversity, biological resources and their habitats is threatened by overuse, abuse or neglect, it could issue directives to the concerned State Government to take immediate ameliorative measures. The Central Government, as seen appropriate, integrates the conservation, promotion and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies. The State Government, under this act, can also declare areas of biological importance as heritage sites.

30. Based on this act's recommendations, the state has started to create Biodiversity Management Committees in Karnataka. The purpose of these committees is promoting conservation, sustainable use and documentation of biological diversity including preservation of habitats, conservation of landraces, folk varieties and cultivars, domesticated stocks and breeds of animals and micro-organism.

31. The UNESCO MAB site – the Nilgiri Biosphere reserve which includes Kudremukh Wildlife Sanctuary and National Park (red pointer Figure 2), the source of Rivers Bhadra and Tunga, and Western Ghats reserve (indicated in Figure 2) are within approximately 80 km of the project area (blue outline shape in Figure 2. Also as indicated above, the Bhadra Wildlife Sanctuary and other wildlife areas are near the project site and shown in Figure 1.

32. While implementing the planned activities there will be a need to consider possible biodiversity concerns, such as those relating to irrigated agriculture. Discussions with the State Biodiversity Board highlighted concerns of the change of the agri-ecosystems due to increased emphasis on high yielding variety crops and other more economically attractive crops, which may result in the areas agri-ecological landraces depleting. However, it is yet to be understood if there will be any impact, and the possible type of impact, on the Gram Panchayat (GP) level biodiversity committees and registers underway at present.

Figure 2: Project Area Proximity to Wildlife Reserve Areas



Karnataka Forest Act, 1963, Karnataka Forest Rules, 1969, Karnataka Preservation of Tree Act, 1976

33. The Karnataka Forest Act defines the use and management of Reserved Forests, District Forests, Village Forests and Private Forests, the control of forest products – both timber and other forest products. It also defines 'reserved trees' or trees that cannot be cut without permission from the Forest Department and the cutting of 'Government Trees' from private lands. According to the Tree Act the felling of any tree; even on private lands, requires permission from the appropriate authority for the area, as specified in the legislation. This authority is designated as the Tree Officer. A few exceptions to the legislation have been given in chapter 5 of the document. The legislation also mentions that there is a need to plant trees of the same or different species in lieu of the felled trees, as directed by the Tree Officer.

34. Construction activities likely to result in the removal of some trees, whether to access identified intervention areas, create infrastructure or even use of wood as fuel wood by the construction labour or other uses are, based upon the provisions of this legislation required to obtain required permissions etc.

Karnataka Groundwater (Regulation for Protection of Sources of Drinking Water) Act, 1999

35. This bill defines the procedures for sinking of wells near public drinking water sources, declarations of watersheds as over exploited and the prohibition of sinking wells in such watersheds and the abstraction of water from wells in the watersheds.

36. Considering existing climate change predictions for the basin and the district there may be changes in the rainfall pattern. Also, there have been droughts in the area in the past. In such a scenario, there is may be additional temporary restrictions on the use of groundwater for all purposes other than drinking. This is may have an impact on any conjunctive water use plans developed for irrigated agriculture.

Karnataka Act No. 25 of 2011. The Karnataka Groundwater (Regulation and Control of Development and Management) Act 2011

37. This act further strengthens the Karnataka Groundwater (Regulation for Protection of Sources of Drinking Water) Act, 1999 as it brings a general legislation to control in-discriminatory exploitation of ground water especially in the notified areas in the State. This act also provides for

declaration of areas as drought hit, restriction and regulation of use of groundwater in notified areas and specifying minimum distance between irrigation bore wells.

38. Conjunctive water use plans would need to consider the provisions of this legislation and obtain required permissions while developing the plan.

Insecticide Act, 1968

39. This act provides a list of pesticides which are restricted or banned for use in India. There is a list of 34 pesticides and formulations banned for use in India. There are another seven withdrawn pesticide, eighteen refused registration and thirteen for restricted use in India.

40. Discussions in the field identified the use of pesticides restricted in India like endosulphan and monocrotophos. The major reason for this use is that they are considered extremely effective in comparison to other known formulations by the farmers. The project would therefore need to undertaken concentrated efforts to ensure that such formulations are not used and appropriate alternate pest management techniques are known, understood and implemented by the farmers.

Noise Pollution (Regulation and Control) Rules, 2000

41. This legislation defines the levels of noise permitted in each area, including from vehicular traffic, generators, construction activities and mechanical devices. This rule would be important especially during the construction period of the project. The ambient noise quality standards under this rule are given in the table below. These levels need to be adhered to for all project activities.

Area Code	Category of Area/Zone	Limits in dB(A) Leq *	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Air (Prevention and Control of Pollution) Act, 1981, its Rules and amendments

42. Under this Act, Boards (Central and State) for the prevention and control of air pollution have been set up to monitor and manage activities that would lead to air pollution in India, and to declare air pollution control areas. The act also sets ambient air quality standards for industrial, residential and ecologically sensitive areas.

43. This will be important during the construction phase, where there is likely to be use of diesel generators for provision of energy and other activities that may result in air pollution. Also, based upon the area where the project activities are underway, the standards, as defined by the Act are to be adhered to. These standards are given in the Act.

Water (Prevention and Control of Pollution) Act, 1974, its Rules and amendments

44. This law is to control and prevent water pollution. This legislation also defines discharge standards and permit needs for any effluent/wastewater discharged. It includes surface and ground water and marine discharges. The Act also discusses possible water pollution, prevention and control areas for the application of this act.

45. Presently the project does not envisage undertaking any activity that would result in effluent discharges and therefore permission under this act is not required. Nonetheless, at the construction phase of the project, there may be a need to look at possible discharge from various activities to ensure that discharges do not result in the change in the quality of water bodies, whether temporarily or permanently. Water quality standards for different uses have been defined by the Central Pollution Control Board, Government of India.

Manufacturing, Storage and Transportation of Hazardous Chemicals Rules, 1989 and Amendments

46. This Rule is for the management and transportation of hazardous chemicals and substances – that include toxic and flammable substances, their use, processing and storage. Schedule 1 to 4 of this rule describes what is categorized as hazardous, their quantities and levels of toxicity. These include a number of pesticides, and liquid and gaseous fuels. According to the rule, the agency needs to identify possible accidents and risk from the chemical during transport, storage or usage, ensure ways to avoid any hazard from taking place and in case of an accident, ensuring clean up and reporting of the accident to the appropriate authority. The rule also states that no industrial activity is to start until a safety report is filed to the concerned authority according to Schedule 8 of the rule. These must be followed and no changes in activities undertaken without updating of the report within another 90 days. Equally, any hazardous chemicals stored or transported need to be labelled as specified in the rules and an updated safety data sheet to be kept.

47. This could be relevant to the project as there could be certain chemicals and fuels likely to be stored for project needs. Some of these could be flammable or toxic. Prior to starting any activity the project would need to identify if there are any chemicals as identified in Schedule 3 of the project. If so, appropriate handling procedures and safety permits etc would need to be developed and submitted to the concerned authority.

Wetlands (Management and Conservation) Rules, 2010

48. Activities not permitted in wetlands include reclamation, setting up of new or expansion of existing industries, dumping of waste or discharge of effluents, any activity that adversely impacts the wetland ecosystem.

49. Any activity that could have an adverse impact on wetlands in the project area must be carefully designed to ensure that they are according to this legislation. By the definition of the Act the existing 20 tanks in the project can be classified as wetlands. However, there are no protected wetlands in the area[4].

Draft Guidelines for Integrated Water Resource Development and Management, 2010, Central Water Commission

50. The Guidelines mention the need to consider ecological needs of water and therefore the maintenance of appropriate minimum flows of rivers for ecological needs, aesthetics and other requirements. The guidelines go further and mention the need for catchment treatment, integrated watershed projects, restoration of ecological balance. No rules of thumb or calculations for assessing minimum flows are given in the guidelines.

51. The activities identified also include increased water use efficiencies. It is therefore suggested that the project consider the implications of the plan on environmental flows and if there is a need to suggest any changes. Any identified concerns would need to be addressed through the project's IWRM activities. There are international guidelines[5] that could be used for guidance on environmental flows for the river.

[4] This rule defines a wetland – which according to the rule is 'an area of marsh, fen, peat land or water; natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters and includes all inland waters such as lakes, reservoirs, tanks, backwaters, lagoons, creeks, estuaries and manmade wetlands and zones of direct influence of wetlands that is to say drainage areas or catchment areas of the wetlands as determined by the authority, but does not include main river channels, paddy fields and the coastal wetlands covered under the notification of the Government of India in the Ministry of Environment and Forests, S.O. 114 (E) dated 19 February, 1991 published in the Gazette of India Extraordinary, Section 3, Sub-Section (ii) of dated the 20th of February, 1991. The rules also identify various types of wetlands including those in UNESCO World Heritage sites, ecologically sensitive areas, below 2500 metres with an area of at least 500 ha, other notified wetlands or those identified by the Wetland Authority.

5 Dyson, M., Bergkamp, G., Scanlon, J. (eds). Flow. The Essentials of Environmental Flows. IUCN, Gland, Switzerland and Cambridge, UK. xiv + 118 pp.

The Ancient Monuments and Archaeological Sites and Remains Act, 1958, The Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010 and their rules and amendments, and The Karnataka Ancient and Historical Monuments and Archaeological Sites and Remains Act, 1961

52. This act identifies limits of prohibited and regulated areas and the activities that can be carried out in them and the required permissions. According to this Act, areas within a 100 meters radius of notified monuments are prohibited and another 200 meters regulated. However, if required this area can be extended to protect the monuments and archaeological site. Any work in the prohibited area needs to be carried out by the archaeological officer and if work is carried out in a regulated area by persons other than the archaeological officer then there is a need for permission to undertake the work as defined in the regulation. Also, for any work in either the prohibited or regulated area permission is required to carry out any work. However, this Act also defines the sort of work that can be carried out within areas notified under this act. Furthermore, any construction, mining or other activity in the vicinity of a protected or regulated area would also need permission from the competent authority. These regulations prohibit cultivation within protected areas if it involves digging of more than 1 foot of soil.

53. While no protected monument has been identified in the project area, there could be chance findings. In the event of chance findings, as required under this Act the competent authority must be consulted and, as required, actions taken up.

54. Given below (Table:1) are the major Indian legislations that are applicable to this project along with the actions that would need to be undertaken for each of these regulations. These must be followed as a part of the environmental compliance activities for the Gondhi Anicut subproject at the time of construction or implementation, as required.

Table 1: GOI Legislative Environmental Compliance Requirements

Component	Applicable Legislation	Action Required
All irrigation project modernization activities	Environmental (Protection) Act, 1986	Requires environmental clearance – as discussed in the Schedule of the act
Any component where there is a need to acquire forest land or access any produce from forest produce Any trees cut by project activities	Karnataka Forest Act 1969, Wildlife Act, 1972 and Karnataka Preservation of Tree Act, 1976	Apply for permission and undertake any action as directed by the Forest Department Apply for permission and undertake any action as directed under this act – e.g. undertake compensatory plantation activities.
Any impact on biodiversity hotspots or sensitive areas due to project activities	Biodiversity Act, 2002	Consult with the Biodiversity Board to identify any sensitive areas and appropriate actions to minimize impact from project activities
For conjunctive water plans where groundwater is to be used	Karnataka Groundwater (Regulation for Protection of Source of Drinking Water) Act, 1999 and Karnataka Groundwater (regulation and Control of Development and Management) Act 2011	Taking permission for sinking of bore wells, ensuring minimum distance between irrigation wells and follow directions of legislation if area declared drought hit.
Especially during construction period	Noise Pollution (Regulation and Control) Rules, 2000	Ensure all activities adhere to the existing noise limits
Pollution due to vehicle and construction activities	Water (Prevention and Control of Pollution) Act, 1974	Ensure any activity undertaken is within the existing discharge standards, based upon the designated use of a water body.

Component	Applicable Legislation	Action Required
At time of construction especially when there is likely to be use of diesel generators for energy and the various vehicles and machinery at the site and for transportation. Also at various quarry and other sites resulting in atmospheric dust	Air (Prevention and Control of Pollution) Act, 1981	Ensure that all activities comply with the existing air quality levels. Vehicles have required pollution under control certification from appropriate authorities
Waste dumping at construction or in the O&M phase	Wetland (Management and Conservation) Rules, 2010	Ensure compliance to the rules by ensuring identified waste disposal is in waterbodies and wetlands.

2.1.2 Asian Development Bank

55. From ADB's perspective there is the 2009 Safeguard Policy Statement (SPS). The SPS describes operational policies that seek to avoid, minimize, or mitigate adverse environmental impacts of development activities where ADB is involved. To ensure this, impacts of project activities on the environment are to be identified early in the project cycle so that appropriate mitigation and management actions are undertaken. This framework also states that the implementation of the identified safeguards is the responsibility of the client/borrower, while the ADB is to monitor compliance.

56. In the case of a MultiTranche Financing Facility (MFF), an Environmental Assessment and Review Framework (EARF) is also to be developed. The EARF will provide guidance to the assessments of the subprojects of subsequent Tranches.

57. The ADB has also developed categorisation of all projects according to the level and type of impacts and type of investments. ADB uses a classification system to reflect the significance of a project's potential environmental impacts. Projects can be categorised into four depending upon their impacts. Based upon this categorisation the Gondhi Anicut project has been categorised as Category B. This is defined as: *'A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination is required'*.

2.2.3 International Conventions

58. India is a signatory to a number of international conventions and treaties. However, none have been identified to apply to the project. The list below gives a list of these conventions.

- Ramsar Convention on Wetlands
- CITES (Convention on International Trade in Endangered Species of Fauna and Flora)
- TRAFFIC (The Wildlife Trade Monitoring Network)
- CMS (Convention on the Conservation of Migratory Species)
- CAWT (Coalition Against Wildlife Trafficking)
- CBD (Convention on Biological Diversity)
- ITTC (International Tropical Timber Organisation)
- UNFF (United Nations Forum on Forests)
- IUCN (International Union for Conservation of Nature and Natural Resources)
- GTF (Global Tiger Forum)
- Cartagena Protocol on Biosafety
- SAICM (Strategic Approach to International Chemicals Management)
- Stockholm Convention on Persistent Organic Pollutants (POPs)
- Basel Convention on the Control of Trans-boundary Movement of
- Rotterdam Convention on Prior Informed Consent (PIC) for certain

- Hazardous Chemicals and Pesticides in International Trade
- UNFCCC (United Nations Framework Convention on Climate Change)
- Kyoto Protocol
- UNCCD (United Nations Convention to Combat Desertification)
- Montreal Protocol (on Ozone Depleting Substances)
- IWC (International Whaling Commission)

2.2. Institutional Arrangements and Systems

59. The national and state level government agencies focusing on environmental management and regulation are given below. State level agencies function directly below their line national level agencies.

2.2.1 National Level

Ministry of Environment and Forests

60. The Ministry of Environment & Forests (MoEF) is the nodal agency in India for planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programme. The principal activities undertaken by Ministry of Environment & Forests consist of conservation & survey of flora, fauna, forests and wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the framework of legislations.

61. It is located at the national level and has regional offices for various regions and works in coordination with the national office in order to undertake any work, clearances and other consultation related activities. This includes one for the South region for which the office is located in Bangalore. This ministry is also in charge of any forest related clearances as identified under the forest acts and to be undertaken by the central ministry.

Central Pollution Control Board

62. Central Pollution Control Board (CPCB) is the statutory organisation constituted in 1974. The board provides field information and technical services to MoEF. The Board also monitors and oversees the implementation of the Environmental Protection, Air and Water acts. The functions of the board are,

- Advise the Central Government on any matter concerning prevention and control of water and air pollution and improvement of the quality of air
- Plan and cause to be executed a nation-wide program for the prevention, control or abatement of water and air pollution
- Co-ordinate the activities of the State Board and resolve disputes among them
- Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts
- Perform such other function as may be prescribed by the Government of India

2.2.2 State Level

Department of Ecology, Environment and Forests, SGOK

63. Department of Ecology, Environment and Forests (DoEF) is the apex body in the state of Karnataka with administrative control of environmental management in the state. The department through KSPCB administers the enforcement of various laws and regulations of Government of India.

The department formulates environmental management and policy guide lines for Karnataka and grants clearances for projects under its purview.

64. The department is headed by a Principle Secretary to Government and Supported by Secretary (Ecology and Environment). The Secretary (Ecology and Environment) is supported by two Under Secretaries and a Director (Technical).

Karnataka State Pollution Control Board

65. KSPCB is the regulatory body in the state of Karnataka for enforcing various environmental legislations of the Government of India. While the regulatory powers are delegated to KSPCB from CPCB, the administrative control of the board rests with DoEF. More specifically, the functions of the board are listed below.

- Implementing the provisions of EPA 1986, Water and Air Acts
- Advise the State Government in respect of suitability of particular areas for industrial development
- Assess the quality of environment in terms of ambient air and water quality through monitoring
- Issue and enforce the consent orders issued for industrial pollution control
- Oversee, supervise and regulate water, air, solid, bio-medical and hazardous waste management in urban areas

66. The board is headed by a Chairperson who is supported by a Member Secretary and a Chief Environmental Officer. The Chief Environmental Officer is supported by Regional Environmental Officers and the District Environmental Officers in each of the district of the state. The Board has its Central Office in Bangalore. The enforcement of the Acts and Rules are being implemented through thirty three Regional Offices spread throughout the state. The Central laboratory of the Board is located in Bangalore. Regional laboratories have been set up along with Regional Offices.

67. Depending upon the needs of the project, for any clearances these agencies will need to be contacted as directed under the relevant acts discussed in the legislation section.

3. DESCRIPTION OF THE ENVIRONMENT

68. The whole of the Gondhi Anicut system is located in the Bhadravati Taluk of Shivamogga District. The Taluk headquarter is Bhadravathi town located on the banks of River. It is located at 130˚ 52' North latitude and 75˚ 40' East longitudes. The town is located at a distance of 270 km from Bengaluru and 20 km from Shivamogga. The altitude of Bhadravathi town is 548.70 m above msl.

3.1 Physical Parameters

Weather Patterns

69. The climate is characterised by moderate summers and winters. The year can be divided into three distinct seasons. These are winter from October to February, summer from March to mid-May and the monsoons from mid-May to October. Humidity is at peak during months of July and minimum during month of April. The average wind velocity is 8 kmph, from the south – west direction. Temperature rises after March, April is the hottest month of the year with mean daily maximum temperature going up to 35.8 ºC. With the withdrawal of the monsoons, by the end of October, there is a sharp decrease in temperature. January is the coolest month of the year, with mean daily minimum temperature of 14.3 °C.

70. The mean summer temperature is 25°C - 37°C and the mean winter temperature is 20ºC - 30ºC. Total annual rainfall is about 993.1 mm. Maximum rainfall is received in months from May to October. More than 80% of rainfall is received during the winter season. The average number of rainy days from 1941 to 1999 was 68 rainy days annually, though in 2009 it was about 10 days more. As is seen from Table 2, Bhadrawati Taluk's rainfall is lower than the total of Shivamogga and rainfall has varied from around 580 mm in 2006 to 1400 in 2009 – nearly a three times difference.

Table 2: Rainfall

	Rainfall (mm)						Rainy Days	
Taluk/District	Normal Rainfall (1941-99)	2005	2006	2007	2008	2009	Normal (1941-99)	Actual 2009
Bhadravathi T.	887	774.2	580.2	1293	952.4	1427.4	68	79
Shivamogga D.	1,818.9	1,966.6	1,847	2,472.4	1,827.6	2,252.7	86	87

Source: - Shivamogga District Statistical Handbook 2009-10

Water Resources

Drainage and Surface Water

71. A number of rivers originate from Shivamogga District. These include Rivers Kali, Gangavathi, Sharavathi and Tadadi. The other major rivers which flow through the district are Tunga, Bhadra and Varada. The rivers Tunga and Bhadra meet at Koodli in Shivamogga District to form the Tungabhadra.

72. There are a number of water bodies both natural and manmade in Shivamogga district. This includes the famous Jog Falls and the Gopashetty Koppa, Sharavati and Gudavi Bird Sanctuary. However, within the project area there are no Ramsar sites and no water body of any major ecological significance has been identified.

73. Surface water is supplied to the project area from the Gondhi Anicut by two main canals one for the Left Bank (14.5 km long, 0.56 cumecs) and another for the Right Bank (74.4 km long, 7.50 cumecs). There are also many pumps that pump water directly into the project area from the Bhadra River.

74. The project area has a high slope and so surface drainage and rainfall runoff flows directly to the Bhadra River. Due to waterlogging, which was said to be significant (20-30% in some areas), there are small areas of sub-surface drainage.

Groundwater

75. Table 3 shows the groundwater levels for Bhardavati and Shivamogga districts which are much larger areas than the irrigation areas and so include areas where there is much groundwater pumping to supplement rainfall. The data shows a general deepening trend for Bhadravathi Taluk with a sudden reduction in depth in 2009. There is no specific groundwater data (depth or usage) for the project area and the household survey and field visits indicated that there was little use for irrigation due to the low yielding sediments. Groundwater is a significant source for household use however. Due to high hydraulic loadings from rice cultivation in particular but also other irrigated crops water table levels are likely to be shallow and this is confirmed from the social survey where water tables were said to be affecting foundations and causing rising damp in buildings.

76. Future activity should look to create a register of groundwater pumps and usages (domestic and agriculture etc) in the project area (depth, volume, quality, seasonality, use of water, area irrigated, etc).

Table 3: Ground Water Level (in meters) 2008-09

Taluk/ District	2005	2006	2007	2008	2009
Bhadravathi T.	7.28	8.71	11.67	12.94	4.24
Shivamogga D.	7.35	7.09	7.20	7.46	5.90

Source: - Shivamogga District Statistical Handbook 2009-10

Water Utilisation

77. About 50% of irrigation supply at a District and Taluk level (and therefore including Taluks outside of the irrigation area boundaries) is from canals with local tanks providing another 33% of irrigation water. This is much higher than the district total, where canals only provide a quarter of the total irrigation needs and tanks 45%. Groundwater is the third highest source of irrigation in both the state and district providing 22 and 15 percent respectively. As can be seen, both surface and groundwater are being used for irrigation already. Furthermore, the tanks and water bodies seem to be an important source of irrigation water for both the district and Bhadrawati Taluk.

Table 4: Net Area Irrigated (hectare) 2008-09

Taluk/ District	**Canals**	**Tanks**	**Wells**	**Bore wells**	**Lift Irrigation**	**Other sources**	**Total**
Bhadravathi	12,745	8,354	399	2,517	1,323	0	25,338
Shivamogga D.	33,733	59,955	4,452	22,836	5,607	5,454	132,037

Source: - Shivamogga District Statistical Handbook 2009-10

78. Water supply in rural zones of Shivamogga indicates that out of 4,566 settlements 3,498 receive more than 55 lpcd (litres/capita/day) supply of water. Based upon the national criteria – of minimum 40 for rural areas, the table reflects that 84% of rural habitations have adequate water supply coverage. However, this data does not provide any information on quality and seasonality to accurately understand the quality of the service. Furthermore, discussions in the field show that people are also dependent upon the canal for provision of water for domestic needs. Canal water is used for washing, cleaning and various domestic purposes, other than drinking. In areas where drinking water is insufficient canal water also supplements the drinking water needs for the rural population. Equally, water from canals is also used by people for bathing of livestock and drinking.

Table 5: Status of Rural Water Supply in Karnataka State - 2003

	Water Consumption (Litres per Capita per Day, LPCD) No. of Settlements								
District	0-10	10-20	20-30	30-40	40-55	# <55 LPCD	% <55 LPCD	> 55 LPCD	Total
Shivamogga D.	4	301	297	288	178	1068	23.39	3498	4566

Source: - Rural Development and Panchayat Raj Department

79. At a project level, based on the results of the socio-economic survey and field visits irrigation water use is predominantly surface water provided from the canal but also by pumping from the Bhadra river. There is little pumping for groundwater for irrigation to low groundwater yields, however groundwater is an important source of water for domestic use.

Water Quality

80. An analysis of groundwater quality by the Department of Rural Development for 14 parameters was undertaken and identifies a number of water quality issues. Of these, some samples of Bhadrawati Taluk tested positive for total hardness, calcium hardness, chloride, sulphate, alkalinity and iron. According to the Karnataka State of the Environment (SOE) report some areas in Bhadrawati are also fluoride affected. The SOE further states that around 25% of household in Shivamogga district are affected by iron and fluoride in ground water. Also identified were problems of total coliform. The river at Bhadrawati is also classified as highly polluted according to the State Pollution Control Board, which is likely to be attributed to its industries such as the iron and steel industries.

81. Canals are used for waste disposal. At times people go alongside them using them as sites for defecation and household waste is disposed of directly into the canal.

82. There is highly prolific aquatic weed growth in canals in the project area thought to be contributed to by nutrient rich runoff from the Bhadra irrigation area entering the canal system as well as from local pollution. This is likely to have adverse impacts on the health of the local population which uses the water for various domestic purposes.

83. Groundwater quality is not known however given the risks of high agri-chemical environment and pit latrines it is potentially a significant issue given its apparent importance for domestic use.

Land Resources

Topography

84. Shivamogga is a part of the Western Ghats and therefore the topography consists of planes interspersed with hills of moderate slopes. Bhadra River flows through the Taluk which is developed on both sides of the river. Bhadravathi town is at an altitude of 548.70 amsl. The total geographical area of the district is about 8,477 sq kms. It is the 9th largest district of the State.

Geology and Soil

85. The predominant geological formations of Bhadravthi which is a part of Shivamogga district are quaternary alluvium, Dharwar super group - ultra mafic complex, grewake, argoillite, quartz chlorite schist with ortho-quartzite, basal polymictconglomarate. The lower precambrian formations include Metabasalt with thin Ironstone. There also are Archaean formations of granite migmatites and granodioritic to tonolitic gneisses, amphibolites and pelitischists.

86. Soil is usually brown clay loamy soil, red soil, sandy soil, red sandy soil, yellowish loamy soil, lateritic soil, mixed soils & black cotton soils are predominant in the region, which favours growth of cotton, paddy & oil seeds. While loamy and sandy soils are better drained, areas with black cotton soil will require specific attention to ensure appropriate drainage to avoid waterlogging.

Land use patterns

87. The total land area in Bhadrawati Taluk is 69,101 ha or about 8% of the total district's land area. Of this 61% is under agriculture and 26% under forests. At the district level however the forest cover is higher, accounting for 32% of the total land area while agriculture accounts for 55% of the total. This higher forest cover at the district is because Shivamogga district includes part of the Western Ghats forests. Nonetheless, as is discussed later in this section, degradation of forests is resulting in dense and closed forests now turning into open forests. For example, part of Shivamogga town has encroached upon the forest area and some of the outskirt areas of the town are presently being cleared of illegal settlers to start an afforestation program and revive part of the forest area. Another 12% of the total land area in Bhadrawati Taluk is under pastures and 5% is fallow. Agriculture areas with more than one crop a year account for 18% of the total land area and 29% of the total area under agriculture. The area under trees and groves is a negligible at 66 ha and is less than 1% of the total land area, according to 2008 – 09 statistics. However, it is likely that these groves do not include the areca nut or coconut plantations, which are an important crop in the Taluk and district.

3.2 Ecological Resources

88. Shivamogga district has around 51% of its geographical area under various categories forest. Part of the Western Ghat forests is also in the district. Of the total area under forests only 4% is very dense forest with about a third as open forest, as is seen from Table. There is also an increasing area under open forests, with a decrease in dense forests. This is of concern not only as open forests are often very vulnerable for being taken over and encroached by settlers, but also this area is one of the sources of the water of the district/state's rivers.

Table 6: District- Forest Cover-2011

District	Geographical Area (GA)	Very Dense	Mod. Dense	Open Forest	Total	% of GA	Change	Scrub
Shivamogga D.	8,477	205	2,808	1,394	4,407	51.99	-1	23

Source: Forest Report, Forest Survey of India

89. The district's forests also provide many minor non-timber forest products, upon which a number of people are dependent for their livelihood. These include spices and medical herbs like Kairaraka, Soapnut, Alaekai and bay leaf. The forests also provide timber and include timber species like rosewood and teak.

90. Apart from a number of forest areas, the district also has Gudavi Bird Sanctuary, part of the Bhadra Tiger Reserve and the Shettihalli Wildlife Sanctuary. The project area does not fall in any of these sensitive areas. However, towards the tail end of the right bank canal near the confluence of rivers Bhadra and Tunga there is an elephant corridor. Also, it is understood that there are a number of wild animals in the forests surrounding the project areas and these may visit the project area.

3.3 Human Environment

91. The Gondhi Anicut system is located in the Bhadrawati Taluk of Shivamogga district. This Taluk has a total of 39 gram panchayats and 1 municipality.

Demography

92. The total population of Bhadravathi Taluk is 338,989 with population density of 491 per km², out of which 52.6% of population resides in the rural areas and 47.4% in urban areas. The sex ratio is 972 females per one thousand males which is higher than the national average.

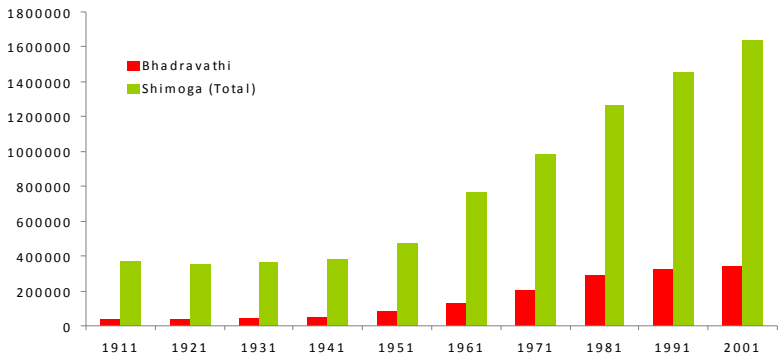
Table 7: Some Demographic Statistics

Taluk/District	Area (km^2)	Total	Males	Females	Rural	Urban	Density	Sex Ratio
Bhadravathi T.	690	338,989	171,917	167,072	178,327	160,662	491	972
Shivamogga D.	8477	1,642,545	830,559	811,986	1,071,535	571,010	194*	978*

** Average, Source: - Shivamogga District Statistical Handbook 2009-10*

93. The population growth in last ten decade shows rapid population growth from 1971-81 (41.6%).**Figure**. During 1991-2001 the annual growth rate was around 4.5%. However, the share of the district's population in Bhadrawati Taluk in 1911 was only about 10% in 1911 by 1981 it had become 23% of the district's total probably because of the introduction of irrigaton. The 2001 census shows that presently Bhadrawati Taluk accounts for 20% of the district's total population. With a population growth rate at 4.5%, even if Bhadrawati Taluk's share of the district's population becomes stable at 20% or declines, it is still growing at a very high rate.

Figure 1: Population Growth Pattern Bhadrawati and Shimoga



Source: - Shivamogga District Statistical Handbook 2009-10

94. There are a total number of 71,771 households in Bhadravati Taluk which is about 20% of the total of the district. Nearly equal numbers reside in rural and urban areas in the Taluk, while about 65% reside in rural areas at the district level. The average household size in rural areas is 5 compared to 4.5 in urban areas.

Table 8: Total Number of Households (2001 census)

Taluk / District	Rural Area	Urban Area	Total
Bhadravathi T.	36,253	35,518	71,771
Shivamogga D.	218,360	120,026	338,386

Source: - Shivamogga District Statistical Handbook 2009-10

Education

95. Overall literacy rates in the rural parts of the Taluk are about 66% and urban 82%. The female literacy rate is lower in rural area (56%) compared to urban and district rates.

Table 9: Literacy Rate (2001 census)

Taluk/District	Rural			Urban		
	Total	Males	Females	Total	Males	Female
Bhadravathi T.	102,032 (66 %)	58,164 (74 %)	43,868 (57 %)	117,181 (82 %)	63,831 (88 %)	53,350 (75 %)
Shivamogga D.	647,632 (70 %)	367,227 (78 %)	280,405 (61 %)	421,302 (84 %)	226,663 (89 %)	194,639 (78 %)

Source: - Shivamogga District Statistical Handbook 2009-10

96. In terms of educational infrastructure, Bhadravathi has 356 primary schools with 40,859 students. There are 81 high schools, 21 pre-university colleges, 2 polytechnics and 4 colleges.

Health

97. The life expectancy at birth in Karnataka is slightly higher compared to the national average, with 2001 statistics indicating a life expectancy of 65.6 for males and 66.6 for females in Karnataka and 62.4 and 63.4 for females at the national level. Infant mortality rate in Karnataka compared to national average, is also lower than national averages with 2003 statistics putting the IMR rate in Karnataka at 52 and nationally at 60.

98. District level health statistics that monitor 20 identified diseases show that malaria, typhoid, hepatitis, dengue and swine flu incidences have been noted in the state in the first half of 2012 itself. Of the district's total, 21% of dengue, 9% of malaria, 23% of hepatitis and 15% of typhoid cases are from Bhadrawati. All cases reported are of men, which is likely as women may not have equal access to medical services. Therefore, it is likely that the total number of cases in both the district and the Taluk may be higher than reported. According to the Compendium of Best Practices in Rural Sanitation of the Water and Sanitation Programme, waterborne diseases in the district include cholera, amoebic dysentery, gastroenteritis, typhoid and jaundice, as is seen in the table below. For all of these there has been a downward trend which has been attributed to the success of the Total Sanitation Campaign in the district which aims at both increasing the use of toilets and improving solid waste management in rural areas.

Table 10: Shivamogga District Level Disease Burden for Selected Waterborne Diseases

Diseases	Affected in 2005-06	Affected in 2007-08	Affected in 2008-09	Affected in 2009-10
Cholera	417	165	130	59
Amoebic Dysentery	2,920	1,529	682	324
Gastroenteritis	764	414	196	97
Typhoid	334	209	117	73
Jaundice	208	110	74	42

Source: - Compendium of Best Practices in Rural Sanitation, WSP, 2011

99. In terms of medical facilities there are 12 hospitals and nursing homes totalling 468 beds in Bhadrawati. Another 10 primary centres with 60 beds and a community centre with 30 beds

Economic systems

Agriculture and Livestock

100. There is a general trend in Shivamogga district to convert single cropped areas to horticulture, agri-horticulture and agri-forestry systems. Depending upon monsoon and irrigation facilities, farmers may grow cash crops such as sugarcane and cotton. Kharif paddy lands and upland scrub may coexist. Arecanut plantations are becoming more popular in the district.

101. Major crops in the district include sugar cane, pulses, chillies, cardamom, pepper and betel nuts. Important cereals include paddy, ragi, jowar and maize. Non food crops grown include cotton, oil seed and coffee. The total area under cultivation for the Taluk is 39,782 ha and for the district 255,854 ha.

102. Understanding use of agrichemicals, their management and disposal is poor. The result is that organophospates like monochlotophos are not only used randomly, but their storage and disposal is poor. Furthermore, the poor understanding of soil nutrition and the lack of soil testing results in random application of fertilizers based upon what farmers consider is most appropriate. These, and low sanitation coverage has lead to the eutrophication of water bodies with them being covered by weeds like water hyacinths. Discussions in one of the villages suggested that the weed cover returns in the canal network within 3 months of desilting, reflecting the high levels of nutrition enrichment of the system.

103. Livestock are also kept in the area and there is an increasing preference for hybrid over local breeds, especially for cows. Of the total livestock 45% of the Taluk's livestock consists of cattle, about 25% buffalo and about 10% each for sheep and goat. Some people also rear poultry and ducks. In fact there have been some concerns from the State Biodiversity Board due to the increase in the introduction of hybrid species as most of these species are less drought resistant than native species.

Mining

104. Mining is not a major activity in Shivamogga district. There are a total of 6 mining leases in the district at present and the total working area of all the mining leases is 158.39 hectares. Limestone mining is carried out in Bandigudda village of Bhadrawati Taluk with the quarry being about 98 ha in size. Building stone quarry leases are situated in Moodalvitthalapur village near Holehonur and Kudligere village and Anthergange villages in Bhadravati Taluk over an extent of 11 hectares. Other mining activities in Shivamogga District include mining for building stones like granite and granite gneiss, sand and brick earth.

Industries

105. Bhadrawati town is an important industrial centre for the area with two big industries – the Visvesvaraya Iron and Steel Plan, and the Mysore Paper Mills. There are also a number of other factories in Bhadrawati. These include chemical and engineering industries – with a total of 29 factories in the Taluk, employing a little more than 8000 people. There are also a number of small scale industries, such as textile, wood, metal, chemical, electronic and electrical, paper and printing and leather. Many of these industries are highly polluting and contribute to the high pollution loads of River Bhadra.

Natural Resource Usage

106. Apart from the forest produce mentioned earlier, there are no other major natural resource products noted in the area. However, most people are dependent on firewood for fuel especially for cooking. Fishing for self consumption and the local market takes place in the many water bodies in the area.

Infrastructure

107. Bhadrawati Taluk has a total of 1,556 km of sealed roads which is about 15% of the district's total road network. Of these state and national highways account for about 25% of the total roads and another 10% are major districts roads of the district. At the Taluk level however state and national highways account for only 8% of the total Taluk roads and major district roads for about 15%. The majority of roads are village roads – accounting for about 65% of the total. However, many village roads are not all weather roads resulting in reduced access during the monsoons.

108. Bhadrawati is also connected by the railways with a total of 19 km of broad gauge railway tracks and 1 railway station in the Taluk.

Cultural heritage, archaeological sites and areas of significant beauty

109. Tourism is an important economic activity for Shivamogga District as there are a number of wildlife sanctuaries and other scenic places such as the Jog Falls. Part of the district is included in the hills of the Western Ghats.

110. There are also a number of temples such as the Lakshmi Narasimha Temple built by the Hoysalas in the 13th century is located in Bhadrawati town. Koodli is another important local pilgrimage area, 15 km from Bhadrawati town and is the confluence of Rivers Bhadra and Tunga.

3.4 Disasters

111. The major natural disasters identified in the state are floods and droughts, with the years 2004, 2007 and 2008 identified as those when the district had been impacted by floods. The years 2002, 2003 and 2007 have been drought affected. That apart, the District Disaster Management Plan identified in 2009 some possible hazards for the district. These are tabulated below. While this table identifies earthquakes as a possible risk, the National Disaster Management Authority, India, Shivamogga district, has Bhadrawati in Zone 2, or the low risk area earthquakes. Similarly cyclones are not expected to directly affect the district, though as the table indicates there is a possibility of indirect impact from cyclones.

Table 11: Possible Hazards and their Impact in Shivamogga District

Type of Hazard	Period of occurrence	Potential impact	Vulnerable area
Floods	June – August	Loss of crops, damage to infrastructure, life, roads, houses and bridges	Along river courses, entire district
Heavy rainfall	June – August	Loss of crops	Entire district
Drought	January – May	Burning of crops, scarcity of drinking water, fodder, etc	Partly in Shivamogga
Earthquake	Anytime	Loss of life and damage to infrastructure	Entire district
Indirect cyclone affect	June – August	Heavy rain, loss of crop	Entire district

Source: - Disaster Management Plan - 2009-10, Shivamogga District

3.5 Climate Change Concerns

112. According to the 2012 Western Ghat Ecological Expert Panel report, the Western Ghats have been identified as landscapes of least resilience, making them very vulnerable to the impacts of climate change. This is of concern as many of the state's rivers including interstate rivers originate there. Part of Shivamogga lies in the Western Ghats and therefore would also be impacted by this assessment.

113. An analysis of the Karnataka Climate Change Action Plan, suggests a variability of rainfall in Shivamogga of be between 15% and 35% with an expected increase in rainfall between 10% and 20% in the district. However, there is expected to be a decrease in the SW monsoon precipitation and an increase in pre and post monsoon precipitation. The Tungabhadra basin districts of Chikmanglur, Shivamogga and Devangare are projected to have an increase in runoff between 0 – 25%, in both kharif and rabi season. There is also expected to be a decrease in the water yields in the Krishna basin overall, which will vary between 30 to 50% in most sub-basins.

114. There is also expected to be an increase in both the maximum and minimum temperature with the projected change for Shivamogga being 1.88 ºC on an average, which will be a change of 1.95 ºC in the minimum temperatures and 1.91 ºC in the maximum temperatures for 2021 to 2050, for A1B scenario. Climate change due to the expected temperature increases is expected to have an adverse on irrigated rice productivity which could loose yield by up to 8% according to the scenario.

4. SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS

115. Below are the potential environmental impacts from planned project activities. The legend identifying the type of impact is given at the end of the matrix. This matrix identifies all possible impacts on the environment. However the management of these impacts is given separately in another section of this document.

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
Physical Environment				
Water resources				
River system and environmental flows	(-, p, l)		Increased efficiencies in agriculture and better systems management with intensification of agriculture are likely to result in reduced river flows. Reduced availability of water for downstream uses.	Overall assessment of existing and appropriate water needs for each sector, including environmental flows needs to be made as part of the project's river basin plan
Wetlands & local water bodies	(+/-, p, w/l)	Better agriculture practices may result in improved health of local water bodies. Improved irrigation practices may reduce waterlogging in areas where practiced. Reduced areas of stagnant water should reduce mosquito populations	Agriculture intensification may be at the cost of water bodies/wetlands. Also, with agriculture intensification there is likely to be increased toxicity and eutrophication from greater use of agrichemicals and creation of waste although the field survey found that usage is already high. Changing some water bodies from ephemeral to perennial may change their characteristic	Development of appropriate drainage structures and management measures, on-farm land management. Consider scope to manage water in tanks and wetlands for multiple benefit. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils and drainage conditions. Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrichemical companies possibilities of buy back system for agrichemical containers etc
Groundwater	(+/-, p, l)	Improved irrigation practices may reduce waterlogging, improving aquifer quality	Increased intensification of irrigation could lead to increased waterlogging and rise in water table Increased contamination of groundwater – due to waterlogging in areas of low sanitation coverage	Development of appropriate drainage structures and management measures, on-farm land management. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
			or high use of agrochemicals contaminating aquifers potentially with health implications Agriculture intensification as a result of greater pumping of aquifer during the dry season, lowering water table although this seems unlikely as the field survey indicated little groundwater pumping opportunities Increased efficiency of agricultural water use, reducing unnecessary pumping of groundwater Reduced return flows in river resulting in lower recharge of connecting aquifers	and drainage conditions. Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrochemical companies possibilities of buy back system for agrochemical containers etc Identify appropriate groundwater management and conjunctive use plans and local level regulation systems based upon local aquifer needs
Water quality	(+/-, p, w/l)	Better on-farm practices improve water quality Improved irrigation practices reduce waterlogging and pollution Water and agricultural practices reduced return flows reducing non point source pollution (NPS) improving water quality	Inadequate drainage planning resulting in drainage effluent contaminating surface water Agriculture intensification resulting in higher agri-chemical use and degradation of surface and groundwater quality	Development of appropriate drainage structures and management measures, on-farm land management. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils and drainage conditions. Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrochemical companies possibilities of buy back system for agrochemical containers etc
Land resources				
Soil quality	(+/-, p, l)	Less water intensive crops are used, resulting in reduced water retention, waterlogging, groundwater induced land salinisation, and improved soil health and reduced toxicity Effective extension activities improve soil management and health and appropriate balance of micronutrients in the soil	Disposal of canal sediment into fields could affect soil quality or result in erosion and sedimentation of waterways Waterlogging takes place due to poor drainage planning Excessive application of water or cultivation of water intensive crops causes waterlogging and poor soil quality Reduced soil health due to soil salinisation from	Develop guidelines for identifying (with land owners), assessing and managing sediment disposal Development of appropriate technologies, drainage structures and management measures, and on-farm land management to reduce hydraulic loadings, waterlogging and poor soil quality Education to farmers on improved agricultural practices, on-farm land management practices Undertake farm management education for farmers

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
			high water tables or toxicity due to agrichemical usage Poor on-farm practices resulting in reduced fertility and erosion	to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrochemical companies possibilities of buy back system for agrochemical containers etc
Erosion/ compaction	(+/-, p, l)	Improved soil management with improved agricultural extension systems resulting in better soil health and reduced erosion	Inadequate agricultural extension resulting in intensive agriculture, poor soil management and erosion	Education to farmers on improved agricultural practices, on-farm land management practices
Salinity, alkalinity	(+/-, p, w/l)	Proper soil, water and drainage management would improve soil health	Poor drainage or excessive water usage raises watertables and increases salinity and alkalinity	Education to farmers on improved agricultural practices, on-farm land management practices
Natural and Biological environment				
Terrestrial				
Fauna	(+/-, p, w/l)	Reduced toxicity in the environment with better on-farm management practices	Alien species and habitat loss - Non-native and alien species planted by project plantation activities, displacing native species resulting in a loss of habitat although almost all command area land is already irrigated with little scope to expand. Increased animal – human conflict due to change in cropping like paddy resulting in raiding of fields by elephants, especially as there are a few elephant corridors (1 in particular) near the project area.	Where possible identify appropriate cropping pattern, considering possible animal raid issues. Discuss with forest department Avoid any activity in animal corridors during migratory season and do not create any permanent structure to obstruct it, such as the elephant corridor towards the tail end of the Gondi Anicut. Identify possible animal corridors and identify possible actions to reduce conflict – such as scheduling any work in any corridors to minimise conflict. Ensure all plantation activities are based upon the local fauna and flora needs, with no invasive species planted Ensure that alien species or those inappropriate for the area are not planted in any animal corridor or fly path area

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
Flora	(+/-, p/t, w/l)		Quarry sites may impact sensitive areas Some trees may be cut along with other vegetation, and possibly inappropriate alternate species planted, displacing native species and resulting in habitat loss. Alien plant species introduced competing with local species/landrace Intensification of area under irrigated agriculture, increase in HYV, monoculture and other crops and introduction of alien species with a corresponding potential loss of local agri-biodiversity Planting of non-native species in areas of local animal corridors resulting in damage to local forest habitats and of animal corridors	Specific quarry and borrow sites are to be identified and assessed for impact. Manual Where possible identify appropriate cropping pattern, considering possible animal raid issues. Discuss with forest department Ensure all plantation activities are based upon the local fauna and flora needs, with no invasive species planted All construction activities should be included in the construction contractor's contract clauses Ensure required permission is taken from the Tree Officer as identified in the Karnataka Preservation of Trees Act, 1976 prior to any tree cutting activity. Ensure design reduces need to cut trees For all trees cut/removed, plantation should be at the ratio of 3 planted for every 1 cut. All plantation activities should consist of appropriate species for the area to be planted, in consultation with the Forest Department and also after understanding the local ecological needs. Include in project budget. Need to include in the construction contractor's contract
Aquatic				
Fauna	(+/-, p/t, w/l)	Improved irrigation practices resulting in improved aquatic habitats for fish	Reduced return flows from irrigated areas will reduce the already low dry season flows. Increased agrichemicals usage resulting in degradation of the aquatic environment and toxicity for species Changing ephemeral water bodies to perennial may impact the dependent local fauna	Overall assessment of appropriate water needs for each sector, including environmental flows as part of river basin plan Development of appropriate drainage structures and management measures, on-farm land management. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils and drainage conditions.
Flora	(+/-, p/t, w/l)	Improved aquatic habitat with improved on-farm practices	Depending on location of various activities and possible changes in river flows, aquatic flora may	Overall assessment of appropriate water needs for each sector, including environmental flows

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
			be impacted adversely. Increase in growth of aquatic weeds due to eutrophication of water Changing ephemeral water bodies to perennial may impact the local flora dependent upon it	Development of appropriate drainage structures and management measures, on-farm land management. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils and drainage conditions.
Sensitive areas	(?, t,l)		There are a number of notified sensitive areas such as the Bhadra Wildlife and Tiger Reserve, and a number of forests area in the vicinity of the project (the wildlife reserve is about 5 km away although there are built up areas in between). Any project activities near these areas or in animal corridors could have an adverse impact .	Ensure project design is compliant with Environment Department requirements Ensure all plantation activities are based upon the local fauna and flora needs, with no invasive or alien species planted, not even in animal corridors Identify possible animal corridors and identify possible actions to reduce conflict – such as scheduling any work in any corridors to minimise conflict. Identify appropriate local species for any firewood plantations Ensure work is done in daylight hours to create least disturbance near sensitive areas.
Corridors, fly paths etc.	(-, p/t, w/l)		Change in land use, flora species changes, or other habitats resulting in disruption of corridors. There is at least one elephant corridor which is likely to cross the command area of the Gondi Anicut project area towards the confluence of Rivers Bhadra and Tunga.	Identify possible animal corridors and identify possible actions to reduce conflict – such as scheduling any work in any corridors to minimise conflict. Ensure that alien species or those inappropriate for the area are not planted in any animal corridor or fly path area
Economic and Infrastructure				
Agriculture	(+/-, p, l)	There is likely to be a positive impact on agriculture due to a move to higher value and more efficient crops. Improved agricultural practices – yield increased Improved livelihood opportunities in	Possible loss of agri-biodiversity due to introduction of other species and HYVs Competition for water use with other industries	Identify methods of preserving and cultivating local agricultural species and cultivars. Work towards breed improvement of local agricultural species and possible methods to improve income from the sale of produce of local agri-biodiversity Education to farmers on improved agricultural

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
		agriculture and better returns		practices, on-farm land management practices Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrochemical companies possibilities of buy back system for agrochemical containers etc
Industries	(+/-,/t, l)	Improved water quality due to improved on-farm management	Competition in water use, ground water or pumping from rivers Impact from industries due to reduced water quality	Identify appropriate conjunctive water use plans and ensure that there is no overdraw by industry on existing aquifers Education of industry to be more water efficient, comply with groundwater rules and control pollutant discharge
Mining and quarrying			Quarrying, borrow and sediment disposal activities could affect local vegetation, biodiversity, cause erosion, dust and noise, and affect communities	Identify specific borrow, quarry and sediment disposal sites, make impact assessments and prepare necessary operational guidelines for construction phase.
Fisheries	(+/-, p, w/l)	Improved on-farm practices result in better water quality and fisheries	Expansion of area under agriculture result in loss of habitat or contamination by agrichemicals	Education to farmers on improved agricultural practices, on-farm land management practices Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrochemical companies possibilities of buy back system for agrochemical containers etc Ensure that alien and invasive species are not planted in the area due to project intervention
Forestry	(-, p/t, l)		Vegetation clearance for structures Alien specie plantation and niche take over by introduced species	Minimise the need for vegetation clearance Ensure that there are no alien or invasive species planted as part of project design

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
				In animal corridors ensure only locally appropriate species are planted
Natural Resource usage and access	(+/-, p/t, l)	Waterlogging reduced and improved agricultural practices	Reduced access as areas are used for other activities – compensatory plantation, used for procuring raw material such as murram	Work with local population and Environment Department to identity appropriate routes and areas for any project activity Obtain environment department approvals for location of quarry and sand mining and borrow areas
WSS infrastructure	(+/-, p/t, l)	Improved groundwater quality due to better agricultural practices and reduced waterlogging Improved on-farm practices result in improved water quality	Many areas are dependent upon canal water for domestic, livestock and other uses. Reduced access to canals would decrease water availability for people Contamination of groundwater due to waterlogging in new areas under agriculture or more water available, more intensive irrigation and inadequate drainage Contamination of groundwater due to agricultural intensification and extensive	Consult with local population to identify required water needs of local population and ensure it is provided in design Ensure appropriate drainage is planned and its management identified Ensure appropriate agrochemical use and management in the area
Settlements		Unlikely to have any impact from project related activities	Poor routing of traffic and heavy traffic loads may damage roads	Identify most appropriate route for construction vehicles
Navigation, roads and other transport infrastructure	(-, p/t, l)		During construction, there is likely to be higher traffic to and from the various sites – traffic disruptions, road damage Poorly identified borrow pits and river sand quarries could lead to a long term damage to both river based and land based infrastructure as landing sites may be disrupted and river courses could shift or lead to erosion downstream, undermining infrastructure on or next to the river Damage to infrastructure due to heavy transport vehicles	Mitigation measures for transport of materials to be prepared during design phase and followed during construction phase. Similarly disposal of any excess material (eg. from canal excavations) to follow guidelines developed for specific sites during design phase Vehicles to take pre-identified routes. Do not overload vehicles or use vehicle loads higher than transport infrastructure capacity or dimensions. Identify possible telecommunication lines or other structures over roads (eg. overpasses, tunnels) in the area prior to starting work to ensure that they are not damaged due to any construction work.

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
				If damage to infrastructure occurs, plan for any maintenance that might required. The contractor through the contractor clauses will need to maintain all infrastructure in its original state.
Energy	(-, t, l)		Increase in sites for re-fuelling machinery	Identify a few centrally located sites for refuelling where possible Where refuelling undertaken ensure all safety measures are in place to minimise risk of accidents Ensure adequate protection from spillage in the area
Waste	(-, p, l)		Agrichemical waste (including containers) as more areas and more intense agriculture takes place Depending upon crops various waste products such as rice hulls, floriculture and horticulture require proper disposal Poor quality pipes used for irrigation/micro-irrigation requiring regular changing and waste dumping in the fields	Identify appropriate waste management system – including agrochemicals Create linkages that help make available good quality material and pipes in local farmer shops Capacity building so that farmers aware of issues and management practices
Telecommunication				
Social				
Population and livelihoods	(+, p, l)	Overall improvement in livelihood opportunities due to increased productivity and improved information on agriculture		
Vector borne diseases	(+/-, p, l)	Due to reduced area of paddy rice and waterlogging reduced habitats for various vectors both due to reduced humidity and waterlogging. Number of vector diseases exist in the project districts and include malaria, dengue, chikungunya, Japanese encephalitis and filarial.	Possible storage reservoirs put in place, increase vector habitats	Identify appropriate vector management with health department or through the use of biological methods such as larva eating fish. However only local fish species should be considered

DESIGN IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation measure**
Water borne diseases	(-, p, l)		Waste management and increasing contamination of both surface and groundwater resulting in contamination of groundwater	Ensure appropriate waste management plans for all project related waste – such as agrochemical waste and waste from agricultural produce
Nutrition and other health problems	(+/-,p/ t, l)	Increased nutrition with more pulses and other crops available	Agriculture expansion resulting in a higher agrichemicals usage and contamination of environment Sand mining destroying local fishing areas	Ensure appropriate farmer's education for the use of agrochemicals and the management of agrochemical waste. Identify any sand mining is not from local fishing areas or their habitats

Legend of Impacts

(-)	Adverse	(+)	Positive
(p)	Permanent	(t)	Temporary
(w)	Widespread	(l)	Localised

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
Physical Environment				
Water resources				
River system and environmental flows	(-, p, w)		Sand mining resulting in changing of river course and river scouring	Identify appropriate areas for taking river sand, based upon existing regulations, but also ensuring that there is no excess sand taken. Rehabilitate land after work is finished to ensure least damage to area Monitor impacts and compliance
Wetlands & local water bodies	(-, p/t, w/l)		Dumping of waste in water bodies casing contamination Washing of vehicles and other activities leading to pollution of water bodies and wetlands	Ensure that vehicles are not wasted in waterbodies Proper storage and disposal of material, including hazardous material, to avoid contamination, spills and accidents. If there are no waste disposal systems in the area, the material should be sent to a pre-identified disposal site. No dumping in river/water bodies, or labour camps/temporary or material storage sites on river bed. Vehicles properly maintained and serviced – and not washed or serviced, at site. Proper waste storage and disposal. Sites restored after work completed. Avoid refuelling at project site. For refilling at site, demarcate site, ensure surface made impermeable. Ensure vehicles are properly maintained Ensure vehicles are covered when carrying raw material
Groundwater	(-, p/t, l)		In areas where vehicles are kept, parked or at the quarry site, there may be spills of petroleum products – which could contaminate the groundwater Poorly managed sites or waste disposal resulting in waterlogging and a rise in the water table.	Vehicles properly maintained and serviced – and not washed or serviced, at site. Proper storage and disposal of material, including hazardous material, to avoid contamination, spills and accidents. Avoid refuelling at project site. For refilling at site,

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				demarcate site, ensure surface made impermeable. Ensure adequate and appropriate drainage for all areas
Water quality	(-, p/t, l)		Construction activities – like sand mining in river bed would impact the river quality, resulting in localized turbidity to spill of grease and oil from heavy machinery and trucks excavating material Washing vehicles etc in river polluting them	Vehicles properly maintained and serviced – and not washed or serviced, at site. Rehabilitate sites after mining activities and ensure that there is no excess harvesting of sand from any area
Atmospheric Parameters				
Air	(-, t,l)		Vehicular pollution is likely as there will be many truck movements and it is noted that many of the vehicles – especially trucks, are old and poorly maintained Dust during excavation – at construction sites and sourcing of raw material such as aggregate, sand and murram, and transportation of these materials to construction site Diesel pump sets for provision of energy during construction – leading to air pollution	Vehicles and other machinery properly maintained and serviced – and not washed or serviced, at site. Avoid refuelling at project site. For refilling at site, demarcate site, ensure surface made impermeable. Ensure vehicles are covered when carrying raw material Reduce blasting and other similar activities that may create dust to the extent possible Use sprinklers etc to settle dust where needed
Noise	(-, t,l)		During construction there is likely to be a relatively high level of noise at construction sites as well as from the large number of truck movements involved in importing fill. This would be heightened by the present quiet environment.	Vehicles and machinery should be properly maintained and serviced – and not washed or serviced, at site. Reduce blasting and other similar activities that may create dust to the extent possible Only work in day hours
Land Resources				
Soil quality	(-, p/t, l)		Localized pollution due to oil and grease spill and waste. Labour camps, for some of the construction activities would create waste and pollution through poor management and poor disposal of waste Large volumes of fill will require borrow pits. Approximately 350,000m^3 material is estimated	Ensure disposal of any sediment from canals disposed consistent with guidelines prepared in consultation with the local community during design phase. Proper storage and disposal of material, including hazardous material, to avoid contamination, spills and accidents. If there are no waste disposal systems in the area, the

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				material should be sent to a pre-identified disposal site. No dumping in river/water bodies, or labour camps/temporary or material storage sites on river bed. Vehicles properly maintained and serviced – and not washed or serviced, at site. Proper waste storage and disposal. Sites restored after work completed. Avoid refuelling at project site. For refilling at site, demarcate site, ensure surface made impermeable. Ensure vehicles are properly maintained Where possible try and reuse material. Try to use material excavated from canal cross section restoration for filling, where possible prior to identification of borrow sites
Erosion/ compaction	(-, p/t, l)		From procurement sites for material – quarries etc, sheet and gully erosion possible Vehicular movement, construction sites and labour sites causing soil compaction and erosion	Rehabilitate all sites after construction/quarrying activities are completed such as ploughing and plantation. Plan site prior to starting excavation activities, including slope stabilization, identify and develop appropriate slope aspect during excavation and contouring to ensure slope stability after earth borrowing activities are completed. Only clear vegetation that must be cleared As far as possible use already identified roads and routes to access various sites
Natural and Biological Environment				
Terrestrial				
Fauna	(-, p/t, w/l)		Depending upon area for procurement of raw material, location of labour camp, transport routes and other activities disturbance to local avian and other species due to construction noise and human	Discuss with local population before starting any construction activity to identify possible wildlife concerns to ensure minimum disturbance Only take up work in daytime

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
			movement is possible. Introduction of alien species for plantation activities could result in loss of habitat Construction in areas with species migration, either at the time of the migration or because of change of habitat due to construction activity resulting in degraded habitat may result in disruption of local migratory patterns. Elephants may disrupt any construction activity in their way.. Habitat loss due to cutting of trees and other vegetation and plantation of alien species as replacement or for fulfilling local fuel wood needs at the time of construction, which are not appropriate habitat for the local species such as *prosopis glandulosa*	In case of local animal movement or migrations, ensure that work does not take place when the migration is underway Do not create blockages by storage, labour camps etc in animal corridors Near sensitive areas ensure that work adheres to local regulations and also use least destructive methods, and rehabilitate area after finishing work
Flora	(-, p/t,w/ l)		Impacts from clearance of vegetation are likely at different sites such as along canal banks and for storage of material Access to the quarries and borrow pits requiring clearance of vegetation. Fuel wood needs obtained from local forests would result in local damage to flora. Introduction of invasive plant and pest species from vehicles and work crews	Undertake firewood plantation with locally appropriate species for labour camps All plantation species should be indigenous or appropriate for the area Ensure that there are no alien or non-native species in areas visited by wild animals or in corridor if any plantation taking place in such areas. Ensure that work adheres to local regulations and also use least destructive methods, and rehabilitate area after finishing work
Aquatic				
Fauna	(-, p/t, w/l)		Depending upon the area, there is a possibility of an increased turbidity or disturbance or degradation of the habitat. This could be due to sand quarrying, disposal of waste or washing of vehicles in the area, or even construction of structures in the aquatic system.	Do not undertake any construction/ quarrying activity in rivers during the spawning period of the different fish species. Discuss with local population before starting any construction activity to ensure minimum disturbance Use least disturbing methods for undertaking activities – such as silt traps if needed

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				Rehabilitate sites after work is competed No dumping of waste or washing of vehicles in water bodies In case of any accidental spillage, clean up after immediately
Flora	(-, p/t, w/l)		Depending upon the area, there is a possibility of an increased turbidity or disturbance or degradation of the habitat. This could be due to sand quarrying, disposal of waste or washing of vehicles in the area, or even construction of structures in the river system.	Do not undertake any construction/ quarrying activity in rivers during the spawning period of the different fish species. Discuss with local population before starting any construction activity to ensure minimum disturbance Use least disturbing methods for undertaking activities – such as use silt traps if needed Rehabilitate sites after work is competed No dumping of waste or washing of vehicles in water bodies In case of any accidental spillage, clean up after immediately
Sensitive areas	(-, t, l)		Depending upon sourcing of material and transportation routes sensitive areas can be impacted due to noise, light, vibrations, and destruction of habitat. Material sourcing and transport routes will be at least 2-3 km away and there are other major roads between.	In case of local animal movement or migrations, ensure that work does not take place when the migration is underway Do not create blockages by storage, labour camps etc in animal corridors Near sensitive areas ensure that work adheres to local regulations and also use least destructive methods, and rehabilitate area after finishing work Do not plant any alien species or those inappropriate for the area as a part of construction activities
Corridors, fly paths etc.	(-, p/t, w/l)		Disruption and destruction of corridors Disruption of migration of species due to construction and other construction related activities – some local migration of elephants	In case of local animal movement or migrations, ensure that work does not take place when the migration is underway Do not create blockages by storage, labour camps etc in animal corridors Near sensitive areas ensure that work adheres to local

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				regulations and also use least destructive methods, and rehabilitate area after finishing work Do not plant any alien species or those inappropriate for the area as a part of construction activities
Economic and Infrastructure				
Agriculture	(-, t, l)		There could be some disturbance accessing various sites such as construction and storage sites, vehicle parking area. Most of this is likely to be temporary, but poor management of sites may result in higher impacts	Discuss with local population prior to identifying appropriate construction sites and site plans Ensure all site plans and traffic management plans identified are adhered to
Industries				
Mining and quarrying	(-, p/t, w/l)		Impact from quarries and mines due to reduced water availability and quality and change in aquifers or surface water systems	Ensure that measures are taken and guidelines followed for quarries, borrow sites and sediment disposal Rehabilitate all sites after construction/quarrying activities are completed such as ploughing and plantation. Plan site prior to starting excavation activities, including slope stabilization, identify and develop appropriate slope aspect during excavation and contouring to ensure slope stability after earth borrowing activities are completed. Only clear vegetation that must be cleared As far as possible use already identified roads and routes to access various sites
Fisheries	(-, p/t, w/l)		Disturbance to local habitats during construction – such as sand mining from riverbeds. Waste dumping and washing and cleaning of vehicles, machinery etc in water bodies or near them	Do not undertake any construction/ quarrying activity in rivers during the spawning period of the different fish species. Discuss with local population before starting any construction activity to ensure minimum disturbance
Forestry	(-, /t, l)		Vegetation clearance for access to construction sites, quarries etc Use of fire wood at sites and other construction	Ensure adequate firewood plantation of appropriate species for labour is created so no conflict occurs Minimise vegetation removal from sites

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
			activities	
Fodder and grazing lands	(+/-, t, l)		Use of grazing areas for storage of construction material etc.	Consult with local population prior to identifying a site and planning for any activity in the area
Natural Resource usage and access	(-, t, l)		There could be some disturbance accessing various sites including construction, storage sites and vehicle parking	Consult with local population prior to identifying a site and planning for any activity in the area
WSS infrastructure	(-, p/t, l)		Damage to infrastructure at construction time – during sourcing of material or at various sites and facilities or during transport Lack of sanitation facilities for labour leading to contamination of existing resources Labour lack of sufficient water supplies leading to competition for existing resources Contamination of water sources due to construction activities – both at construction sites and in areas raw material is sourced from– impact availability of potable water.	Ensure labour had adequate facilities at all sites such as drinking water and sanitation and other resources Avoid using any transport routes which are unlikely to take weight of vehicles. In case of damage to any infrastructure due to construction activity immediately repair the damage and bring infrastructure back to original condition Ensure that there are appropriate waste and spillage management systems in place and that vehicles and machines are properly maintained
Settlements	(-, t, l)		Frequent heavy vehicle traffic causing air (dust, exhaust fumes), noise, safety and traffic disruption issues. Disruptions and disturbance due to construction activities	Identify and enforce appropriate access routes, speed limits and timings with community. Identify appropriate material storage areas to ensure least possible disturbance. Consult with local population on hours of operation and any entry of private land Consult with local population to identify any concerns and appropriate routes and construction sites to minimise disturbance Provide signage, demarcate and cordoning of areas to reduce access to construction site and to avoid accidents. Ensure appropriate site drainage. Restore areas after work is over. Minimize transportation of material through heavily

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				populated areas. Only use road worthy vehicles and ensure vehicles are properly maintained Cover vehicles carrying material Use sprinklers to reduce dust Avoid working in high wind periods
Navigation, roads and other transport infrastructure	(-, p/t, l)		During construction, there is likely to be higher traffic to and from the various sites – traffic disruptions, road damage Poorly identified borrow pits and river sand quarries could lead to a long term damage to both river based and land based infrastructure as landing sites may be disrupted and river courses could shift or lead to erosion downstream, undermining infrastructure on or next to the river Damage to infrastructure due to heavy transport vehicles	Follow operational guidelines for mitigation measures for transport of materials. Similarly disposal of any excess material (eg. from canal excavations) to follow guidelines Vehicles to take pre-identified routes. Do not overload vehicles or use vehicle loads higher than transport infrastructure capacity or dimensions. Identify possible telecommunication lines or other structures over roads (eg. overpasses, tunnels) in the area prior to starting work to ensure that they are not damaged due to any construction work. If damage to infrastructure occurs, plan for any maintenance that might required. The contractor through the contractor clauses will need to maintain all infrastructure in its original state.
Energy	(-, t, l)		Construction sites and intense traffic will require energy possibly causing conflict with the local population or destruction of local vegetation	Ensure labour camp needs are met without putting pressure on existing resources in an area
Waste	(-, t, l)		Increased waste from silt, raw material procurement sites, construction sites Malfunctioning vehicles with on-site maintenance Waste from areas dug for infrastructure construction – such as old infrastructure.	Proper storage and disposal of material, including hazardous material, to avoid contamination, spills and accidents. If there are no waste disposal systems in the area, the material should be sent to a pre-identified disposal site. No dumping in river/water bodies, or labour camps/temporary or material storage sites on river bed. Vehicles properly maintained and serviced – and not washed or serviced, at site.

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				Proper waste storage and disposal. Sites restored after work completed. Avoid refuelling at project site. For refilling at site, demarcate site, ensure surface made impermeable. Ensure vehicles are properly maintained Ensure vehicles are covered when carrying raw material Reduce blasting and other similar activities that may create dust to the extent possible Use sprinklers etc to settle dust where needed
Telecommunication and power network	(-, t, l)		Possible damage to telecommunication or power lines during construction – near material procurement sites and during transportation. Though considering the rural setting, the possibilities are limited	Identify possible infrastructure networks lines or other structures over roads (eg. overpasses, tunnels) in the area prior to starting work to ensure that they are not damaged due to any construction work. If damage to infrastructure occurs, plan for any maintenance that might required. The contractor through the contractor clauses will need to maintain all infrastructure in its original state.
Social				
Population and livelihoods	(-, t, l)		Disturbance to local population due to construction activity Accidents due to construction activies	Identify and enforce appropriate access routes, speed limits and timings with community. Identify appropriate material storage areas to ensure least possible disturbance. Consult with local population on hours of operation and any entry of private land Provide signage, demarcate and cordoning of areas to reduce access to construction site and to avoid accidents. Control traffic dust Ensure appropriate site drainage. Restore areas after work is over. Minimize transportation of material through heavily populated areas.

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				Only use road worthy vehicles.
Vector borne diseases	(-, p/t, l)		Disruption of drainage, borrow pits and sand mining areas resulting in an increase in vector habitats	Ensure appropriate drainage, sanitation and waste management for all construction sites Rehabilitate sites once construction activity is over
Water borne diseases	(-, p/t, l)		May increase if waste management, sanitation and drainage systems for the labour camps are not adequately addressed	Ensure appropriate drainage, sanitation and waste management for all construction sites Rehabilitate sites once construction activity is over
Nutrition and other health problems	(-, p/t, l)		Accidents due to the proximity of the construction and transport sites to the residential area Accidents at the construction sites resulting in injury to the labour or local population. Labour health and accident concerns	Have a health and safety operational plan on site. Ensure that all construction sites are cordoned off and only permitted people enter Ensure appropriate signage at construction, mining sites Ensure that where blasting takes place, such as at mines, timings are known and followed In case of accident ensure required first aid etc is given immediately. Provide appropriate shelter and other facility for any labour brought from outside. Do not use hazardous materials like asbestos for construction of shelters or temporary housing. Ensure no conflict with local population due to labour camp. Provide sanitation and waste management faculties Select any labour camp sites to ensure least possible conflict with local population – e.g., at a distance from where population density is high. Ensure labour camps have required infrastructure like water supply, sanitation facilities and energy. Develop appropriate waste management system, and rehabilitate the site after construction is over Do not develop any construction site – material storage, labour camps etc without consultation with the local

CONSTRUCTION IMPACT				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				population. Where possible do not use grazing lands etc for labour and material storage
Archaeological, cultural sites, paleontological sites and aesthetics	(-,p/ t, l)		Any riverbed quarries would impact the aesthetics of the area, though the impact is expected to be low Quarries may have impact on forests if not properly selected. Quarries have an impact on local aesthetics Chance findings could exist and may be damaged if not cared for adequately	In the event that such sites are encountered, all work that may be underway or planned in the area should be stopped and discussed with District Commissioner for further action Ensure that the construction company and supervising consultants have an understanding of archaeological concerns in the area Ensure that any important archaeological area is well identified and demarcated and that required actions are specified in a detailed management and mitigation plan so that no damage takes place to it Quarrying within forest sites should not be permitted

Legend of Impacts											
(-)	Adverse	(+)	Positive	(p)	Permanent	(t)	Temporary	(w)	Widespread	(l)	Localised

OPERATION IMPACTS				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
Physical Environment				
Water resources				
River system and environmental flows	(-, p, l)		Increased areas under irrigation outside of project area and intensification of irrigation in the project area resulting in reduced return flows to river, adversely impacting any environmental flows Where water reaches river/water bodies, but after being reused, higher level of agri-chemicals with agricultural intensification in increased toxics in river system and more aquatic weeds	Overall assessment and specification of appropriate water needs for each sector, including environmental flows as part of river basin plans and monitored accordingly Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design
Wetlands & local water bodies	(+/-, p, w/l)	Improved on-farm management resulting in lowering agrichemical usage, contamination of water bodies Improved irrigation practices resulting in reduced waterlogging	Dumping of agricultural waste agrichemical and their containers will degrade water bodies Additional and better maintained drainage resulting in waterlogging	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design Consult with users, study existing and planned uses and consider options for best management of the tank areas recognising their multiple uses (eg. environment, irrigation water supply/control, weed collection, fishing, fringe grazing etc
Groundwater	(+/-, p, l)	Improved agricultural practices resulting in lowering agri-chemical usage, improving aquifers health Improved irrigation practices may reduce, with positive impact on aquifer quality	Poor drainage management leading to silting and choking, resulting in waterlogging and rising water table Poor agricultural practices – like excessive irrigation leading to rising water table and waterlogging Agri-chemicals leaching into aquifer causing contamination	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design
Water quality	(-, p, w/l)		Return flows, drainage into canal system (silt and water quality – agrichemicals) deteriorating water quality of both surface and ground water systems	Identify appropriate cleaning and maintenance of drainage system, including disposal of waste removed. Improved agriculture practices – understanding plant

OPERATION IMPACTS				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				needs and use of irrigation water as required through improved understanding of the system Identify appropriate systems for the management of drains and disposal of silt Ensure there is a budget for the management of drains and the budget is spent on it
Land resources				
Soil quality	(+/-, p, w/l)	Effective agriculture extension improves soil quality	Excessive use of agri-chemicals, poor soil and land management practices leading to soil exhaustion, toxicity and degradation, due to poor agricultural extension	Identify appropriate soil management and soil testing systems and educate farmers. Ensure that farmers remember through repeated information sharing on good agriculture and soil management practices Farmers education on proper use and management of agrichemicals, including their waste
Erosion/ compaction	(+/-, p/t, l)	Better awareness due to agriculture extension resulting in reduced erosion along waterways	Agriculture intensification and poor farmland management without adequate attention to soil erosion control	Identify appropriate soil management and soil testing systems and educate farmers. Ensure that farmers remember through repeated information sharing on good agriculture and soil management practices
Salinity, alkalinity	(+/-, p, w/ l)	Improved soil, irrigation and drainage management will ensure soil salinity and alkalinity is reduced	Inadequate drainage management resulting in poor irrigation and drainage practices	Identify appropriate cleaning and maintenance of drainage system, including disposal of waste removed Identify appropriate soil management and soil testing systems and educate farmers on it. Ensure that farmers remember through repeated information sharing on good agriculture and soil management practices
Natural and Biological environment				
Terrestrial				
Fauna	(+/-, p, w/l)	Reduced toxicity in the environment with better on-farm management practices	Poor management of agriculture waste – especially agri-chemicals and their waste products, contaminates the area and impacts local or migratory species.	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of

OPERATION IMPACTS				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
			Excess agri-chemicals in environment create toxicity and affect some of the species that are likely to either live there Change to the functioning of wetlands and local water bodies could result in loss or change to local habitats	agrichemical waste, as identified during project design Work with local community to ensure that cultivation is not extended into areas environmental assets Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture. Identify important wetlands and monitor land use and condition Through the IWRM activities identify appropriate land management and conservation methods, and work with farmers to educate and ensure that wetlands are not degraded Work with farmers to identify appropriate land management and waste management systems at the village level
Flora	(-, p, w/l)		Increased intensification of agriculture resulting in greater use of agri-chemicals damaging flora and assisting invasive species	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design
Aquatic				
Fauna	(+/-, p/t, w/l)	Improved irrigation, agriculture and on-farm practices resulting in improved aquatic habitats for fish	Agrichemical waste and increased toxicity of the local aquatic environment	Work through a community system to identify wetlands, other habitats and local environmental assets Work with local community to ensure that cultivation is not extended into areas environmental assets Educate community on management of soil and agrichemical usage Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.

OPERATION IMPACTS				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
Flora	(+/-, p/t, l)	Improved aquatic habitat with improved on-farm practices	Agrichemical waste and increased toxicity and degradation of local aquatic habitat, and increase in aquatic weeds	Identify important wetlands and monitor land use and condition Through the IWRM activities identify appropriate land management and conservation methods, and work with farmers to educate and ensure that wetlands are not degraded Work with farmers to identify appropriate land management and waste management systems at the village level Ensure appropriate drainage management to keep the canals and drains silt free and not allowing the disposal of any waste Work with farmers through farmer's education system to ensure appropriate application of agrichemicals, including fertilizers Educate farmers on proper soil management and testing
Sensitive areas	(?, t,l)		Agriculture and irrigation intensification and use of new species may have an impact on area of influence of sensitive area	Work through a community system to identify wetlands, other habitats and local environmental assets Work with local community to ensure that cultivation is not extended into areas environmental assets Educate community on management of soil and agrichemical usage Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.
Corridors, fly paths etc.	(-, p/t, w/l)		Changing the functioning of wetlands and local water bodies may result in changed local habitats, Intensification of agriculture or other anthropogenic activities resulting in destruction of habitats	Work through a community system to identify wetlands, other habitats and local environmental assets Work with local community to ensure that cultivation is not extended into areas environmental assets

OPERATION IMPACTS				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
				Educate community on management of soil and agrichemical usage Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.
Economic and Infrastructure				
Agriculture	(+/-, p, l)	Improvement in yields and productivity with improved agriculture extension /agricultural practices, more reliable water supply, higher water use efficiency and reduced waterlogging.		
Fisheries	(+/-, p/t, w/l)	Improved on-farm practices resulting in better fisheries	Changed functioning of water bodies (tanks) affect habitat and recruitment. Agrichemical and other waste dumping contaminating water bodies	Work through a community system to identify wetlands, other habitats and local environmental assets Work with local community to ensure that cultivation is not extended into areas environmental assets Educate community on management of soil and agrichemical usage Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.
Fodder and grazing lands	(+/-, p, l)		Less open land in fields for grazing	Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.
Natural Resource usage and access				
WSS infrastructure	(-, p, l/w)		Poor management of agriculture waste leading to pollution of groundwater reducing availability of potable water Contamination of groundwater used for stock and domestic purposes in areas where soak pits and septic tanks are used or due to poor storage of agrichemicals	Educate community on management of soil and agrichemical usage and storage and disposal of agrochemical waste Ensure appropriate drainage plans and their management Identify any

OPERATION IMPACTS				
Environmental Issue		**Positive Impact**	**Adverse Impact**	**Mitigation Measures**
			Increased usage of agrichemicals resulting in higher pollution loads in water bodies	Work with farmers for improved management of agriculture and irrigation
Settlements				
Waste	(+/-, p/t, l)		Increased weeds rivers due to eutrophication resulting in increased need for disposal of weeds	Identify appropriate silt management – desilting, other waste, disposal sites, silt applied to fields as a manure Educate farmers for appropriate agrochemical usage
Vector borne diseases	(+/-, p, l)	Reduced area of paddy rice and waterlogging reduced habitats for various vectors both due to reduced humidity and waterlogging	Additional storage reservoirs increase vector habitats	Identify appropriate vector control methods, including biological control methods if appropriate
Water borne diseases	(+/, p, l)	Improved drainage and better water supply through canal rather than overland flow		
Nutrition and other health problems	(+/-, p/t, l)	Better food and nutritional levels due to better yields and food availability and incomes	Toxicity and other health risks due to use of agrichemicals without adequate protection Reuse of agrichemical packages for food and other storage purposes Burning of agrichemical plastic packaging Increased agri-industry waste disposal without adequate treatment and management	Work with and educate farmers on the best management of agrichemicals Consider options for improving quality of NPS runoff

Legend of Impacts

(-)	Adverse	(+)	Positive
(p)	Permanent	(t)	Temporary
(w)	Widespread	(l)	Localised

5. INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING

116. The project implementation is to be done through a Project management Unit (PMU) which will have an environment specialist as part of the team. The PMU will be located in Munirabad within the Karnataka Neeravari Nigam Limited (KNNL) with Chief Engineer, Irrigation Central Zone, Munirabad as the Project Director. The PMU staff will be working from its Project Director's Office. The Project Director will operate under the overall guidance and with the support of the Managing Director, KNNL and the Principle Secretary, WRD.

117. A technical consultancy support will be required by the KNNL and PMU to implement the program. The Program Support Consultancy Team (PSC) will consist of International and Domestic Specialists in the areas of irrigation management, irrigation operation, water institutions, PIM, agriculture, social, gender and environment.

118. This environment specialist is expected to have adequate knowledge on how to ensure the implementation of the EMP and also include any environmental concerns identified during the detailed design, construction and implementation phase. However, to ensure that the officials' in-charge of the system at KNNL understand ADB requirements and EMP needs basic training is needed. The PSC environmental specialist and the capacity building specialist will provide required training.

119. Most project activities are geared towards improving agriculture and therefore directly working at the farm level. However, discussions in villages show that there is a lack of awareness on the management of land resources and use of agricultural inputs like fertilizers and pesticides. Therefore, the project will need to undertake capacity building of farmers to ensure that they purchase, store, use, and dispose of chemicals and their waste (eg. wrappings, containers, etc) appropriately.

120. It is also suggested that there is an awareness programme with the appropriate authorities – implementing field engineers and Superintending and Chief Engineers on ADB environment compliance requirements and the EMP so that they are aware of what is required in the project.

6. INFORMATION DISCLOSURE CONSULTATION, AND PARTICIPATION

121. The consultative process for this subproject has identified a number of issues, such as the interest of 95% of villagers supporting the canal being lined mainly for livelihood and health related reasons. These include reduced waterlogging, improved and more efficient availability of irrigation water. Another benefit identified by the villagers from the project was of reduced damage and dampness to houses caused by waterlogging in the area. This section discusses the relevant environment related issues which came up during the discussions.

122. **Agrichemical usage:** Discussions on the use of agrichemicals – both fertilisers and pesticides show that understanding of agrichemical usage is poor. Most information is either from their friends, family or neighbours or from agrichemical shops. Therefore in many cases it seems to be a hit and try process. Discussion with both farmers and agrichemical shops showed that the chemicals suggested for a specific pest do not always work and therefore another is tried until the appropriate one is found and the problem is solved. It was also noted that organophosphates are being used by the farmers, which is of concern both due to their impact on health and bio-diversity, and the poor understanding of dosage and disposal of unused agrichemicals and their waste.

123. **Management of agrichemicals:** Another issue identified was the poor understanding of agrichemical storage and management of the waste. Discussions show that there is no proper disposal of agrichemical waste. Therefore, waste such as empty containers and partly used chemicals are disposed in the village itself. This includes burning the waste containers, burning the chemicals, or reusing containers. Reuse includes for storage of food stuff.

124. Most people mention that agrichemicals are stored in the house, in places often easily accessed by all family members and also not necessarily separately in order to avoid contamination.

125. **Soil health:** Soil testing is not common in the area. The result is agrichemical usage is based on what the farmers consider to be appropriate. This inadequate information, according to the agricultural specialist of CADA has resulted in micro-nutrient deficiencies in some areas and apparently high application of N:P:K.

126. **Organic farming and IPNM:** At present organic farming is limited as the common understanding is that there is little value added and often crop productivity suffers. Therefore, most farmers prefer not to undertake organic farming. Equally, organic farming is only seen as the use of organic manures. The use of IPNM is not common in the area. Nonetheless, there are a few progressive farmers who experiment with vermi-compost, IPM and IPMN, though because of the common understanding that yields go down with use of organic manures these practices have not spread to many farmers.

127. Recently there has been an increase in the use of micronutrients. While the agrichemical shops identify these as 'organic inputs' farmers see these as fertilizers. This usage is however limited at present.

128. **Access to information on on-farm management:** Access to information on agrichemicals, their use and management is limited. Most information is from the shops that sell agrichemicals. The shop owners are informed mainly by the chemical companies who supply the various chemicals and tell them what to use and how. Discussions on the use of organic fertilizers or biocides among shopkeepers, shows their limited understanding on the subject. Shop keepers mainly see organic farming as the use of micronutrients.

129. Some farmers access government extension services – the Agriculture Department officials at the Hobli level. However, this is limited to only those who are living close to the area. The others mainly consult shopkeepers for any agrichemical information.

130. Management of soil health, soil testing and other farmland management activities are largely limited to existing knowledge of farmers and information from neighbours and relatives, as

access to information is limited. While farmers understand that soil testing can improve their soil health, they do not have sufficient information or access to appropriate systems to undertake soil testing activities.

131. **Water hyacinth management:** In some areas, farmers have mentioned the use of the water hyacinth as manure. This is confined to areas and periods when water hyacinth is easily available. Farmers understand that the use of water hyacinth improves productivity. Also, farmers seem to be happy to use this resource where available. Therefore, possibilities could be explored how the weed could be managed through farmer's participation. However, this cannot be assumed as a shift towards organic farming but just an available opportunity in selected areas.

132. **Canal water usage:** Discussions with villagers highlight that they use the canals for various purposes other than just for irrigation. They wash their clothes and animals with the water, animals also drink from the canal directly. Therefore, there is a need to consider these issues while designing any modernisation activities for the project.

7. GRIEVANCE REDRESSAL MECHANISM

133. Consultation and information disclosure would be needed at various stages of the project. These are outlined below.

- At the time of identification of projects undertake consultation to ensure all concerns of project stakeholders are incorporated in the project design. Consultations should help inform project design and therefore there is a need to ensure consultations are undertaken at the time of identification of project feasibility and before the finalization of design
- Depending upon the assessment needs of the project, such as whether it is a Category A, B, C or F1 under ADB guidelines or GoI Category A, A/B, or B under EPA, 1986 EPA guidelines consultations must be undertaken.
- Consultations must be documented and made a part of the final environment report.
- Any issues identified during the consultations should be considered during the final project design.

134. Grievance redressal needs to be considered to ensure any unintended consequences, or violations of planned actions and activities is brought to the notice of the authorities to ensure compliance and resolution of problems and issues faced by the local population. The grievance redressal mechanism must,

- Be accessible to the local population and therefore should be present close to the area where project activities are under implementation.
- Ensure fairness and transparency in any grievance system planned. This could include making information on project activities available at the impacted areas itself, keeping a register of complaints and a system to identify progress of complaint and resolution taken, providing for a higher level authority for any problem resolution that has not be solved at the local level, ensure that contact information on the existing grievance redressal mechanism is available at the project implementation/construction sites.
- Ensure there are time limits set for solving all issues at each level of the system and is adhered to.
- Also, if any adverse impact is identified by the local population, they need to be immediately addressed and the grievance redressal system should be able to include any such complaints into project design.
- It must be a dynamic process that is able to help correct any adverse impact that project activities occur

135. The grievance redressal system as developed in the PMU will be used for the management of all identified grievances. The PMU is to develop and make operational a grievance reporting mechanism that will include the programme's vigilance officer, project managers and the Program Director. The PMU and PIOs will also organize awareness campaigns on the grievance reporting mechanism for the WUCS and other stakeholders.

8. ENVIRONMENTAL MANAGEMENT PLAN

136. Below is the EMP for the Gondhi Anicut project. This is based upon the findings of the impact assessment, a public consultative process, review of existing legislation and review of secondary information. All of these are given in earlier sections of this document.

Environmental Issue	Mitigation Action	Project Responsible Authorities
Project Design and Location		
Reduced environmental flows due to increased efficiency	Overall assessment of appropriate water needs for each sector, including environmental flows	AC-IWRM and River Basin Plans
Waterlogging or aquifer degradation due to project activities	Development of appropriate drainage structures and management measures, on-farm land management. Work with farmers to identify appropriate cropping patterns and agrichemical usage given existing soils and drainage conditions. Identify and manage quarries such that they cause minimum if any damage to surface and ground water systems, and ensure that during quarrying there is minimum if any damage to aquifers and surface water systems	PMU Command Area Development (CAD) and Institutions Cells WUCS and agricultural extension sub-project
Water quality degradation due to existing agricultural practices – agrichemicals and land management practices	Education to farmers on improved agricultural practices and use of agrichemicals, on-farm land management practices	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Increased soil toxicity, reduction in soil quality, soil exhaustion and erosion	Education to farmers on improved agricultural practices, on-farm land management practices	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Lowering groundwater table	Identify appropriate groundwater management and conjunctive use plans and local level regulation systems based upon local aquifer needs.	AC-IWRM's IWRM plans PMU CAD and Institutions Cells
Cutting of trees	Ensure design reduces need to cut trees For all trees cut/removed, plantation should be at the ratio of 3 planted for every 1 cut. All plantation activities should consist of appropriate species for the area to be planted, in consultation with the Forest Department and also after understanding the local ecological needs. Include in project budget. Need to include in the construction contractor's contract Ensure required permission is taken from the Tree Officer as identified in the Karnataka Preservation of Trees Act, 1976 prior to any tree cutting activity.	PMU CAD and Institutions Cells
Reduction in habitat for local fauna and flora	Ensure all plantation activities are based upon the local fauna and flora needs, with no invasive species planted Identify possible animal corridors and identify possible actions to reduce conflict – such as scheduling any work in any corridors to minimise conflict. Ensure that alien species or those inappropriate for the area are not planted in any animal corridor or fly path area	PMU CAD and Institutions Cells

Environmental Issue	Mitigation Action	Project Responsible Authorities
	Identify appropriate local species for any firewood plantations All construction activities should be included in the construction contractor's contract clauses	
Human – animal conflict	Where possible identify appropriate cropping pattern, considering possible animal raid issues. Discuss with forest department Avoid any activity in animal corridors during migratory season and do not create any permanent structure to obstruct it.	PMU CAD and Institutions Cells
Reduced fodder and grazing lands	Identify areas which are specifically for grazing in the area and through community management ensure that they are not encroached upon or overgrazed Identify appropriate agencies, such as the Animal Husbandry Department to help with improving fodder availability and reduction in open grazing. Implementation of locally identified issues through guidance form PMU	PMU CAD and Institutions Cells AC-IWRM's IWRM plan
Chance finding of an archeologically or culturally important site.	The EMP should include: In the event that such sites are encountered, all work that may be underway or planned in the area should be stopped and discussed with District Commissioner for further action Ensure that the construction company and supervising consultants have an understanding of archaeological concerns in the area Ensure that any important archaeological area is well identified and demarcated and that required actions are specified in a detailed management and mitigation plan so that no damage takes place to it	PMU Institutions Cells
Reduced aesthetics due to quarries on river bed, hills etc.	Rehabilitation of all sites must be undertaken once work is completed and plans developed well in advance of construction activities. Include rehabilitation requirements in the construction company contract to ensure it is taken up and appropriate budget should be made for the activity Avoid any quarrying work in an aesthetically important/significant place During design phase once any sites are identified, ensure budget to rehabilitate sites are identified and remediation actions included in EMP. All construction related activities should be included in the construction consultant's contract as clauses, including material procurement.	PMU Irrigation and Institutions Cells.
Loss of local agri-biodiversity	Identify methods of preserving and cultivating local agricultural species and cultivars. Work towards breed improvement of local agricultural species and possible methods to improve income from the sale of produce of local agri-biodiversity	PMU Institutions Cell
Conflict with local fisheries	Do not undertake any construction/quarrying activities in areas where local fish populations are important. In case unavoidable, identify methods to reduce impact after discussion with local population and also consider ways to compensate for loss Consider and include fish passage opportunities at anicuts	PMU Institutions Cell

Environmental Issue	Mitigation Action	Project Responsible Authorities
Reduced access to water for domestic, livestock and other purposes from canal system due to design changes and increased water use efficiencies	Identify water needs for different users and in consultation with them develop appropriate design changes to ensure access to identified groups at required places	PMU Institutions Cell
Disruption of traffic routes due to sighting of infrastructure	Identify any landing and other sites along the planned infrastructure site. Where possible consider design changes to ensure there are no problems faced by the local population. Where not possible in consultation with the local population create alternate facilities.	PMU CAD and Institutions Cells
Increase in agricultural waste such as agrichemical waste	Undertake farm management education for farmers to ensure that they know how to dispose agrichemical waste in most appropriate way Explore with KVK's, Agriculture Department, local agrichemical shops and agrichemical companies possibilities of buy back system for agrichemical containers etc	PMU CAD and Institutions Cells WUCS and agricultural extension sub-project
Increased vector habitats and diseases	Ensure adequate drainage needs are identified, designed and there maintenance is also identified If required, develop extra drainage plans for various structures to ensure there is no waterlogging	PMU CAD and Institutions Cells
Reduction in food supplements – fish and wild berries etc	Identify any use of lands where structure is planned, or fishing areas and consider how best to take into account people's needs Through an IWRM approach identify various needs of lands not presently occupied by agriculture and ensure that these uses are accounted for any land use and management plan developed for the area	PMU Institutions Cell
Increase in agri-industrial waste from local factories (eg. rice or sugar mills)	Review waste management processes and prepare better plans as required.	PMU Institutions Cell with State Pollution Control Board
Project Construction		
Sand mining and possible change in river course and river scouring	Identify appropriate areas for taking river sand, based upon existing regulations, but also ensuring that there is no excess sand taken. Rehabilitate land after work is finished to ensure least damage to area	Through appropriate contract clauses of construction agency under supervision of PMU Environmental specialist
Waterlogging from poor site planning and management	Ensure proper site planning takes place and site management is adequate – to be put into construction contractor's clauses	Contractor clauses of construction agency under supervision of PMU Environmental specialist
Erosion due to sand and murram mining and material procurement methods	Plan mining and procurement sites before starting work to keep in mind any erosion issues that may occur Rehabilitate site after finishing work, as appropriate	To be ensure by construction company through contract clauses from agency providing raw material , monitoring PMU environmental specialist

Environmental Issue	Mitigation Action	Project Responsible Authorities
Disturbance to wildlife species due to construction and material procurement activities, including in fly paths and corridors	Discuss with local population before starting any construction activity to identify possible concerns to ensure minimum disturbance Only take up work in daytime In case of local animal movement or migrations, ensure that work does not take place when the migration is underway Do not create blockages by storage, labour camps etc in animal corridors Near sensitive areas ensure that work adheres to local regulations and also use least destructive methods, and rehabilitate area after finishing work	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental and gender and social specialists
Occupational safety and construction hazards.	Provision of protective gear and safety equipment as required. Signage, site plan, lighting and restricted entry. Vaccination and preventive health measures as required, and first aid at site. Facilities for handling emergencies at site. Restricted access to hazardous materials. Personnel handling hazardous material properly trained, licensed and with sufficient experience. As needed have toilet and drinking water infrastructure, at construction sites.	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Pollution from construction activities	Proper storage and disposal of material, including hazardous material, to avoid contamination, spills and accidents. If there are no waste disposal systems in the area, the material should be sent to a pre-identified disposal site. No dumping in river/water bodies, or labour camps/temporary or material storage sites on river bed. Vehicles properly maintained and serviced – and not washed or serviced, at site. Proper waste storage and disposal. Sites restored after work completed. Avoid refuelling at project site. For refilling at site, demarcate site, ensure surface made impermeable. Ensure vehicles are properly maintained Ensure vehicles are covered when carrying raw material Reduce blasting and other similar activities that may create dust to the extent possible Use sprinklers etc to settle dust where needed	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Accidents and health concerns of local population	Ensure that all construction sites are cordoned off and only permitted people enter Ensure appropriate signage at construction, mining sites Ensure that where blasting takes place, such as at mines, timings are known and followed In case of accident ensure required first aid etc is given immediately	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Compaction of soil/soil erosion for access to various sites and quarries	Rehabilitate all sites after construction/quarrying activities are completed such as ploughing and plantation. Plan site prior to starting excavation activities, including	To be ensured by construction company through contract clauses

Environmental Issue	Mitigation Action	Project Responsible Authorities
– such as metal quarries for aggregate, murram quarries and sand mining areas	slope stabilization, identify and develop appropriate slope aspect during excavation and contouring to ensure slope stability after earth borrowing activities are completed. Only clear vegetation that must be cleared As far as possible use already identified roads and routes to access various sites	both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Impact on local fisheries and fish spawning and aquatic fauna.	Do not undertake any construction/ quarrying activity in rivers during the spawning period of the different fish species. Discuss with local population before starting any construction activity to ensure minimum disturbance	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Disturbance to local population.	Identify and enforce appropriate access routes, speed limits and timings with community. Identify appropriate material storage areas to ensure least possible disturbance. Consult with local population on hours of operation and any entry of private land Provide signage, demarcate and cordoning of areas to reduce access to construction site and to avoid accidents. Control traffic dust Ensure appropriate site drainage. Restore areas after work is over. Minimize transportation of material through heavily populated areas. Only use road worthy vehicles.	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Reduced access to sites for local population, construction sites or material procurement sites	Identify alternate routes for project construction activities where possible If not possible, in consultation with the local population identify appropriate alternatives for them and provide required facilities	To be ensured by construction company through contract clauses both for work carried out by them and for any procurement form other agencies, monitoring PMU environmental specialist
Damage to infrastructure.	Vehicles to take pre-identified routes. Do not overload vehicles or use vehicle loads higher than transport infrastructure capacity or dimensions. Identify possible telecommunication lines or other structures over roads (eg. overpasses, tunnels) in the area prior to starting work to ensure that they are not damaged due to any construction work. If damage to infrastructure occurs, plan for any repair and maintenance that might required. The contractor through the contractor clauses will need to maintain all infrastructure in its original state.	To be ensured by construction company through contract clauses, monitoring PMU environmental specialist
Workers / labour camps and facilities.	Provide appropriate shelter and other facility for any labour brought from outside. Do not use hazardous materials like asbestos for construction of shelters or temporary housing.	To be ensured by construction company through contract clauses both for work carried out by them and for any

Environmental Issue	Mitigation Action	Project Responsible Authorities
	Ensure no conflict with local population due to labour camp. Provide sanitation and waste management faculties	procurement form other agencies, monitoring PMU environmental specialist
Conflict with labour camps on resources.	Select any labour camp sites to ensure least possible conflict with local population – e.g., at a distance from where population density is high. Ensure labour camps have required infrastructure like water supply, sanitation facilities and energy. Develop appropriate waste management system, and rehabilitate the site after construction is over Do not develop any construction site – material storage, labour camps etc without consultation with the local population. Where possible do not use grazing lands etc for labour and material storage	To be ensured by construction company through contract clauses both for work carried out by them, monitoring PMU environmental specialist
Chance findings – archaeological sites.	Stop all work that may be underway or planned in the area and discuss with District Commissioner for further action Ensure that the construction company and supervising consultants have an understanding of archaeological concerns in the area Ensure that any important archaeological area is well identified and demarcated and that required actions are specified in a detailed management and mitigation plan so that no damage takes place to it	To be ensured by construction company through contract clauses, monitoring PMU environmental specialist
Project Operation		
Increased agricultural waste in water and water bodies	Ensure through farmer's education that waste is not disposed in water bodies and appropriate waste disposal systems are found and used	PSC environmental specialist with WUCS Service Support Teams (SST)
Increased agrichemicals in surface and ground water systems, and reduced quality of return flows	Farmers education on proper use and management of agrichemicals, including their waste Ensuring a farmer-friendly method for disposal of agrichemical waste, as identified during project design	WUCS Service Support Teams (SST with PSC environmental specialist
Waterlogging and reduced drainage	Identify appropriate cleaning and maintenance of drainage system, including disposal of waste removed. Improved agriculture practices – understanding plant needs and use of irrigation water as required through improved understanding of the system Identify appropriate systems for the management of drains and disposal of silt Ensure there is a budget for the management of drains and the budget is spent on it	PMU CAD and Institutions Cells
Soil degradation due to poor on-farm management, intensive agriculture, soil exhaustion and soil toxicity due to chemical usage and lack of knowledge among farmers	Identify appropriate soil management and soil testing systems and educate farmers on it. Ensure that farmers remember through repeated information sharing on good agriculture and soil management practices	PMU CAD and Institutions Cells
Change and degradation	Identify important wetlands and monitor land use and	PMU Cells, SSTs, PSC

Environmental Issue	Mitigation Action	Project Responsible Authorities
of wetlands due to waste dumping and expansion of agricultural lands	condition Through the IWRM activities identify appropriate land management and conservation methods, and work with farmers to educate and ensure that wetlands are not degraded Work with farmers to identify appropriate land management and waste management systems at the village level	environmental specialist
Reduced and degradation of habitats for species – both aquatic and terrestrial species	Work through a community system to identify wetlands, other habitats and local environmental assets Work with local community to ensure that cultivation is not extended into areas environmental assets Educate community on management of soil and agrichemical usage Demarcate all areas though an IWRM plan for conservation and limitation of areas for agriculture.	PMU Institutions Cell AC-IWRM's IWRM plan
Increased aquatic weeds	Ensure appropriate drainage management to keep the canals and drains silt free and not allowing the disposal of any waste Work with farmers through farmer's education system to ensure appropriate application of agrichemicals, including fertilizers Educate farmers on proper soil management and testing	PMU Irrigation and Institutions Cell
O&M waste – spoils from drainage system and canals	Identify appropriate waste management system for drain cleaning Weeds can be used, in consultation with farmers, for manure. Therefore, if farmers are interested a system for their use and disposal on farmlands at the time that drains are cleaned should be undertaken.	PMU Irrigation and Institutions Cell
Increased toxicity in environment and for people with more agrichemical packages being reused	Farmer education on appropriate management of agrichemical packaging. Where possible consider a buy-back system for agrichemical packages by the agrichemical companies	PMU Institutions Cell
Non point source pollution of waterways	Work with and educate farmers on the best management of agrichemicals Consider options for improving quality of NPS runoff	PMU Institutions and CAD Cells AC-IWRM studies
Multi-objective use of tanks and off line storages	Consult with users, study existing and planned uses and consider options for best management of the tank areas recognising their multiple uses (eg. environment, irrigation water supply/control, weed collection, fishing, fringe grazing etc	PMU Institutions and Cell AC-IWRM IWRM plans
Increase waste from fields due to micro-irrigation system	Educate farmers on best management of systems to be used, where to get good quality material that does not break down and spoil fast, its maintenance and proper disposal of waste	PMU Irrigation and Institutions Cells WUCS and agricultural extension sub-project

Monitoring Plan for Sub-Project

137. Prior to developing a monitoring plan there is a need to develop a baseline for some activities to help with the monitoring activities. The baseline is described below along with monitoring needs and responsibilities. The reporting of implementation of EMP will need to be done on a bi-annual basis and will form a part of the regular status update on the project progress.

Project Phase	Parameter	Frequency to monitor	Action	Responsible authority
Construction	Noise	Monthly before (baseline) and during construction period	Pre-construction baseline. Day time measurement since all activities are expected to be done in the day time If not possible to identify schedule – should be done for 3 different times: peak traffic, day quite hours and late evening The location should include any construction site near habitations, any transport route which may pass in close proximity to a sensitive forest/wildlife area	The actual measures should be available in the Detailed Project Report (DPR) for those areas where actions have been identified
	Site for quarries and borrow pits	Before work baseline and end of work prior to making final payment for work to contractor.	Photographic baseline (pre-construction) for restoration of site after the construction activity is completed	Undertaken by the construction company or PMU, as appropriate. All records are to be with the PMU for future reference
	Removal of vegetative cover and trees	Prior to work starting and before making the final payment to the agency identified for undertaking all plantation activities.	Assessment to include cost in DPR Vegetative survey to identify type and amount of vegetation that needs to be replaced Tree surveys where trees are to be cut to estimate the amount that has to be replanted	Costs need to be included in the DPR too.
	Waste management at sites	At random at sites, but report compiled on a monthly basis from before construction commences.	Review if the waste management plan is in place and being followed properly.	The actual measures should be available in the DPR for those areas where actions have been identified
	Site management	Monthly for the duration of the work	To ensure that all required facilities are available – like safety equipment, workers sanitation facilities and domestic needs water for workers and their families etc. as defined in the EMP	To be identified as a list of actions and conditions in the construction contractor's contract.
	Site restoration	Once prior to work commencing and then before final payment of the construction	To ensure that restoration is undertaken appropriately. Photographic baseline to	To be done by the contractor or the PMU with all records available with the PMU.

Project Phase	Parameter	Frequency to monitor	Action	Responsible authority
		company in-charge of the area	be maintained.	
Project Operation	IPMN implementation	Six monthly	Review progress of knowledge and use of IPNM by farmers and access to required facilities.	Based upon the activities identified by the PMU CAD and institutional Cells and in the subproject documents
	Water Quality	Annually, at the same time each year	A baseline to identify the quality of water and an annual review for changes in water quality for a 5 year period. Monitoring locations to include upstream of project command and downstream area, and if any return flows exist, monitoring of water quality of return flow quality	The baseline to be developed and included in the DPR and therefore the DPR consultant's responsibility The annual monitoring should be based upon the activities identified by the PMU institutional cell, and should include the PMU environmental specialist to review and provide any corrective measures if needed and where possible

9. CONCLUSION AND RECOMMENDATIONS

138. While there are sensitive areas in the District – Shivamogga, where this sub-project is located, none of them fall in the planned sub-project area. The planned activities of this modernisation sub-project are also unlikely to have an adverse impact on these sensitive areas. Nonetheless, as the site is near sensitive areas and particularly Wildlife reserves, which are both ecologically important and sensitive, certain issues will have to be taken into account in project activities. In addition, there are a number of issues that will need to be managed in order to protect the environment of the project area and related areas.

139. The IEE has screened the range of potential environmental impacts, prepared a proposed Environmental Management Plan and sub-Project Monitoring Plan.

140. In addition to these plans there are a number of areas requiring further attention and these are:

- Appropriate mechanisms to improve on-farm soil and land management and to introduce IPNM and other mechanisms to ensure reduced use of agrichemicals need to be developed and implemented. It is expected that intensification of agriculture will be tend to increase agrichemical usage. Any expansion of agriculture, although not expected would also increase usage of agrichemicals.
- Discussion with forest officials is required to identify and pin point any elephant corridors that are in the planned project area and the requirements to preserve these. There is a need to ensure that there are no disturbances during their migratory period and that damage to infrastructure will not occur.
- The existence of elephant herds is likely to result in animal-human conflicts and the cultivation of rice and bananas may also result in elephants raiding fields although no more than in the pre-project case.
- Care also is needed to prevent the introduction of invasive alien plant species that may be transported by migrating animals to the Western Ghat forests.
- Another issue that would require serious consideration is environmental flows. The envisaged plan is to improve efficiencies of the system, save water for upstream consumption, which together will reduce return flows to the river. This is expected reduce water supply for the downstream environment and water users. This is something that should be considered in larger IWRM project.
- There is thought to be little scope for expansion of the irrigated area as the command area is now fully irrigated and on one side is bordered by the Bhadra river and on the other by the Bhadra command area. Internally there could be some minor scope however by encroaching upon tank areas which have some ecological value. It is suggested that local land use plans be developed in discussion with the local populations to protect any such important areas including along the river and waterways. This perhaps again is an area where the IWRM project could assist.
- The main area where there is a need for close monitoring is during the construction period – where issues of material procurement, site planning, management of any labour camps and labour needs, noise and dust control, disposal of waste, vegetation clearance, and the restoration of sites after the work is completed need to be ensured. These must be included in contractor contracts with adequate funds available for the activities to be undertaken properly.

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