ANNEX - 6

REPORT
OF THE
INTER-MINISTERIAL GROUP
ON
ISSUES RELATING TO
RIVER GANGA

GOVERNMENT OF INDIA
NEW DELHI
(March, 2013)

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EXECUTIVE SUMMARY

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1. The Ministry of Environment and Forests has constituted an Inter-Ministerial Group (IMG) to consider the issues relating to hydropower plants and environmental flows (Annex-IA–IC). The IMG has finalised its recommendations on the Terms of Reference (ToR) referred to it. A summary of its recommendations is given in following paragraphs.

2. The IMG held extensive discussions and met a number of experts, non-Governmental organizations and individuals with varied experience (Annex-II).

ToR (i)

3. The IMG has been charged with the responsibility of facilitating collection of information for the "Ganga River Basin Management Plan Study" being carried out by the Consortium of IITs. The specific Term of Reference in this for the IMG was as follows:

> *"To facilitate cooperation with government agencies for early completion of the study being conducted by the Consortium of IITs for preparing a Ganga River Basin Management Plan."*

3.1 The IMG has considered the above issue and felt that it needs a longer term arrangement for facilitating data collection as the term of the IMG of few months may be quite inadequate to get the extensive data required for the above study. After writing to the concerned Departments, some progress was made (Annex-III). It was noted that the data was to be obtained from a wide variety of sources including several Ministries of Government of India and of the State Governments. It, therefore, recommends the following:

(i) The IIT consortium should contact individual departments, officers to collect as much information as feasible in the normal course of business. The Mission Director of Ganga may be in touch with them and with the State Governments to facilitate flow of information. The flow of information may be reviewed by the Mission Director, National Mission for Clean Ganga, once every fortnight with the IIT Consortium.

(ii) A standing mechanism under Secretary, Ministry of Environment and Forests be created to review and resolve difficulties if any in-flow of information to the Consortium. In this mechanism, concerned

Secretaries of Government of India or their representatives may meet once in 15 days to review the flow of data. For data related to State Government a time limit of one month be set by the Chief Secretary. The Chief Secretary may develop a mechanism to keep the Secretary (E&F) informed of the progress in the flow of information. For data related to Government of India Departments, a time limit of two months be set after which the matter be placed before the Cabinet Secretary for review and assessment.

(iii) The concerned Central Ministries should be charged with the responsibility of coordinating with the States Governments of Energy, Power and Irrigation for ensuring that adequate response is available from them for data collection.

(iv) It may be appropriate to place this issue, before the Cabinet Secretary in June, 2013 to give a strong push to this. This will facilitate resolution of any outstanding inter-Departmental issues and any wider concern on providing data which may not be in public domain or not likely to be so.

ToR (ii)

4. *"Pending finalization of the Ganga River Basin Management Plan, to consider and make recommendations on the following short-term measures in the upper reaches of the river Ganga on the basis of available reports, within three months:*

(a) To suggest environmental flow requirement that could be prescribed for various stretches of Bhagirathi, Alaknanda and other tributaries of river Ganga, taking into account suggestions in the reports prepared by the IIT-Roorkee, Wild Life Institute of India and any other available report on the subject that the Group wishes to consider.

(b) To examine how best to make the suggested flows applicable to projects currently in operation, taking into account, inter alia, its impact on tariff.

(c) To make a review of the environmental impacts of projects that are proposed on Bhagirathi, Alaknanda and other tributaries of river Ganga and recommend necessary remedial action."

Environmental Flows (E-Flows)

4.1 River Ganga and its tributaries have special importance for social, religious and cultural perspective. The river has occupied central stage in the folklores and has been a part of our religious scriptures. The environmental flows in the river Ganga have to be hence decided based on comprehensive assessment of ecology, bio-diversity, environment, and people's need for social, religious and other community activities.

4.2 The development needs for hydro power projects is well recognized for economic growth and prosperity of the States. These projects, however, should lead to a sustainable development of the region with positive impact on their economic, social and cultural life. There are 69 power projects at various stages, apart from one on Ganga, which is outside the remit of IMG and the objective must be to ensure that these projects do not compromise on the health of the river.

4.3 Environmental flows in the river must lead to a continuous availability of water *(Aviraldhara)* in the river for societal and religious needs. With this objective, adequate water should be available to the community, especially in the winter season when the river streams have a small quantity of water.

4.4 For assessing the requirement of e-flows, the IMG has taken in to account Reports of IIT-Roorkee, Wild Life Institute of India (WII) and World Wildlife Foundation (WWF). It has also considered the recommendations of CWC and views given before it by various non-governmental organizations, experts and social groups.

4.5 The IMG has considered the e-flow practices being followed in different countries. It has noted the policies in France for 10% of the Mean Flow for new schemes, the U.K. for 95% of the time the e-flow being equal to or exceeding the minimum flow in the river during the year, the Montana method practice in the US based on look up tables and the Hydrological Index being developed in South Africa. None of the above approaches appear to be suitable for our conditions as they do not take into account conditions of our rivers and bio-diversity. These include requirements of fish, especially Mahseers and Snow Trouts, other fish species and river and terrestrial bio-diversity which is to be preserved and developed. In addition, there are other societal requirements, too. The IMG, therefore, does not consider the above approaches as appropriate.

4.6 The method used by IIT-Roorkee is based on percentage of Mean Annual Flow (MAF). Data for 10 days flows has been collected/computed for 22 sites and fine analysis of various methodologies used globally has been made. It has also assessed specific requirements of fish and other bio-diversity needs. The WII Report, while using the data collected by IIT-Roorkee, has specially focussed on environment and bio-diversity aspects. It has suggested the e-flow based on requirement of aquatic bio-diversity, especially fish. It has recommended 21.5% of MSF of river if it falls in 'Mahseer Extract Zone' and 14.5% of MSF in 'No Fish Zone'. These recommendations should, therefore, be considered more appropriate for meeting the needs of the environment and ecology.

4.7 The recommendations of WWF for various seasons are based on the views of Smakhtin et al, 2007, who have recommended environmental flows for the river (Annex-IV). However, considering that this is for the lower regions, where the fish requirements for water are much more and hydropower potential does not exist, a modification of that assessment has been made by WII considering that there EWR (Environmental Water Required) was for areas near Rishikesh for a different nature of biodiversity. The assessment of e-flows at Bhagirathi and Alaknanda basin has to be adjusted. The IMG assesses that the requirement as recommended by WII are quite adequate to meet the needs of the fish eco system of the above basins.

4.8 The IMG recognises that while suggesting the e-flows, an appropriate balanced approach needs to be taken. The needs of Hydro power for the State also are required to be considered. It is essential so that the e-flows meet the total societal requirements including for social, cultural and economic growth needs. It is also important to see that the flows do not result in exorbitant cost of power which the people of the region may not be able to afford. This would make these power projects uneconomic and un-implementable.

4.9 The IMG also recognizes that while recommendations of WII which are based on an EnvironmentalManagement Category (EMC), Bio Diversity Value and Mean Seasonal flow approach (MSF) need to be given weightage for deciding the e-flows, the diverse religious, cultural and social needs of society, particularly during the winters if water in the river is reduced considerably, also need to be also provided for, even though, the fish ecology may not need that much of water. Similarly, during the rainy season when there is adequate water in the river, the requirements for animal life,

including fishes should be carefully assessed and appropriately balanced with the needs for generating hydro power.

4.10 An important component of the e-flows regime has to be mimicking of the river flows so as to keep it very close to the natural flows. Cumulative norms even on seasonal basis do not meet this objective. Daily inflow norms may, however, enable a sustained river flow as well as have large flows in the high season and hence are more suitable. These will invariably be higher than similar norms of MSF and provide an effective mechanism for use of e-flows both by community and for hydropower.The IMG is also very conscious of the need to have an e-flow policy regime which is effectively implementable by different hydro power projects. An essential ingredient of such a policy is simplified e-flow norms with minimum variations during the year.

4.11 In view of above, the e-flows in the above river basins in 'fish zone' should be,except to the extent modified in para 4.14 below, fixed in terms of percentage of daily uninterrupted inflows at following levels:

October–November April–May	– 25%	WII has recommended the same, percentage, except for May (30%) and November (20%) on MSF basis.
June–September	– 20%	WII has recommended 30% on MSF.
December–March	– 30%	WII has recommended 20% on MSF.

The actual river flows during the high season (June–September) would be higher than 30% of the cumulative flow in the river in that period with the above norms in place. This is due to the fact that lot of water during the high flood season will have to flow in the river directly considering the design of the hydro power machines. The above flows will also be more than WII recommendations on MSF in all seasons (Annex-V).

4.12 The e-flows for the 'No Fish Zone' should be,except to the extent modified in para 4.14 below, fixed in terms of percentage of daily inflows at following levels:

April–September	–	20%
October–March	–	30%

While the WII has suggested 14.5% of the MSF as appropriate, the IMG feels that it will be necessary to have daily flows as above so as to meet the requirements for community purposes.

4.13 While suggesting above, the IMG has considered the views of CWC on minimum e-flows in the river and also the analysis that shows that hydropower in these stretches is optimised during the months of high discharge. In the winter months, with low and variable water discharge in the river, the plant load factor is already low. The IMG's recommendation is based on optimisation of energy during high discharge and balancing the needs for society and river water flow in low discharge.

4.14 The IMG has considered the need for e-flows, especially during the winter, when the water discharge is very low. River flow data in some of the rivers indicates that the discharges during the winter months becomes as low as 5% of the high season flow discharge. In view of this, the IMG recommends that, in addition to above, during the winter months in rivers where the water flow goes down drastically, the societal needs have to be met and the flows should, therefore, be increased to 50% in December–March. Since data for all the projects is not available, no specific recommendation for any project is being made. However, the IMG strongly feels that the need for adopting this policy.

4.15 The IMG has considered the need for an effective implementation of the e-flows as cardinal to its recommendations. It is recommended that the power developer must be responsible for developing a monitoring system which is IT-based and gives on a real time basis the flow of water in the river, both at the inflow and in the outflow after the river gates in the river stream. This should be (a) monitored by an independent group, (b) reviewed yearly by the Ministry of Environment and Forests in the first five years and (c) put in public domain the e-flows for the above 25 MW power projects. This real time public monitoring of e-flows will be the key to future hydropower development as it will build confidence in local communities that these projects will not be at the cost of environment.

4.16 The suggested e-flows should be applicable to the existing power projects in operation in these States. A phased adjustment of modified e-flows can be introduced in these projects to minimise disruption. For this purpose, necessary changes in the tariff structure and the PPA may be needed. Also, the State Governments which has allotted the power projects to the power developers should advise them to re-compute the tariffs on the revised e-flow norms for decision by State Power Regulatory Commissions.

4.17 Considering environment, societal, religious needs of the community and also taking into taken in to account the status of river Ganga as national river, the IMG recommends adoption of Building Block Methodology (BBM)

for assessing the e-flow requirements on a long-term basis. This recognizes the fact that the riverine species are reliant on basic elements (Building Block) of the flow regime, including low flows, and floods that maintain the sediment dynamics and geo-morphological structure. It also includes an understanding of the functional links between hydrology and ecology of the river systems. While recognizing the fact that it may be time consuming, requiring large financial resources, and highly skilled manpower in diverse disciplines and filling gaps in knowledge needing research studiesand consensus of experts may be difficult rendering decision making difficult, it would be appropriate to use the same for River Ganga to meet societal and community needs for cultural and spirituality but in situations where the required conditions are satisfied and resources, time and data are available.

Environmental Impact of Projects

4.18 Development of new hydro power projects has impact on environment, ecology, biodiversity, both terrestrial & aquatic and economic and social life. 69 hydro power plants with a capacity of 9,020.30 MW are proposed in Bhagirathi and Alaknanda basins. This includes, 17 projects which are operational with a capacity of 2,295.2 MW. In addition, 26 projects with a capacity of 3,261.3 MW (including 600 MW LohariNagpala hydropowerproject, work on which has been suspended by Government decision) which were under construction, 11 projects with a capacity of 2,350 MW CEA/TEC clearances and 16 projects with a capacity of 1,673.8 MW under development.

4.19 The implementation of the above 69 hydro power projects has extensive implications for other needs of this society and the river itself. It is noticed that the implementation of all the above projects will lead to 81% of River Bhagirathi and 65% of River Alaknanda getting affected. Also there are a large number of projects which have very small distances between them leaving little space for river to regenerate and revive.

4.20 The IMG has also considered the environmental impact of proposed 69 hydro projects (Annex-VI). While IIT-Roorkee has made no specific exclusion of projects on this ground, though some norms have been suggested (Annex-VII), WII recommendations are for implementing projects worth 6,942 MW only in view of high aquatic and terrestrial biodiversity and leaving out projects worth 2,608 MWfor review (Annex-VIII). By excluding these, the river length impact will be reduced by 37.31%, forest area by 21.71% and power generation capacity by 27%. E-flow norms will further reduce this and implications will need to be assessed.

4.21 The process of construction of hydro projects in itself is often accompanied by poor management of overburden and construction waste, inadequate soil erosion and sedimentation measures and unsatisfactory efforts at protecting adverse geological impact. The IMG recommends that all such projects must follow environment protection guidelines during and after their implementation (Annex-IX).

4.22 There is a clear need to ensure that adequate river length is available to meet the societal needs and River gets adequate time during its flow to regenerate itself. The IMG notes the recommendations of IIT-Roorkee and WII, Dehradun, on these issues. It is, however, clear that there is no scientific study which suggests a specific norm which can be applied on this issue. While the final recommendations of IIT Consortium will consider this issue and suggest appropriate norms, as an interim measure, the IMG recommends that while implementing the above projects two norms be followed. First, the river length affected should not be more than 60%. Second, the distance between two hydro projects should generally be such as to ensure that over-crowding is avoided. This is recognising the fact that this distance will, however, depend upon the gradient of the river and consequently hydro-potential at that point. If the gradient is high and the hydro potential is large, the distance will have to be smaller in view of technical requirement of the hydro power. This could result in continuity in some cases. Similarly, for low gradients, the distance would be higher than the above norms. With the recommendation of IMG for environmental flow which will always be available and which would have travelled throughout the diverted stretch, any significant gaps and large distance may not be required. The IMG feels that a comprehensive environment impact study be done by IIT Consortium only as part of Ganga River Basin Management Plan, which will recommend the mandatory distance requirements of projects, keeping in mind the need for ecology, sustainability and power generation.

4.23 The River Ganga has over a period of years suffered environmental degradation due to various factors. It will be important to maintain pristine river in some river segments of Alaknanda and Bhagirathi. It accordingly recommends that six rivers, including Nayar, Bal Ganga, Rishi Ganga, AssiGanga, Dhauli Ganga (upper reaches), Birahi Ganga and Bhyunder Ganga, should be kept in pristine form and developments along with measures for environment up gradation should be taken up. No new power projects should be taken up in these River Basins. In the IMG's assessment, this will mean about 400 MW of power being not available to the States.

4.24 Pending a long-term perspective on the Ganga Basin Management Plan, following policy needs to be followed to implement the hydro power projects on the River Ganga on Bhagirathi and Alaknanda basins:

(i) All operational projects will be modified for the recommended e-flow and monitoring requirements. (17 projects/2,295 MW capacity) (Annex-VIA)

(ii) All projects under construction (other than those where work has been suspended due to specific government orders) will be completed with the modified recommended e-flow and monitoring requirements. Work on Srinagar hydropower project (330 MW) will, however, be as per MoE&F decision on suspension and ToR (iii). (25 projects/2,661.3 MW capacity) (Annex-VIB).

(iii) Projects with EC and FC clearance can be taken up for construction. These projects should be re-designed to optimise the energy generation, especially during the high-discharge season, economic operations of the project and take into account the e-flow regime that will be in force in the river. In addition, considering the hydropower needs of the State, after CEA/EC/FC clearances, a view on BowalaNandprayag (300 MW) and Karmoli Dam (140 MW) projects may also be finalised (10 projects/1,430 MW capacity) (Annex-VIC).

(iv) Remaining hydropower projects will be reviewed and appropriate decisions taken after the Ganga basin study by IIT Consortium (17 projects/2,633.8 MW capacity) (Annex-VID).

4.25 To meet the energy requirements of the State, 6–8 MMSCMD of gas may be made available to it. This will be adequate for 2,000 MW capacity. For future needs of the State, other fuels may be allocated/used.

4.26 A number of suggestions have been received by the IMG on alternate methods of power generation. There are also concerns on the recommendation relating to e-flows and impact of hydropower projects. Some of these have been given by very eminent people (Annex-X). The IMG would suggest that these should be referred to an expert technical group for its assessment.

ToR (iii)

5. Srinagar hydropower project on Alaknanda River in PauriGarhwal District of Uttarakhand is being implemented. A temple, namely, Dhari Devi

Temple, in upstream of the project is to come under submergence due to the project. The representations are made to the Government that religious sentiments will be irrevocably hurt if the temple is touched. It should be accordingly preserved. In the light of these facts, following reference was made to the IMG:

> *"The matter may be referred to the Inter-Ministerial Group headed by Shri B.K. Chaturvedi constituted by the National Ganga River Basin Authority (NGRBA) for examining the questions of environmental flow requirements on Bhagirathi, Alaknanda and other tributaries of River Ganga. The Committee may kindly review the impacts of the Alaknanda Hydro Power Project on flow of the River and the issues related to the temple relocation".*

5.1 The IMG has considered the above issues and made interim recommendations on the issues of Dhari Devi Temple. A copy of the recommendations was sent to Ministry of Environment and Forests (Annex-XI). In respect of the other issues relating to flow of the River, necessary recommendations are being made separately in ToR (ii), where environmental flows are being recommended for different projects.

ToR (iv)

6. "The *IMG would also recommend on innovative means of abating pollution in river Ganga.*"

6.1 In August, 2009, GOI re-launched the Ganga Action Plan with the reconstituted National Ganga River Basin Authority. Under the notification, dated 20th February, 2009, GOI gave Ganga the status of a National River. The objective is to ensure abatement of pollution and conservation of the river. The key difference between the first Ganga Action Programme and now is the recognition that the entire basin of the river has to be the basis of planning and implementation. It is not enough to plan for one city's pollution, without considering the impact of pollution on the downstream area. It is accepted that the plan for pollution control, must take into account the need for adequate water in the river – its ecological flow.

6.2 The challenge of pollution remains grim. According to recent estimates of the CPCB, fecal coliform levels in the mainstream of the river – some 2,500 km – from Gangotri to Diamond Harbour – remain above the acceptable level in all stretches, other than its upper reaches. But even

there, there are worrying signs as fecal coliform levels are increasingly even in places like RudraPrayag and Devprayag, suggesting that there is inadequate flow even in these highly oxygenated stretches for dilution

6.3 The (IMG) recommends that controlling pollution in Ganga will require the following paradigm shift.

6.4 The recognition that for cleaning rivers in India, where cost of pollution control treatment is unaffordable and unmanageable, the availability of water for dilution will be critical. The available standards for 'acceptable water quality' – BOD provide for a dilution factor of 10. This is why discharge standards for waterbodies are set at 30 for BOD, while bathing water quality standard is 3 BOD. The fact is that given the huge unmet challenge of wastewater treatment, the cost of reducing standards will be unaffordable. Instead, what should be provided is water inflow, to build the assimilative capacity in the river for self-cleansing waste. It is essential to note that rivers without water are drains. It is also a fact that this release of additional water deprives farmers upstream of irrigation; cities and industries of water. The additional water for ecological flow becomes contested. But this flow must be mandated so that it comes from the state government's own allocation of riparian water. The government then has a choice to build storage to collect monsoon water for dilution within its territory or to 'release' water to rivers and make other choices for use in agriculture, drinking or industry. In other words, all users must be forced to plan for water needs based on what the river can spare, not what they can snatch.

6.5 The recognition that urban areas will not catch up with the infrastructure needs to build conventional sewage networks at the scale and pace needed for pollution control. Therefore, the conveyance of waste must be re-conceptualized and implemented at the time of planning treatment plants. This will then lead to innovative ideas for controlling pollution in drains – in situ – treatment of sewage as well as local treatment and reuse.

Once planning for pollution control is premised on the acceptance on non-availability of sewerage networks then discharge of treated effluent will be carefully reconsidered and designed. The treated effluent will not be 'mixed' with the untreated waste in drains. Instead all treated effluent will either be designed for reuse or it will be discharged directly into the river.

6.6 The recognition that there is a need to design affordable water and sanitation solutions. Even if current situation requires Central government

assistance for capital and operational costs, this is not tenable in the long run or for the scale of pollution control infrastructure that is required to clean the river. As long as states do not have the responsibility to build sewage treatment systems, they will have no incentive to release more water for pollution control. Therefore, there will be a clear conditionality in Central government funding, which is matched to the quantum of ecological flow released by the state in the river.

6.7 IMG would recommend the following policy should be adopted for cleaning the Ganga:

(i) Ecological flow will be mandatory in all stretches of the river. In the upper stretches, where the requirement is for critical ecological functions as well as societal needs, it will be mandated at 50% for mean season flow and 30% for other seasons. In the urbanized stretches, it will mandated based on the quantum of wastewater released in the river and calculated using a factor of 10 for dilution.

(ii) All Central government funding under the National Mission for Clean Ganga will be conditional on the quantum of ecological flow made available by the state.

(iii) Phase-I of the project for controlling pollution in the next five years for this region should be taken up and necessary resources for this need to be provided. Later, this requirement can be posed to the Fourteenth Finance Commission.

(iv) All proposals submitted by state governments to the National Mission for Clean Ganga for pollution control will be evaluated to ensure conformity with the paradigm shift recommended by IMG.

(v) The JNNURM-II funding for all water and sanitation projects in the cities on the Ganga will also be in conformity with the paradigm shift recommended by IMG.

(vi) The National Mission for Clean Ganga will launch a specific programme to incentivize the use of innovative bioremediation and in-situ drain treatment. The programme will monitor performance and cost effectiveness of the different technologies in different cities. This experience will be used to design technical bid and tender conditions for these technologies to compete in pollution control efforts.

(vii) The proposal for Ganga cleaning at Varanasi as conceptualized by SankatMochan Foundation, which is based on non-electrical gravity system, will be implemented as a special project of the National Mission for Clean Ganga.

(viii) The innovative technologies used for pollution control in industrial units will be incentivized through a financial package. At the same time there will be stringent enforcement with standards.

(ix) The MoEF 26th April, 2011 office memorandum on Corporate Environment Responsibility will be made applicable to all industrial units discharging into the Ganga, which will require violations to be reported to the Board and made public on the website of the company.

The Maharashtra and Tamil Nadu Governments' Notifications on minimum distance requirements for siting of industrial units near rivers and waterbodies will be used as models for similar steps on the Ganga basin. The requirement for zero-discharge, as stipulated by Maharashtra will be examined for replication in Ganga basin.

CHAPTER – I
INTRODUCTION

*****

1.0 The National Ganga River Basin Authority (NGRBA) has been set up by Government of India for developing policies and taking measures for holistic development of River Ganga. The Authority has decided to constitute a Multi-Disciplinary Group to look at various options with regard to conservation, irrigation use and running Hydro Electric Projects (HEP) to ensure uninterrupted flow of the river. In pursuance of the above recommendations an Inter-Ministerial Group (IMG) was set up(Annexure-I-A).The Terms of Reference (ToR) of the Group were:

"*(i) To facilitate cooperation with government agencies for early completion of the study being conducted by the Consortium of IITs for preparing a Ganga River Basin Management Plan, and;*

(ii) Pending finalization of the Ganga River Basin Management Plan, to consider and make recommendations on the following short-term measures in the upper reaches of the river Ganga on the basis of available reports, within three months:

(a) To suggest environmental flow requirement that could be prescribed for various stretches of Bhagirathi, Alaknanda and other tributaries of river Ganga, taking into account suggestions in the reports prepared by the IIT-Roorkee, Wild Life Institute of India and any other available report on the subject that the Group wishes to consider.

(b) To examine how best to make the suggested flows applicable to projects currently in operation, taking into account, inter alia, its impact on tariff.

(c) *To make a review of the environmental impacts of projects that are proposed on Bhagirathi, Alaknanda and other tributaries of river Ganga and recommend necessary remedial action."*

1.1 Subsequent to above, the IMG was also asked to review the impact of Alaknanda Hydro Power Project on flow of the river and issues related toDhari Devi temple which was getting submerged as a result of the project. A Background Note was also sent to the IMGto explain the above Term (Annexure-I-B).

1.2 In November, 2012, the IMG was asked to look at the issues relating to pollution of River Ganga, too (Annexure-I-C).

1.3 The constitution of the IMG was as follows:

(i)	Shri B.K. Chaturvedi, Member, Planning Commission	Chairman
(ii)	Additional Secretary, Representative of the Ministry of Environment & Forests (MoEF)	Member
(iii)	Shri J.M. Mauskar, former Special Secretary, MoEF and nominee of the MoEF	Member
(iv)	Representative of the Ministry of Power	Member
(v)	Representative of Ministry of Water Resources	Member
(vi)	Representative of Central Electricity Authority	Member
(vii)	Representative of Central Water Commission	Member
(viii)	Representative of Wild Life Institute of India	Member
(ix)	Representative of IIT-Roorkee	Member
(x)	Representative of Government of Uttarakhand	Member
(xi)	Chairperson, Central Pollution Control Board	Member
(xii)	Dr. Veer Bhadra Mishra, Expert Member, NGRBA	Member
(xiii)	ShriRajendra Singh, Expert Member, NGRBA	Member
(xiv)	Ms.SunitaNarain, Expert Member, NGRBA	Member
(xv)	Mission Director, National Mission for Clean Ganga (NMCG), MoEF	Member-Convenor

1.4 The IMG has since then given its recommendations on ToR (iii) relating to Dhari Devi Temple. A copy of this Report along with the recommendations sent is being annexed at the end of this Report as well (Annex-XI).In the following chapters, Recommendations about ToR (i) & (ii) and (iv) innovative means of abating pollution are given.

CHAPTER – II
ToR(i) – GANGA RIVER BASIN MANAGEMENT PLAN

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2.0 This Term of Reference is aimed at facilitation by the IMG so that the study being conducted by the Consortium of IITs for a Ganga River Basin Management Plan may be completed expeditiously. It accordingly mentioned as follows:

> *"To facilitate cooperation with government agencies for early completion of the study being conducted by the Consortium of IITs for preparing a Ganga River Basin Management Plan."*

2.1 The IMG has considered the above Term and decided that it may write to the concerned Departments for sending the information expeditiously to the Consortium. For this purpose, the consortium was asked to send a list of Departments and information required from them. A copy of the information received by them since the constitution of the IMG, along with the information which is yet to be received is placed at Annexure-III.

2.2 The IMG noted that the information was to be obtained from a number of Departments some of whom were members of the IMG. CWC which had to provide substantial information was specifically requested to expedite providing this information to the Consortium of IITs. The other Departments or State Governments or their agencies which had to provide information included irrigation departments of number of States, including Uttarakhand, U.P and Bihar;State Departments of Power and Energy in several States; Central Ground Water Board and concerned State Ground Water Boards; Indian Methodological Department; Central Water Commission and its 11 Divisions; National Remote Sensing Centre,Hyderabad; Central Pollution Control Boards and State Pollution Control Boards and Ganga Flood Control Commission, Patna.The Secretary of the IMG wrote to the concerned Departments on 12th and 14th September, 2012 to make the data available. He followed-up with them through personal interactions also so that the information can be obtained expeditiously.As a result of the above exercise and efforts made by the IIT Consortium some progress has been made.

2.3 The IMG has noted that the information required for the study is quite extensive and is to be obtained from the number of sources, both in the State Governments and in the Central Governments. It will be appropriate

to, therefore, have a nodal officer who is attached with the Head of the Organisation to support this exercise. It will also require continuous follow up. The IMG has noted that the work of the IIT Consortium will take about three years. During the course of it, information may be required even after the initial set of data has been received by the Consortium.

2.4 In view of the above, the IMG felt that a long term view will have to be taken for collecting the above information. Considering that the period of the functioning of the present IMG is very short, it was felt that an institutional mechanism needs to be provided to collect this informant. It is, therefore, suggested that:

(i) The IIT consortium should contact individual departments, officers to collect as much information as feasible in the normal course of business. The Mission Director of Ganga may be in touch with them and with the State Governments to facilitate flow of information. The flow of information may be reviewed by the Mission Director, National Mission for Clean Ganga, once every fortnight with the IIT Consortium.

(ii) A standing mechanism under Secretary Environment and Forestsbe createdto review and resolve difficulties if any inflow of information to the Consortium. In this mechanism, concerned Secretaries of Government of India or their representatives may meet once in 15 days to review the flow of data. For data related to Government of India Departments, a time limit of two months be set after which the matter be placed before the Cabinet Secretary.

(iii) The concerned Central Ministries should be charged with the responsibility of coordinating with the States Governments of Energy, Power and Irrigation for ensuring that adequate response is available from them for data collection. For information related to the State Governments, each State Government should set up a committee of concerned departments under the Chief Secretary to ensure that all the available information is provided within a month.

(iv) It may be appropriate to place this issue, before the Cabinet Secretary in June, 2013 or in the first year of the preparation of the above Report to give a strong push to this. This willfacilitate resolution of any outstanding inter-Departmental issues and any wider concernon providing datawhich may not be in public domain or not likely to be so.

CHAPTER – III
ToR (ii) – VARIOUS ISSUES RELATING TO RIVER GANGA

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3.0 The IMG has also been requested to make interim recommendations, pending finalization of the Ganga River Basin Management Plan in the upper reaches of the River Ganga basins about environment flow requirements and review of environmental impact of hydro power projects that are proposed on these. Specifically, the Term of Reference (ToR) mentioned are as follows:

> *"Pending finalization of the Ganga River Basin Management Plan, to consider and make recommendations on the following short-term measures in the upper reaches of the river Ganga on the basis of available reports, within three months:*
>
> *(d) To suggest environmental flow requirement that could be prescribed for various stretches of Bhagirathi, Alaknanda and other tributaries of river Ganga, taking into account suggestions in the reports prepared by the IIT-Roorkee, Wild Life Institute of India and any other available report on the subject that the Group wishes to consider.*
>
> *(e) To examine how best to make the suggested flows applicable to projects currently in operation, taking into account, inter alia, its impact on tariff.*
>
> *(f) To make a review of the environmental impacts of projects that are proposed on Bhagirathi, Alaknanda and other tributaries of river Ganga and recommend necessary remedial action."*

Background

3.1 The River Ganga and its main tributaries, Bhagirathi and Alaknanda, originate in the State of Uttarakhand. The State lies between 28°44' to 31°28' N Latitudes and 77°35' to 81°01 E Longitudes. It has an area of 53,483 km^2 and has 13 Districts, 49 Tehsils and 95 Development Blocks.

3.2 The State has a per capita State Domestic Product (SDP), at 2004-05 prices, of Rs.47,831 (2011-12). It has grown at a rapid rate in the last few years. The average rate of growth and increase in per capita incomes as against the overall national growth is given in the following Table:

Table-1: Per Capita Net State Domestic Product of Uttarakhand vis-à-vis All-India Per Capita at Constant (2004-05) Prices

Year	Per Capita Net SDP (in Rupees)	Percentage Change over the Previous Year	All-India Per Capita (in Rupees)	Percentage Change over the Previous Year
2004-05	24726	-	24143	-
2005-06	27702	12.04	26015	7.75
2006-07	30720	10.89	28067	7.89
2007-08	35437	15.36	30332	8.07
2008-09	38625	9.00	31754	4.69
2009-10	42292	9.49	33843	6.58
2010-11	44723	5.75	35993	6.35
2011-12	47831	6.95	38005	5.59

Source: Col.2 Directorate of Economics & Statistics of State, and for All-India – CSO.

3.3 The State, however, has a very large area covered with hills. These districts have comparatively slow pace of economic growth and lower incomes. The infrastructure of electricity, hospitals and higher educational institutions are also required. The growth in horticulture which is a focus area of these parts and has been slow as compared to neighbouring State of Himachal Pradesh. The State needs more investment and financial resources. Hydropower is considered as a very major natural resource.

3.4 The State has a forest area of 3.47 million hectares, which constitute about 65% of its geographical area. The recorded forest cover is 34,651 km^2 (FSI, 2009). The forest is divided into reserve forest (68.74%), protected forest (0.36%) and unclassified forest (30.9%). The State has been divided into 18 Sub-Basins of Rivers Bhagirathi and Alaknanda. These are rich in biodiversity, especially fish and terrestrial biodiversity. Four major rivers originate in the State: Ganga, Yamuna, Ramganga and Sharada. Two major tributaries of River Ganga are Alaknanda and Bhagirathi.

3.5 The river is rich in fish, mammals and terrestrial bio diversity. A total of 76 fish species belonging to 32 general and 13 families were recorded in the above basins. Estimates of catches at four points along the Alaknanda in Garhwal Himalaya showed a range between 1,035 to 2,475 kg per km per year with an average 1,650 kg per km per year. A lower tributary Nayar River was an important fish breeding habitat in the region and produce 621 kg per km per year. Overall, the basin was characterised by snow trouts, mahseers, lesser barils and hill stream loaches and the sesorid torrent cat fish. Above 2400–3000 meters elevation, there was no record of fish.

3.6 The region has several RETs. Details of these are given below:

Table-2 :Rare, Threatened and Endangered (RET) Species in Different Sub-Basins of Alaknanda and Bhagirathi Basins, as per WII Report

Sub-Basins	No.of Terrestrial RET Species			No.of Aquatic RET Species	Total RET Species
	Mammals	Birds	Plants		
Bhagirathi-I	5	1	8	0	14
Bhagirathi-II	3	4	10	4	21
Asiganga	3	4	6	1	14
Bhagirathi-III	2	3	1	5	11
Bhagirathi-IV	2	3	0	12	17
Bhilangana	3	4	2	11	20
Balganga	3	4	5	11	23
Alaknanda-I	2	4	1	12	19
Nandakini	5	5	10	8	28
Alaknanda-II	2	4	6	5	17
Pindar	4	4	8	7	23
Mandakini	4	4	1	5	14
Birahi Ganga	3	5	0	4	12
Rishi Ganga	4	5	15	0	24
Dhauli Ganga	5	5	14	0	24
Bhyundar Ganga	5	4	21	0	30
Alaknanda-III	5	1	8	0	14
Ganga Basin	2	3	1	16	22

3.7 According to the studies made, three sub-basins, vis. Ganga sub-basin, Alaknanda-I sub-basin and Bhagirathi-IV have very high fish diversity. The Ganga sub-basin alone had 56 fish species of the 76 available in the region, including all certain fish species.The fish biodiversity value of the sub-basin was high among all 18 sub-basins. The Alaknanda-I sub-basin, harbours 64% of the total fish species in the area, and out of 16 threatened fish species, 12 occurred in this sub-basin. The Bhagirathi-IV sub-basin harboured 63% of the total fish studies and 12 species out of 16 threatened fish species. In terms of habitat diversity, the three sub-basins have all five types of aquatic habitats and contain breeding/congregational sites and migratory pathways for golden mahseers and snow trouts. Some of the other basins had also fish biodiversity due to breeding/congregational sites and migratory pathways for golden mahseers and snow trouts.

3.8 These sub-basins also have high flora and fauna diversities and some valleys with unique biodiversity values and high density of species. The Gangotri National Park is located in the upper catchment of Bhagirathi. About 15 species of mammal and 150 bird species have been documented in this National Park. This includes some rare species, such as snow leopard, black bear, brown bear, musk deer, blue sheep, Himalayan tahr etc.

3.9 Within the Alaknanda Basin, the Nanda Devi National Park and the Valley of Flowers National Park are two areas with rich biodiversity values that have been designated as UNESCO World Heritage site. Over 43 mammal and 250 bird species have been recorded from this basin. While there were no confirmed recent reports on presence of otters, some parts of Alaknanda basin are potential otter habitats. These basins have high flora and fauna diversities too.

3.10 The region is rich in biodiversity and has RETs. The riverine habitats serve critical role as corridors and migration pathways for several fauna and flora species. The courses of Bhagirathi and Alaknanda support a number of forestformations, which are typically riverine in nature, such as Khair–sissoo and Jamun–Putranjiva in the lower areas, alder, Hippophae–Myricaria and Willow communities at higher altitudes. The riverine forests also support large number of rare, endangered and threatened (RET) species in the flora and fauna. Among fish, there are several threatened species including golden mahseer, snow trout etc. that breed in this area. Some of the threatened flora, typically found in the riverine forests, along the stream courses of rivers Bhagirathi and Alaknanda, include Datiscacannabina, Iteanutans, Eriocaulonpumilio, Eriaoccidentalis, Flickingeriahesperis, Nerviliamackinnonii and Cautleyapetiolaris etc. Out of a total of over 1,000 species of plants, 55 are RET/endemic species. Similarly, in the mammals 6 out of 85, in birds 6 out of 500 and in fish 16 out of 76 can be categorised as RET. While making an assessment of various interventions, the above biodiversity values would be important.

Energy Demand, Gap and Hydro Potential

3.11 At present the State of Uttarakhand is facing shortage in both energy and peak demand as indicated below:

Table-3: Power Supply Position (Energy)

	Energy (Million Units)				Peak Demand (Mega Watt)			
	Requirement	Availability	Surplus (+) / Deficit(-)		Requirement	Availability	Surplus (+) / Deficit (-)	
			MU	%			MW	%

Jan 2010	815	729	-86	-10.5	1386	1232	-154	-11.1
Feb 2010	701	620	-81	-11.5	1353	1289	-64	-4.7
Mar2010	766	680	-86	-11.3	1269	1207	-62	-4.9
April 2010	781	640	-141	-18.1	1406	1033	-373	-26.5
May 2010	846	722	-124	-14.7	1494	1327	-167	11.2
June 2010	846	775	-71	-8.4	1485	1367	-118	-7.9
July 2010	838	812	-26	-3.1	1393	1313	-80	-5.7
Aug 2010	816	782	-34	-4.2	1488	1178	-310	-20.8
Sept 2010	770	747	-23	-3.0	1396	1312	-84	-6.0
Oct 2010	794	787	-7	-0.9	1420	1420	0	0
Nov 2010	757	746	-11	-1.5	1390	1286	-104	-7.5
Dec 2010	901	828	-73	-8.1	1472	1332	-140	-9.5
Average	**803**	**739**	**-64**	**-8.0**				
Jan 2011	905	861	-44	-4.9	1520	1520	0	0
Feb 2011	832	808	-24	-2.9	1474	1204	-270	-18.3
Mar 2011	832	808	-24	-2.9	1379	1239	-140	-10.2
April 2011	841	790	-51	-6.1	1446	1409	-37	-2.6
May 2011	902	877	-25	-2.8	1533	1366	-167	-10.9
June 2011	880	863	-17	-1.9	1566	1517	-49	-3.1
July 2011	920	912	-8	-0.9	1506	1361	-145	-9.6
Aug 2011	826	812	-14	-1.7	1529	1429	-100	-6.5
Sept 2011	869	844	-25	-2.9	1526	1427	-99	-6.5
Oct 2011	857	797	-60	-7.0	1517	1412	-105	-6.9
Nov 2011	821	813	-8	-1.0	1506	1496	-10	-0.7
Dec 2011	877	853	-24	-2.7	1586	1586	0	0
Average	**863**	**836**	**-27**	**-3.1**				
Jan 2012	947	945	-2	-0.2	1612	1532	-80	-5.0
Feb 2012	889	849	-40	-4.5	1600	1600	0	0
Mar 2012	884	853	-31	-3.5	1506	1506	0	0
April 2012	883	824	-59	-6.7	1467	1237	-230	-15.7
May 2012	1023	959	-64	-6.3	1700	1620	-80	-4.7
June 2012	1025	973	-52	-5.1	1757	1397	-360	-20.5
July 2012	1003	931	-72	-7.2	1749	1409	-340	-19.4
Aug 2012	953	867	-86	-9.0	1607	1527	-80	-5.0
Sept 2012	963	926	-37	-3.8	1646	1646	0	0
Oct 2012	932	879	-53	-5.7	1672	1592	-80	-4.8
Nov 2012	891	836	-55	-6.2	1679	1449	-230	-13.7
Dec 2012	965	925	-40	-4.1	1742	1487	-255	-14.6
Average	**946**	**897**	**-49**	**-5.2**				

3.12 Projection for unrestricted energy and power at peak load demand of Uttarakhand at power station in the next decade (2021-22) has also been made.It is given in the following Table:

Table-4: Power Demand Projection

	2011-12	2016-17	2021-22
Energy Requirement (MU)	10,513	12,751	16,774
Peak Load (MW)	1,612	2,189	2,901

3.12.1 At present, the State is facing deficit in peak demand by 85 MW (from April, 2012 to February, 2013)(Provisional), which is 4.8% of its requirement (1,759 MW).

3.12.2 Uttarakhand State has contribution from predominantly hydro-based power projects. During peak winter, when their load is maximum, the hydro generation reduces considerably. Therefore, to arrive at peak shortage and considering share of the State from hydro projects at approximately 25% of the capacity allocated to the State, the likely deficit in the State at the end of 12th Plan is 1,665 MW as detailed below:

Table-5: Power Demand Projection

(in MW)

Anticipated Demand	IC required by2016-17	IC at the end of 11th Plan considering 25% Hydro	Capacity Tied-up during 12th Plan considering 25%Hydro	Balance Capacity to be Tied-up
2,189	2,846	963	218	1,665

3.13 The main source of power of Uttarakhand is hydro power. The State does not have coal or gas reserves. Thus, in order to meet their power demand, they have to fall back on hydro projects. Uttarakhand is one of the States, where substantial hydro potential exists. As per studies carried out by CEA, a total potential of 18,175 MW (17,998 MW above 25 MW) has been estimated. Out of above, only 3,426.40 MW (19.04%) have been developed.

3.14 A study of hydro potential in the basins of Bhagirathi and Alaknanda has been made by Central Electricity Authority (CEA) and the State Government. A comparison of this is given in the following Table:

Table-6: Hydro Potential Assessed by CEA and State Government

Authority	Potential Assessed	Total

	Bhagirathi	Alaknanda	
CEA	17 Projects of 4,924 MW above 25 MW)	26 Projects of 5,067 MW (above 25 MW)	43 projects of 9,991 MW (above 25 MW)
State Government	12 schemes of 4,709 MW (above 25 MW) 31 schemes of 174 MW (below 25 MW)	27 schemes of 4,948 MW (above 25 MW) 64 schemes of 281 MW (below 25 MW)	39 schemes of 9,657 MW (above 25 MW) 95 schemes of 455 MW (below 25 MW)

Note: CEA assesses only above 25 MW projects potential. The difference in the number of projects is due to breaking up of several storage projects into RoR projects and reassessment of hydro capacities.

3.15 A total of 70 HEPs are under operation, construction or development, including 30 projects of above 25 MW and 40 projects of below 25MW. Following Table gives the details.

Table-7: Hydro Power Development in Bhagirathi and Alaknanda Rivers

		Under Operation		Under Construction		CEA Clearance/TEC by State Govt.		Under Development		Total	
		No.	MW	No.	MW	No.	MW	No.	MW	No.	MW
Bhagirathi	Above 25 MW	4	1794	2	1600	2	675	3	571	11	4640
	Below 25 MW	4	51.75	11	97	2	33	3	49	20	230.75
Alaknanda	Above 25 MW	1	400	5	1469	5*	1573	8	1026	19	4468
	Below 25 MW	8	49.45	8	95.3	2	39	2	27.8	20	211.55
Total	Above 25 MW (1)	5	2194	7	3069	7	2248	11	1597	30	9108
	Below 25 MW (2)	12	101.2	19	192.3	4	72	5	76.8	40	442.3
Grand Total(1+2)		**17**	**2295.2**	**26**	**3261.3**	**11**	**2350**	**16**	**1673.8**	**70**	**9550.3**

* Kotlibhel-II H.E Project (530 MW) located on Ganga River after confluence of Alaknanda and Bhagirathi.

3.16 The projects thus fall in four categories:

(a) In Category-I, a total of 17 projects which are under operation, including 5 above 25 MW and 12 below 25 MW. The total capacity under operation is thus 2,295 MW (Annex-VIA).

(b) In Category-II, there are 26 projects of 3,261.3 MW capacities. All these projects are under construction. These include, 7 projects of above 25 MW capacities with a Hydro potential of 3,069 MW and 19 projects of 192.3 MW Hydro potential of below 25 MW capacities. Of these, construction of LohariNagpalahydro power project (600 MW) has been suspended by Government of India. The total capacity of 25 projects under construction is thus 2,661.3 MW (Annex-VIB).

(c) In Category-III, there are 11 projects with a hydro capacity of 2,350 MW. Of these, work on Pala Maneri hydropower project (480 MW) and Kotlibhel Stage-IB hydropower project (320 MW) has been discontinued or not taken up in absence of clearances. In addition, Kotlibhel-II hydropower project (530 MW) is on Ganga River, which is outside the remit of IMG. There are thus 8 projects with a capacity of 990 MW inthis category(Annex-VIC).

(d) In Category-IV, there are 16 projects with a capacity of 1,673.8 MW. Most of these are either under scientific investigation or project feasibility report has been prepared and are under development stage Annex-VID).

ENVIRONMENTAL FLOWS (E-FLOWS)

3.17 In recent years,there has been an increasing awareness all over the world aboutthe premier role of the flow regime as a key driver of the ecology of the rivers and associated river planning. Since the 1970s,there has been a progressive evolution of methodologies for assessing the Environmental Flow Requirements (EFRs) of riverine ecosystems, from *ad hoc*, case-specific approaches through to well-described, formal methodologies with more broad scale application. Historically, and still today in many instances, the focus of environmental flow assessment was entirely on the maintenance of economically important freshwater fisheries. More recently, however, the field has expanded to include assessments of the flow needs for other biota, like riverine invertebrates and water-dependent birds, and for biotic assemblage diversity. Many assessments now also encompass aspects of ecosystem structure, such as channel form, riparian vegetation and floodplain wetlands.It also includes ecosystem processes like nutrient

cycling and primary production. Recently, societal and community needs have also been considered in these assessments.

3.18 In some cases, water is returned to the river after use, i.e. in the case of hydropower generation or cooling of an industrial plant. However, the timing of the river flow downstream of the point where water is returned is likely to be altered. In the bypassed river section, the flows will be lower than natural. In other cases, i.e. when abstracting water for irrigation, the water may be returned in such small quantities or so far away from the abstraction point that, effectively, it is consumed. It is also important to recognize that flow is not the only factor affecting river health. Water quality, over-fishing and physical barriers to migration of species all influence aquatic ecosystems.

3.19 Environment flow needs to be released from hydro power station to meet the following major needs:

- Flow to provide required various ecological cues to perform natural life cycle of aquatic organisms during different seasons.
- Flow to support normal ecological functioning of river at least in minimum level even in the dry zones of hydro-electric projects.
- Flow to make sure that cultural and heritage values of river arenot affected significantly.

3.20 According to an assessment, more than 200 methods are used worldwide to prescribe river flows needed to maintain healthy rivers. However, very few of these are comprehensive and holistic, accounting for seasonal and inter-annual flow variation needed to support the whole range of ecosystem services that healthy rivers provide. Generally, the application of an intensive E-Flows assessment method should lead to recommended flows with a higher confidence level (from the perspective of accuracy and clarity), and provide clear consequences for the biodiversity, livelihoods or other aspects. The various EFA methods can be grouped into the following commonly-used generic types which require differing amounts of time and resources:

(a) Hydrology-based and look-up table approaches
(b) Extrapolation approach
(c) Hydraulic rating methodologies
(d) Habitat simulation methodologies
(e) Holistic methodologies

Hydrology-based and Look-up Table Approaches

3.21 These are the original and simplest of the assessment types. Hydrology-based methods are confined to the use of existing or simulated flow data, on the assumption that maintaining some percentage of the natural flow will provide for the environmental issues of interest. Hydrological methods primarily use hydrological data (historical monthly or daily flow records) for making e-flow recommendations for maintaining river health at designated level.

3.21.1 Worldwide the most commonly applied methods to define Target River flows are rules of thumb based on simple indices given in look-up tables. The most widely employed indices are purely hydrological, but some methods employing ecological data were developed in the 1970s. Water managers use hydrological indices to define water management rules and to set compensation flows below reservoirs and weirs. Examples are percentages of the mean flow or certain percentiles from a flow duration curve. This method has been adopted for environmental flow setting to determine simple operating rules for dams or off-take structures where few or no local ecological data are available. Such indices may be set using various techniques or assumptions including those that are purely hydrological, those that are from generalized observations on hydro-ecological relationships, or those that stem from more formal analysis of hydrological and ecological data. Implicit in these indices is that they are based on statistical properties of the natural flow regime.

3.21.2 Look-up Tables are typified by the Montana Approach, perhaps the original of all the methods, developed by Tennant in 1976. The Montana Approach provides a Table which indicates the percentage of the average (natural) flow required in the wet and dry season, to maintain conditions variously described as "optimum (60% to 100%), outstanding, excellent, good, fair or degrading, poor or minimal and severe degradation (less than 10%)".

Table-8:Montana Approach

Narrative Description of Flows	Recommended Base Flow Regimes	
	October – March	April – September
Flushing or Maximum	200% of the average flow	
Optimum Range	60% - 100% of the average flow	
Outstanding	40%	60%
Excellent	30%	50%

Good	20%	40%
Fair or Degrading	10%	30%
Poor or Minimum	10%	10%
Severe Degradation	10% of average flow to 0 flow	

Extrapolation Approach

3.22 This method, developed in South Africa, is based on the results of a large number of detailed EFA studies. It correlates the results of existing EF estimates with environmental objectives and a hydrological index which generally describes the reliability or "flashiness" of the flow regime. The method recommends an appropriate percentage of the natural flow, and allows the EF monthly time series to be subsequently estimated using monthly duration curves.This method can only be used in regions where numerous existing EFAs have already been done using more comprehensive methods, which provide the data set for the extrapolation.

Hydraulic Rating Methodologies

3.23 Hydraulic rating methodologies measure changes in the available hydraulic habitat (wetted perimeter, depth, velocity, etc.) based on a single cross-section of the river that measures the shape of the channel. This cross-section is used as a surrogate for biological habitat, and allows an estimate of the changes that would occur inthat habitat as a result of changing flows. The required flows can be inferred from an assessment of the habitat available for sensitive, or "indicator" species.

Habitat Simulation Methodologies

3.24 Habitat rating simulation methodologies combine hydraulic rating with the characterisation of habitat preferences of target species. Multiple rated cross-sections are used in a hydraulic model to simulate the conditions in a river reach, again based on wetted perimeter, depth and velocity. Biological sampling of indicator species, combined with measurements of the hydraulic characteristics where they are found, are used to populate the habitat part of the model. The combined hydraulic/biological model then calculates the area of preferred habitat available for the indicator species at different flows, and can be used to infer the required flows. This method, and particularly the In-stream Flow Incremental Methodology (IFIM), a type of habitat simulation methodology, has been used extensively, especially in the

United States, and flow recommendations based on it have been successfully defended in court.

Holistic Methodologies

3.25 These are multidisciplinary methodologies based on the inputs of multiple specialists (or working groups) from different disciplines, who aim to reach a consensus regarding the setting of appropriate flows to meet a pre-defined set of environmental objectives, and to describe the consequences of different levels of modifications to the flow regime. Most of these holistic methods make use of a multi-disciplinary team including a hydrologist and a hydraulics engineer to provide the baseline data on flows and hydraulic conditions; freshwater biologists (for fish, invertebrates and riparian vegetation) to characterize the requirements of the biotic communities; a geomorphologist to predict the changes in sediment transport and channel maintenance at different flows; a water quality specialist; and a socio-economist. A number of different specific methodologies exist, such as the Building Block Methodology (BBM) and the Downstream Response to Imposed Flow Transformation (DRIFT), which provide structured frameworks for the collection, analysis and integration of the data to provide an expert prediction of the effects of flow modifications.

International Practices

3.26 Globally, countries have used different methods to prescribe e-flows. Practices followed in some of the countries are mentioned below:

France: Fresh water fishing law of June 1984 required that residue flows in bypassed sections of river must be a minimum of 1/40 of the mean flow for existing schemes and 1/10 of the mean flow for new schemes.

United Kingdom: Q95 (flow which is equalled or exceeded 95% of the time) should be maintained. Figure of Q95 was chosen purely on hydrological ground. However, implementation of this approach (e.g. how much Q95 can be reduced) often includes ecological information.

USA (Montana Method): Percentages of mean flow are specified that provide different quality habitat for fish eg. 10% for poor quality(survival).30% for moderate habitat and 60% for excellent habitat.This method is known as Tennant or Montana method.

South Africa: Hughes and Munster(2000) and Huges and Hannart (2003) used a hydrological index [i.e. coefficient of variation of flows (CV) divided by

the proportion of total flow that is base flow (BFI) or(CV/BFI)] to assess the e-flow needs. Relationshipwas developed between this hydrological index (CV/BFI) and the percentage of the Mean Annual Run-off (MAR) required to maintain river flow. Relationship is established by plotting results of individual detailed environmental flow studies on the graph of (CV/BFI) vs %MAR.

3.27 E-Flow Practices in India

3.27.1 Himachal Pradesh State Environment Production and Pollution Control Board have issued guidelines for minimum releases to be made from the various projects. 15% threshold value of minimum flow observed in lean season has been specified as EF.

3.27.2 So far Uttarakhand is concerned in some of the projects like Badrinath-II (1.52 MW), Jummagad (1.20 MW), Birahi Ganga, (7.20 MW), Urgam (3MW), Pilangad (2.25 MW), AssiGanga–I (4.5 MW), Assiganga-II, (4.2 MW), Assiganga–III (9 MW), Suwarigad (2.0 MWE),Limchagad (3.5 MW), Kaldigad (9MW), Kali Ganga-I (4 MW), Kaliganga-II (6MW),MadhyaMaheswar(15 MW),Bihilangna-2A(24MW), a 10% lean season flow has been specified for e-flows.In projects having installed capacity of above 25MW, Alaknanda (300 MW),Devsari (250 MW) 10% of lean flow have been specified. UJVNL have indicated that, it has been the practice to specify environment flow as 10% of the minimum discharge observed in hydrology or 0.3 cumec whichever is higher.

3.27.3 While there is no practice in vogue in other States but from time to time MOEF have started stipulating minimum environment flow requirement.

Recent Studies on Hydro Power and Environmental Flows in Upper Region of Ganga

3.28 Studies on hydro projects, environmental flows and related issues have been conducted by Wild Life Institute of India (2012), Alternate Hydro Energy Centre (AHEC) of Indian Institute of Technology-Roorkee (December, 2011) for Alaknanda and Bhagirathi Basins. In addition World Wildlife Foundation (2012) has also conducted study on assessment of environmental flows for the upper Ganga Basin which covers Ganga from Kaudiyala (near Rishikesh) to Bithoor (near Kanpur). The Central Water Commission (CWC) has also commented on this. A number of other experts

and non-governmental organizations have also expressed their views on this. Following programme give, in brief, their suggestions and recommendations.

3.29 The Alternate Hydro Energy Centre (AHEC) of IIT-Roorkee were asked to study cumulative impact of hydro power projects in Alaknanda and Bhagirathi basins, up to Devprayag in July, 2010. The report was finalised in December, 2011. The objective of study was also to assess the extent to which the hydro power potential identified in the basins should be developed without risking stability and environment and at the same time ensuring that the quality, quantity and timing of water flows required to maintain the functions and assimilative capacity that provide goods and services to people are maintained. The Institute has made extensive recommendations on the above issues. These covered the area of impact assessments, geology and seismology, soil erosion and sedimentation, hydrological aspects, hydro power related aspects, environment and biodiversity, religious and social aspects, monitoring and construction related aspects. A copy of the recommendations is placed at Annexure-VII.

3.30 During their study, IIT-Roorkeeanalysed river flows for 10-days intervals on 10 HEPs on Bhagirathi River, 13 HEPs on Alaknanda River and 8 HEPs and flows at various religious places. They considered several methods for computing environmental flows. These included:

(a) 10% method
(b) France method
(c) 75% of Q95
(d) EMC-HMD method

3.30.1 TheIIT-Roorkeerecommended environment flows by EMC–HMD method for HEPs located at main stream of the river and 75% of Q95 method adopted by the UK for schemes located in tributaries. The environmental flows recommended based on the above studies are inTable-10.

3.31 The WII also conducted a study on cumulative impact of hydroelectric projects on aquatic and terrestrial biodiversity in Alaknanda and Bhagirathi basins.The objective of the study was similar to that of IIT-Roorkee. The terms of reference were accordingly provided. The study specially focussed on:

(a) Assessment of ecological flows required for conservation of rare, endangered and threatened (RET) floral and faunal species.

(b) Assessment of the cumulative impacts of hydropower projects in the two basins on the riverine ecosystem in general and terrestrial and aquatic biodiversity in particular.

The Report was finalised in December, 2012.

3.31.1 Some of the major recommendations of the study covered, the aquatic biodiversity profile, critically important fish habitats, including recommendation on conservation reserve at NayarRiverandBalGanga River–Tehri reservoir complex. It also made recommendations on impact on aquatic biodiversity and their habitats, terrestrial component of the biodiversity and details about these in the river basins. It especially made number of recommendation covering environmental flows, conservation reserve, strategic option of regulating impact of hydroelectric projects of different categories and impact on aquatic biodiversity and terrestrial biodiversity in the above basins.

3.32 The recommendations on environmental flows made by WII differed in two important respects with the IIT-Roorkee suggestions. First, it recommended environmental flows based on Mean Seasonal Flows (MSF). While IIT-Roorkee recommendations were based on Mean Annual Flow (MAF), IIT-Roorkee made similar suggestions. Second, it made distinction between two river domains: flows for 'fish zone' and 'no fish zone'. It also made special mention of flows which are necessary to see that two major varieties of fishes, namely, Mahseer and SnowTrout are protected, preserved, sustained, and developed. A copy of the recommendations made by WII on thisis placed at Annexure-VIII.

3.33 World Wildlife Foundation (WWF) Recommendations

3.33.1 The study cover three specific sites, viz. Kaudiyala (near Rishikesh), KachlaGhat and Bitthoor (near Kanpur). Started in 2008, it was completed in three years. It adopted the Building Block Method for assessment of e-flows. The e-flows recommended by them based on the above are given in the following Table:

Table-9: Environmental Flows at Selected Sites

Name of Site	Maintenance Flows as % of MAR	Drought Year Flows as % of MAR
Kaudiyala	72%	44%
KachlaGhat	45%	18%

Bitthoor	47%	14%

3.33.2 The issue of environmental flows has been extensively commented upon also by Central Water Commission (CWC) who maintains extensive data on river flows. According to them, the environmental water needs of rivers have been duly recognized in the development and management of water resources in the country. This has been clearly spelt out in the National Water Policy. However, the estimation of minimum environmental flows is still a challenge primarily due to lack of both the understanding of and quantitative data on relationships between river flows and ecological characteristics of river. The assessment of environmental flows rationally, keeping in view limited water resources and dependence of livelihood of large population on it, is still at infancy stage. For more than 20 years now, the efforts have been made to quantify EFR. The so called "rational method" on it seeks to map all the flora and fauna in a given reach of the river, and study their life cycles and water requirement during various stages of life. Though it sounds simple, in reality this is an extremely complex exercise that demands a huge amount of time, efforts and resources. Such a study has not been completed anywhere in the world for any major river system.

3.33.3 Few studies have come out recently on the assessment of e-flows for reaches of Bhagirathi and Alaknanda rivers in Upper Ganga basin, namely studies by IIT-Roorkee, Wildlife Institute of India, WWF etc. These studies lack in depth assessment of e-flows and at most can be called "Desktop Study" due to lack of data availability and time and resources needed for such assessment. However, these studies are a step in right direction and would help in framing appropriate policy on e-flows, adopting suitable approach and methodology for assessment of e-flows for upper reaches of Ganga basin etc.

3.33.4 Commenting upon the recent studies, CWC has stated that IIT-Roorkee have adopted hydraulic rating or hydraulic mean depth method in the assessment of e-flows for main river reaches and UK method for tributaries with catchment area of less than 500 sq.km. WII has adopted environmental management class (EMC) method for assessment of e-flows. The WWF study has adopted Building Block Method. However, assessment details of e-flows are not given in the report and report has not used any observed data including information on flow data. Moreover, the WWF study covers Ganga river reach below Rishikesh and may not be applicable to upper reaches of Ganga basin. As such the WWF report may not be worth

considering in deciding e-flows for projects in the upper reaches of Ganga basin.

3.33.5 The data/information which is broadly available at present is the flow data to some extent and the broad information on the aquatic life in various river reaches of upper Ganga river basin. However, the requisite data for assessing the quantum of e-flows number precisely is not available. Information on river geometry, morphology, information on aquatic life reach wise, minimum flows/flow characteristics to sustain aquatic life, sensitivity of flows on aquatic life etc. are not available quantitatively at present. As such generation of some number for e-flows may not be appropriate at this stage. There are significant differences in assessment of e-flows even in these two studies.

3.33.6 Looking at the data availability and present level of understanding of river ecological characteristics, the hydrological index based method may be appropriate and be used in the allocation of e-flows to begin with. WII study recommendations for e-flows at various project locations are on similar lines and have been expressed as a percentage of gross flows at that location i.e. 20% during lean period (November to March), 25% during October and April, 30% during flood period (May to September). A Sub-Committee constituted by Ministry of Water Resources in 2010 on "Minimum Environmental/ Ecological Flows in Rivers" suggested an allocation 10%–20% of MAR distributed on the pattern of Flow Duration Curve (FDC), i.e. mimicking the natural rivers flows for e-flows. Looking at importance of river Ganga and sensitivity of people on ecological health of this river, an allocation of 20% of flows may be reserved for e-flows. This would broadly maintain the river ecosystems in a reasonable state. This suggestion has been compared with e-flows by AHEC, IIT-Roorkee and WII. Reservation at 20% level for e-flows is exactly same as assessed by WII during lean months and far exceeds the assessment by IIT-Roorkeeduring monsoon period.

3.33.7 Suitable structural measures should also be looked at for maintaining appropriate hydraulic conditions (flow depth etc) for aquatic life even with lesser flows, particularly in limited/small reaches duly considering the techno-economic viability.

3.33.8 CWC has further suggested that the above allocation of e-flows at 20% level may be adopted at this stage and may be reviewed later when site/reach specific more data and detailed studies are available. Also, the requirement of e-flows may be reviewed every 10 year to assess the

adequacy vis-à-vis change in availability of water and various measures (structural and non-structural) adopted for the management of river regime. Moreover, for each water resources development project, detailed environmental studies are required to be carried out including requirement of e-flows and if requirement of e-flows is found to be different, the same may be addressed at project specific study and environmental management plan.

3.33.9 Commenting on the need for maintaining a balance, CWC has observed that the Ganga river system is not backed by storages and most of the projects are run of the river scheme except Tehri dam. As majority of flows are available in 3-4 months, allocating all water to e-flows during lean period would be detrimental to other developmental needs and a fine balance between development and environmental needs to be maintained.

3.34 A number of other experts and organizations have also expressed their views on e-flows and other issues relating to the river (Annex-II). These fall broadly in three categories. The first group consists of persons, who have objection to any construction of dam on the river, especially on river Ganga, for hydro power projects. It has been argued that this has harmful effect on the eco system and people's lives. However, regarding the need for power they have not suggested any economic and viable alternative options.

3.34.1 The secondgroup of personsare thosewho have objection to any obstruction in the river flow. They have stated that the River Ganga is pure, sacrosanct and close to the heart of millions and millions. It is important that we do not do further damage to the river. Construction of hydro power projects and diversion of water through tunnels should not be done on the pure and pious river. Alternative technology solutions have been suggested to build hydro power plants and harness hydro energy. These suggestions, however,requireexaminationby subject experts for their technical feasibility and economicviability.

3.34.2 It has been suggested that we should ensure that the river is clean. For this purpose, any flows in river of urban sewage must be stopped immediately. The urban sewage should be used in an imaginative manner for fertilizers and recycled within the town instead of putting it in the river. Plans should be prepared for this purpose quickly. It is also important that the industries should be kept away from the river Ganges. In the first instance, such industries should not be permitted in the upper reaches which should be kept pure.

3.34.3 The third group of persons are thosewho have strong support the construction of HEPs. It has been argued by them that development of the State cannot take place unless hydro power is available to the people. It has been argued that hydro power is the main resource of this region. It has also been mentioned that local people want development of these projects so that power for development and growth is available in the region. These views have been strongly supported by the State Government. On environmental flows, however, while objecting to the report of the WII as not being based on facts, they have suggested such flows as necessary. However, no specific numbers have been suggested by them or by the State Government.

3.35 An Assessment of Alternative Methods of E-Flows

3.35.1 The studies of e-flows in the Indian conditions and specifically in the Alaknanda and Bhagirathi River basins have been assessed by the Committee. The Committee notes that the study by IIT-Roorkee has analysed both the hydraulic as well the hydrological dimensions of the flows. It has made extensive recommendationsafter considering international practices and making a judgement on their suitability for the Indian conditions. The e-flows recommendations specifically covered 31 places, including 10 projects on river Bhagirathi, 13 on river Alaknanda and 8 at various religious places. The water flows in the River on a 10 days basis have been studied by them. The e-flows suggested by them based on percentage of Mean Annual Flow (MAF) are given in the following Table:

Table-10: Summary of Results obtained for EFR using various EFA Methodologies(as Percentage of MAF) by IITR

Sl. No.	HEP Site	Catchment Area (Km^2)	MAF (cumec)	10% Method (%)	France (%)	75% of Q95 (%)	EMC-HMD (%)	Range of EFR using four methods with cumulative impact	
								Minimum (%)	Maximum (%)
Bhagirathi River									
1	Asiganga III-	110	5.29	10.00	10.00	2.3	7.2	2.3	10.00
2	Agungathati	121	5.48	10.00	2.5	16.0	21.46	2.5	21.46
3	BhilanganaIII-	407	13.74	10.00	10.00	15.1	17.0	10.00	17.00
4	Bhilangana	696	35.4	10.00	2.5	7.66	6.61	2.5	10.00
5	LohariNagpala	3316	92.27	10.00	10.00	4.0	5.80	4.0	10.00
6	Maneribhali I	4024	114.22	10.00	2.5	4.0	7.50	2.5	10.00
7	Maneribhali II	4416	116.67	10.00	2.5	4.24	9.51	2.5	10.00
8	TehriStage-I	7287	222.83	10.00	2,5	16.48	16.38	2.5	16.48
9	Koteshwar	7691	222.97	10.00	10.00	17.57	16.67	10.00	17.57
10	Kotlibhel 1A	7887	210.54	10.00	10.00	19.08	17.34	10.00	19.08

Alaknanda River									
1	Badrinath	970	39.69	10.00	2.5	7.6	19.58	2.5	19.58
2	Birahi Ganga-II	219	8.18	10.00	10.00	16.2	26.41	10.00	26.41
3	Bhyunder Ganga	230	9,41	10.00	10.00	7.7	28.69	7.7	28.69
4	PhataByung	247	15.57	10.00	10.00	13.29	27.75	10.00	27.75
5	Rajwakti	545	16.38	10.00	10.00	20.27	26.37	10.00	26.37
6	Rishiganga-II	680	24.51	10.00	10.00	7.6	22.03	7.6	22.03
7	SingoliBhatwari	963	78.41	10.00	10.00	6.80	6.75	6.8	10.00
8	Alaknanda	1010	28.91	10.00	10.00	10.90	20.34	10.00	20.34
9	Devsari	1138	60.06	10.00	10.00	5.43	11.99	5.43	11.99
10	Vishnuprayag	1130	35.11	10.00	2.5	14.92	18.74	2.5	18.74
11	TapovanVishnugad	3100	77.68	10.00	10.00	18.74	15.99	10.00	18.74
12	VishnugadPipalkoti	4672	117.06	10.00	10.00	12.43	18.80	10.00	18.80
13	NandaprayagLangrasu	6233	177.16	10.00	10.00	10.97	14.92	10.00	14.92
Religious Places									
1	Vishnu Prayag	4435	178.64	10.00	10.00	8.1	22.57	8.1	22.57
2	Joshimath	4508	181.58	10.00	10.00	8.1	22.21	8.1	22.21
3	Uttarkashi	4400	123.93	10.00	10.00	4.1	15.36	4.1	15.36
4	NandPrayag	6200	254.51	10.00	10.00	7.6	24.14	7.6	24.14
5	Karan Prayag	8460	303.06	10.00	10.00	16.5	16.89	10.00	16.89
6	RudraPrayag	10675	395.38	10.00	10.00	13.6	7.85	7.85	13.6
7	Srinagar	11332	339.11	10.00	10.00	20.72	14.69	10.00	20.72
8	Devprayag	19600	647.10	10.00	10.00	14.8	7.70	7.7	14.80

Values for some projects have been modified marginally by IIT-Roorkee.

3.35.2 IIT-Roorkee has studied and found the Environment Management Class (EMC)– Hydraulic Mean Depth (HMD) method most suitable for determining e-flows under the given time, data and resource constraint of their study. During the course of the discussions, it was explained that the study was initiated with the aim to determine EFR at various hydropower projects and religious sites in Alaknanda-Bhagirathi basins up to Devprayag. In this study for the assessment of EFR, various methods/approaches are used. The first method is the Hydrological index method in which the environmental flow requirements at various sites are computed by using look-up tables, low flow indices such as Q95 (i.e. that flow which is equalled or exceeded 95% of the time) is often used in regulating abstraction in Uttarakhand. Figure of Q95 was chosen purely on hydrological ground. However, implementation of this approach (e.g. how much Q95 can be reduced) often includes ecological information. The Environment Agency of England and Wales is responsible for ensuring that the needs of water users are met whilst safeguarding the environment. It has specified percentages of natural Q95flow that can be abstracted for different environmental weighting bands. For the present study area, the environmental weighing band is considered as 'D', in which 25% of Q95 can

be abstracted and 75% of Q95 will be released as environmental flow. The second hydrological indexing method used for the present analysis is Tessman or Modified Tenant's method. This method is based on the computation of Mean Annual Flow (MAF).

3.35.3 The third is a desktop approach known as the Environmental Management Class (EMC) based Flow Duration Curve (FDC) approach. In this methodology, seventeen fixed percentage points are taken for the computation of dependable flows. The flow duration curve plotted using these fixed points are termed as reference flow duration curve. The Six EMCs (Environmental Management Classes) are used in this study and six corresponding default levels of EWR may be defined. It starts with the unmodified and largely natural conditions (rivers in classes 'A' and 'B'), where no or limited modification is present or should be allowed from the management perspective. In moderately modified river ecosystems (Class 'C'rivers), the modifications are such that they generally have not (or will not from the management perspective) affected the ecosystem integrity. Largely modified ecosystems (Class 'D' rivers) correspond to considerable modification from the natural state where the sensitive biota is reduced in numbers and extent. Seriously and critically modified ecosystems (Classes 'E' and 'F') are normally in poor conditions where most of the ecosystem's functions and services are lost. In addition, the habitat simulation method is also used based on the limitation of the study in terms of data availability and time frame. In this method, the available habitat conditions (including hydraulics) and their suitability to target biota is linked with minimum discharge required for their survival. Since, the cross sections in Alaknanda-Bhagirathi basin were available at limited sites, the available data were proportionately used for other projects sites.

3.35.4 The IMG notes that for collection of data, the IITR used the long term average 10 days daily flow series generated for various stream gauging stations. The data from these stations was then transposed to generate 10 day series for the HP sites. The long term average 10 day series thus generated for various HP sites was analysed using different EFA methodologies mentioned earlier. The secondary data of Habitat characteristics such as geological, morphological, hydrological and biological characteristics were collected from Department of Environmental Sciences, H.N.B. Garhwal University Srinagar-Garhwal, Uttarakhand. Accordingly, the entire basin under study was divided into different stretches/zones on the basis of the habitat characteristics. The primary data on collection of biotic valued ecosystem components (macro invertebrates, fish and fish otter)

were made after visiting all the major river zones of study area. The secondary data related with biotic components were also collected from the published literature. Benthic macro-invertebrate data were derived from samples taken following standard protocols. The data on fishes and fish otter were collected through primary and secondary sources. Hydrological requirements (water depth and water velocity) of macro invertebrates, fish and fish otter were also obtained from the analysis of the characteristics of their natural habitat and their life activities in the Alaknanda-Bhagirathi basin. Based on the various approaches as stated earlier for classifying the rivers on the basis of biotic communities or various basin ecological indicators, the entire reach of Alaknanda and Bhagirathi Basins up to Devprayag were classified in to different stretches. Data on important basin ecological indicators were also collected for assessing the environmental management class (EMC) of the rivers. On the basis of hydrological requirements (water depth and water velocity) of macro invertebrates, fish and fish otter in the various stretches, and EMC of the various river stretches, the hydraulic mean depth (HMD) and velocity were computed at various HP sites.

3.35.5 The IMG noted that a number of issues have been raised on the above report. Specifically, three areas were pointed out.First, it is being argued that the Building Block Method (BBM), which may be more suitable for Indian conditions has not been used. Second, the importance of monsoon flushing to meet the needs of the aquatic biota has not been adequately covered.In this context, it also been mentioned that the region harbours diverse fish species from small sized loaches to big Mahseers, the different requirements of these have not been adequately considered. Thirdly, it has been mentioned that it is not an accumulative impact study, as impact of only individual projects have been given.The IIT-Roorkee while responding to the above issues has mentioned that the building block methodis suitable but has not been carried out due to constraints of time, availability of data and resources. This view has also been reiterated in the report as well. However, considering the time frame in which the study has been conducted, it has made appropriate recommendation. It is also been stated by them that the 69 sites and other religious places required for studies byBuilding Block Method will be highly time consuming and shall require a large data as well as financial resources. Explaining this, they have quoted the example of WWF, which has done this study and used a large number of experts in different fields and taken a period of three years to complete the study for only three sitesand cautioned theirrecommendation be seen as preliminary and as those will require considerable future improvement and

verifications.The requirementof flushing during monsoon is not required in both rivers as all hydro projects except Tehri reservoir are run of river types where silt is not trapped/stored. The depth and velocity required for fish and other aquatic life has been calculated by them at 22 locations.Further IITR has responded that a full analysis on cumulative impact of both rivers have been done and a chapter has been dedicated to this aspect by following internationally well accepted method of valued ecosystem components (VECs).

3.36 The Committee also considered the recommendationsand methodology of Wildlife Institute of India (WII). The WII has taken data which was available with the IIT-Roorkeestudy. It, however, focussed on four specific areas in the study. These were:

(a) To assess the baseline status of rare, endangered and threatened (RET) species of flora and fauna dependent on riverine habitats and floodplains of Alaknanda and Bhagirathi river basins.

(b) To identify the critically important habitats along the existing and planned Hydro Electric Projects located on rivers Alaknanda and Bhagirathi uptoDevaprayag.

(c) Delineate river stretches critical for conservation of rare, endangered and threatened (RET) aquatic species.

(d) To assess the key habitat variables for RET species, including minimum flows and volume of water for ecological sustainability of the two rivers.

3.36.1 For assessing the environmental impact assessment in the hydro power plants, it observed that the cumulative impact can result from (i) multiple action at a given site associated with a single project, or (ii) can be additive or synergistic in nature when potential impacts of multiple projects are taken into account and are concentrated in time or space.For example, (ii) impacts are important when series of small diversion/dams are constructed on a single stream or on streams within a single river basin.

3.36.2 While assessing the e-flows, it observed that several studies have been conducted on the water quality and aquatic biodiversity of Bhagirathi (Sharma, 1983, 1985, 1986), Bhilangana (Sharma et al. 1990, Sarkar et al. 2011), Alaknanda (Singh and Sharma, 1998), Dhauliganga(Sharma et al. 2004), Tons (Sharma et al., 2008) and Asan (Sharma and Rawat, 2009, Sarkar et al. 2011). There is no information

available on the precise hydrological requirements of the organisms living in the upper Ganga. It is possible to provide minimum e-flow required for different fish communities which occur in different fish zones by studying their spatial distributions with supporting data on immediate habitats.

3.36.3 In the absence of the above studies, the WII adopted the results of the study done by Smakhtin and Anputhas to assess the default flows based on the River class. The methodology prescribed by the International Water Management Institute (Smakhtin et al, 2007) to assess the environmental management class of Alaknanda and Bhagirathi basins using fish as a major indicator for aquatic lifewas applied. Reasons for applying along with the markings are given in Annexure-VIII.

3.36.4 After having decided the environmental class of the river based on the above methodology, the WII then argued that Smakhtin (2006)had assessed 28.9 % of Mean Annual Run-off (MAR) as environmental water required for Ganga river to retain the status of its EMC. However, the proposed EWR for Ganges was based on analysis downstream from Rishikesh. This downstream stretch of Ganges is considered to have more than 140 species of fishes, of which about 19 species are in threatened categories. Moreover, in the same stretch, two species of crocodile Crocodyluspalustris and the Gavialisgangeticus are found. Both are considered endangered (JUCN 1994). The common Indian Otter, and Smooth Indian Otter, have also been sighted in this stretch of the river. In addition, endangered Gangetic dolphin, 12 species of freshwater turtles have also been reported in this stretch apart from hundreds of species of aquatic insects. Several thousands of people are also directly dependent on the fisheries resources on this stretch of Ganges. In view of these facts, the WII assessed that 28.9% of MAR as suggested for downstream of River Rishikesh would not be appropriate EWR for River Alaknanda and River Bhagirathi basins. These basins have been observed to be having less than the half of the aquatic biodiversity when compared to other parts of the Ganges. IN the absence of larger animals such as dolphin, crocodiles etc. and with 76 species of fishes (in comparison to 143 species reported in the entire Ganges), it was estimated that 14.5% to 21.8% of MAR may be the Minimum EWR for the aquatic biodiversity of Alaknanda and Bhagirathi basins as a conservative estimate during the lean season. It was further argued that the Minimum Environmental Flows (MEF) were specifically for environmental purposes, especially to meet the requirements of different aquatic biota. These would not include for any flows necessary downstream commercial activities or for water supply purposes. It also assessed that the river stretch

that falls in the "no fish zone" may need water flows equal to 14.5% of MSF sinceit has no fish butit does have other aquatic biota.

3.36.5 There are several issues which need to be considered while assessing the environmental flows based on this methodology. First, the report has focussed primarily on environmental flows based on needs of bio diversity and fish which has been computed based on studies done by Smakhtin for environmental flow in the River Ganges downstream of Rishikesh. The assessment of needs for environmental flow arrived at for upper reaches of the River in the basins of Alaknanda and Bhagirathi is not based on any independent study of the region. It is an estimate based on the extent of biodiversity and fish and making an assessment of EFR needs taking into account broad comparison with the needs downstream. Secondly, the overall cumulative environmental impact has not been assessed, particularly when talking of geomorphology in the River basin. Thirdly, the report does not make any mention of environment flows required based on other needs of the River and of the society specially hydropower. Specially, these relate to fluvial geomorphology, livelihood needs, spiritual-cultural needs and the water quality needs.

3.37 The third report prepared by WWF has used the building block method for assessing the environment flow requirements. The report describes in great detailed, the building block methodology and gives a manual for its implementation. It recommends environmental flows for different places studied by it namely, Kaudiyala(Rishikesh), Tushlaghat and Bitthoor near Kanpur. The methodology involves a number of stakeholders who give their own assessment of EFR needs. In case of Kachlaghat for example, the recommendations were based on the flow indication selected by following specialist group which concentrated on different areas:

- The fluvial geomorphology group concentrated on the flow velocities and depths required to move, sort and deposit different sizes of sediment, so as maintain or restore channel size and other important channel features (such as multiple channels and bars).

- The biodiversity group concentrated on the habitat characteristics required for important flow-dependent species such as the river dolphin, selected fish species, macro-invertebrates and floodplain vegetation. These characteristics included the depth, flow velocity, river width, and substrate types required for different parts of their lifecycle.

- The livelihood group focussed on depth, water quality and river width required to maintain certain livelihood activities (such as ferrying or rafting).

- The spiritual/cultural group had to ascertain the depth and water quality issues that would affect religious and cultural activities (such as ritual bathing).

- The water quality group responded to the recommendations of the other groups, estimating the effects that the recommended flows would have in mitigating pollution or other water quality issues.

3.37.1 The Hydraulics groups then converted this information into flows using the modelled hydraulic characteristic on the survey cross sections. Based on the flow motivation by the different working groups, the critical flows for each site were identified. For example:

- At Kaudiyala, the January maintenance flow was determined by fluvial geomorphology, whereas the August maintenance flow was determined by biodiversity requirements.

- At KachlaGhat and Bitthoor, cultural and spiritual needs drove the recommendations for the August flows (both during maintenance and drought years).

- Almost half of the critical flow recommendations were influenced by the biodiversity requirements as these were usually higher than the other requirements.

3.37.2 Based on the above, the e-flows recommended for Kaudiyala were 72% of the Mean AnnualRun-off (MAR) during normal years and 44% during drought years. During the study, it has been mentioned by the WWF in its report that although the recommended e-flows constitute a significant proportion of the total flow in the river, it is important to recognize that the water required during the monsoon months (July–September) forms the bulk of the annual requirement, and is presently unused for consumption purposes.No flow restoration is necessary to maintain these flows. It is mainly during the dry season (January–June and November–December) that flow restoration is required, because the present flows in the river are significantly lower than the recommended e-flows. The annual volume of water required for this restoration constitutes a much smaller proportion of

the MAR, therefore requiring smaller adjustments to water allocations to be met.

3.37.3 The WWF studies have also thrown up several issues. First, the study for only three places has taken about 3 years to complete. It required setting up of a number of working groups and expert in different fields. Further WWF has pointed out that their recommendations, "... *could be refined with the availability of more credible and long term real time data.*" And further"..... *It is also important to recognise the fact that assessment and implementation of e-flows is an adaptive process, in which flows may be successively modified in thelight of increased knowledge, changing priorities, and changes in infrastructure over time.*"In case, it is to be expanded to all these 69/70 sites for which hydropower projects and environmental flows have to be recommended, it may take considerable time. Even if it is argued that some of the projects may be taken up at a later stage or not been taken up for other reasons, the requirements of personnel is quite large. Second, apart from manpower, the time taken in the study would also be quite substantial. It is necessary to see how this methodology can be coordinated with the requirements of development of hydro power. Third, the e-flows recommended in this study are not directly relevant, especially for the upper reaches. The critical flows at different places are determined by different factors. For example, at Kaudiyala, the January maintenance flow was determined by fluvial geomorphology whereas the August maintenance flow was determined by biodiversity requirements. In the upper reaches, where the water availability is small during the winter season, the livelihood needs and the water quality needs may also be important during that season. Fourth, the study recognizes the fact that the river flows in its study points could be implemented as there was already substantial flow during the rainy season and only some changes were required in the winters. This position may not be true in the upper reaches.

3.38 The above assessment indicates that all the three studies have issues to be addressed. While clearly the Building Block Method is the most comprehensive and considers the entire needs of the community.It suffers from the fact that its extensive application across the board is time consuming. Secondly, it requires extensive expertise in a wide range of areas. Since, this method is not applied in our country on rivers, it may take some time. The IMG, however, feels that,in the long-run,this is an appropriate method for determining e-flows.

3.39 While the above method should be used in the long-run, as an interim measure, the e-flows for hydro power plants in the two basins has been assessed based on existing studies. The IMG noted that the WII study prescribes the e-flows for different seasons to meet the requirements of environment and ecology, especially fish, including Mahseer and Snow Trouts. It also observed that the IIT study has used specific river points and assessed detailed e-flow requirements after considering hydrological requirements (water depth and water velocity) of macro invertebrates, fish and others in various stretches and EMC of various river stretches. It has computed mean depth and velocity on the above 23 sites based on this.

3.40 The IMG noted that while both the studies aim to meet the requirements of fish and other aquatic requirements, the results are different. Following Table indicates the result at the 23 sites:

Table-11: Comparative E-Flows of IIT-Roorkee & WII Studies at Various Sites

Sl. No.	HEP Site	IIT-Roorkee Study		WII Study			
		E-Flow (Cumec)	E-Flow in % of MAF	Season-I (May-Sept) High Flow (30%)	Season-II (Apr) Average Flow (25%)	Season-III (Nov-Mar) Low Flow (20%)	Season-IV (Oct) Average Flow (25%)
A	**Bhagirathi River**						
1	Asiganga-III UDHP	0.38	7.2	2.53	0.41	0.08	0.15
2	AgundaThati	1.18	21.46	1.59	1.11	0.91	0.81
3	Bhilangana-III UDHP	2.34	17.0	5.28	1.92	1.24	1.20
4	Bhilangana-III	2.34	10.2	15.04	10.46	8.63	7.63
5	LohariNagpala-UDHP	5.36	5.80	44.14	7.30	1.46	2.66
6	ManeriBhali-I	8.57	7.50	54.64	9.05	1.81	3.29
7	ManeriBhali-II	11.09	9.03	58.78	9.72	1.95	3.55
8	Tehri Stage-I	36.50	15.00	93.57	34.01	21.92	21.28
9	Koteshwar-UDHP	36.50	14.05	99.83	36.28	23.38	22.72
10	Kotlibhel 1A	36.50	13.70	102.38	37.21	23.98	23.28
B	**Alaknanda River**						
1	Badrinath	7.77	19.58	-	-	-	-
2	Birahi Ganga-II	2.16	26.41	3.08	1.94	0.67	0.65
3	Bhyunder Ganga-UDHP	2.70	28.69	3.85	1.79	0.61	0.74
4	PhataByung SHP	4.32	25.68	6.51	2.79	1.47	1.48
5	Rajwakti	4.32	21.8	7.46	4.69	1.61	1.57
6	Rishiganga II	5.40	22.03	-	-	-	-
7	SingoliBhatwari LHP	5.29	9.88	21.30	9.09	3.76	4.82
8	Alaknanda UDHP	7.77	18.80	16.90	7.89	2.67	3.23
9	Devsari	7.20	17.19	7.53	4.29	1.55	1.57

10	Vishnuprayag	6.58	14.2	28.08	13.10	4.43	5.36
11	TapovanVishnugad	12.42	9.8	-	-	-	-
12	VishnugadPipalkoti	22.01	6.05	78.19	36.47	12.35	14.91
13	NandaprayagLangrasu	26.44	10.36	104.32	48.68	16.48	19.90

3.41 The IMG has considered the above assessments of IIT-Roorkee, WII, WWF, Central Water Commission and national and international policies. It has also considered the views of various groups which have presented their suggestions before the IMG. Based on it several points emerged. It is clear that the methodology adopted by WWF based on Building Block method has been recommended by all the Committees, including IIT-Roorkee and WII. During the course of discussions in the IMG, it was felt that this is the most holistic method for assessing e-flows in hydropower projects. It was, however, noted that because of the comprehensive nature of these studies, they invariably take a lot of time. Also, so far these studies have not been conducted in India on any large rivers. The technical capability for this will also develop gradually. Considering that the study will have to cover 69 hydro projects individually, each one of which will require constitution of 5–6 Groups, it is clearly going to be a time-consuming process. It is, therefore, necessary that interim e-flow recommendations are made by IMG so that hydro power development is not held up for want of environmental decisions. Subsequently, when the final recommendations of the IIT Consortium on Ganga River Basin are received, revised e-flows can be prescribed.

3.41.1 The IMG considered following options while assessing the need for e-flows:

(a) **Option-1**: Recommendations made by IIT-Roorkee for 23 hydro sites. For other sites, similar recommendations could be made.

(b) **Option-2**: Recommendations made by WWF for Kaudiyala (near Rishikesh) for e-flows based on Building Block Method.

(c) **Option-3**: Recommendations made by WII, Dehradun on e-flows for all the sites based on Mean Seasonal Flows (MSF) and flows for 'no fish zone'.

(d) **Option-4**: Suggestions of the Central Water Commission (CWC) on maintaining e-flows at 20% of the daily river flows.

(e) **Option-5**: Fixing up e-flows in accordance with standard norms being prescribed in the U.K. or France or other countries. Or in the alternative, prescribing e-flows as is being done by Himachal Pradesh for its hydro power projects.

(f) **Option-6**: Fixing up e-flowsat50%–75% of the river flows as suggested by some groups.

3.41.2 The IMG is not in favour of Option-1 as the e-flows suggested in the IIT-Roorkee study vary widely as a percentage of daily river flowson a 10-day basis though it attempted to mimic the flows. Administration of such a e-flow regime would pose problems considering that many of the hydro projects are in far-off places. Secondly, the flows prescribed are quite different for the needs of fishes and other biota than suggested by WII. Considering that the WII study is more focussed on bio diversity, the IMG is inclined to accept their suggestions on this issue.

3.41.3 The IMG also does not favour Option-2 (recommendations of WWF). It finds that the study relates to an area downstream of the present Bhagirathi and Alaknanda basins where the requirement of fishes and other aquatic life are quite different. Further, the needs of community and other river flows are also not comparable with the basin under study.

3.41.4 The IMG has also considered Options 4, 5 and 6. It is not inclined to recommend these options as some of these suggestions are not backed by any specific assessment of rivers in the Alaknanda–Bhagirathi basin unlike the studies of IIT-Roorkee, WII and WWF. Also, it suggests that the international practice can be a useful guide for our basin in absence of specific studies on e-flows. In the current instance, there are already three studies on this issue. It is also not very useful to accept the recommendations of the CWC for 20% e-flows as it is purely *ad hoc* and has no riverneeds assessments to support it. The IMG, however, notes that this could be useful guide for prescribing minimum e-flows. The recommendations for fixing up e-flows at 50%–75% of river flow also do not have any assessment of river needs to support the view. While larger e-flows will clearly help the health of the river, the fixation of flows has to be done on the basis of balancing of needs of the environment, ecology and community for all aspects, including hydro power. In view of the above, the IMG is inclined to give a strong weightage while finalizing its recommendations on e-flows to the specific recommendations of the studies done on this issue.

3.41.5 The IMG, therefore, considered the Option-3 as the appropriate as a starting pointfor further work on the needs of the e-flow norms in the Bhagirathi and Alaknanda rivers basins. It has several advantages. First, it prescribes different percentages for different seasons, which is in accordance with the requirements of the fishes and other aquatic biota. Second, it has taken into account the lower needs of 'no fish zone'. Third, the variation in its seasonal flow recommendations is not very high. The flows recommended vary from 20% to 30% of Mean Seasonal Flow (MSF). Fourth, it has taken in to account the needs of Mahseer and Snow Trout and other aquatic varieties while making recommendations on the e-flows. Fifth, it makes a distinction between 'fish zone' and 'no fish zone' for e-flows. The IMG, therefore, considered their recommendations as more suitable for prescribing e-flows.

3.42 An important component of the e-flows regime has to be mimicking of the river flows so as to keep it very close to the natural flows. Cumulative norms even on seasonal basis do not meet this objective. Daily inflow norms may, however, enable a sustained river flow as well as have large flows in the high season and hence are more suitable. These will invariably be higher than similar norms of MSF and provide an effective mechanism for use of e-flows both by community and for hydropower.The IMG is also very conscious of the need to have an e-flow policy regime which is effectively implementable by different hydro power projects. An essential ingredient of such a policy is simplified e-flow norms with minimum variations during the year.

3.43 In view of above, the e-flows in the above river basins in 'fish zone' should be,except to the extent modified in para 3.46 below, fixed in terms of percentage of daily uninterrupted inflows at following levels:

October–November April–May	– 25%	WII has recommended the same, percentage, except for May (30%) and November (20%) on MSF basis.
June–September	– 20%	WII has recommended 30% on MSF.
December–March	– 30%	WII has recommended 20% on MSF.

The actual river flows during the high season (June–September) would be higher than 30% of the cumulative flow in the river in that period with the above norms in place. This is due to the fact that lot of water during the high flood season will have to flow in the river directly considering the design of

the hydro power machines. The above flows will also be more than WII recommendations on MSF in all seasons (Annex-VIII).

3.44 The e-flows for the 'No Fish Zone' should be,except to the extent modified in para 3.46 below, fixed in terms of percentage of daily inflows at following levels:

April–September – 20%

October–March – 30%

While the WII has suggested 14.5% of the MSF as appropriate, the IMG feels that it will be necessary to have daily flows as above so as to meet the requirements for community purposes.

3.45 While suggesting above, the IMG has considered the views of CWC on minimum e-flows in the river and also the analysis that shows that hydropower in these stretches is optimised during the months of high discharge. In the winter months, with low and variable water discharge in the river, the plant load factor is already low. The IMG's recommendation is based on optimisation of energy during high discharge and balancing the needs for society and river water flow in low discharge.

3.46 The IMG has considered the need for e-flows, especially during the winter, when the water discharge is very low. River flow data in some of the rivers indicates that the discharges during the winter months becomes as low as 5% of the high season flow discharge. In view of this, the IMG recommends that, in addition to above, during the winter months in rivers where the water flow goes down drastically, the societal needs have to be met and the flows should, therefore, be increased to 50% in December–March. Since data for all the projects is not available, no specific recommendation for any project is being made. However, the IMG strongly feels that the need for adopting this policy.

3.47 The IMG has assessed the impact on its recommendations on existing power plants. FollowingTable gives the impact on their tariffs if the e-flows are prescribed as recommended by the Committee.

Table-12: Project-wise Design Energy, Tariffs withVariable E-Flows

Sl. N.	Name of Project	IC (MW)	Design Energy (Gwh)	Annual Energy after EFR (Gwh)	Cost at June, 2012 PL (Rs Cr)	Tariff (Rs/kWh) with Different E-Flows					
						Without EFR		After Variable EFR			
						1st Year	Levelised	1st Year	% of Tariff High	Levelised	% Increase in Lev. Tariff

Bhagirathi											
1	Loharinag Pala	600	2582	2221	3420	3.39	2.85	3.95	16.5	3.32	16.5
2	Asiganga III	9	31	28	102	8.49	7.13	9.40	10.7	7.90	10.8
3	ManeriBhali I	90	412	377	193	1.20	1.01	1.32	10.0	1.11	9.9
4	ManeriBhali II	304	1497	1288	1294	2.22	1.86	2.58	16.2	2.16	16.1
5	AgundaThati	3	16	13	22	3.62	3.04	4.46	23.2	3.74	23.0
6	Bhilangana III	24	141	120	189	3.45	2.90	4.05	17.4	3.40	17.2
7	Bhilangana	22.5	126	108	177	3.61	3.04	4.22	16.9	3.54	16.4
Alaknanda											
8	Badrinath	1.25	11	11	8	1.96	1.64	1.96	0.0	1.64	0.0
9	Alaknanda	300	1221	1027	1352	2.84	2.38	3.37	18.7	2.83	18.9
10	Bhyunder Ganga	24.3	149	133	138	2.37	1.99	2.65	11.8	2.23	12.1
11	Rishiganga II	35	210	186	824	10.06	8.45	11.35	12.8	9.54	12.9
12	Birahi Ganga II	24	78	64	132	4.33	3.64	5.28	21.9	4.44	22.0
13	Vishnuprayag	400	2087	1787	1776	2.18	1.83	2.55	17.0	2.14	16.9
14	TapovanVishnugarh	520	2649	2261	3602	3.48	2.93	4.08	17.2	3.43	17.1
15	VishnugahPipalkoti	444	1859	1494	2750	3.79	3.19	4.72	24.5	3.96	24.1
16	PhataByung	76	354	300	627	4.54	3.81	5.35	17.8	4.50	18.1
17	SingroliBhatwari	99	495	427	783	4.05	3.41	4.70	16.0	3.95	15.8
18	Rajwakti	4.2	28	25	34	3.08	2.58	3.44	11.7	2.89	12.0
19	NandprayagLangrasu	100	494	418	1529	7.93	6.67	9.38	18.3	7.88	18.1
20	Devsari	252	968	777	1715	4.54	3.81	5.66	24.7	4.75	24.7
21	Srinagar	330	1253	1199	2277	4.66	3.91	4.87	4.5	4.09	4.6

*Tehri Stage-I, Koteshwar and Kotlibhel-IB have the dams for generation and hence there will not be any major impact on the tariff on account of environmental flows as the required minimum flows shall pass through the turbines. However the generation shall be regulated for 24 hours to ensure the continuous release of water for minimum environmental flow.

Table-13: Cumulative Impact of Hydropower Projects in Alaknanda and Bhagirathi Basins– EFRs and Reduction due to EFRs

Sl.No.	Project Name (Representative Only)	Design Energy (95%)	Annual Energy After EFR (95%)	Reduction in Annual Energy due to EFR (in %)
BHAGIRATHI				
1	Loharinag Pala	2582	2221	14%
2	Asiganga III	31	28	8%
3	ManeriBhali I	412	377	9%
4	ManeriBhali II	1497	1288	14%
5	AgundaThati	16	13	19%
6	Bhilangana III	141	120	15%
7	Bhilangana	126	108	14%
8	Tehri Stage I	2893	2164	25%

	EFR (% of Flow) ofIn-flows
Jan	30
Feb	30
Mar	30
April	25
May	25
June	20
July	20
Aug	20

9	Koteshwar	1243	931	25%
10	Kotlibhel 1A	1017	771	24%
	Total	**9957**	**8022**	**19%**
			ALAKNANDA	
11	Badrinath	11	11	0%
12	*Alaknanda*	1221	1027	16%
13	*Bhyunder Ganga*	149	133	11%
14	Rishiganga II	210	186	11%
15	Birahi Ganga II	78	64	19%
16	*Vishnuprayag*	2087	1787	14%
17	TapovanVishnugarh	2649	2261	15%
18	VishnugahPipalkoti	1859	1494	20%
19	*PhataByung*	354	300	15%
20	SingroliBhatwari	495	427	14%
21	Rajwakti	28	25	11%
22	NandprayagLangrasu	494	418	15%
23	Devsari	968	777	20%
24	Srinagar	1270	1199	6%
	Total	**11872**	**10107**	**15%**

Sept	**20**
Oct	**25**
Nov	**25**
Dec	**30**
No Fish Zone project	
(projects shown in Italic)	
Jan	30
Feb	30
Mar	30
April	20
May	20
June	20
July	20
Aug	20
Sept	20
Oct	30
Nov	30
Dec	30

3.48 It is quite clear that there will be requirement to revise the PPA and increase the tariffs after the increased e-flows are implemented. Of the commissioned projects, those which are owned by the State Government or State power utilities or Central utilities could revise the tariff after approval of the PPA by the power regulator. To ensure that the increase is minimised, the hydro power plants can be permitted to sell a certain share ofenergy generated (say 5% to 10%) on power exchanges and thereby reduce the impact on tariff. It is, however, quite clear that the burden of this increased e-flow would have to be passed on to the consumer, either fully or partially.

Environmental Impact of Hydro Power Projects

3.49 The IMG has also considered the environmental impact of projects that have proposed on rivers Bhagirathi, Alaknanda and other tributaries of River Ganga and remedial action required. It noted that at this juncture, 70 projects are being proposed or under commissioning in this State. The total hydro capacity involved in this is 9,550.3 MW. Of these, 17 projects of 2,295.2 MW capacities have already being commissioned. In addition, 26 projects of 3,261.3 MW capacities are under construction, which includes LohariNagpala Hydro Electric Project (600 MW) being executed by NTPC work on which had been discontinued in December, 2010, as a result of Government decision. As a result, the net capacity under construction is

2,661.3 MW. If these projects are commissioned, the total capacity would increase to 4,956.3 MW (51.89%).

3.50 In addition to above, there are 2,320 MW capacities involved in 11 projects which has been cleared by CEA or after Technical Economic Clearance (TEC) were under project development. Of these, Palmaneri (480 MW) has been discontinued by Government of India on the basis of the suggestions of the National River Ganga Basin Authority. Forest clearance for Kotlibhel Stage-1B (320 MW) and KotlibhelStage-II (530 MW) has been rejected by MoEF. Based on these, therefore, the balance capacity, which is under development remains 980 MW.

3.51 In the fourth category are 1,673.8 MW projects (16) which are under development. These include 11 projects of 1,597 MW of above 25 MW capacities and 76.8 MW of below 25 MW capacities. In most of these cases, either the primarily feasibility report is being prepared or the DPR which being prepared has been found wanting and has been returned.

3.52 The IMG noted that cumulative environmental impact assessment of the projects which are operative or under commissioning or under development has been done by both IIT-Roorkee and WII, Dehradun. The IIT-Roorkee report has not given any specific number power plants or hydro potential, which should be in consistent with the environment. It has recommended that based on the analysis, hydro power potential at identified sites can be harnessed if consistent with environmental sustainability. It has suggested certain measures to mitigatediverseimpacts. These relate to construction, hydrological aspects, geology and seismology soil erosion and sedimentation, environment and biodiversity, religious and social aspects. It has also emphasised monitoring of the projects on an online basis for e-flows. The report has also stipulated other requirements. First, while assessing sustainability of the projects, a threshold of, say, 70% of the river length may be fixed. No further allotment for HP sites can be made for the river where river length affected is higher than threats. This can be revised later on better information and clearer understanding of river systems. Second,it has also recommended fixing up a bench mark if energy generation per unit of diverted discharge is low.It has suggested that such projects may be discouraged. Third, it has recommended a reasonable gap between two consecutive projects along a river stream which should be sufficient for the river to regenerate itself. However, no specific distance has been suggested between two such projects. In respect of River Nayar,

BirahiGanga, Bhyunder Ganga, Bal Ganga and Assi Ganga, the report has mentioned that these rivers should not be further exploited.

3.53 The WII Report has also considered the 70 hydro projects, including 17 in operation. It has suggested that 24 projects with a capacity of 2,608.6 MW may not be implemented because there are either in high/very high terrestrial or aquatic biodiversity zone. It has mentioned that dropping this would affect a river length of 244.57 kms. Considering that overall length involved in these 70 projects is 655 kms, the overall reduction in the river length affected would be 37.3% and the requirement of forest area would decrease by 21.71%. The committee has also recommended setting up of fish conservation reserve at two places which are comparatively less disturbed and have critically important habitats for long term survival of Himalayan fishes. These are (a) Nayar River and part ofthe Ganga stretch between Devprayag and Rishikesh, and (b) Balganga–Tehri Reservoir complex. The WII have also suggested measures for regulating impact of hydroelectric projects. In respect of projects only commissioned, they have suggested the following:

(i) Ensure revised environmental flows are implemented.

(ii) Monitoring for compliance of clearance conditions and conducting environmental audits to identify areas of negligence in environmental management so that regulatory frameworks can be better tailored for ensuring the reduction in the combined footprint of all projects operating in the sub-basins.

(iii) Identifying biodiversity offsets and compensatory opportunities for areas of high biodiversity values. The nearest parallel of such an offset scheme is the proposal to set up two Conservation Reserves.

(iv) Review the sustainability of livelihoods that are dependent on bio-resources and promote alternatives to protect remnant biodiversity in areas of use.

(v) Treatment of released water (to ensure a natural range of salinity, turbidity, temperature, oxygenation etc) and restoration of river bed substratum for making them suitable habitats of fish.

(vi) Controls on access, and low impact siting of resettlement areas, workforce camps, sites and stockyards.

3.54 The report also makes recommendations for projects under construction. In such cases, in addition to the projects steps already proposed above, following additional suggestions have been made:

(i) Ensure revised environmental flows are implemented.

(ii) Material and waste management to reduce impacts on natural habitats of animals and plants in the sub-basins(s).

(iii) Location of temporary and permanent structures (muck disposal sites, resettlement areas, workforce camps, workshops and stockyards) to reduce the zone of project influence to avoid their impacts on wildlife areas.

(iv) Prevention of physical disturbances along river courses, to maintain unhindered flow and stream quality during construction.

(v) Appropriately plan operation of the dam/barrage to maintain continuous natural flow in post construction and inundation stages;

(vi) Rescheduling construction activities where necessary to avoid prolonging the duration of impacts linked to construction phase. This would specially apply to activities causing physical disturbance at sites that can affect habitat utilisation, impair movement of animals and destruction of sites that harbour important plant species.

The above suggestions would help mitigate the environmental impact of the projects.

3.55 The IMG has considered the need to have portions of the river free from hydro projects. With the present proposals in several basins, the river length affected is 80% and above. Such a large portion of the river if affected by hydro-electric projects has little room for other needs of the community. It also does not leave adequate stretches for the river to regenerate itself ecologically. While internationally no specific studies are available on the length to be covered for such projects, the IIT-Roorkee has suggested 70% of the river length as one of the norms. WII study has suggested that projects worth 2,608 MW may be taken up after further study. According to this assessment, the total river length which will then remain affected if these projects were not to be taken up would be 62.7%. While there is no specific strong norms coming up, the IMG is inclined, in view of the above recommendations to suggest that, in Phase-I, projects may be implemented so that not more than 60% of the length may be affected.

Table-14:Affected Length of Bhagirathi and Alaknanda Rivers and its Tributaries due to Allotted Hydropower Development

Sl. No.	River	Total River Stretch (m)	River Stretch Diverted	River Stretch Submerged	Affected length	% of River Length Diverted	% of River Length Submerged	% of River Length Affected
Bhagirathi Basin								
1	Bhagirathi	217000	38200	76300	114500	18%	35%	53%
2	Asi Ganga	20500	0	0	0	0	0	0
3	Bal Ganga	37000	2000	0	2000	5%	0%	5%
4	Bhilangana	109000	9200	0	9200	8%	0%	8%
5	Small Tributaries	73000	28500	0	28500	39%	0%	39%
		456500	77900	76300	154200	17%	17%	34%
Alaknanda Basin								
6	Alaknanda	224000	55160	0	55160	25%	0%	25%
7	Dhauli Ganga	50000	24000	0	24000	48%	0%	48%
8	Rishi Ganga	38500	1000	0	1000	3%	0%	3%
9	Birahi Ganga	29500	1400	0	1400	5%	0%	5%
10	Nandakini	44500	10700	0	10700	24%	0%	24%
11	Mandakini	81000	31800	1200	33000	39%	1%	41%
12	Pindar	114000	6700	19605	26305	6%	17%	23%
13	Small Tributaries	83000	21500	0	21500	26%	0%	26%
		664500	152260	20805	173065	23%	3%	26%

Note: Upper reaches of river have not been accounted.

Kotlibhel-II is located on main Ganga River therefore it is not included on these studies.

3.56 There is a clear need to ensure that adequate river length is available to meet the societal needs and River gets adequate time during its flow to regenerate itself. The IMG notes the recommendations of IIT-Roorkee and WII Dehradun, on these issues. It is, however, clear that there is no scientific study which suggests a specific norm which can be applied on this issue. While the final recommendations of IIT Consortium will consider this issue and suggest appropriate norms, as an interim measure, the Committee recommends that while implementing the above projects two norms be followed. First, the river length affected should not be more than 60%. Second, the distance between two hydro projects should generally be such as to ensure that over-crowding is avoided. This is recognising the fact that this distance will, however, depend upon the gradient of the river and consequently hydro-potential at that point. If the gradient is high and the hydro potential is large, the distance will have to be smaller in view of

technical requirement of the hydro power. This could result in continuity in some cases. Similarly, for low gradients, the distance would be higher than the above norms. With the recommendation of IMG for environmental flow which will always be available and which would have travelled throughout the diverted stretch, any significant gaps and large distance may not be required. The IMG feels that a comprehensive environment impact study be done by IIT Consortium only as part of Ganga River Basin Management Plan, which will recommend the mandatory distance requirements of projects, keeping in mind the need for ecology, sustainability and power generation.

3.57 The IMG also considered the impact of hydro power projects on the environment in general and need to mitigate its effects. A number of recommendations on these issues have been made by both IIT-Roorkee and WII as mentioned above. Based on this, Model Norms should be suggested for implementing the hydro power projects (Annex-IX). These would need to be effectively monitored by environmental regulatory authorities to minimize the adverse impact of hydro power construction on the environment and ecology of the area.

3.58 The River Ganga has over a period of years suffered environmental degradation due to various factors. It will be important to maintain pristine river in some river segments of Alaknanda and Bhagirathi. It accordingly recommends that six rivers, including Nayar, Bal Ganga, Rishi Ganga, AssiGanga, Dhauli Ganga (upper reaches), Birahi Ganga and Bhyunder Ganga, should be kept in pristine form and developments along with measures for environment up gradation should be taken up. No new power projects should be taken up in these River Basins. In the IMG's assessment, this will mean about 400 MW of Power being not available to the States.

3.59 Pending a longer term perspective on the Ganga Basin Management Plan, following policy needs to be followed to implement the hydro power projects on the River Ganga on Bhagirathi and Alaknanda basins:

(i) No new hydro power projects be taken up beyond 69 projects already identified (Annex-VI-A – VI-D).

(ii) New hydro power projects may be permitted to be constructed with limitations as in Paras 3.52–3.54 above and giving priority to those projects already under construction.

(iii) New hydro power projects which are still under investigation or under development are not being proposed for implementation. However, two such projects can be considered and a view taken after technical assessment by the CEA.

Based on the above, projects at Annex-VI-D may need a review and decision till after long-term Ganga basin study by IIT Consortium.

3.60 The restrictions on setting up new hydro power projects will clearly adversely impact the development of the State of Uttarakhand. It is, therefore, important that their power needs are effectively met. For this purpose, the IMG suggests that natural gas be allotted to power developers (State or private) for setting up gas-based power plants. Considering the impact of e-flows and hydro power potential which may get delayed, it is suggested that gas allocations for the State for setting up power capacities should be to the extent of 2,000 MW. For this purpose, an allocation of about 6–8 MMSCMD will be adequate for a PLF of 65%–85%. While it is appreciated that the gas at this juncture is in short supply, given the importance of environmental issues, this allocation should have a very high priority.

Monitoring

3.61 One of the most critical areas for ensuring effective e-flow regime is a good monitoring system. As part of this process the IMG has recommended simple and easy to understand norms for e-flows round the year. Subsequently, however, these will need to be more fine-tuned after the Ganga River Basin Management Plan is finalized. The monitoring system should, therefore, cater to these requirements, too. As part of this process, an effective monitoring should, therefore, be installed. This should be done by the hydro power developers on a real time basis. It is possible with the development of IT to install such systems. Secondly, the information on this system should be available in the public domain for selected projects to ensure that the e-flows are consistent with the prescribed norms.

3.61.1 The second component of this exercise should be to appoint environmental monitors for major projects. This could be done at two levels: State Government and Central Government. The State monitors could visit the project more frequently while the Central monitor may have a larger number of projects with them. Their reports should be examined by the

State/ Central Environment Ministries for action as may be necessary for ensuring compliance. These monitors may be appointed based on an open advertisement, from which qualified engineers, management experts, environmental experts and other suitable person could be selected. The process should be somewhat similar to what is being used for monitoring of PMGSY scheme of the Central Government for construction of rural roads.

3.61.2 While the monitoring systems are installed and the two-pronged assessments are made based on the reports of the monitors and real time e-flow numbers, a strict mechanism for penalties and cancellation of projects for continued and serious violations should be put in place. The IMG feels that with regular and effective monitoring it may be possible to ensure an effective continued compliance of e-flow regime and substantially mitigate the impact of hydro power projects during construction.

Pristine River

3.62 The River Ganga has been a pristine River. Over a period of years, it has been used for irrigation, drinking water, and other purposes. The efforts to keep it in the pristine form have been minimal. The IMG felt that it will be necessary to take measures for ensuring that several parts of it which have so far not been impacted continue to be in the pristine form. Secondly, it consider necessary to take measures on pollution, particularly in the upper reaches and the two basins of Bhagirathi and Alaknanda. The IMG, therefore, recommends that six rivers, including Nayar, Bal Ganga River, Rishi Ganga, Assi Ganga, Dhauli Ganga(upper reaches), Bhirahi Ganga and Bhyunder Ganga rivers should be kept in pristine form no further hydro power developments should take place in this region. Further, environment upgradation should be taken up in these sub-basins extensively.

CHAPTER–IV
ToR(iii) – Dhari Devi Temple

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4.0 Srinagar hydro power project on Alaknanda River in PauriGarhwal District of Uttarakhand is being implemented. A temple, namely, Dhari Devi Temple, in upstream of the project is to come under submergence due to the project. The representations are made to the Government that religious sentiments will be irrevocably hurt if the temple is touched. It should be

accordingly preserved. In the light of these facts, following reference was made to the IMG:

> *"The matter may be referred to the Inter-Ministerial Group headed by Shri B.K. Chaturvedi constituted by the National Ganga River Basin Authority (NGRBA) for examining the questions of environmental flow requirements on Bhagirathi, Alaknanda and other tributaries of River Ganga. The Committee may kindly review the impacts of the Alaknanda Hydro Power Project on flow of the River and the issues related to the temple relocation".*

4.1 The IMG has considered the above issues and made Interim Recommendations on the issues of Dhari Devi Temple. The copy of the recommendations was sent to Ministry of Environment and Forests (Annex-XI). In respect of the other issues relating to flow of the River, necessary recommendations are made inChapter-III, where environmental flows are being recommended for different projects.

CHAPTER–V
ToR(iv) – Innovative Means of Abating Pollution in River Ganga

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5.0 The IMG has been requested to also consider the question of pollution in river Ganga and suggest innovative means to abate pollution. The Term of Reference received by the IMG (2nd November, 2012) indicates as follows:

> *"The IMG would also recommend on innovative means of abating pollution in river Ganga."*

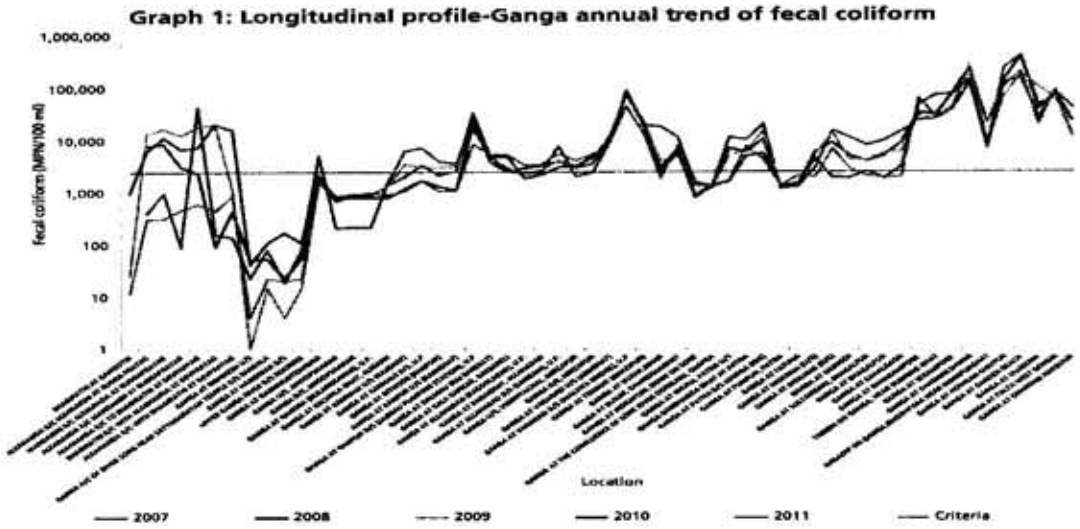
5.1 Objectives of Ganga Pollution Control Programmes and Status

5.1.1 The Government of India launched the Ganga Action Plan (GAP) way back in 1986. This Rs.462crore project's objective was to improve the water quality of this river to acceptable standards (defined as bathing water quality standards) by preventing pollution from reaching it. In other words, intercepting the sewage and treating it before discharge into the river. The programme selected 25 towns located along the river in Uttar Pradesh, Bihar and West Bengal. In 1993, the second phase (GAP-II) continued the programme, but included work on four tributaries of the Ganga – Yamuna, Gomti, Damodar and Mahanadi.

5.1.2 In August, 2009, the Union government re-launched the Ganga Action Plan with a reconstituted National Ganga River Basin Authority. Under the Notification dated 20th February, 2009, the government gave the river the status of a National River. The objective is to ensure abatement of pollution and conservation of the river. The key difference between the first Ganga Action Programme and now, is the recognition that the entire basin of the river has to be the basis of planning and implementation. It is not enough to plan for one city's pollution, without considering the impact of pollution on the downstream area. It is accepted that the plan for pollution control, must take into account the need for adequate water in the river – its ecological flow.

5.1.3 But the challenge of pollution remains grim. According to recent estimates of the CPCB, fecal coliform levels in the mainstream of the river – some 2,500 km – from Gangotri to Diamond Harbour – remain above the acceptable level in all stretches, other than its upper reaches. But even there, there are worrying signs as fecal coliform levels are increasingly even in places like RudraPrayag and Devprayag, suggesting that there is

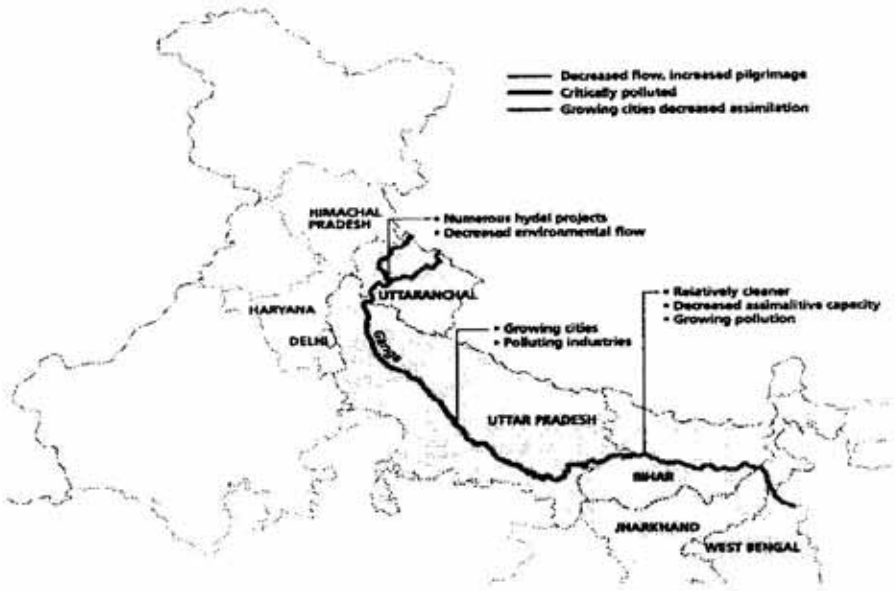
inadequate flow even in these highly oxygenated stretches for dilution (see graph 1).



Source: CPCB 2012-13: Overview of Ganga River Pollution

5.1.4 The pollution levels are a cause of worry in the hotspots – the mega and fast growing cities – along the river. According to CPCB monitoring data, BOD levels are high downstream of Haridwar; Kannauj; Kanpur and peak at Varanasi. But what is worrying is that in all stretches, pollution is getting worse. This is not surprising given that all along this heavily populated stretch, fresh water intake from the river is increasing. In this way, water is drawn for agriculture, industry and cities but what is returned is only waste.

5.1.4.1 The funds have been used to create infrastructure, without much attention on the use and efficacy of this hardware. But with all this done, the cities are still losing the battle with the amount of infrastructure that still has to be built to convey the sewage and then of course, to treat it and dispose it.



5.1.5 There are three problem areas that need to be addressed in order to find a comprehensive solution to Ganga pollution:

(i) The inadequate flow of water in the river, needed to dilute and assimilate waste;

(ii) The growing quantum of untreated sewage discharged from cities along the river;

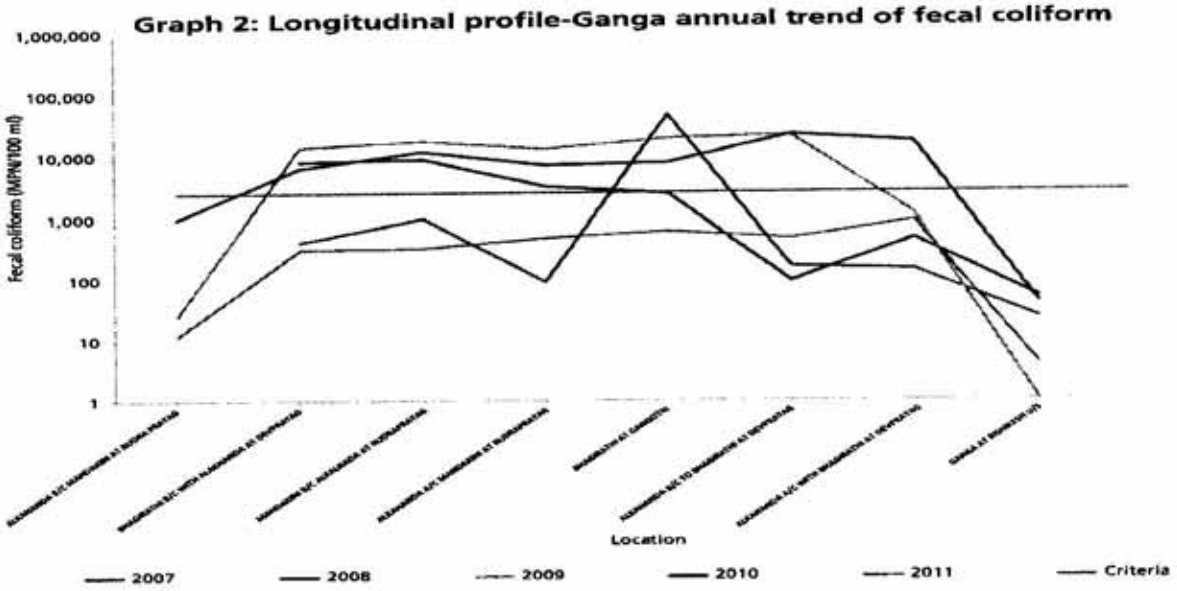
(iii) The lack of enforcement against point-source pollution from industries discharging waste into the river.

5.2 Ecological flow and need for dilution

5.2.1 Rivers have a self-cleansing ability, which allows for assimilation and treatment of biological waste. But in the current context, where withdrawal from the river is much higher than the discharge of waste, pollution is inevitable.

5.2.1.1 In the upper reaches of the river, where the oxygenating abilities of the river are the highest, there are growing signs of contamination. This suggests that even here, water withdrawal for hydroelectricity is endangering the health of the Ganga. (See graph 2).

Graph 2: Longitudinal profile-Ganga annual trend of fecal coliform



Source: CPCB 2012-13: Overview of Ganga River Pollution

5.2.2 As the river reaches the plains, the water withdrawal peaks for irrigation and drinking water. In the stretch of the river – from Rishikesh to Allahabad, during winter and summer months, there is almost no water. In other words, the river stops flowing. But wastewater flow does not ebb. The river, then receives only waste and turns into a sewer (see graph 3).

5.3 Estimates and Issues concerning Domestic Sewage

5.3.1 The non-point source pollution of sewage is clearly the major cause of contamination in the river. The 2012 CPCB reveals that 2723 mld of sewage is generated and 500 mld of industrial waste is generated in the mainstream of the river. The pollution from sewage is roughly 85 per cent.

5.3.2 **Growing Gap between Installed Capacity and Treatment:**The most recent assessment shows that there is a massive gap between the generation of domestic sewage and treatment capacity in the main stretch of the Ganga. The 2012 CPCB estimate shows that generation is 2723.30 mld, while treatment capacity lags behind at 1208.80 mld. It is important to compare this with the 2009 estimate (see table), which shows that even as we invest in sewage treatment capacity, the gap remains the same.

Table-15:CPCB estimates: 2009 and 2013:
Sewage Generation and Treatment Capacity Created in Ganga

	2009	2012
Sewage generation (mld)	2,638	2,723.30
Treatment capacity (mld)	1,174	1,208.80

Gap (mld)	1,464	1,514.50
% Gap: Treated vsUntreated	55	55

Source: CPCB 2009 and 2012

5.3.2.1 According to this estimate, over half the sewage goes untreated into the river or other water bodies. This without factoring the utilization of the sewage treatment capacity, which is known to be poor, because of factors ranging from lack of electricity to operate the plant, to the lack of sewage that reaches the plant for treatment. There are no recent estimates of the functioning of the individual treatment plants set up in the cities along the main Ganga stretch.

5.3.3 **Sewage generation is underestimated and so treatment capacity needed is higher**: The actual gap between generation and treatment is grossly underestimated. The problem lies in the manner in which pollution load is estimated and plan for sewage treatment. The estimation of sewage generation is based on the quantum of water supplied. The assumption is that 80% of the water supplied is returned as wastewater. But as cities do not know how much water is lost in distribution and how much groundwater is used in cities, the waste generation estimate could be widely off the mark.

5.3.3.1 This shows up in the most recent data collected by CPCB for Ganga. The difference between official estimates of sewage and actual measured discharge of wastewater into Ganga is 3,364 mld – 123% higher. The quality of wastewater will vary, but the estimation is that the BOD load is 1000 tonnes/ day in the main stream of the river.

Table-16: CPCB 2012: Difference between Estimates of Sewage Generation

	Sewage Generation (mld)	No. of Drains	Measured Flow (mld)	BOD Load (tonnes/day)	Gap (Untreated Waste)
Uttarakhand	61.30	14	440	42	95 %
Uttar Pradesh	937.40	45	3289	761	86%
Bihar	407.20	25	579	97	71%
West Bengal	1317.30	54	1779	97	69%
Ganga Mainstream	**2723.30**	**138**	**6087**	**999**	**80%**

5.3.4 **Sewage treatment plants are ineffective because of lack of connectivity**: The fact is that most cities along the Ganga mostly do not have any sewage conveyance systems. In Kanpur, Allahabad and Varanasi as much

as 70 to 85 per cent of the city does not have drainage. As a result of this, drains are not connected to the sewage treatment systems. What exist are open drains, which make their way through the crowded cities into the river. In Allahabad as many as 57 drains flow into the river, of which city officials say that 10 drains do not add to pollution as their discharge does not reach the river[1](see table). But the problem is that this untreated effluent adds to the pollution load by contaminating groundwater.

Table-17: Connectivity for Sewerage Treatment Plants: UP Cities

City	Area of City (ha)	Area with Sewerage(ha)	Unsewered area (ha)	Unsewered are (%)	Drains
Kanpur	25,810	7558	18,252	71	37
Allahabad	9,510	2013	7,397	78	57
Varanasi	10,058	1635	8,432	84	23

Source: UP government 2010, Presentation made at the meeting of the Executive Committee of the State Ganga River Conservation Authority, Lucknow, mimeo

5.3.4.1 Therefore, cities must address the underlying problem of lack of connectivity to sewage systems. This is not done and estimates are prepared, which suggest that cities – old and congested – will be able to lay underground sewage and intercept waste before it reaches the river over time. But experience shows that building a fully connected system across the old and new city does not happen. In this way, the sewage treatment plant is first built, but the drains to intercept sewage do not get completed and the river continues to be polluted.

5.3.5 **Cities lack funds to build and operate sewage treatment plants:**There are three key costs that need to be estimated during the planning of projects. One, the capital cost of building the treatment plant; two, cost of operating the plant; three cost of intercepting and treating sewage at the plant. Over and above this is the cost of maintaining the drainage network. These costs vary, depending of the quality of sewage generated and the effluent standards.

5.3.5.1 The capital costs of sewage treatment plants, in early 2000, ranged from Rs 30 Lakh/mld to Rs 60 lakh/mld. These costs have now climbed to roughly Rs 1-1.25 crore per mld, even without the cost of land being included in the project. The operation and maintenance costs, which primarily are electricity, chemicals and labour, are anywhere between Rs

[1]UP Government 2010, Presentation made at the meeting of the Executive Committee of the State Ganga River Conservation Authority, Lucknow, mimeo

0.60 to Rs 3 per kl, but can increase for tertiary treatment. In the current stretched system, where municipalities are strained to pay for basic services, running a sewage treatment plant becomes difficult.

5.3.5.2 What is difficult to estimate is the cost of constructing the sewage network, particularly as cities are not greenfield projects – the network needs to be built, or repaired and refurbished in already congested and built up areas. If projects under JNNURM-I are used for estimation then the average cost of a comprehensive sewage project, including collection network and treatment plant is anywhere between Rs 3.33-6.00 crore per mld, per capita costs would be Rs 4000. But this is widely considered to be an underestimation as the per capita costs are lower than even what is estimated for a comprehensive water supply scheme – Rs 4500 mld. This lack of clarity on the full costs of sewage networks and treatment is understandable because there have been few instances where such comprehensive sewage system have been built.

5.3.5.3 An analysis of NGRBA projects show that costs range from Rs 2.4 crore per mld in Begusarai to Rs 7.8 crore per mld in Deoprayag (see Table).

Table-18

WHAT SEWAGE PROJECTS COST, REAL-TIME

City	Project cost[1] (Rs crore)	STP capacity (MLD)	Cost (Rs crore/MLD)
Badrinath	11.88	3.00	3.9
Rudraprayag	12.62	3.00	4.2
Karanprayag	8.81	1.4	6.3
Deoprayag	10.93	1.4	7.8
Moradabad	279.91	58	4.8
Begusarai	65.40	27	2.4
Buxar	74.95	16	4.7
Hajipur	113.62	22	5.2
Munger	187.89	27	7.0

[1]Treatment plant and drainage and pumping stations, under National Ganga Basin Authority: sanctioned projects in 2010-2011
STP: Sewage treatment plant; MLD: million litres daily
Source: Anon 2011, 'List of approved projects under National Ganga River Basin Authority (NGRBA)', Ministry of Environment and Forests, *mimeo*

5.3.6 The payment for the system – capital and O&M – is a key issue between the Central and state governments. When it began, the programme was funded totally by the central government. But in early 1990, states were

asked to invest half the funds. Seven years later, there was a reversal in government policy and this decision was revoked in 1997. It was then agreed, once again, that the central government would spend 100% of the funds.

5.3.6.1 This arrangement did not last for long. In 2001, a new cost-sharing formula was evolved: 70% funded by Centre and 30% by States. Local bodies were expected to contribute one-third of the 30% share of the state. The operation and maintenance of the assets created under the programme was also the full responsibility of the state government and the local body. But this arrangement did not work, because of the poor financial state of the municipal bodies.

5.3.7 Under the National Mission Clean Ganga the payment formula has been re-visited. The Centre plans to build projects through a PPP route, which will require the concessionaire to design-build-operate the plants for 5 years. The Central government will bear the full costs of capital and maintenance for 5 years. After which the plant will be handed over to the state government and the assumption is that in 5 years, the funds will be available to run the plant. It is no clear how these assumptions have been made, given the poor financial state of local bodies in all states along the Ganga.

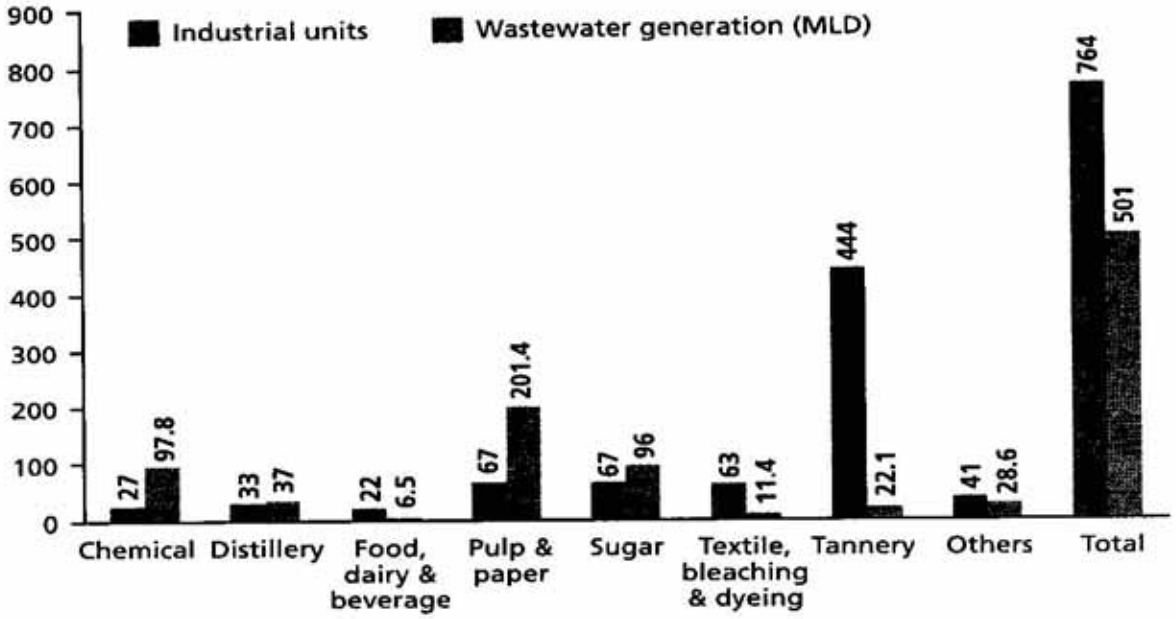
5.4 Industrial Pollution: Need for enforcement and technologies

5.4.1 Industrial pollution into the main Ganga has been an issue of attention and focus, but without much success. The problem is that many of the industries that discharge noxious chemical pollutants into the river are small scale, where technologies for treatment are inadequate or unaffordable.

5.4.2 The 2012 CPCB estimates are that roughly 500 mld of industrial discharge flows into the river from 764 industries. The bulk of these industries (90%) operate in the Uttar Pradesh stretch of the river.

5.4.3 The sector specific industrial wastewater generation from the bulk of the pollution comes from pulp and paper sector. Tanneries are the highest in number but have a lower wastewater generation in comparison. But the problem is that this waste is both concentrated in stretches of the river, where there is no dilution and assimilative capacity and is particularly toxic because of its high chemical load (see graph 4).

Graph 4: Sector specific industrial wastewater generation



Source: CPCB 2012-13: Overview of Ganga River Pollution

5.4.4 Over the past years, many efforts have been made to reduce the pollution impact of these industries, but with little success. As a result, the only real difference is seen when industries are given closure or stop work notices, as seen during the recent Kumbhmela. But as this is not a permanent solution, clearly more will need to be done to find ways to reduce the pollution from these industries, urgently and effectively.

5.5 KumbhMela Learning and Replication

5.5.1 MahaKumbh in Allahabad has perhaps no parallel in terms of the sheer size of the congregation – with over 100 million people visiting the city of the confluence of the Ganga and Yamuna in just 2 months. At this Kumbh, the Central and state government's efforts to combat pollution have had impact. These steps tell us that it is possible to reduce pollution in the Ganga and all other rivers of the country. The steps taken were as follows:

5.5.2 First, more water is allowed to flow in the river. The UP government mandated the irrigation department to release 2,500 cubic feet per second (cusec) (71 cubic metre per second/cumec) from January 1 until February 28 to ensure adequate depth and dilution of expected pollution loads at the bathing site in Allahabad. Additionally, two days before and one day after each of the 6-shahi snan days, the state irrigation departmentreleased 11.3 cumec, over and above the minimum stipulated flow.

5.5.3 Secondly, Allahabad broke convention in intercepting sewage from open drains to convey to treatment plants. Given that the city does not have underground sewage, the built plants did not ever work to capacity. This changed during the Kumbh as sewage was conveyed and treated, without underground drainage.

5.5.4 Thirdly, the city tried experiment with innovative ways of treating sewage—by using bio-remediation techniques. The preliminary reports suggest that this system is working but needs careful scrutiny and constant monitoring. During the project period the Uttar Pradesh Pollution Control Board (UPPCB) took 19 grab samples from the 39 drains, where bio-remediation was being tried. According to their data there was a 40% reduction in BOD using this technology. A report assessing this technology experiment is awaited, which will help review its effectiveness and options for the future.

5.5.5 Fourthly, the government took tough measures against polluting industries—mainly tanneries and distilleries—discharging into the river. In 2012, Central and state government's had already directed one-fifth of the tanneries in the upstream city of Kanpur, which were failing to meet the discharge norms to shut down. During the Kumbh a complete closure of all tanneries in the city was ordered.

5.6 Paradigm shift for innovative pollution control recommended by IMG

5.6.1 The Inter-Ministerial Group (IMG) recommends that controlling pollution in Ganga will require key paradigm shifts.

5.6.2 One, accept the fact that for cleaning rivers in India, where cost of pollution control treatment is unaffordable and unmanageable, the availability of water for dilution will be critical. The available standards for 'acceptable water quality' – BOD provide for a dilution factor of 10. This is why discharge standards for waterbodies are set at 30 for BOD, while bathing water quality standard is 3 BOD. The fact is that given the huge unmet challenge of wastewater treatment, the cost of attaining standards will be unaffordable. Instead, what should be provided is water inflow, to build the assimilative capacity in the river for self-cleansing waste.

5.6.3 It is essential to note that rivers without water are drains. It is also a fact that this release of additional water deprives farmers upstream of irrigation; cities and industries of water. The additional water for ecological flow becomes contested. But this flow must be mandated so that it comes

from the state government's own allocation of riparian water. The government then has a choice to build storage to collect monsoon water for dilution and supplementing availability for use in the State within its boundary or to 'release' water to rivers and make other choices, including small tanks for use in agriculture, drinking or industry. In other words, all users must be forced to plan for water needs based on what the river can spare, not what they can snatch.

5.6.4 Two, plans will accept that urban areas will not catch up with the infrastructure to build conventional sewage networks at the scale and pace needed for pollution control. Therefore, the conveyance of waste must be re-conceptualized and implemented at the time of planning treatment plants. This will then lead to innovative ideas for controlling pollution in drains – in situ – treatment of sewage as well as local treatment and reuse.

5.6.5 Also as the plans are premised on the acceptance of on non-availability of sewerage networks, discharge of treated effluent will be carefully reconsidered and designed. The treated effluent will not be 'mixed' with the untreated waste in drains. Instead all treated effluent will either be designed for reuse or it will be discharged directly into the river.

5.6.6 Three, plans will accept the need to design affordable water and sanitation solutions. Even if current situation requires Central government assistance for capital and operational costs, this is not tenable in the long run or for the scale of pollution control infrastructure that is required to clean the river. As long as states do not have the responsibility to build sewage treatment systems, they will have no incentive to release more water for pollution control. Therefore, there will be a clear conditionality in Central government funding, which is matched to the quantum of ecological flow released by the state in the river.

5.7 Specific Recommendations

(i) Ecological flow will be mandatory in all stretches of the river. The IMG has made recommendations on it elsewhere for hydro projects. In the upper stretches, where the requirement is for critical ecological functions as well as societal needs and water flow decline sharply in winter, it may be mandated at 50% for lean season flow and 20%–30% for other seasons. In the urbanized stretches, it will mandated based on the quantum of wastewater released in the river and calculated using a factor of 10 for dilution.

(ii) All Central government funding under the National Mission for Clean Ganga will be conditional on the quantum of ecological flow made available by the state.

(iii) Phase-I of the project for controlling pollution in the next five years for this region should be taken up and necessary resources for this need to be provided. Later, this requirement can be posed to the Fourteenth Finance Commission.

(iv) All proposals submitted by state governments to the National Mission for Clean Ganga for pollution control will be evaluated to ensure conformity with the paradigm shift recommended by IMG.

(v) The JNNURM-II funding for all water and sanitation projects in the cities on the Ganga will also be in conformity with the paradigm shift recommended by IMG.

(vi) The National Mission for Clean Ganga will launch a specific programme to incentivize the use of innovative bioremediation and in-situ drain treatment. The programme will monitor performance and cost effectiveness of the different technologies in different cities. This experience will be used to design technical bid and tender conditions for these technologies to compete in pollution control efforts.

(vii) The proposal for Ganga cleaning at Varanasi as conceptualized by SankatMochan Foundation, which is based on non-electrical gravity system, will be implemented as a special pilot project of the National Mission for Clean Ganga. Based on the experience of the pilot project, further action can be taken.

(viii) The innovative technologies used for pollution control in industrial units will be incentivized through a financial package. At the same time there will be stringent enforcement with standards.

(ix) The MoEF Office Memorandum dated 26th April, 2011 on Corporate Environment Responsibility will be made applicable to all industrial units discharging into the Ganga, which will require violations to be reported to the Board and made public on the website of the company.

(x) The Maharashtra and Tamil Nadu Governments'Notifications on minimum distance requirements for siting of industrial units near rivers and waterbodies will be used as models for similar steps on the

Ganga basin. The requirement for zero-discharge, as stipulated by Maharashtra will be examined for replication in Ganga basin.

Abbreviations

AHEC	Alternate Hydro Energy Centre, IIT-Roorkee
BBM	Building Block Method
CEA	Central Electricity Authority, Govt. of India
CWC	Central Water Commission, Govt.of India
DRIFT	Downstream Response to Imposed Flow Transformation
e-Flows	Environmental Flows
EFR	Environmental Flow Requirement
EMC	Environmental Management Category/Class
EMC–HMD	Environment Management Class – Hydraulic Mean Depth
EWR	Environmental Water Required
FDC	Flow Duration Curve
IFIM	In-stream Flow Incremental Methodology
IITR	Indian Institute of Technology, Roorkee
IMG	Inter–Ministerial Group
MAF	Mean Annual Flow
MAR	Mean Annual Run-off
MEF	Minimum Environmental Flows
MMSCMD	Million Metric Standard Cubic Meter Per Day
MOEF	Ministry of Environment and Forests
MSF	Mean Seasonal flow
NGRBA	National Ganga River Basin Authority
NMCG	National Mission for Clean Ganga
PPA	Power Purchase Agreement
TEC	Techno Economic Clearance
WII	Wild Life Institute of India, Dehradun

5.

References:

1. Kumar, Arun et.al.; (2011) Study on Assessment of Cumulative Impact of Hydropower Projects in Alaknanda–Bhagirathi Basins up to Devprayag, Alternate Hydro Energy Centre, IIT-Roorkee, Roorkee, Vol.Ipp 388, Vol.IIpp 292 and Executive Summary pp 31.

2. Rajvanshi, Ashaet.al.; (2012) Assessment of Cumulative Impacts of Hydroelectric Projects on Aquatic and Terrestrial Biodiversity in Alaknanda and Bhagirathi Basins, Uttarakhand. Wildlife Institute of India, Dehradun Technical Report. Pp 203 plus Appendices.

3. O'Keefee Jay et.al.; (2012), Assessment of Environmental Flows for the Upper Ganga Basin, World Wide Fund – India, Delhi.

List of Persons whom the IMG/Chairman met to ascertain their Views

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(i) Prof. Vinod Tare, Coordinator, IIT Consortium made a Presentation on 'Preparation of Ganga River Basin Management Plan' before the Inter-Ministerial Group on 26th July, 2012.

(ii) Shri Paritosh Tyagi, former Chairman, Central Pollution Control Board expressed his views before the Inter-Ministerial Group on 14th August, 2012. He has also given his views in writing.

(iii) Sri Ravi Singh, CEO and Secretary, WWF-India and his colleagues made a presentation on the 'Assessment of Environmental Flows for the Upper Ganga Basin' before the Inter-Ministerial Group on 14th August, 2012.

(iv) The President and Secretary of Aadyashakti Maa Dhari Devi Pujari Nyas expressed their views before the Committee on 14th August, 2012. They have also given their views in writing through a letter.

(v) Shri P.V. Prasanna Reddy, CEO, Alaknanda Hydropower Company and his colleagues made a detailed presentation on Dhari Devi Temple issues before the Inter-Ministerial Group on 14th August, 2012.

(vi) Shri Swami Gyan Swarup Sanand (formerly Prof. G.D. Aggarwal). He was the first Member-Secretary of the Government of India's Central Pollution Control Board. He was formerly Head of the Department of Civil & Environmental Engineering at IIT Kanpur. Honorary Professor of Environmental Sciences at the Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot, Madhya Pradesh and renowned environmental activist.
Shri Swami Gyan Swarup Sanand had a meeting with the Chairman on 17th September 2012 and expressed his views to the Chairman.

(vii) Acharya Pramod Krishnam, Convener, Ganga Mukti Sangram alongwith a group of Swami's had a meeting with the Chairman on 24th August, 2012 and expressed their views.

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(viii) Ms. Mallika Bhanot and others met with Chairman and made a presentation on Save Ganga on 24th August, 2012 in the presence of Shri Revati Raman Singh, MP (Lok Sabha) and Shri Rajendra Agrawal, MP (Lok Sabha) on 24th August, 2012.

(ix) Shri Bharat Jhunjhunwala, former Professor of Economics at the Indian Institute of Management, Bangalore and environmental activist had a meeting with the Chairman on 27th August, 2012 and his views were heard.

(x) Prof. Avdhesh Kaushal, former Member of the Doon Valley Board and faculty member of the Lal Bahadur Shastri National Academy of Administration, Mussoorie and well known environmental activist will be giving his views to the Chairman on 16th October, 2012.

(xi) Prof. A.N. Purohit, former Vice-Chancellor of H.N.B. Garhwal University, Srinagar Garhwal, Director of High Altitude Plant Physiology Research Centre of H.N.B. Garhwal University. He was also the Director of G.B. Pant Institute of Himalayan Environment and Development from 1990 to 1995 will be giving his views to the Chairman on 16th October 2012.

Annexure-X

मुझे स्वीकार नहीं

1. अंतरमंत्रालयी समूह का गठन का उद्देश्य था - "गंगा जी का पर्यावरणीय प्रवाह देना।" रिपोर्ट ~~अविरल~~ पर्यावरणीय प्रवाह सुनिश्चित करने की बजाय बांधों के बने को आगे बढ़ाने की मंशा वाली लिखी हुई है। अतः यह हमें स्वीकार्य नहीं है।

1.क) समूह ने चर्चा सर्दियों में न्यूनतम 15% तथा गर्मी में 50% प्रवाह की थी। रिपोर्ट सर्दी में 30% तथा गर्मी में न्यूनतम 20% की बात करती है। अतः नामंजूर करते हैं

1.ख) गंगाजी की ऊपरी धाराओं पर निर्माणाधीन, स्वीकृत व प्रस्तावित बांधों को रद्द करने की बात, ~~मैं~~ वर्ष 2012 में गंगाजी का पक्ष रखते हुए उन्हें रद्द करने की मांग की। यह रिपोर्ट इसके विपरीत मंशा रखती है। अतः नामंजूर

2. किसी भी शोधित-अशोधित अवजल का गंगाजी में ~~मैं~~ मुझे मंजूर नहीं।

3. गंगाजी के जल, भूमि, वनस्पति, प्राणीजगत, महत्व व गुणों का व्यावसायीकरण मुझे मंजूर नहीं।

4. धारी देवी एक शक्तिपीठ है। इसकी आस्था का केंद्र। इसका विस्थापन मंजूर नहीं।

राजेंद्र सिंह
(सदस्य, अंतरमंत्रालयी समूह - गंगा)
जल बिरादरी, नई दिल्ली
19.03.2013

ENVIRONMENT PROTECTION GUIDELINES

IX

Guidelines for Hydropower Projects

MoEF, State Governments and Hydro Project Developers should follow the following guidelines for hydropower project development.

Geology and Seismology

1 At the planning and execution stages of hydropower projects, detailed geo-scientific and siesmotectonic studies should be carried out to identify problematic areas of earth mass failure. Site-specific, cost effective measures such as plantation on slope, re-grading of slope, shotcreting, grouting, anchoring, retaining and supporting walls, etc. along with proper drainage (surface and subsurface) measures to avoid saturation of earth mass, should be taken up.

Soil Erosion and Sedimentation

2 Hill slopes around reservoir are likely to be affected by discrete, isolated shallow landslides in the initial stages of operation, a no-activity buffer zone above the Maximum Reservoir Level (MRL) along the rim of the reservoir may be created to avoid untoward incidences. The width of this zone may vary from a few meters to about 50m, depending on topography, lithology and structural attributes of the area. The zone should be monitored for change in hill slope of the rim area.

3 Catchment Area Treatment Plans are prepared for all major projects. However, their effective implementation is crucial. Their implementation needs to be monitored and its effectiveness ensured. Reforestation or riparian planting in degraded sites of the regulated river should be undertaken for stabilizing banks to reduce peak temperatures and source of particulate matter which could entrain into river bed sediments during bed load movements.

Hydrological

4 Environmental flows should be released in every project keeping in view hydrological requirements of organisms, especially during the dry season. Environmental flows should be set at levels that are compatible with maintaining integrity of the aquatic environment downstream.

5 Hydrological variability is important for maintaining health of fluvial ecosystems. Natural variation occurs during flooding, and the period of snow melting, which determine biological aspects of the ecosystem, such as habitat and species distribution, fish migration and spawning and various stages of life cycles of benthic aquatic macro-invertebrates. To mimic natural variations in flow regime, required variability in environmental flows should be maintained.

6 Regular flushing of the river bed should be carried out so that the sediment deposited on the bed at the barrage is removed and benthic condition for fish eggs is improved.

Environment and Biodiversity

7 Fish passes may be made an integral part of hydropower projects. Regular monitoring for their effectiveness be done by project developers.

8 Regular biological monitoring should be undertaken at the project level under the guidance of expert environmental biologist, for assessing the level of environmental degradation with the help of potential bio indicators by project developers. The potential indicators for assessing the health of ecosystem are recommended as members of macroinvertebrates (Ephemeroptera and Trichoptera), hyporheic organisms (meiofauna), fish (Mahseer and other migratory fish) and a few aquatic periphyton/phytoplankton and macrophytes. This biological monitoring is required for adaptive management.

Religious and Social

9 Project developers should ensure that a fair deal is offered to the affected areas and inhabitants and that the promises made, such as those relating to jobs, minimum water discharge, etc, are adhered to in 'letter and spirit'.

10 Sites of religious and cultural importance at the local level should be clearly identified and efforts should be made to minimize adverse effects on them on account of the hydropower projects.

11 Bathing ponds (kunds) may be constructed adjacent to rivers at places of religious and social importance. These should be connected to the river so that there is continuous flow of fresh water and adequate depth of water is present.

12 Water requirement at places of religious importance, on normal days and different festivals should be ascertained and the needed quantity of water should be released.

Construction

13 It is necessary to plan human settlements that will arise as a result of HPs and the growth of service industry such as tourism, banking, business etc. Needless to say that safe disposal of solid and liquid waste should have the highest priority. For temporary shelters needed during the construction phase, arrangements for safe disposal of solid and liquid waste should be made and monitored.

14 Suitable dumping sites for disposal of muck generated during construction should be identified well in advance. The dumped muck should be protected by a retaining wall at the toe up to Highest Flood Level (HFL). This is equally necessary for small hydropower projects.

15 Construction gives rise to large quantities of dust. During construction water should be regularly sprinkled on roads so that it does not become airborne. Water should also be sprinkled on crushing and batching plants. Construction should be rescheduled, where necessary, to avoid prolonging the duration of impact linked to construction phase.

Monitoring

16 Project developers of large scale hydropower projects should monitor prescribed parameters of the project and send periodical reports to the state and MoEF. It shall be desirable to monitor, among others, the following parameters:

- Aquatic biodiversity in the reservoir and in the river beyond the reservoir,
- Landslides near the rim of the reservoir,
- Water quality at different depths and at different parts of the reservoir,
- Impact on water table and springs in the catchment upstream of the project,
- Landslides downstream of the dam,
- Inflow and flow (discharge) in the diverted length of the river,
- Any springs that may have dried up due to hydropower project.

17 Online flow monitoring devices with display facilities to show inflow and discharge may be installed by each project developer.

18 There should be a State Environmental Monitoring Mechanism to formulate a monitoring programme for all projects to generate data so that Adaptive Management can be practiced. Monitoring is done with the association of representatives of project affected civil society.

19 There should be a depository at the state level where all the data generated in relation to the project should be deposited and it should be available to any interested person and preferably, also on the internet.

20 Since aquatic biodiversity is closely linked to water quality, Central Pollution Control Board (CPCB) may institute water quality monitoring studies to determine the impact of hydro power project.

21 The detailed Remote Sensing and Geographical Information Systems (RS & GIS) studies be carried out at periodic intervals (say every 3 to 5 years) to monitor changes and to take appropriate steps to mitigate any future adverse effects of hydropower projects in the area by the project developers.

WWF Recommendations

Chapter 5 RECOMMENDED FLOWS FOR THE UPPER GANGA: PROCESS AND RESULTS

5.1 BACKGROUND

The preceding chapters have described the background to the study, the choice of EFA methodology, the river zonation and choice of sites, the information that was collected to assess flows, the present state and the desired future state of the river at each site.

This chapter summarises the flows which the specialist groups recommended would be required in order to maintain or restore the Upper Ganga River to the state which would achieve the environmental objectives set for the river sections, as described in Chapter 4. It also describes the process by which the flows were arrived at.

Whilst the recommendations in this Chapter are based on the best available information at the time of the study, the recommended E-Flows values here are based on simulated data, due to the lack of access to observed flow records.

5.2 THE PROCESS

The goal of the EFA process is to achieve a consensus among all the specialist groups on a modified flow regime that will meet the requirements of all species, components and processes in the river during different seasons at particular Environmental management classes (EMCs) during the setting of the desired future state. The recommended flows are based on the flow indicators that were chosen by each specialist group during their assessment.

In each case, the flow-related parameters are converted to discharge values using hydraulic relationships for cross-sections at each site. The values based on various motivations were discussed and deliberated by the team to arrive at the E-Flows value (e.g. a maintenance flow in the driest month of the year, or a high flow in the wettest, etc.). The feasibility of these flows is evaluated by a hydrologist to ensure that the river can in fact produce them within the bounds of its normal functioning. The concept of maintenance flows is explained in Box 5.1 below.

The E-flows setting process that was undertaken for each site at the Ganga EFA workshop is described in more detail below.

5.2.1 STEP 1 Presentation of hydrology and hydraulics cross sections for each zone

The role of the hydrologists and hydraulics specialists was to provide the other specialist groups with information about the natural flow patterns in the river, the seasonal and year-to-year variability, and the relationship of the different flows to depths, widths and velocities in different parts of the river, so that the ecologists, geomorphologists, sociologists, etc. could relate their habitat, activity, and process requirements to flows (in cubic metres per second), which would achieve the pre-set objectives.

- The hydrology group presented a summary of the natural flow regime at each site, illustrating intra-annual and inter-annual flow variability, and flow conditions throughout a normal (maintenance) year and a "drought" year. The driest month (January) and wettest month (August) were identified.

Box 5.1: Maintenance flows

Maintenance Flows are for "normal" years, neither very wet nor very dry, when all the ecological functions and processes (fish breeding, invertebrates emerging, floodplain wetlands full, sediment transported, etc.) can be expected to be working properly.

For river Ganga, it has been estimated that the Maintenance Flows would be equaled or exceeded 70 years out of 100. However flows would be lower for 30 years out of 100 or in other words, 70% probability on the flow duration curve. Drought flows are the lowest that would still provide some habitat and survival conditions (i.e. fish would survive but may not breed that year). So, for long-term E-Flows, the water volume required would be at maintenance recommendations or higher for 70% of the time, and between drought and maintenance for 30% of the time.

- The hydraulics group presented and explained the surveyed cross-sections, which illustrated the relationships between river depth, width and flow velocity for any discharge.

5.2.2 STEP 2 Flow motivations by working groups

At each site, "maintenance" years were addressed first, starting with an estimation of the low flows for the driest month (January), followed by estimation of the low flows in the wettest month (August). Next, the high flow requirements for the driest and wettest months were estimated.

The process was then repeated at each site for the "drought" years.

To estimate each such "building block" (E-Flow) above, each specialist group first considered the river characteristics (depth, width, current velocities, riparian and floodplain inundation, substrate type) necessary to achieve the pre-set environmental objectives.

This information was collated by each specialist group using a *flow motivation form* that summarises the depth, width or flow velocity required to achieve the objectives relevant to the group for a particular month. The specialist groups explained (or motivated) the rationale behind the values they recommended, as well as the consequences of *not* providing this flow on their respective component. The recommendations were based on the *flow indicators selected* by each specialist group:

- **The fluvial geomorphology group** concentrated on the flow velocities and depths required to move, sort and deposit different sizes of sediment, so as maintain or restore channel size and other important channel features (such as multiple channels and bars).
- **The biodiversity group** concentrated on the habitat characteristics required for important flow-dependent species such as the river dolphin, selected fish species, macro-invertebrates and floodplain vegetation. These characteristics included the depth, flow velocity, river width, and substrate types required for different parts of their lifecycle.
- **The livelihood group** focused on depth, water quality and river width required to maintain certain livelihood activities (such as ferrying or rafting).
- **The spiritual/cultural group** had to ascertain the depth and water quality issues that would affect religious and cultural activities (such as ritual bathing).
- **The water quality group** responded to the recommendations of the other groups, estimating the effects that the recommended flows would have in mitigating pollution or other water quality issues.

The hydraulics group converted this information into flows, using the modeled hydraulic characteristics from the surveyed cross-sections.

An example of a flow motivation form is shown in Box 5.2. All the flow motivation forms are attached in Annexure – 5.

Box 5.2: A flow motivation form filled by the fluvial geomorphology group

FLOW MOTIVATION FORMS

River: Ganga **Date:** 11-05-10 **Site:** Kaudiyala

Specialist: Geomorphology **Month:** January

Low flow or flood? Low Flow (MAINTENANCE Year)

Discharge: 400 m^3/s **Depth:** 9.5 m **Average velocity:** 0.64 m/s

Reasons for recommending this flow:
At low flow, maintenance of longitudinal connectivity will be critical. Otherwise, the geomorphology is in good condition. According to the cross section (CS-3), plus the plan form parameters in longitudinal direction and field observation, the longitudinal connectivity will be lost at water level lower than 397 meters above mean sea level (depth 9.5 m), while water level at 404 meters above mean sea level will be good to maintain lateral connectivity. Since discharge of 1400 m^3/s at 404 meters above mean sea level is unrealistic, lateral connectivity cannot be maintained at low flows. Hence, the final recommendation at low flow is 9.5 m of flow depth (400 m^3/s discharge).

Consequences of not providing this flow:
Flow less than 400 m^3/s (corresponds to 9.5 m flow depth) will break the longitudinal connectivity and will be critical for movement of biota. A water level of less than 404 m amsl will break the interaction between channel and adjoining bars which has implications for nutrient supply and habitat conditions as well as the general functioning of the river system.

5.2.3 STEP 3 Calculating critical flows

Based on the flow motivations by different working groups, the critical flows for each site were identified. The largest of the flows recommended by the specialist groups was considered to be a critical flow for each "building block". The assumption was that critical flows would satisfy the requirements of all specialist groups. For example:

- At Kaudiyala, the January maintenance flow was determined by fluvial geomorphology, whereas the August maintenance flow was determined by biodiversity requirements.
- At Kachla Ghat and Bithoor, cultural and spiritual needs drove the recommendations for the August flows (both during maintenance and drought years).
- Almost half of the critical flow recommendations were influenced by the biodiversity requirements as these were usually higher than the other requirements.

5.2.4 STEP 4 Calculating annual E-Flow requirements

Using the final critical flow recommendations for the driest and wettest months under maintenance and drought conditions (Table 5.1 – 5.12), the E-Flow values were then interpolated by the hydrologist for the remaining months of the year. The monthly flow volumes for each month of the year for low-flow and high-flow components were then calculated. Finally, the total annual volume of E-Flows for maintenance and drought years were calculated and expressed as a percentage of natural and/or present-day mean annual runoff (MAR[1]).

Although the recommended Environmental Flows constitute a significant proportion of the total flow in the river, it is important to recognise that the water required during the monsoon months (July to September) forms the bulk of the annual requirement, and is presently unused for consumptive purposes: no flow restoration is necessary to maintain these flows. It is mainly during the dry season (January to June and November and December) that flow restoration is required, because the present flows in the river are significantly lower than the recommended E-Flows. The annual volume of water required for this restoration constitutes a much smaller proportion of the MAR, therefore requiring smaller adjustments to present water allocations to be met.

5.3. THE RESULTS

The results of the Ganga EFA, in terms of recommended E-Flows for each of the zones/sites together with their motivations, and a comparison with the available natural and present day flows are detailed in the following section.

E-Flows are actually a *pattern* of flows: In addition to annual MAR percentages, the monthly and seasonal flow requirements, depicted on the graphs, should be noted.

[1] Mean Annual Runoff: The average volume of water flowing through that site in the river in one year

5.3.1 Zone 1: Site: Kaudiyala

Figures 5.1 and 5.2 depict the monthly E-Flows recommendations at Kaudiyala in Zone 1, for the low and high flows for maintenance and drought years, respectively. The Naturalised Flows[2] are also plotted.
The E-Flows recommendations at this site were calculated as 72% of the natural Mean Annual Runoff (MAR) during normal years, and 44% during drought years.

The present day flows were not available for this site, hence could not be plotted.

Figure 5.1: Recommended E-Flows requirement for maintenance years for the Kaudiyala site in Zone 1

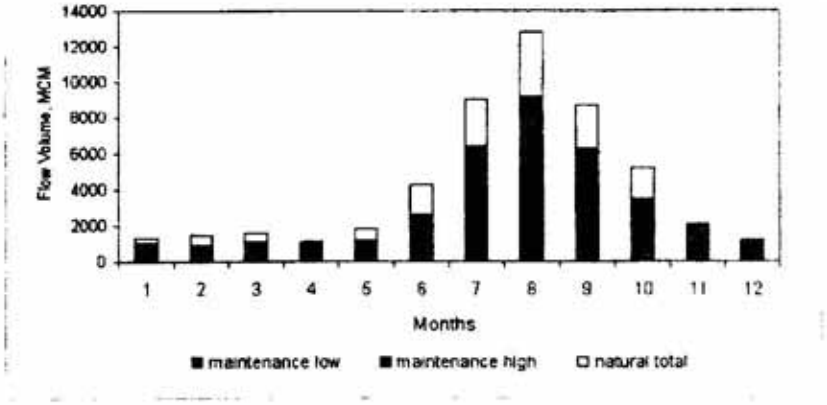
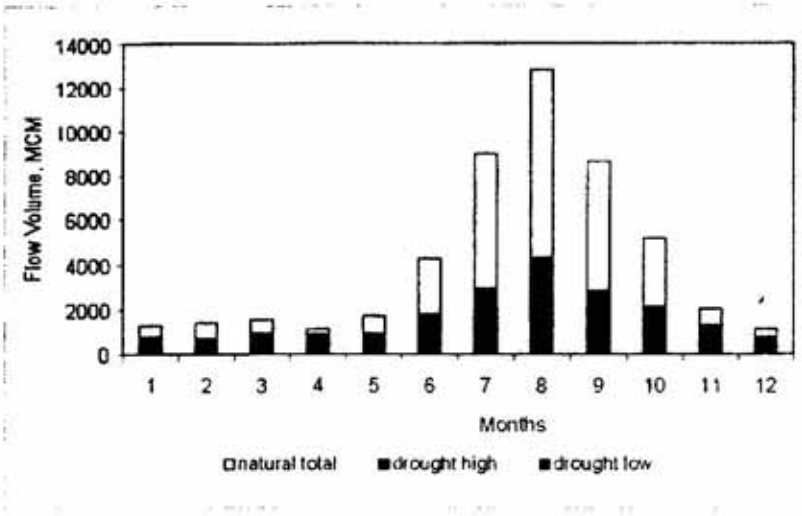


Figure 5.2: Recommended E-Flows requirement for drought years for the Kaudiyala site



Tables 5.1 to 5.4 provide the data on which the above graphs are based, summarising the critical flow requirements for the driest and wettest months in maintenance and drought years at Kaudiyala, and providing the specialists' motivations for each flow.

[2] **Naturalised Flows:** The flows that would have occurred historically, in the absence of reservoirs, water supply diversions and return flows and other types of water management activities that are reflected in the present day input dataset

Table 5.1: Critical flow requirements and their motivations at Kaudiyala for January in a maintenance year

Speciality	Critical Flows (m^3/s)	Depth (m)	Average Velocity (m/s)
Biodiversity	285	8	0.5
This is highest production period after the floods. The river is recharged due to various organic and inorganic inputs from the catchment. The suggested flow is therefore a basic requirement. An average current velocity of 0.5 m/sec is suggested to maintain the oxygen rich water to which the biodiversity has adapted.			
Fluvial Geomorphology	400	9.5	0.64
At low flow, maintenance of longitudinal connectivity will be critical. According to the cross section, plan form parameters in the longitudinal direction, and field observation, longitudinal connectivity will be lost at a flow lower than 397 m amsl (depth 9.5 m), while a water level of 404 m amsl will be sufficient to maintain lateral connectivity. Since a discharge of 1400 m^3/s at 404 m amsl is unrealistic, lateral connectivity cannot be maintained at low flows. The final recommendation at low flow is therefore 9.5 m of flow depth (400 m^3/s discharge).			
Cultural and Spiritual	386	0.5	NA
An extra flow of ~37.6 m^3/s is needed at Rishikesh in January to satisfy spiritual needs. This additional water will allow holy bathing in the Ganga within 2 m of the *ghats* and provide a depth of 0.5 m at the lowest step on this *ghat*. Assuming that between Kaudiyala and Rishikesh the volume of flow is the same except for a small addition of 1.6 m^3/s from river Nayar and other streams, an additional 36 m^3/s is expected at Rishikesh. The minimum amount of water to satisfy spiritual needs is present when "boulders in the middle of the river should not be visible from the *ghats*." If the bed is visible, it means that the river has shrunk to an unacceptable level and is not the imagined mighty river. This volume of water also prevents decomposing offerings, flowers and other debris from becoming visible.			
Livelihoods	305	8.7	0.58
The recommended flow is close to the present flow conditions since the adventure tourists and Service Providers (white water rafters and beach campers) are satisfied with this flow.			
Recommended Flow: 400 m^3/s (Fluvial Geomorphology)			

Table 5.2: Critical flow requirements and their motivations at Kaudiyala for August in a maintenance year

Speciality	Critical Flows (m^3/s)	Depth (m)	Average Velocity (m/s)
Biodiversity	3250	21.05	1.15
The flood/high-flow is required to bring the nutrients needed by algae and riparian vegetation, and to deposit fine sand along the banks. It is also necessary for the mass emergence of macro-invertebrates. The constant water temperature is necessary for their proper metabolism during emergence. The high flood level connects the spawning grounds for *Mahseer* and other fish species. For fish which lay eggs during this season, the high oxygen level is necessary for hatching, particularly for the Snow Trout and Catfish. To fulfill this requirement, the river should span up to 240 m in width, with a depth of 21.05 m.			
Fluvial Geomorphology	1494	18.37	0.91
Lateral connectivity should be established at least once in a year; hence the lateral bars should be submerged. The water should also touch the banks so that the riparian zones and vegetation are inundated. However, prolonged high flows are not desirable as they may erode the bars, modifying the channel morphology. Compared to low flow, the recommended flow represents a 3.7 times increase in discharge, a doubling of width, and 1.5 times increase in hydraulic radius. This multiplies the unit stream power by ~2.5. Such variability is acceptable for the functioning of the river ecosystem.			
Cultural and Spiritual	295-300	1 m additional at *ghats*	1.6
Based on what respondents recalled about conditions about 40-50 years ago, and on what they imagine a resplendent Ganga should look like in the monsoon season, it is estimated that an extra depth of 1m is required so that people can bathe conveniently at the first platform of the *ghats*. This amounts to an additional flow of 315 m^3/s. Transposing this flow to Kaudiyala requires accounting for additional in-stream flows from small streams and river Nayar, estimated at about 15-50 m^3/s			
Livelihoods			
Adventure sports are not supposed to be carried out during August, because of the prevailing high water currents and resulting high risk.			
Recommended Flows: 3250 m³/s (Biodiversity)			

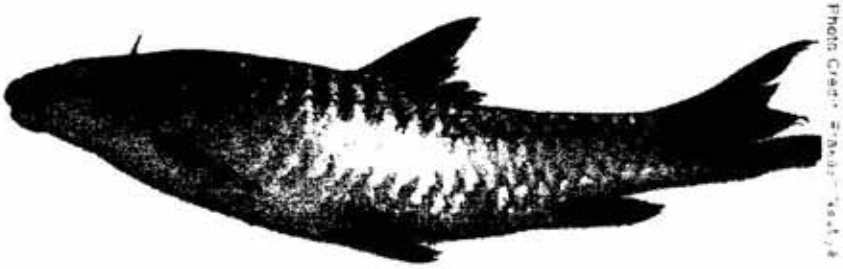


Figure 5.3: Mahseer, an endangered fish species, loosing migration routes due to loss of connectivity

Table 5.3: Critical flow requirements and their motivations at Kaudiyala for January in a drought year

Speciality	Critical Flows (m^3/s)	Depth (m)	Average Velocity (m/s)
Biodiversity	200	7.27	0.5
This is the period of maximum productivity in the river; hence the maximum substrate area should be submerged for maintaining minimum productivity in the river to sustain the freshly recruited macro-invertebrates and fish population. The recommended flow in the river is also necessary to hydrate the banks enough for the survival of riparian grasses and sedges present in this zone.			
Fluvial Geomorphology	33.3	3.4	0.32
Allowing for the monsoonal variability, which accounts for about 6 m water depth variation, the level for the driest drought year was analysed. Mostly, there will be reduced or no longitudinal connectivity, but some biota will survive in the disconnected pools.			
Cultural and Spiritual	NA	NA	NA
The respondents believe that the present flow conditions in January are the low flows for a drought year. The river barely touches the *ghats* at Rishikesh and there is no longitudinal connectivity along the *ghats*. This means that people have to enter the river even to pour some water over their heads: there is not enough water for them to have a ritual bath.			
Livelihoods	290	5.26	0.57
The Threshold of Potential Concern (TPC) for adventure sports (from a livelihood point of view) is 290 m^3/sec, because there is a need for a certain water depth and velocity in order to carry out this activity.			
Recommended Flows: 290 m^3/s (Livelihoods)			

Photo Credit: Sandeep Behera / WWF-India

Figure 5.4: Ganga basin is home to rich aquatic biodiversity with several species of flamingoes, pelicans etc. Shown here is a snapshot of the rich biodiversity in National Chambal Sanctuary

Table 5.4: Critical flow requirements and their motivations at Kaudiyala for August in a drought year

Speciality	Critical Flows (m^3/s)	Depth (m)	Average Velocity (m/s)
Biodiversity	1469	16.28	0.91
This flow is required to maintain ecosystem integrity in terms of adequate nutrient replenishment for the upcoming season.			
This flow is necessary for preventing the invasion of mesophytic shrubs and trees in the riparian zone.			
The migratory passage of the *mahseer* and other fish, as well as otters can be maintained at this flow. It would also offer adequate food for otters			
Fluvial Geomorphology	400	9.5	0.65
In a drought year, the wettest flow should be the equivalent of the driest flow of the normal year. At this flow, longitudinal connectivity will be maintained, which will allow free migration of biota, and movement of nutrients and sediment.			
Cultural and Spiritual	1056	2-2.5	1.5
The current low flows in August are considered adequate for a drought year. Here, water touches the 1st platform (2-2.5m above the bed level) of the *ghat*.			
The quantum of water required for this period is derived by adding the required flow from the bottom of the ghats to the 1st platform, and the existing flow in January for a maintenance year			
Livelihoods			
Adventure sports are not supposed to be carried out in August because of the prevailing high water currents and resulting high risk.			
Recommended Flows: 1469 m^3/s (Biodiversity)			

5.3.2 Zone 3: Site: Kachla Ghat

Figures 5.3 and 5.4 depict the final monthly E-Flows recommendations, naturalised flows, and simulated present day flows for Zone 3 (Kachla Ghat).

The E-Flows recommendations were calculated as 45% of the natural MAR during normal years and 18% during drought years.

The present day flows are lower than the environmental requirements in the dry season months. During the wet season, the E-Flows requirements are met by present day flows.

Table: Data Request for Preparation of GRBEMP by IITs: Status Before and After IMG

S. No.	Data: Major Head	Data: Sub Head	Available With	Status Before IMG	Status After IMG
01	Water Resources Projects: Reservoir Based	Location, Date of Operation of Reservoir, Catchment Area during Gross Storage Capacity (GSC), GSC, Catchment Area during Live Storage Capacity (LSC), LSC, Initial Reservoir Capacity, Initial Sediment Concentration in the Reservoir, Equilibrium Sediment Concentration in the Reservoir, Median Particle Size of Sediment, Hydraulic Conductivity at the Reservoir Bottom, Lake Evaporation Coefficient, Reservoir Daily Inflow and Outflow File	Irrigation Department of the Concerned States	Request Letters with format sent to concerned officers, Request Letters also sent by MOEF, IIT Team Members have tried to contact the concerned persons, Small fraction of the data received from UP	Letters sent to Principal Secretary of the Concerned Ministry of the Concerned States by the Mission Director, NMCG and MS, IMG on September 14, 2012; Meeting with Engineer-in-Chief along with several Chief Engineers of Irrigation Department, UP held on September16, 2012 by IIT Representatives, Concerned Officers have been identified; **Some Hydrological data of irrigation projects received from Water Resource Zone Jaipur, Rajasthan vide letter dated 1.8.2012.** **Data related to Bansagar Multipurpose Project received from Water Resources Department, Madhya Pradesh vide letter dated 10.1.2013.** No information from other States
02	Hydro Power Projects	DPR of all existing, under construction and approved projects; Daily power generation data since inception of all commissioned projects, Daily flow release immediate downstream of obstruction since commissioning of the project, Average monthly revenues generated from sale of the project	Ministry/Department of Power/Energy of Concerned States	Request Letters with format sent to concerned officers, Request Letters also sent by MOEF	Letters sent to Secretary/Principal Secretary of the Concerned Ministry of the Concerned States by the Mission Director, NMCG and MS, IMG on September 14, 2012; **Soft copies of DPRs, Power generation and discharge data of the Hydro Power Projects received from the Uttarakhand Jal Vidyut Nigam Limited, Dehradun vide letter dated 5.11.2012.** No information from other States
03	Canal Network	Physical and hydraulic (including lining) details, Sources of supplies and particulars of head works, Operation schedule,	Irrigation Department of the Concerned States	Request Letters with format sent to concerned officers, Letters also sent by	Letters sent to Principal Secretary of the Concerned Ministry of the Concerned States by the Mission Director, NMCG and MS,

		Purpose: irrigation/domestic/ industrial/Any other, Water release data from inception, Command area details and location		MOEF, IIT Team tried to contact the concerned persons	IMG on September 14, 2012; Meeting with Engineer-in-Chief along with several Chief Engineers of Irrigation Department, UP held on September16, 2012 by IIT Representatives, Concerned Officers have been identified. **Data related to canal network received from Irrigation Department, Haryana vide letter dated 23.10.2012.** No information from other States
04	Lift Schemes if any and similar details as at 3 above	- do -	Irrigation Department of the Concerned States	- do -	Letters sent to Principal Secretary of the Concerned Ministry of the Concerned States by the Mission Director, NMCG and MS, IMG on September 14, 2012; Meeting with Engineer-in-Chief along with several Chief Engineers of Irrigation Department, UP held on September16, 2012 by IIT Representatives, Concerned Officers have been identified **Data related to Lift Schemes received from Irrigation Department, Haryana vide letter dated 23.10.2012** No information from other States
05	Water Diversion Data	Irrigation: Command area attributes such as aerial extent, number of districts covered and locations of command area; Irrigation planning details; Irrigation potential created and utilized; Industrial supplies including: Quantity committed for thermal (coal, oil and gas) power generation; Quantity committed for nuclear power; Others: Domestic, commercial, etc.	Irrigation Department of the Concerned States	- do -	Letters sent to Principal Secretary of the Concerned Ministry of the Concerned States by the Mission Director, NMCG and MS, IMG on September 14, 2012; Meeting with Engineer-in-Chief along with several Chief Engineers of Irrigation Department, UP held on September16, 2012 by IIT Representatives, Concerned Officers have been identified **Data related to water diversion received from Irrigation Department, Haryana vide letter dated 23.10.2012**

					No information from other States
06	Soil Data	Layer wise soil profile characteristics	NBSS LUP, Nagpur	Request Letters with format sent to concerned officers, Request Letters also sent by MOEF, IIT Team Members have tried to contact the concerned persons; Action awaited	Letter sent to Director, NBSS LUP by the Mission Director, NMCG and MS, IMG on September 12, 2012. Clearance from Ministry of Defense required; Response awaited **Letter also sent to Surveyor General of India by the Additional Secretary, MoEF to give permission to NBSS & LUP to disseminate digital data of soil map information.** **Hard copies of "Soil Series Reports" of Bihar and West Bengal received from NBSS&LUP vide letter dated 27.9.2012.**
07	Ground Water Data	Location of observation and production wells; Depth and log details of wells; Well abstractions and recuperation details; Observations on water levels with discernible trends; MSL at well sites; Pumping schedule followed; Characteristics of pumping and other lifting devices; Observations on various well water quality parameters including presence of fluorides, arsenic, nitrates, phosphate; Aquifer delineation maps; Aquifer recharge areas; Water table contours; Estimates of block wise recharge and corresponding sources; Pump test data and other inferred aquifer characteristics such as S, K, T values	Central Ground Water Board (CGWB) and Concerned State Ground Water Boards (SGWB)	IIT Team held several meetings with CGWB and has sent representatives to some of the State Ground Water Boards (SGWB). However, not much progress has been made in gathering required data	Letter sent to the Chairman, CGWB by the Mission Director, NMCG and MS, IMG on September 12, 2012; Response awaited
08	Meteorological Data	Daily minimum and maximum temperatures and elevations at which observations are recorded; Daily observations on point rainfall by IMD and other state agencies; Location	Indian Meteorological Department (IMD)	Request Letters with format sent to concerned officers, Request Letters also sent by MOEF, IIT Team Members	Letter sent to the Director General, IMD by the Mission Director, NMCG and MS, IMG on September 12, 2012; Response awaited

		and elevation of rainfall observation stations; Wind speed and wind direction; Relative humidity; Pan evaporation data; Solar radiation data; Cloudiness; Snow cover information		have tried to contact the concerned persons; Action awaited	
09	Hydro-meteorological data from Nepal	Part of the Ganga Basin in Nepal	Through CWC	Discussing with officials of CWC	Action Pending
10	River Data	Gauge, Discharge, Sediment, and Water Quality Data	Central Water Commission (CWC) and its Eleven Divisions	IIT Team is closely interacting with concerned CWC officials. Much of the data has been provided, remaining is in the process of acquiring. Much of the data is in hard copy form. IIT Team is in the process of digitizing the data. Data from some of the divisions is yet to be received. It is expected that this exercise will take about 3-4 months.	Letter sent to the Chairman, CWC by the Mission Director, NMCG and MS, IMG on September 12, 2012; **Data on Water Quality and Sediment is being digitized by IIT Team in Patna Office. It is expected to take 2-3 months. Response from Damodar Division is awaited.** **MoEF has also requested Chairman, CWC to direct the concerned divisions to expedite the delivery of data to the IIT consortium vide letter dated 11.10.2012.**
11	River Cross Section Data	Additional river cross-section surveys spanning the entire width of flood plains; Engineered cross sections such as at bridge and other river crossing sites and river bank training works; Rating curve details; Coordinate details and bearing of cross section alignment (incl. distance to the reference survey point from two or three prominent and identifiable features/places)	Central Water Commission (CWC) and its Eleven Divisions	IIT Team is closely interacting with concerned CWC officials. Much of the data has been provided, remaining is in the process of acquiring. Much of the data is in hard copy form, and is being digitized	Letter sent to the Chairman, CWC by the Mission Director, NMCG and MS, IMG on September 12, 2012; Action likely to be completed in 3-4 months
12	Digital Elevation Model	High resolution Cartosat based digital elevation data for the	National Remote Sensing Center (NRSC), Hyderabad	IIT Team has been pursuing the matter with partial success.	Letter sent to the Director, NRSC by the Mission Director, NMCG and MS, IMG on September 12, 2012; Response is awaited
13	Industrial	List of industries in Ganga	Central	IIT Team has	Letter sent to the Member

	Pollution Data	Basin; Location and details of contact person; Product name and installed capacity; Water consumption and wastewater generation (Quantity); Details of existing ETP (Treatment Capacity, Treatment Level & Units/steps and Operating status); Details of effluent discharge (Receiving water bodies); Raw wastewater (influent) characteristics in terms of TSS, VSS, TDS, COD, BOD5, TKN, Phosphorus, etc.; Effluent characteristics in terms of TSS, VSS, TDS, COD, BOD5, TKN, Phosphorus, etc.; Type of industry (Small, medium & large); Number of employees	Pollution Control Boards (CPCB) and the concerned State Pollution Control Boards (SPCBs)	been pursuing the matter with very little success.	Secretary, CPCB by the Mission Director, NMCG and MS, IMG on September 12, 2012; Response is awaited
14	Reports and Presentations related to Flood Control	Comprehensive plans for flood management; Assessment of adequacy of waterways under existing rail and road bridges; Performance evaluation of flood management schemes; Special studies	Ganga Flood Control Commission (GFCC), Patna	IIT Team has been pursuing the matter with very little cooperation from the concerned agency.	Letter sent to the Chairman, GFCC by the Mission Director, NMCG and MS, IMG on September 12, 2012; Response is awaited

SUMMARY OF 69 HYDRO POWER PLANTS IN BHAGIRATHI/ALAKNANDA BASINS IN UTTARAKHAND

Status	Bhagirathi River		Alaknanda River		Total	
	Nos.	Installed Capacity (MW)	Nos.	Installed Capacity (MW)	Nos.	Installed Capacity (MW)
Under Operation	8 (including 4 Nos. below 25 MW)	1,845.75	9 (including 8 Nos. below 25 MW)	449.45	17	2,295.20
Under Construction	12 (including 11 Nos. below 25 MW)	1,097.00	13 (including 8 Nos. below 25 MW)	1564.30	25	2,661.30
CEA Clearance/ TEC by State Government	4 (including 2 Nos. below 25 MW)	368.00	6 (including 2 Nos. below 25 MW)	1,062.00	10	1,430.00
Under Development/ To be Reviewed	7 (including 3 Nos. below 25 MW)	1,560.00	10 (including 2 Nos. below 25 MW)	1,073.80	17	2,633.80
Total					**69**	**9,020.30**

A. Hydropower projects in Operation in Bhagirathi/Alaknanda Basins in Uttarakhand

Sl. No.	Project Name	Installed Capacity (MW)	Status	Remarks
	Bhagirathi River			
1	Maneri Bhali-I	90.00	-	
2	Maneri Bhali-I	304.00	-	
3	Tehri-I	1000.00	-	
4	Koteshwar	400.00	-	
5	Pilangad	2.25	-	E.F.-10% of lean flows
6	Agunda Thati	3.00	-	
7	Bhilangana (Swasti)	22.50	-	
8	Bhilangana (Polyplex)	24.00	-	
	Alaknanda			
9	Vishnu Prayag	400.00	-	
10	Badrinath-II	1.25	-	E.F.-10% of lean flows
11	Jummagad	1.20	-	E.F.-10% of lean flows
12	Birahi Ganga	7.20	-	E.F.-10% of lean flows
13	Debal	5.00	-	
14	Rajwakti HEP	3.60	-	
15	Rishiganga	13.20	-	
16	Vanla	15.00	-	
17	Urgam	3.00	-	E.F.-10% of lean flows
Total		**2295.20**		

E.F. - Environmental Flow

B. Hydropower projects under construction in Bhagirathi/ Alaknanda Basin in Uttarakhand

Sl. No.	Project Name	Installed Capacity (MW)	Status	Remarks
	Bhagirathi River			
1.	Tehri PSS	1000.0	E.C. - cleared F.C. - cleared	
3.	Asiganga-I	4.5	E.C. - N.A. F.C. - received for 0.923 ha land in 2003 and for addl. 1.239 ha land on 30.08.09	E.F. - 10%
4.	Asiganga-II	4.5	E.C. - N.A. F.C. - received for 0.72 ha land in 2003 and for addl. 1.583 ha land on 30.08.09	E.F - 10%
5.	Suwarigad	2.0	E.C. - N.A. F.C. - revised land case has been submitted to DM, Uttarkashi on 03.03.12	E.F. - 10%
6.	Limchagad	3.5	E.C. - N.A. F.C. - received for 0.9875 ha land on 21.04.08	E.F. - 10%
7.	Kaldigad	9.0	E.C. - N.A. F.C. - received for 2.351 ha land on 04.03.08 and for additional 1.685 ha land on 28.10.09	E.F. - 10%
8.	Balganga-II	7.0		
9.	Jalandharigad	24.0		E.F. - 0.3 cumecs
10.	Jhalakoti	12.5	F.C. - Stage-II clearance accorded on 09.05.12	E.F - 15%
11.	Kakoragad	12.5		E.F. - 0.3 cumecs
12.	Kotbudhakedar	6.0		
13.	Siyangad	11.5		E.F. - 0.3 cumecs
	Alaknanda River			
14.	Tapovan Vishnugad	520.0	E.C. - cleared F.C. - cleared	E.F.-1 cumecs (Sept. to May)
15.	Shrinagar	330.0	E.C. - cleared F.C. - cleared	Ministry of Environment & Forest has issued stop notice for works from 30.05.11
16.	Phata Byung	76.0	E.C. - cleared	

			F.C. - cleared	
17.	Singoli Bhatwari	99.0	E.C. - cleared F.C. - cleared	E.F.-10% of Min. flow
18.	Vishnugad Pipalkoti	444.0	E.C. - cleared F.C. - Awaited	Pre-construction activities are in progress
19.	Kaliganga-I	4.0	E.C. - N.A. F.C. - received for 4.1 ha land on 08.01.06	E.F. - 10% Project commissioned in the month of July 2012
20.	Kaliganga-II	6.0	E.C. - N.A. F.C. - received for 3.129 ha land on 06.03.07	E.F. - 10%
21.	Madhyamaheshwar	15.0	E.C. - N.A. F.C. - received for 4.99 ha land on 06.03.07	E.F. - 10%
22.	Bhyunderganga	24.3	E.C. - cleared F.C. - cleared	
23.	Birahiganga-I	24.0		E.F. - 0.72 cumecs
24.	Dewali	13.0		
25.	Kaliganga	5.0	F.C. - cleared	
26.	Khiraoganga	4.0		
	Total	**2661.3**		

E.C. - Environmental Clearance; F.C. - Forest Clearance; E.F. - Environmental Flow

Note: As per MoEF notification dated 14.9.2006, Environmental Clearance is not required for SHPs less than 25 MW capacity.

C. Hydropower projects with EC/FC Clearancs and others in Bhagirathi/ Alaknanda Basin in Uttarakhand

Sl. No	Project Name	Installed Capacity (MW)	Status	Remarks
	Bhagirathi River			
1	Kotlibhel Stage-IA	195.0 (3x65)	CEA Concurrence-03.10.06 E.C. - cleared (09.05.07) F.C. - Stage-1 approval accorded on 13.10.11	E.F. - As per IIT Roorkee/WII Report/Govt. decision **Reasons for delay:** Compliance of provisions of Stage-I clearance. Awaiting Stage-II approval from GoI
2	Asiganga-III	9.0	E.C. - F.C. -	E.F.-10% **Reasons for delay:** - Introduction of Tunnel in place of open power channel - Revision of capacity
3	Bhilangna-II A	24.0	E.C. - F.C. -	E.F.-10%
	Alaknanda River			
4	Lata Tapovan	171.0 (3x57)	CEA Concurrence-08.02.06 E.C. - cleared (21.02.07) F.C. - cleared (29.08.09)	E.F. - 1 cumecs (September-May) **Reasons for delay:** TEC of the project is under revalidation by CEA
5	Alaknanda	300.0 (3x100)	CEA Concurrence-08.08.08 E.C. - cleared (12.03.08) F.C. – cleared (10.12.12)	E.F.-10% of Min. flow **Reasons for delay:** IA to be signed
6	Devsari	252.0 (3x84)	CEA Concurrence - Awaited E.C. - Awaited F.C. - Awaited	E.F.-10% of average inflow during Nov. to April **Reasons for delay:** CEA Concurrence - meeting

				held on 29.05.12, letter of concurrence yet to be issued
7	Melkhet	15.0	E.C. - F.C. -	**Reasons for delay:** Approval for enhanced capacity of 24.3 accorded. SIA to be signed.
8	Rambara	24.0	E.C. - F.C. -	
Total		**990.0**		
Other Projects suggested for consideration after CEA/EC/FC clearances				
9	Karmoli **(Bharathi River)**	140.0	PFR prepared	
10	Bowala Nand Prayag **(Alaknanda River)**	300.0	DPR returned. To be prepared again. Submitted for clearance.	
Total		**1,430.0**		

E.C. - Environmental Clearance; F.C. - Forest Clearance; E.F. - Environmental Flow

Note: As per MoEF notification dated 14.9.2006, Environmental Clearance is not required for SHPs less than 25 MW capacity.

D. Hydropower Projects to be Reviewed in Bhagirathi/Alaknanda Basin in Uttarakhand

Sl. No.	Project Name	Installed Capacity (MW)	Status	Remarks
	Bhagirathi River			
1	Jadhganga	50.0	PFR Prepared	
2	Bhaironghati	381.0	DPR returned	
3	Bhilangana- IIB	24.0	Under S&I	
4	Bhilangana- IIC	21.0	Under S&I	
5	Pilangad-II	4.0	Under S&I	
	Alaknanda			
6	Maleri Jhelum	55.0	PFR Prepared	
7	Tamak lata	280.0	DPR under revision	
8	Rishiganga-I	70.0	PFR Prepared	
9	Rishiganga-II	35.0	PFR Prepared	
10	Gohana Tal	60.0	PFR Prepared	
11	Nand Prayag	100.0	DPR returned	
12	Jhelum Tamak	126.0	DPR returned	
13	Birahi Ganga-II	24.0	Revised DPR is to be submitted by developer	
14	Urgam-II	3.80	Under S&I	
Total		**1,233.8**		
Other Projects				
15	Loharinagpala **(Bhagirathi River)**	600.0	E.C. - cleared F.C. - cleared	E.F.-1 cumecs (Sept. to June) **Discontinued as per the Ministry of Power letter dated 24.12.10 in accordance with the decision of National Ganga River Basin Authority**
16	Pala Maneri **(Bhagirathi River)**	480.0 (4x120)	CEA Concurrence-23.02.07 E.C. - cleared (07.12.05) F.C. - cleared (06.06.06)	E.F. - 3 cumecs during lean period (October-May) **The project is discontinued by GoI on the basis of meeting of National Ganga River Basin Authority (NGRBA)**
17	Kotlibhel Stage-IB **(Alaknanda River)**	320.0 (4x80)	CEA Concurrence-30.10.06 E.C. - cleared (14.08.07) F.C. - Awaited	E.F. - As per IIT Roorkee/WII Report/Govt. decision **Reasons for delay:** Forest clearance denied by MoEF, GoI vide letter dated

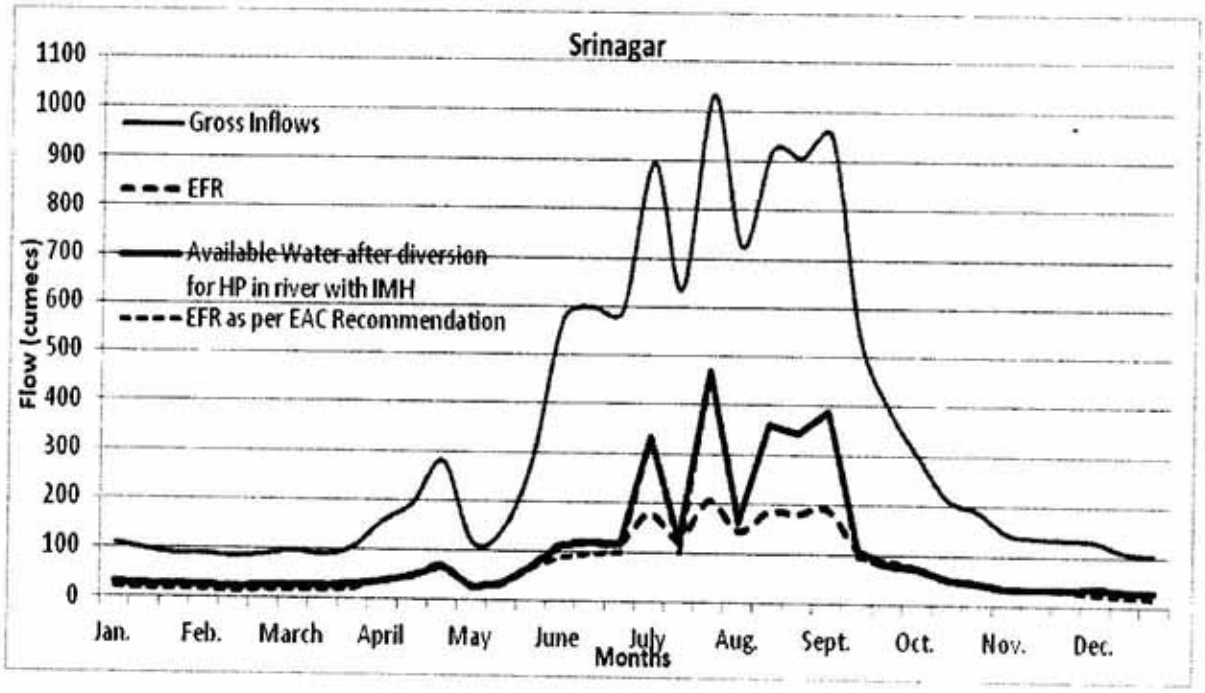
				07.07.11
Total		**2,633.8**		

Comparison of EAC E-flows & IMG Norms

Srinagar Q = 560 cumec H = 65.97 m IC = 330 MW

Period		Gross Inflows		EFR as per IMG draft	Net Inflow	Available Water after diversion for HP in river	As per IMG Water in river after	% IMG EFR to Gross Inflow	EFR as per EAC Recommendation		% EAC EFR to Gross Inflow
Month	10-daily	(cumec)		(cumecs)					(cumecs)		
June	I	571.3	8748.4	114.3	457.05	114.3	2723.2	31%	90.0	2630.0	30%
	II	596.9		119.4	477.54	119.4			98.0		
	III	589.6		117.9	471.66	117.9			100.0		
July	I	892.4		178.5	713.94	332.4			332.4		
	II	633.6		126.7	506.90	126.7			100.0		
	III	1028.8		205.8	823.00	468.7			468.7		
Aug.	I	723.4		144.7	578.73	163.4			163.4		
	II	919.9		184.0	735.89	359.8			359.8		
	III	904.4		180.9	723.54	344.4			344.4		
Sept.	I	948.4		189.7	758.74	388.4			388.4		
	II	544.6		108.9	435.64	108.9			95.0		
	III	395.2		79.0	316.12	79.0			90.0		
Oct.	I	297.5	1107.6	74.4	223.13	74.4	276.9	25%	74.4	276.9	25%
	II	211.1		52.8	158.33	52.8			52.8		
	III	187.8		46.9	140.81	46.9			46.9		
Nov.	I	144.1		36.0	108.05	36.0			36.0		
	II	134.8		33.7	101.12	33.7			33.7		
	III	132.3		33.1	99.25	33.1			33.1		
Dec.	I	128.7	1189.7	38.6	90.09	38.6	356.9	30%	25.7	237.9	20%
	II	108.6		32.6	76.03	32.6			21.7		
	III	102.9		30.9	72.00	30.9			20.6		
Jan.	I	109.0		32.7	76.28	32.7			21.8		
	II	97.5		29.3	68.27	29.3			19.5		
	III	90.0		27.0	63.02	27.0			18.0		
Feb.	I	90.0		27.0	62.98	27.0			18.0		
	II	84.9		25.5	59.44	25.5			17.0		
	III	88.3		26.5	61.78	26.5			17.7		
March	I	96.3		28.9	67.38	28.9			19.3		
	II	90.0		27.0	63.00	27.0			18.0		
	III	103.6		31.1	72.51	31.1			20.7		
April	I	156.3	1162.3	39.1	117.25	39.1	290.6	25%	39.1	290.6	25%
	II	192.7		48.2	144.54	48.2			48.2		
	III	277.9		69.5	208.43	69.5			69.5		
May	I	116.6		29.2	87.47	29.2			29.2		
	II	138.1		34.5	103.55	34.5			34.5		
	III	280.7		70.2	210.52	70.2			70.2		
OTAL		12208.0				3647.60		30%	3435.41		28%

Comparison of EAC E-flows & IMG Norms



Comparison of EAC E-flows & IMG Norms

povan Vishnugad Q = 108.8 cumec H = 530 m IC 520 MW

Period		Gross Inflows	cumulative gross inflow	EFR as per IMG draft	Net Inflow	Available Water after diversion for HP in river	As per IMG Water in river after d	% IMG EFR to Gross Inflow	EFR as per EAC Recommendation		% EAC EFR to Gross Inflow
Month	10-daily	(cumecs)	(cumecs)	(cumecs)		(cumecs)			(cumecs)	(cumec)	
June	I	178.2	1743.9	35.6	142.6	69.4	537.7	31%	69.4	527.8	30%
	II	169.9		34.0	135.9	61.1			61.1		
	III	162.0		32.4	129.6	53.1			53.1		
July	I	158.5		31.7	126.8	49.7			49.7		
	II	119.6		23.9	95.7	23.9			20.0		
	III	172.4		34.5	138.0	63.6			63.6		
Aug.	I	173.2		34.6	138.5	64.3			64.3		
	II	164.4		32.9	131.5	55.6			55.6		
	III	145.8		29.2	116.6	36.9			36.9		
Sept.	I	121.8		24.4	97.4	24.4			18.0		
	II	94.0		18.8	75.2	18.8			18.0		
	III	84.2		16.8	67.3	16.8			18.0		
Oct.	I	78.2	350.7	19.6	58.7	19.6	87.7	25%	19.6	87.7	25%
	II	75.6		18.9	56.7	18.9			18.9		
	III	59.9		15.0	44.9	15.0			15.0		
Nov.	I	60.5		15.1	45.4	15.1			15.1		
	II	42.0		10.5	31.5	10.5			10.5		
	III	34.5		8.6	25.9	8.6			8.6		
Dec.	I	31.3	330.4	9.4	21.9	9.4	99.1	30%	6.3	66.1	20%
	II	32.0		9.6	22.4	9.6			6.4		
	III	28.4		8.5	19.9	8.5			5.7		
Jan.	I	29.5		8.8	20.6	8.8			5.9		
	II	30.5		9.1	21.3	9.1			6.1		
	III	26.7		8.0	18.7	8.0			5.3		
Feb.	I	24.9		7.5	17.4	7.5			5.0		
	II	25.8		7.7	18.1	7.7			5.2		
	III	23.9		7.2	16.7	7.2			4.8		
March	I	23.9		7.2	16.7	7.2			4.8		
	II	24.5		7.4	17.2	7.4			4.9		
	III	29.2		8.8	20.5	8.8			5.8		
April	I	31.2	371.2	7.8	23.4	7.8	92.8	25%	7.8	92.8	25%
	II	42.2		10.6	31.7	10.6			10.6		
	III	43.9		11.0	32.9	11.0			11.0		
May	I	51.6		12.9	38.7	12.9			12.9		
	II	90.0		22.5	67.5	22.5			22.5		
	III	112.4		28.1	84.3	28.1			28.1		
TOTAL		2796.30				817.31		29%	774.36		28%

Comparison of EAC E-flows & IMG Norms