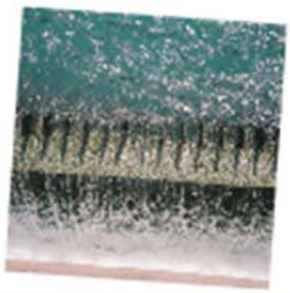
Towards the hydroelectric plant of the 21st century



A guide for the development of small hydroelectric plants with due respect to the natural environment

2011

ADEME

Agence de l'Environnement et de la Maîtrise de l'Energie

France Hydro Electricité

Introduction for the English version:

This guide has been translated into English at the initiative of France Hydro-Electricité, the main syndicate of small hydroelectricity producers in France. While it was initially compiled for use in France within a specific regulatory context, it is an example of best practices common to State/local government authorities and private hydroelectricity producers. The goal is to facilitate the assessment of development permit applications, to share a common approach and vocabulary for the development of small hydroelectric projects with due respect to the environment.

Please contact France Hydro-Electricité at Francehydro@france-hydro-electricite.fr for any further information required

Acknowledgements:

This guide has been produced thanks to:

- the financial and technical support of ADEME, joint contracting authority
- ISL, consulting engineers and project manager
- the members of the Science Committee (see appended list of members)
- the persons consulted concerning the usefulness and the timeliness of such a guide

We thank them all most warmly for their expert contributions, the time they spent on the project, and the real spirit of consensus in which they worked.

We have no doubt that this guide, however unpretentious, will contribute to the development of the small hydroelectric plants of high environmental quality which we so heartily wish to see in operation.

Translated in English by :

PREFACE

Proposer des conditions techniques standards pour développer de nouveaux aménagements exemplaires, efficaces énergétiquement et respectueux des milieux aquatiques : l'objectif du présent guide est au cœur de la C*onvention d'engagements pour le développement d'une hydroléctricité durable en cohérence avec la restauration des milieux aquatiques*, signée le 23 avril 2010 par le ministre d'Etat chargé de l'Ecologie et de l'Energie, Jean-Louis Borloo et les principales parties prenantes.

Inscrit comme produit de cette convention, et validé par son comité de suivi le 1er avril 2011, il témoigne de son ambition de concilier deux des objectifs du Grenelle de l'environnement :
- le développement des énergies renouvelables, et en particulier de l'hydroélectricité à hauteur de 3 TWh/an nets de productible à l'horizon 2020, et
- la préservation et la reconquête de la qualité des cours d'eau, avec un objectif de 66% des masses d'eau en bon état dès 2015.

Ce guide auquel nos services ont été étroitement associés apporte, à l'attention des acteurs de la filière hydroélectrique, les éléments nécessaires pour que les projets de développement soient élaborés dans cette double perspective. Il accorde une place importante à la construction des éléments d'analyse de l'impact du projet sur les milieux aquatiques qu'il va toucher, phase cruciale pour l'aboutissement du projet, souvent itérative, dont la qualité aura une influence certaine sur le délai et la fluidité de la phase d'instruction.

Il insiste sur le caractère essentiel d'un dialogue avec le service instructeur à établir dès les toutes premières étapes de l'examen du projet qui doit être nourri d'une réflexion sur l'équilibre entre la motivation énergétique et la protection des milieux. La conciliation de ces enjeux repose tout d'abord sur le choix du site, d'autant moins propice que les cours d'eau considérés sont riches et préservés du point de vue environnemental, d'autant plus pertinent que le potentiel énergétique est important.

Nous avons souhaité que ce guide destiné aux porteurs de projets soit également largement diffusé et connu des services chargés de leur instruction, et avons particulièrement veillé à sa parfaite cohérence avec les instructions qu'ils reçoivent par voie de circulaires.

Nous saluons donc l'initiative de France-Hydro-Electricité et de l'Agence de l'Environnement et de la Maîtrise de l'Energie , et la qualité du résultat atteint, et souhaitons que la large diffusion de ce guide et son emploi dans les projets locaux contribuent avec succès au déploiement des objectifs de la convention.

Le directeur de l'énergie

La directrice de l'eau et de la biodiversité

FOREWORD

With its objective of proposing standard technical conditions for developing benchmark new installations which would combine effective energy use with respect for the aquatic habitat, the present guide fulfils key requirements of the *Convention d'engagements pour le développement d'une hydroélectricité durable en cohérence avec la restauration des milieux aquatiques* (Convention for commitment to the development of sustainable hydroelectricity compatible with the restoration of the water habitat). This was signed on 23 April 2010 by the Minister of State responsible for Ecology and Energy, Jean-Louis Borloo, and the main stakeholders.

Listed as an outcome of this convention, and ratified by its follow-up committee on 1 April 2011, this guide fulfils its ambition of reconciling two of the objectives of the *Grenelle de l'Environnement*, namely:

- the development of renewable energies, and particularly hydroelectricity, to the extent of a net 3 TWh/year of producible energy by 2020, and
- the preservation and restoration of the quality of waterways, with an objective of 66% of water volume in good shape as early as 2015.

This guide, with which our services have been closely involved, brings essential aspects for the drafting of development projects from this double perspective to the attention of the key players in the hydroelectric sector. It highlights the elaboration of essential aspects for the study of the impact of projects on the water habitat which will be affected. This is a crucial phase, albeit often repeated, for the successful achievement of a project. Quality of input on this phase will have considerable impact on the speed and fluidity of the decision-taking phase.

The guide emphasises the necessity of establishing a dialogue with the local government authority right at the start of the project evaluation process, as this must be based on careful consideration of the balance between the drive to generate energy and the protection of the natural habitats. Meeting these challenges depends first of all on the choice of the site. The richer and the better preserved the waterways under review are from the environmental perspective, the less will they be deemed appropriate. The greater the energy potential, the more interesting will be the site.

It is our hope that this guide, which is intended for those who develop projects, should also be widely distributed to and be known to the services responsible for decision-taking. We have taken special care to ensure that the information it contains should be perfectly aligned with the instructions they receive through official circulars.

We therefore welcome the initiative of *France-Hydro-Electricité* and of the *Agence de l'Environnement et de la Maitrise de l'Energie*, (ADEME). We appreciate the quality of the result, and hope that the guide will be widely distributed and used in local projects, thereby successfully contributing to the implementation of the aims of the Convention.

Director of Energy

Director of Water and Biodiversity

Contents

I. INTRODUCTION

The ambitious goals ratified by the *Grenelle de l'Environnement* (+3TWh net by 2020) and the European Directive « EnR » concerning the development of renewable energies, which reinforce those introduced by the POPE[1] law in 2005, imply that there will be new expansion in the creation of hydroelectric plants on French territory.

Concurrently, every project concerning water faces the challenge of protecting and restoring water habitats and their associated biodiversity, as defined at European level by the *Directive Cadre sur l'Eau* (DCE) and the Habitats directive, and at national level by the law on water and water habitats (LEMA).

The hydroelectric sector therefore needs to take up the double challenge of energy efficiency and respect for the environment, while the State services need to get ready to vet a large number of projects in the best conditions.

In such a context, it is necessary to ensure smooth cooperation between the various agents of the sector (producers, specialists, consultants and authorities), in order to agree on a shared technical vision of what an "ideal" hydroelectric development should be, in other words a vision which reconciles energy and environmental goals.

This guide, which has been written following a request by the Ministry responsible for Ecology and Energy, is a tool for the use of those involved in the hydroelectric sector in order to foster a common approach and language concerning the development of small hydroelectric projects, whether they be installations in virgin sites, or improvements to existing installations, for low and high heads, for installed power levels inferior to 4.5 MW.

It is the product of consultations between the representatives of the main stakeholders involved: (Ministry, ONEMA, Water Police Service, producers, turbine manufacturers, consultants, environment experts), who have each defined their expectations, the most frequent areas of potential disagreement and required best practices. This work has been supervised by a scientific committee consisting of representatives of ONEMA, CEMAGREF, of the turbine manufacturers and of France Hydro-Electricité.

This guide aims to present the essential points of the development of a small hydroelectric plant project (SHP) in a concise and targeted form. It is not intended as a substitute for the many technical works existing on the sizing of plants nor to studies of environmental impacts, nor to existing regulations. It is meant to facilitate project preparation by the petitioner and its evaluation by the local government authority. For each theme, a bibliography is suggested to the reader.

The document is divided into two chapters:

- The first chapter describes the stages in the development of a SHP project and the actions required at each stage. Summary sheets will be found recalling the objectives and recommendations for each stage, as well as a technical bibliography.
- The second chapter goes further into the key elements which help a project to be rated as "benchmark", i.e. firmly geared to meeting both energy-production and environmental goals.

[1] *Loi-programme d'orientation de la Politique Energétique Française* : Program law defining the French Energy Policy

II. PHASES IN THE DEVELOPMENT OF A PROJECT

The development of a project for a small hydroelectric plant consists of four main phases:

- Preliminary project survey
- Meeting to present the project to the Water Police Service
- Preliminary design study and environmental impact study/assessment
- Editing and submission

In the following pages of the document, "project study" is understood to mean the set of studies undertaken in order to prepare the request for an operating permit:

- Preliminary design study (or feasibility study)
- Environmental impact study/assessment
- All the complementary specific technical surveys which might prove necessary for the consideration of the permit application.

These studies may take 1 or 2 years. Duration depends to a large extent on carrying out an environmental impact study/assessment which must extend over 3 or 4 seasons in order to provide a true reflection of the site surveyed.

When the application is submitted, the authorities begin by checking that it is **complete**, in other words that all the elements required have been included, and that they are sufficiently detailed[2]. If that is not the case, further information will be requested from the applicant, thereby postponing the start of actual consideration of the application.

This stage involves an **administrative enquiry** which aims to open a **"regular" file**, that is a compilation of all the necessary information and explanations on the impacts, the corrective and compensatory measures proposed, in order both to enable the authorities to take a decision and the public to understand the application and the issues involved. This file will be the subject of a **public enquiry** after the administrative enquiry. This stage of administrative and public enquiry will have a maximum legal duration of 2 years (cf. article 2, paragraph 7 of the law of 16 December 1919).

The first part of the guide describes the various steps to be taken by the developer, from the identification of the site to the submission of the application permit request, in order to enable him right from the start to submit a comprehensive document meeting all the requirements, so as to facilitate decision-taking by the authorities. These steps, summarised in the table below, are described in the following pages.

CAUTION:

While it is particularly recommended that discussions, as described in the present guide, should be held with the local government authority, (the Water Police Service - WPS) before the official submission of the permit application, it must be stated that they are not mandatory. They are merely a sound practice, which may help to speed up the official handling of the application.

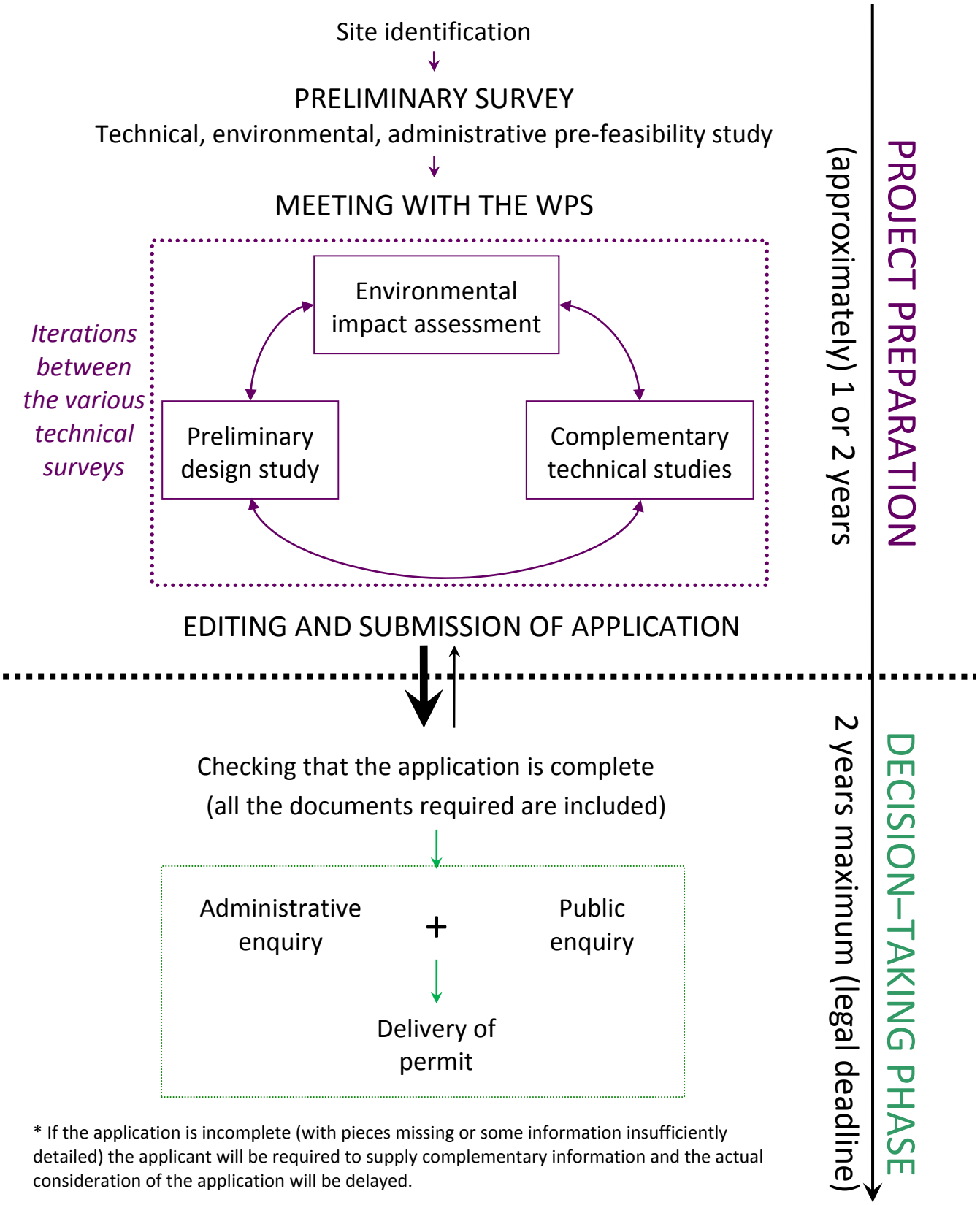
We also remind readers that it is important that the developer should be accompanied by his consultants, specially for the first meeting with the local government authority, and that he should continue at every stage to consult the appropriate technical, legal or economic specialists. The information thus collected, the surveys carried out and the conclusions reached, as well as the corrective measures recommended in the context of the environmental impact assessment, together with the effectiveness of these measures, remain the responsibility of the developer and his consultants.

Finally, while the key local government authority negotiating partner of the developer is truly the Water Police Service, this department does not have within it the specialist knowledge required to analyze all the elements of the environmental impact study/assessment (noise, wildlife on the ground, or sites for example). All the necessary information will therefore not always be available from that very department, especially during the

[2] A reminder of the documents required will be found at Annex iV.3, as stipulated at Article R 214-72 of the *Code de l'Environnement*

preliminary stage of the official decision-taking process. The developer may have to seek complementary information from other state departments or eventually indicate to which service to refer regarding certain aspects.

Indications concerning the various services or institutions which may be involved during the assessment of an application are given at Annex 4.



* If the application is incomplete (with pieces missing or some information insufficiently detailed) the applicant will be required to supply complementary information and the actual consideration of the application will be delayed.

II.1. Preliminary project survey

Description of this stage

The preliminary site survey provides the means of evaluating its potential for energy production and to showcase the technical, environmental, real estate and administrative contexts of the project. This preliminary survey must provide the developer with the means of knowing whether his project is technically and legally feasible, to identify and prioritize the constraints, and to modify his project according to these constraints, before finally reaching the stage of selecting the most appropriate development scenario from among all the possible scenarios.

The contents of a preliminary site survey match those described in the typical specifications of ADEME for feasibility studies of small hydroelectric plants.

Finally, this analysis paves the way for the first contact with Water Police Service (the next stage).

Actions required from the producer

The preliminary survey of a projected development must at the very least include:

- The technical aspects (general observations about the site, hydrology, head, flow, choice of plant output, brief description of the project estimate of production)
- The environmental aspects (physical, biological, human, corrective and compensatory measures available, any further studies that may be required)
- The financial aspects (investment, operation and maintenance, operational revenue, profit and loss account)
- The real estate and legal aspects (present legal status, likely legal obstacles)

Expectations of the local government authorities

The preliminary survey will briefly describe the projected development and the main energy and environmental issues.

It will indicate the location of the project: at departmental or regional level, then village level (by means of maps), then the exact local site (by means of site photographs).

If the project is located in the midst of one or several protected area/s, this will be highlighted.

Recommendations

The choice of the site is of paramount importance. The preliminary survey provides the opportunity of identifying at the very outset any eventual obstacles (rich biodiversity, rare or protected species...) and of checking the overall feasibility of the project with regard to the legal and environmental aspects (means of managing impacts) of the project. At the end of this stage, a preliminary survey report is produced and sent to the WPS in order to prepare a first meeting (cf. next stage).

Bibliography

- ADEME, 2003. *Guide pour le montage de projets de petite hydroélectricité. Connaitre pour agir, Guides et cahiers techniques*. 158 pages.
- ADEME, 2001. *Cahier des Charges type pour des études de faisabilité et son complément. Cahier des charges pour les études de pré-diagnostic*
- Please refer to Appendix 2, which lists the required administrative procedures.

II.2. First presentation to the Water Police Service

Description of this stage

The meeting with the WPS at this stage of project development is vital (although not required by law).

The WPS could eventually request that the applicant should complete the preliminary survey concerning environmental issues and the required administrative procedures.

The meeting with the WPS at this stage of the project provides an opportunity to highlight the context of the environmental impact study/assessment, namely by defining the content and scale of the project (both in its geographical and technical aspects) and by clarifying the train of actions to be taken on site (with regard to noise, fauna, flora, quality of water etc.).

The meeting to present the project to the Water Police Service is convened at the initiative of the applicant. Its agenda is as follows:

- Presentation by the developer of the general characteristics of the site and of the expected development
- Presentation by the applicant of the investigations and the actions already taken or planned for the preparation of the permit application. The presentation will focus both on the type of investigation (inventories of fish life, noise prevention measures, etc.) and on the details of their implementation (dates, number of stations, etc.)
- Views and comments of the WPS on the aspects presented
- General remarks by the WPS on the definition of the zone to be surveyed (water volume, or total water volumes) to be taken into consideration and on the challenges and global conservation objectives for these particular water masses (see §III.4.)
- Discussion on eventual amendments to the contents of the permit application, bearing in mind the particular characteristics of the site or of the development (see note following this table)
- General remarks/recommendations of the WPS on the procedure to follow.

The preliminary framing of the environmental impact study/assessment guarantees that survey resources will be properly deployed while allowing the applicant to concentrate his inevitably limited resources on essential issues. It facilitates early detection of eventual difficulties and consequent modifications to the project in order to solve any problems. Finally, it reduces the risks that the applicant should hand in an incomplete or faulty application, which would delay the decision-taking process.

Actions required from the producer

- Request a meeting with the WPS.
- Send the preliminary survey report. This document, which must be concise (about 10 pages) will help the WPS prepare for the meeting and will help the applicant frame the environmental impact study/assessment.
- Present the methods and tools used or envisaged, in order to obtain a technical opinion on their relevance.
- Include with the report a list of points to be raised during the meeting.
- The aim is to have a genuine dialogue, it is therefore necessary that the applicant should come with clear aspects to discuss and precise questions to raise.

Reactions from the local government authorities

- After reading the preliminary survey, the WPS will assemble the aspects to be considered at local and global level (issues and global conservation goals) and will thus be enabled, should the applicant so request:
- to check the legal feasibility of the project and show the eventual obstacles
- to provide relevant points of information about the project site and the advantages, goals and constraints associated with it, while indicating eventual advisory documents available regarding water management (SDAGE, SAGE);
- to draw attention to local environmental issues;
- to mention possibilities of alleviation of existing damages to the environment
- The meeting should help to define the principles behind the procedures and methods used to conduct the technical surveys, namely concerning calculation of the compensation water discharge (see §III.2.) and the protocols

	for the inventory of fauna/flora (aquatic and on land).

Recommendations

The applicant may draw inspiration from the prioritization of environmental impacts suggested in the grid in Part 2 of this guide in order to pinpoint the challenges of the site which he proposes to develop.

It must be borne in mind that « Les précisions apportées par l'autorité compétente n'empêchent pas celle-ci de faire, le cas échéant, compléter le dossier de demande d'autorisation ou d'approbation et ne préjugent pas de la décision qui sera prise à l'issue de la procédure d'instruction » "The clarifications provided by the relevant authority will not prevent the latter from requesting complementary information to be added to the permit application or request for approval as necessary, and do not affect the decision which will be taken at the end of the vetting procedure." (article R122-2 of the *Code de l'Environnement*). In other words, WPS approval of aspects of the preliminary survey does not guarantee the issue of an approval permit at the end of the vetting procedure.

The applicant is also advised to properly highlight the "repercussions on water and the aquatic environment" sections of the environmental impact study/assessment so as to facilitate checking by the WPS. The applicant is reminded that the study/environmental impact assessment will only be acceptable as a valid document regarding water legislation if it includes all the aspects required at article R213-6 of the *Code de L'Environnement*.

It must also be pointed out that article R 122-9, paragraph 4, stipulates that authorizations concerning installations using hydraulic energy with a maximum gross power of 500 kW or less are subject only to the environmental impact assessment.

Article R 122-9 declares that the requirements of the environmental impact assessment are much less exhaustive than those of an environmental impact study. It must mention the impact of the intended works and development projects on the environment and the conditions in which the intended development aims to fulfill environmental requirements.

In order to ensure effective further follow-up of the application (for instance, in the case of an eventual transfer of the WPS representative) it may be useful for the various parties to have several representatives. The applicant may have recourse to a member of the profession.

We suggest that the applicant should write up minutes of the meeting and send them to his contact at the WPS. This will enable him to keep a trace and chronological details of the various meetings throughout the permit application process.

Bibliography

- Article R 122-2 of the *Code de l'Environnement* :

  « *Le pétitionnaire ou le maître de l'ouvrage peut obtenir de l'autorité compétente pour autoriser ou approuver le projet de lui préciser les informations qui devront figurer dans l'étude/notice d'impact. Les précisions apportées par l'autorité compétente n'empêchent pas celle-ci de faire, le cas échéant, compléter le dossier de demande d'autorisation ou d'approbation et ne préjugent pas de la décision qui sera prise à l'issue de la procédure d'instruction.* »

  "The applicant or contractor may obtain from the relevant authority with power to authorize or approve the project that it should clarify or further define the information which should be contained in the environmental impact study/assessment. The details provided by the relevant authority do not preclude it from requesting, if necessary, that further information should be supplied to complement the application permit request. They do not have any effect on the decision which will be taken at the end of the vetting procedure."
- Ministry of Ecology and Sustainable Development, 2004. *Le cadrage préalable de l'étude/notice d'impact sur l'environnement*. 40 pages.
- ADEME Guide: « *Guide pour le montage de projets de petite hydroélectricité* »

Note: in the case of developments already authorized within the framework of the *Loi sur l'Eau*, section R214-18 provides for simplified administrative procedures, but only for the benefit of the site owner. If the development project is promoted by a third party, an agreement between the site owner and the developer must be signed.

II.3. PRELIMINARY DESIGN STUDY AND ENVIRONMENTAL IMPACT STUDY/ASSESSMENT

Description of this stage

This phase involves preparation of :

- The preliminary design study: sizing and design of the works, drawing up plans, calculation of producible output, costing;
- The environmental impact study/assessment.

These two documents make up the core of the permit application. They involve definition of the plant design, taking into account the specificities of the site.

Actions required from the producer

- Initiate the specific surveys necessary for designing the plant and for the environmental impact study/assessment: topographical survey, fauna/flora surveys, analysis of the physical/chemical quality of the water, analysis of the hydrobiological quality of the aquatic environment, the fishing grounds, sound measurements, landscape survey and integration of the installation within the landscape, property acquisitions needed etc.
- Ensure that on-site surveys are relevant: fauna/flora surveys to be done at the right seasons in the context of the environment surveyed (on land, river banks, or in the water), hydrological measurement during high and low tides, etc.
- Make clear distinctions between impacts during works (installation and maintenance works), and during normal operation;
- Deal in two separate chapters with corrective measures (which aim to reduce a particular impact) and compensatory measures (which are put into place in the event of a residual impact which cannot be reduced);
- Not to be content with mere “declarations of intent” concerning corrective and compensatory measures: integrate them within the costing and technical description of the project (for example, the fish-pass must be described and its dimensions specified).
- Write a complete non-technical and pedagogical summary (i.e., one which takes up all the points of the environmental impact study/assessment). This will often be the most widely read text. It therefore needs to be accessible to non-specialists. An application which could not be understood by all because it was too technical might be deemed unacceptable by the authorities’ assessor in case of dispute.

Expectations of the local government authorities

- Description of the original state of the site in the context of environmental impact risk (biological and hydro-morphological data) and diagnosis;
- Use of valid and recent data (e.g.: fish inventory, hydrological measurements) and relevant protocols (siting of stations, etc.);
- Justification of the amount of compensation water discharge proposed (cf. § III.2.);
- Clear and precise analysis of the impacts during installation works, maintenance and normal operation;
- Analysis of the impacts at the level of the body of water, based on available data;
- Proposal of corrective measures relevant to the challenges, including specifically that of ecological sustainability;
- Technical details concerning the feasibility of the proposed measures: conditions of installation and costs, plans of proposed works (e.g. fish-pass).

Recommendations

- Have recourse to a professional consultancy to conduct these surveys, especially for the water environment chapter, and to draft the permit application.
- Plan for measurement campaigns or specific studies which are sometimes subject to lengthy delays or need to be undertaken at specific times of the year.
- Meet local stakeholders and other water consumers (environment protection associations, sports clubs, fishermen's federations etc.) while the environmental impact study/assessment is being carried out. This will provide the opportunity of considering their views at an early stage of planning for the sizing of the development (e.g. entrance for kayaks).
- Conduct preliminary surveys (including assessment of economic constraints) and environmental impact study/assessment jointly and repeatedly. These studies cross-fertilize each other: while the environmental impact study/assessment is being undertaken for a specific project, it can lead to modifications of the project.
- Mention all the themes which must statutorily be discussed in an environmental impact study/assessment. It is not necessary, however, to give full details of aspects which are not relevant to the project, and are not subject to any impact. Thus, for a project which has no impact whatsoever on health and public sanitation, the corresponding paragraph only needs to contain one sentence mentioning that "examination of the project's impacts does not reveal any impact on health and public sanitation". The aim here is to demonstrate that all statutorily required aspects have been considered, failing which the application could be rejected.

Bibliography

- ESHA, 2005. *Petite hydroélectricité : guide technique pour la réalisation de projet*. French version of the "Layman's Guidebook on how to develop a small hydro site" translated and updated by Ademe, MHyLab, and SCPTH. 290 pages.
- Onema, 2011 : *Référentiel milieu aquatique – documents d'incidences appliqués aux aménagements hydroélectriques (état initial et prévision d'impact)*, which is available for consultation on the internet as from 2012.

II.4. Editing and submission of the application

Description of this stage

Article R214-72 of the *Code de l'Environnement* lists the documents and information which the application for a permit to install small hydroelectric plant must contain. The *préfet* acknowledges receipt of the application and hands it over to the Water Police Service.

Before the application is submitted, a second meeting between the developer and the Water Police Service is convened. The purpose of this second meeting is essentially to present to the WPS the permit application which is about to be submitted. This second and last meeting with the WPS gives the applicant the opportunity of making sure that his application is in order.

The purpose of the meeting is not at all to request that prior consideration be given to the application before it is officially submitted: at this meeting, the applicant will only present his application orally (it will not be sent in beforehand). The meeting provides an opportunity to mention the surveys that have been carried out, the eventual difficulties faced, and the results obtained, so as to ensure that all the essential aspects have been studied. During the whole period of project development, the only document transmitted to the WPS before submission of the permit application will have been the report on the preliminary survey described at stage II.2.

Actions by the producer

- Submit a complete and proper application which thoroughly takes into account all the aspects discussed during the first meeting with the WPS.
- In the event of the application having been prepared by consultants, the applicant must continue to drive the project and present it himself, even if he is accompanied by his adviser.

Reactions from the local government authorities

- Acknowledge receipt of a thoroughly completed application in which the environment impact study/assessment considers the key aspects described in the second part of this guide.

Recommendations

- It is advisable to collect the documents in a file with dividers for greater legibility.
- The environmental impact study/assessment is one of the main documents consulted during the public enquiry. It must be pedagogical and understandable by all: do not hesitate to explain technical terms.
- In its chapter outlining the rationale for the project, the latter could usefully be placed within a more global context; that of the *Schémas Régionaux Climat Air Energie*, the departmental energy context, national electricity production, energy-saving... This would enable the project to be easier to read and understand when it is presented to CODERST, for instance.
- Document III « Main characteristics of the development » must be carefully presented and provide justification for the scale of the development.

Bibliography

- *Code de l'environnement,* article R214-72
- Please consult annex 3, which lists the documents required for a permit application.

III. KEY ASPECTS

This second part clearly explains the key aspects which must be taken into account during the elaboration of a small hydroelectric plant project so that it may be considered excellent both from the point of view of energy optimization and that of the preservation of water habitats.

III.1. Context of the environmental impact study/assessment

During the preliminary survey, listing the potential effects of the development on its environment allows the developer to identify the challenges of the site and the aspects that require in-depth study. That is the purpose of describing the context of the environmental impact study/assessment, which will be discussed during the first meeting with the WPS.

Two complementary tools for successfully completing this phase are proposed in the following pages:

- The first is a table listing the statutory preventive measures and the environmental zonings that may be encountered, and indicates, in the boxes highlighted in grey, which specific aspects of the environment would eventually be concerned by these safeguards. This information draws attention to the particular environmental value of a site: as explained later, this table is used to refine the evaluation of the project's risk of impact.

  The list is not exhaustive and should be discussed with the WPS during the meeting to discuss the project framework. The same site may require several protective measures.

- The second tool is a general table showing the challenges created by various types of project on aspects of the environment. It is built up according to a typology of projects, taking into account the major characteristics of the river and of the intended development.

  The developments concerned are assumed to be run-off water plants; installations which function by means of locks represent specific cases, which are not covered in the present guide. The environmental parameters likely to be modified by the project are identified according to each type of development. A score of 1 to 3 is allocated to each of them: this score is meant to draw attention to priority areas of study, it is not an evaluation of the impacts of a specific project. **It is therefore possible that the environmental impact study/assessment may reveal that an aspect originally thought to be very important should not in the end be affected by the project (and conversely)**.

  The « protection/zoning » column is meant to be filled in during the preliminary survey and to increase the score attributed to the relevant issues by 1 if a protected area or zoning is identified in this region. Indeed, the existence of a safeguard indicates the particular value of the site, so that the project impact assessment should automatically be more detailed. The two tables are presented in the following pages and are followed by an example of their application to a development project for an existing dam without a bypassed section located in a ZNIEFF zone and near a listed site.

During the meeting with the WPS, the latter can provide further specific information concerning the key issues and the way to approach them. When filled in, the table therefore provides a basis for discussion and gives the opportunity of determining the level of precision required for the various themes of the impact study/assessment.

Finally, the table highlights types of situation which are favourable because they present fewer impact risks, such as existing sites of low heads without bypassed sections.

			STATUTORY PROTECTIONS AND ZONINGS																
			ENVIRONMENT													TOWN PLANNING AND HERITAGE			
	Item	Parameter liable to modification	L214-17 (1°) EU classification	L214-17 (2°) CEhh classificiation	Natura 2000 "water enviroment"	Natura 2000 "land environment"	Nature reserve	Biotope protection regulation	Listed wetland/s	Mapped out spawning places (L432-3 CE)	Axis of major unclassified migrating fishes	Axis of other migrating fishes	Biological sanctuary listed in the SDAGE	ZNIEFF	Nature Park	Constraints (plan for risk prevention, catchment preservation perimeter...)	Classified woodland areas	Listed site	Classified site
ENVIRONMENT	Hydrological system	Localised flow reduction and alteration of variability of water flow																	
	Hydromorphology	Flooding																	
		Bypassed section																	
	Continuity of sediment transportation	Sedimentation transit																	
		Sedimentary equilibrium (erosion, deposit, incising)																	
	Physical chemistry	Modification of thermal system																	
		Change in water quality																	
	Fish circulation	Upstream swimming path																	
		Downstream swimming path																	
	Aquatic vegetation	Macrophytes																	
	Aquatic fauna	Benthic invertebrates																	
		Fish																	
	Riverbank vegetation																		
	Land vegetation																		

			STATUTORY PROTECTIONS AND ZONINGS																
			ENVIRONMENT													TOWN PLANNING AND HERITAGE			
	Item	Parameter liable to modification	L214-17 (1°) EU classification	L214-17 (2°) CEhh classificiation	Natura 2000 "water enviroment"	Natura 2000 "land environment"	Nature reserve	Biotope protection regulation	Listed wetland/s	Mapped out spawning places (L432-3 CE)	Axis of major unclassified migrating fishes	Axis of other migrating fishes	Biological sanctuary listed in the SDAGE	ZNIEFF	Nature Park	Constraints (plan for risk prevention, catchment preservation perimeter...)	Classified woodland areas	Listed site	Classified site
	Land animals																		
	Soil																		
	Air																		
HEALTH &SAFETY	Security of property and persons	Works and their surroundings																	
		Change in flood risk																	
SOCIO-ECONOMICS	Water utilisation	Pumping (drinking water conveyance, irrigation, industries)																	
		Wastes																	
	Environment utilisation	Leisure: kayak																	
		Leisure: fishing																	
		Other leisure activities (rambling, cycling…)																	
	Noise	Noise pollution																	
	Local economy																		
	Landscape	Integration into the landscape																	
	Heritage																		

INDICATIONS ON THE CHALLENGES TO TAKE INTO ACCOUNT FOR EACH TYPE OF PROJECT

Reminder : this guide does not apply to works which function by means of locks

				New development			Equipment of an existing dam	
				Plain or Piemond		Mountain		
	Item	Parameter liable to modification	Statutory protections	Dam without BRS	Dam + BRS	Intake + BRS	without BRS	with BRS
ENVIRONMENT	Hydrological system	Localised flow reduction and alteration of water flow		1	3	3	1	3
	Hydromorphology	Flooding		3	3	1	1	1
		Bypassed section		1	3	3	1	3
	Continuity of sedimentation	Sedimentation transit		2	2	3	2	2
	Physical chemistry	Modification of thermal system		1*	1*	1	1	2
		Change in water quality		2	2	1	2	2
	Fish circulation	Upstream swimming path		3	3	2	3	3
		Downstream swimming path		3	3	3 **	3	3
	Aquatic vegetation	Macrophytes		2	2	1	1	2
	Aquatic fauna	Benthic invertebrates		2	3	3	1	2
		Fish		2	3	3	1	2
				2	2	2	1	2
	Riverbank vegetation			1	2	2	1	2
	Land vegetation			1	2	1	1	2
	Land animals			1	1	1	1	1
	Soil			1	1	1	1	1
HEALTH &SAFETY	Security of property and persons	Works and their surroundings		2	2	2	2	2
		Change in flood risk		3	3	2	2	2
SOCIO-ECONOMICS	Water utilisation	Pumping (drinking water conveyance, irrigation, industries)		2	2	2	2	2
		Wastes		2	2	2	2	2
	Environment utilisation	Leisure: kayak		3	3	3	3	3
		Leisure: fishing		2	3	3	2	3
		Other leisure activities (rambling, cycling…)		2	2	2	1	1
	Noise	Noise pollution		2	2	2	2	2
	Local economy			2	2	2	2	2
	Landscape	Integration into the landscape		2	2	2	2	2
	Heritage			2	2	2	2	2

** In mountainous regions, the downstream swimming path is always available, while the upstream swimming path may be blocked by natural obstacles such as falls

* In Piemond: 2

	Priority level	Action to initiate
1	Aspect assumed to be of little or no consequence	Bibliography check (and study of any specific issues which may arise)
2	Aspect to be studied	Bibliography check and site visit
3	Aspect to be studied in detail or very important aspect of the permit application	Complementary checks and investigations on site or detailed studies and onsite investigations ; likely further statutory requirements to fulfil : information to be sought from the authorities

Example of a project aiming to equip an existing dam, without bypassed river section, In a ZNIEFF and closed to a listed site

Reminder : this guide does not apply to works which function by means of locks

In red : changes in priority levels linked to the existence of a statutory protection measure

	Item	Parameter liable to modification	Protection / zoning ZNIEFF and listed site	Equipment of an existing dam, without bypassed river section
ENVIRONMENT	Hydrological system	Localised flow reduction and alteration of water flow		1
	Hydromorphology	Flooding	x	2
		Bypassed section		1
	Continuity of sedimentation	Sedimentation transit		2
	Physical chemistry	Modification of thermal system		1
		Change in water quality		2
	Fish circulation	Upstream swimming path		3
		Downstream swimming path		3
	Aquatic vegetation	Macrophytes	x	2
	Aquatic fauna	Benthic invertebrates	x	2
		Fish	x	2
	Riverbank vegetation		x	2
	Land vegetation		x	2
	Land animals		x	2
	Soil			1
	Air			1
HEALTH & SAFETY	Security of property and persons	Works and their surroundings		2
		Change in flood risk		2
SOCIO-ECONOMICS	Water utilisation	Pumping (Drinking water conveyance, irrigation, industries)		2
		Wastes		2
	Environment utilisation	leisure :kayak		3
		leisure : fishing		2
		Other leisure activities (rambling, cycling…)		1
	Noise	Noise pollution		2
	Local economy			2
	Landscape	Integration into the landscape	x	3
	Heritage		x	3

	Priority level	**Action to initiate**
1	Aspect assumed to be of little or no consequence	Aspect assumed to be of little or no consequence
2	Aspect to be studied	Aspect to be studied
3	Aspect to be studied in detail or very important aspect of the permit application	Aspect to be studied in detail or very important aspect of the permit application

III.2. Determination of non-turbined discharges

A few definitions

By "non-turbined discharges," we mean:

- the minimum discharge maintained in the by-passed section, which we shall mark as Q_{BPS}, aimed at guaranteeing satisfactory conditions for the life, circulation and reproduction of fish.
- Discharge of fishways, rated Q_F, used at various upstream or downstream fish-passes, whether they are situated at the level of the crest or the power house.

We draw attention to the fact that these two discharges must be determined independently and are not correlated. The present chapter aims to present various methods for determining them. It also describes the situations in which the first integrates the second or, on the contrary, situations in which the two discharges must be added to each other with respect to non-turbined discharges.

For a start, a reminder of the importance of the hydrological study of the river as a basis for determining the calculation of non-turbined discharges is presented in the box below.

Hydrological analysis

The average flow of the river corresponds to the average inter-annual flow. This is a statistical measure whose precision improves with the number of years of observation. The LEMA requires that at least 5 years' worth of measurements be available. The longer the record of measures, the more representative will it be assumed to be, but the waterway's hydrology may have changed over the last decades, so that average flow calculated on the basis of a very long record may lead to an erroneous estimation of the real average flow of the river at present.

As a general rule, it is recommended to calculate the average flow of the river by taking an average of **the natural daily flow reconstituted** from the measurements taken during the last 20 years. The average flow will be expressed as a range corresponding to a confidence interval of 95%, the interval chosen for calculating characteristic values of river flow to be found in the HYDRO bank.

This figure for average discharge, estimated right at the place of the works, will be used as a reference for the sizing of the development and the financial analysis of the project.

If the record of measurements available extends over much less than 20 years:

It will be necessary to correct the figure for average flow by means of correlations made either from the data obtained from a catchment area with similar geological and climate characteristics, or from series of rainfall measurements. These correlations will need to be justified.

If the record of measurements available extends over much more than 20 years:

The environmental impact study/assessment must examine the evolution of the average flow over time and recalculate the amount of minimal discharge maintained in the by-passed river section if this is justified.

Description of existing methods for determining minimum discharge in the by-passed river section

This determination represents a key phase in the sizing of a SHP project: it is indeed an important corrective measure, the objective of which is to ensure compatibility between hydroelectric usage and environmental objectives. The purpose is to decide on a figure appropriate to the site and acceptable both for energy production and for the aquatic environment, within the framework of regulations which already stipulate a basic minimum.

A reminder about the regulations

The regulation concerning minimum discharge is formulated at article L214-18 of the *Code de l'Environnement*:

« I - Tout ouvrage à construire dans le lit d'un cours d'eau doit comporter des dispositifs maintenant dans ce lit un débit minimal garantissant en permanence la vie, la circulation et la reproduction des espèces vivant dans les eaux au moment de l'installation de l'ouvrage ainsi que, le cas échéant, des dispositifs empêchant la pénétration du poisson dans les canaux d'amenée et de fuite.

Ce débit minimal ne doit pas être inférieur au dixième du module du cours d'eau en aval immédiat ou au droit de l'ouvrage correspondant au débit moyen inter annuel, évalué à partir des informations disponibles portant sur une période minimale de cinq années, ou au débit à l'amont immédiat de l'ouvrage, si celui-ci est inférieur. Pour les cours d'eau ou parties de cours d'eau dont le module est supérieur à 80 mètres cubes par seconde […], ce débit minimal ne doit pas être inférieur au vingtième du module du cours d'eau en aval immédiat ou au droit de l'ouvrage évalué dans les mêmes conditions ou au débit à l'amont immédiat de l'ouvrage, si celui-ci est inférieur. Toutefois, pour les cours d'eau ou sections de cours d'eau présentant un fonctionnement atypique rendant non pertinente la fixation d'un débit minimal dans les conditions prévues ci-dessus, le débit minimal peut être fixé à une valeur inférieure.

II – Les actes d'autorisation ou de concession peuvent fixer des valeurs de débit minimal différentes selon les périodes de l'année, sous réserve que la moyenne annuelle de ces valeurs ne soit pas inférieure aux débits minimaux fixés en application du I. En outre, le débit le plus bas doit rester supérieur à la moitié des débits minimaux précités »

"I - Any works to be constructed in the bed of a waterway must include the necessary devices to maintain within this bed a minimal discharge which will permanently safeguard the life, circulation and reproduction of species living in the waters at the time of the installation of the works as well as, if necessary, the devices necessary to prevent fish from entering the headrace and tailrace canals.

This minimum output must not be less than one-tenth of the average flow of the river in the area immediately upstream or right at the place of the works, corresponding to the average inter-annual flow, estimated on the basis of data available over a minimum period of five years, or to the discharge immediately downstream from the works, if the latter is less. For rivers or parts of rivers whose average flow amounts to more than 80 cubic metres per second [...], this minimum discharge must not amount to less than one-twentieth of the average flow of the river immediately upstream, or right at the place of the works, estimated in the same conditions, or of the discharge immediately downstream from the works, if the latter is less. However for the rivers or sections of rivers presenting an atypical mode of functioning which would render the fixing of a minimum discharge in the conditions described above inappropriate, the minimum discharge can be set at an inferior figure.

II – The acts of authorization or concession can set variable amounts of minimum discharge according to the times of year, with the proviso that the yearly average of these amounts should not be less than the minimum discharge stipulated with respect to I. Besides, the lowest discharge must remain superior to half the minimum discharge stipulated above."

- **The legal obligations consist in respecting the objective of permanently safeguarding the life, circulation and reproduction of the fish species in the by-passed river section. The minimum amount corresponding to 1/10th of the discharge is a precautionary lower limit but does not represent an objective in itself.**

The minimum discharge needed to achieve this objective is unique to each waterway and its definition requires a specific study.

The methods

Determining the minimal discharge should ensure that the discharge returned to the river will be sufficient to sustain the life, circulation and reproduction of aquatic species. The main existing methods are presented in the table below.

Type of method	Basis for analysis	Premise	Tools	Advantages	Required precautions for use	Limitations
Hydrological	Natural hydrological cycle, and, in particular, the volumes characteristic of low-water mark conditions.	Key role of low discharges and need to maintain a certain level of discharge comparable to the natural situation in order to limit the level of disturbance.	➢ Graph of classified flows with frequencies of excess; ➢ Average discharge levels associated to return periods: VCN7 with 10-year of return; ➢ Percentage of average discharge of river: 2.5% to 50% of average discharge of river.	Quick and simple approach.	➢ Good knowledge of the river's natural hydrology measured over a relatively long period of time; ➢ To determine the characteristics of low-water marks, use stations for which data concerning low discharge have been validated.	➢ There are no biological validations of the proposed volumes.
Hydraulic	Study of variations in hydraulic parameters according to flow.	Any decrease in certain parameters can have strong repercussions on biological communities Definition of the discharge value under which significant decrease in these parameters occurs.	Hydraulic parameters : wet perimeter, maximum depth, water surface, speed, etc.	Real onsite measures enabling consideration of the morphological specificities of the river.	➢ Relevance and representativeness of measurement sites (to determine the characteristics of low-water marks, use stations for which data concerning low discharges have been validated); ➢ Adaptation of the hydraulic model to the river being studied (slope, roughness etc…); ➢ Gathering of data for setting on range of targeted discharges (data on waterline levels, discharges measurements).	➢ Tricky utilisation in morphologically altered sectors (channelled rivers, existing by-passed river sections...); ➢ No biological criteria taken into account.

Type of method	Basis for analysis	Premise	Tools	Advantages	Precautions required	Limitations of method
Micro-Habitats	Study of variations in hydraulic parameters in relation to flow coupled with species' preferences within these parameters.	Most species show marked preferences for certain hydraulic conditions.	Method applicable to waterways containing running water Cyprinidae or salmon species.	Genuine onsite measurements enabling consideration of the morphological specificities of the river and direct contact with biological elements.	➢ Choice of targeted species and their level of development : ➢ Relevance of data concerning their habitat preferences ; ➢ Quality of hydraulic modelling (for characterisation of low-water marks, use stations for which low-output data have been validated) ; ➢ Method of choice applied to trout – bearing rivers (except for mountain streams) and to mixed waterways predominantly containing salmon species, with the following characteristics: - slope ranging between 2‰ and 50‰; - width less than 20 m; - average discharge/flow of less than 30 m^3/s; - summer temperature inferior to 20°C daily average) [3]	➢ Tricky to use in morphologically altered segments/sectors (channelled waterways, existing by-passed river sections).

[3] Ministry of the Environment / Cemagref, « *Evaluation de l'habitat physique des poissons en rivière* », Methodological Guide (december 1998)

Which method to use?

Ideally, the determination of minimal discharge should be based on the application of all three types of method. In practice, the challenges presented by the site do not always justify such an in-depth study. On the other hand, recourse to the micro-habitats method is not appropriate in certain cases, (See the precautions for utilization mentioned in the above table).

A logical progression in three stages ensures definition of the requirements concerning complementary studies relating to the determination of minimum discharge. This is outlined overleaf.

CAUTION:

A circular from the Ministry of Ecology and Energy is being prepared on the interpretation of clauses concerning minimum discharge at article L214-218 of the *Code de l'Environnement*. It will also highlight the various existing methods and provide advice on their use. As soon as it is signed, this circular will supersede the information provided in this guide.

Dichotomical key for the choice of method for determining the amount of compensation water discharge

1 Hydrological analysis, characterisation of low water marks

- Low-water mark =<10% average discharge of river → Except for very long by-passed river sections (> 5 km) and provided that hydrological studies and/or simplified habitats are done, compensation water discharge can be determined on the basis of minimum regulation amounts with possible seasonal fluctuations according to issues of free circulation and reproduction

Low-water mark discharge amount corresponding to a range situated between average monthly discharges recorded every two and five years

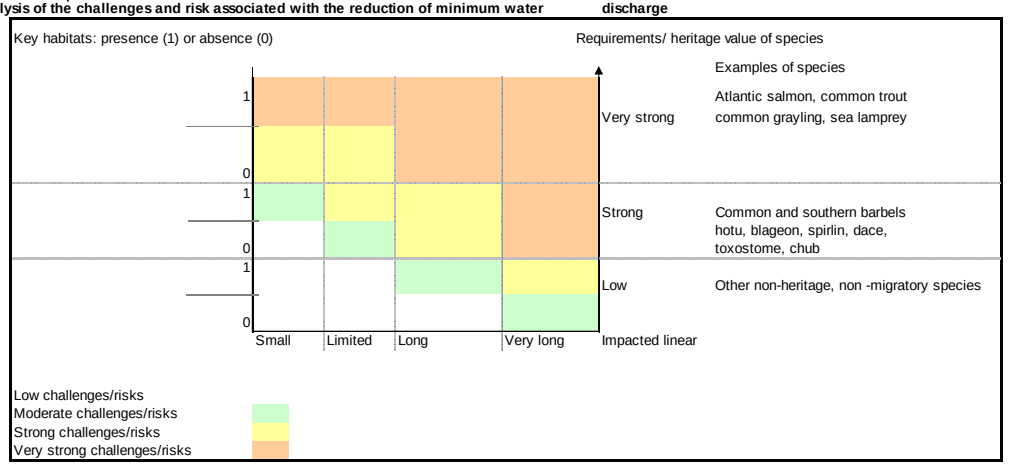
- Low-water mark >10% discharge of river

2 Comparison of the proposed discharge with the natural low-water mark discharges

- Minimum water discharge proposed within the range of variations of low-water mark discharges recorded every 2 or 5 years → No complementary studies needed. Seasonal fluctuation possible according to challenges of free circulation and reproduction
- Proposed minimum discharge lower than natural low-water marks

3 Eventual complementary studies to determine minimum discharge

Analysis of the challenges and risk associated with the reduction of minimum water discharge



Risk analysis enables selection of method to use for calculating the required discharge

- → Very high risk: combine hyraulic and micro-habitat methods (provided that validation requirements are met)
- → Strong and moderate risk: hydraulic method
  + estimation of the loss of wet surface for the minimal discharge proposed
    - if the loss is small: discharge amount is correct
    - if the loss is important: evolution of habitats following this reduction of wet surface must be studied
- → Low risk: the regulation minimum is adequate for determining compensation water

Determination of fishway discharges

The regulations stipulate that « the plant operator must ensure the operation and maintenance of these fishways » (Article L432-6 of the *Code de l'Environnement*).

In order to be operational, the works need an adequate discharge which really allows fish to use the fishway. The fishway discharge is the discharge value which fish species need in order to be attracted to the fishway and to be able to use them in good conditions. Determining this therefore depends both on the characteristics of the fishway (implantation, type, etc), of the river and the targeted fish species.

This discharge must be determined at the time of the technical studies for sizing the fishways.

In cases where the fishways are at the level of the crest, the fishway discharge feeds the bypassed river section and is therefore an integral part of the minimum discharge decreed by the LEMA (Q_{BRS}); however it is calculated separately as it is not based on the same objectives.

For a fishway created at the level of the diversion, the fishway discharge is a non-turbined discharge which is added to the minimum discharge, as it does not feed the bypassed river section and does not therefore contribute to the sustainability of fish life in that sector.

The discharges which guarantee good effectiveness of fishways may be very variable depending on migration issues and the characteristics of the works. They may sometimes be more than 10% above the average discharge of the river, with seasonal variations in the discharge attributed for downstream swimming paths.

Comment
In areas which present strong migratory challenges, it can be interesting to create variations in the fishway discharge in order to increase it in periods of downstream migration and reduce it at non-migratory periods. This requires a more detailed study according to the targeted species: calculation of the discharge and the possibilities of seasonal variations must be studied at the time of designing the fishway.

III.3. Aspects of ecological continuity

Ecological continuity is an essential element of the functioning of aquatic ecosystems. It concerns the free circulation of species, specially fish, as well as that of sediments. Hydroelectric installations may have an impact on the migration of species and the transit of sediments both at the level of water intake works and at the level of the power house. Technical solutions exist to reduce these impacts. Two essential phases are necessary for the application of these techniques:

- the evaluation of ecological challenges within the sub-catchment area affected by the works.
- if necessary, the definition of the measures which must be taken in order to reduce the impact of the works.

Definition of the challenges of ecological continuity

The classification of waterways according to article L214-17 of the *Code de l'Environnement* enables identification of sections of rivers where there are very strong continuity challenges (1° of L 214-17) or of challenges of limitation of the impacts of works (2° of L214-17).

However, these are not the only river sections where it may be necessary to install devices in order to ensure the free circulation of species and/or the transit of rough sediments. The environmental impact study/assessment will determine whether such mechanisms are necessary for other rivers.

Determination of ecological continuity challenges is carried out by correlating:

- Biological challenges and species of fish present,
- Available habitats upstream and downstream (spawning zones, shelter zones, river annexes, tributaries...),
- Natural slope or level of grade separation of the river section.

The table overleaf defines the assumed challenge level with regard to the ecological continuity of a site when applying the parameters described above.

Definition of level of ecological continuity challenges

<table>
<tr><td></td><td>Rivers classified L214-17</td><td>Upstream spaw ning grounds (L432-3) and/or tributaries or annexes</td><td>Unmapped L432-3 spaw ning grounds</td><td>Unmapped L432-3 spaw ning grounds</td><td>Atypical (L214-18) non -karstic river</td></tr>
<tr><td></td><td></td><td>No natural obstacle and/or small amount of grade separation</td><td>No natural obstacle and/or small amount of grade separation</td><td>Natural obstacle and/or large amount of grade separation</td><td></td></tr>
<tr><td>Zone w ith salmon</td><td rowspan="5">Very strong challenges</td><td rowspan="2">Strong challenges</td><td colspan="2" rowspan="2">Average to strong challenges</td><td>Minor challenges</td></tr>
<tr><td>Dow nstream zone w ith salmon</td><td>Average to strong challenges</td></tr>
<tr><td>Running w ater Cyprinidae zone</td><td colspan="2" rowspan="2">Average challenges</td><td></td></tr>
<tr><td>Pike zone</td><td></td></tr>
<tr><td>Calm w ater Cyprinidae zone</td><td colspan="2">Minor challenges</td><td>Average to strong challenges</td><td></td></tr>
</table>

Examples of natural obstacles are: impassable obstacles or a steep river slope.

Measures that must be taken according to the level of challenges to ecological continuity

	Upstream swimming path	**Downstream swimminp path**	**Sediments**
Very strong challenges	Devices imposed by regulations	Devices imposed by regulations	Devices eventually imposed by regulations
Strong challenges	Essential devices in case of the absence of natural obstacles and in case of the absence downstream of L432-3 spawning grounds, or shelter zones (tributaries): justified by the environmental impact study	Essential devices	Management adapted to the transit of rough sediments to be envisaged according to the supply by the catchment area and the downstream "needs"
Average to strong challenges	Installation of devices to be envisaged according to the amount of grade separation of the river and the presence of spawning grounds		Management adapted to the transit of rough sediments to be envisaged according to the supply by the catchment area and the downstream "needs"
Average challenges	Devices that become optional as soon as distances between crests are sufficient to constitute habitats of large enough size (> 2 km)		
Minor challenges			

When devices to ensure ecological sustainability prove to be necessary,

- for installations on pristine sites: they must be integrated into the project right from the preliminary survey (in order to take their cost into account when calculating the eventual profitability of the project), and then for the sizing of the works;
- for existing installations: on river sections listed under sub-section 2 of Article L1214-7, the installation will have to be upgraded in line with the requirements within 5 years after the publication of the lists; the best cost-benefit solution for the environment must be sought on a case by case basis (construction of an appropriate fish pass, modification to the regulations for managing the plant etc...)

Devices for reducing the impacts of the hydroelectric plant on ecological continuity

Devices for the upstream swimming path

The main types of devices are concisely described in the table overleaf.

In order to be effective, an upstream swimming path device must be implanted near the zones with the greatest amount of discharge. In certain cases, a fish pass can be built at the dam and another at the plant. Easy access to the device must be integrated as a criterion for installation in order to enable maintenance of the works.

Type of mechanism/device	Principles	Maximum height of head which can be equipped (in m)	Biological target	Remark
Fish pass with speed reducers	Slope ramps of 10 to 20% equipped with lateral and/or deep water structures	< 2,5 m	Large fish of the salmon species Lampreys	Very sensitive to variations in upstream water levels
Fish pass with successive ponds with saddles	Succession of heads and ponds used for rest and dissipation of energy – head height between ponds from 25 cm to 35 cm	< 10 m	Salmon species	Fairly sensitive to variations in upstream water levels
Fish pass with successive ponds with vertical clefts	Succession of heads and ponds used for rest and dissipation of energy – head height between ponds from 20 cm to 30 cm	< 10 m	All species	Not very sensitive to variations in upstream water levels The height of heads between basins, as well as their volume, must be adapted to each fish species
Pre-dam	Succession of heads and ponds of large dimensions – head between ponds from 30 cm and 40 cm	< 3 m	Salmon species, running water, Cyprinidae, shads	Fairly sensitive to variations in upstream water levels - very appropriate to specific dam configurations (steep slope, river arm)
Lift	Trapping of fish in a weir basket, mechanical lifting in a tub	No limit	All species	The lift is generally associated with a device such as fish passes with ponds for the downstream part
Rough-bottomed pass	Raft or river arm with a slope of 3 to 7%, equipped with rough bottoms and /or ± porous crests	< 3 m	All species	The slope, the discharge per metre of width and the placing of the rough elements must be adapted to each species
Specific fishpass	Ramps with specific substrata (brushes, blocks) with slopes of 30 to 60°	< 20 m	Elvers and young eels	Special device for young eels, requiring a small water supply

Devices for the downstream swimming path

As far as the downstream swimming path is concerned, the devices aimed at limiting the passage of fish into turbines are based on the combination of:

- a physical barrier made from a screen with narrowly spaced bars,
- of one and more outlets allowing the evacuation of fish downstream,
- or equipping the plant with a 'fish-friendly' turbine which, on account of its special features (low rotation speed or geometry of the blades, for example) reduces the risk of fish deaths during their passage through the turbine

Certain hydrodynamic conditions must be sought for the functioning of these devices (barriers or outlets) so as to:

- limit the risk of throwing the fish against the screen (on account of a too strong current).
- facilitate their drive through the outlets (through the presence of a tangential speed at the screen).

III. 4. Rationale for the project

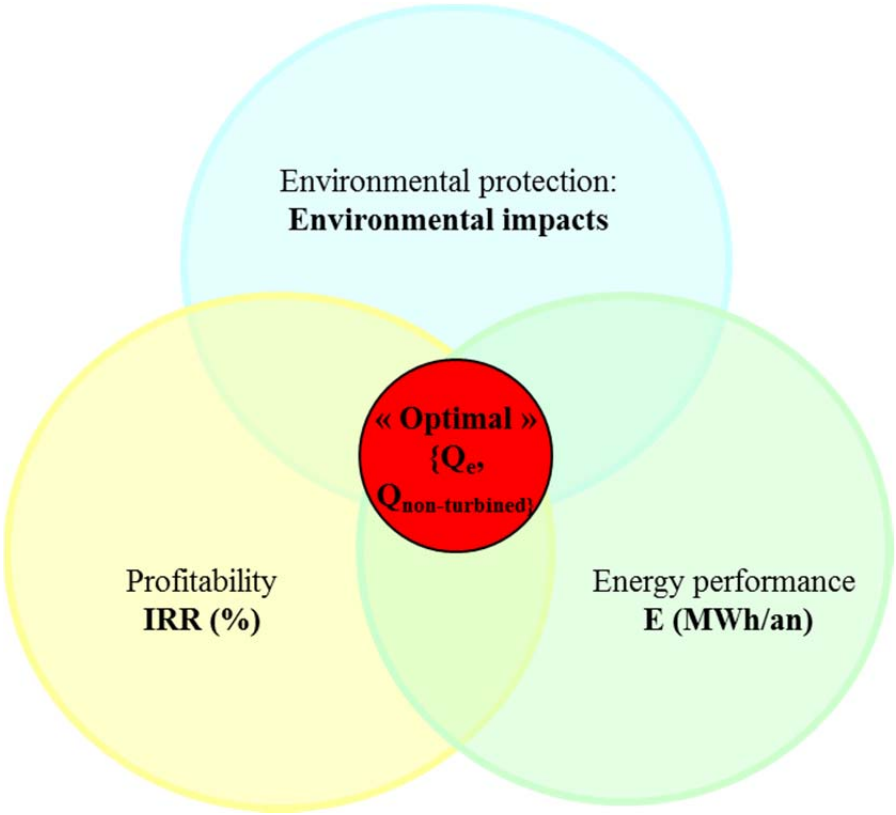
The promoter of a SHP project has to take up a triple challenge:

- To contribute to achieving the renewable energy development objectives of the *Grenelle de l'Environnement* by making the most of the energy potential of a site;
- Through a development which respects the environment;
- And one which is economically viable, the essential condition for implementing it.

The "optimal" project will be found at the junction of the technical, environmental and economic spheres, as represented by the diagram below.

It must be emphasized that the "optimal" project for a given site is not unique, for the following main reasons:

- the environment impacts are sometimes difficult to quantify;
- every project promoter has his own criteria for investing.



The procedure for considering an application for a permit does not require the promoter to demonstrate that his proposed project is ideal, nor to present its economic performance. However, a rationale for the project showing **the energy advantages arising from creating an impact on the environment** will enable stakeholders to evaluate its soundness.

The energy performance of a development is linked to many parameters, of which the two main ones the promoter must determine are **the installation discharge from the works and the non-turbined discharges**.

The energy aspects of the project can be explained in two documents of the development permit application:

- in document 3 "Main characteristics of the project and technical rationale" (see Appendix IV.3) ;
- in the environmental impact study/assessment (document 4), which includes a chapter entitled "Rationale for the project". The theme of this chapter must be taken up again in a pedagogical manner in

the non-technical summary of the impact study/assessment, which is often the one of the only documents of the application which are actually read in detail by the general public.

The present guide proposes a methodology for justifying the optimal character of the project and a model for presenting the results. While the presentation of these results can be made in different ways, it seems essential to draw the attention of the stakeholders to the sensitivity of the energy and economic performances of a project in relation to the choice of discharge equipment Q_e and of non-turbined discharges, $Q_{non\text{-}turbined}$.

A brief reminder of important hydroelectricity principles

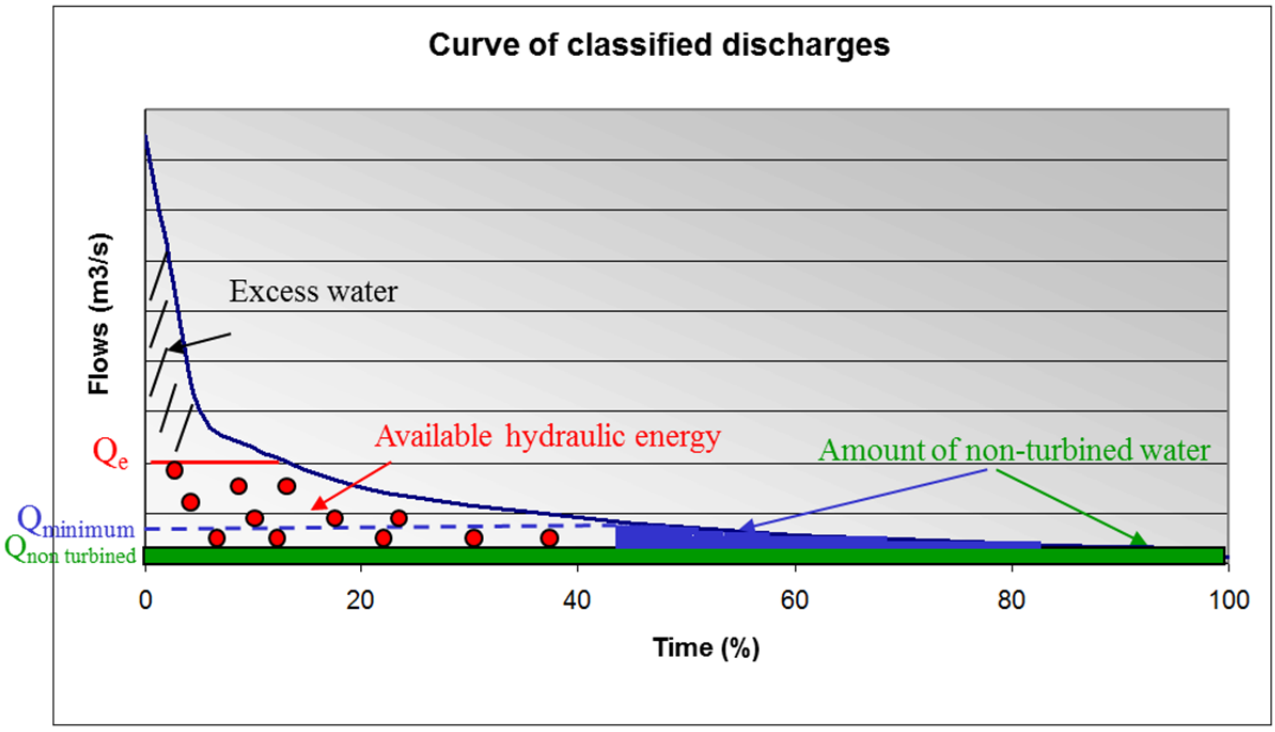
The energy performances of a hydroelectric plant functioning in the current can be quickly worked out from the curve of classified flows, which, by indicating the frequency of the flows, characterizes the hydrology of a river.

The producible of such a plant, equipped at Q_e and leaving the $Q_{non\text{-}turbined}$ permanently in the by-passed section of the river and/or in the fishway installations, is equal to the area of the surface comprised between the classified discharge curve, clipped by Q_e, and the horizontal line of $Q_{non\ turbined}$ or $Q_{minimum}$ ordinate. The minimum discharge is the minimum discharge which can be handled by the hydroelectric turbine. The ratio Q_e / $Q_{minimum}$ depends on the type of turbine. It usually ranges between 0.2 and 0.6.

The determination of the installation's discharge is conditioned by technical and economic imperatives:

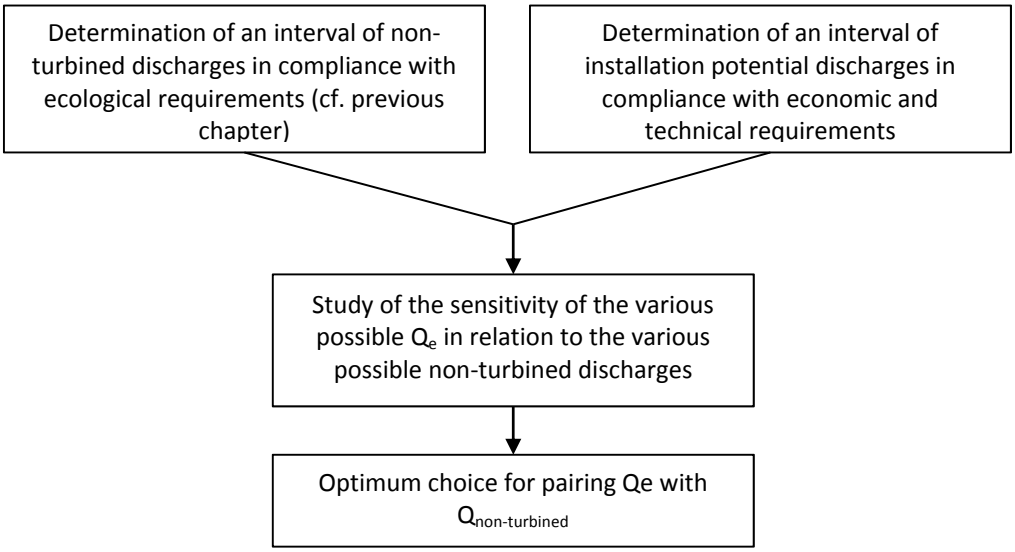
- An installation discharge which is too high requires high investment and restricts the operation of the plant to the high water season. Indeed, the turbine stops as soon as the discharge falls below the minimum discharge level.
- An installation discharge which is too small allows the plant to function practically throughout the year but a large part of the flow will be discharged above the crest, which results in a total energy loss. In that case, the impact on the environment is reduced, but not to nil, and for a low energy output.

The notions described above are illustrated in the following scheme:



Proposed methodology

The methodology proposed here to describe a project which reconciles the requirements of energy efficiency, of preservation of the environment and profitability is broken down into four stages, the first two of which are carried out simultaneously. This methodology is summarised in the diagram which follows.



An example of the application of the methodology and of the presentation of the results

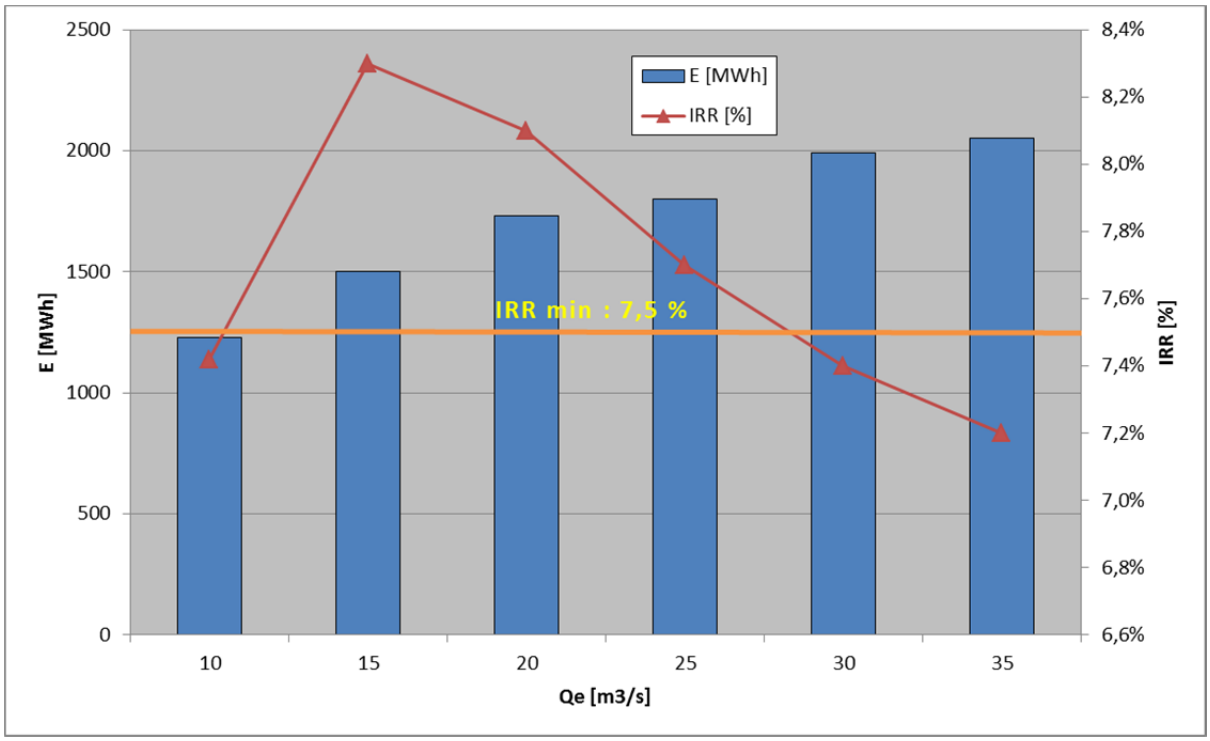
Take a small hydroelectric plant project for a river in France. The project's promoter is attempting to maximize his plant's producible. He is prepared to increase the amount of non-turbined discharge slightly, as long as the Internal Rate of Return of the project remains above the lower amount of return on investment which he has set at 7.5% and as long as his energy performances justify the impact on the site.

In the first place, the minimum discharge and the discharge allocated to the fishways are calculated according to the methods described in chapter III.2. In this case study, the minimum non-turbined discharge must be included in the range [10% of the average discharge; 15% of the average discharge].

Secondly, the range between the possible installation discharges which would comply with the energy and economy requirements of the project are determined as follows:

- the non-turbined discharge is taken to be equal to 10% of the average discharge of the river,
- several of the installation discharges are tested,
- for each of the installation discharges tested the producible and the profitability of the plant are calculated (the IRR, or Internal Rate of Return, is used here as the economic indicator).

The results are shown on the graph below.



Evolution of energy and financial performances of the proposed installation in relation with the choice of Q_e

with $Q_{non\text{-}turbined}$ = 10% of average discharge of the river

(In this example, the average flow of the river is equal to 25 m^3/s)

The graph highlights:

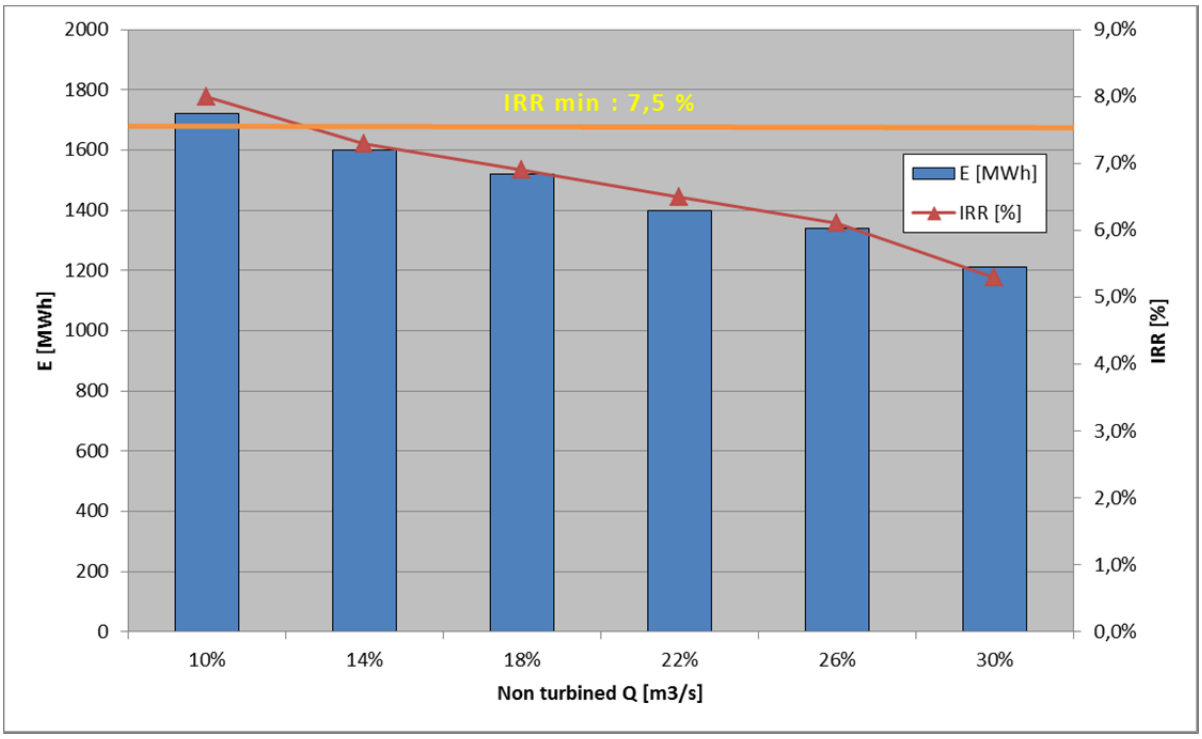
- a range of installation discharges (between 15 and 25 m^3/s, i.e between 0.6 and 1 times the average discharge) which enables the project to show an internal rate of return above the developer's projected lowest rate (i.e 7.5%). It must be said that the non-turbined discharge is taken at the level of the lower limit of the interval.
- the economic optimum, which is reached with an installation discharge equal to 0.6 times the average discharge;
- the fact that, within the range of discharges [15 m^3/s, 25 m^3/s], the producible amount increases with the installation discharge.

In order that the project should contribute as far as possible to the national objectives of renewable energy production, the promoter has decided in this case to move slightly away from the goal of economic optimization so as to increase the annual producible amount. An installation discharge amount of 20 m^3/s was therefore finally selected.

Thirdly, the installation discharge is fixed at an amount taken within the range of installation discharges chosen, and several amounts of non-turbined discharge are tested. For each of these, the producible amount and the profitability of the development have been calculated.

The exercise is repeated with another figure for the works discharge. And so on.

The results of part of this analysis (for a figure of $Q_{e)}$ are represented by the following graph.



Evolution of the energy and financial performance of the proposed development with Q_e = 20 m^3/s in accordance with the choice of $Q_{non-turbined}$

The graph shows that with an installation discharge fixed at 20 m^3/s, the non-turbined discharge can be increased to 12% of the average discharge of the river without reducing the profitability of the project to a figure below the developer's lower threshold.

An installation discharge of 20 m^3/s and a non-turbined discharge equal to 12% of the inter-annual average discharge were finally chosen. In these conditions, the Internal Rate of Return is 7.6%.

III.4. Compatibility of the project with the *Directive Cadre sur l'Eau* (Water Regulatory Framework)

A short history of the *Directive Cadre sur L'eau*

The *Directive Cadre sur l'Eau* (DCE) was decreed on 23 October 2000 by the Parliament and the Council of Europe; it defines « a framework for the Community's policy with respect to water » and thus organizes the management of water resources in all the member states.

This directive has been integrated into French law in 2004 and has given birth, two years later, to the *Loi sur l'Eau et les Milieux Aquatiques* (LEMA), or Law on Water and Aquatic Environments.

What is it actually about?

The DCE requires the member states to commit themselves to achieving the goals defined at article 4a):

« i) les Etats membres mettent en œuvre les mesures nécessaires pour prévenir la détérioration de l'état de toutes les masses d'eau de surface […] ;

ii) les Etats membres protègent, améliorent et restaurent toutes les masses d'eau de surface […] afin de parvenir au bon état des eaux de surface au plus tard quinze ans après la date d'entrée en vigueur de la présente directive ».

" i) the member States will apply the necessary measures to prevent the deterioration of all surface bodies of water [...]

ii) the member States protect, improve and restore all surface bodies of water [...] in order to attain a healthy state of surface water masses at latest fifteen years after the date of application of the present directive."

In simple terms...

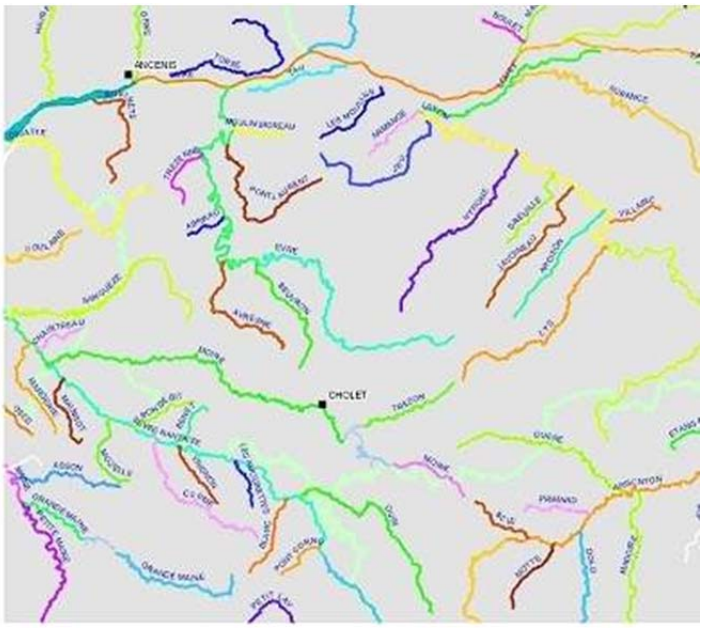
➔ <u>bodies of water</u>

They correspond to a river or part of a river and its arms; they constitute a homogeneous aquatic whole.

Bodies of water have been identified per large hydrographic basin (at the level of the SDAGEs), according, among other aspects, to the size of the waterway and its geographic location.

They can be linear (rivers or sections of rivers) or dammed up (reservoirs).

For surface bodies of water, a distinction is made between "natural' bodies of water, highly modified bodies of water, and artificial bodies of water (canals, artificial lakes, etc.).



Example of the identification of bodies of water (one colour per body of water)
Agence de l'Eau Loire-Bretagne

➔ <u>objective concerning the condition of bodies of water</u>

Each body of water mass must achieve a "healthy condition", that is, must enjoy both sound chemical and ecological conditions.

Soundness of the chemical state is evaluated with reference to a list of dangerous substances for which environmental quality standards have been set. It is not very relevant to small hydroelectricity projects.

Ecological condition, on the other hand, is assessed on the basis of several biological parameters in conjunction with hydromorphological parameters (for example: hydrological behaviour during high and low water marks, transport of sediments etc.) as well physicochemical parameters (for example: oxygen count, concentrations of nutriments, acidification...).

With regard to bodies of water which are already highly affected by human activity and artificial bodies of water (canals, artificial lakes, etc...), one refers to "good ecological potential"; any project concerning this type of body of water must maintain or support efforts aimed at achieving this good potential.

Moreover, the goal of **non-degradation** set by the DCE implies an obligation not to degrade the condition of bodies of water, except for exemptions allowed under strict DCE supervision, which implies in particular that bodies of water currently enjoying a very healthy ecological condition must retain this status, which is highly sensitive to any alteration of the components of hydro-morphological quality (morphology, hydrological system, ecological continuity in the case of rivers).

➔ <u>the tools</u> available under French law for achieving these objectives (LEMA)

- the **new classifications** of waterways according to article L214-17 of the *Code de l'Environnement*:
  - « 1° Une liste de cours d'eau, parties de cours d'eau ou canaux parmi ceux qui sont en très bon état écologique ou identifiés par les schémas directeurs d'aménagement et de gestion des eaux comme jouant le rôle de réservoir biologique nécessaire au maintien ou à l'atteinte du bon état écologique des cours d'eau d'un bassin versant ou dans lesquels une protection complète des poissons migrateurs vivant alternativement en eau douce et en eau salée est nécessaire, sur lesquels aucune autorisation ou concession ne peut être accordée pour la construction de nouveaux ouvrages s'ils constituent un obstacle à la continuité écologique.

    Le renouvellement de la concession ou de l'autorisation des ouvrages existants, régulièrement installés sur ces cours d'eau, parties de cours d'eau ou canaux, est subordonné à des prescriptions permettant de maintenir le très bon état écologique des eaux, de maintenir ou d'atteindre le bon état écologique des cours d'eau d'un bassin versant ou d'assurer la protection des poissons migrateurs vivant alternativement en eau douce et en eau salée ;
  - 2° Une liste de cours d'eau, parties de cours d'eau ou canaux dans lesquels il est nécessaire d'assurer le transport suffisant des sédiments et la circulation des poissons migrateurs. Tout ouvrage doit y être géré, entretenu et équipé selon des règles définies par l'autorité administrative, en concertation avec le propriétaire ou, à défaut, l'exploitant. »
  - "1° A list of rivers, parts of rivers or canals among those which are in a very good ecological condition or which have been identified by the SDAGE as playing the role of essential biological sanctuaries for the preservation of a good ecological condition or for achieving such a condition within the rivers of a catchment area or for rivers in which full protection of migrating fishes living alternately in fresh and salt water is necessary. For such waterways, no authorization or concession can be granted for the construction of new works if they represent an obstacle to ecological continuity.

    The renewal of the concession or the permit for existing works, installed on these rivers, parts of rivers or canals with due respect to regulations is subject to prescriptions ensuring the preservation of the waters in very good ecological condition, the preservation or achievement of the healthy ecological condition of the rivers of a catchment area or the provision of full protection for migrating fishes living alternately in fresh and salt water;
  - 2° A list of rivers, parts of rivers or canals in which it is necessary to ensure sufficient movement of sediments and circulation of migratory fish. Any installation there must be managed, maintained and equipped according to regulations established by the administrative authority, in consultation with the owner or, alternatively, the operator. "

These new classifications, which are currently being prepared, will replace the present classifications (for reserved or classified rivers) as from 1 January 2014 at the latest.

- The **SDAGE**s contain a pre-identification of biological sanctuaries, as well as the objectives and actions to be undertaken for each large hydrographical basin. In particular, the objectives concerning the ecological and chemical condition of the water masses and the related deadlines are defined in the SDAGE for each body of water. This must be translated into practical methods of implementation. The LEMA requires justification of the compatibility of any project linked to the aquatic environment with the stipulations of the SDAGE.

♦ The **SAGE**s represent the means of applying the DCE in practice. Any development project must therefore also be compatible with the SAGEs. Opposition to the SDAGEs can be lodged by third parties.

WARNING:

The precise methods for assessing the compatibility of the project with the objectives for the condition of bodies of water of the *Directive Cadre sur l'Eau* will be defined in the documents to be published by the Ministry responsible for Ecology (circulars, technical guides,...). These documents, when published, will supersede the present guide.

Implications for SHP projects

The applicant must provide arguments to justify the compatibility of his project with the SDAGE; he must, in particular, demonstrate:

1. that his project does not jeopardize, but in fact may participate in the drive to achieve the objectives targeted for the body of water on which he proposes to intervene.
2. that his project will not degrade the ecological condition of the body/bodies of water which might be affected by it.

The environmental impact study/assessment must therefore be carried out at two levels:

- the "local" project implementation level;
- the "global" level, which provides the possibility of checking the implications of the project's implementation for the aquatic zone which has been defined as being concerned by the project.

Indeed, even in a case where the impact of a single installation is limited one body of water, the cumulative effects of a new project added to existing water utilisation of this same body of water may end up having quite a large impact on habitats.

For example, as far as fishways are concerned, a single installation equipped with a good fishway may permit adequate fish circulation, but if there are several installations to cross, the fishway conditions of the installations as a whole must be examined.

The project analysis must be conducted both at local level (for example, the project's catchment area) and at global level (the body of water, or the various bodies of water taken as a whole on which the impacts of the project

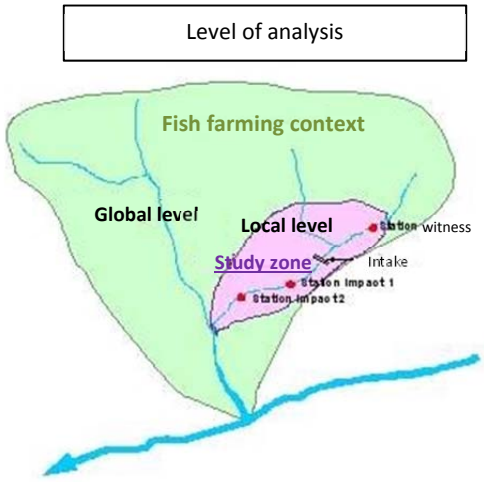


Figure 1 : Definition of the levels of analysis of a SHP project
After ONEMA

What can be found in this global analysis which is not in the environmental impact study/assessment?

The global analysis is an aspect of the environmental impact study/assessment. Its exact contents will depend on the type of body of water and the objectives planned for it, but its general plan will be as follows:

- presentation of the zone under analysis (body of water or bodies of water as a whole, consistent with the anticipated impacts of the project). The purpose is to supply general information on the zone's boundaries and its main characteristics (area and/or linear, present condition, utilizations, challenges and DCE goals, sensitive parameters at the monitoring stations);
- evaluation of the project impacts on the zone being studied, including the cumulative impacts in connection with other utilizations or works existing in the zone;
- evaluation of the remaining impact;
- compensatory measures proposed;
- analysis of the project's compatibility with the objectives stipulated in the regulations, with reference to the direct impacts and cumulative remaining impacts.

The detailed analysis – at local level – relies on the results of onsite samplings carried out within the framework of the environmental impact study/assessment; the global analysis, on the other hand, can be based, in particular, on the synthesis of the monitoring indicators of environmental conditions carried out according to the DCE framework. However, the information supplied by these indicators must be confirmed by other available information about the condition of the habitats, the pressures brought to bear on them, and on the impact of these pressures on the habitats.

The global analysis must specifically enable a sound assessment of whether the residual impact of the project, combined with the existing pressures on the zone of study, risks impairing the achievement of the objectives for the conditions of the bodies of water involved.

How should one proceed?

It is important to emphasize that the global analysis relies on **existing data** concerning, for instance, present utilizations of the river. The applicant does not need to produce the data himself, but he must use it to carry out his analysis. The data collected must be sufficiently complete to enable a viable evaluation of the project's impacts at global level.

In order to achieve this, the applicant must know, in particular:

- the body of water in which the project will be located and its status (highly modified body of water, artificial or natural body of water);
- the known characteristics of water-connected human activities occurring within this body of water;
- the issues and objectives associated with the body of water, so as to achieve the required condition (good condition or potentially good condition for highly altered bodies of water, absence of degradation) within the allocated deadlines;
- in some cases, information must also be researched concerning adjacent bodies of water needing to be taken into account within the framework of a global analysis of the project's impacts on the aquatic habitats.

The WPS, which has a global knowledge of the territory, can help the project developer to define and describe the appropriate zone for analysis; it will be the main point of contact to gather the information needed for the analysis. This subject must be discussed during the first project presentation meeting.

Thus, the applicant's local vision is integrated within the global vision contributed by the local authority services.

The WPS participates in the definition of the global zone to be analysed. It contributes to a sound understanding of the issues and objectives connected with this zone, and to the determination of compensatory measures; its role is to **transmit the correct information** which will enable the applicant to successfully carry out an effective and consistent analysis.

The applicant, for his part, is **responsible for the proposed compensatory measures**. Although the State services play a key part in defining these measures, it is not up to them to conceive them.

Comment on the compensatory measures [4]

French law is structured in such a way that, in the case where a project might have an impact on the environment, the project developer must, in sequence:

- avoid it;
- if this is not possible, attempt to reduce the impact;
- if that is not possible, provide compensation for it.

Compensation only occurs at the end of the process, when the other methods (avoidance, or reduction of impact) have been found to be impossible to apply or insufficient. Compensation then applies to the impact remaining after putting in place the measures required to reduce the initial impact. **The remaining impact must therefore be evaluated at the end of the environmental impact study/assessment, before proceeding to define eventual compensatory measures.**

In order to be effective, the compensatory measures must fulfil certain criteria:

- spatial consistency must be sought after. It is not always feasible, but it is preferable that compensation should occur within the body of water or the bodies of water, as a coherent whole, impacted by the project;
- there must be an equitable ratio between the compensatory measure applied and the degree of impact. In some cases, indications concerning the type and scope of the compensatory measures can be found in the SDAGEs. This does not always happen; the applicant must propose appropriate measures and justify their proportion with regard to the subsisting impact.

The compensatory measures are taken into consideration in the analysis of the compatibility of the project with the objectives set by the DCE.

Their feasibility must be demonstrated in the study, and their cost estimated.

Among the compensatory measures, a financial contribution to installations connected with the management of the aquatic environment can be envisaged. Compensation then takes the shape of financing rehabilitation actions or participation in programmes existing for the body/bodies of water affected by the works. In certain cases this may amount to payment of the fish farming dues when the fishermen's federation engages in a rehabilitation activity which has been recommended for the body of water concerned (warning: a fish farming management activity must not be confused with a rehabilitation activity and does not provide compensation for the impact on the achievement of the objective of good water condition).

While certification in itself is not a compensatory measure, it provides a mastery and a stronger management of impacting elements.

Opportunities for compensatory measures must also be discussed with the Water Police Service. They will depend on the type of body of water and the objectives associated with it (on a highly altered body of water, the achievement of a good potential condition does not require the same installations as for the achievement of sound condition for a natural body of water) and above all the compensations will depend on the real subsisting impact of the project. At the level of the body of water, the definition of the compensatory measures is based in the first place on the eventual losses in normal functioning of the habitats, whether they may be linked to the project's implementation or not. The rehabilitation of damaged functionality may thus be considered a compensatory measure, even if the damage is not connected with the project.

[4] The compensatory measures can concern the local level as well as the global level.

IV. APPENDICES

IV.1. Glossary

ADEME	***A**gence **D**e l'**E**nvironnement et de la **M**aîtrise de l'**E**nergie* ; French Environment and Energy Management Agency
BRS	**B**y-passed **R**iver **S**ection
CEMAGREF	Today IRSTEA : ***I**nstitut national de **R**echerche en **S**ciences et **T**echnologies pour l'**E**nvironnement et l'**A**griculture*, the national science and technology research institute for the environment and agriculture
Code de l'Environnement	French regulations concerning the environment
DCE	***D**irective **C**adre sur l'**E**au*, a regulatory framework adopted on 23 October 2000 by the European Parliament
DDT	***D**irection **D**épartementale des **T**erritoires* : the local government service (at D*épartement* level) in charge of roads, lodging, agriculture, forests, water and territory planning in general
DUP	***D**éclaration d'**U**tilité **P**ublique* : legal procedure in French law that permits the installation of a work (infrastructure for example) on private land expropriated for reasons of public
Grenelle de l'Environnement	The aim of this Environment Round Table, instigated by the President of France in 2007, is to define the key points of government policy on ecological and sustainable development issues for the following five years.
HYDRO bank	French data bank gathering the results of all flow measurement stations installed in rivers
LEMA	***L**oi sur l'**E**au et les **M**ilieux **A**quatiques*, the law concerning Water and the Aquatic Environment
Macrophyte	Aquatic plant visible to the naked eye
ONEMA	***O**ffice **N**ational de l'**E**au et des **M**ilieux **A**quatiques*: the State department concerned by Water and the Aquatic Environment
Qe	Power house discharge, that is, the maximum discharge which can be used at the power house
Qr	Compensation water discharge, that is, the minimum discharge left in the river bed
SRCAE	***S**chémas **R**égionaux **C**limat **A**ir **E**nergie* : Regional plans for climate, air and energy, defined by the *Grenelle de l'Environnement*
SDAGE	**S**chéma **D**irecteur d'**A**ménagement et de **G**estion des **E**aux: Master Plan for Water Development and Management : there are 6 SDAGEs in metropolitan France, one for each of the great hydrographical basins
SHP	**S**mall **H**ydroelectric **P**lant
WPS	Water Police Service (see § IV.4.)
ZNIEFF	***Z**one **N**aturelle d'**I**ntérêt **E**cologique, **F**aunistique et **F**loristique* : natural area of ecological, fauna and flora interest

IV.2. Administrative Procedures

The preparation of a SHP project may require that certain administrative procedures be carried out, in addition to the request for permission to take advantage of hydraulic energy. It is sometimes required that the permit application should include proof that these procedures have been carried out. They must therefore be undertaken in good time so as not to delay the submission of the permit application.

The most usual procedures are listed below (the list is not exhaustive). They are not systematic; it is important to check with the local authorities as early as possible whether it will be necessary to undertake them.

The request for authorization according to the characteristics of the project and the works under the « water legislation » section of the *Code de L'Environnemnent*

♦ Article L214-3 of the *Code de l'environnement* :

« Sont soumis à autorisation de l'autorité administrative les installations, ouvrages, travaux et activités susceptibles de présenter des dangers pour la santé et la sécurité publique, de nuire au libre écoulement des eaux, de réduire la ressource en eau, d'accroître notablement le risque d'inondation, de porter gravement atteinte à la qualité ou à la diversité du milieu aquatique, notamment aux peuplements piscicoles. »

" Developments, installations, works and activities which may present hazards to public health and safety, which may affect the free flow of water, reduce water resources, significantly increase the risk of flooding, or have serious effects on the quality and diversity of the aquatic environment, and to the fish population in particular, must be subject to authorization from the administrative authorities."

♦ See also : L214-1 to 11, R214-1 to 5, R214-6 to 40 of the *Code de l'Environnement*

The evaluation of Natura 2000 occurrences

♦ Article L414-4 of the *Code de l'Environnement* :

« Lorsqu'ils sont susceptibles d'affecter de manière significative un site Natura 2000, individuellement ou en raison de leurs effets cumulés, doivent faire l'objet d'une évaluation de leurs incidences au regard des objectifs de conservation du site, dénommée ci-après " Evaluation des incidences Natura 2000 " :

1° Les documents de planification qui, sans autoriser par eux-mêmes la réalisation d'activités, de travaux, d'aménagements, d'ouvrages ou d'installations, sont applicables à leur réalisation ;

2° Les programmes ou projets d'activités, de travaux, d'aménagements, d'ouvrages ou d'installations ;

3° Les manifestations et interventions dans le milieu naturel ou le paysage. »

"When they may significantly affect a Natura 2000 site, either individually or by reason of their combined effects, the following documents must be assessed with regard to their impact on the conservation objectives for the site, called thereafter: "Assessment of Natura 2000 impacts":

1° Planning documents which, while they do not in themselves represent permission to undertake activities, works, developments, or installations, are applicable to their execution;

2° Programmes or projects for activities, works, developments or installations;

3° Demonstrations or interventions in the natural environment or the landscape."

The application for permission to clear woodland

♦ Article L311-1 of the forestry Code stipulates that "no person can take upon himself to clear his woods without having obtained permission beforehand"; this applies not only to individuals but also to local authorities or legal entities. However, below a threshold determined at departmental level, clearings may be exempted from permit applications; this threshold is in the range of 0.5 and 4 hectares for privately owned woods.

The application permit to occupy public river space

♦ Article L2124-8 of the *Code de la Propriété des Personnes Publiques*:

« Aucun travail ne peut être exécuté, aucune prise d'eau ne peut être pratiquée sur le domaine public fluvial sans autorisation du propriétaire de ce domaine.

Les décisions d'autorisation fixent les dispositions nécessaires pour assurer notamment la sécurité des personnes et la protection de l'environnement. »

"No work may be undertaken, no water intake can be made on public river space without the permission of the owner of that space.

The decisions to grant permits define the necessary conditions to ensure, in particular, security of persons and protection of the environment."

Assessment of occurrences under the « biotope protection by-law »

If a by-law for biotope protection exists for the project zone, its contents must be consulted to find out about forbidden activities or activities for which permission is needed.

Declaration of a project in a heritage site and special request for developing a project within a classified site

♦ Article L341-1 of the *Code de l'Environnement*:

« L'inscription entraîne, sur les terrains compris dans les limites fixées par l'arrêté, l'obligation pour les intéressés de ne pas procéder à des travaux autres que ceux d'exploitation courante en ce qui concerne les fonds ruraux et d'entretien normal en ce qui concerne les constructions sans avoir avisé, quatre mois à l'avance, l'administration de leur intention. »

"Listing involves, on lands included within the decreed limits, the obligation for the persons involved to refrain from proceeding with any works other than those of current operations concerning rural possessions and of normal maintenance of constructed works, without having informed the local authority of their intention four months beforehand."

♦ Article L341-10 of the *Code de l'Environnement*:

Natural monuments or classified sites cannot be destroyed nor have their condition or aspect altered without special permission.

The construction permit or declaration

According to the size of the hydroelectric production power house and the technical buildings, it may be necessary to file a construction permit request or a declaration. See articles L421-1 to L421-8 of the *Code de l'Urbanisme* (town planning regulations).

IV.3. Documents required for a permit application

This appendix provides a reminder of the headings and contents of the documents required for a permit application.

Documents 1 and 2: the name and address of the applicant ; the site on which the works will be installed

- Provide a general location plan, to the scale of the department for example, and a plan of the local situation (to the scale of the district, and overlaid on the cadastral plan if possible, or on the IGN Scan25©); the river or rivers must be clearly identified.

Document 3: the main characteristics of the most important installations and their technical specifications: maximum discharge drifted, maximum height of gross head, maximum gross power, stockable volume, compensation water discharge

- Demonstrate the energy optimization of the site and the appropriateness of the technological choices to the environment characteristics.

Document 4: Environmental impact study

- Adapt the contents to the real issues of the project,
- Clearly define the zone under study,
- Provide a sound diagnosis of the original condition,
- Pay attention to the validity of the data and the protocols,
- Analyze all the impacts and present corrective and compensatory measures.

Documents 5, 6 and 7: Plan of the lands submerged at the normal damming up level, graphic elements, lengthwise profile of the waterway affected by the development, as well as that of the drift

- Choice of the appropriate scale,
- Fishway works must be localized and sized right at this stage, otherwise the services concerned will not be able to express their opinion on their appropriateness for the environment and the species present at the site.

Document 8: Indications concerning the first works to be installed upstream and downstream and having hydraulic effects

- Position and characteristics to be defined (height, utilization, etc...). Contact the authorities to obtain a copy of the permits

Document 9: Time-scale of the permit requested and probable duration of the works

- The law of 1919 provides for a maximum duration of 75 years ; in general, permits are granted for 40 years ;
- The likely duration of the works must be assessed with enough precision to enable correct estimation of the project's impacts (environmental study/assessment of the works installation phase).

Document 10: Rough estimate of expenditure

- Highlight environmental expenditure. This document is a tool to assist decision-taking. Its purpose is to estimate the economic return of the development. The economic return for the applicant (investments, income, and maintenance) is considered, as well as the return for the community (environmental costs and benefits). This document only deals with the solution chosen, in contrast to the chapter on "rationale for choosing a solution" of the environmental impact study/assessment. It therefore needs to describe in greater depth the costs and benefits of the project (in the financial and qualitative sense).
- It must also include the cost of corrective and compensatory measures and an estimation of their effectiveness with regard to the impact involved.

Document 11: Explanatory note describing the applicant's technical and financial capabilities and the nationality conditions prescribed at article 26 of the law of 16 October 1919 concerning the utilization of hydraulic energy

Document 12: Any document enabling the applicant to establish that he will, before the public enquiry is launched, have obtained the right to dispose freely of the plots of land falling outside public property limits on which the works will be installed

- Title deeds or sales agreements

Document 13: If clearing of land is necessary, as defined by the *Code forestier* (forestry Code), a document describing the location and area of the woodlands concerned and the clearings anticipated, as well as an estimation of their effect on flood.

- Clearing is defined as a « voluntary operation intended to destroy the woodland character of a plot of land and put an end to its forest existence ». We are therefore talking here of a permanent effect transforming a woodland plot into a space with a different vocation (damming, buildings, road...).
- It is necessary to check with the DDT of the department concerned by the project to find out whether or not it is necessary to file a request for clearing land. The purpose of the document concerning land clearing is to confirm the need for this operation, and its harmlessness, in particular with regard to run-offs in case of flooding.
- Localization of the site must be done on the land register.

Document 14: Agreements reached with the Department Council or districts

Obsolete

Document 15: For power plants of more than 500 kW, the proposed sharing between the districts concerned of the property value of the head and its installations

Cf. taxation regulations

Document 16: Draft water management regulations, established according to the water management regulations appended to article R.214-85 of the *Code de l'Environnement*, including supplements and exemptions to this model for water management regulations

Document 17: Indication of the means of surveillance and intervention in case of incident or accident

Section 9 of R214 of the *Code de l'Environnement* sets the conditions applicable to the surveillance and operation of works as well as the operator's obligations. This document must enable verification of the conformity of the operating instructions stated in the application with current regulations, and specially to check that the operator and/or the owner understand/s them.

It is pointless therefore to be content with a mere sentence declaring that "the instructions concerning surveillance and maintenance will be in conformity with current regulations".

Document 18: Compendium of the instructions for surveillance in all circumstances and instructions for operation at times of flooding

Instructions for operation in periods of flooding are particularly important for works which may constitute an obstacle to the outflow of flood waters; their operation must ensure that the risk of flooding neighbouring zones is not increased.

Document 19: the assessment of potential dangers

The study of dangers is essential for compliance with the *Code de l'Environnement*'s stipulations concerning "retention dams and canal dykes" bearing classification A or B.

Dam classification has been defined in decree n°2007-1735 relative to the security of hydraulic works. The contents of the assessment of dangers are stipulated in the decree of 12 June 2008, which defines the plan for the assessment of the dangers of dams and dykes.

Particular care must be taken in writing up the non-technical summary which, as its name implies, must enable anyone and everyone to understand the issues. The elements of the study as a whole must therefore be reported in it in clear language, illustrated with simplified tables and diagrams. It is essential to clearly describe the probabilities linked to each of the events studied.

This didactic approach is not exclusively reserved to the non-technical summary; the whole of the study must be understandable by non-specialists, in order to avoid misinterpretation at the public enquiry stages.

Document 20: Explanatory note on security measures during water priming

Concerns the creation of new dams (priming)

Document 21: Applicable when the applicant is a local authority or a group of local authorities requesting a DUP (Derogation for Public Utilization)

- Plan of the perimeter concerned by a temporary or permanent land occupancy
- Advice of the public property ownership service
- Table of compensations for non-utilized water rights
- Proposals for returning in kind water rights already utilized and plan of the plots of land subject to servitudes with regard to these returns.

IV.4. Services and organisations involved in the consideration of a permit request for the installation and operation of a hydroelectric plant

The WPS (Water Police Service)

This is the department which vets permit applications on behalf of the *préfet* or local government authority.

In general, it is a service of the *Direction Départementale des Territoires* (and also, eventually, of the sea). In certain cases, the WPS is part of the navigation control service.

The WPS is the key contact of the applicant, his entry point into the administrative circuit.

During the official permit application consideration process, its mission is to gather the views of the various other services and organisations concerned by an application. It conducts the examination of the application itself, paying particular attention to the section about "effects on water and aquatic habitats", while relying on the technical support of ONEMA.

The **ONEMA** (*Office National de l'eau et des milieux aquatiques*), created to implement the 2006 law on water and aquatic environments, is a State department. It is the major French technical organization concerned with knowledge about and surveillance of water conditions and the ecological functioning of aquatic environments.

Its inter-regional offices (9) and departmental services provide technical support to the Water Police Service, particularly with regard to the analysis of data relating to the ecology of aquatic habitats, to biological minimum discharge and to the methods used to assess it, to fishway installations, the approach to downstream migration problems, etc.

Officials of the WPS and the ONEMA may later carry out monitoring checks to ensure compliance with the regulations decreed at the time of permit application approval.

What are the other main services or organizations involved?

The **DREAL** (Regional Direction of Environment, Land settlement and Lodging) is the regional office responsible for implementing national policy regarding:

- energy
- management of natural resources, sites and landscape
- assessment of impacts on the environment

It is the service responsible for the latter specialized aspect which will analyze the environmental impact study/assessment in all its dimensions (natural land habitats, landscapes, sites, noise, etc.).

It must be emphasized that the WPS, as the only entry point into the process, cannot have all the information necessary for the preliminary study. It is therefore essential to have recourse to consultants, specially to target essential aspects or to participate in discussions during the preliminary consultations with the WPS and/or the DREAL.

Since the passing of ordinance n°2009-496 of 30 April 2009, **the *préfet* of the region is the "environmental authority"** with responsibility for giving an opinion concerning hydroelectric permits. In order to fulfil this mission, he relies on the service within the DREAL responsible for assessing environmental impact.

The opinion of the governmental authority on a project must be produced at the public enquiry and also when the draft of the by-law to be proposed by the local authority after the enquiry comes before the CODERST. It is published on the local authority's website.

The CODERST (*Conseil départemental de l'environnement et des risques sanitaires et techniques*) or departmental council for the environment and health and technical risks:

The CODERST has a consultative role concerning all decisions related to the environment, health and technical risks particularly the ICPE (Installations classified for the protection of the environment) authorizations or the Law on water.

Its members are:

- local government representatives (7), including the DREAL, the DDT, the *Agence Régionale de Santé et Protection Civile* (Regional Agency for Health and Civil Protection)...
- representatives of local councils (5): *Conseil Général* and mayors
- representatives (9) of consumer associations, fishermen's clubs, nature conservation associations, the professionals concerned (Chamber of Commerce and Industry, Chamber of Agriculture, Handicrafts Agency), experts (architect, health insurers, ANAH (National Agency of Housing) etc.
- qualified persons (4): hydrogeologist, veterinarian, doctor, etc.

The opinion of CODERST is sought after the public enquiry. The SPE will present to it a synthesis of the hydroelectric permit application (or of changes), of the proceedings for vetting the permit application and the conclusions of the enquiry's chairperson. The WPS will concurrently propose a draft of the permit authorization by-law setting out the adequate conditions, or a draft of rejection of the permit application or again, a draft of the by-law concerning complementary requirements.

The members of the CODERST as a whole are not hydrolectricity nor aquatic habitat specialists.

The applicant can request to be heard by this council or appoint a representative to do so.

In that case it is essential, as was the case for the application submitted for the public enquiry, that simple points be put forward to explain the rationale for the project both in terms of renewable energy production benefits and of the adequate consideration paid to environmental issues (natural habitats, security, in particular) through appropriate corrective and compensatory measures.

It is imperative to be able to prove that the residual impact, which cannot be corrected and which, where the building of a new plant is concerned, always brings "additions" to the environment in comparison with its initial condition, is acceptable in relation to these issues and to the advantages to be derived from energy production.

The advice of the CODERST is merely consultative but experience shows that it is often heeded by the *préfet*.

IV.5. Members of the Science Committee, persons met, writers and translators

➢ **Composition of the Science Commitee**

CEMAGREF	André Paquier
France Hydro-Electricité	Hugues Albanel Xavier Casiot Jean-Pierre Catalan Daniel Farges Jean-Marc Lévy Anne Pénalba Olivier Roussel Ghislain Weisrock
MJ2	Jacques Fonkenell
ONEMA / GHAAPE	Philippe Baran Dominique Baril Alexis Delaunay Michel Larinier

➢ **Persons met**

MEEDDAT	Claire-Cécile Garnier
GHAAPPE	Dominique Courret
WPS Pyrénées Atlantiques	Claire-Emmanuelle Mercier Joséfa Ponté
WPS Hautes Pyrénées	François Steinbrecher
DIREN Midi-Pyrénées	Patrice Beaudelin

➢ **Writers**

ISL Ingénierie	Laurène Bregeault Olivier Crepon Claire Gabarrou

➢ **Translators**

	Monica Maurel
Setec Energy Solutions	Blandine Bascouert