



Reservoir Management

This guideline expands on what is expected by the criteria statements in the Hydropower Sustainability Tools (HST) for the Reservoir Management topic, relating to assessment, management and conformance/compliance. The good practice criteria are expressed for different life cycle stages.

In the Hydropower Sustainability Assessment Protocol (HSAP), this topic is addressed in P-22 for the preparation stage, I-19 for the implementation stage, and O-18 for the operation stage. In the Hydropower Sustainability ESG Gap Analysis Tool (HESG), this topic is addressed in Section 11.

This guideline addresses planning for and management of environmental, social and economic issues within the reservoir area during project planning, project implementation, and operations of the hydropower facility. The intent is that reservoir preparation, filling, and operations are well-managed, taking into account construction, environmental and social

management requirements, power generation operations, maintenance, and multi-purpose uses where relevant.

Reservoir in this context refers to any artificial pondage or lake used by the project for the storage and regulation of water, regardless of whether the hydropower development is labelled as a storage or run-of-river scheme. All hydropower projects create some sort of impoundment or water retention behind the dam wall, which is drawn on through the power station to power the turbines. Reservoirs vary considerably in character depending on many factors. Reservoirs with little storage capacity may be called run-of-river, but there is still some water retention behind a dam wall. **Pump storage** projects will have two reservoirs, an upper and lower.

Reservoir area refers to the area that is inundated when the reservoir is at its maximum operational level, referred to as **Full Supply Level (FSL)**. There may be a dry **buffer zone** on the land above the FSL, often defined for land use planning and reservoir management purposes. The **operating range** of the reservoir is the difference in level between FSL and the **Normal Minimum Operating Level (NMOL)**. The reservoir depth over its area is referred to as the **bathymetry**. Bathymetric surveys will show if siltation is reducing the reservoir water

storage area. **Active storage** is the water above the power station intake that can be drawn on to generate power. **Dead storage** is the water stored in the reservoir that cannot be drawn through the power station intake. In addition, **Reservoir operating rules** will dictate patterns of reservoir water level change.

Assessment

Assessment criterion - Preparation Stage: An assessment has been undertaken of the important considerations prior to and during reservoir filling and during reservoir operations, with no significant gaps.

During the preparation stage, a number of considerations need to be evaluated and optimised with respect to siting, design and planning for the future reservoir. Siting and design are strongly influenced in the first instance by the hydrological resource assessments (see both the Siting and Design and the Hydrological Resource topic guidelines), the analyses of electricity generation potential and demand, and by the geotechnical studies conducted to ensure suitable geology and foundations for the future dam. Technical and financial aspects need to be considered alongside environmental, social and governance considerations. The location, scale and future operational plans may give rise to relatively greater (or fewer) social and environmental impacts compared to other options, and this needs to be carefully assessed through analyses of alternatives (see the Siting and Design guideline). Land tenure, land acquisition and land compensation processes are important governance considerations that need to be well-understood in terms of roles, responsibilities, and social and environmental consequences. Future land and water resource rights and responsibilities for the reservoir and surrounding area need to be clarified at the outset and are likely to differ depending on the focal areas (e.g. fisheries, water abstraction, development, recreational uses).

Assessments during the preparation stage should be embedded within the Environmental and Social Impact Assessment (ESIA) and should separately consider and inform construction and operation stage Environmental and Social Management Plans (ESMPs).

A number of implementation stage activities will need to be undertaken for reservoir preparation purposes, and assessments during the preparation stage should inform the extent and approach required for these activities. Relevant activities might include: resettlement planning; clearing of vegetation; retrieval and appropriate protection for vegetation species that are recognised to be of value; management of contaminated or cultural heritage sites that would be inundated; slope stabilisation and treatment works; construction of boat ramps; establishment of a vegetated buffer zone; and preparation of areas to receive relocated wildlife presently living in the area that will be inundated. The timing of these activities should be carefully planned so that there are no conflicts or interface issues with other aspects of the overall hydropower project development (see the Integrated Project Management guideline). Worker occupational health and safety is an important consideration with the activities undertaken in the reservoir area during the implementation stage (see under the Management criterion below); because the areas can be remote, vast and in some cases forested, there can be high risks that are not managed as closely as those risks on the actual construction worksite.

Assessments to inform operation stage reservoir planning should address: optimising power generation; maintenance requirements; debris management (particularly an issue in monsoon prone parts of the world); multiple uses (e.g. commercial, recreational); safety; flood management; shoreline erosion; reservoir sedimentation; public access and safety; water quality; biodiversity; invasive species; waterborne diseases; and monitoring.

Assessment

Assessment criterion - Implementation Stage: The important considerations prior to and during reservoir filling and during operations have been identified through an assessment process; and monitoring of implementation activities is being undertaken appropriate to any identified issues.

Assessments during the implementation stage beyond those listed for the preparation stage relate to detailed planning for all implementation stage activities in the reservoir area as described

above. Timing and rate of reservoir filling in relation to other management measures is a critical consideration at this stage. Important considerations relating to reservoir filling include: the consequences for dam safety and for downstream flow regimes with the rate of filling; the water quality impacts from decomposition of inundated biomass and soil; and community preparedness and community safety. Modelling of reservoir water quality undertaken for the ESIA should inform expectations on issues arising with reservoir filling. Wildlife rescue programmes may be implemented during reservoir filling as faunal species will migrate to high ground, which may end up becoming islands in the new reservoir area. Monitoring of effectiveness of rescue efforts, and the fate of relocated species, is an important assessment focal area.

Assessment

Assessment criterion - Operation Stage: Ongoing or emerging reservoir management issues have been identified, and if management measures are required then monitoring is being undertaken to assess if management measures are effective.

Mechanisms by which ongoing or emerging reservoir management issues might be identified could include: risk assessments and management plans; stakeholders and community engagement mechanisms; observations by operations and maintenance staff; hydrological analyses; incident reports; contractor communications; monitoring programmes; and periodic reviews of specific consideration areas (e.g. of public access or of notification mechanisms for maintenance related drawdowns).

The reservoir may have an operational life of many decades or even a century. Surrounding communities and developments will evolve over that time, as will governance arrangements, environmental awareness and trends, and societal expectations. Emerging risks or opportunities may be in relation to, for example: climate change related issues; multi-purpose considerations; leveraging of the reservoir for other industries (e.g. tourism, aquaculture, irrigation) or as a vehicle for development (e.g. a source of clean water, fisheries and other livelihoods,

improved water-based transport); public safety; public facilities; lake level fluctuation patterns; timber build up; invasive species; recreational or commercial fishing; reservoir rim erosion; flood management; development in the buffer zone; and modes of travel around the reservoir (walking, cycling, boating, vehicles).

Monitoring may be undertaken by a variety of mechanisms and may include visual observations, water level recording, water quality measurements, reservoir rim stability measurements, or bathymetric surveys to assess reservoir sedimentation.

Management

Management criterion - Preparation Stage: Plans and processes to manage reservoir preparation, filling and operations have been developed.

Sections of the ESMP should address specific reservoir related issues that require management interventions during either the construction or operation stage. Specific planning aspects that may be addressed could include, for example, reservoir vegetation clearance, reservoir rim stabilisation works, wildlife rescue plans for the reservoir filling period, public safety plans, and cultural heritage management plans. The reservoir area may be the focus of an ESMP section or addressed in dedicated management plans for specific actions (e.g. wildlife rescue, water quality, resettlement).

Management

Management criterion - Implementation Stage: Measures are in place to address identified needs during reservoir preparation and filling; and plans are in place to manage the reservoir and any associated issues for the operating hydropower facility.

Management criterion - Operation Stage: Measures are in place to manage identified issues.

Management actions during the implementation and operation stages should be consistent with relevant plans. Mechanisms should be in place by which reservoir management issues can be identified and addressed. Identification of ongoing or emerging issues may take place through follow-up monitoring programmes that

were committed to during project development if the operating hydropower facility was commissioned relatively recently.

Once the reservoir is filled and the power station is operating, reservoir management considerations are multiple. These may include: optimising power generation; maintenance requirements; debris management (particularly an issue in regions prone to storms and/or flooding); multiple uses (e.g. commercial, recreational); safety; flood management; shoreline erosion; reservoir sedimentation; public access; water quality; biodiversity; invasive species; waterborne diseases; development pressures; waste management; transport; and aesthetic issues. Every reservoir's context, uses and issues are unique and the management considerations will differ from operating facility to facility.

Reservoir operating rules should reflect agreed measures to address generation needs and balance competing uses, risks and safety issues. These should include flood and drought operating rules, and necessary notifications. Any operating measures to address environmental or social values should be embedded and explained in the operating rules.

Responsibilities for the different reservoir management considerations, especially during the operating stage, are likely to vary from site to site. Some of these may rest with the operator, others with national government agencies, and others with the local council or departmental level government.

Over time, responsibility for management of different aspects of the reservoir may be passed over to the government or local or other agencies, ceasing to be within the sphere of direct responsibility of the operating facility. In this case, there should be mechanisms for shared information and collaborative management around the ongoing reservoir management (e.g. a reservoir management committee). Management

measures taken by the operators to minimise risks should be evident, such as barriers and signage keeping boats sufficiently far away from the intake.

Conformance/Compliance

Conformance/Compliance criterion - Implementation and Operation Stages: Processes and objectives in place for reservoir management have been and are on track to be met with no significant non-compliances or non-conformances, and reservoir management related commitments have been or are on track to be met.

Good practice requires evidence that reservoir management measures are compliant with the relevant legal and/or administrative requirements, which may be expressed in licence or permit conditions or captured in relevant legislation. Compliance requirements may relate to, for example, standards to be met, the frequency and type of monitoring to be performed, and reporting to be submitted. Conformance refers to delivering what is in the plans. Commitments may be expressed in policy requirements of the developer or owner/operator, or in company statements made publicly or within management plans. Evidence of adherence to commitments could be provided through, for example, internal monitoring and reports, government inspections, or independent review. Variations to commitments should be well-justified and approved by relevant authorities, with appropriate stakeholder liaison.

The significance of not meeting a commitment is based on the magnitude and consequence of that omission and will be context-specific. For example, a failure to demonstrate delivery of a major commitment such as developing infrastructure for public usage (e.g. a public boat ramp) is likely to be a significant non-conformance, whereas a slight delay in delivery of a monitoring report could be a non-significant non-conformance.