Good Practice Note

Environmental & Social Framework for IPF Operations

Water Use

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Good Practice Note (GPNs) are produced to help World Bank staff in providing implementation support to Borrowers in meeting the requirements of the Environmental and Social Framework (ESF). They are written in a style and format that is intended for all staff and development partners to use. GPNs are advisory in nature and are not World Bank policy nor are they mandatory. They will be updated according to emerging good practice.

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Glossary

Ecosystem services	The role of ecosystems in four broad categories: *provisioning* (such as the production of food and water); *regulating* (such as the control of climate and disease); *supporting* (such as nutrient cycles and crop pollination) and *cultural* (such as spiritual and recreational benefits).
ESIA	Environmental and Social Impact Assessment - an instrument to identify and assess the potential environmental and social impacts of a proposed project, evaluate alternatives, and design appropriate mitigation, management, and monitoring measures.
ESCP	Environmental and Social Commitment Plan - a summary document setting out the material measures and actions that are required for the project to achieve compliance with the ESSs over a specified timeframe in a manner satisfactory to the Bank. The ESCP forms part of the Legal Agreement.
ESMF	Environmental and Social Management Framework – an instrument that examines the risks and impacts when a project consists of a program and/or series of sub-projects, and those risks and impacts cannot be determined until the program or sub-project details have been identified. The ESMF sets out the principles, rules, guidelines and procedures to assess the environmental and social risks and impacts.
ESMP	Environmental and Social Management Plan - an instrument that details (a) the measures to be taken during the implementation and operation of a project to eliminate or offset adverse environmental and social impacts, or to reduce them to acceptable levels; and (b) the actions needed to implement these measures.
ESP	Environmental and Social Policy
ESRS	Environmental and Social Review Summary - a publicly disclosed summary of the Bank's environmental and social due diligence relating to a project.
ESS	Environmental and Social Standards (ESS1-10) - sets out the requirements for Borrowers relating to the identification and assessment of environmental and social risks and impacts associated with projects supported by the Bank through Investment Project Financing.
GPN	Good Practice Note

High Water Demand	Relatively high amounts of water withdrawal and/or use considering the sector or locational context, though the amount may or may not be significant as compared to availability.
SEP	Stakeholder Engagement Plan – a plan that describes the timing and methods of engagement with stakeholders throughout the life cycle of the project as agreed between Bank and Borrower. It also describes the range and timing of information to be communicated to project-affected parties and other interested parties, as well as the type of information to be sought from them.
Significant water use (quality)	Significance from a quality perspective, implies that there are releases of contaminants or other actions, such as reduction in water quantity needed to dilute pollutants, contributing to significant reduction in viability in water use due to quality concerns.
Significant water use (quantity)	Significance from a quantity perspective, implies that the projected withdrawal of water could contribute to the depletion of water resources—either temporarily or permanently -- to the extent that third parties' access is adversely affected.
TORs	Terms of References
Water Balance	Numerical calculation accounting for the inflows to, outflows from, and changes in the volume of water in the various components (e.g. reservoir, river, aquifer) of the hydrologic cycle, within a specified hydrological unit (e.g. a river catchment or river basin) and during a specified period of time (e.g. during a month or year).
Water Use	Water Use is water that is utilized for a specific purpose; either from surface or subsurface sources, regardless of whether that water is returned to its source. Such purposes may include: (i) withdrawals or off-stream uses such as individual and community water supply for domestic or commercial purposes, diversion for irrigation, cooling water for thermal power generation, diversion for hydropower turbines, industrial processes, water incorporated into food or manufactured products, etc., and (ii) instream uses such as navigation "run-of-river" hydropower, and aquatic ecosystem.
Water use; instream	Water that is used but not withdrawn, from a surface-water source including for hydro-electric power generation, navigation, water-quality improvement, fish propagation, and recreation.
Water withdrawal, or water abstraction	Freshwater taken from ground or surface water sources, either permanently or temporarily, and conveyed to a place of use. Can include abstractions for public water supply, irrigation, industrial processes and cooling of electric power plants. Mine water and drainage water are included, whereas water used for

	hydroelectricity generation is normally excluded (OECD) unless resulting from diversion. Water removed from the ground or diverted from a surface water source for use. (USGS) Water withdrawn or diverted from a groundwater or surface water source for aquaculture, commercial, domestic self-supply, industrial, irrigation, livestock, mining, public supply, thermoelectric power, or other uses. (USGS)
Water use; consumptive	Withdrawn water that is subsequently evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise not available for immediate use. (USGS)

1. Introduction

1. Under the Environmental and Social Framework (ESF), the World Bank has strengthened its commitment to promoting sustainable development, mitigating risks and impacts on project-affected individuals, groups, and workers, and to enhancing development opportunities. The Environmental and Social Framework (ESF) applies to World Bank Investment Project Financing (IPF) with Project Concept Note date after October 1, 2018, including the Environmental and Social Policy, the Environmental Social Standards (ESS1-10) and the ESF Directives. Associated *Guidance Notes* provide guidance for borrowers (e.g. Guidance Note for ESS3) and World Bank *Good Practice Notes (GPN),* such as this one, are aimed at supporting task teams and other ESF practitioners.

2. Environmental and Social Standard 3 (ESS3) on Resource Efficiency and Pollution Prevention and Management recognizes that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. Under the umbrella of ESS 1, this ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life cycle. One of its objectives is to promote sustainable use of resources, including water.

3. A wide range of investments that withdraw water could impact adversely the water quantity and quality of the associated surface and groundwater system while generating risks to the environment and communities. Previously such water risks have been addressed in Bank projects as part of the environmental assessment provisions of the Bank's safeguard policies. Under ESS3 such risks and impacts (including avoidance and mitigating measures) are addressed in a more comprehensive and integrated way.

Scope of this GPN

4. **This Good Practice Note (GPN) assists Task Teams in their approach to identification, mitigation and management of risks and impacts associated with Water Use in accordance with ESS3.** This GPN builds on ESS1, ESS3, the Guidance Notes for ESS1 and ESS3, and other World Bank Group sources such as the IFC Performance Standards, extensive Bank experience with investment projects affecting water resources under the previous environmental safeguard policies, and evolving global good practice. The ESS3 requirements related to Water Use are indicated in the following Box.

Box 1

ESS3 Requirements related to Water Use

When the project is a potentially significant user of water or will have potentially significant impacts on water quality, in addition to applying the resource efficiency requirements of this ESS, the Borrower will adopt measures, to the extent technically and financially feasible, that avoid or minimize water usage so that the project's water use does not have significant adverse impacts on communities, other users and the environment. These measures include, but are not limited to, the use of additional technically feasible water conservation measures within the Borrower's operations, the use of alternative water supplies, water consumption offsets to maintain total demand for water resources within the available supply, and evaluation of alternative project locations.

For projects with a high water demand that have potentially significant adverse impacts on communities, other users or the environment, the following will apply:

- *A detailed water balance will be developed, maintained, monitored and reported periodically;*
- *Opportunities for improvement in water use efficiency will be identified and implemented;*
- *Specific water use (measured by volume of water used per unit production) will be assessed; and*
- *Operations must be benchmarked to available industry standards of water use efficiency.*

The Borrower will assess, as part of the environmental and social assessment, the potential cumulative impacts of water use upon communities, other users and the environment and will identify and implement appropriate mitigation measures.

Source: ESS3 Paragraphs 7,8,9

5. This GPN sets out good practice (not minimum requirements) in applying the above elements of ESS3 for Task Teams, recognizing that practice is context-specific. While most projects in the Bank portfolio are unlikely to have both high water demand and significant adverse impacts on water quality, the significance of impacts on water quantity and quality in individual projects are typically determined during environmental impact assessment under ESS1. It is expected that the studies, analyses and outcomes discussed in this GPN will largely be incorporated into well-established environmental and social assessment documentation such as EIAs, ESIAs, ESMFs, ESMPs, and ESCPs. Rather than introducing a wholly new set of considerations, this GPN in essence builds on good professional practice in past World Bank projects, and provides good practices to Bank staff as to how such instruments reflect water-related assessments and mitigation/management tools to address water use risk.

6. The approaches in this GPN are illustrative and will need to be adapted to specific situations, especially in countries where data availability is scarce, or where there will be additional challenges on capacity and existing institutional, policy and regulatory framework, such as FCV countries

7. The following sections of this GPN address three key questions that Task Teams face in supporting clients during project preparation. First, are the water use considerations of ESS3 **relevant** to a project in question, and if so, what actions in terms of analysis and response are **required**? Next, what **methodologies** are available to assess risks and response options? Finally, what are the **operational implications** of this process extending through project preparation and implementation?

2. Addressing ESS3 Water Use Requirements

Relevant Operational Contexts

8. Water use is water that is utilized for a specific purpose; either from surface or subsurface sources; regardless of whether that water is returned or not to its original source. Such purposes (see figure below) may include: (i) withdrawals or off-stream uses such as individual and community water supply for domestic or commercial purposes, diversion for irrigation, cooling water for thermal power generation, diversion for hydropower turbines, industrial processes, water incorporated into food or manufactured products, etc., and (ii) instream uses such as navigation "run-of-river" hydropower, and aquatic ecosystems. Less obvious are changes in the water cycle due to adjustments in forest cover, rainfed agricultural production, rainwater harvesting, and system storage (e.g. in filling reservoirs), that can also impact other users. Some of these investment-related water uses could be temporary (e.g. in the case of water supply for construction camps) and some more longer-term.

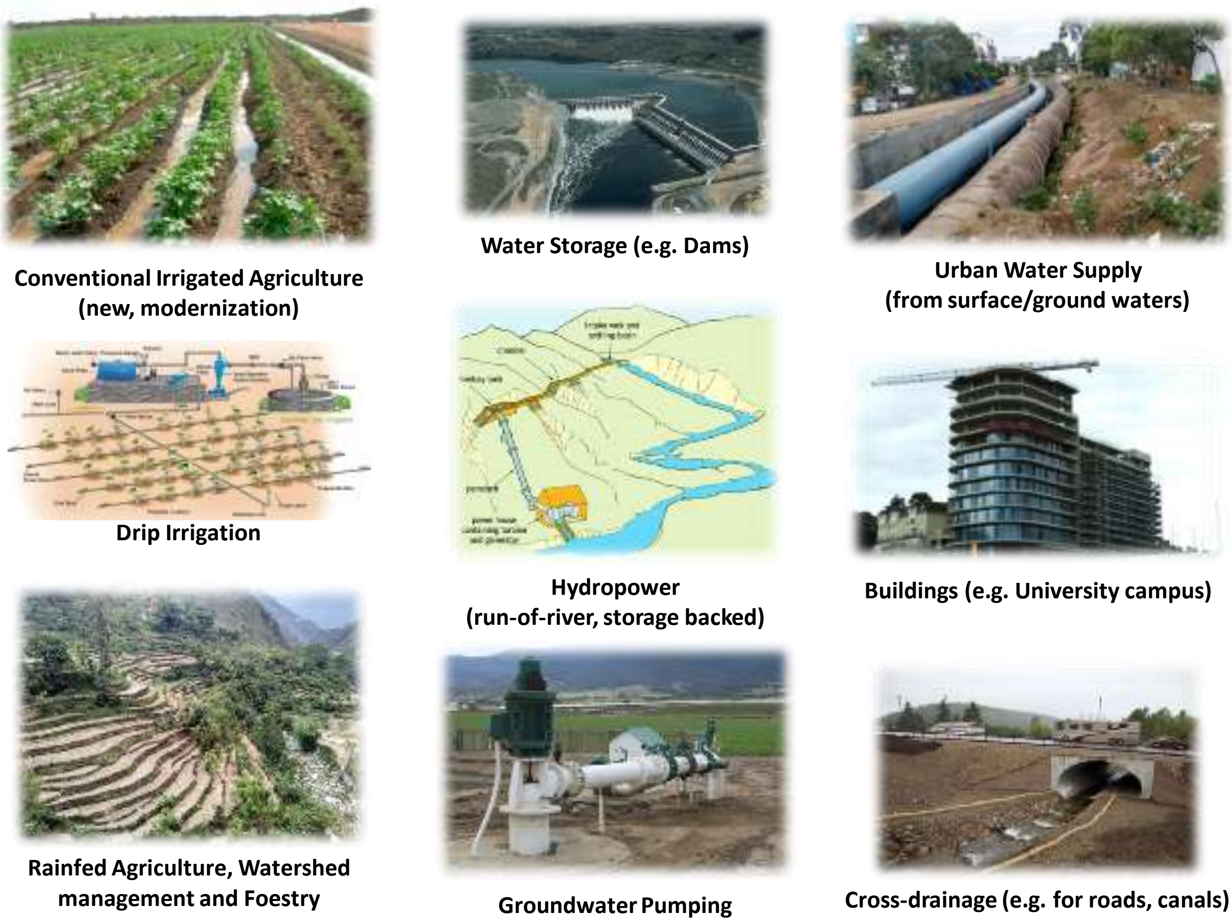


Figure 1: Illustrative types of relevant projects

9. Water use pertains to the interaction of populations with the hydrologic cycle, where some volumes are considered "consumptive" if no longer available for use (e.g. evaporated, transpired or included in agricultural products) and "non-consumptive" if returned to surface or groundwater after release from the point of use (e.g. "run-of-river" hydropower, return flows, or water treatment/reuse). There

are many terms which further sub-divide components of water use; for example, urban water systems may distinguish between for industry, commercial or residential uses. Irrigation system design often considers water use by crops, recharge water which escapes the root zone and replenishes groundwater aquifers, potential improvements through new forms of irrigation technologies, and return flows to support, for example, surface water supplies and ecosystems.

10. Water use needs to be considered in an appropriate systems context such as a watershed or aquifer. Water use or withdrawal for Bank-financed projects can impact other users and ecosystems that depend on pre-existing flows, and hence need to be considered. Water use has quality as well as quantity implications since hydrologic changes and pollution (either introduction of pollutants or reductions of impact from treatment) associated with project development and operation can affect chemical, physical and microbial composition and hence the viability of use.

11. While many World Bank infrastructure investments do affect the water cycle in some fashion, certain sectors tend to have more implications than others. Water is obviously a critical input for supporting new irrigation schemes, major bulk water supply schemes, or for driving hydropower turbines. In some other sectors, water needs may be less obvious. Depending on the type, scale, and location of these investments, the implications on other users will vary.

12. The applicability of ESS3 is established during the environmental and social assessment described in ESS1, and documented in associated instruments such as EIAs, ESIAs, ESMFs, ESMPs and ESCPs.

13. While most water use considerations take place during the preparation of investment projects that finance civil works, technical assistance (TA) activities which are supported by the Bank through Investment Project Financing (IPF) should also be screened to see if the water use considerations of ESS3 apply. Example TA types related to water use include[1]:
    - where the TA supports detailed technical designs; one possible outcome would be TORs for E&S due diligence instruments that assess whether the investments could be potentially significant users and/or high demand uses of water;
    - feasibility studies; these could include the necessary hydrologic studies to ascertain significance of water use or benchmarking; or
    - advice on the development of policies or strategies which could reflect the need for strategic or cumulative assessments on a watershed basis.

Requirements

14. The requirements for action under the water use considerations of ESS3 <u>are related to the implications of a proposed Bank-supported project on water demand, and the consequent significance of impacts on water use or water quality.</u> Following considerable Bank experience on these matters, there are no absolute numerical thresholds or benchmarks for action that apply globally. Instead, professional judgement is needed to assess relevance based on local circumstances of the interventions proposed, as well as both sectoral and system context.

[1] These examples are provided in the World Bank Operations Environmental and Social Review Committee (OESRC) Advisory Note on TA, May 2019.

15. This section provides basic definitions and information to be considered by specialists when advising the Borrower to identify the relevant ESS3 requirements and decide how to meet those requirements. The examples depicted in this GPN section are not meant to be absolute, but to support good professional judgment in the spirit of proportionality.

16. ESS3 makes a distinction in analytical needs and management implications between: (i) projects that are *"significant"* or *"potentially significant"* in terms of impacts on water use or water quality, and (ii) those which do not rise to such levels of concern. Significance from a quantity perspective, implies that the projected withdrawal of water could contribute to the depletion of water resources - either temporarily or permanently - to the extent that third parties' access is adversely affected. Regarding quality, significance would recognize, among other factors, changing viability in resource use due to pollution. In any case, "*significance*" indicates that certain additional actions are required under ESS3, including that the Borrower should consider and present in their project design and documentation technically and financially feasible means to avoid or mitigate such impacts. These additional actions would be captured in the ESCP.

17. Beyond "significance", ESS3 requires the identification of projects which have or potentially have *"high water demand."* There are no Bank-wide numerical thresholds for distinguishing "High Water Demand." Instead, it can be considered as a relative measure of high volumes of water withdrawal considering the sector or locational context. Such amounts may or may not be significant as compared to availability. In the cases where high water demand also poses significant impact, the Borrower must carry out a detailed water balance to further elaborate changes in basin or hydrologic unit inputs and outputs, identify opportunities to enhance system water use efficiency, and provide further information on resource intensity along with benchmarking to industry or other standards where these are available. Water balance calculations and benchmarking are not required for: (i) "significant water use" projects that do not meet the test of "high water demand", or (ii) "high water demand" projects that do not pose significant impacts, though these tools and comparators could be helpful in such cases as well.

18. Table 1 below provides some notional examples of requirements related to water use, the level of water use analysis needed under ESS3, and how the impacts of water use can be mitigated and managed. The implications of these requirements are described in further detail in Annex A. These suggestions reflect Bank experience under the previous Safeguard Policies as well as emerging practice under the ESF (see examples in Annex B.)

Table 1: Examples of assessing and managing impacts of water use in projects

Water Use Category & Working Definition	Example Requirements	Implications of ESS3 for Analysis	Implications for Mitigation & Management
Non-significant	-ESIA shows insignificant impact -Project or sub-project does not require water use permit (or equivalent)	No need from an ESS3 perspective for further modeling or water balance	Probably no need to develop specific mitigation or water use management measures
Potentially Significant (quantity) *Contributes to depletion to the extent that third party access is adversely affected*	-National laws might require project environmental impact assessment if water use is projected to be above national or regional threshold, e.g. % reduction in Mean Annual runoff. -Screening shows basin under some water stress	-Further hydrologic analysis is needed as part of the environmental and social impact assessment process -Water balance calculations and benchmarking not required under ESS3 if there is no High Water Demand (see last row of this table)	If the environmental impact assessment determines that water use is indeed significant in terms of quantity, the Task Team advises the Borrower to adopt technically and financially feasible measures for reducing water use, and reflect such measure in the ESCP.
Potentially Significant (quality) *Release of contaminants or other actions (e.g. thermal pollution from cooling water) contributes to significant reduction in viability in use due to quality concerns*	-Civil works could exacerbate non-point source pollution (e.g. sediments or nutrients) -Point source discharge requires permitting -Rapid draw down of aquifers could cause mineral leaching	-Further hydrologic (quantity and quality) analysis is needed as part of the environmental and social impact assessment process -Consider Pollution Prevention and Management aspects of ESS3	The Task Team advises the Borrower to develop suitable point and non-point pollution controls measures under the Pollution Prevention and Management sections of ESS3, and reflect such measures in the ESCP.
High Water Demand *Relatively high amounts of water use considering sectoral and locational context compared to availability, which may or may not be significant*	-Projected use falls above national or regional threshold of highest risk -Screening suggests potential for project to eliminate most or all "unallocated" flows -Screening shows basin under documented water stress -Water demand high compared to similar sector use in comparable location	-If significant water quantity is used (or necessary to assess significance), water balance calculations included as part of project preparation; water balance updates required in implementation if both conditions met -Benchmarking is required if both conditions met	If there is both high water demand and significant impacts from such high water demand, it is important to agree with the Borrower on the documentation and adoption of reasonable levels of water use efficiency, as one of the commitments in the ESCP.

Implications for Illustrative Types of Investment

19. Given the wide range of sectors and regions involved, setting absolute thresholds of significance and relative demand is not possible for screening Bank investment projects globally. Case-by-case judgment is required. From Bank experience, some possible requirements for determining when water use is non-significant, potentially significant (quantity and quality) or represents high water demand, are illustrated in the table below and further outlined in Annex B. Bank teams are encouraged to work with clients to reflect national or regional thresholds which could provide additional guidance on these matters. For example, for projects in the European Union, the EIA Directive of the European Union requires mandatory EA for groundwater extraction, wastewater treatment and water reservoir projects that exceed certain limits, and some countries (e.g. Zambia) require mandatory EA for irrigation, forestry and reservoir projects exceeding certain hectare thresholds. In such cases, more attention to water use considerations in the respective EA documentation would be logical.

Table 2: Illustrative analysis implications by investment[2]

Example Investment	Likelihood of significant water use	Likelihood of high water demand	Example scope of water use analysis by project phase
12 new schools	Uncommon	Uncommon	Screening by PCN Follow-on work only as needed from ESIA
New 30-km transmission line	Uncommon	Uncommon	Screening by PCN Follow-on work only as needed from ESIA
New 300 MW HPP with storage	Probable	Probable	Screening & literature review by PCN Advise to Borrower (e.g. TOR) on modeling needs and water balance (including ecosystem services) Bank specialist review of results at Appraisal
New small irrigation dams	Possible	Possible	Screening by PCN Field review by Borrower; some targeted sub-basin hydrology included in ESIA Bank specialist review of results at Appraisal
Irrigation Modernization (e.g. upgrade/extend major irrigation network for higher value crops)	Possible-probable	Possible-probable	Screening by PCN Advise to Borrower (e.g. TOR) on modeling needs and water balance Bank specialist review of results at Appraisal
Program of 100 km secondary road rehabilitation/upgrading	Uncommon-possible	Uncommon	Screening by PCN to consider alignments (if known) Focus on quality of ES Commitment Plan
New national park for wetlands restoration	Probable	Possible-probable	Screening & literature review by PCN Advise to Borrower on specialized studies; ecosystem and possibly water balance Bank specialist review of results at Appraisal
Strengthen national health system; clinics, capacity building	Uncommon-possible	Uncommon	Screening by PCN Follow-on work only as needed from ESIA; focus on quality of ES Commitment Plan

[2] Relative scale in ascending order of likelihood: uncommon to possible to probable

20. There is an enormous variation within and across sectors in the likelihood that use would be significant and/or constitute high water demand. On one end of the spectrum, considerations of significance in terms of water use will naturally arise with a proposed new hydropower plant, taking into account the expected change in hydrology from a large dam and reservoir, or from a new large irrigation project. Smaller "run-of-river" plants without high dams and significant storage – other things being equal -- generally pose less risk in terms of changing water availability than a large reservoir. In such situations, simpler analysis might suffice in the ESIA to address ESS3 Water Use requirements.

21. Some sub-sector investments might appear as posing no significant risk, yet it is still necessary for the Borrower to undertake detailed screening and scoping to ascertain if site specific conditions require further analysis. This is because investments could impact local water resource systems. For example, road rehabilitation and upgrading could be of concern if streams are crossed. Even small-scale irrigation systems in arid regions could impact existing demands. New civil works such as culverts and bridges would benefit from a redesign to accommodate flood conditions under current or potential future conditions to avoid excessive erosion that would alter water quality. These issues could also be present in Community Driven Development (CDD) projects. The ESCP could outline the material measures e.g. for avoiding excessive erosion and refer to the more detailed ESMPs and/or contractor ESMPs.

22. While there is no substitute for good professional judgement on such case-by-case decisions, Annex B provides a set of notional example project types arrayed by the likelihood of significant or high demand in water use, with suggestions on consequent water use analysis methods by project phase. Where a Bank-financed project is supported by additional bilateral or multilateral investment partners, it is logical to seek harmonization of threshold considerations and analytical methods, as outlined in the ESF.

3. Methodology

23. This section provides an overview of methodologies that are integral to studies of pre- and post-project water balances that are required by the ESF. Particular technical elements presented in this section are provided as illustrative guidance for good practice only, and do not constitute Bank requirements for any specific project, country, sector, or client. The level of detail appropriate in any analysis for a project will depend on many factors, including the level of water usage of the specific project as well as the overall water availability in that basin (or other appropriate unit of analysis), and other enabling factors including the quality and comprehensiveness of available data, client capabilities, and project preparation schedules and available budgets. This section also describes methods and sources to assess water use efficiency and benchmarking water use.

24. **System Definition:** For each investment and its location, it is important to define the appropriate systems boundary for analysis. This system could be a small aquifer, a watershed or a transboundary basin depending on the project location and water use context. It could also be a combination in more complex cases – for example, two basins in an inter-basin transfer or a basin and an overlapping aquifer. The temporal scales for analysis can be critical as well. For example, some irrigation projects have high water demand during the dry season, which may impact third party access and cause environmental flow deficits in the dry season. Such cases could require analysis conducted at monthly/seasonal scales, rather than annual scale.

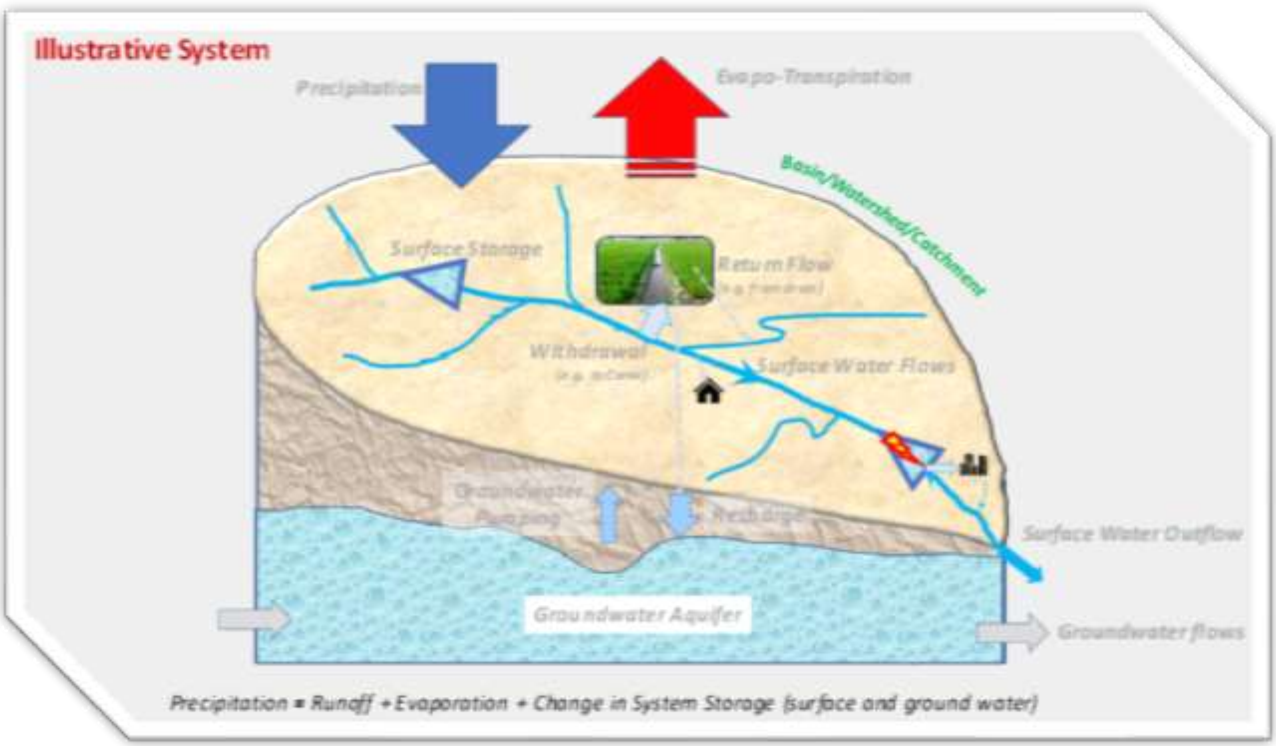
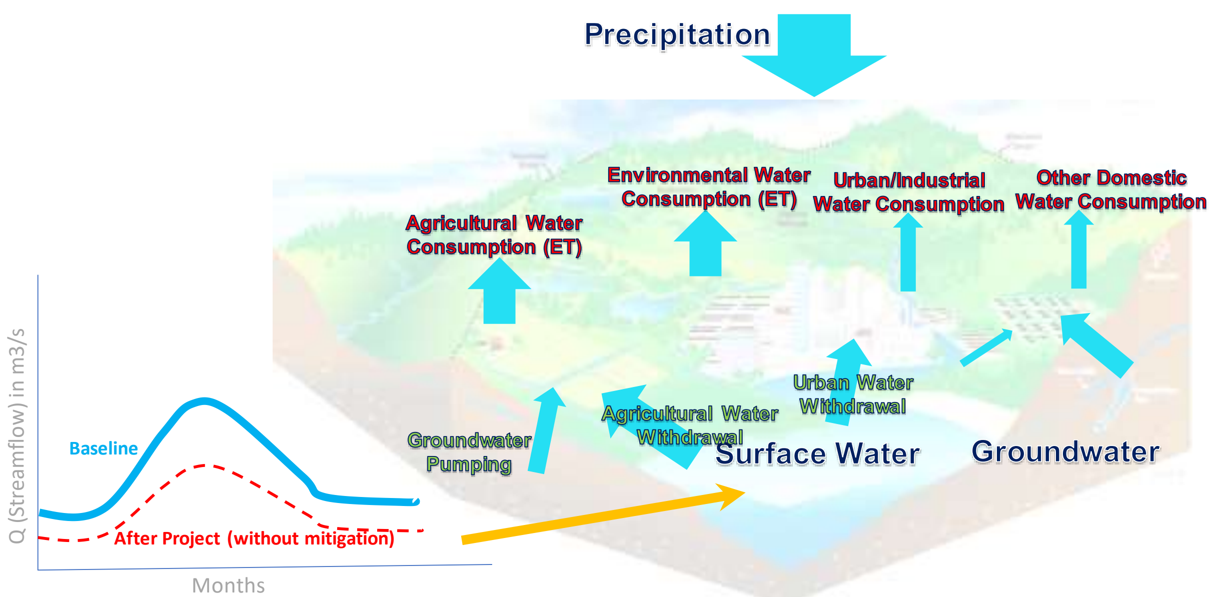


Figure 2: Illustrative system (e.g. watershed/sub-basin/aquifer) for proposed project

25. **Water Balance:** A detailed or complete water balance factors in climate variability and incorporates estimates relating to: (a) all inputs, such as precipitation, external inflow of rivers and groundwater, inter-basin water transfer and returned water from users to a hydrological unit, for example, a catchment/watershed or river basin; (b) all outputs from the hydrological unit, for example, water abstraction from surface/groundwater resources, outflow of rivers and groundwater to the sea or neighboring territories, inter-basin water transfer, evapotranspiration and other consumption, and water reuse; and (c) changes in water storage in the hydrologic unit over a defined period of time, for example, during a month or a year. Data accuracy and quality will vary in such calculations; encompassing direct measures, indirect measures, estimates from nearby watersheds, and notional estimates from the literature. In preparing the water balance, estimates of future water availability and predictions of future water demands are included, which can vary based on scenarios of anticipated changes in water demands or other factors, such as climate change.

26. Water balance determinations can support improved management of water allocation among water users. They can also support river basin management planning by providing information on water availability and demand and can indicate potential for water conservation. Methods to support water balances include a review of historical records (e.g. streamflow, hydrographs, water table and piezometric surface levels, lake and reservoir levels, etc.), water accounting through remote sensing, in-situ sensors with appropriate analysis, and model simulation (including changing water use, management and climate change considerations as relevant for the system). To the extent technically and financially feasible, and in a manner proportionate to the project scope, these support determination of water flows, fluxes, stocks, consumption (see figure below), and services, and communication of water-resources-related information to communities, users, and decision makers.



Note: Consumption is water that leaves the system being considered and will be less than the withdrawal from surface and ground water or surface/groundwater storage and any direct use of rainfall with most of the rest returning as return flows to surface and ground water. Most of the agricultural and environmental landscape consumption will be in the form of evapo-transpiration (ET).

Figure 3: Illustration of a system indicating supply and consumption and how one of the parameters (e.g. streamflow) may change with a project intervention (e.g. irrigation)

27. **Estimating Water Balance Elements:** The following table indicates the key system parameters that could be part of a water balance and illustrative sources of data. These would need to depend on in-situ monitoring, global earth observation or global modeling tools in data-constrained environments where local water balance parameter estimation does not exist or cannot be accessed.

Table 3: Water Balance Parameters

System Element	Estimation Source	Comments
Precipitation	Local or Global Data (e.g. from Global Precipitation Mission, CHIRPS)	Useful especially for larger systems – grid resolution is about 8-25 km
Evapotranspiration	From remote sensing estimation (e.g. the Open ET Partnership models – e.g. SSEBoP, METRIC, SEBAL, MOD16, ET Watch)	An increasing number of these are starting to become available for free in the public domain as services (e.g. through the OPEN ET Partnership) - resolution ranges from 1 km to 5 m grids.
Streamflows	Local observations Satellite-derived estimates Model estimates (e.g. GEOGLOWS-ECMWF)	Local observations could have significant data coverage, quality, and access issues. Satellite-derived flows estimates (e.g. DFO) need good calibration and could sometimes be useful for large rivers which vary significantly in width at different observed flow levels. Model estimates are getting increasingly useful in this regard.
Groundwater	Groundwater models Local observations Earth observation for very large areas	Gravity based earth observations to estimate groundwater changes are very coarse and only useful for very large areas.
Water Quality	Local observations Remote sensing only for a few parameters	Generally poor data collection and access for key water quality parameters.
Water Consumption	Measurements/Records Estimates using specific water use and efficiencies Satellite-based Evapotranspiration Estimates Crop water models (e.g. AquaStat) and Water systems models.	Water requirements and evapotranspiration for large uses of blue water such as irrigated agriculture can now be approximately estimated, but return flows are difficult to estimate. More organized water reuse may also be estimated through in-situ monitoring in some cases.
Climate Change	Various IPCC models for scenario analysis	Very little agreement across the models especially on precipitation and implied hydrology (even direction of change) for any given area.

28. If the data available is very inadequate for estimating and reporting during the project preparation and implementation, project financing often seeks to help strengthen the monitoring or estimation of key parameters as part of the project to further facilitate reporting and evaluation during implementation.

29. **Models:** A water balance model can be considered as a system of equations designed to represent some aspects of the hydrological cycle[3]. They can range from very simple mathematical algorithms to very detailed and complex numerical computer-simulation models. Two important aspects in water balance modelling are to clearly define the objective of the analysis and to select an appropriate model.

30. Some considerations when selecting a model are:
    - The selected model should fit the specific objective of the water balance analysis. In some cases, however, possible changes in the initial scope of the analysis may need to be considered when selecting the model.
    - Preference should be given to use/enhance models already in use by the client where appropriate and accessible.
    - A simple model may provide an overall water balance for an accounting unit but is unlikely to provide insight into the processes that drive water movement within that unit. A more complex model may provide that insight but at substantially greater expense[4].
    - Complex computer-simulation models can simulate different components of the balance, as well as different scenarios (e.g. proposed project water management interventions, possible future water policy, water allocation, climate change, etc.) in order to assess their potential impact on water use, demand and availability.
    - Complex models require more data and more effort during the modelling process (model parametrization, calibration, validation).
    - Depending on the objective of the analysis, the development of a surface-water balance or a groundwater balance may be required. In other cases, however, there may be need of a water balance of the entire (land phase) of the water cycle.
    - While free/open source modelling tools could be useful for more collaborative work and updating throughout the project cycle in a cost-effective manner, some commercial tools could offer more specialized analytic services.

31. Illustrative Types of Models:
    - Some computer-simulation models are capable of doing surface-water modelling (e.g. rainfall-runoff models); others are groundwater models; and there are also integrated surface-water and groundwater models, which can simulate the main surface and subsurface water flow processes in an integrated manner and provide insights on surface-water/groundwater interaction.
    - Watershed models can estimate stream discharge within a basin in response to precipitation and snowmelt, usually accounting for processes such as evapotranspiration, groundwater/surface-water exchange, and surface-water routing; and are widely used for watershed management and planning.
    - Groundwater models simulate the physics of groundwater motion within an aquifer system. Two types of groundwater models are: interpretive and predictive[5]. An interpretive model tries to

3 Lu Zhang, Walker, G.R. and Dawes, W.R., 2002., Water balance modelling: concepts and applications.
4 Healy, R.W., Winter, T.C., LaBaugh, J.W., and Franke, O.L., 2007, Water budgets: Foundations for effective water-resources and environmental management: U.S. Geological Survey Circular 1308, 90 p.
5 Leenhouts, Jim, 2013, Groundwater Modeling Basics, U.S. Geological Survey.

understand how the groundwater system works. The predictive model purpose is to predict system response to stresses/physical alterations (e.g. intensification of agricultural land use, higher rates of groundwater extraction, climate change). Predictive models require calibration, and can predict, for instance, how water levels in an aquifer would be affected by changes in withdrawals or in recharge rates.

- General circulation models forecast weather and climate trends at the continental scale over periods of days to centuries[6]. These could be useful to generate climate change scenarios.
- Coupled models combine different type of simulation models, for instance: surface water/groundwater models, water allocation/groundwater models, etc.

Additional information on modelling considerations aspects and examples of water balance case studies using models can be found in the Good Practice Note e-book (that include relevant information from the *Model Primer* and *Water Accounting* e-books).

32. The type of analysis required (ranging from simple analysis to more involved water balance computation) would depend on the level of water demand and the potential adverse impacts to the system that it may cause.

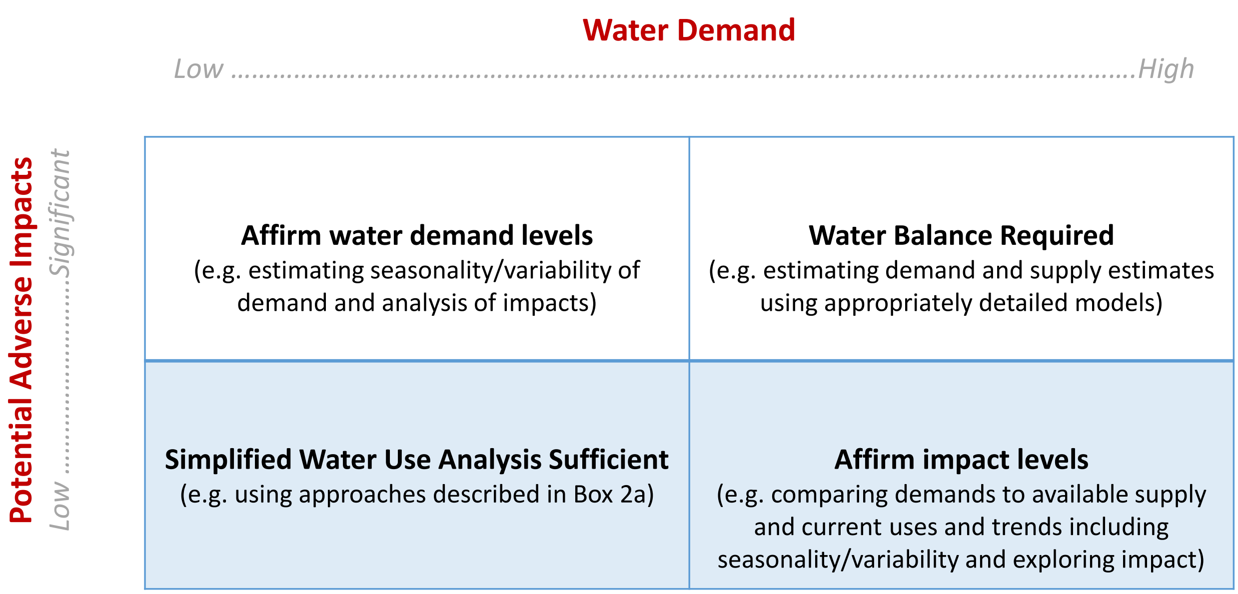


Figure 4: Level of Water Use Analysis

33. Unfortunately, there are currently few sub-basins in the developed world – and far fewer in developing countries – where there are sufficient "hard data" to support detailed water balance calculations. Therefore, when it comes to understanding water balances at the sub-basin level there is a need to adapt the ambition of analysis to both address the spirit of ESS3 as well as the evolving realism of client capacity and technological advances. Two examples reflecting a comprehensive and simplified assessments are provided in Boxes 2a and 2b.

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6 Healy, R.W., Winter, T.C., LaBaugh, J.W., and Franke, O.L., 2007, Water budgets: Foundations for effective water-resources and environmental management: U.S. Geological Survey Circular 1308, 90 p.

34. **Water Use Efficiency:** The ESS3 places great significance on improving Water Use efficiency. Not all the water withdrawn from surface or ground water to supply any use is actually used. This is because of system "losses" (e.g. conveyance and field efficiency in irrigation, leakage in urban systems, etc.) that could either reappear as surface or groundwater sources for downstream areas or be lost to evaporation/evapotranspiration or to inaccessible groundwater percolation. The proportion of the withdrawn water that is actually used determines the water use efficiency that could be a function of how well the system is designed, maintained, and operated. However, when examined from the perspective of the appropriate system, the "basin efficiency" may be a more useful construct than a "scheme efficiency" as reducing the "losses" could, in fact, also reduce sources of water for downstream users. Teams may wish to consider both facets of efficiency as appropriate in advising Clients. In addition, water use efficiency improvements would need to usually be accompanied by some kind of water use cap (e.g. through water use permits) to be truly effective and not result in paradoxical situations where system water use may actually increase (also explained later in Box 4).

35. **Assessment of specific water use intensity** as measured by volume of water per unit of production is not well documented for some sectors; or only address one part of the hydrologic cycle. Annex C shows the ranges of specific water use for a variety of illustrative uses. For example, in the Beverage industry examples noted in the Annex, there are good practice examples of how much water is used at the point of manufacturing (e.g. volumes of water at the entry versus volume of product). However, in the agricultural sector, the amount of water used to grow the agricultural inputs have not yet been assessed.

36. **Benchmarking comparators for water use efficiency**. ESS3 indicates referencing to benchmarking data where available, to help assess relative resource efficiency. The EHS Guidelines (General and Sector-specific ones) also make reference to benchmarking. It may be difficult to find workable benchmarks due to the lack of reliable and meaningful comparator data, and the often very localized context of water use estimates that need to be assessed based on technical judgement. There may also be relevant local laws and guidelines that are applicable in a project context. While ESS3 only requires benchmarking in situations of high-water demand and potential impact, benchmarking is clearly encouraged where helpful to reflect on water use efficiency. This provision of ESS3 codifies the good practice of increased application of water utility and irrigation benchmarking in past Bank projects prepared under the Safeguards Policies. Considerable progress has been made on benchmarking water and wastewater utilities; albeit looking much more broadly than say amounts of "lost" water in collection or distribution. In hydropower sector, the benchmarking of hydropower facilities typically focuses more on the power generation side (e.g. turbine, generator, and transmission efficiency). However, such benchmarking has implications for water use. For irrigation and forestry operations, there are often national and regional comparators, although these tend to document use patterns given historic system design and operations. Moreover, water use efficiency for agricultural production varies greatly by location, because of temperature, humidity, soli type and other biophysical variations. Hence, comparing the efficacy of water use intensity statistics of agriculture production across regions should be limited because the result of such comparison might or might not necessarily be very useful. Nevertheless, there is a clear direction in global good practice to advance sustainability thinking in the water sector. The supplementary e-book has incorporated information on these recent developments and will be periodically updated based on experience with ESF application and evolving global good practices. These project-level monitoring and estimation

could be used by countries to also contribute to relevant Sustainable Development Goal (SDG) 6.4 indicators (e.g. 6.4.1 on "change in water use efficiency over time" and 6.4.2 on "level of water stress: freshwater withdrawal as a proportion of available freshwater resources" and methodologies for assessment of environmental flows.

37. **Social and Environmental Risks.** Water use as a consequence of project development and operation could result in changes in system hydrology (e.g. impacts on quantity and quality) that could result in environmental and socio-economic impacts to other users in the system (including impacts on formal and informal water rights). Assessing such impacts requires an approach to determine process changes and implications on social and environmental considerations (as shown in Figure 5). Such assessment could take into account cumulative impacts.[7] Where appropriate, client capacity could be strengthened to adopt more holistic approaches (e.g. considering upcoming investments in a basin/watershed context) as part of strategic assessments, monitoring systems, planning frameworks, and decision support tools. Implications from a Bank-supported project as well as other existing or planned activities could apply to upstream uses as well as downstream uses. Potential impacts on both upstream and downstream water uses would need to be considered.

38. **Borrower capacity:** This clearly varies by Borrower and by project. Some Borrowers have good experience in assessing water quantity and quality project risks, including analysis of water balance, and the provisions of ESS3 in this regard does not add a major additional burden. Other Borrowers do not have such capacity, and it will be important for the Bank to share, for example, simplified screening tools or TORs to modify ESIAs or guide additional studies that address water use more comprehensively. TA components of Bank investment projects could be used to strengthen understanding and capabilities in hydrologic analysis by Government, universities, and other entities in a country.

[7] Footnote 22 of ESS1 states "The cumulative impact of the project is the incremental impact of the project when added to impacts from other relevant past, present, and reasonably foreseeable developments, as well as unplanned but predictable activities enabled by the project that may occur later or at a different location. Cumulative impacts can result from individually minor but collectively significant activities taking place over a period of time. The environmental and social assessment will consider cumulative impacts that are recognized as important on the basis of scientific concerns and/or reflect the concerns of project-affected parties. The potential cumulative impacts will be determined as early as possible, ideally as part of project scoping."

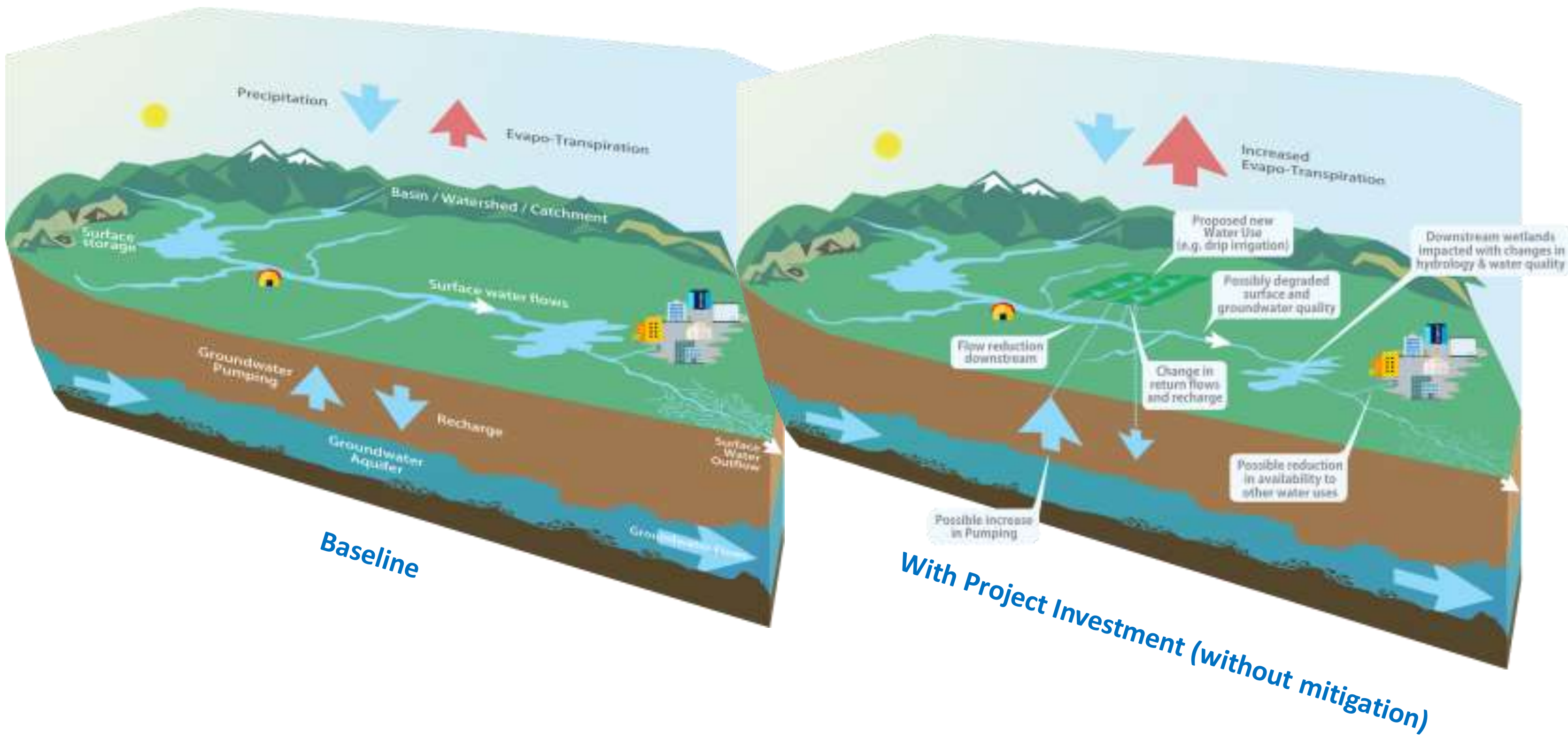


Figure 5: Illustrative project impacts on water balance

Box 2a

Example of Simple Water Balance

While conducting water balances, at the minimum, it would be useful to indicate the additional withdrawal and net consumption that the project implies, in a manner that indicates both comparison to the resource availability and the seasonality of supply and demand. The basic elements of this can be captured by a table as below with the values being generated by monitoring or estimated/modeled outputs.

	Surface Water (m^3)		Ground Water (m^3)		Consumption (m^3)	
Timeframe	Additional Withdrawal	Resource Availability (with min-avg-max if possible)	Additional Withdrawal	Resource Availability (with min-avg-max if possible)	Existing Consumption	Additional Net Consumption
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Jul						
Aug						
Sep						
Oct						
Nov						
Dec						
Annual						

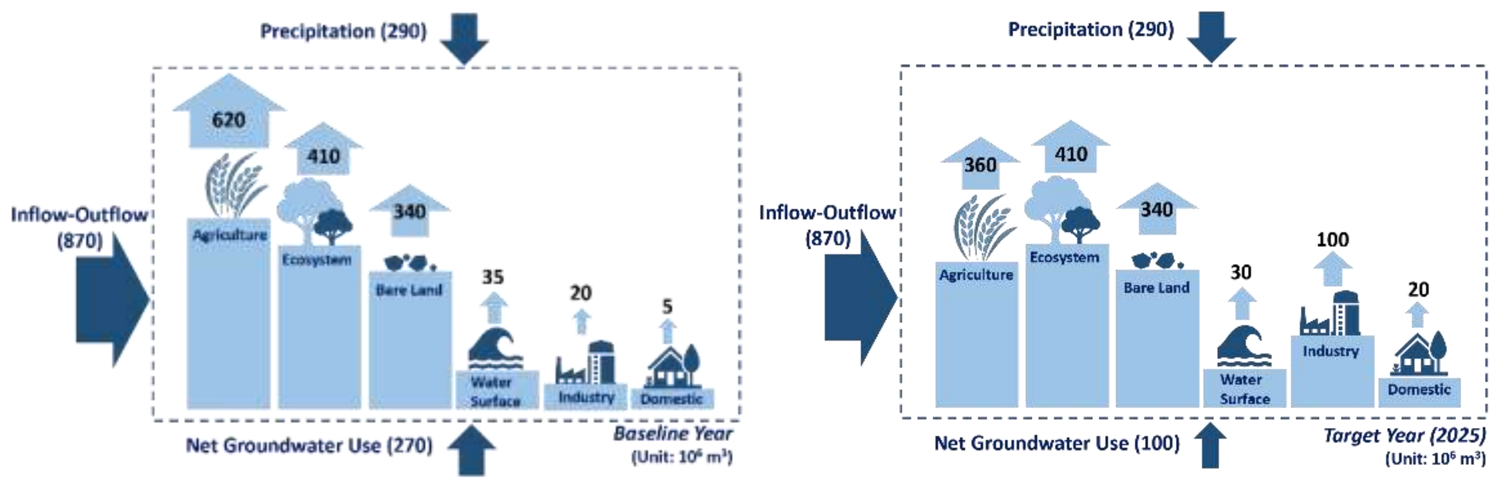
This could help indicate the need to consult other users (e.g. downstream users) if the additional withdrawal is a significant part of the net available resources. Expanding the data to multiple years is encouraged to better capture inter-annual variability in addition to basic seasonality.

Box 2b

Example of More Detailed Water Balance

Much more complex models could also be used to determine water balance for relatively large uses and where data availability and analytics are better established. These can not only be useful for major project analysis but could also play an important part in a basin planning context, especially when augmented with more spatial and temporal scenario analytics relating to climate and cumulative impacts. However, it should be noted that the data and capacity required for this type of analysis may not currently be available in many Borrower countries, although earth observation is helping considerably to estimate some of these parameters globally.

Example: Detailed water balance analyses were conducted at basin level in the China: Xinjiang Turpan Water Conservation Project (P111163). The project is located in the most arid region of China, with annual precipitation less than 20 mm and potential evaporation as high as 3,000 mm. Snowmelt contributes to most streamflow in the river. The water balance analysis was first conducted at a baseline year of 2009. The precipitation and the changes in surface water (i.e. inflow-outflow) was calculated based on measured data. Only limited groundwater abstraction data were available to estimate net groundwater use. The actual water consumed by agriculture (i.e. actual evapotranspiration from agricultural lands), ecosystem (i.e. actual evapotranspiration from grasslands and other terrestrial ecosystems), bare land and water surface (i.e. actual evaporation from bare lands and water bodies) was estimated through remote sensing. The actual water consumption by the industrial and domestic sectors was converted from the industrial and domestic water use data collected through field studies. Another water balance analysis was conducted for the target year 2025, based on the scenario to eliminate groundwater overdraft by reducing agricultural water consumption.



4. Operational Implications

39. Project screening for environmental and social considerations is critical for the Bank at the Project Concept stage to determine risk classification. During the Concept Stage, the Task Team shares its perspective on water use significance, derived from initial identification and preparation mission(s), discussions with the Borrower, and (as necessary) any simplified calculations or literature review commensurate with the Bank's internal risk management responsibilities. If there are basic uncertainties as to the expected significant/high water demand use, further guidance to the Borrower (e.g. on Terms of Reference and global good practices) would be important as environmental assessments proceed under national policies and ESF. If the initial assessment of water use for a project appears to be of significance/high demand, the Borrower may need additional advice on using modeling tools for further analysis. The Borrower is responsible for undertaking such modeling. However, Bank staff might advise, for example, on the TORs for analytical studies (with examples to be included in the e-book), strategic guidance at training workshops, or sharing good practice examples and relevant experiences.

40. By Project Appraisal, it is expected that a clearer picture of water use needs, potential impacts, and mitigating measures is available based on project preparation studies. In some cases, the analyses might warrant delay, for example where sub-projects will be identified during implementation and the range of probable risks is manageable. For cases where water balance calculations, advanced models, and benchmarking studies are provided to support financing decisions (both during preparation and implementation), it is expected that Bank water specialists would be called on for peer review. An illustrative summary of example recent Bank projects that addressed water use and efficiency considerations is included as Annex B.

41. The expected requirements for Water Use related work at various project stages is summarized in the table that follows, detailing how responsibilities might differ between Bank E&S specialists and the borrower at different project stages. It is not expected that the Borrowers would need to develop stand-alone instruments to meet ESS3 requirements on water uses. Assessments and suitable mitigation measures on water use typically can be developed as part of the environmental and social instruments prepared by the Borrower.

Table 4: Typical Responsibilities for ESS3 Water Use Analysis by Project Phase

Phase	Example Tasks for Bank Team	Example Tasks for Borrower
Identification	• Review available background info • Identification mission: collate available data and visit field if possible; gather maps and listen to stakeholders • Review and advise on the results from Borrower's screening	• Provide maps, data, and studies to Bank • Facilitate field visits and stakeholder consultations • Join Bank team for initial field survey • Undertake screening of potential impacts related to water use
Concept Review	• Outline project spatial context • Carry out basic hydrologic screening for ENV risk determination; quantitative or qualitative • Assess borrower capacity • Summarize in Concept Review package (including in ESRS) • Review and provide advice on Borrower's ToRs for any relevant EIA/supplementary studies and analytics	• Scope project spatial context • As relevant, begin process to engage Government specialists and/or consultants to carry out relevant studies and analyses (including as part of the EIAs or other preparatory studies)
QER	• Reviewing progress of studies by the Borrower and continue providing advice to the Borrower on how to meet ESS3 requirements Determine if additional studies are required (e.g. on mitigation measures such as operating rules and system storage) • Support Borrower on technical aspects (e.g. methods in GPN E-book) • Reflect any important impacts related to water use in Draft PAD	• Provide progress report on administrative and technical aspects of supplementary studies, including identification of appropriate national or regional benchmarks, if required • Request any further help from Bank (ToRs; specific methods from GPN E-book, etc.) • Provide draft EIAs if available
Decision Meeting	• Provide technical review and clearance of studies/analyses from Borrower • Determine if additional expert advisors/panel on water use needed (e.g. pg. 13 para. 33 in the Guidance Note for ESS 1). • Update risk screening as relevant • Incorporate results of the studies, key mitigation measures, or where necessary, rationale for deferring the development of site-specific analyses and mitigation measures until after project Approval into Decision Package (e.g. updated ESRS, ESCP, SEP, revised PAD and draft Legal Agreement) • Verify if disclosure obligations have been met	• Complete interim or final results from hydrologic, water use and water efficiencies studies • Undertake consultations with relevant stakeholders on the issue of water use, and take such feedback into account into project preparation • Incorporate the results of technical studies in ESIA; ESMF; ESMP as relevant • Provide the rationale for deferring specified analyses and the development of site-specific mitigation measures until after project Approval if needed (e.g. for framework projects with project activities not yet identified)
Board	• Update above as relevant	• Update above as relevant
Implementation	• Track Borrower progress on ESCP (including capacity building) through ISR • Monitor any changes in E&S risks • Support Borrower on technical matters (e.g. methods in GPN E-book as requested)	• Provide progress report on administrative and technical aspects of supplementary studies • Undertake monitoring to confirm if the impacts that have materialized are different from predictions, in which case the adequacy of previously developed

		mitigation measures might need to be reconsidered • Implement water efficiency and risk mitigation measures • Conduct water balance updates as specified in the ESCP • Request any further help from Bank (ToRs; specific methods from GPN E-book, global good practices, etc.)
Closure	• Include lessons-learned on water use in ICR and for GPN E-book	• Maintain post-project monitoring as useful

42. **Mitigation Measures.** Most often, mitigation measures required by Water Use considerations of ESS3 would result in improved designs to improve the development outcome of an investment and its sustainability. Various options exist to improve water use efficiency to avoid adverse impacts of water use. For example, agricultural water use efficiency can be improved through technologies and policies that incentivize maintaining net consumptive use (evapo-transpiration) within specified limits, taking into account the implications for the overall watershed. In another example, urban water use efficiency can be increased through building codes that encourage installation of low flow toilets and showers, consumer awareness campaigns to promote water efficient appliances, and repair of water-distribution systems to reduce leakage. Water use in agriculture, the largest consumer of water, can be made more efficient through irrigation-system improvements, irrigation scheduling, improving water-conveyance efficiency and leakage losses, managing soils to reduce runoff, and reusing water on-farm.

43. Depending on the significance of the project's potential impacts on communities, other users, ecosystems, or the environment, it may be useful to include an assessment of the volume of water used per unit of production in the project's environmental and social assessment. With respect to water productivity, approaches such as system water accounting may be useful to assess the extent to which water-productivity increases have an effect on other water users. For example, increasing water productivity, while maintaining existing water withdrawal, will increase the efficiency of water use. However, at the same time, the measures to increase water productivity may affect downstream water users who depend on return flow in rivers or groundwater aquifers.

44. The level of mitigation measures to be undertaken also depend on the level of water demand and its implied potential adverse impacts on the system considered as illustrated below.

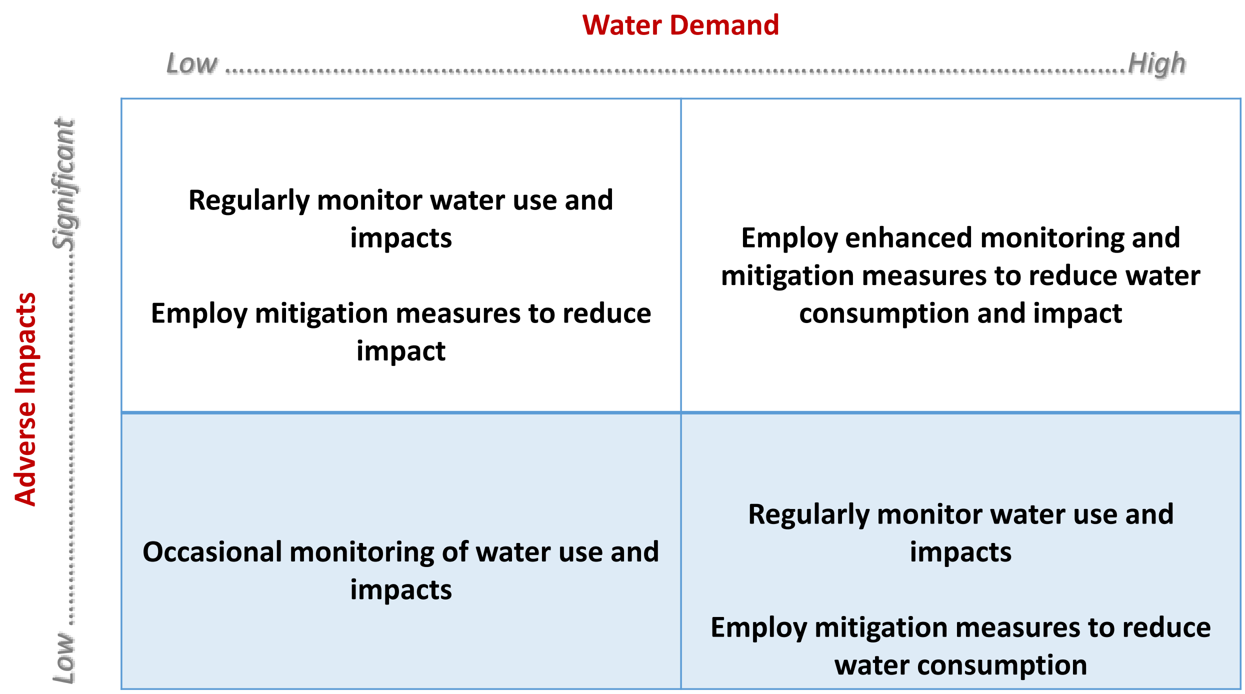


Figure 6: Level of Mitigation Measures

45. The ESS3 requires that the Borrower will implement technically and financially feasible measures for improving efficient consumption of water and other resources. Table 5 illustrates some of these options for different water use contexts. For example, there are many options to improve water efficiency (e.g. drip irrigation). However, efforts to improve water efficiency without any resource use caps (e.g. by basin/watershed) can themselves often cause environmental and social risks due to impacts on hydrology as described in Box 4.

46. These measures for improving efficient consumption of water and other resources could be related to different aspects of a project, such as:
    a. *Information:* Improved monitoring, analytical and knowledge management systems. Improved access to relevant information among key stakeholders and in the public domain.
    b. *Institutions & Policy:* Improved institutional arrangements and interaction as well as the enabling policy framework for effective planning, implementation, and operation of investments from a water use perspective. There needs to be appropriate attention to **capacity-building** related to water use in projects both at preparation and implementation stage. At preparation stage, capacity-building could include socialization of ESS3 requirements on water use, and support for integration of appropriate analytical and mitigation aspects in environmental and social impact assessment. At implementation stage, capacity-building could include more systematic training of relevant client officials and project management staff on more intensive monitoring, analysis, and mitigation/management measures. Capacity-building measures to improve understanding of such risks and measures has been a critical element of Bank investment lending operations, including technical

assistance projects. The ESF provides even further impetus for such inclusion of technical advice to Borrowers

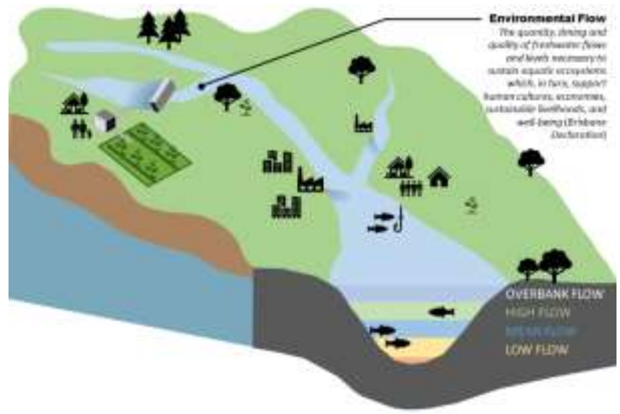
c. *Investments:* Utilizing appropriate efficiency improvement along with appropriate use caps; use of new technologies and processes to reduce overall water use and impacts to other users in the system.

Table 5: Illustrative Mitigation/Management Measures

Type	Mitigation/ Management Measure	Comments
Institutional	Integrated Basin/Watershed/Aquifer Approaches	Useful in many cases to include capacity building of relevant institutions as part of the project to monitor, assess, and manage water uses in a more holistic water systems context. With adequate attention to analytical and stakeholder engagement measures, this could help set the longer-term context to better manage cumulative impacts. This could also include appropriate consideration of grey water from wastewater treatment and reuse.
Policy	Water Use Cap (e.g. by system)	Useful when water efficiency measures are required/incentivized
	Payment for Ecosystem Services	Useful to incentivize upstream measures for measurable downstream impacts (e.g. related to water quality or quantity)
	Offsets	Policies to enable new consumers to pay other users in the system to reduce equivalent water consumption
	Mandated E-Flows	To ensure minimum adherence to environmental flow regimes (see Box 3)
	Operating Rules	Managing project operations (e.g. reducing withdrawal during extreme drought to reduce impact on other existing uses)
Enhanced Monitoring	In-Situ Monitoring systems (e.g. for water quantity, water quality, soil moisture)	Monitoring, telemetry, and data management systems (including provisions for data access, analysis, and use). Illustrative systems at this link.
	Earth Observation Monitoring systems	A range of increasingly powerful systems based on satellites, aircraft, and UAVs (drones) can now be used to assess some relevant water use and impact related parameters.
Analysis	Detailed Analysis during Implementation	More detailed modeling and other analyses to develop and report on detailed water balances
Technical	Drip Irrigation	Good for water saving but can reduce return flows to surface and ground waters that can have other impacts on those that depend on those resources (see Box 4). Useful with a system water use cap policy
	Canal Lining	Useful for surface irrigation systems with appropriate lining (concrete, earthen, stone, geotextiles, etc.) for either keeping channel shape or reducing infiltration. Could also result in reduced infiltration and return flows. Also useful with a system water use cap policy.
	Floating/Canal Solar	"Flotovoltaics" on reservoirs or canal solar covering to reduce evaporation from these systems.
	System Storage	Surface or groundwater storage could be useful to buffer downstream users from changes in water demand or supply

Box 3

Environmental Flow (EF)[8]



Sustainable project development needs to consider the potential impact of the use of water resources in the area, including areas downstream from the project intervention. A development project should seek to minimize the negative impacts on natural ecosystems and ecosystem services. Regular variations in the flow of a river provide a certain level of predictability for the ecosystems and communities that depend on the water resources. This dynamic regularity of flow is referred to as the flow regime. The flow regime necessary for maintaining the ecosystems is referred to as the Environmental Flow (EF), and defined as *the quality, quantity and timing of water flows required to maintain the components, functions, processes, and resilience of aquatic ecosystems that provide goods and services to people quantity, timing and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being* (*Brisbane Declaration*[9]).

Environmental Flow Assessments (EFAs) provide information on how the physical characteristics of the river could change with planned developments, how ecosystem services and biodiversity could be impacted, and how all these changes could affect people and local and wider economies. In many cases, the EFA also assesses mitigation measures according to the mitigation hierarchy and proposes an Environmental Flow Requirement (EFR), which may then be imposed on the operation scheduling of the water infrastructure. The information provided by the EFA can underpin decision making in a variety of ways, such as i) informing discussions on the trade-offs between resource protection and resource development; ii) identifying the degree to which the river's natural ecosystem services should be maintained and thus the desired future condition of the river; iii) identifying additional alternative benefits that the river could also provide through development; and iv) defining important monitoring targets. EFAs generally are conducted in collaboration with, or included in, the ESIA development and should be commenced early in the project development process.

It is also important to adopt an adaptive approach to the management of EF based on adequate monitoring during project implementation and operational phases. Capacity-building for considering cumulative flows as part of basin planning with appropriate tools and mechanisms at a systems level would also be useful, especially as the consideration of e-flows is becoming a more established practice (e.g. in large hydropower).

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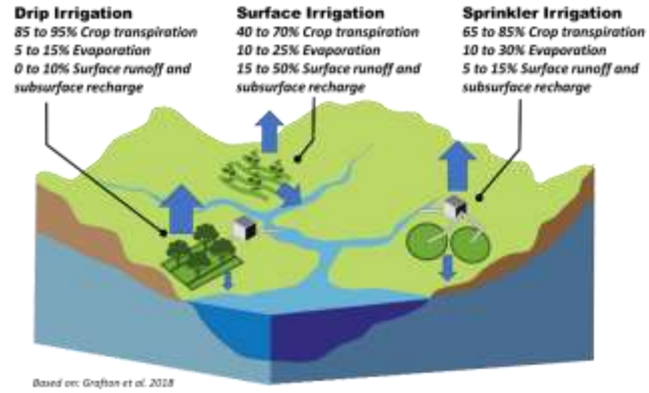
[8] World Bank's Good Practice handbook 'Environmental Flows for Hydropower Projects – Guidance for the Private Sector in Emerging Markets' (2018).

[9] Arthington, A. H., Bhaduri, A., Bunn, S. E., Jackson, S. E., Tharme, R. E., Tickner, D., … Ward, S. (2018). The Brisbane Declaration and Global Action Agenda on Environmental Flows (2018). Frontiers in Environmental Science.

Box 4

The paradox of "water saving"



Improving water use efficiency is usually considered as an opportunity for water saving, particularly in the agricultural sector. Given that irrigation accounts for around 70% of global water extraction, governments often promote modern irrigation technologies to improve irrigation efficiency for getting more "crop per drop." A common consideration for promoting modern irrigation technologies is the view that more efficient irrigation will "save" water and make it available for other users, such as environmental, domestic and industrial water users. However, substantial scientific evidence identified the paradox that an increase in irrigation efficiency at the farmland scale fails to increase the water availability at the basin scale, which may ultimately defeat the original purpose of "water saving".

The figure (adopted from Grafton et al. 2018) visualizes the paradox in watersheds with three types of irrigation technologies, including drip, sprinkler and flood irrigation. Modern irrigation technology (such as drip or sprinkler) is often seen as a water-saving strategy due to its ability to increase yield while reducing water use in a single plot. However, scale matters and efficiency gains at plot level cannot be extrapolated at farm, system and basin level. Empirically, efficiency gains at plot level typically lead to higher consumptive water demand (i.e. crop evapotranspiration) because the improved irrigation service enables intensification, area expansion, and shifts to higher water consuming crops. Water savings at plot or system levels recaptured for use within the same plot, farm, or system often result in a higher consumptive use and subsequent net reduction of downstream water flows or other return flows to groundwater, and therefore translate into a water reallocation rather than a net saving of water. From a basin optimization perspective, system water saving could be a sound policy as it is likely to improve water productivity, optimize farm resource utilization (e.g. labor, land), improve service delivery and improve water quality. In terms of the ESS3, however, such paradox points to the need to understand each of the fluxes in the water balance: where is the "saved" water going after the investment, and where is it no longer going and implications to the former beneficial uses of that water (for people or ecosystems). If in a specific context water conservation technologies are indeed to bring about basin water savings, they will have to be accompanied with measures that monitor and cap system use, or measures that transfer the saved water use to downstream users.

Therefore, contrary to the policy intent, the investments of irrigation efficiency improvement could sometimes translate into the increasing of water consumption, rather than the increasing of water availability at the basin level – a concept called the "Jevons Paradox" in economics.

Robust water balance estimation and scenario analysis helps understand the impacts of irrigation efficiency improvement on basin-scale water availability. Such impacts vary by river basins with different climate, topography, soil and vegetation characteristics, hydrogeology, and social and economic conditions. Water accounting beyond the farmland scale to the basin scale is necessary to support decision-making in the interventions of irrigation efficiency improvement, such as irrigation modernization. Similar to the case of irrigation efficiency improvement, basin level water balance is needed for the other activities with significant increases in water consumption, such as plantation.

Partial Source: *R. Q. Grafton, J. Williams, C. J. Perry, F. Molle, C. Ringler, P. Steduto, B. Udall, S. A. Wheeler, Y. Wang, D. Garrick, R. G. Alle (2018), Science: Vol. 361, Issue 6404, pp. 748-750, DOI: 10.1126/science.aat9314*

47. **Relation to other parts of the ESF** (e.g. inputs to cumulative impacts of projects with respect to water implications or on Transboundary Waters)

Table 6: Environmental and Social Framework/ESSs and Water Use [10]

Aspect of the ESF	Link to Water Use
ESS 1: Assessment and Management of Environmental and Social Risks and Impacts	ESS1 recognizes the environmental and social assessment, informed by the scoping of the issues, will consider all relevant environmental and social risks and impacts of the project, including those related to transboundary and global risks such as impacts from increased use or contamination of international waterways; cumulative impacts; additional expert advisors/panel
ESS 3: Resource Efficiency and Pollution Prevention and Management	ESS3 recognizes that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, water resources and the environment at the local, regional, and global levels. The current and projected atmospheric concentration of greenhouse gases (GHG) threatens the welfare of current and future generations.
ESS4: Community Health and Safety	**Safety of Dams**. Where appropriate and feasible, the Borrower will identify the project's potential risks and impacts on water use that may be exacerbated by climate change, and any adverse health and safety risks to and impacts on affected communities.
ESS6: Biodiversity and Conservation and Sustainable Management of Living Natural Resources	ESS6 recognizes that protecting and conserving biodiversity and sustainably managing living natural resources including freshwater, marine and other aquatic ecosystems are fundamental to sustainable development. People benefit from regulation of ecosystem services which may include surface water purification. Impacts on water can therefore often adversely affect the delivery of ecosystem services.
ESS10 – Stakeholder Engagement and Information Disclosure	ESS10 enhances transparency and timely stakeholder engagement in terms of project-related impacts on and from water use.

ESS1 and ESS4 linkage to water implications including transboundary impacts: Water quality and its use are affected by economic growth and intensive non-sustainable use of natural resources. Water use management should consider environmental and social risks in addition to other aspects such as geopolitical aspects (including on international waterways as described below). Water sources and natural hydrologic regimes are being changed by increased water use, water pollution, alteration of natural flow patterns and disruption of fisheries due to hydropower dams and transport infrastructure, and droughts and floods exacerbated by climate change. Mitigation measures, including setting operational requirements to reduce downstream impacts of dams, designating protected areas along key river stretches where dams cannot be installed, and installing terrestrial protected-area networks, are practical solutions to reduce irreversible impacts on water flows. Also, it is important that countries have appropriate institutional and regulatory systems in place to reduce adverse transboundary impacts and prevent conflicts by facilitating informed decision-making for transboundary water management and development decisions. Where appropriate, these elements could be included as part of project design.

Efficient cumulative impact assessments (CIA): For example, when developing mechanisms to maintain the integrity and quality of the aquatic ecosystems, it is important to consider the combined impacts several dams in a cascade or multiple intakes for urban and agricultural supplies. Models that feed into the CIA should allow the flexibility to invoke transboundary environmental mechanisms, aligned with international laws and the relevant national laws to ensure water equity and eco-security.

[10] Based on ESF, 2018.

Linkages with other Operational Policies (OP): Projects on International Waterways – OP 7.50: In instances where project activities use or risk polluting water of international waterways, the Bank's Operational Policy concerning Projects on International Waterways (OP 7.50) is triggered and relevant procedures need to be followed. The Policy requires riparian notification of planned projects, unless exceptions apply (see paragraph 7 of the Policy). International waterways are defined as rivers, canals, lakes, their tributaries and alluvial aquifers as well as confined aquifers, or similar bodies of water that form a boundary between or flow through, two or more countries. The definition also includes bays, gulfs, straits, or channels bounded by two or more states or, if within one state, recognized as a necessary channel of communication between the open sea and other states. The requirements for water use under ESS3 and OP7.50 address quite different issues and hence follow different processes.

Other:

Water Use aspects could also be reflected in climate screening considerations for projects. Special considerations may also be required for emergency projects, and for COVID-19 related procedures.

This GPN is informed by, and will help inform, many other ESF related documents, including:

- *Dam Safety Good Practice Note:* especially on technical modeling approaches
- *Gender Good Practice Note:* which recognizes that poor resource management can disproportionately affect female stakeholders where women have a differentiated role in water collection or subsistent production.
- *Disadvantaged or Vulnerable Individuals or Groups:* potential impacts on disadvantaged or vulnerable individuals or groups.
- *Stakeholder Consultation:* which provides guidance on identifying and meaningfully consulting relevant stakeholders.
- *ESF Technical Note:* Screening and Risk Classification, and
- *World Bank Group EHS Guidelines:* Industry benchmarks for water conservation

These linkages to relevant environmental and social issues are expected to be explored as part of the environmental and social assessment of a project during preparation.

This ESF Good Practice Note is supplemented with an interactive e-book resource for staff. This will be updated from time to time based on the experience of implementation and evolving technology.

Annex A: Implications of ESS3 Requirements

Water Use Category and Working Definition[11]	Example Requirements	ESS3 Implications for Analysis	Implications for Mitigation and Management
"Non-significant" water use Projected withdrawal of water under the project which does not rate as "significant", "potentially significant", or comprises "high water demand" under ESS3	▪ ESIA[12] shows that projected water use poses either no or inconsequential impact on water availability and quality. ▪ Specialized study attests to non-significance of use. ▪ Project or envisaged sub-projects do not require national or sub-national water permit or approval. ▪ Project or envisaged sub-projects requires national or sub-national water permit: (i) without conditionality based on projected impact, or (ii) with sufficient conditionality and supervision to minimize potential impacts.	No need for further modeling and water balance calculations.	No additional requirements
"Potentially significant" water use Projected withdrawal of water which contributes to the depletion of water resources to the extent that third parties' ability to access water is adversely affected. Implied to include ecosystem services.	▪ ESIA shows potential water use falls above some national or regional threshold (set in law or guidance) that is functionally equivalent to "significant". For example: (i) some % reduction in Mean Annual Runoff or base flow during dry conditions, or (ii) where a proposed irrigation system or bulk water supply project requires full mandatory environmental impact assessment under appliable law[13]. ▪ EA or simplified calculations suggest that project water use could reduce instream flow below thresholds formally set or informally used to guide maintenance of minimum ecological flows. ▪ Documented/anecdotal evidence of water stress in affected river segments, sub-basins, local aquifers, etc. ▪ Project location in basins or sub-basins where screening methods suggest elevated overall water risk; and/or threatened or actual water stress, etc. [14]	Further analysis is needed to determine potential impacts. At PCN this could mean the Bank providing estimates from simplified calculations or desktop modeling and agreement on follow-up studies as appropriate. By Appraisal, the Borrower should provide an assessment of factors outlined in GN7.1 based on further desktop to more advanced analysis and modeling as appropriate. Water balance calculations are not required by ESS3. Some analyses may be deferred until implementation if site locations not yet determined and/or baseline date needs collection.	If deemed "significant" the Borrower is instructed (EES3 para 7 and GN7.2) to adopt technically and financially feasible measures aimed at, for example: conserving water, reducing demand, switching to alternative water supplies, and/or shifting project locations. The above will likely be reflected in the project ESCP[15]

[11] "Working definition" as interpreted largely from ESS3 language and related Guidance to Borrowers

[12] Referring broadly to environmental and social assessment screening and/or documentation processes

[13] For example, the EIA Directive of the European Union requires mandatory EA for groundwater extraction, wastewater treatment and water reservoir projects that exceed certain limits, and some countries (e.g. Zambia) require mandatory EA for irrigation, forestry and reservoir projects exceeding certain hectare thresholds.

[14] In lieu of characterizations by a Borrower or River Basin organization, global maps and tools might be consulted in this regard (e.g. WRI Aqueduct Water Risk Atlas).

[15] Environmental and Social Commitment Plan (ESCP) as outlined in ESS1

Water Use Category and Working Definition [11]	Example Requirements	ESS3 Implications for Analysis	Implications for Mitigation and Management
"Potentially significant" impact on water quality Projected release of contaminated wastewater, pollutants, or other actions contributes to an adverse reduction in viability and type of use (human needs and ecosystems)	▪ ESIA and project design suggest that construction related non-point pollution could elevate surface water suspended solid concentrations to a point where ecosystems might be negatively impacted. ▪ A new discharge of treated municipal or industrial wastewater effluent (replacing on-site septic systems) poses potential positive and negative impacts on ground and surface water resources. ▪ Project type/size requires full Environmental Impact Assessment, permitting with major stakeholder engagement, etc. ▪ Changes in water flow poses unknown but potentially complex implications on water quality which needs to be examined as part of the ESA process.	Further analysis is needed to determine potential impacts. At PCN this could mean the Bank providing estimates from simplified calculations or desktop modeling, and agreement on follow-up studies as appropriate. By Appraisal, the Borrower should provide further analysis on quality impacts. Borrower and Bank also covered under Pollution Prevention and Management ESS3 paras 11-14	While ESS3 on Water Use mentions mitigating measures such as nonpoint controls for runoff and wastewater treatment, a more complete presentation of measures is included in ESS3 paras. 11-14.
"High water demand" Projects which require or affect relatively high amounts of water use considering sectoral and locational context compared to availability. Such use may or may not be significant. Further analysis and management considerations may apply to ascertain risks.	▪ ESIA shows potential water use falls above some national or regional threshold of highest risk. ▪ ESIA or simplified calculations suggest project water use would eliminate most/all of the current "unallocated" annual flows. ▪ River segments, sub-basins, or aquifers are clearly identified from global screening tools as under water stress.	Further analysis is needed to determine potential impacts. At PCN this will likely mean the Bank assist the Borrower to calculate estimates from simplified calculations or desktop modeling, and if impacts could be significant, advise the Borrower to carry-out further analyses which could include water balance calculations [16]. By Appraisal the Borrower would be required to provide water balance calculations and supporting studies of a quality acceptable to the Bank Some analyses may be deferred until implementation if site locations not yet determined and/or baseline date needs collection.	Similar to that described above for "potentially significant water use", but with even further emphasis required to assess significance and document and adopt higher levels of water efficiency (as per ESS3 GN8.3). If significant, benchmarking of project technologies and operations must be provided as part of design. Basin management (including formalized water allocation) factors will be especially relevant.

[16] Methodologies for conducting water balance calculations are described in the Methodology section and elucidated further in the supporting e-book; some characteristics are discussed in ESS3 GN8.1 through 8.3.

Annex B: Water Use Considerations by Type of Investment

for illustration only[17]

Example investment	*Typical project water use*	*Likelihood that use would be "significant"*	*Likelihood of "high-water demand"*	*Example scope of water use analysis by project phase*[18]
Education build 12+ small primary schools	Drinking water; toilets; garden	Uncommon; some risk of impacts to domestic water supplies if drawing from small streams or shallow aquifers	Uncommon	Screening by PCN Further analysis only as required through ESIA process
Education build a major university campus	Laboratories; housing; toilets; drinking water; communal dining; maintenance	Possible if: reduction in local domestic and communal supplies; construction could pollute streams or aquifers if nonpoint runoff not controlled and/or poor sanitation.	Possible; for example, if relying on small watershed or aquifer. Uncommon if supplied with safe piped water and with proper sanitation.	Screening by PCN As part of ESIA in some smaller/critical basins, borrower might utilize desktop modeling augmented as needed with field monitoring.
Energy new 60-kilometer transmission line	Water newly seeded area; possible stream crossings need protection.	Uncommon for quantity; some possibility for quality as construction could pollute stream if crossing is inadequately protective	Uncommon unless project does not comply with E&S Commitment Plan	Screening by PCN to consider alignment (if known) and potentially impacted water courses. Further hydrologic analysis normally not required; focus instead on ESMP
Energy New 50 MW+ concentrated solar power station	Depending on technology, may require water for steam generation, cooling and cleaning mirrors	Possible if water needs are relatively high compared to availability.	Possible if water needs are relatively high compared to availability.	Screening and possibly desktop simplified analysis by PCN Desktop or modeling prior to QER might be carried out by Borrower depending on initial EA; in some cases, including water balance calculations
Energy new 100-Megawatt run-of-river hydropower station (without small storage)	Construction will require river diversion; operating regime can impact ecosystem services.	Possible-probable depending on basin scale and current uses.	Possible-probable depending on tradeoffs in specific water uses (e.g. irrigation)	Screening and possibly desktop simplified analysis by PCN Desktop or modeling prior to QER might be carried out by Borrower depending on initial EA; in some cases, including water balance calculations

[17] Notional examples for illustrative and training purposes only; not meant as reference or guideline to any particular investment decision. "Likelihood" in 3rd and 4th column is relative; in ascending order from uncommon to possible to probable.

[18] Illustrative examples only; further details on simple to more advanced models in e-book.

Example investment	***Typical project water use***	***Likelihood that use would be "significant"***	***Likelihood of "high-water demand"***	***Example scope of water use analysis by project phase*** [18]
Energy new 300-Megawatt hydropower station with large storage reservoir	Dam and reservoir storage and operational regime. Construction and operation causing river diversion and possible sedimentation. Introduction of new water uses if multi-purpose.	Probable given size and nature of such facilities, and public sensitivities.	Probable in most instances where Bank financing is sought. Especially a concern if basin size is small and/or substantially allocated, or in water stressed sub-region.	Screening to consider overall potential changes in water balance; literature review considers basin risk and stress; by PCN. Bank can provide TORs and other technical guidance to Borrowers to frame ESIA and any supplemental studies; likely to include water balance calculations, climate and ecosystem services. Quality assurance review by Bank specialists on results by Appraisal; continuing support to clients as required during implementation (e.g. operating rules).
Agriculture new series of multiple small dams (some reservoirs) for village crop irrigation	Change in natural flow based on operational regime. Construction causing diversions; possible localized sedimentation.	Possible; depending on basin size versus demand, current and projected water stress, and sub-project density.	Uncommon-Possible in some cases but less likely than with larger schemes.	Screening by PCN As part of ESIA by Borrower, field review and further screening might be required to clarify impact; perhaps identifying sub-basins which require further analysis. Possibly more advanced or targeted modeling if sub-projects concentrated in a sub-basin.
Agriculture Expand and upgrade 100 km network of irrigation canals for high value crops	Restore and expand water use for irrigated agriculture with changes reflecting new cropping demands.	Possible-probable depending in part on ongoing use and scale of irrigation system improvement. Change in relative water use could increase efficiency without reducing overall consumptive use; perhaps consequent reduction in groundwater recharge affecting local wells.	Possible-Probable; very site and basin-specific -- for example there could be no net change if efficiency gains make up for higher crop demands.	Screening at PCN to consider overall potential changes in water balance; literature review considers basin risk and stress. Bank can provide TORs and other technical guidance to Borrowers to frame ESIA and any supplemental studies; likely to include water balance calculations, climate and ecosystem services. Quality assurance review by Bank specialists on results. Some analyses could be deferred to implementation. Bank to provide guidance as required.

Example investment	*Typical project water use*	*Likelihood that use would be "significant"*	*Likelihood of "high-water demand"*	*Example scope of water use analysis by project phase*[18]
Urban upgrade wastewater treatment from primary to secondary; extend collection network	Receiving water flow and quality will change from effluent volumes and quality.	Possible; even with higher levels of treatment, receiving water dilution will remain a factor. Sewage collection could reduce groundwater recharge; possibly lowering levels but also improving water quality.	Not typical with upgraded treatment at an existing facility	Screening at PCN to consider overall potential changes in water balance; literature review considers basin risk and stress. Monitoring of groundwater in zones with new sewage collectors.
Urban new major bulk water supply on surface water source.	Multi-sector change in volumes and patterns of use within basin.	Probable but impact would depend on current and projected water use and stress.	Possible to probable; depending on scope of water demand and current/projected uses (including ecosystem services).	At a minimum, desktop simplified analysis and literature review at Concept Stage. More advanced modeling prior to QER might be needed and should include water balance calculations at watershed scale (including ecological flows)
Environment establish new National Park for wetland restoration and protection	Potentially complex changes in water flow (possibly quality as well) and availability to basin users, other sector needs, and ecosystems	Probable by definition such projects typically pose risks at a local to watershed scale.	Possible-Probable, but uncertain without appropriate analysis and monitoring regimes.	At a minimum, simplified screening and literature review regarding ecosystem services by PCN. Bank can provide TORs and other technical guidance to Borrowers to frame ESIA and any supplemental studies; likely to include water balance calculations. Quality assurance review by Bank specialists on results by Appraisal. Some analyses could be deferred to implementation. Bank to provide guidance as required.
Transport 100 km secondary road rehabilitation and upgrade	Watering for dust control; rehabilitating bridges and culverts	Uncommon-Possible; work on bridges and culverts could pollute local stream if inadequate nonpoint controls are put in place.	Uncommon unless project completely ignores E&S management.	Screening by PCN to consider alignments (if known) and potentially impacted water courses. Routinely considering possible impacts and mitigating measures in ES Commitment Plan
Health Strengthen national health system through renovation of clinics, training and disease tracking and response.	Drinking water and laboratories, medical waste disposal.	Uncommon for quantity; some possibility for localized impacts from erosion or improper medical waste disposal.	Uncommon	Screening by PCN Further hydrologic analysis normally not required; focus instead on ESMP

Annex C: Illustrative Specific Water Use Ranges and Benchmarks

Type	Water User	Specific Water Use	Units	Source	Sample Benchmarks
Domestic Water	Urban	18-73	m^3/person/year	Gleick(1996), Howard (2003), AfDB(2016), Morote(2016)	48.5 (ESP); 20 (UGA)
	Rural	7-18	m^3/person/year	Howard (2003), Oageng(2014), TD&H(2017)	141 (USA); 20.6 (BWA)
Crop	Barley	1,000-5,000	m^3/ha	FAO(2012), Bennett(2011), Laouisset(2016)	4,155 (CAN); 2110 (DZA)
	Cotton	4,100-7,800	m^3/ha	FAO(2012), Fisher(2012), Ibragimov(2007),	5,700 (US); 6,960 (UZB)
	Maize	5,000-8,000	m^3/ha	FAO(2012), Bennett(2011), IUCN (2006)	5,140 (CAN); 7,910 (PAK)
	Rice	4,000-11,000	m^3/ha	FAO(2012), Bethune(2001), Dong(2001)	9,480 (AUS); 6,130 (CHN)
	Sorghum	4,500-7000	m^3/ha	FAO(2012), Manaze(2013), Howell(2012)	5,780 (USA); 5,000 (ETH)
	Soybean	3,000-8,000	m^3/ha	FAO(2012), Singh(2013), Specht(2014)	5,600 (USA); 3,540 (IND)
	Sugar cane	8,500-20,000	m^3/ha	FAO(2012), Kumar(2012), SRA(2014)	13,100 (AUS); 17,200 (IND)
	Sunflower	5,000-6500	m^3/ha	FAO(2012), Sadras (2012), Tolk(2011)	6,300 (ARG); 5,060 (USA)
	Wheat	2,000-5,000	m^3/ha	FAO(2012), Bennett(2011), IUCN (2006)	5100 (CAN); 5160 (PAK)
Livestock	Beef Cattle	8.9-15.6	m^3/cattle/year	Water Footprint (2010)	NA
	Dairy Cattle	16.4-36.1	m^3/cattle/year	Water Footprint (2010)	NA
	Poultry	0.1	m^3/chicken/year	Water Footprint (2010)	NA
	Pig	16.4	m^3/pig/year	Water Footprint (2010)	NA
	Sheep	2.9	m^3/sheep/year	Water Footprint (2010)	NA
	Goat	2	m^3/goat/year	Water Footprint (2010)	NA
Beverages	Brewery	4	(m3/m3)	BIER (2018), NPR(2013)	3.35
	Carbonated Soft Drink	2.02	(m3/m3)	BIER (2018), NPR(2013)	1.84
	Distillery	34.55	(m3/m3)	BIER (2018), NPR(2013)	32.68
	Water Bottling	1.47	(m3/m3)	BIER (2018), NPR(2013)	1.47
	Winery	4.74	(m3/m3)	BIER (2018), NPR(2013)	3.98
Public Institutions	Hospital	164-405	m^3/bed/year	García-Sanz-Calcedo et al.(2017)	166 (GER); 292 (MEX)
	Schools	4.8-20.7	m^3/student/year	Nunes (2019)	3.6 (US); 4.5 (BRA)
Dams	Hydropower	0-1740	m^3/GJ	Marence et al. (2013)	1,736 (EGY); 38-208.4 (ETH); 1.3-32.9 (TUR); 737.8 (GHA)

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