How water is shared between the environment and consumptive purposes in the Greater Metropolitan Region Groundwater Sources

This document explains how the NSW Government sets limits on extraction and reserved water for environmental purposes in the greater metropolitan groundwater sources.

Water sharing plans are the primary legal framework for managing water access and sharing in NSW. The plans are valid for 10 years from their start date.

Near the end of a plan's 10-year term, the Natural Resources Commission formally reviews it to identify any changes necessary. When it reviewed the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*, the Natural Resources Commission recommended that:

- the replacement plan is informed by a water balance model which includes up-to-date evidence for recharge, hydrogeology, connectivity, and climate
- extraction limits are based on sound evidence of ecosystem requirements, recharge, hydrogeological boundaries, and connectivity
- extraction in the Greater Metropolitan region is managed to protect, preserve and maintain the water sources, aquifer integrity and dependant ecosystems
- all environmental, cultural and socio-economic values are reassessed with the latest information and that plan rules are based on the best available information.

Planned environmental water

Groundwater may contribute to ecosystems such as wetlands, springs, caves, terrestrial vegetation and coastal sand dune systems and provide important base flows to rivers and tidal creeks.

Water sharing plans must reserve water as planned environmental water for fundamental ecosystem health or other environmental purposes and protect this water from extraction.

In NSW coastal groundwater sources, where rainfall recharge is used as the basis for sharing water, planned environmental water is equivalent to:

- the water stored in a groundwater source
- between 95% and 100% of the average annual rainfall recharge to high-conservation areas (for example, national parks) within a groundwater source
- between 30% and 95% of annual rainfall recharge to non-high conservation areas of the groundwater source, depending on environmental and socio-economic risks

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- the water remaining after water is taken under access licences and rights that cannot be carried over in accounts for use in a later year.

Extraction limits

Water sharing plans for groundwater set long-term average annual limits on extraction (extraction limits). While the total amount extracted by all water users varies each year, on average it cannot exceed the extraction limits.

In NSW coastal groundwater sources, where rainfall recharge is used as the basis for sharing water, extraction limits are equivalent to between:

- 0% and 5% of the average annual rainfall recharge to high-conservation areas (for example, national parks) within a groundwater source
- 5% and 70% of annual rainfall recharge to non-high conservation areas of the groundwater source, depending on environmental and socio-economic risks.

Method used to set extraction limits

For these Greater Metropolitan Region groundwater sources, the NSW Department of Planning and Environment does not have enough information on extraction, discharge and groundwater response to develop a water balance model, as recommended by the Natural Resources Commission. Instead, the department uses a macro risk-assessment method (the 'macro method') to set extraction limits. This is documented in the *Macro water sharing plans — the approach for groundwater — A report to assist community consultation, 2015.*

The method establishes and maintains water for the environment while allowing extraction of a portion of the average annual rainfall recharge for social and economic benefit. To determine the proportion available for extraction, the department assesses environmental and socio-economic risks and considers if these can be mitigated by other water sharing rules or *Water Management Act 2000* provisions.

In summary, for each groundwater source, the department:

1. estimates average annual rainfall recharge
2. identifies areas that have high conservation value (such as national parks) and areas that do not (that is, urban, agricultural, industrial areas)
3. assesses environmental risks and socio-economic risks
4. identifies mitigating actions that can reduce these risks. These include the:
    a. plan's distance restrictions for new bores, which prevent impacts on high-priority, groundwater-dependent ecosystems, Aboriginal cultural sites and existing water users
    b. *Access Licence Dealings Principles Order 2004*, which requires the department to assess the potential effects of trade and water supply works construction on an aquifer; contaminant movement; high-priority, groundwater-dependent ecosystems; Aboriginal cultural sites; and existing water users, before it gives approval

c. *Environmental Planning and Assessment Act 1979*, which prevents groundwater contamination

d. *Water Management Act 2000*, which prevents effects on groundwater-dependent ecosystems

5. compares the highest environmental risk and the highest socio-economic risk for each groundwater source in a risk matrix (see Figure 1) to determine the portion of recharge to be made available for extraction from the non-high conservation value areas. This is known as the **sustainability index**.
6. determines the proportion of throughflow from high-conservation value areas that can be available for extraction (0% or 5%)
7. calculates the total extraction limit, expressed as ML/year.

Figure 1. The risk matrix and sustainability indices, based on risk assessment (from macro method)

High environmental risk	5%	25%	50%
Moderate environmental risk	25%	50%	60%
Low environmental risk	50%	60%	70%
Risk	**Low socio-economic risk**	**Moderate socio-economic risk**	**High socio-economic risk**

The department used this approach to set the extraction limits in the current plan. However, there are opportunities to:

- review the risks, which may have changed over the life of the plan
- improve recharge estimates
- incorporate new information to assess environmental and socio-economic risks and consider factors specific to metropolitan areas, such as urbanisation, changing demand, significant dewatering and potential emergency drought water supply for Greater Sydney
- improve how we assess environmental and socio-economic risks by replacing qualitative assessments with quantitative ones, where possible

Estimating rainfall recharge

For the Greater Metropolitan Region's groundwater sources, the department has revised recharge estimates using expanded rainfall data and a method that improves on the one we used in 2011. This improved method uses:

- the infiltration rate for all the rock types at the surface of the groundwater source. Previously, the infiltration rate for the most common rock type was used as an estimate for the entire groundwater source.
- an expanded rainfall dataset (up to 2019 rather than 2006) to determine the average annual rainfall.

The department considered the effects of climate change on average annual rainfall. The NSW and ACT Regional Climate Modelling (NARCliM) indicates a potential increase of 0% to 5% in the average annual rainfall from the 1990–2009 period to the 2020–2039 one. Given the small, anticipated increase that would occur over the 10-year period of the plan, we took a precautionary approach that used the lower, average annual rainfall.

Assessing environmental and socio-economic risks

To establish extraction limits, the department used multiple sources of information when assessing risks.

In 2021, the department contracted environmental consultancy GHD to:

- quantify the risks for the Greater Metropolitan Region groundwater sources and dependent ecosystems
- identify the strategies that were either in place or needed to mitigate the identified risks.

In collaboration with the department, GHD tailored the risk assessment for the groundwater sources and land uses of the Greater Metropolitan Region. This was based on an approach the department used for the inland water resource plans in 2018–19.

Where suitable, the GHD risk assessment results were used for determining the sustainability index and extraction limits. The GHD assessment provided a consistent approach. It was less dependent on local knowledge and data not available for all groundwater sources than the established 'macro method'. It incorporated:

- spatial information on the location of bores
- spatial information on the volume of groundwater potentially extracted at any location
- spatial information on contaminated sites
- mapped high ecological value aquatic ecosystems
- spatial information on acid sulfate soils and potential sea level rise.
- The department identified existing mitigation strategies to address risks and refined the outcomes of the GHD risk assessment.

Environmental risks

Table 1, Table 2 and Table 3 show the risks assessed for the plan and the metrics used. There is more information on the risk outcomes for each groundwater source in the *Background* document to the draft water sharing plan.

Table 1. Ecological asset

Risk description	Consequence	Likelihood
Extraction causes drawdown, affecting access for groundwater-dependent ecosystems (GDEs)	**Dominant high ecological value aquatic ecosystem category** (based on significance and naturalness) (low, medium, high to very high)	**Entitlement density** • Nil <0.5 ML/km^2 • Low 0.5 ML to 5 ML/km^2 • Medium 5 ML to 50 ML/km^2 • High >50 ML/km^2
Groundwater extraction inducing connection with poor-quality water on GDEs	Dominant high ecological value aquatic ecosystem category	Two metrics contribute to ranking (matrix approach): • **Entitlement density** • **Occurrence of multiple sources of contamination**
Climate change reducing recharge and groundwater available for GDEs	Dominant high ecological value aquatic ecosystem category	Two metrics contribute to ranking (matrix approach): • **Decrease in average annual rainfall:** — Low <0.1% — Medium 0.1% to 0.5% — High >0.5% • **Storage (S) to recharge (R) ratio(S/R)** — Low: S/R value > 40 — Medium: S/R value 20 to 40 — High: S/R value < 20
Extraction causes drawdown reducing access for instream ecological values	Two metrics contribute to ranking (matrix approach): • **Dominant high ecological value aquatic ecosystem category** • **Connectivity between ground and surface water.**	Two metrics contribute to ranking (matrix approach): • **Entitlement density** • **Proximity to stream** — Low: >100 — Medium: 40 to 100 — High: <40

Table 2. Water quality asset

Risk description	Consequence	Likelihood
Groundwater extraction inducing connection with poor-quality water (impacts on consumptive users)	**Bore density.** (low, medium, high density compared to the average for all groundwater sources in the Greater Metropolitan area)	• Ranked low for all groundwater sources due to legislated mitigation • Multiple sources of contamination

Table 3. Aquifer integrity asset

Risk description	Consequence	Likelihood
Risks of extraction impacting on structural integrity and access for consumptive users.	**Bore density.**	Two metrics contribute to ranking (matrix approach): • **Compressible sediments** — Nil <20% — Low 20% to 50% — Medium 50% to 80% — High>80% to 100% • **Groundwater decline in seasonal recovery** — Low <20% difference — Medium between 20% to 40% difference — High >40% difference

Socio-economic risks

The department modified the socio-economic risk evaluation for the Greater Metropolitan Region groundwater sources from the 'macro method'. This was to address data gaps and incorporate information specific to the Greater Metropolitan Region.

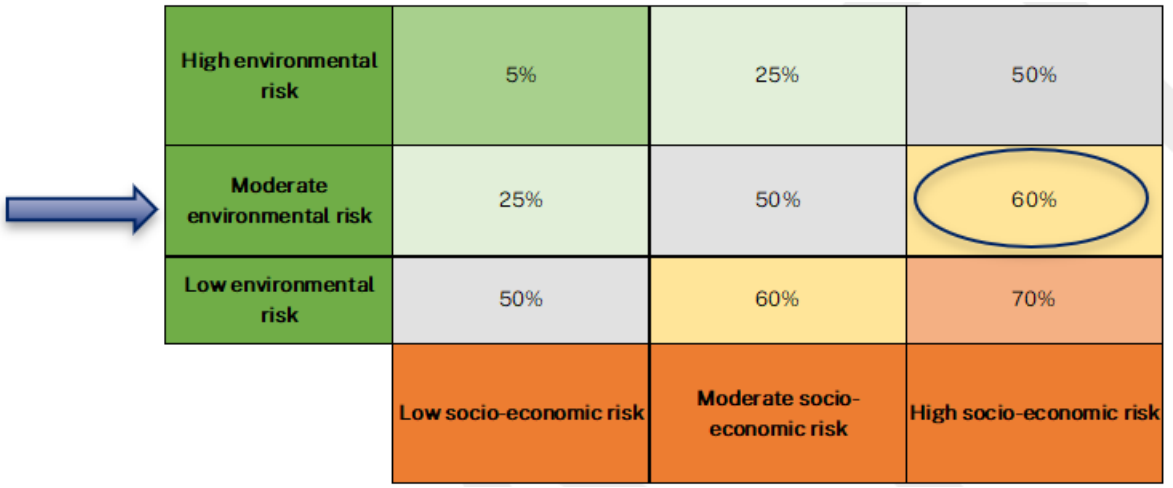
While the GHD risk assessment looked at some socio-economic risks, these were based on the 2011 plan's extraction limits and estimates of 'basic rights', making them unsuitable to use for informing the new extraction limits. Therefore, we did not consider risk outcomes from the GHD report that relied on these volumes for assessment when we determined the sustainability index.

Under the 'macro method', the department assesses the socio-economic risks independently of the environmental risks. For this plan, we used the maximum potential sustainability index arising from the environmental risk evaluation to quantitatively assess some of the economic risks.

Example: Using environmental risk outcomes to assess socio-economic risk

If the environmental risk analysis identifies a moderate environmental risk in a groundwater source, the **maximum** portion of recharge available for extraction is 60%, as Figure 2 shows.

Figure 2. Maximum portion of recharge available for moderate environmental risk



To assess socio-economic risk, we calculate 60% of the recharge volume. We compare this 'available recharge' to the estimated volume of groundwater needed to meet current and anticipated demand. The comparison indicates if there is a low, moderate or high risk that the demand will be met over the life of the plan (see Table 5).

This improved the process by:

- better reflecting the intent of the water sharing plan, which is to protect a volume of the recharge for environmental needs before providing water for extraction
- enabling quantitative evaluations of some risks rather than relying on qualitative assessment only
- allowing evaluation that does not rely on data that is sometimes unavailable (for example, groundwater level changes).

Table 5 shows the socio-economic risks assessed for the plan and the metrics used. There is more information on the risk outcomes for each groundwater source in the *Background* document to the draft water sharing plan.

Table 4. Socio-economic risks in the Greater Metropolitan Region groundwater sources

Risk	High	Moderate	Low
What is the risk to security of access from extraction?	No option for alternative water supply (source)	Limited options for alternative water supply (source)	Alternative water supply readily available (that is, can extract all entitlement at all times of the year)
What is the risk to ongoing groundwater access?	Large volume of groundwater commitments (current licences plus basic rights) compared to residual recharge* (that is, >70%)	Average volume of groundwater commitments (current licences plus basic rights) compared to residual recharge* (that is, 30% to 70%)	Small volume of groundwater commitments (current licences plus basic rights) compared to residual recharge* (that is, <30%)
What is the risk to dependence on town water supply?	Large volume of groundwater licensed or known future demand for town water supply compared to residual recharge* that could potentially be committed to town water supply (that is, >70%)	Average volume of groundwater licensed or known future demand for town water supply compared to residual recharge* that could potentially be committed to town water supply (that is, 30% to 70%)	Small volume of groundwater licensed or known future demand for town water supply compared to residual recharge* that could potentially be committed to town water supply (that is, <30%)
What is the risk to dependence on groundwater-related activities (requiring licenses, basic rights and other take that is exempt from licensing)?	Large volume of groundwater commitments and expected growth compared to residual recharge* (that is, >70%)	Average volume of groundwater commitments and expected growth compared to residual recharge* (that is, 30% to 70%)	Small volume of groundwater commitments and expected growth compared to residual recharge* (that is, <30%)
What is the risk to investment in activities that require access or exempt from access?	Significant investment in activities requiring groundwater (percentage of gross domestic product of council area)	Moderate investment in activities requiring groundwater (percentage of gross domestic product of council area)	Little investment in activities requiring groundwater (percentage of gross domestic product of council area)

*Residual recharge is the maximum rainfall recharge available from non-high conservation areas minus the sum of current and projected requirements.

There is more information on the socio-economic risk outcomes for each groundwater source in the *Background* document to the draft water sharing plan.

Determining the extraction limit – final steps

To determine the extraction limit, the department:

- compares the environmental and socio-economic risks in the risk matrix
- determines the sustainability index and multiplies it by the volume of rainfall recharge received across non-high conservation areas
- adds 5% of the recharge volume from high-conservation areas to the volume from non-high conservation ones to give the final extraction limit, if we expect high demand and throughflow from high-conservation areas to non-conservation ones.

In determining the 2011 extraction limits, we applied 5% of recharge from the high-conservation areas in the Botany Sands Groundwater Source, the Sydney Basin Blue Mountains Groundwater Source, Metropolitan Coastal Sands Groundwater Sources and the Maroota Tertiary Sands Groundwater Sources. We have kept this approach for the draft 2023 plan.

Some groundwater sources were amalgamated for the draft 2023 plan. The department assessed the risks to these and added the risk outcomes for each original groundwater source to give a final extraction limit.

Other ways to support environmental values

Establishing planned environmental water and maintaining it by setting extraction limits is not the only way that water sharing plans protect, preserve and maintain the water sources, aquifer integrity and dependant ecosystems.

For example, the draft plan sets restrictions on granting or amending water supply works near groundwater-dependent ecosystems to ensure extraction does not compromise their water needs.

The Minister can also impose conditions on licences to protect the environment or restrict or prohibit the taking of water from existing water supply works to:

- maintain or protect water levels in an aquifer
- maintain, protect or improve the quality of water in an aquifer
- prevent land subsidence or compaction in an aquifer
- protect groundwater-dependent ecosystems
- maintain pressure, or to ensure pressure recovery, in an aquifer.

More information

The read the draft water sharing plan, *Background* document and other fact sheets, including the report cards for each groundwater source, visit the department's website.