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**Assigning Groundwater Assessment Criteria for Pollutant Inputs. WAT-PS-10-02**

Applies from February 2025

# Purpose and scope

The purpose of this guidance is to set out:

* The objectives for protecting and improving groundwater quality.
* Criteria to assess if these objectives are met.
* The approach that you should take to demonstrating compliance with the objectives.
* The circumstances in which the groundwater objectives do not need to be met.

This guidance applies to all activities, both existing and new, and to all pollutants that could potentially impact on groundwater.

This guidance does not apply to unauthorised inputs into groundwater such as recent spills or leaks. This is because there is a prohibition under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR)[[1]](#footnote-2) on the input of pollutants into groundwater without authorisation. Therefore, any input, such as a leaking tank or a detection of pollutants in groundwater, which can be attributed to the unauthorised activity, may be evidence of a breach of CAR.

# Objectives for groundwater quality

The legislative objectives for groundwater quality are to:

1. Control inputs of hazardous substances
2. Limit inputs of non-hazardous substances
3. Prevent deterioration in status
4. Return groundwater bodies to good status
5. Prevent direct discharge to groundwater of hazardous or non-hazardous substances.

You must use the Groundwater Standards ([Section 3](#_Groundwater_standards_to)) to determine whether these objectives are being met.

In some circumstances the groundwater objectives can’t be achieved. In these cases, you can ask the regulator if they will accept the application of any exemption as set out in [Section 5](#_Next_steps_if).

# Groundwater standards to assess objectives

The Groundwater Standards are designed to assess the degree of impact on groundwater and to groundwater-dependent receptors. Groundwater-dependent receptors include surface waters, wetlands and existing abstractions.

Inputs of pollutants into groundwater should also not cause harm to property, amenities, and other legitimate uses of the water environment. SEPA considers that this will be achieved by protecting groundwater and groundwater-dependent receptors.

The Groundwater Standards are not necessarily authorisation limits or remedial targets, although they may form the basis on which these can be derived once site-specific considerations are taken into account.

The Groundwater Standards for non-radioactive chemical substances comprise a concentration, a statistic and a location at which they should be assessed.

Radioactive substances are assessed differently, in accordance with relevant national legislation, and international recommendations and standards. This guidance does not apply to inputs of radioactive substances.

## 3.1 Objective 1: Control inputs of hazardous substances

Inputs of hazardous substances into groundwater must be controlled so that there is no risk of deterioration in the quality of groundwater. You should use one of the two environmental standards depending on whether the input is less than or more than or equal to 50m from a surface water.

**Table 1: Groundwater standards to assess inputs of hazardous substances into groundwater**

| **Receptor** | **Spatial assessment rules** | **Assessment concentration** | **Assessment statistic** |
| --- | --- | --- | --- |
| Groundwater | Assessed at base of the unsaturated zone. For sources below the water table this should be assessed at the point of entry to groundwater. | Environmental Standard for inputs into groundwater of hazardous substances  (>50 m from surface waters) | Annual average |
| Groundwater near surface waters | Assessed at base of the unsaturated zone. For sources below the water table this should be assessed at the point of entry to groundwater. | Environmental Standard for inputs into groundwater of hazardous substances  (≤50 m from surface waters) | Annual average |

This objective only applies to groundwater which is less than 400 m depth below ground level and which is located inland of the mean high water springs tidal limit, or groundwaters at depth greater than 400m below ground level and/or below mean high water springs if the water is fresh or there is a pathway for contaminants to reach surface ecosystems.

## 3.2 Objective 2: Limit inputs of non-hazardous substances so that they do not cause deterioration of groundwater

This objective also applies to hazardous substances that have already entered groundwater from historical land contamination. It does not apply to new or ongoing hazardous substance inputs, which should be controlled to prevent deterioration, see [Objective 1](#_3.1_Objective_1:).

You should assess the impact on the receptors set out in Table 2 using the standards in that table.

**Table 2: Groundwater standards to assess if inputs of non-hazardous substances are causing deterioration of groundwater**

| **Receptor** | **Spatial assessment rules** | **Assessment concentration** | **Assessment statistic** |
| --- | --- | --- | --- |
| Future groundwater resource | Standard exceeded over 1 hectare[[2]](#footnote-3) | Threshold Value | Annual average |
| Current abstractions | Assessed in abstraction prior to treatment | Use-based standard  If multiple uses, then the most stringent use-based standard applies | Maximum |
| Surface waters | Assessed in surface water following mixing | Environmental standard for surface waters or other SEPA agreed standard | The relevant assessment statistic for the pollutants in surface water. |
| Groundwater dependent wetlands | Assessed in the wetland | Environmental standard for wetlands or other SEPA agreed standard | Annual average |

## 3.3 Objectives 3 & 4: Prevent deterioration in status and restore to good status

Inputs of pollutants must be controlled to prevent deterioration in the status of a groundwater body. Groundwater bodies at poor status should be restored to good status.

This objective also applies to hazardous substances that have already entered groundwater from historical land contamination. It does not apply to new or ongoing hazardous substance inputs, which should be controlled to prevent deterioration, see Objective 1.

You should assess the impact on the receptors set out in Table 3 using the standards in that table.

**Table 3: Groundwater standards to assess good groundwater chemical status.**

| **Receptor** | **Spatial assessment rules** | **Assessment concentration** | **Assessment statistic** |
| --- | --- | --- | --- |
| Future groundwater resource | Hazardous substances exceed standard over 20 hectares[[3]](#footnote-4).  Non-hazardous substances exceed standard when averaged across groundwater body | Threshold Value | Annual average |
| Current abstractions for human consumption | Assessed in abstraction prior to treatment | Drinking Water Standard plus upward trend in concentrations[[4]](#footnote-5). | Maximum |
| Surface water bodies | Assessed in surface water following mixing taking into account the spatial rules[[5]](#footnote-6). | Environmental standard for surface waters or other SEPA agreed standard | The relevant assessment statistic for the pollutants in surface water. |
| Groundwater dependent wetlands designated as Natura 2000 or SSSI sites | Assessed in the wetland | Environmental standard for wetlands or other SEPA agreed standard | Annual average |

## 3.4 Objectives 5: Prevent direct discharges to groundwater

For hazardous substances you should determine if Environmental Standards for inputs into groundwater of hazardous substances is exceeded at the point of entry into groundwater.

For non-hazardous substances you should determine if the threshold value is exceeded at the point of entry into groundwater. This is assessed as an annual average.

This objective only applies to groundwater which is less than 400 m depth below ground level and which is located inland of the mean high water springs tidal limit, or groundwater at depths greater than 400 m below ground level and/or below mean high water springs if there is a pathway for contaminants to reach surface ecosystems.

# Demonstrating compliance with objectives

This section sets out how you should demonstrate if the groundwater objectives can be achieved. You must consider both the source and associated downgradient plume.

## 4.1 Low risk activities

You don’t need to carry out a site-specific quantitative risk assessment to demonstrate you can meet the standards for low risk activities. Low risk activities are those where generic assessment of risks is normally adequate taking into account the typical scale of the activity and the likely consistency between sites in terms of contaminant type and loading.

To assess the impact on the water environment from these activities you should determine if you can meet generic criteria as set out in SEPA guidance. For specific low risk development activities this may be in our standard planning guidance for local authorities. If these criteria and rules are met, the activity can proceed without breaching the objectives.

Low risk activities include, but are not limited to:

* Activities regulated by SEPA using registrations or general binding rules.
* Small septic tank discharges (≤50 p.e).
* Grouting of former mine workings.
* Small cemeteries.
* Most site investigation and drilling activities.

Examples of types of generic criteria include:

* Soil thickness.
* Soil type.
* Depth to groundwater.
* Proximity to abstractions or surface waters.

If you can’t meet the generic criteria and standard rules, you should follow the approach outlined for higher risk activities set out in [Section 4.2.](#_4.2_High_hazard)

## 4.2 High risk activities

For higher risk activities, you should undertake a site-specific risk assessment. This should be based on a site-specific conceptual site model (CSM), supported by appropriate site characterisation. The CSM should be used to identify relevant pollutant linkages using a Source-Pathway-Receptor approach.

Where relevant pollutant linkages exist, you should undertake a phased approach to the detailed quantitative risk assessment as set out in Annex 3.

# Next steps if objective may not be achieved

Where risks to groundwater exist, it may not always be feasible to meet the Groundwater Standards in full. Similarly, in some circumstances, meeting the Groundwater Standards may not represent the best overall option for human health or the quality of the environment as a whole. This section sets out scenarios where you may consider whether an exemption from meeting the groundwater objectives applies.

The application of exemptions will take account of what is technically feasible. Technical feasibility can vary from site to site depending on local ground conditions, the environmental setting, and the nature, concentrations and mobility of the contaminants in question. Therefore, some professional judgement will be required. In addition, scientific and engineering advances mean that technical feasibility may change over time.

For new activities, you must follow best practice. For existing authorised activities, you must follow best practice as far as practicable. However, you can consider whether implementing additional measures would increase the risks to human health or the quality of the environment as a whole.

For historical land contamination, you can consider if remedial measures are disproportionately costly or would increase the risks to human health or the quality of the environment as a whole. For further details regarding historical land contamination, you should refer to SEPA Guidance Land Contamination and Impacts on the Water Environment, commonly known as the ‘Brown Booklet[’](http://www.legislation.gov.uk/ukpga/1990/43/contents)

Exemption on the grounds of disproportionate cost only applies to measures to remove quantities of pollutants from, or otherwise control their transport in, contaminated ground or subsoil. Therefore, this exemption may only be applied to existing historical contamination and not to new or ongoing activities. However, SEPA does not consider that remediation of source zones and/or groundwater plumes will always be disproportionately costly.

The assessment of disproportionate cost may include several factors such as:

* The scale of the contamination impacts and the sensitivity of affected receptors.
* The expected timescales for contamination impacts to persist without remediation.
* Socio-economic factors relating to the redevelopment works.
* The likely cost of remedial works including monitoring and validation.

Even if complete remediation is deemed to be disproportionately costly at a particular site, this does not necessarily mean that partial remediation of that site will also be disproportionately costly.

Some sites may have both historical land contamination and current regulated activities. The nature and expected duration of the current regulated activities may influence the technical feasibility and acceptable timescales for remediation of the historical land contamination.

## 5.1 Scenarios where SEPA will consider exemption from meeting objective 1 to control inputs of hazardous substances

These are the factors you can take into account when you are requesting that the regulator applies an exemption.

### 5.1.1 Inputs from historical land contamination

If measures to achieve the objective are disproportionately costly or would increase the risks to human health or the quality of the environment as a whole.

Action beyond remediation of the sources of hazardous substances as far as practicable is considered to be disproportionately costly and may not need to be undertaken provided Objectives 3 and 5 are met.

In this context, sources are considered to include:

* Tanks and associated pipework
* Other underground infrastructure or services containing hazardous substances
* Free product non-aqueous phase liquids (NAPL).
* Soil containing leachable concentrations that could result in groundwater pollution.

You can take into account the likely mobility of NAPL sources.

### 5.1.2 Inputs from current and new activities

If measures to achieve the objective would increase the risks to human health or the quality of the environment as a whole.

New activities must apply Best Available Techniquesand comply with SEPA guidance.

Existing activities must apply BAT and comply with SEPA guidance as far as practicable, provided any additional measures will not increase the risks to human health or the quality of the environment as a whole.

## 5.2 Scenarios where SEPA will consider exemption from meeting objective 2 to limit input of non-hazardous substances

As stated in Section 3, the objective 2, 3 and 4 may also be applied to hazardous substances with respect to historical land contamination where the contaminants have already entered groundwater. They do not apply to new or ongoing inputs, which should comply with the Environmental Standard for inputs into groundwater of hazardous substances.

Set out below are the factors you can take into account when you are requesting that the regulator applies an exemption.

### 5.2.1 Inputs from historical land contamination

If measures to achieve the objective are disproportionately costly or would increase the risks to human health or the quality of the environment as a whole.

Source management to break the pollutant linkage is not normally considered to be disproportionately costly. Any proposals to undertake less action than this must be supported by a detailed cost-benefit assessment.

### 5.2.2 Inputs from current and new activities

If measures to achieve the objective would increase the risks to human health or the quality of the environment as a whole.

New activities must apply Best Available Techniquesand comply with SEPA guidance.

Exemptions may be acceptable for activities where it can be justified that it is reasonable for the source zone to exceed 1 ha, such as landfills or cemeteries.

Existing activities must apply BAT and comply with SEPA guidance as far as practicable, provided any additional measures will not increase the risks to human health or the quality of the environment as a whole.

## 5.3 Scenarios where SEPA may consider exemption from meeting objective 3 to prevent deterioration in status

You are not permitted to breach this objective. You must ensure that you avoid a breach of the groundwater status standard by controlling inputs and/or by remedying the impact on groundwater and/or groundwater-dependent receptors.

This should include undertaking remedial measures where a plume is expanding or there is an upward trend in concentration such that groundwater body is likely to be at poor status in future.

## 5.4 Scenarios for where SEPA may consider exemption from meeting objective 4 to return groundwater bodies to good status

Set out below are the factors you can take into account when you are requesting that the regulator applies an exemption.

### 5.4.1 Inputs from historical land contamination

If measures to achieve the objective would be infeasible or disproportionately expensive.

Action beyond that listed below is considered to meet this criteria and does not need to be undertaken.

* Where the contamination has impacted on an abstraction for human consumption or caused a surface ecosystem to be at poor status, then action must be taken to remedy the impact on the receptor.
* Where the long-term groundwater resource is at poor status then action must be undertaken to prevent further expansion of the plume or an upward trend in concentration at the source.
* Action should also be undertaken to achieve good status in the groundwater resource in future.

Any proposals to undertake less action than that specified above must be supported by a detailed cost-benefit assessment.

### 5.4.2 Inputs from current and new activities

Activities will be authorised unless they will prevent a groundwater body already at poor status from being restored.

## 5.5 Scenarios for where SEPA may consider exemption from meeting objective 5 to prevent direct discharges

Set out below are the factors you can take into account when you are requesting that the regulator applies an exemption.

### 5.5.1 Inputs from historical land contamination

Not applicable as in situ historical land contamination sources are considered to be inputs but not discharges (see Annex 1.4).

### 5.5.2 Inputs from current and new activities

As detailed in Regulation 13(j) of The Water Environment (River Basin Management Planning: Further Provision) (Scotland) Regulations 2013.

Activities involving direct discharges will be authorised only where they otherwise comply with CAR. Refer to CAR Practical Guide for details regarding relevant GBRs.

# Annex 1 Background to the Groundwater Standards

## A1.1 What is groundwater?

Groundwater is defined by legislation[[6]](#footnote-7) as ‘water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil’. This definition has no size limit or depth limit so even small volumes of water in the subsurface or at depth are considered as groundwater if the ground or subsoil[[7]](#footnote-8) are saturated. Groundwater is present in all parts of Scotland and to considerable depth.

Legally controlled activities taking place in groundwater within the landward limits of coastal waters (up to 3 miles from limit of the highest tide) are subject to control under CAR or equivalent legislation. The sea will be a major discharge zone for most coastal groundwaters and this can be taken into account when assessing plume geometry and size.

Groundwater at significant depth and under coastal and transitional waters is typically saline, naturally unsuitable for potable use, and its flow is not usually significant for associated surface water or wetland ecosystems. However, in some limited circumstances groundwater at great depth and/ or under the sea may be potable and have resource value if these waters have an annual average level of natural electrical conductivity less than the Scottish drinking water standard for conductivity. In such cases or where groundwater at depth or beneath the sea is likely to influence surface waters or wetland ecosystems, either Environmental Standards for the input into groundwater of hazardous substances or Threshold Values for non-hazardous substances should be applied.

## A1.2 What is groundwater resource potential?

Future groundwater resource potential includes groundwater within all aquifers capable of supplying 10 m3/day or 50 people (on a continuous basis), that are less than 400 m below ground level, and located inland of the mean high water springs tidal limit. This is in line with the UK TAG criteria for defining groundwater bodies[[8]](#footnote-9). Aquifers that are not currently used for potable supply may still have future groundwater resource potential.

The following groundwater has future resource potential:

* Groundwater within all bedrock aquifers[[9]](#footnote-10) to a depth of 400 m below ground level in mainland Scotland plus those islands mapped by SEPA as groundwater bodies[[10]](#footnote-11).
* Groundwater in sand and gravel aquifers mapped by SEPA as groundwater bodies. Selected extensive sand and gravel aquifers are mapped as groundwater bodies[[11]](#footnote-12).
* Groundwater in superficial deposits that are not mapped as groundwater bodies unless it has been demonstrated using the methodology in Annex 4 that the groundwater does not have resource potential.

Where groundwater is not classed as having future resource potential, it still requires consideration as a pathway to other receptors, such as other groundwater that does have future resource potential, surface waters, abstractions or wetlands.

## A1.3 What is a hazardous substance?

Hazardous substances are “substances or groups of substances that are toxic, persistent and liable to bioaccumulate, and other substances or groups of substances which give rise to an equivalent level of concern[[12]](#footnote-13)”.

CAR require SEPA to publish [a list of the Groundwater Hazardous Substances](https://www.sepa.org.uk/regulations/water/groundwater/#discharges) that are applicable in Scotland on the basis of their intrinsic properties. This list is based on the recommendations of the Joint Agency Groundwater Directive Advisory Group (JAGDAG).

Radioactive material and radioactive waste[[13]](#footnote-14) are considered hazardous pollutants in groundwater.

Any substances that are not designated as hazardous by SEPA will be considered as non-hazardous for the purposes of regulation. Non-hazardous substances also include pathogens and heat.

## A1.4 What is an input and a discharge?

An input of a contaminant is a direct or indirect introduction of contaminants into groundwater as a result of human activity.

Inputs into groundwater may be divided into three categories:

* **Active inputs** - those resulting from an ongoing activity, even where the activity is a series of separated events, for example, inputs arising from septic tank drainage fields, or disposal of waste sheep dip to land.
* **Passive inputs** - those resulting from some previous activity that has now ceased, for example, an input from historical land contamination.
* **Accidental inputs** - those arising due to an unintended activity that initially gives rise to an active input, but which eventually produces a passive input.

A direct discharge is an active input directly into groundwater i.e. it bypasses the unsaturated zone during at least part of the year. Direct discharges of pollutants to groundwater[[14]](#footnote-15) are prohibited except in certain exceptional circumstances. [Section 5](#_Next_steps_if) provides more details.

The deliberate placement of materials, where leaching exceeds the standard, below the water table without an appropriately engineered barrier will be considered to be a direct discharge. Engineered barrier in this context means an artificial barrier composed of low permeability material of sufficient dimensions to adequately constrain advection and diffusion of contaminants. Engineered barriers should be constructed of a suitable material (or combination of materials) that has been designed taking into account the behaviour and persistence of the contaminants and any daughter products, the hydrogeological setting, and the proximity of receptors. In addition, it may be necessary to comply with additional requirements when designing engineered barriers for certain activities e.g. landfills or radioactive substances authorisations.

Discharge of effluents below the water table containing substances in concentrations above the relevant standard is a direct discharge and will be prohibited except in specific circumstances. You should not create an artificial discharge point, such as a soakaway, that extends below the water table even if effluent concentrations are expected to be below the relevant standard. This is because of the risk of creating a preferential pathway that might allow accidental inputs directly into groundwater in the event of a pollution incident.

An indirect discharge is an active input into groundwater via the unsaturated zone. The source is located wholly within the unsaturated zone, even during seasonal fluctuations of the water table. Indirect discharges are potentially acceptable provided that the input does not result in exceedance of the relevant standards.

Historical land contamination sources that remain in situ, including those that are in contact with or extend below the water table, are inputs but not discharges. However, if the historical land contamination source is moved during site redevelopment, this may result in a discharge.

Diffuse inputs, such as use of fertilisers in agriculture, are inputs but not point source discharges.

In summary, all discharges are inputs but not all inputs are discharges.

## A1.5 What is an assessment point and how does it differ from compliance?

An “assessment point” may be defined as ‘the point at which the standard should be met’ i.e the point used to assess if there has been or will be an impact.

The assessment point may be real or theoretical; that is, it may represent a real borehole from which groundwater samples can be obtained, or a virtual point at a location where the concentration of the polluting substance may be deduced from information on the fate and transport process. It can be derived from the spatial assessment rules.

Assessment point(s) should be used to determine whether or not there is entry of hazardous substances and/or groundwater pollution or impact on status (or if this is likely to occur in future).

[Annex 3.3](#_A3.3_Tier_2) provides further guidance on the choice of assessment points.

Assessment of risks to groundwater may be separate from demonstration of compliance with an authorisation. Assessing whether a source poses a risk to groundwater is a separate question as to what regulatory action may be required, taking into account any relevant exemptions.

A “compliance point” is defined as a physical sampling point used to demonstrate that the activity is likely to have achieved the agreed objectives and the input is acceptable. It need not be in the same location as the assessment point because:

* It may not be practical to install monitoring points at the assessment point e.g. at the base of the unsaturated zone or due to land use or access constraints.
* A compliance point may be required to provide an early warning to receptors e.g. by being located between the source and a water supply.

It is important that the compliance point is located within the plume or the potential pathway of the plume, including monitoring at an appropriate depth and in appropriate strata.

More than one assessment point may be required to assess the impact on multiple receptors.

The compliance concentration measured at the compliance point may also differ from the concentration at the assessment point because:

* It may need to be adjusted to take account of attenuation and dilution between the assessment point and compliance point.
* The agreed action, e.g. a remedial target, may not be to achieve the assessment criteria if an exemption has been applied.
* Compliance criteria may be lowered to provide early warning of potential impacts for sensitive receptors.
* Compliance criteria may be modified to account for existing background concentrations upgradient of the site.
* Compliance criteria may use site- or sector-specific statistical metrics, such as trend assessment or use of percentiles.
* Compliance criteria may be set for selected indicator parameters rather than for all potential contaminants of concern.

## A1.6 What is the basis for the environmental standards for input into groundwater of hazardous substances?

Entry of hazardous substances into groundwater must be controlled to ensure there is no risk of deterioration. In order to achieve this the Environmental Standards for input into groundwater of hazardous substances should be used.

For locations more than 50 m from surface waters, the Environmental Standard for input into groundwater of hazardous substances is set at 50% of the relevant potable standard[[15]](#footnote-16) assessed as an annual mean concentration. This ensures that, even if there were no dilution in groundwater and irrespective of the size of the source, the Threshold Value (as referred to in A1.8) should not be breached.

In close proximity (<50 m) to surface water features, the Environmental Standard for input of hazardous substances into groundwater is either 50% of the potable standard OR twice (2x) the relevant Environmental Standard for surface waters, whichever value is lower. The latter is based on an assumption that dilution is likely to occur within the surface water feature; the 95th percentile baseflow index for Scottish rivers is <0.5. While baseflow does vary both spatially and temporally, SEPA has chosen to assume a single baseflow index value to aid consistency in decision making.

In addition, there is likely to be dilution on entry to groundwater in most scenarios. Therefore, there should be no risk of deterioration if compliance with the Environmental Standard for input into groundwater of hazardous substances is achieved.

## A1.7 What is the basis for the threshold value?

Threshold Values are indicative of the ability of groundwater to support human uses.

Threshold Values are values set at 75% of the relevant potable standard and assessed as an annual mean concentration. This approach has been adopted to help ensure that the potable standard (assessed as a maximum concentration) is unlikely to be breached whilst allowing for a small margin of error to address minor temporal fluctuations in water quality. This approach is consistent with the approach recommended by UK TAG[[16]](#footnote-17) for general chemical assessment during groundwater body classification.

The decision on which potable value to use has been based on the hierarchy set out in Table 2 of Schedule 5 of the 2024 Directions.

If the values derived via the hierarchy are above the effective solubility of the substance in groundwater, then the standard will be set at the value of the effective solubility. This effective solubility cap applies if the relevant potable standard is likely to result in the presence of non-aqueous phase liquids in contact with groundwater. This capping threshold may be modified on a site-specific basis if appropriate to account for the likely effective solubility based on the local conditions, particularly if a mixture of contaminants is present.

Only where none of these values are available has a value been based on laboratory detection limits.

## A1.8 What is the basis for the groundwater pollution standards?

Pollution in relation to the water environment means the direct or indirect introduction, as a result of human activity, of substances or heat into the water environment, or any part of it, which may give rise to any harm.

The groundwater pollution standard considers both existing groundwater uses, by humans, surface water ecosystems or groundwater-dependent terrestrial ecosystems (GWDTE), and potential future groundwater use. The groundwater pollution standard applies to all future groundwater resource as well as groundwater supporting surface waters, GWDTEs or abstractors.

The groundwater pollution standard for future groundwater resources is set at >1 ha of groundwater exceeding the Threshold Value assessed as an annual mean. The 1 ha area is equivalent to the area required to support 10 m3/day of groundwater supply assuming a typical Scottish recharge rate of 1 mm/day. Whilst recharge does vary both spatially and temporally, a single recharge value has been chosen to aid consistency in decision making. The flow threshold of 10 m3/day is aligned with the determination of whether a hydrogeological unit has future resource potential (see A1.2).

For hazardous substances, the groundwater pollution standards only apply to contaminants that have already entered groundwater. New or ongoing entry above the Environmental Standards for input into groundwater of hazardous substances is not permitted without a relevant exemption (see Sections 3 and 5).

## A1.9 What is the basis for the groundwater status standards?

Status standards in relation to the water environment reflect a serious impact on nationally or regionally important receptors. The status of water bodies are classified in accordance with the WFD.

The groundwater status standards consider both existing groundwater uses, by humans, surface water ecosystems or GWDTEs, and potential future groundwater use. In this document groundwater status is used in relation to chemical status, as opposed to quantitative status.

The groundwater status standard in relation to surface water receptors is based on the actual or potential impact on the status of the relevant surface water body, taking into account the spatial rules used to determine surface water body status.

The groundwater status standard for GWDTEs is based on the potential impact on designated sites i.e. sites that have been designated as Natura 2000 sites or as Sites of Special Scientific Interest (SSSI). The impact or potential impact on a designated GWDTE is sufficient to also impact or potentially impact on groundwater body status.

The groundwater status standard for existing abstractions is based on potential anthropogenic impact on abstractions supplying water for human consumption. The standard also includes assessment of whether there is an upward trend in concentrations.

The groundwater status standard for substances hazardous to groundwater for future groundwater resources is set at >20 ha of groundwater exceeding the Threshold Value assessed as an annual mean. The 20 ha area is equivalent to the area required to support 200 m3/day of groundwater supply assuming a typical Scottish recharge rate of 1 mm/day. The 20ha area is based on an area that is 20% of the area of the smallest potential groundwater body, which is assumed to be 1 km2. This is aligned with current guidance[[17]](#footnote-18), which provides that an acceptable extent of exceedance for each substance would not exceed 20% of the total groundwater body. Whilst groundwater bodies vary in size, a single areal value for point source status assessment is used to aid consistency in decision making and to account for scenarios where a source and/or plume may straddle groundwater body boundaries. The groundwater status standard for non-hazardous substances for the future groundwater resources is measured as an annal average over the groundwater body.

For hazardous substances, the groundwater status standards only apply to contaminants that have already entered groundwater. New or ongoing entry above the Environmental Standards for input into groundwater of hazardous substances is not permitted without a relevant exemption (see Sections 3 and 5).

## A1.10 What is significant pollution?

Part IIA of the Environment Protection Act 1990[[18]](#footnote-19) uses the concept of significant pollution of the water environment, or significant possibility of significant pollution.

SEPA considers the following to represent significant pollution of groundwater:

* Breach of the groundwater pollution standard for existing abstractions, for surface waters and for GWDTEs
* Breach of the groundwater status standard for future groundwater resources.

What can constitute significant pollution is discussed further in SEPAGuidance: Land Contamination and Impacts on the Water Environment.

# Annex 2 Groundwater standard concentrations

## A2.1 Groundwater standards for common substances

Schedule 6 of the 2024 Directions includes a methodology for setting Environmental Standards for inputs into groundwater of hazardous substances and Threshold Values for groundwater. SEPA has applied this methodology to derive Groundwater Standards to protect Scotland’s groundwater.

You must use the list of Groundwater Standards for groundwater for common non-radioactive substances[.](https://consultation.sepa.org.uk/circular-economy/78f28f61/user_uploads/list-of-standards-06112020.pdf)

For radioactive substances, the Groundwater Standards are dose based and assessed by the risk to members of the public and non-human organisms and their habitats in accordance with relevant legislation.

For heat, no generic temperature standard has been set for groundwater. Groundwater temperature varies naturally over a range that may exceed what might be acceptable at specific receptors. Groundwater temperature is influenced by depth from surface and by the geological and hydrogeological setting. Any anthropogenic change in temperature of groundwater must not be high or low enough to cause adverse direct or indirect impacts in groundwater-dependent receptors including surface waters, wetlands or abstractions. The typical temperature range of Scottish groundwaters with resource potential is 5-25°C. if you are undertaking activities that are likely to cause groundwater to be outwith this temperature range you must carry out a site-specific assessment. Such activities might include large-scale geothermal projects or remedial activities involving in situ thermal treatment. The level of assessment required will depend on the expected change in temperature, the duration of the activity, and the proximity of sensitive receptors.

You should use the Scottish [drinking water standards](http://eur-lex.europa.eu/legal-content/EN/TXT/) when assessing risks to existing potable abstractions. In addition to contaminant-specific potable standards, you should consider the potential cumulative effect of contaminant concentrations on colour, taste and odour in existing potable abstractions.

## A2.2 Methodology for deriving standards

For contaminants where no standards are presented in The List of Groundwater Standards, you can derive a standard using the methodology set out in Schedule 6 of the 2024 Directions.

When assessing risks to surface waters posed by metals in groundwater, you can consider bioavailability as set out in WAT-SG-53 provided the relevant supporting surface water quality data is available for the receiving waterbody.

## A2.3 Modifying standards to account for naturally elevated background concentrations

Where appropriate site-specific assessment shows that natural background concentrations exceed the relevant Groundwater Standard, you can use a site-specific value equal to the annual average natural background concentration.

You must not modify the standards due to background concentrations that are elevated due to anthropogenic influences. A3.3.2 provides further information on how to consider background concentrations when undertaking site-specific risk assessments.

## A2.4 Managing limits of quantification

It can be difficult to achieve limits of detection and quantification that are below the relevant Groundwater Standards, particularly for contaminated water samples.

When undertaking numerical modelling or calculations during quantitative risk assessment you must use the standard without modifying it because of issues relating to limits of detection or quantification.

When undertaking site investigation or water monitoring, for example during site characterisation or for compliance assessment, you should try to achieve limits of detection and quantification that are below the relevant standard. If this is not feasible, you should:

* Use the minimum achievable limit of detection as an initial screening value.
* Adopt a ‘lines of evidence’ approach to determine the potential significance of the consequent uncertainty.

Take the significance of the uncertainty into account.

You must take a precautionary approach in relation to abstractions used for potable water supply and in relation to ecosystems and habitats that are designated sites (e.g. SSSI).

# Annex 3 Recommended assessment approach

For activities that pose a high risk, you must undertake a site-specific risk assessment to determine if the objectives have been met. This annex sets out how you should undertake such an assessment.

Table 1 sets out which Groundwater Standards you must apply when undertaking assessment of impacts on the water environment. For hazardous substances, the Environmental Standards for input into groundwater of hazardous substances apply to new or ongoing inputs into groundwater whereas pollution and status standards apply where hazardous substances have already entered groundwater due to past activities. You can also take other criteria into account when setting site-specific compliance limits or deriving remedial targets. [Section 5](#_Next_steps_if) provides further details.

## A3.1 General approach

You should use an assessment methodology based on a source-pathway-receptor approach. You can use a phased approach using the following tiers:

Tier 1, Compare source concentrations with relevant standards.

Tier 2, Compare predicted concentrations at the relevant assessment point with the relevant standard after dilution

Tier 3, Compare predicted concentrations at the relevant assessment point with the relevant standards taking into account natural attenuation.

Dilution (Tier 2) does not apply to the Environmental Standards for input into groundwater of hazardous substances since this applies immediately prior to entry into groundwater.

The level of detail you should apply to the assessment should be proportional to the risk posed by the source and the sensitivity of the receptors. If site-specific data is not available, you can use literature values. You must state and justify all relevant assumptions.

This guidance is general and cannot cover every possible scenario. You may need to use professional judgement and therefore site-specific risk assessments should be undertaken by groundwater professionals with appropriate qualifications and experience relevant to the sector. Ideally you will be accredited by the National Quality Mark Scheme or similar accreditation scheme.

### A3.1.1 Pollutant Linkages

You should develop a site-specific conceptual model to characterise the fate and transport of an input. This should use the concept of source-pathway-receptor linkages. It should identify and characterise the process and/or processes which cause migration of the substance(s) between source and receptor(s), together with the major limits and boundaries on these processes.

You must consider the following factors:

* Properties and geometry of the source.
* Unsaturated and, if required, saturated zone migration and attenuation.
* Receptors that could be affected.
* Where the potential impact will be assessed.
* What assessment limit to use.

When developing a site-specific conceptual model you should consider both current and potential future conditions.

You should also consider potential climate change impacts and potential extreme events whilst developing the conceptual site model as well as during any detailed quantitative modelling or sensitivity analysis.

Some climate change impacts that may be worth considering include:

* Changes in precipitation, both annual average and individual rainfall events.
* Changes in frequency or magnitude of extreme events such as floods and droughts.
* Changes in sea level & coastal erosion.
* Changes in groundwater levels including seasonal trends.
* Changes in air and water temperature, which may influence contaminant mobility and microbial activity.
* Changes to ecosystems.

Whether or not you need to include site-specific climate change impacts in your modelling will depend on the timescale of the scenario being assessed, the environmental setting, and the degree of uncertainty that is tolerable in the assessment results. Not all potential climate change impacts will be of significance for every site or for every activity. For example, coastal erosion is only likely to be important for sites near the coast. Deciding which factors to consider further for a particular site will require professional judgement. You should accompany any submissions of conceptual models and associated risk assessment with a justification as to why potential climate change impacts have been included or discounted.

### A3.1.2 Source characterisation

You must characterise or define the source(s) as part of the conceptual model. Both the geometry and the composition of the source must be considered.

For proposed new inputs (i.e. not yet built), you should define the source area based on the system design and specification.

For existing inputs, you should characterise the source area based on the available evidence, which might include:

* Details of the system design and construction (if known) for active discharges (e.g. soakaways) or for engineered systems (e.g. PPC landfills).
* Desk study and / or ground investigation in accordance with BS5930:2015 +A1:2020 and BS10175:2011+A2:2017 for historical passive inputs (e.g. land contamination).

It may not be feasible to fully characterise source geometry/volumes, for example:

* Access constraints related to structures or services.
* If the source extends beyond the site boundary.
* DNAPLs in a fractured rock setting.

You should identify and manage any uncertainty in the source characterisation and any consequent assumptions as part of the risk assessment. The degree of uncertainty that can be tolerated at a particular site will depend on the likely risks posed by the source, which in turn depends on the nature of the source, the potential pathways, and the proximity of sensitive receptors.

If there are multiple sources of the same/similar composition in close proximity to one another, you should consider whether they should be assessed individually or together as a combined source. If the sources are likely to result in a combined plume (i.e. individual plumes are predicted to overlap), then you should normally consider the impacts cumulatively.

When considering sources that include NAPLs, you should take into account the effective solubility when estimating inputs into groundwater. This can be modified on a site-specific basis. For example, to account for the mixture of contaminants present.

You should consider whether the source is best assessed as a constant source term or whether a declining source term would be more representative taking into account the site-specific conditions. You can take factors such as variations in leaching behaviour over time or natural source zone depletion if they can be adequately justified using measured and/or modelled data.

### A3.1.3 Pathway characterisation

You must characterise the pathway(s) between the point of entry to groundwater and the relevant receptors as part of the conceptual model.

You can take into account any constraints on contaminant migration if they are appropriately justified. For example, hydraulic barriers to groundwater flow or major discharge zones such as the sea or a river. You should also consider the potential for the existence of preferential pathways (natural or man-made) that may influence contaminant migration.

You can consider attenuation processes in the unsaturated and saturated zone between the source and the receptor if they are appropriately justified (see A3.4 for further details). You should only assume there will be degradation of contaminants where hydrogeological conditions indicate that it is likely to occur. Both the original contaminant and its daughter products should be taken into account in the assessment.

The thickness of the mixing zone within groundwater will be dependent on:

* Source geometry.
* Geological setting, particularly in relation to layering, fracturing, and/or weathering.
* Groundwater flow regime.
* Presence of any preferential pathways.

You should estimate the mixing zone thickness using professional judgement and site-specific data on local ground conditions and/or by the use of empirical equations. Your approach should be justified in the risk assessment submission.

If you can’t fully characterise all pathways, for example owing to access constraints related to structures or services you can use published maps and literature sources to supplement site-specific investigation and data. You must justify any uncertainty in the pathway characterisation and any consequent assumptions in the risk assessment.

### A3.1.4 Receptor characterisation

You must consider the key receptors in your risk assessment including:

* Groundwater (for hazardous substances only).
* Potential future groundwater resources (for both hazardous and non-hazardous substances).
* Surface waters.
  + Rivers and streams.
  + Lochs.
  + Coastal and transitional waters.
* Existing abstractions.
* Groundwater dependent terrestrial ecosystems.

### A3.1.5 Calculation of annual average concentrations

You should calculate annual average concentrations for comparison with the Groundwater Standards using the following guidelines:

* When assessing risks to future groundwater resources, you can use an annual average source term concentration that accounts for any seasonal variations in loading.
* When assessing risks to groundwater-dependent receptors, such as surface waters or abstractions, you can take into account seasonal factors for the source term, pathways and receptors. Both annual average and peak loading should be assessed.
* You should calculate annual average concentrations in groundwater at the assessment or compliance points on a temporal basis only.
* You can calculate annual averages on a rolling basis if appropriate, rather than being for a specific calendar year.
* The minimum number of data points required to calculate an annual average will vary on a site-specific basis, taking into account the conceptual site model, the variability of the dataset, comparison of measured concentrations relative to relevant standards, and the anticipated level of risk to the water environment. You should take into account any potential seasonal or other temporal variations in the dataset. If datasets are comparatively limited, then you should take a more conservative approach to risk assessment, including appropriate sensitivity analysis. Some suggestions regarding typical dataset requirements are presented below:
  + To give a ‘snapshot’ of current groundwater quality, you should take a minimum of three rounds at least a week apart.
  + For scenarios where seasonality may be of greater significance, you should carry out a minimum of quarterly monitoring over at least 12 months. Alternatively, you could undertake monthly monitoring over at least 6 months during the most relevant season (summer or winter) for the activity in question.
  + For complex sites and/or higher risk situations, you should carry out monitoring at least monthly over at least 12 months.
  + If long-term (>5 years) monitoring is required, you should take a phased approach with the frequency of monitoring gradually reducing over time, taking into account any seasonal or other temporal patterns observed.
  + If monitoring groundwater that is tidally influenced, you should consider both the frequency of monitoring and the exact timing of the monitoring rounds relative to the tidal cycle when planning monitoring and when interpreting the results.
* It may be more appropriate for you to use a geometric mean, rather than an arithmetic mean, for parameters varying by more than two orders of magnitude, depending on the distribution of the dataset.
* If values are less than the limit of detection you should assume that they are equal to 50% of the limit of detection.
* You should only exclude potential outliers from the dataset if you have supporting evidence to justify their omission. For example, a documented problem with the sampling /analysis or results of more detailed statistical analysis. You should apply caution in the treatment of outliers, particularly when:
  + Assessing small datasets.
  + Datasets include a significant proportion of non-detects.
  + Datasets are collected by more than one operator.
  + More than one sampling/analytical method is used.
  + Datasets include extreme events.
  + Datasets are for locations that are influenced by multiple sources and/or pathways.
* You should present confidence intervals with calculated means to help support decision making.

When undertaking probabilistic predictive modelling use should use the 95%ile value to compare to the relevant standard. The 50%ile value is not necessarily equivalent to the annual average.

You can use alternative statistical approaches if you appropriately justify them.

## A3.2 Tier 1 Screening

To carry out a Tier 1 assessment you should compare the concentrations within the source with the relevant Groundwater Standards.

If the source concentration does not exceed any of the relevant Groundwater Standards, then no further assessment is required.

If the source concentration does exceed the relevant standards, you should proceed to Tier 2.

As it is not usually possible to physically monitor the assessment point for the entry of hazardous substances (i.e. the base of the unsaturated zone) the Tier 1 screening should be based on predicted source zone concentrations (effluent concentrations, leachable concentrations in soil, or NAPL solubility) for new activities. For historical land contamination, you can use groundwater concentrations immediately adjacent to the source zone (either directly beneath and/or immediately downgradient) as a supporting line of evidence to help identify potential contaminants of concern requiring more detailed assessment.

## A3.3 Tier 2 QRA dilution only

To carry out a Tier 2 assessment you need to undertake a quantitative risk assessment (QRA) to determine whether dilution is sufficient to prevent the standards being exceeded. This requires comparison of input loading rates with the hydrogeological regime to assess potential dilution.

The methodology you should use for the assessment of dilution varies depending on the receptor being assessed. This section sets out the recommended approach for each type of receptor.

If the Tier 2 assessment indicates that there is potential for the relevant standard to be exceeded, either currently or in the future, even after dilution, then you should progress to Tier 3.

### A3.3.1 Input loading

You should calculate the load of contamination being added to groundwater per day from the source. This requires consideration of the nature and geometry of the source and the rate at which substances will enter groundwater.

The geometry of the source area should be based on the spatial extent of:

* Active discharge to ground.
* Leachable substances in soils or wastes.
* Non-aqueous phase liquid (NAPL).

The nature of the source will influence how the loading rate to groundwater (concentration multiplied by flow rate) should be estimated. You can use Table 3 to help you calculate this but you can use alternative methods if you can appropriately justify them. You should consider both source concentration and flow rate as annual averages, except for abstractions for human consumption where maximum values should be used.

If a source zone straddles the water table, then you should estimate the cumulative input into groundwater. This will require consideration as to:

* Any seasonal, tidal or other fluctuation in groundwater levels.
* The consequent relative proportion of the source above and below the water table.
* The potential for the source geometry to change over time.
* The potential for mobility of contaminants to vary.

If you want to derive a conservative loading value you can add the estimated loading above and below the water table. However, in some circumstances this may be overly conservative and you may wish to undertake more detailed consideration of cumulative loading.

**Table 4: Suggested approach for the estimation of source input loading rates**

| **Source Type** | **Concentration** | **Flow Rate** |
| --- | --- | --- |
| Active discharge to ground | Effluent concentration (measures or calculated | Discharge rate |
| Leachable soils or wastes | Leachable concentration (measured[[19]](#footnote-20) or calculated) | Recharge rates multiplied by source areas for sources located above the water table.  Groundwater flux passing though source for sources located below the water table. |
| NAPL | Solubility limit[[20]](#footnote-21) | Recharge rates multiplied by source area for NAPL located above the water table.  Groundwater flux passing NAPL located at or below the water table. |

If the source zone straddles more than one hydrogeological unit, either vertically or laterally, you should estimate the proportional loading into each hydrogeological unit. You will need to consider the relative proportion of the source within each unit, the potential for the source geometry to change over time, and the potential for mobility of contaminants to vary between hydrogeological units.

You must take into account the presence of preferential pathways for contaminant migration, such as mine workings or service runs if appropriate, during source input loading estimation.

You should try to use site-specific infiltration and recharge rates. However, you can use literature vales if appropriately justified.

Source composition and concentrations may change over time. You can take into account temporal trends in source concentrations in predictive modelling of future impacts, provided this can be appropriately justified.

When measuring leachability, the analytical method used can influence the results. You should consider what analytical methods are likely to be representative for the scenario being assessed. You may wish to undertake a bespoke leachability assessment as this may be more representative of the long-term leaching that might occur under the site-specific conditions than generic leachability testing. For example, amending the duration of the leaching test and/or the water quality (e.g. pH, salinity).

You can adopt a lines-of-evidence approach when estimating site-specific source loading rates. This may include comparison of contaminant concentrations in soil and groundwater for historical land contamination sources, consideration of the potential influence of background groundwater quality on solubility and leachability, and the potential influence of the mixture of contaminants present.

If there is uncertainty as to the geometry and/or composition of the source zone, then any assumptions you use in estimating the loading rates must be documented and justified.

### A3.3.2 Accounting for upgradient groundwater quality

Where the background groundwater upgradient of the site being assessed contains naturally elevated concentrations, then you should use site-specific values in accordance with Annex 2.3 instead of applying the Groundwater Standards set out in Annex 2.1.

You must not adjust the Groundwater Standards to take account of any background anthropogenic contamination already present in the groundwater.

Where background groundwater concentrations upgradient of the site being assessed are already impacted by anthropogenic contamination[[21]](#footnote-22), you should consider this during the quantitative risk assessment process. The levels of background contamination are often not within the control of site owners or operators. However, groundwater resources do not have an infinite capacity to accept inputs before the groundwater becomes no longer suitable for future use.

If the background contamination does not yet exceed the relevant groundwater pollution or status standard, you should check that the input being assessed does not result in the standard being exceeded. You should take into account upgradient groundwater concentrations, including consideration of any significant temporal trends when calculating acceptable source concentrations. You can also consider natural attenuation within both the unsaturated zone and the saturated zone if this can be adequately justified.

If the background contamination already exceeds the relevant groundwater pollution or status standard, significant additional inputs will not be permitted unless a relevant exemption is applicable (see Section 5). The input concentration must not exceed the relevant standard at the point of entry into groundwater. Natural attenuation within the unsaturated zone only may be considered provided this can be adequately justified.

You should check that the input into groundwater being assessed does not result in the groundwater body becoming poor status or prevents a groundwater body already at poor status from being restored.

You should also check that the input into groundwater being assessed does not result in any additional adverse impact to surface waters, abstractions or wetlands.

### A3.3.3 Assessing impacts on future groundwater resources

When assessing impacts on future groundwater resources you should compare the combined area of both the source and the predicted maximum extent of the associated downgradient plume with the relevant assessment areas (1 ha for pollution or 20 ha for status).

#### Setting assessment points

Many commonly used quantitative risk assessment methods involve 2-dimensional equations or models that simulate a vertical cross-section of the source and plume. To aid such calculations, you will need to calculate equivalent downgradient assessment points based on the source area geometry, particularly the source width perpendicular to the groundwater flow direction. The equivalent assessment point distance must be measured from the upgradient boundary of the source in the direction of groundwater flow.

The maximum acceptable equivalent assessment point distances are 500 m for pollution and 4 km for status. These values have been based on consideration of typical Scottish topography, geology and hydrology whilst adopting a nationally consistent approach.

You should define the depth of the equivalent assessment point on a site-specific basis, taking into account the local hydrogeological setting, so as to be representative of the vertical centreline of the plume (i.e. the highest concentration in the vertical dimension). The exception to this is where the centreline of the plume is located within superficial deposits that are not classed as having future groundwater resource potential. In these cases, the equivalent assessment point should be located at the top of the underlying groundwater resource receptor.

For larger source areas, the equivalent assessment point for future groundwater resources may be located within the source area. If this is the case, your risk assessment should then predict the maximum spatial extent of the potential impact (source + plume). The likely maximum extent of the plume will be influenced by factors such as the geological setting and the presence of groundwater discharge zones. You may need to carry out a more detailed consideration of the consequent predicted impact on the groundwater body as a whole, which is likely to require discussion with SEPA. You may need to take into account exemptions when considering large sources.

If you have multiple source zones of the same or similar contaminants that are present in close proximity to one another and it is predicted that the plumes will overlap, you should normally measure the equivalent assessment point distance from the upgradient boundary of the source zone located furthest upgradient.

If the equivalent assessment point is located at or beyond the coast (mean high water springs tidal limit), you don’t need to consider the future groundwater resource as a receptor because the coast is expected to be a major discharge zone. You should consider the groundwater as a pathway to the coastal or transitional water body receptor.

If the equivalent assessment point is located on the opposite side of a river or loch from the source you need to undertake further assessment. If you can demonstrate that the majority of the downgradient plume enters the surface water body as baseflow, then you can consider groundwater as a pathway rather than as future groundwater resource. However, where the geological and hydrogeological evidence suggests that the majority of the plume may pass beneath the surface water feature, then you should consider the future groundwater resource as a receptor. You should base the assessment on site-specific evidence obtained from site investigation and/or groundwater and surface water monitoring. In the absence of plausible site-specific evidence, you should adopt a precautionary approach.

For complex sites, such as those with multiple source zones, multiple hydrogeological units, or with preferential pathways for contaminant migration, you may need to undertake 3-dimensional modelling rather than 2-dimensional cross-section modelling. If you are undertaking 3-dimensional modelling, then you may be able to model the spatial footprint of the source and plume directly and it may not be necessary to set an equivalent assessment point.

#### Assessing potential impacts on status

If there is a plume of hazardous substance that is or is likely to become greater than 20 hectares in plan view then this would impact groundwater body status for the groundwater body(bodies) in which the source(s) is located.

For non-hazardous substances, if the average concentration across the groundwater body exceeds the Threshold Value, then this would impact groundwater body status for the groundwater body in which the source(s) is located.

As an initial screening step, you should determine if there is a plume of non-hazardous substances that is or is likely to become greater than 200 hectares in plan view. If there is then further assessment of potential groundwater body status failure is likely to be required.

This further assessment should consider:

* Potential loading from the source term relative to the recharge to the groundwater body as a whole.
* Background groundwater concentrations elsewhere in the groundwater body.
* Geological setting, particularly features such as faults or geological boundaries that may influence groundwater flow paths and plume geometry.
* Proximity to major discharge zones.

If relevant background water quality data is not available for the contaminant in question, then you need to make assumptions regarding likely groundwater quality. You should provide justification for these assumptions in the risk assessment.

### A3.3.4 Assessing potential impacts on surface waters

Surface waters are defined[[22]](#footnote-23) as all inland waters (except groundwater); transitional waters, and coastal waters. This includes small watercourses as well as water bodies.

You need to determine if the groundwater pollution standard for surface water impacts is exceeded. This is the exceedance of the relevant Environmental Standard for surface waters in the surface water beyond the mixing zone due to groundwater inputs.

You should locate the assessment point in the surface water beyond the mixing zone (i.e. taking dilution into account). The actual assessment point you chose will depend upon the type of surface water feature.

You can find the assessment concentrations for surface waters in WAT-SG-53 Environmental Standards for Surface Waters.

You only need to take into account dilution in surface waters where:

* The surface water feature is located within the equivalent assessment distance set out in A3.3.3; and
* The predicted groundwater concentrations at the point of entry to surface waters exceed the surface water assessment concentrations.

If the groundwater pollution standard for surface waters is exceeded you should determine if the groundwater status standard for surface water is exceeded. This involves determining if there has been or is likely to be a deterioration (actual or predicted) in surface water status due to exceedance of the relevant Environmental Standard for surface waters in the surface water body beyond the mixing zone over a specified spatial extent of the water body as set out in Schedule 4 of 2022 Directions. You should only consider water bodies used for classification under the Water Framework Directive (WFD). You need to check if any impacts on tributaries will cause the main water body to be impacted, or is predicted to be impacted, to the point at which deterioration in status below Good could occur.

If this is the case you then need to check if groundwater inputs account for at least 50% of the surface water quality impacts[[23]](#footnote-24).

If it is then you can determine that the groundwater status standard for surface water has or will be exceeded.

When you are doing any dilution calculations in surface water you can consider the input from groundwater as arising from an equivalent pipe discharge. You can assume instantaneous mixing in the surface water when undertaking mass balance calculations.

The Surface water calculation methods you use to determine the acceptable load from groundwater depend upon the type of water body:

**Rivers** - as described WAT-SG-03 Data Analysis and River Quality Planning Models.

**Lochs** – for phosphorous as described in [WAT-RM-37: Regulation of](https://consultation.sepa.org.uk/circular-economy/922ed503?number=WAT-RM-37) [Phosphorus Discharges to Freshwater Lochs](http://stir-app-qpl01/QPulseDocumentService/Documents.svc/documents/active/attachment?number=WAT-RM-37)[3](http://www.legislation.gov.uk/ssi/2011/209/contents/made?number=WAT-RM-37)6.

**Coastal and transitional waters** - as described in [WAT-SG-11: Modelling](http://www.legislation.gov.uk/ssi/2012/360/contents/made?number=WAT-SG-11) [Coastal and Transitional Discharges](http://stir-app-qpl01/QPulseDocumentService/Documents.svc/documents/active/attachment?number=WAT-SG-11) or alternatively you can calculate this as outlined below:

Dilution in coastal & transitional waters = (2 x W x TR x 100) / Q

Where:

W is the groundwater plume width in m.

TR is the tidal range in m, i.e. height difference between mean high and low water.

Q is the groundwater seepage rate in m3/d, i.e. rate at which groundwater emerges from ground at low tide.

The calculation assumes a mixing zone of 100 m measured from low tide and two tidal cycles per day.

You may be able to use alternative approaches to calculating dilution[[24]](#footnote-25), including detailed hydraulic modelling.

You need to take account of the capacity of the surface waters in accordance with WAT-RM-21 Allocation of Capacity and Protection of the Water Environment.

Diffusion of poor quality groundwater through the hyporheic zone may cause harm to some sensitive species living in or on sediments (for example, fish eggs, freshwater mussels). Significant harm is more likely from larger sources. In order to minimise the risk to these sensitive species, we will consult NatureScot in accordance with agreed procedures. You should apply the relevant Environmental Standard at an assessment point located in groundwater immediately before entry into the surface water; that is, dilution in surface waters will not be considered. Parameters can be measured, modelled, or estimated as appropriate to the level of risk posed by the site. If compliance monitoring is required this should be undertaken in groundwater immediately prior to entry into the surface water.

### A3.3.5 Assessing potential impacts on abstractions

Where the assessment point is an existing abstraction, the assessment limit should prevent an increase in the level of purification treatment applied. This means that where treatment is not currently applied for the substance in question, the assessment limit should ensure that future treatment will not be necessary. Where treatment is currently applied to such an abstraction, the assessment limit should ensure that the level of treatment does not increase. In all cases, upgradient concentrations must be taken into account.

Where an abstraction exists at or within the distance of the future groundwater resource assessment point, in addition to the calculation of the concentration at the future groundwater resource assessment point, you must also calculate the concentration at the abstraction assessment point, prior to any treatment the abstracted water might receive. The assessment limit you adopt should protect both receptors. The groundwater pollution and status standards for abstractions are based on maximum, rather than annual average, values. You need to take into account concentration trends when assessing status.

If compliance monitoring is required, this should be undertaken in the abstracted groundwater (raw water) prior to any treatment this might receive.

When assessing of risks to potable abstractions you should also take into consideration the potential cumulative impact of contaminant concentrations in relation to factors such as colour, taste and odour.

You should contact SEPA prior to assessing impacts on existing abstractions for human consumption.

### A3.3.6 Assessing potential impacts on groundwater terrestrial ecosystems

Groundwater dependent terrestrial ecosystems (GWDTE), which are wetlands that are wholly or partially reliant on groundwater, can be damaged by contaminated groundwater.

There can be many pressures affecting a wetland, e.g. vegetation management, however this procedure only relates to chemical pressures transmitted through groundwater.

Criteria on which significant damage to a GWDTE is based is set out in EU CIS technical report no 6[[25]](#footnote-26) . For example, for GWDTE that are part of the designation of Natura 2000 nature conservation sites, significant damage can equate to failure to meet conservation targets.

You should assess the impact on any GWDTE. The assessment point you should use for the GWDTE should be:

* Located at the up-gradient boundary of the wetland in the relevant groundwater flow path; and
* In groundwater that is hydraulically linked to the GWDTE such that the groundwater containing the source/plume is likely to be the irrigation source that critically supplies the GWDTE.

Where more than one hydrogeological unit is present at a GWDTE, you can often use the vegetation composition of the GWDTE to identify the groundwater source. Where uncertainty exists, you should seek advice from a qualified wetland ecologist.

You can find threshold Values for nitrates in wetlands in Schedule 6 of the 2024 Directions. These values identify acceptable limits for nitrate concentrations in groundwater in different wetland types at the relevant wetland assessment point. The standards are dependent on the type of GWDTE which is impacted. The wetland types are set out in Schedule 1 of the 2024 Directions.

Exceedance of these values does not automatically mean that the wetland that receives this water would be damaged, but that the risk of damage is significant.

Water quality standards for other pollutants specific to Scottish wetlands have not yet been developed. You will need to consult a qualified wetland ecologist to assess if other pollutants could cause significant damage and the concentrations that may cause significant damage[[26]](#footnote-27).

If compliance monitoring is required, this should be undertaken in groundwater immediately prior to entry into the GWDTE. You should locate any compliance point at an appropriate location and depth along the pathway to the GWDTE to monitor the pollutant plume.

## A3.4 Tier 3 DQRA including natural attenuation

To carry out a Tier 3 assessment you need to undertake a detailed quantitative risk assessment (DQRA) to determine whether natural attenuation processes are sufficient to prevent the standards being exceeded. Your DQRA must be supported by site-specific evidence obtained from site investigation and/or groundwater monitoring. You should only use literature values if you can adequately demonstrate their relevance to the hydrogeological conditions at the site in question.

Unless previously explicitly stated otherwise (e.g. in A3.3.2), you can take into account natural attenuation:

* In the unsaturated zone prior to entry into groundwater.
* In the saturated zone between the source and the assessment point.

You must not take natural attenuation into consideration:

* In the hyporheic zone when assessing risks to surface waters.
* Within surface water features.

Within groundwater dependent terrestrial ecosystems.

The subsurface has a limited and finite ability to retard contaminants. For inputs that will continue over long time scales (e.g. decades), you should not place significant reliance on retardation processes that might significantly decline, stop or be reversed.

You should only consider degradation where the ground conditions are consistent with it plausibly occurring. You must also take into account the impacts of the resultant daughter products.

# Annex 4 Assessing future groundwater resource potential in superficial deposits

## A4.1 Background

All groundwater within superficial deposits that have been mapped by SEPA as groundwater bodies is considered to have resource potential.

However, most superficial deposits are considered to be part of an amalgamated superficial/bedrock groundwater body. Some of these superficial deposits, particularly where clay-rich, have low potential as a future groundwater resource. This annex sets out broad guidelines on the type of investigations that SEPA will consider acceptable for determining whether groundwater within superficial deposits that are not currently mapped by SEPA as individual groundwater bodies has future groundwater resource potential. This methodology only applies to onshore superficial deposits, located inland of the mean high water springs tidal limit.

Assessing the supply capacity of groundwater beneath the site will enable correct location of the assessment and compliance points to protect the future groundwater resource.

## A4.2 Recommended approach

The methodology described below consists of three stages of increasing complexity and cost aimed at assessing whether the superficial deposits above bedrock fulfil the UK TAG criteria for a groundwater body. If you wish to use this approach you should start at Stage 1 as appropriate and continue to the next stage(s) as necessary. You should be aware that SEPA will use the ‘weight of evidence’ from the investigation to decide the resource potential of the deposit.

SEPA will make a final decision on whether or not the stratum should be considered to have resource value based upon the following properties of the superficial deposit:

* Areal extent.
* Average thickness.
* Physical properties.

Permeability / productivity.

### A4.2.1 Stage 1: Prior to site investigation

You should start by assuming that all saturated natural superficial strata have future groundwater resources potential.

In some situations, it may be more cost effective to accept this assumption. However, examination of the implications of acceptance might reveal that it may be to your advantage to test this assumption by progressing to Stage 2; that is, the cost of the investigation could be offset by savings elsewhere.

### A4.2.2 Stage 2: Drilling/excavation to bedrock

You need to determine if the superficial strata can provide more than 10 m3/day using information from site investigation and available geological mapping.

If you find that the superficial strata are of significant areal extent (>1 ha) and a significant thickness of saturated sand or gravel (or coarser material) is present (>2m continuous thickness), then you should either undertake a Stage 3 investigation or the you should consider the stratum to form part of the underlying groundwater body with its limit at the top of the relevant stratum.

You can determine if the superficial strata are ‘sand or gravel strata’ by either:

* Using field descriptions made by qualified personnel in accordance with British Standards (BS5930:2015+A1:2020 Codes of Practice for Site investigations). In samples from sand or gravel strata, the ‘“principal soil type’” should be sand or coarser, with the material having no apparent plasticity/cohesion or being dominantly cobbles or boulders.
* Using particle size analysis, the distribution from the relevant strata should be less than 20% fines (silt and clay) in all samples, with average clay content of less than 13% clay[[27]](#footnote-28).

You should use available geological mapping to provide additional confidence to the conclusions drawn from site investigation, e.g. areal extent and connectivity of granular deposits.

Where the superficial geological sequence is complex, or where there is doubt concerning any of the Stage 2 assessments, then you should undertake a Stage 3 investigation. This is particularly the case where the superficial deposits have an areal extent of >1 ha but there is uncertainty as to whether the granular horizon thickness criteria have been met. An example of a complex sequence is the common situation where numerous thin layers or lenses of permeable strata are present within less permeable deposits.

If the areal extent is <1 ha, you can conclude that the superficial deposits are unlikely to have future resource potential.

### A4.2.3 Stage 3: Productivity testing

Using enhanced information you need to demonstrate with more confidence if the relevant stratum identified in Stage 2 can provide more than 10 m3/day.

You can consider the saturated superficial deposits to have resource value and the top of the groundwater body is the top of the relevant stratum unless flow within the superficial strata is demonstrated to be less than 10 m3/day.

You should assess flow within the superficial strata taking into account the following factors:

* Average[[28]](#footnote-29) transmissivity of the superficial strata.
* Lateral extent of the permeable superficial strata perpendicular to the dominant groundwater flow direction.
* Hydraulic regime within the superficial deposits, taking into account potential interactions with the underlying bedrock and with surface waters.

Depending on the degree of uncertainty, you should undertake this through representative in-situ test pumping or through a combination of in-situ testing and analytical or numerical calculations of flow based upon data representing the relevant strata as a whole. You should undertake any field testing in accordance with British Standards (BS5930:2015+A1:2020 Code of Practice for Site investigations).

You must assess the potential sustainable yield of the superficial aquifer as a whole rather than the potential yield from any individual borehole.

# Glossary

**Table 5: Glossary**

| **Term** | **Interpretation** |
| --- | --- |
| Assessment | The concentration of a substance which should not be exceeded.  Assessment limits may be modified by the application of exemptions. |
| Assessment point. | A point associated with a receptor where an assessment limit should be met. |
| Background water quality. | The concentrations of chemical, physical, biological, or radiological constituents, or other characteristics in or of groundwater at a particular point in time and upgradient of an activity that have not been affected by that activity . |
| BAT | Best available techniques.  The available techniques for a given sector or activity which are the best for preventing or minimising emissions and impacts on the environment. |
| Capacity | The ability of the water environment to assimilate a pollutant, related to the background water quality and the relevant water quality standard. |
| CAR | Water Environment (Controlled Activities) (Scotland) Regulations |
| Compliance limit | The concentration of a substance at a compliance point back-calculated using:   * the appropriate assessment limit; * the fate and transport processes influencing the concentration of the substance between the assessment point and the compliance point; * other factors such as technical feasibility etc. |
| Compliance point | The point where the compliance limit is measured and therefore where the compliance limit must be achieved. |
| CSM | Conceptual Site Model.  A written or graphical representation of a site that presents the available information in a clear and transparent structure to aid decision making. |
| Control measures | A regime designed to ensure that a concentration on a discharge licence, a remedial target for contaminated land or a control level on a landfill permit, is met. |
| Deterioration in status | A worsening of the water body status class |
| DQRA | Detailed Quantitative Risk Assessment  Numerical assessment of risk posed to a receptor, taking into account the site-specific hydrogeological regime and factors influencing the fate and transport of the contaminants.  Usually undertaken using numerical models. |
| Direct discharge | The introduction of substances into groundwater without percolation through the ground or subsoil. |
| DWS | Drinking Water Standards  Standards used by SEPA to define when water is fit for human consumption. Refer to hierarchy of potable standards in the 2024 Directions. |
| Environmental Standards | Standards adopted by the Scottish Government and used by SEPA to protect the water environment and define water body classification for status purposes. These are published in The Scotland River Basin District (Standards) Directions 2024 (also referred to in this document as the ‘2024 Directions’). |
| Groundwater | Water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil (defined in the GWD and the WFD). |
| Groundwater Standards | Standards used by SEPA to protect the water environment. These standards vary according to the nature of the contaminant and the relevant receptor being assessed. |
| GWD | Groundwater Directive  European directive regarding groundwater that is transposed into Scottish Law via WEWS and CAR. |
| GWDTE | Groundwater Dependent Terrestrial Ecosystem.  A wetland or similar ecosystem that is reliant on groundwater. |
| Hazardous substances | Substances or groups of substances that are toxic, persistent, and liable to bio-accumulate, and other substances which give rise to an equivalent level of concern (defined in the WFD). |
| Indirect discharge | The introduction of substances into groundwater after percolation through the ground or subsoil. |
| Inland waters | All standing or flowing water on the surface of the land and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured (defined in the WFD). |
| Input | The introduction of pollutants into groundwater as a result of past or present human activity, from a point or diffuse source. |
| JAGDAG | Joint Agency Groundwater Directive Advisory Group  A partnership of UK and Ireland environment agencies and other stakeholders set up to interpret and support the implementation of the GWD. |
| LoD | Limit of detection  The output signal or concentration value above which it can be affirmed, with a stated level of confidence that a sample is different from a blank sample that does not contain the substance of interest. |
| LoQ | Limit of quantification  The output signal or concentration value above a substance can not only be detected but predefined goals for bias and precision are also met. |
| Natural groundwater quality | Groundwater quality that that has not been significantly affected by anthropogenic influences. |
| NAPL | Non-Aqueous Phase Liquid  An organic liquid which does not readily dissolve in or mix with water.  There are two types: Light (LNAPL), which are less dense than fresh water and tend to float; and Dense (DNAPL), which are more dense than fresh water and tend to sink. |
| Pathway | A route for contaminant migration between source and receptor. |
| Plume | A volume of contaminated groundwater that extends beyond the original source of the contamination due to transport of the contaminant mass in groundwater. The size and shape of the plume is influenced by the local geology, the groundwater flow regime, the nature of the contaminants and the time since the contamination first entered the groundwater. |
| Pollution | Anthropogenic contamination causing harm to a receptor. |
| Pollutant linkage | A connection existing between a source and a receptor via a pathway. |
| Receptor | The part of the water environment or user of the water environment that could be impacted by an input. Relevant receptors for groundwater include:   * surface waters * dependent terrestrial ecosystems * current abstractors * future groundwater resource. |
| Saturation zone | The part of the ground below the water table in which all accessible voids (pores, fissures and other spaces) are filled with water. |
| Source | Contamination hazard with the potential to cause harm. |
| Status | The physical, chemical or ecological condition of a water body, defined in accordance with the WFD. |
| Surface waters | Surface water means inland waters (other than groundwater), transitional waters, and coastal waters (defined in the WFD). In this context SEPA regards springs as surface waters. |
| Threshold Values | Standards based upon risk to human health and used to maintain a minimum level of groundwater quality with respect to potable use. |
| UK TAG | The United Kingdom Technical Advisory Group  A partnership of UK and Ireland environment and conservation agencies set up to interpret and support the implementation of the WFD. |
| WEWS | Water Environment and Water Services (Scotland) Act |
| WFD | Water Framework Directive.  European directive regarding the water environment that is transposed into Scottish Law via WEWS and CAR. |
| WHO | World Health Organisation |

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1. and in Pollution Prevention and Control Regulations (PPC), The Waste Management Licensing Regulations and the Environmental Authorisations (Scotland) Regulations 2018. [↑](#footnote-ref-2)
2. In scenarios where surface recharge is not the dominant control on the groundwater flow regime (e.g. groundwater at >30 m depth in hard rock terranes), an alternative site-specific assessment area capable of supporting a flow of 10 m3/d may be proposed for consideration by SEPA. [↑](#footnote-ref-3)
3. In scenarios where surface recharge is not the dominant control on the groundwater flow regime (e.g. groundwater at >30 m depth in hard rock terranes), an alternative site-specific assessment area capable of supporting a flow of 200 m3/d may be proposed for consideration by SEPA. [↑](#footnote-ref-4)
4. As per UKTAG Paper 11b(i). [↑](#footnote-ref-5)
5. As set out in Schedule 4 of The Scotland River Basin District (Standards) Directions 2024. See also Annex A3.3.4. [↑](#footnote-ref-6)
6. Water Environment and Water Services (Scotland) Act 2003 [↑](#footnote-ref-7)
7. Subsoil is considered here to include both natural soils and anthropogenic soils (‘made ground’). [↑](#footnote-ref-8)
8. UKTAG, 2012, *Defining & Reporting on Groundwater Bodies* [↑](#footnote-ref-9)
9. Including weathered bedrock [↑](#footnote-ref-10)
10. a groundwater body is a management unit for Scotland’s groundwater. All of mainland Scotland and the majority of inhabited islands are split into groundwater bodies. Each groundwater body includes the bedrock and/or overlying superficial deposits [↑](#footnote-ref-11)
11. Ó Dochartaigh et al, 2015, *Scotland’s aquifers and groundwater bodies* [↑](#footnote-ref-12)
12. As defined in GWD – note that other regulatory regimes may use alternative definitions for ‘Hazardous’. [↑](#footnote-ref-13)
13. As defined in The Environmental Authorisations (Scotland) Regulations 2018 and associated guidance. [↑](#footnote-ref-14)
14. Direct discharges of pollutants to groundwater may be permitted to groundwater below 400m below ground level or below mean high water springs if the water has elevated salinity and there is no pathway for contaminants to reach surface ecosystems. [↑](#footnote-ref-15)
15. See Annex 2 for further details. [↑](#footnote-ref-16)
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17. Common Implementation Strategy for the Water Framework Directive – Guidance Document No. 18 – Guidance on Groundwater Status and Trend Assessment. [↑](#footnote-ref-18)
18. This regime is also subject to The Contaminated Land (Scotland) Regulations 2000 (SSI 2000 No. 178) as amended and the Scottish Government’s Statutory Guidance: Edition 2. [↑](#footnote-ref-19)
19. Using an appropriate testing method for both the media being tested and the contaminant(s) of concern. [↑](#footnote-ref-20)
20. Where mixtures of substances are present within a NAPL, the solubility of the individual substances may be adjusted in accordance with Raoult’s Law. [↑](#footnote-ref-21)
21. This includes impacts to upgradient groundwater quality due to anthropogenic atmospheric emissions or other forms of diffuse pollution. [↑](#footnote-ref-22)
22. Water Environment and Water Services (Scotland) Act 2003 [↑](#footnote-ref-23)
23. Takes into account that 95th percentile baseflow index for Scottish water bodies is <0.5. [↑](#footnote-ref-24)
24. For example, as described in Mixing in Inland and Coastal Waters by Fischer *et al* 1979. [↑](#footnote-ref-25)
25. Technical report on groundwater dependent terrestrial ecosystems, December 2011 [↑](#footnote-ref-26)
26. Pollutant criteria for water destined for human consumption or surface water ecosystems may often be used as a starting point to risk screen if these pollutants could cause significant damage. [↑](#footnote-ref-27)
27. Based on low permeability indicator quoted in Swartz, M., Misstear, B.D.R, Daly, D. and Farrell, E.R., 2003. Assessing subsoil permeability for groundwater vulnerability. Quarterly Journal of Engineering Geology and Hydrogeology, v36, p173-184. [↑](#footnote-ref-28)
28. Taking into account the relative thicknesses and hydraulic conductivities of the various lithological horizons within the saturated superficial deposits. [↑](#footnote-ref-29)