Appendix A
Physical Environment Assessment Methodology

March 2021
Version 4.0

Southern Water

Contents

A.1 Hydrological and hydrogeology impact assessment

Consideration is required of the likely changes in flow level regime due to implementing the drought permit/order, specifically:

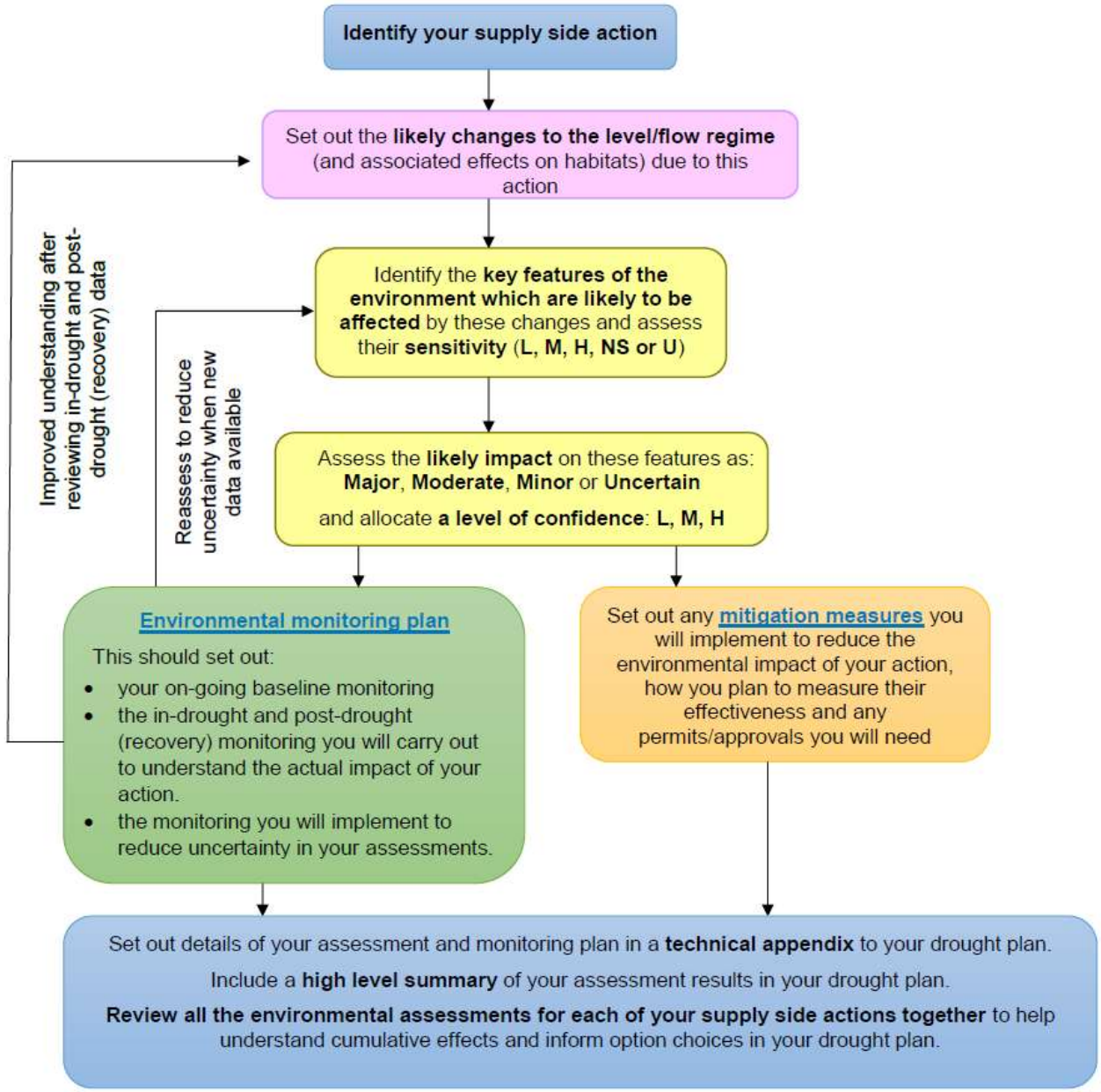
- the spatial extent of potential impact
- the nature and duration of the potential impact
- the timing of the potential impact.

Hydrogeological and hydrological information is used together with information on the environmental features in the study area to identify the environmental risk of the drought permit/order. A flexible approach[1] has been developed to identify the spatial extent of the study area from hydrological information and characterising the hydrological impact within the study area, in terms of the scale, nature, duration and timing of impacts.

A hydrological methodology for watercourses that naturally dry up for part of the year has also been developed that characterises the hydrological impact within the study area of such watercourses, in terms of the scale, nature, duration and timing of impacts. Similarly, methodologies for reservoirs, estuaries and groundwater bodies have been developed. These methodologies are presented below.

[1] The approach was developed and agreed with the Environment Agency in 2013 as part of EAR development for water companies in South East England and North West England

Figure A.1 Environmental Screening Approach (from Environment Agency Drought Plan Guideline – Environmental assessment for water company drought planning supplementary guidance, July 2020)



A.1.1. Perennially flowing watercourse hydrological methodology

This methodology is applied to watercourses that flow throughout the year and that are potentially impacted on by the drought order/permit. For designated rivers, reference will need to be made to the relevant Common Standards Monitoring guidance, conservation objectives and favourable conservation tables, or other standards as applicable to the designated site. Core to this approach is the use of relevant long term flow statistics to inform the scale of hydrological impact and thereby delimit the zone of influence in the downstream river system. To determine these, potential reductions in flow resulting from implementation of the drought order/permit are compared with flows without the drought order/permit in place (i.e. the additional abstraction advocated by the drought order/permit over and above the existing abstraction). This helps to determine the scale of potential impact at any particular site/feature using the matrix in **Table A1** or **Table A2** depending on the altitude of the waterbody and whether it is classified as lowland or upland[2].

Table A.1 Hydrological Assessment Matrix (Upland – above 80m AODN)

	% reduction in flow	Summer Q99		
		<10%	10-25%	>25%
Summer Q95	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

Table A.2 Hydrological Assessment Matrix (Lowland – below 80m AODN)

	% reduction in flow	Summer Q99		
		<10%	10-25%	>25%
Summer Q95	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

Table A.1 illustrates that at the time of implementation of a drought order/permit in summer months, upland river systems will exhibit high sensitivity to changes in low flow (represented by Q_{95}, summer[3]) and very high sensitivity to changes in extreme low flow (represented by Q_{99}, summer). As illustrated by **Table A.2**, lowland rivers are considered to be less sensitive to reductions in summer low flows (summer Q_{95}), but similarly sensitive to reductions in extreme summer low flows (summer Q_{99}).

[2] The River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. ISBN 978-0-85521-192-9. The Directions set out the principles of classification of surface water and groundwater bodies, including the use of 80m above Ordnance Datum as the altitude that differentiates water quality requirements for upland and lowland biology. Where there are ambiguities, or thresholds are crossed, upland is assumed to apply to ensure a precautionary assessment.

[3] The River Basin Districts Flow statistics indicate the proportion of days a flow is equalled or exceeded. Therefore Q95 indicates flow equalled or exceeded on 95% of days in the measured record (equivalent to an average of 347 days per year)

Tables A.1 and **A.2** are appropriate for the assessment of hydrological impacts on low flow regimes in watercourses during the spring, summer and autumn. However, there could also be a need to assess the impacts of drought permits/orders on watercourses during the winter. During the winter season, watercourses have relatively lower sensitivity to changes in low flow, and moderate sensitivity to changes in moderate flow. This can be reflected by the use of the matrices in **Tables A.3** and **A.4** for the assessment of drought order/permit schemes which might impact on a watercourse during the winter. The categorisation of impacts as negligible, minor, moderate or major is based on the percentage reduction in year round low flow (Q95) and year round median flow (Q50).

Table A.3 Hydrological Assessment Matrix (Upland / Winter)

	% reduction in flow	Year round Q95		
		<10%	10-25%	>25%
Year round Q50	<10%	Negligible	Minor	Moderate
	10-25%	Minor	Moderate	Major
	>25%	Moderate	Major	Major

Table A.4 Hydrological Assessment Matrix (Lowland / Winter)

	% reduction in flow	Year round Q95		
		<10%	10-25%	>25%
Year round Q50	<20%	Negligible	Minor	Moderate
	20-50%	Minor	Moderate	Major
	>50%	Moderate	Major	Major

The matrices can be used to identify:

1) the overall zone of influence – which extends downstream of the abstraction until the hydrological impact has reduced to negligible

2) reaches with similar scales of impact within the overall zone of influence

3) the scale of hydrological impact within each reach.

Typically, reaches are delimited by the addition of flow from a significant tributary or discharge, although the similarity of geomorphological characteristics of the reach may also be important in reach specification. The matrices can be applied to a variety of upland or lowland catchments respectively including those dominated by groundwater and can be applied down to the tidal limit.

In addition to the information provided by summary flow statistics in the matrix, information on the timing, duration and relevant seasons of the drought order/permit impacts will be informed by licence details and hydrological/hydrogeological data to characterise the likely nature of the drought order/permit hydrological/hydrogeological impacts.

If the drought order / permit does not impact on the magnitude of low flows in a watercourse, but does cause changes in the duration of low flow periods (which can be quantified), then the matrix in **Table A.5** may be appropriate. The assessment is based on the percentage increase in the number

of days for which flow is at or below the low flow (Q95) value. Typically, this would be the case when the low flow regime in a watercourse downstream of a reservoir is protected by a statutory compensation flow release from the reservoir, but the reservoir may be drawn down below top water level for longer periods due to increased direct abstraction under the drought order / permit conditions.

If low flows in a watercourse are adversely affected in both magnitude and duration, then the impacts on magnitude are always used to determine the significance of hydrological impacts, using the appropriate matrix from **Tables A.1** to **A.4** inclusive. **Table A.5** is only used when the impacts on low flows are on duration only.

Table A.5 Hydrological Assessment Matrix (Low Flow Duration)

Percentage increase in low flow duration	Significance
<5%	Negligible
5-10%	Minor
10-25%	Moderate
>25%	Major

A.1.2. Intermittently flowing watercourse hydrological methodology

This methodology will be applied to watercourses, potentially impacted on by the drought order/permit, that flow for most of the time but seasonally or occasionally cease to flow in response to decreased water availability (e.g. due to increased evapotranspiration or bed seepage). Such watercourses are identified from local knowledge, previous investigations and/or from available hydrological/hydrogeological data. Examples of watercourses where this methodology would be applied include winter bournes or watercourses that dry up along their route due to losses to underlying aquifers. The impact classification of this methodology is as follows:

- Major - If the drought permit resulted in sections drying up that did not dry up anyway
- Moderate - If the drought permit resulted in sections drying up earlier (by more than a handful of days (i.e. more than a week)) and/or recovering later (by more than a handful of days (i.e. more than a week)) and hence flow reduction occurring in the channel for more than just a handful of days (i.e. more than a week)
- Minor - If the drought permit resulted in sections drying up earlier (by just a handful of days (up to a week)) and/or recovering later (by just a handful of days (up to a week)) and hence flow reduction occurring in the channel for just a handful of days (up to a week) OR if the drought permit were a secondary flow driver (e.g. flow through gravels being primary cause of flow losses rather than the drought permit)
- Negligible - No significant impact

In addition to these derived classifications, information on the timing, duration and relevant seasons of the drought order/permit impacts will be informed by abstraction licence details, available hydrological/hydrogeological data and findings of previous investigations.

A.1.3. Reservoir hydrological methodology

A similar approach to categorise the significance of hydrological impacts of drought order/permit operations on reservoirs will be used. For designated sites reference will be made to the relevant Common Standards Monitoring guidance, conservation objectives and favourable condition tables, or other standard as applicable to the site. The assessment requires an estimate of the relative change in duration of reservoir drawdown (i.e. the period for which water in the reservoir is below top water level), and the percentage decrease in the minimum reservoir level reached during the drawdown period. These two parameters are then compared against the reservoir impacts hydrological assessment matrix in **Table A.6**.

This approach would be a suitable method to assess the impacts of a drought order/permit which involves significant changes to the reservoir water level regime (that would not normally be experienced during a drought without any additional measures implemented). For example, a drought order/permit may involve increasing daily or annual licensed abstraction limits to allow an increased rate of direct abstraction from the reservoir. This is likely to lead to both lower water levels and increased periods of time below top water level. However, effects may be beneficial to water levels (e.g. due to a drought permit/order to allow increased pumped refill of a reservoir from a river).

Table A.6 Hydrological Assessment Matrix (Reservoir Impacts)

% Decrease in minimum reservoir level	% Increase in duration of reservoir drawdown			
	<5%	5-10%	10-25%	>25%
<5%	Negligible	Negligible	Minor	Moderate
5-10%	Negligible	Minor	Moderate	Major
10-25%	Minor	Moderate	Major	Major
>25%	Moderate	Major	Major	Major

A.1.4. Estuarine methodology

There is currently no accepted methodology of assessing the impact of surface water abstractions on transitional water bodies in England. A reduction in fresh water flow may have impacts upon the hydromorphology of a transitional waterbody, alongside impacts on the water quality (and thus on the ecology).

The UK Technical Advisory Group (UKTAG) have developed a methodology of characterising the sensitivity of estuarine waterbodies to abstraction of freshwater flow. This methodology, which has currently only been adopted in Scotland, uses the following equation:

$$= \frac{\sum Qn95}{V_H} \times 1000$$

This equation takes the ratio of the total Qn95 freshwater inflow (in cubic metres per second) into the transitional water, or part thereof, from rivers with a catchment area ≥ 10 km^2; to the volume (in cubic metres) of water in the transitional water, or part thereof, at mean high water (VH). The higher

the resulting P95 value, the greater the proportion of freshwater to saline water in the estuary and thus the greater the degree of attributed sensitivity.

The transitional waterbodies identified in the screening have been assessed for sensitivity by the SNIFFER (2007 and 2008) studies known as WFD83[4], these sensitivities are shown below:

The UKTAG methodology takes this assessment further, proposing a set of freshwater flow condition standards, which are put forward as limits to the percentage of allowable surface water abstraction (dependent on waterbody sensitivity and daily Qn values) permissible to support Good, Moderate and Poor WFD status. As no other method of assessing risk of abstraction to estuarine environments is currently used in the UK, the above sensitivity and condition assessment methods are used in this study to form the basis of an estuarine hydrology impact assessment, as show in **Table A.7**.

Table A.7 Condition limits for transitional waters likely to support good status

Type	Daily flows greater than or equal to Qn60	Daily flows less than Qn60 but greater than or equal to Qn70	Daily flows less than Qn70 but greater than or equal to Qn95	Daily flows less than Qn95
High sensitivity	40% of Daily Qn	35% of Daily Qn	30% of Daily Qn	25% of Qn95
Medium sensitivity	45% of Daily Qn	40% of Daily Qn	35% of Daily Qn	30% of Qn95
Low sensitivity	50% of Daily Qn	45% of Daily Qn	40% of Daily Qn	35% of Qn95

The possible impact on estuarine environments must be assessed in the context of low flow conditions (<Qn95) of the major freshwater flow carrier. The freshwater flow from the main river and the tributaries to the main estuary channel is considered to be the primary influence. Flows from areas adjacent to the transitional water body, that are not part of designated river waterbodies, were considered to be significant in supporting the intertidal ecology but not to the ecology of the transitional waterbody as a whole. Such flows are small compared with flows from river waterbodies and are unlikely to affect water quality or salinity gradients across the whole waterbody.

As such, the percentage abstraction limits at the <Qn95 flow level have been adopted as thresholds for major impacts. These thresholds (a reduction of >35 % of total or net freshwater inflow to waterbodies classed as having a “Low Sensitivity”, and >30% for those of “Medium Sensitivity”) are applicable for all the screened-in waterbodies, as these estuaries have been classed as “Supports Good” hydromophological status. The UKTAG methodology drew on the advice of UK experts to develop its proposals. The condition limits were therefore conceived in light of possible impacts on macrophytes, macro-invertebrates and fish, as well as combinations of physical parameters that could indicate the sensitivity of estuaries to the impacts of abstraction on freshwater flow. The thresholds for Major impact provide the basis of the assessment methodology, as shown in **Table A.8**.

Table A.8 Threshold abstraction impact limits (% of Qn95) derived from UKTAG condition of TraC waters likely to support Good Status

Impact	Negligible Impact	Minor Impact	Moderate Impact	Major Impact
Medium sensitivity	<10% of Qn 95	10 - 20% of Qn 95	20 - 30% of Daily Qn	>30% of Qn95
Low sensitivity	<10% of Qn 95	10 - 20% of Qn 95	20 -35% of Qn 95	>35% of Qn95

[4] SNIFFER, 2008. Rapid validation of WFD83 Standards for Freshwater Flows to Estuaries.

The threshold for negligible impact is taken from the estuarine value put forward by the UKTAG Guidance Document (2003)[5], specifically the value is referred to as the "Tier 1 Threshold for where abstraction pressures do not present a Significant Risk". As no intervening impact thresholds have been developed, a precautionary staged approach of reducing the abstraction pressure threshold by 10% for each impact magnitude. As the <10% threshold is fixed, a precautionary approach has been taken with the Low Sensitivity magnitude thresholds, resulting in the larger band range of 20-35% for Moderate Impact.

A.1.5. Groundwater assessment

For drought permits/orders that impact on groundwater, available relevant hydrogeological data will be reviewed to inform the study area and duration of any impacts (noting impacts on groundwater may extend well beyond the six-month period of a drought order/permit implementation due to the time lag involved between abstraction and impacts on river flows or wetlands, depending on the groundwater properties). An increase in groundwater abstraction would generally lead to an increased cone of depression in groundwater levels in the immediate vicinity of the abstraction source, or where a disused abstraction source is being brought back into supply, a new cone of depression. This impact can affect both surface water receptors as well as other borehole/well abstractions, springs, and groundwater dependent ecosystems. It could also mean that surface water impacts would extend upstream of the abstraction point or, in significant instances, to other watercourses some distance from the abstraction.

To calculate the potential radius of influence of the increased abstraction, where applicable, both the Cooper Jacob and the Theis methodologies have been followed. The Theis methodology is a standard method of analysing drawdown in confined aquifers. The Cooper Jacob methodology, which uses a modified Theis equation, has been used with a corrected drawdown for unconfined aquifers (Kruseman and de Ridder, 1994) to be applicable to unconfined conditions. The radius of influence has been estimated assuming a drought permit/order duration of 180 days (six months), which is likely to be a precautionary approach but will depend on the prevailing drought conditions at time of implementation. The resulting distance where drawdown is less than 0.5m and 0.1m is considered by the assessment. Given the uncertainties around this type of assessment, calculating the absolute radius of influence is not deemed appropriate. It is also generally acknowledged that this type of assessment overestimates the radius of drawdown. Therefore, a 0.5m threshold is suggested as an acceptable level of confidence and a 0.1m threshold has also been tested for comparison.

For groundwater abstractions, the impact of a drought order/permit could extend beyond the six-month period of a drought order/permit depending on the local hydrogeology of the area and the scale of the abstraction. During drought situations, where there is limited recharge to the aquifer system, the abstraction can be mainly at the expense of groundwater storage in the aquifer. This can, in the long run, delay groundwater level recovery and have a knock-on effect on baseflow contributions to watercourses and water dependent habitats. Consequently, river flows could be reduced for longer than the six-month period during which the drought order / permit could be implemented and, as such, will be considered in the hydrological/hydrogeological assessment.

A.1.6. Environmental sensitivity

With the extent of hydrological/hydrogeological impact determined and mapped, potentially sensitive receptors (sites/features) located within the spatial extent of the impact will be identified. Potentially sensitive features include:

[5] UKTAG2003WP7b(02) Draft guidance on abstraction and flow regulation + Annex (P2v4.21-01-04)

- licensed and unlicensed abstractions and new authorisations
- discharges authorised through environmental permits
- designated biodiversity sites (Local Nature Reserves (LNR), National Nature Reserves (NNR), Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Ramsar and Natural Environment and Rural Communities (NERC) Act Section 41 species/habitats which are located within the hydrological/hydrogeological zone of influence of the proposed option.
- priority habitats and species (ecological communities) and, where identified, Water Framework Directive (WFD) status of designated waterbodies which contain the impacted reaches.
- wider features which should be taken into account in determining the potential impacts of drought option implementation – specifically landscape, navigation, recreation and heritage.

Each of the identified sensitive receptors within the extent of impact will be listed, alongside a brief summary of their potential susceptibility to flow impacts. For designated sites, this will include an indication as to whether the sites have water dependent qualifying interests (cross-referenced to the Habitats Regulations Assessment for European sites and the Strategic Environmental Assessment assessments for SSSIs).

The environmental sensitivity of each site will be identified according to the ecological and nature conservation interests of the area and, in particular, the proximity and / or connectivity with of the designated protected area or priority habitat. Each site will be assessed according to whether the extent of hydrological/hydrogeological influence includes or is considered to influence a water dependant protected site. Designated sites outside the extent of hydrological/hydrogeological influence are considered not to be influenced by the drought permit/order except for offsite use by mobile habitats and species. Potential effects on compensatory habitats will also be considered.

WFD groundwater body status is a relatively 'coarse' feature to use for screening with respect to groundwater impacts as WFD groundwater bodies are often significant in size and the assessment for WFD groundwater status involves the use of long-term average data sets for the groundwater body as a whole. Hence WFD groundwater body status has been identified at the screening stage for context, however, assessment will focus on the assessed spatial extent of impacts on groundwater-dependent features/sites.

The environmental sensitivity screening identifies the outcome for each feature/site according to one of five categories: uncertain; high sensitivity; medium sensitivity; low sensitivity; not sensitive. This outcome identifies the appropriate next steps. Outcomes of the screening will be agreed with the Environment Agency and Natural England. Those features identified as either: 1) uncertain; 2) high or medium sensitivity; or 3) low sensitivity in a designated site[6] will form the scope of monitoring, environmental assessment, and consideration of mitigation actions in the EAR.

Environmental assessment, mitigation and/or monitoring is not required for features where screening has identified a minor (unless a site is designated) likely impact. However, the requirement for assessment, monitoring and/or mitigation will nevertheless be reviewed on a case-by-case basis. In some cases, mitigation and/or monitoring may still be recommended where minor likely impacts are identified, where considered appropriate.

[6] Specifically: Special Area of Conservation, Special Protection Area, Ramsar site, Site of Special Scientific Interest, National Nature Reserve and Local Nature Reserve.

A.2. Assessment Methodologies

The hydrology/hydrogeology assessment (see above) will set out the baseline flow/water level regime, changes in wetted parameters (such as wetted width and depth) and flow velocity in river channels (or equivalent hydrological effects on water dependent wetlands, etc.), together with an assessment of the range of anticipated changes as a result of the drought permit/order implementation. This is supported by the physical environment characterisation which describes the baseline geomorphology, anthropogenic features, water quality and environmental pressures, together with an assessment of the consequences of the hydrological/hydrogeological changes on the physical environment.

Assessment of specific features will then be undertaken using all available environmental data. Where sufficient supporting existing baseline data on hydrological conditions, habitat availability and species occurrence are not available, this will be clearly identified and other appropriate supporting data will be used to inform the assessment, supplemented by expert judgement. An example may be where flow-induced changes to river habitat for fish would ideally be defined through information on the total wetted area, depth and flow velocities to describe the habitat preferences of a species and its lifestages. Where such data are currently unavailable, the use of habitat walkover, RHS and/or aerial survey data may be used in combination with expert judgement on the hydrological change resulting from the drought order/permit (e.g. x Ml/d reduction in river flows) to assess the likely change in habitat availability and consequent impact on the fish species. The analysis will detail the increased uncertainty prevalent in such an approach. A gap analysis will be undertaken, and associated baseline monitoring will be completed. Baseline monitoring will incorporate seasonal variations for aquatic macroinvertebrates and could include protected species surveys such as white-clawed crayfish.

Material gaps in data and evidence will be noted and recommendations made as to how these gaps should be closed; any required baseline monitoring will be included in the accompanying Environmental Monitoring Plan.

The following methodologies detail the approach to the assessment for key environmentally sensitive receptors:

- Geomorphology
- Flow and water level pressures due to abstractions
- Water quality pressures

As previously mentioned, additional methodologies will be developed to assess designated waterbodies and water dependent habitats and species, once the screening exercise is complete. Post-drought monitoring will be undertaken where deemed appropriate.

A.2.1. Geomorphology

Potential Effects
In support of understanding the physical environment and the risk assessment in the zone of influence of each drought permit/order option, a review will be undertaken of the impacts to fluvial geomorphological processes. Given potential changes in flow as a result of implementing a drought permit, there are expected to be reductions in the volume of flow in a river, leading to possible reductions in wetted width and depth as well as reductions in flow velocity. Using this information, relevant pressures on the geomorphology within an impacted river will be discussed and the impacts classified.
Definition of Risk
In order to define the potential risk to fluvial geomorphological processes due to changes in hydrology and hydraulics of river flow from the drought permit/order, a series of criteria have been defined. The geomorphological assessment uses the following criteria, based on the potential severity of the risk to geomorphological processes against the background of a natural drought: High: A major positive or negative impact occurs, which affects sediment dynamics, the river channel or bank on a large scale (regionally); these impacts can be temporary or permanent in nature. Medium: A moderate positive or negative impact on sediment dynamics, the river channel or bank at a local or reach scale is likely, including changes to wetted areas, erosional and depositional character. Low: A small positive or negative impact on sediment dynamics, the river channel or bank may occur, which is unlikely to lead to significant changes in wetted areas or the integrity of river function. Negligible: No significant change from the current baseline characteristics.
Data Requirements
Relevant zone of influence identified during the hydrological/hydrogeological assessment Hydrological information detailing existing flow regime and flow regime altered under natural drought conditions, including flow velocity Information on the presence, location and extent of geomorphological features within a river (e.g. depositional and erosional features, bank morphology, bed substrate, etc.) River Habitat Surveys and walkover surveys data (where available) Information on suspended solids and channel sediment particle size An understanding of anthropogenic modification of the channel bed and banks, where relevant, including any in-channel barriers to migratory species (e.g. weirs).
Assessment Methodology and Uncertainty
Using the hydrology impact assessment, identify the spatial extent of flow impacts, the expected duration of impacts as well as an understanding of the magnitude of key changes in flow expected from the operation of a drought permit/order. Detail the morphology of the catchment of the impacted river, including geology, soils, relief, catchment area etc. and the presence of significant tributaries which may contribute to the amelioration of drought permit/order impacts and/or act as sediment sources.

Using existing data from River Habitat Survey, walkover surveys, aerial imagery and other surveys containing relevant data (e.g. fluvial audits), identify the form and distribution of:

- Flow types
- Bed substrate
- In-channel depositional features
- Channel and bank erosional features
- River bank
- Riparian vegetation structure
- Surrounding land-use types.

Define the location and extent of anthropogenic features within the impacted sections of the river, behind which ponding and low flow velocities may occur.

Identify the potential risks to fluvial geomorphology and channel morphology and assign expected impacts. Key risks include:

- Changes in wetted width and depth
- Changes in exposure of bed and banks
- Reductions in flow velocity
- Change in sediment dynamics, particularly sediment deposition
- Impact of changes in flow, depth and velocities at relevant anthropogenic structures.

A2.2. Water Quality Pressures

Potential Effects
In support of the physical environment understanding and risk assessment in the zone of influence of each drought permit/order, a review will be undertaken of additional water quality pressures from surface water or groundwater discharges. Discharges put pressure on water quality during a drought as lower than normal river flows (or groundwater levels) mean that there is less water available to dilute discharges such as final effluent from sewage treatment works. A drought permit/order may exacerbate these low flows/groundwater levels and contribute to a reduction in water quality, with potentially detrimental impacts on sensitive features in the impacted reach. Discharges impacting the oxygen balance and ammonia concentration in the river will have been reviewed earlier in the process as part of the physical environment impact assessment. Intermittent discharges from combined sewer overflows (CSOs) may also contribute to a reduction in water quality during an environmental drought. CSOs relieve strain on the sewers during storm events by temporarily diverting water into nearby watercourses to prevent sewer flooding. As there is usually a time lag between discharges from CSOs and rises in river levels during a storm event, the potential exacerbation of low flows by the drought permit/order may decrease the amount of water immediately available to dilute CSO discharges, leading to a temporary reduction in river water quality if a storm event occurs.
Definition of Risk
In order to define the potential risk to water quality from discharges in a readily understandable manner, a series of criteria have been defined. The assessment will use the

following criteria, based on the potential severity of the risk to water quality during an ongoing drought.

High: A major risk to water quality under low river flow/low groundwater conditions (without the drought permit/order in place). For surface water bodies, this may affect the suitability of the water quality to maintain the current WFD status for fisheries and macroinvertebrates, with a high risk of deterioration in WFD status; and exacerbation of the risks due to flow reduction from the drought permit/order. For groundwater bodies, this may lead to a significant risk of adverse impacts to the current WFD chemical status (with a moderate risk of deterioration in WFD status) and/or the quality of any spring discharges fed by groundwater (noting the lag time involved depending on the groundwater properties).

Medium: A moderate risk to water quality under low river flow/low groundwater conditions (without the drought permit/order in place). For surface water bodies this may affect the suitability of the water quality to maintain the current WFD status for fisheries and macroinvertebrates, with a moderate risk of deterioration in WFD status; or exacerbation of a minor risk due to the flow reduction from the drought permit/order. For groundwater bodies, this may lead to a moderate risk of adverse impacts to the current WFD chemical status (with a minor risk of deterioration in WFD status) and/or the quality of any spring discharges fed by groundwater (noting the lag time involved depending on the groundwater properties).

Low: A minor risk to water quality under low river flow/low groundwater conditions (without the drought permit/order in place). For surface water bodies this may have a minor effect on water quality but with no risk to the current WFD status for fisheries and macroinvertebrates; or exacerbation of a minor risk due to the flow reduction from the drought permit/order. For groundwater bodies, this may lead to a minor risk of adverse impacts to the current WFD chemical status (but no risk of deterioration in WFD status) and/or the quality of any spring discharges fed by groundwater (noting the lag time involved depending on the groundwater properties).

Negligible: Indicative of no significant risk without the drought permit/order in place nor exacerbation of risk by the flow reduction/groundwater level reduction from the order/permit.

Data Requirements

Relevant zone of influence

Discharge permits in the zone of influence (including numeric water quality and flow conditions where these are set)

Routine riverine water quality monitoring data for the water quality determinands of dissolved oxygen saturation and total ammonia for relevant monitoring sites in the zone of influence and significant tributaries (or dissolved oxygen concentration and any other appropriate determinands relevant to ecological receptors for estuarine waters, where applicable)

Routine groundwater quality monitoring data consistent with key determinands for WFD chemical status (and drinking water quality where relevant)

River flow and/or groundwater levels representative of the zone of influence (daily gauged flow, spot flow surveys, observation borehole records) – all relevant available records

Flow or groundwater level impact assessment and zones of hydrological impact for each drought permit/order

CSO and other intermittent discharge locations and any available assessments of intermittent discharges.

Assessment Methodology and Uncertainty
Identify all discharge permits within the zone of hydrological impact. Assign relevant discharge permits to an impacted reach/groundwater zone of impact, and list relevant details including purpose, location and any relevant numeric consent conditions where these have been set (e.g. dry weather and/or stormwater flow, BOD, ammonia (N) and any other determinands, e.g. phosphorus). Identify those discharge permits which relate to effluent from Southern Water's sewage treatment works (STWs) (as there may be a need to identify possible mitigation measures associated with these works). Assess the maximum current contribution of each STW to BOD (and where applicable, ammonia (N) and/or phosphorus (P) concentrations) in the river at low flows (based on the permits and discharge flows plus upstream river flows). Assess the maximum potential increase in each STW's contribution to river BOD (and ammonia (N) and/or phosphorus (P) concentrations at low flows as a result of the drought permit/order (based on the water quality permit, discharge flows, upstream river flows and maximum flow reduction from drought permit/order). Assess the maximum potential increase to key determinands (BOD, ammonia, phosphorus) from other identified discharges to surface waters. Assess the potential risk arising from reduced dilution on downstream surface water quality. Identify those discharges which relate to combined sewer overflows (CSOs) or other relevant intermittent discharges. If required, carry out qualitative analysis to evaluate whether intermittent discharges are likely to present a significant water quality pressure as a result of the drought permit/order. Where applicable, assess the risk of groundwater discharges (discharges to the groundwater environment) to groundwater quality, taking account of the WFD chemical status and any drinking water quality determinands along with the effect of the drought order/permit on groundwater storage (natural or artificial). Incorporate any water quality pressure risks identified as significant into the assessment of impacts on significant features/receptors and the selection of any required mitigation measures for the drought permit/order.