Worcestershire Minerals Local Plan

Amendments to the Surface and Ground Water Protection Issues, including a Flood Risk Assessment of the Areas of Search, following the Fourth Stage Consultation.

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Executive Summary

Minerals development can have both positive and negative effects on the water environment.

Positive effects can include

- The creation of new water bodies and features,
- Increasing flood storage and flood attenuation,
- Improving water quality,
- Creating a wide range of new habitats including wetlands, water bodies or ponds and improving biodiversity,
- Creating or enhancing water based recreation and tourism facilities and
- Supporting agriculture; by improving land drainage and creating new storage reservoirs.

However, if not properly managed more negative effects can include

- Harm to the character of Worcestershire's landscape by introducing alien features,
- Pollution of groundwater and/or surface water,
- Adverse effects on groundwater, damaging both land drainage and water supplies and
- Adverse effects on surface water flows, by affecting watercourses and changing land drainage patterns, potentially worsening natural drying up or flooding processes.

This report outlines these positive and negative effects and focuses on the links between them and mineral, mostly sand and gravel and potential clay working. It identifies the policy issues that need to be developed in the Worcestershire Minerals Local Plan (WMLP) to enable positive effects on the water environment to be maximised and negative effects minimised.

The assessments made in this report are based on evidence from the SFRAs completed to date in the County, the Worcestershire Local Flood Risk Management Strategy and Worcestershire Surface Water Management Plan, the Environment Agency Flood Risk Maps, Catchment Based Management in Worcestershire (Technical Background Document) and assessments of the quality and quantity of surface and groundwaters in the county. The Council considers that they are enough to identify the broad issues that need to be considered to inform the policies, the priorities for the Strategic Corridors and the potential designation of Areas of Search and specific sites selection in the "Fourth Consultation" for the Minerals Local Plan.

The National Planning Policy Framework requires Local Plans to apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change and using the best available information. The intention is to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. The aim is to avoid development in medium and high flood risk areas (Flood Zones 2 and 3) and other areas affected by other sources of flooding wherever possible.

The Environment Agency issues flood maps, which take into account flooding from surface and groundwater and sea flooding (where appropriate). The Agency's Updated Flood Map for Surface Water (April 2014) gives an indication of the broad areas likely to be at risk of surface water flooding. It is not suitable for identifying whether an individual property will flood and cannot be definitive but it does inform local flood risk management in the absence of better information. In Worcestershire it can be supplemented by the SFRAs undertaken by all 6 District Councils in the county for their own Plans and the Worcestershire Surface Water Management Plan and Local Flood Risk Management Strategy for Worcestershire, which focus on "local flood risk" from surface run off, groundwater and "ordinary watercourses" (streams and ditches etc.) to give a more detailed assessment of land liable to flooding.

However, the fact that a site is in Flood Zone 1 (FZ1) does not mean that it will not flood. Only watercourses with a catchment area greater than 3km^2 have been modelled, therefore smaller watercourses may not be covered by the Environment Agency Flood Zone maps. As such, for any development site located adjacent to an unmapped watercourse within Flood Zone 1, it is recommended that an 8-metre development easement from the top of bank is applied (although with regard to sand and gravel workings this can be negotiated with the Environment Agency) and a site specific FRA is undertaken.

This document assesses which Flood Zones the 164 Areas of Search proposed for inclusion in the WMLP fall within. A summary of the Sequential Test for these proposals is set out in main body of the report and the detail is contained within the appendices.

The SFRA Findings

Following extensive consultation and in response to stakeholder responses the County Council undertook a review of strategic corridors and site allocations identified in the Third Stage Consultation on the Minerals Local Plan and assessed in the Surface and Ground Water Protection Issues, including Flood Risk Assessment of Submitted Sites report 2016.

The approach to site allocations and the Analysis of Minerals Resources has been refreshed to take account of environmental and amenity screening criteria. In addition the role of the strategic corridors has also been reviewed, and it is proposed that rather than having the status of areas of search in themselves, these should now provide policy direction, with areas of search based on resource areas being identified within them.

The approach to identifying specific site and preferred area allocations has been considered alongside the approaches to strategic corridors and areas of search, so that screening criteria can be applied consistently across all aspects including flood risk and the water environment.

Due to constraints on the county's crushed rock supply the Malvern Hills Strategic Corridor and the Bredon Hill Strategic Corridor were not included in the Spatial Strategy in the *Third Stage Consultation*, although they were included in the statutory assessments of the document.

This process has resulted in changes to the area and estimated tonnages of many resource areas. It has not changed the classification of the significance of the majority of sand and gravel resources, but has resulted in the majority of Worcestershire's crushed rock resources being classified as "compromised".

The strategic corridors have now been reviewed to take account of the key and significant aggregate resources and the Mercia Mudstone clay deposits, which have the potential to be suitable in planning terms, to ensure that they continue to represent significant clusters of mineral resources within coherent landscapes. The strategic corridor boundaries have also been trimmed using settlement boundaries and site allocations to increase certainty over where mineral development is likely to take place.

The role of the strategic corridors has been reviewed, and it is proposed that rather than having the status of areas of search in themselves, these should now provide the high-level direction for the location of development and the policy framework for the delivery of co-ordinated, landscape-scale green infrastructure benefits.

The individual resources that have been through the screening exercise (Chapter 2) which have the potential to be suitable in planning terms and which fall within the new strategic corridor boundaries will be identified as Areas of Search.

This is considered to meet the definition of areas of search as set out in PPG[1] of "areas where knowledge of mineral resources may be less certain but within which planning permission may be granted, particularly if there is a potential shortfall in supply".

The proposed Areas of Search will be subject to further assessment, including Habitats Regulations Assessment and Sustainability Appraisal. It is therefore possible that not all of the Areas of Search, which have been proposed, will be allocated in the final Minerals Local Plan, but all have been assessed in this document and these findings will inform the development of the Worcestershire Minerals Local Plan.

The scale of the Areas of Search can vary from as little as 1 hectare up to 9,000 ha and the desk based assessment of these area have been undertaken at a necessarily strategic level and is considered reasonable and proportionate at this strategic scale. However, and given the strategic scale, further SFRA assessment will need to be undertaken at the appropriate stage and level to inform the Mineral Site Allocations Development Plan Document.

Given the strategic nature of the Areas of Search it stands to reason that they may potentially be impacted by a number of factors including level of flood risk, surface water flooding or proximity to sensitive receptors.

[1] PPG Minerals: Paragraph 8

*It would also be unreasonable to expect detailed assessment to have been undertaken at this stage or for landowners and operators to have clear proposals of working methods, depths and what landform would be the likely result, as these will be influenced by the policies in the final Minerals Local Plan and worked up into full proposals at application stage.

A hierarchical approach has been taken to assessing the risk of flood using GIS Layers provided by Worcestershire County Council. Areas of Search within each of the five Strategic Corridors have been given a unique reference based on their mineral type. A sequential test has been completed for each mineral type that will be subject to allocation in the Minerals Local Plan.

The majority of Sand and Gravel Areas of Search, are located in the river corridors of the River Severn, River Avon and the River Salwarpe and their tributaries. As a result, many of the mineral extraction sites identified for potential development lie wholly or partially within Flood Zones 2, 3 and Flood Zone 3.

One hundred and fourteen of the Areas of Search are in Flood Zone 2. One hundred and thirty five of the Areas of Search are in Flood Zone 3. One hundred and nineteen of these sites are in Flood Zone 3b. Therefore, these areas are considered to be at a medium to high risk of fluvial flooding.

Such workings are considered water compatible and an Exception Test will not need to be undertaken. However, further assessment will be required to determine the potential risk from a combination of flood depth and velocity in order to determine the appropriate location for stockpiling and associated ancillary works.

These areas may also be an increased risk of surface water and overland flow paths should be taken into account in the spatial planning for future mineral developments in the Minerals Allocation Plan.

Nine of the Building Stone Areas of Search are within Flood Zone 3b and six Brick Clay Areas of Search are within Flood Zone 3b. Sites within Zone 3b Functional Floodplain are suitable for sand and gravel workings only. The extraction of other minerals e.g. clay and building stone are not appropriate land uses within this zone and should not be permitted.

In conclusion, the Sequential Test requires "the lowest risk sites" to be allocated first; in the circumstances this is not possible. Minerals can only be worked where they exist and Worcestershire does not have sufficient submitted sites to be able to express a preference for some sites in Flood Zone 1 over those in zones 2 or 3. Additional sites will be required to meet the aims of the WMLP.

Summary of flood risk to Areas of Search

Flood Zone 2	Flood Zone 3	Flood Zone 3b
119	140	124

Next steps

Table 3 in the NPPF does not require the Exception Test to be applied to water compatible development in any Flood Zone (i.e. all sand and gravel working). Other types of mineral working (i.e. brick clay and building stone) and processing are considered less vulnerable and again do not require an Exception Test for Flood Zones 1-3a however they are not permitted in Flood Zone 3b.

Substantive details are not available at this stage about the areas to be worked, the working method proposed or how deep they will be worked, to enable assessment of the impacts they might have on the water environment. Detailed Flood Risk Assessments (FRAs) of these sites are not therefore possible at this stage.

This document shows that land outside of flood risk areas cannot appropriately and adequately accommodate all necessary development, and therefore a Level 2 assessment may be required.

The PPG states that '*a Level 2 Strategic Flood Risk Assessment should also replace burdens on developers, in particular, at windfall sites, in the preparation of site-specific flood risk assessments'*.

It may be the case that whilst the Exception Test is not required for the potential mineral sites, due to the location of a number of sites in Flood Zones, further detailed modeling may be required to define flood risk as part of a site-specific FRA. Given the strategic scope of this document it is essential that site-specific flood risk assessments are also developed for individual development proposals and that where appropriate, suitable mitigation measures are incorporated.

The WMLP will therefore include policies to ensure that FRAs including Hydrogeological Impact Assessments of all proposals for mineral working are required at application stage. This will ensure that no applications could be given planning permission for extraction unless their implications for all aspects of the water regime and all sources of flooding are addressed and mitigating options for the management of the risk, without increasing flood risk elsewhere, taking climate change, have been taken into account. The same kind of policy approach was included in Waste Core Strategy and found "sound".

The WMLP will include policies that require applicants to demonstrate that development will avoid increasing flood risk, manage any residual risk and avoid harm to the water environment.

The WMLP will also include policies to ensure that both surface and groundwater quality and quantity are properly assessed when applications to work minerals are submitted and subsequently protected.

The WMLP will include monitoring indicators to assess the appropriateness and effectiveness of these policies.

Emerging Minerals Local Plan Fourth Stage Consultation

The fourth stage consultation on the Minerals Local Plan ran from 17 December 2018 to 8 February 2019.

The Fourth Stage Consultation Document set out the proposed vision and objectives for mineral development in Worcestershire and included the proposed strategic policies and development management policies which will be used to make decisions on planning applications once the plan is adopted.

Responses to the Fourth Stage Consultation have been taken into account in the preparation of this report and a full response document will be published by Worcestershire County Council, in Summer 2019.

Addendum to the Fourth Stage Consultation on the Minerals Local Plan (November 2018)[2]

In November 2018, following the finalisation and printing of the Fourth Stage Consultation document for the emerging Worcestershire Minerals Local Plan, officers identified that a technical error had occurred when applying the screening methodology.

When applying the screening criteria from Appendix A of the methodology, to identify land with national or international designations which should be afforded the highest level of protection, a software error meant that the overlap between Scheduled Monuments and terrace and glacial sand and gravel deposits was not identified.

Of the resource areas which overlapped with Scheduled Monuments, only those shown below were situated within strategic corridors and therefore proposed as areas of search:

- TGSG36 (within the Avon and Carrant Brook Strategic Corridor)
- TGSG39 (within the Avon and Carrant Brook Strategic Corridor)
- TGSG43 (within the Avon and Carrant Brook Strategic Corridor)
- TGSG53 (within the Avon and Carrant Brook Strategic Corridor)
- TGSG64 (within the Lower Severn Strategic Corridor)

[2] Addendum to the Fourth Stage Consultation on the Minerals Local Plan (November 2018) https://www.worcestershire.gov.uk/info/20657/emerging_minerals_local_plan_consultation_stages/373/emerging_minerals_local_plan_previous_consultation_stages/7

This error did not affect any other type of mineral deposit and therefore Scheduled Monuments were correctly identified (and overlaying land recorded as compromised) for solid sands, silica sand, brick clay and building stone deposits.

The "Review and update of the Surface and Ground Water Protection Issues, including a Flood Risk Assessment of the Areas of Search" which formed a part of the 4 stage consultation document did not take account of the issues outlined in this Addendum.

Amended Areas of Search GIS shape files were provided by WCC, and the flood risk assessment ratings for the five affected areas of search reviewed to consider any potential impacts to the findings of the flood risk assessment. Consideration was also given to other issues such as the number of flood risk receptors, the number or status of watercourses or source protection zones, which fall within an area of search.

The conclusion of the review is that none of the Areas of Search assessed during this analysis appear to effect the previous results with there being no visible effects to watercourses or other criteria.

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Glossary

Glossary	Definition
1D Hydraulic Model	Hydraulic model which computes flow in a single dimension, suitable for representing systems with a defined flow direction such as river channels, pipes and culverts.
2D Hydraulic Model	Hydraulic model which computes flow in multiple dimensions, suitable for representing systems without a defined flow direction including topographic surfaces such as floodplains
Annual probability	Annual probability of occurrence in any one year, expressed as a percentage. For example, a 1% annual probability event has a 1 in 100 chance of occurring in any year.
Area of Search	Areas where knowledge of mineral resources may be less certain but within which planning permission may be granted, particularly if there is a potential shortfall in supply.
Areas Benefitting from Flood Defences (ABD)	Areas Benefiting from Flood Defences shows those areas that would benefit from the presence of formal flood defences in the event of flooding from rivers with a 1% (1 in 100) chance in any given year. If the defences were not there, these areas would be flooded.
Asset Information Management System (AIMS)	Environment Agency database of assets associated with main rivers including defences, structures and channel types. Information regarding location, standard of service, dimensions and condition.
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree

	policies to secure the long-term sustainable management of flood risk.
Climate Change	Long term variations in global temperature and weather patterns caused by natural and human actions. Refer to Planning Practice Guidance - Flood risk assessments: climate change allowances, for the values that should be applied for river catchments.
Combined Sewer	Sewers that accept both wastewater and surface water run-off .
Culvert	A channel or pipe that carries water below the level of the ground.
DG5 Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
Development Plan Document	The collective term given to all statutory documents that form the Local Development Plan.
Exception Test	The exception test may fall to be applied following the application of the sequential test. Conditions need to be met before the exception test can be passed refer to NPPF Paragraph 102.
Flood Defence	Infrastructure used to protect an area against floods as such as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Resilience	Measures that minimise water ingress and promote fast drying and easy cleaning, to prevent any permanent damage.
Flood Resistant	Measures to prevent floodwater entering a building or damaging its fabric. This has the same meaning as flood proof.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption).
Flood Zone	Flood Zones show the probability of flooding, ignoring the presence of

	existing defences
Flood Zone Map	Nationally consistent delineation of 'high' and 'medium' flood risk, published on a quarterly basis by the Environment Agency
Fluvial Flooding	Flooding by a river or a watercourse.
Fluvial	Relating to the actions, processes and behaviour of a watercourse (river or stream).
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater Flooding	The emergence of groundwater at the ground surface away from perennial river channels or the rising of groundwater into man-made ground, under conditions where the 'normal' ranges of groundwater level and groundwater flow are exceeded.
Lead Local Flood Authority	As defined by the Flood and Water Management Act (2010), Worcestershire County Council is the LLFA for Worcestershire.
Local Planning Authority (LPA)	Body that is responsible for controlling planning and development through the planning system.
Main river	Watercourse defined on a 'main river map designated by Defra. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for main rivers. However overall responsibility for maintenance lies with the riparian owner.
Mitigation measure	An element of development design, which may be used to manage flood risk or avoid an increase in flood, risk elsewhere.
Ordinary watercourse	A watercourse that does not form part of a main river. This includes "all rivers and streams and all ditches, drains, cuts, culverts, dikes, sluices (other than public sewers within the meaning of the Water Industry Act 1991) and passages, through which water flows" according to the Land Drainage Act

	1991.
Pluvial Flooding	Flooding arising from surface water runoff and/or the failure of the stormwater (or sewer) drainage system
Preliminary Flood Risk Assessment	The PFRA is a high level screening exercise to identify areas of most significant flood risk
Reservoir Flooding	*Flooding from reservoirs, canals and other artificial sources:* flooding can also be caused from artificial sources such as reservoirs, mines and canals. Such flooding can be caused by overtopping, bank failure or from a cessation of pumping which has artificially lowered the ground water causing flooding when water levels return to their natural level.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	Risk is a factor of the probability or likelihood of an event occurring multiplied by consequence: Risk = Probability x Consequence. It is also referred to in this report in a more general sense.
Sequential Test	Aims to steer all development to areas of lowest flood risk.
Sewer Flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Sites	Specific locations for working minerals or developing waste management facilities.
Source Protection Zone (SPZ)	Defined areas in which certain types of development are restricted to ensure that groundwater sources remain free from contaminants.

Surface Water	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Sustainable drainage systems (SuDS)	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Topographic survey	A survey of ground levels.
Water neutrality	A concept for managing water resources in the context of new development whereby total demand for water should be the same after new development, as it was before.

Acronyms

AOS	Area of Search
CBMW	Catchment Based Management in Worcestershire
CFMP	Catchment Flood Management Plan
CLG	Department for Communities & Local Government
DEFRA	Department for Environment, Food & Rural Affairs
EA	Environment Agency
EU	European Union
FCERM	National Strategy for Flood and Coastal Erosion Management
FRA	Flood risk assessment
FWMA	Flood and Water Management Act
FZ	Flood Zone
GIS	Geographical information systems
GPZ	Groundwater Protection Zone
HIA	Hydrological Impact Assessment
IDB	Internal Drainage Board
LDD	Local Development Document
LDF	Local Development Framework
LPA	Local Planning Authority
LFRMS	Local Flood Risk Management Strategy
MAFP	Multi Agency Flood Plan
MPA	Mineral Planning Authority
MLP	Minerals Local Plan
NERC	Natural Environment and Rural Communities Act
NPPF	National Planning Policy Framework
NPPG	National Planning Policy Guidance
ODPM	Office of the Deputy Prime Minister
PFRA	Preliminary Flood Risk Assessment

PPG	Planning Policy Guidance
PPS 25	Planning Policy Statement 25
RMA	Risk Management Authority
RBMP	River Basin Management Plan
RFRA	Regional flood risk appraisal
SAB	SUDS Approval Body
SAC	Special Area for Conservation (designated under the EU Habitats Directive)
SFRA	Strategic Flood Risk Assessment
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
STW	Sewage treatment works
SUDS	Sustainable Urban Drainage systems
SWMP	Surface Water Management Plan
UKCIP	United Kingdom Climate Impacts Programme
WCC	Worcestershire County Council
WFD	Water Framework Directive
WMLP	Worcestershire Minerals Local Plan

1 Introduction

1.1 Overview

Worcestershire County Council has a statutory duty to produce a Minerals Local Plan (MLP) to deliver sustainable minerals development and to make sure that mineral resources are not sterilised by other development. The current Hereford and Worcester MLP was adopted in 1997 and needs to be updated to reflect current policy, practice and guidance. The new Worcestershire Minerals Local Plan (WMLP) will replace the existing Minerals Local Plan and will be a Development Plan Document, which is used to guide new development and determine planning applications.

It is a requirement of national and international regulations (e.g. The Flood Directive 2007, transposed in the UK into the Flood Risk Regulations 2009 and the Flood and Water Management Act 2010) and of national planning policy that Planning Authorities must take account of flood risk and protect water quality when allocating land for development and in developing their policies and plans and must pay due regard to a wide range of policies in assessing what the issues and risks to them are.

A Surface and Ground Water Protection Issues, including Flood Risk Assessment of Submitted Sites was produced in 2016. However, following changes to the preparation of the Worcestershire Minerals Plan Worcestershire County Council, updates to the NPPF and the emergence of new evidence it is necessary to review and update this document.

This document is intended to provide evidence on flooding issues to inform the development of the emerging WMLP.

1.2 Aims

The National Planning Policy Framework (NPPF) aims to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. Where new development

is necessary in such areas, exceptionally, the policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.

The WMLP will therefore use the information and data presented to allow a sequential approach to the allocation of Minerals sites within Worcestershire. Once adopted, the WMLP will provide the strategic context when determining whether applications should be granted planning permission for the winning and working of minerals and related development in Worcestershire. The WMLP will set out the strategy to enable the sustainable supply of minerals in Worcestershire and the broad locations where associated development could be developed within the county. These will need to accord with wider issues of water management in the county.

The aim of this report is to assess all forms of flood risk and use this as an evidence base to ensure minerals development is located in the appropriate flood risk areas, with preference given to the lowest flood risk area (Zone 1). Clearly minerals can only be worked where they occur, therefore the findings of this study should be used to decide if an alternative mineral site in a lower risk Flood Zone would be more appropriate to take forward as a preferred site. Where minerals sites cannot be located in Flood Zone 1, the planning authority will need to apply the Sequential Test to minerals allocations and, where necessary, the Exception Test (Level 2 SFRA).

This report covers surface and groundwater protection issues, including flooding issues in relation to the emerging WMLP. The issues are intertwined but for simplicity flooding issues are addressed first and groundwater and water quality and quantity issues separately.

Each element is briefly introduced, related to mineral development generally and specifically to the issues to be covered in the WMLP. Much of the detail is listed in Appendices in order to keep the main report concise.

The report brings together the key findings from Environment Agency policy, Regional Flood Risk Assessment (RFRA), Local Strategic Flood Risk Assessments and the Worcestershire Local Flood Risk Management Strategy and non-statutory Surface Water Management Plan for Worcestershire. Reference has also been made to the Worcestershire Preliminary Flood Risk Assessment and the Catchment Based Management in Worcestershire (Technical Background Document).

It is important to note the risk of flooding cannot be entirely avoided. Mitigation of residual flood risk will ensure that development includes measures to reduce the impact of flooding. This will be achieved through flood related management plans and design measures such as sustainable drainage. This is a 'live' document which is intended to be updated when new guidance and/or flood risk information becomes available. Where necessary, this document will be reviewed and updated throughout the preparation of the WMLP.

1.3 Objectives

The objectives of this document are to:

- Assess the impact of all potential sources of flooding including Main Rivers, Surface water and Groundwater,
- Assess any implications associated with climate change and flood risk;
- Provide the information needed to apply the sequential approach and exception test in site identification and assessment in mineral development;
- Enable the development of mineral planning policies that minimise and manage flood risks;
- Provide data that can be used to inform the Sustainability Appraisal of future minerals strategy; and
- Provide guidance on the applicability of sustainable drainage systems (SuDS) techniques for managing surface water run-off.
- Support wider sustainability and environmental policies such as water quality and green infrastructure.

2. Policy Context

2.1 Overview

Worcestershire County Council is in the process of preparing a new Minerals Local Plan (MLP) to provide up to date minerals planning strategy and policies.

The WMLP will form part of the statutory Development Plan for Worcestershire, which delivers the spatial planning strategy for the area. Each Plan, including the WMLP, has to undergo a Sustainability Appraisal (SA), which assists Worcestershire County Council in ensuring their policies fulfil the principles of sustainability.

The report brings together the key findings from Environment Agency policy, Regional Flood Risk Assessment (RFRA), local Strategic Flood Risk Assessments (SFRA) and the emerging Worcestershire Local Flood Risk Management Strategy (LFRMS) and non-statutory Surface Water Management Plan (SWMP) for Worcestershire. Reference has also been made to the Worcestershire Preliminary Flood Risk Assessment (PFRA) and the Catchment Based Management in Worcestershire – Technical Background Document (CBMW).

2.2 National Policy and Flooding

The Government's Water Strategy for England "Future Water"[3] sets out the long-term vision for sustainable and secure water supplies and an improved and protected water environment for the water sector by 2030. This includes addressing flood risk and a greater understanding and use of good surface water management.

[3] Future Water - https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69346/pb13562-future-water-080204.pdf

The Environment Agency has produced a Water Resource Strategy for England and Wales (March 2009)[4], which sets out actions towards water resources based on the twin track approach of demand management and resource development. Multiple general recommendations are made for the entire country surrounding the use of Sustainable Drainage Schemes (SuDS), inter-organisational planning and increased water efficiency. Relevant countrywide recommendations include:

- Encourage planning authorities to use planning conditions and/or legal agreements to secure the implementation of SuDS, especially in areas where pressure on water resources is high.
- Less connection of surface water with combined sewers.
- Developers should work in partnership with water companies and others to explore the feasibility of achieving water neutrality when new developments are proposed. [5]
- In areas where water resources are under pressure, include measures that support water neutrality where new development is planned.

Since the release of the national strategy these broad-ranging recommendations have been translated into more locally specific and detailed actions, for example in the Water Resource Strategy Regional Action Plan for the Midlands. [6]

2.3 National Planning Policy Framework (2018)

The NPPF was published on 24th July 2018 together with accompanying Technical Guidance replacing the previous NPPF published in March 2012. At the time of writing this document it is

[4]The EA are publishing revised/updated river basin management plans https://www.gov.uk/government/collections/river-basin-management-plan-update

[5] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291675/scho1009bqzr-e-e.pdf

[6] See Page 13 in http://www.worcestershire.gov.uk/cms/pdf/WATER%20RESOURCES%20July2012update4.pdf

anticipated that there will be further updates to the national planning guidance in due course to reflect changes to the NPPF. [7]

The NPPF provides a framework within which councils and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities. The overall approach to flood risk is broadly summarised in NPPF Paragraph 155 to 157:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.

Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.

All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property."

Each LPA within the study area is responsible for preparing an SFRA to inform the allocation of development sites within their administrative areas in accordance with their established SA. In a similar manner, as the Minerals Planning Authority for Worcestershire the County Council is responsible for following the same guidelines in consideration of future development sites for use in waste management and mineral extraction. Further detail regarding the application of the Sequential and Exception Tests is included in Section 5.0

[7] Where plans are being prepared under the transitional arrangements set out in Annex 1 to the revised National Planning Policy Framework, the policies in the previous version of the framework published in 2012 will continue to apply, as will any previous guidance which has been superseded since the new framework was published in July 2018.

The relevant sections of the National Planning Policy Framework (NPPF) and associated Planning Practice Guidance (PPG) for Flood Risk and Coastal Change emphasise the active role Local Planning Authorities (LPAs) such as Worcestershire County Council should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process.

The NPPF outlines that Local Plans should be supported by a SFRA and LPAs should use the findings to inform strategic land use planning. The purpose of the Level 1 SFRA is to collate and analyse the most up to date flood risk information from all sources to provide an overview of flood risk issues affecting those parts of the county that could be affected by future minerals development.

2.4 National Planning Practice Guidance (2014)

The Planning Practice Guidance supports the NPPF. The PPG: Flood Risk and Coastal Change[8] section outlines how LPAs should use the SFRA, as follows:

- SFRAs should assess the flood risk from all sources within a specified potential site or area identified for development, both in the present day and in the future. The impacts of climate change should be considered when assessing future flood risk;
- The impact on flood risk of future development and changes to land use should also be considered;
- The SFRA should provide the foundation from which to apply the Sequential and Exception Tests in the development allocation and development control process (see Flood Zone 1- Flood Zone 3b). Where decision-makers have been unable to allocate all proposed development and infrastructure in accordance with the Sequential Test, taking account of the flood vulnerability category of the intended use, it will be necessary to increase the scope of the SFRA (to a Level 2 SFRA) to provide the information necessary for application of the Exception Test;
- Waste and mineral planning authorities should apply the sequential approach to the allocation of sites for waste management and, where possible, mineral extraction and processing.

[8] Planning practice Guidance - http://planningguidance.communities.gov.uk

- The SFRA should inform the sustainability appraisal of the Local Plan;
- The SFRA should define the flood risk in relation to emergency planning's capacity to manage flooding;
- Opportunities to decrease the existing flood risk within the study areas should be explored, such as surface water management, provision of flood storage and managing conveyance of flood flows.

SFRAs should be prepared in consultation with the Environment Agency, emergency planning and drainage authority functions of the LPA, Lead Local Flood Authorities (LLFAs) and where appropriate Internal Drainage Boards (IDBs).

2.5 Flood Risk Regulations

As well as the duties under the Flood and Water Management Act (FWMA) to prepare a Local Flood Risk Management Strategy (LFRMS), WCC have legal obligations under the EU Floods Directive, which was transposed into UK Law through the Flood Risk Regulations 2009 ('the Regulations').

Preliminary Flood Risk Assessment (PFRA)

Under the Regulations, all LLFAs were required to prepare a PFRA report and reviewed on a 6 yearly cycle. This is a high level screening exercise to identify areas of significant risk as Indicative Flood Risk Areas across England where 30,000 people or more are at risk from flooding for reporting to Europe.

WCC prepared a PFRA to provide a high level overview of flood risk from local flood sources and includes flooding from surface water (i.e. rainfall resulting in overland runoff), groundwater, ordinary watercourses (smaller watercourses and ditches) and canals. It excludes flood risk from main rivers, the sea and reservoirs, as these are assessed nationally by the Environment Agency.

The PFRA report looks at past flooding and where future flooding might occur across the area and the consequences it might have to people, properties and the environment. No areas of 'significant risk' were identified. The report was, however, used to help WCC in the development of the LFRMS required under the FWMA.

The Preliminary Flood Risk Assessment (PFRA) for Worcestershire was first produced in 2011 in response to the EU Flood Directive, transposed into the Flood Risk Regulations in the UK.

During 2017 PFRAs underwent their six-year review, as required by the Flood Risk Regulations, first at a strategic level by the EA and then more locally by the LLFAs.

As part of the review a new methodology was introduced by the EA for identifying 'areas of significant risk' and in Worcestershire this spotlighted the central area of Redditch. As a result a multi-RMA group was established to assess the flood risk in Redditch in more detail and produce a plan for its mitigation. The assessment stage is currently ongoing.

2.6 The Flood and Water Management Act (2010) (FWMA)

Following the significant flooding in 2007, one of the recommendations from Sir Michael Pitt's review was that "the role of local authorities should be enhanced so that they take on responsibility for leading the co-ordination of flood risk management in their areas".

The Flood and Water Management Act (FWMA) (2010) brought in new roles and responsibilities for local authorities. In particular, the Act defines the role of the Lead Local Flood Authority (LLFA), which includes County Councils. WCC is therefore the LLFA for Worcestershire. LLFAs are encouraged to bring together relevant bodies and stakeholders to effectively manage local flood risk, which may include County, City and District/Borough Councils, Internal Drainage Boards, highways authorities, water companies and the Environment Agency. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses).

The Act also formalises the flood risk management roles and responsibilities for other organisations including the Environment Agency, water companies and highways authorities. The responsibility for a strategic overview of the management of all sources of flooding and coastal erosion remains that of the Environment Agency. The Agency also has operational responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea.

2.7 National Strategy for Flood and Coastal Erosion Risk Management

In accordance with the FWMA, the Environment Agency has developed a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England[9]. This Strategy provides a framework for the work of all flood and coastal erosion risk management authorities including WCC.

The National FCERM Strategy sets out the long-term objectives for managing flood and coastal erosion risks and the measures proposed to achieve them. It sets the context for, and informs the production of local flood risk management strategies by LLFAs, which will in turn provide the framework to deliver local improvements needed to help communities manage local flood risk.

2.8 Worcestershire County Council Local Flood Risk Management Strategy (LFRMS)

The Environment Agency is responsible for managing flood risk from main rivers and reservoirs but the Flood Risk Regulations (2009) and the FWMA designates the County Council the lead local flood authority (LLFA) for the county. The Council is now required to develop a strategy to manage local flood risk – from surface water runoff, groundwater and 'ordinary watercourses', [10] (i.e. not 'main Rivers,' which remain the responsibility of the Environment Agency).

The Council's duty is to develop, maintain, apply and monitor a strategy for local flood risk management in their area, the "Local Flood Risk Management Strategy". This strategy must in turn be informed by strategic studies and initiatives such as River Basin Management Plans (RBMP), Catchment Flood Management Plans (CFMP), Strategic Flood Risk Assessments (SFRA) and Surface Water Management Plans (SWMP).

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[9] National flood and coastal erosion risk management strategy for England https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/228898/9780108510366.pdf

[10]Ordinary watercourses are a statutory type of watercourse in England and Wales which include a river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and passage through which water flows and which does not form part of a 'main river'. A main river is another statutory type of watercourse, usually larger streams and rivers.

The Council also has regulatory and enforcement duties for ordinary watercourses, which include regulating elements directly applicable to mineral working, and also therefore has powers outside of the planning system to regulate these matters (e.g. where 'riparian owners' fail to maintain a watercourse for which they are responsible).

The LFRMs is a statutory document and as such is an important evidence base and framework for managing and addressing future flood risk. It is a living document drawing together baseline evidence, including historic flooding, existing defences and future changes and an assessment of flood risk in the area, drawn from Surface Water Management Plans (SWMPs), CFMP, SFRAs and Preliminary Flood Risk Assessments (PFRA). This will provide a consistent baseline for managing future flood risk including identifying objectives and measures for addressing this risk.

The County Council as a flood management authority (defined by the FWMA) has a duty to act consistently with the local and national flood strategies in respect of exercising their flood risk management functions. There will therefore be a greater need for the County Council as LLFA and District, Borough and City Councils in Worcestershire to work together so that strategic policies in Local Plans, including those in the Minerals Local Plan, align with the LFRMS and are taken into account when determining planning applications, including those proposed for determination in accordance with the WMLP once adopted.

The County Council Minerals Planning Team has engaged with the LLFA in the development of the strategy and this report supports the strategic aims of the LFRMS. The Minerals Local Plan will include policies to ensure that these issues generally and evidence emerging from the LFRMS are properly recognised and addressed. Flood spots are already being identified for example in the SWMP which will need to inform site design and development, both for working and restoration phases, either as a potential constraint or as an opportunity for the site to result in positive impacts. The emerging LFRMS may also create opportunities for partnership working with the WMLP or mineral developers in future.

2.9 Worcestershire Surface Water Management Plan (SWMP)

Surface Water Management Plans are a tool to manage surface water flood risk on a local basis by improving and optimising coordination between relevant stakeholders. The goal of a SWMP is

to establish a long term action plan setting out priorities for action and to influence future strategy development for maintenance, investment, planning and engagement linked to local development frameworks and emergency plans.

The County Council as LLFA commenced work on developing the SWMP in 2010 working closely with colleagues from the District Councils and other key partners including the Environment Agency, Severn Trent Water and Lower Severn Internal Drainage Board.

Initial stages of work on the SWMP have focused on a high-level overview of flooding in Worcestershire using existing data to identify potential 'quick win' solutions and identify locations where further investigation would be beneficial. This has enabled the LLFA and partners to arrive at a list of historical and potential future flooding locations.

Along with the Environment Agency surface water mapping, this has enabled the development of an extensive evidence base of over 1,700 known floodspots across Worcestershire and a wealth of information about each of them. The floodspot attribute data enables the many locations at risk to be placed into a consistent, criteria-based priority order, which will facilitate properly informed strategic decisions about the management of flood risk in the future.

This will assist the LLFA and partners when considering the location and design of new housing, business and infrastructure development. This evidence base will, via implementation of its action plan and its influence on the emerging LFRMS, make a significant contribution to the further reduction of flood risk in Worcestershire.

In developing the WMLP and this document liaison and data sharing with the LLFA has been key and future policies will make reference to the SWMP and its use to inform development applications.

2.10 Catchment Flood Management Plan (CFMP)

The Environment Agency (EA) has prepared catchment Flood Management Plans (CFMPs). These are designed to act as high-level strategic documents that provide an overview of the main

sources of flood risk for the specific catchment. This catchment-based approach defines the assessment boundary by river pattern, allowing for consideration of all the flood risk conditions.

2.11 River Basin Management Plans (RBMP)

The Environment Agency is the lead organisation responsible for implementing the Water Framework Directive (2000/60/EC) (WFD) and will do so through the production of River Basin Management Plans (RBMP) for each of the River Basin Districts in England and Wales. The WFD was transposed into UK law in 2003 and is designed to improve the ecological, chemical and biological condition of the whole water environment, prevent its further deterioration, promote the sustainable use of water, reduce water pollution and ensure a progressive reduction in groundwater pollution. It is based on the strategic catchment level approach of River Basin Districts, across England and Wales. RBMP are produced for each river basin district every six years.

An important corollary to the WFD in English Law is set out in the 2006 Natural Environment and Rural Communities Act (NERC) which gives local authorities, the Environment Agency and water companies a legal duty to have regard to biodiversity in carrying out all of their functions.

Further details about these matters and on the principal policies, which relate to land use planning and water management can be found in the LFRMS and SWMP.

2.12 Sustainable Drainage Systems (SuDS)

Following a consultation by Defra on the delivery of SuDS in 2014 the Department for Communities and Local Government (DCLG) issued a Written Statement outlining the Government's response regarding the future of SuDS. This was followed by a consultation exercise carried out in December 2014 by DCLG on the proposal to make LLFAs statutory consultees for planning applications with regards to surface water management, and the Government published its formal response in March 2015. The PPG has subsequently been amended to reflect the new approach to implementation of SuDS in development.

The FWMA and NPPG make the County Council as LFRMS a statutory consultee on SuDS.

Planning guidance explains that local planning authorities should ensure local plan policies are compatible with the LFRMS. The guidance also suggests that local planning authorities and the LLFA should agree the circumstances and locations where LLFA advice should be sought on a planning application for developments that raises surface water or other local flood risk issues.

From 6th April 2015 LPAs are expected to ensure that local planning policies and decisions on planning applications relating to major development include SuDS for the management of run-off, unless demonstrated to be inappropriate. Minor developments with drainage implications would continue to be subject to existing planning policy (Section 103 of the NPPF) and smaller developments in flood risk areas should still give priority to the use of SuDS.

The PPG has been amended to state:

"Sustainable drainage systems may not be practicable for some forms of development (for example, mineral extraction). New development should only be considered appropriate in areas at risk of flooding if priority has been given to the use of sustainable drainage systems. Additionally, and more widely, when considering major development, sustainable drainage systems should be provided unless demonstrated to be inappropriate." Paragraph 079 revised 15/04/2015[11]

LPAs should consult the relevant LLFA when considering major development. In considering planning applications LPAs will need to

- Consult Worcestershire County Council, as the LLFA, on the management of surface water for major development,
- Satisfy themselves that the proposed minimum standards of operation are appropriate, and

[11] Planning Practice Guidance – When should a sustainable drainage system be considered? http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/reducing-the-causes-and-impacts-of-flooding/why-are-sustainable-drainage-systems-important/#paragraph_051

- Ensure through the use of planning conditions or planning obligations that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

Local planning authorities are also advised to consult as appropriate

- *The relevant sewerage undertaker where a connection with a public sewer is proposed.*
- *The Environment Agency, if the drainage system directly or indirectly involves the discharge of water into a main river*
- *The relevant highway authority for an affected road*
- *The Canal and River Trust, if the drainage system may directly or indirectly involve the discharge of water into or under a waterway managed by them*
- *An Internal Drainage Board, if the drainage system may directly or indirectly involve the discharge of water into an ordinary watercourse (within the meaning of section 72 of the Land Drainage Act 1991) within the board's district.* PPG paragraph 086.

"The decision on whether a sustainable drainage system would be inappropriate in relation to a particular development proposal is a matter of judgement for the local planning authority. In making this judgement the local planning authority will seek advice from the relevant flood risk management bodies, principally the lead local flood authority." NPPG paragraph 082

WCC, as the LLFA, has become a statutory consultee for planning applications for major developments that have a drainage implication. As a statutory consultee, the LLFA has a duty to respond to the LPA and report on their performance on providing a substantive response within deadlines set out in legislation.

The CIRIA 'SuDS Manual C753' (published in 2015) and CIRIA 'Guidance on the Construction of SuDS – C768' (published 2017) provide technical guidance to assist in the planning, design, construction, management and maintenance of effective SuDS.

2.13 National SuDS Standards

The National Non-Statutory Technical Standards (NS) were published by Defra in March 2015 setting the requirements for the design, construction, maintenance and operation of SuDS. The NS are intended to be used alongside the NPPF and PPG. [12]

2.14 The Green Infrastructure Strategy for Worcestershire

A further significant issue for the WMLP and the Council's duties regarding flood management arises from the County Council's wider landscape and ecological duties. Section 40 of the Natural Environment and Rural Communities Act 2006, places a duty on all public authorities in England and Wales to have regard, in the exercise of their functions, to the purpose of conserving biodiversity. A key purpose of this duty is to embed consideration of biodiversity as an integral part of policy and decision-making throughout the public sector, which should be seeking to make a significant contribution to the achievement of the commitments made by Government in its Biodiversity 2020 strategy. The National Planning Policy Framework is clear that pursuing sustainable development includes moving from a net loss of biodiversity to achieving net gains for nature, and that a core principle for planning is that it should contribute to conserving and enhancing the natural environment and reducing pollution.

The WMLP will seek to achieve these principles through policies and guidance on how mineral workings should be restored and the benefits desired, including flood alleviation, can be achieved. The Green Infrastructure Strategy for Worcestershire will be particularly important in this regard. It is designed to secure integrated land uses and benefits. It encourages the recreation of more natural surface flows and the restoration of flood plains to a more natural condition and these could enable significant improvements to floodwater control and mitigation in and outside of the county. They could also enhance agricultural reservoirs, biodiversity value, historic landscape character and recreational and tourism opportunities within the county.

[12] Department for Environment, Food and Rural Affairs. March 2015. Sustainable Drainage Systems - Non-statutory technical standards for sustainable drainage systems. https://www.gov.uk/government/publications/sustainable-drainage-systems-non-statutory-technical-standards

Defra`s Countryside Stewardship funds include a range of priorities for land managers to support to improve the natural environment which mirror the approach taken in the Green Infrastructure Strategy. The statements are organised on the basis of Natural England`s Natural Character Areas[13] and include many matters which the Minerals Local Plan could assist.

2.15 Catchment Based Management in Worcestershire – Technical Background Document.

A key driver of the Worcestershire Minerals Local Plan is to consider the potential for mineral development in Worcestershire to positively impact on green infrastructure. The Environment Agency and Worcestershire County Council (in its role as Mineral Planning Authority and as Lead Local Flood Authority) have therefore been working together to develop a robust evidence base in support of this objective, setting out the water environment evidence and subsequent recommendations which can be used to inform a robust green infrastructure policy approach within the Local Plan.

This technical background document sets out the joint approach that has been followed by the Environment Agency and Worcestershire County Council. It outlines the local evidence on flood risk, water quality and river morphology pressures and future management opportunities that has been brought together by the partners. It explains how this best available evidence has been combined into a catchment based tool for Worcestershire and sets out management guidelines and green infrastructure recommendations as a basis for targeting appropriate local policy.

A detailed assessment has been undertaken for each proposed strategic corridor within the Minerals Local Plan. These strategic corridors seek to reflect where clusters of mineral resources exist and to direct appropriate green infrastructure enhancement measures which are best suited

[13]https://www.gov.uk/government/collections/countryside-stewardship-statements-of-priorities

to the individual corridor in order to deliver multifunctional benefits. The detailed evidence on catchment flood risk and water quality has been used to identify the most appropriate green infrastructure measures, based on the specific environmental characteristics of each corridor.

2.16 Worcestershire Climate Change Strategy.

The vision of the Worcestershire Climate Change Strategy[14] is for

- A county resilient to volatile costs of fossil fuels and severe weather,
- A county with businesses and residents empowered to take action themselves

The strategy responds to the UK Climate Change Risk Assessment 2012, which sets out key risks to the UK from a changing climate, and the subsequent National Adaptation programme due to start in 2013 and brings together countywide strategies to build resilience and adapt to inevitable climate change. The programme identifies the risk of major damage from flooding and the increasing pressure on water resources and Objective 1 of the programme includes:

Objective 1: To work with individuals, communities and organisations to reduce the threat of flooding and coastal erosion, including that resulting from climate change, by understanding the risks of flooding and coastal erosion, working together to put in place long-term plans to manage these risks and making sure that other plans take account of them.[15]

2.17 Climate Change Guidance (2016)

The National Planning Policy Framework (NPPF) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change.

[14] Worcestershire Climate Change Strategy 2012-2020 http://www.worcestershire.gov.uk/downloads/file/3765/worcestershire_climate_change_strategy_2012_to_2020

[15] The National Adaptation Programme Making the country resilient to a changing climate https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209866/pb13942-nap-20130701.pdf

The Environment Agency published updated climate change guidance for planners [16] to support the NPPF, which supersede all previous allowances written in the NPPF and accompanying PPG. This guidance is particularly supportive when considering future impacts from climate change on site specific allocations.

The 2016 guidance included predictions of anticipated change for:

- — Peak river flow by River Basin District;
- — Peak rainfall intensity;
- — Sea level rise; and,
- — Offshore wind speed and extreme wave height.

The climate change allowances are based on percentiles, with the 50th percentile being the point at which half of the possible scenarios for peak flows fall below it and half fall above it. There are three allowance types identified

- – Central Allowance: Based on the 50th percentile;
- – Higher Central: Based on the 70th percentile; and,
- – Upper End: Based on the 90th percentile.

In addition, three primary epochs are used

- – '2020s' (2015 to 2039);
- – '2050s' (2040 to 2069); and,
- – '2080s' (2070 to 2115).

Climate change scenarios are predicted to have an impact on flooding. Rainfall is likely to become more frequent, more intense and covering longer periods. Mineral sites in Worcestershire, will only be impacted by peak river flow and peak rainfall intensity, as they are not situated in areas of tidal flooding.

[16] Environment Agency (February 2016) Flood risk assessments: climate change allowances. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Whilst the allowances in 'Flood risk assessments: climate change allowances' (published Feb 2016) are still considered the best national representation of how climate change is likely to affect flood risk for:

- peak river flow
- peak rainfall intensity

Research is due to be published in 2019 which may result in changes to these allowances and in line with the UK Climate Projections 2018 (UKCP18).

Until then, The Environment Agency[17] considers that it is reasonable to continue to use the sea level rise allowances in 'Flood risk assessments: climate change allowances' (published in 2016) for planning decision making, because the allowances that have been used to date represent the high end of the range of sea level rise projected by UKCP18.

Once 'Flood risk assessments: climate change allowances' has been updated, over time it is anticipated that the Environment Agency will update their flood risk modelling to reflect the revised climate change projections.

Rather than applying the guidance very specifically at this higher strategic level, a precautionary approach has been adopted for making allowances for future climate change, and for the purposes of this Flood Risk Assessment it is assumed that the current day fluvial Flood Zone 2 will be the extent of Flood Zone 3 (3a and 3b) in the future. This will provide an indication of where future fluvial flooding could affect.

However, future flood risk assessments will need to fully consider the climate change guidance referred to above and prepare climate change flood maps to include outlines, depths and resultant hazards based on the recently published climate change allowances. A detailed assessment of the

[17] The Environment Agency - Using 'Flood risk assessments: climate change allowances' following publication of new climate projections in UKCP18

future impact of climate change will need to be carried out at a later stage (later than the Level 1 SFRA) in the planning process. It is expected that this will be addressed as part of the Flood Risk Assessment that would accompany any planning application for proposed minerals or waste development.

3 SFRA Methodology

3.1 The Study Area

The SFRA covers the county of Worcestershire, encompassing six local authorities, which are Bromsgrove District Council, Malvern Hills District Council, Redditch Borough Council, Worcester City Council, Wychavon District Council and Wyre Forest District Council.

3.2 General Characteristics

The county of Worcestershire covers 1741km^2 and has a population estimated at around 569,000 in six administration districts in 2013, with the population estimated at 70.4% in urban area and over 20% in rural areas. The county benefits from a wide range of rural and urban landscapes, which have differing effects on flood risk.

Worcestershire is a predominantly rural county with a population centred around the main urban areas of Worcester, Kidderminster, Bromsgrove, Redditch, Evesham, Droitwich Spa, Stourport-on-Severn, Upton-on-Severn, Pershore and Great Malvern. There are also numerous other smaller towns, villages and scattered rural communities.

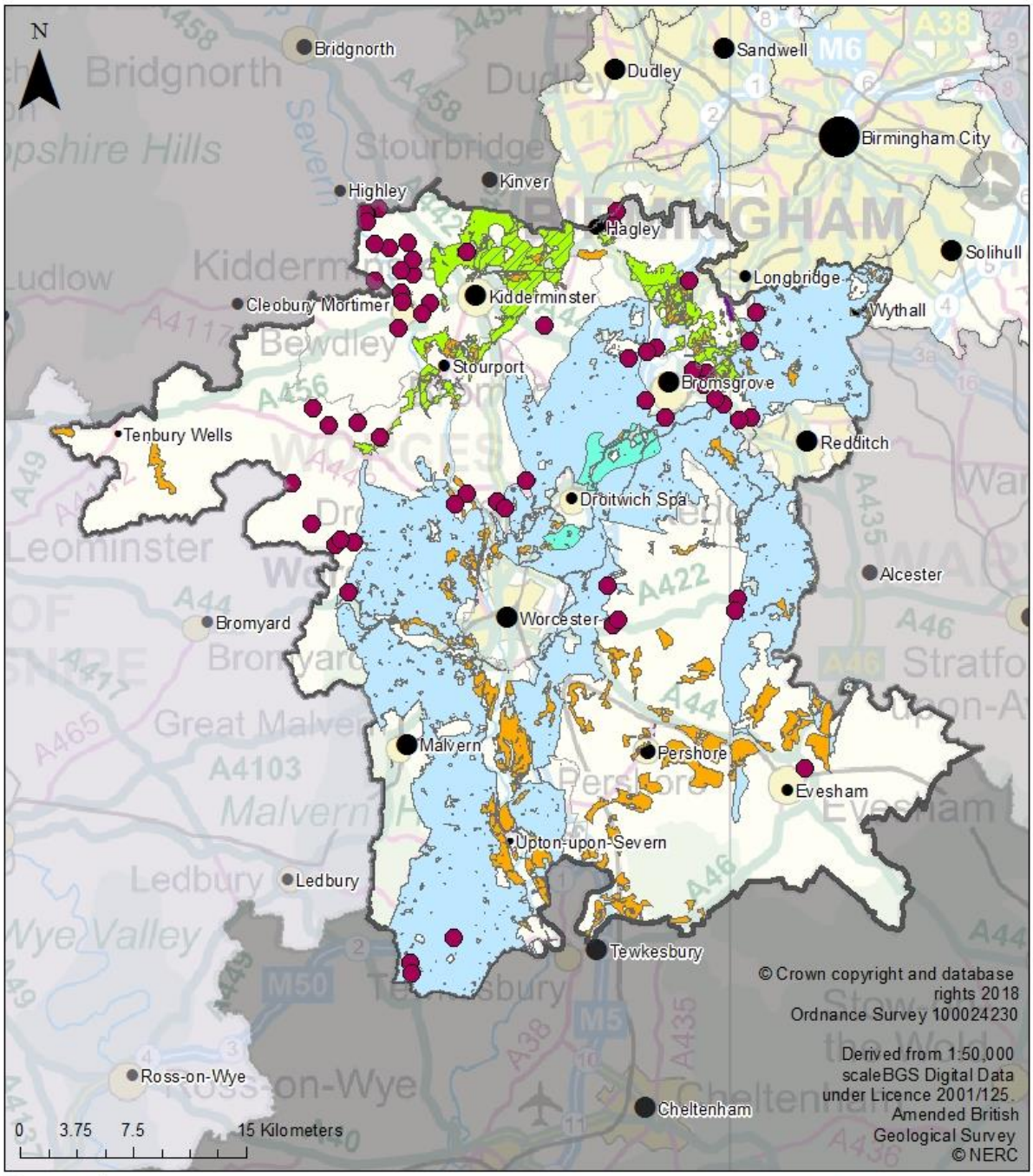
3.3 Topography and Geology

Worcestershire has a diverse geology. It is made up of a wide variety of rock types covering 600 million years of earth history.

In the west, the Malvern Hills run north-south along the county boundary and are largely formed from ancient Precambrian rocks. These are some of the oldest rocks in England and form one of the most important basement structures of southern Britain. In the north the county is bounded by the Clent Hills and Lickey Hills, which are formed from Carboniferous and Cambrian rock from the more recent Paleozoic era. Carboniferous formations are also found in the Wyre Forest Area in the form of red mudstone and coal.

Elsewhere in the county the broad floodplains of the Severn, the Teme Valley and Vale of Evesham are floored by easily eroded mudstones and sandstone of Devonian, Triassic and Jurassic age. In the south east of the county, Jurassic mudstone is overlaid by Jurassic sandstones and limestones, which form the limestone escarpment of the Cotswolds. Over the past 500,000 years ice sheets and melt water have covered the land surface, and the resulting sediments and alluvium deposited have formed terraces along the major river systems.

The south of the county is largely underlain by impermeable Lower Lias clay and Triassic mudstones. By contrast, the north of the county includes: a major aquifer due to the presence of Permian and Triassic sandstones beneath much of Wyre Forest, the west of Bromsgrove District and small parts of Wychavon and Malvern Hills; and a minor aquifer due to the presence of Lower Old Red Sandstone beneath the western part of Malvern Hills in Herefordshire. The majority of the main river corridors are underlain by drift geology (silts and gravels) with the associated potential for perched groundwater accumulations.



Legend

- Terrace and glacial sand and gravel resources
- Solid sand resources
- Droitwich Halite Member
- Wildmoor Sandstone Formation (silica sand potential)
- Mercia Mudstone Group (brick clay potential)
- Crushed rock resources
- Former building stone quarry (H&WEHT)

NOTE: Not all resources are visible on this diagram. In some areas, surface resources overlie bedrock resources. This affects how resources are displayed. They can be viewed in more detail on the interactive minerals mapping tool) at www.worcestershire.gov.uk/minerals.

The resources shown are the remaining deposits (and former building stone quarries) after environmental and amenity screening criteria have been taken into account. For further information see Worcestershire County Council's background document "Location of development: screening and site selection methodology" (August 2018), available at www.worcestershire.gov.uk/mineralsbackground.

Figure1 Worcestershire mineral resources

3.4 Main Rivers In Worcestershire

The county is drained almost entirely by the River Severn, which flows through the centre of Worcestershire from the north to the south. The majority of the county is of gentle topography, forming part of the broad River Severn basin, with the notable exceptions of the Malvern Hills, the Wyre Forest to the west of Kidderminster, the Clent Hills in the north-west of Bromsgrove and Bredon Hill and the Cotswold scarp in Wychavon.

The River Severn and its tributaries, including other Main Rivers such as the River Avon, River Arrow, River Salwarpe and River Teme, dominate the hydrology of Worcestershire. The following section provides a summary of the catchment's characteristics and known flood events by district.

Bromsgrove

Bromsgrove district contains the headwaters of three Main Rivers:

- The River Salwarpe/Sugar Brook/Spadesbourne Brook/ Battlefield Brook, which flows from Bromsgrove to towards Droitwich (River Salwarpe)
- The Gallows Brook, which is located in the north-western corner of the District and flows due west bisecting the village of West Hagley
- The River Arrow, which initiates as Main River east of Alvechurch and then flows south, parallel to the A441 towards Redditch

The district is drained by numerous ordinary watercourses, all of which have their sources located within the District boundaries, most notably to the north, on the Birmingham Plateau.
The district also contains sections of two canals: the Worcester and Birmingham Canal which bisects the district from the north east to the southwest; and the Stratford-upon-Avon Canal of which approximately 700m cuts across the very northeastern corner of the district.

Although there are no reports of flooding from the Stratford-upon-Avon canal, overtopping of the Worcester and Birmingham Canal has been blamed for flooding in Stoke Prior, Bromsgrove,

most notably in 2007. It is known that the canal embankment failed circa 1936, where the canal passes nearby and over the outlet from Lower Bittel Reservoir. In addition, there are numerous pools and reservoirs within the district. The two largest are the Upper and Lower Bittel and Tardebigge Reservoirs, which are all canal feeder reservoirs.

Due to its headwater location, lack of Main Rivers and small watercourses, Bromsgrove district has not suffered from the severe fluvial flooding experienced in other parts of Worcestershire during June and July 2007. However, due to the number of watercourses present, there have been numerous occurrences of smaller-scale flooding, most notably flash flooding from rapid catchment response. In many cases this has resulted in flooding of properties and overwhelming of the road, rail and canal networks and their associated drains and outflows.

Redditch Borough

The River Arrow bisects the northern half of the Borough of Redditch from north to south. Numerous ordinary watercourses drain through the town and feed into the River Arrow. Most of these smaller watercourses have their headwaters located on the southern extent of the Birmingham Plateau.

The southern, more rural, half of Redditch borough is drained by two Main River channels, which flow from north to south. The western branch is referred to as Swans, or Elcocks Brook. The eastern branch is referred to as The Wharrage / Wixon Brook. Downstream of their confluence, the watercourse is referred to as Swans Brook and, finally as the Bow Brook. Although there are numerous balancing ponds located within the borough, the only notable water body is Arrow Valley Lake, which is situated within the floodplain of the River Arrow, just north of the confluence of the Blacksoils Brook.

As Redditch is located at the base of the incline of the Birmingham plateau and is on relatively flat land, it suffers from rapid flash flooding as its numerous brooks and ordinary watercourses deliver storm water from the higher ground to the River Arrow.

As the gradient suddenly reduces, the watercourses rapidly exceed their capacity and have a tendency to 'pool', flooding the surrounding area. This is most notable on the Batchley Brook, which flows into the northwestern corner of Redditch town.

Multiple accounts of sewer flooding have been reported within the borough, although limited to Redditch town, Astwood Bank and the village of Feckenham.

Wyre Forest District

The principal town of Kidderminster is located along the River Stour, which flows through the main town centre. The Staffordshire and Worcestershire Canal follows approximately the same route as the River Stour, both of which have a long history of development giving rise to concern over flooding.

Stourport-on-Severn, the second largest settlement, is affected by a number of watercourses. Most notable is the River Severn, which flows to the south of the town centre. The River Stour, one of the River Severn's tributaries, joins the Severn at Stourport. Additionally, the Staffordshire and Worcestershire Canal terminates in Stourport and consequently there are a number of canal basins located near to the town centre.

Bewdley, the third main settlement, has historically suffered from large flooding events. This is due to the proximity and relationship of the town to the River Severn. Bewdley has recently benefited from multi-million pound flood defences along Severnside North and South, which indicates the pressures from flooding experienced within the town. The east side of the river is also currently protected by temporary demountable defences, both defences led by the Environment Agency.

The district also has a network of streams, pools and brooks which all have the potential to cause flooding. There is a large water supply reservoir located at Trimpley, which is situated to the north of Bewdley and in close proximity to the River Severn.

The main tributaries of the River Severn within the Wyre Forest district are Dowles Brook, Snuffmill Brook, Riddings Brook, Burnthorpe Brook and the River Stour. Dick Brook and Gladder

Book rise within the District and flow in a south easterly direction before joining the River Severn to the south of the district.

South Worcestershire (Worcester City, Malvern Hills and Wychavon Districts)

Significant watercourses within the area are the River Severn, River Avon, River Salwarpe, Barbourne Brook, Badsey Brook, River Isbourne and River Teme.

The main causes of flooding are considered to be fluvial and surface water (either overland or from sewers). Fluvial flooding has occurred in the South Worcestershire on several occasions in the past. The most recent notable events occurred in 1998, 2000, 2007 and the large scale and disruptive flooding experienced in the winter of 2014.

The floods in 1998 were attributed to a large storm event whilst the November and December 2000 events were the largest flood events since 1947. In 2007, there were over 1600-recorded incidents of flooding in Wychavon alone and nearly 200 properties flooded in Worcester. This particular event was a combination of fluvial and surface water flooding. A summary of the risks to settlements is outlined below:

Worcester City

The main causes of flooding within Worcester are the River Severn, River Teme, Barbourne Brook, several smaller watercourses and surface water flooding from sewers and overland flow. Canal flooding has also been recorded in the past, which has been attributed to vandalism of the lock gates.

Wychavon

Significant watercourses within the area include the River Avon, River Salwarpe, Badsey Brook, Carrant Brook and River Isbourne.

Evesham - The main causes of flooding within Evesham are the River Avon, River Isbourne, Battleton Brook, Carrant Brook, several smaller watercourses and surface water flooding from sewers and overland flow.

Pershore - The main causes of flooding within Pershore are the River Avon, several smaller watercourses and surface water flooding from sewers and overland flow.

Droitwich Spa - The main causes of flooding within Droitwich are the River Salwarpe, Elmbridge Brook and surface water flooding from sewers and overland flow. In addition, the Droitwich Canal interacts with the River Salwarpe in several places all of which result in 'in-combination effects' and require consideration.

The Carrant Brook. While the impact of flooding of this watercourse is largely felt in Tewkesbury (Gloucestershire) it has also had a significant impact upstream in Worcestershire (e.g. in Beckford). The catchment of this brook is the subject of the Carrant Brook Catchment Restoration Project involving a number of partners including the Kemerton Conservation Trust, the Environment Agency, Worcestershire Biological Records Centre and various landowners in the catchment. Flood alleviation through reintroducing meanders is part of this project and the EA has already carried out some work on the Kemerton Estate below Aston on Carrant.

Malvern Hills

Significant watercourses within the area include the River Severn, River Teme, Kyre Brook, Hatfield Brook and Pool Brook.

Malvern - The main cause of flooding within Malvern is surface water flooding from sewers and overland flow. Outside of Malvern itself but within Malvern Hills District the Hatfield Brook in Kempsey causes flooding. Short duration intense storms causing flash or rapid response flooding in smaller watercourses are a particular problem.

Tenbury Wells - The main causes of flooding within Tenbury Wells are the River Teme, Kyre Brook and surface water flooding from sewers and overland flow. Flooding usually occurs first from the Kyre Brook before flooding from the River Teme starts. In addition, a culverted section of an un-named watercourse causes flooding at Bog Lane.

Upton upon Severn - The main causes of flooding within Upton upon Severn are the River Severn and surface water flooding from sewers and overland flow. There is an important flood flow route to west of the town during extreme flood events on the River Severn, which essentially isolates

the town. In 2012 a new permanent flood defence designed to protect 64 properties from a 1 in 150 chance of flooding was completed.

A small area in the south of Malvern Hills District is included within boundaries of the Lower Severn Internal Drainage Board and their responsibilities including leading on local flood and surface water management within this area.

3.5 Strategic Corridors

Mineral resources are widely distributed across the county. Historically, individual applications for mineral development have been assessed on their merits against policy criteria relating to their local setting. It has been recognised in developing the WMLP that there is an opportunity to deliver development that takes a more holistic view of its surroundings and delivers integrated multifunctional benefits.

To deliver this, the WMLP identifies Strategic Corridors and considers flood risk and the water environment as part of a holistic approach to green infrastructure.

The Strategic Corridors comprise of clusters of potentially viable mineral resources that occur within coherent landscape-scale corridors. Green infrastructure priorities will be identified in the Minerals Local Plan for each of these corridors. The policy framework is being developed to enable these priorities to be tailored and delivered on a site-by-site basis (both through sites allocated in the plan and any which are brought forward subsequently) in order to ensure that amenity and environmental assets are protected and to deliver a lasting positive legacy from mineral development.

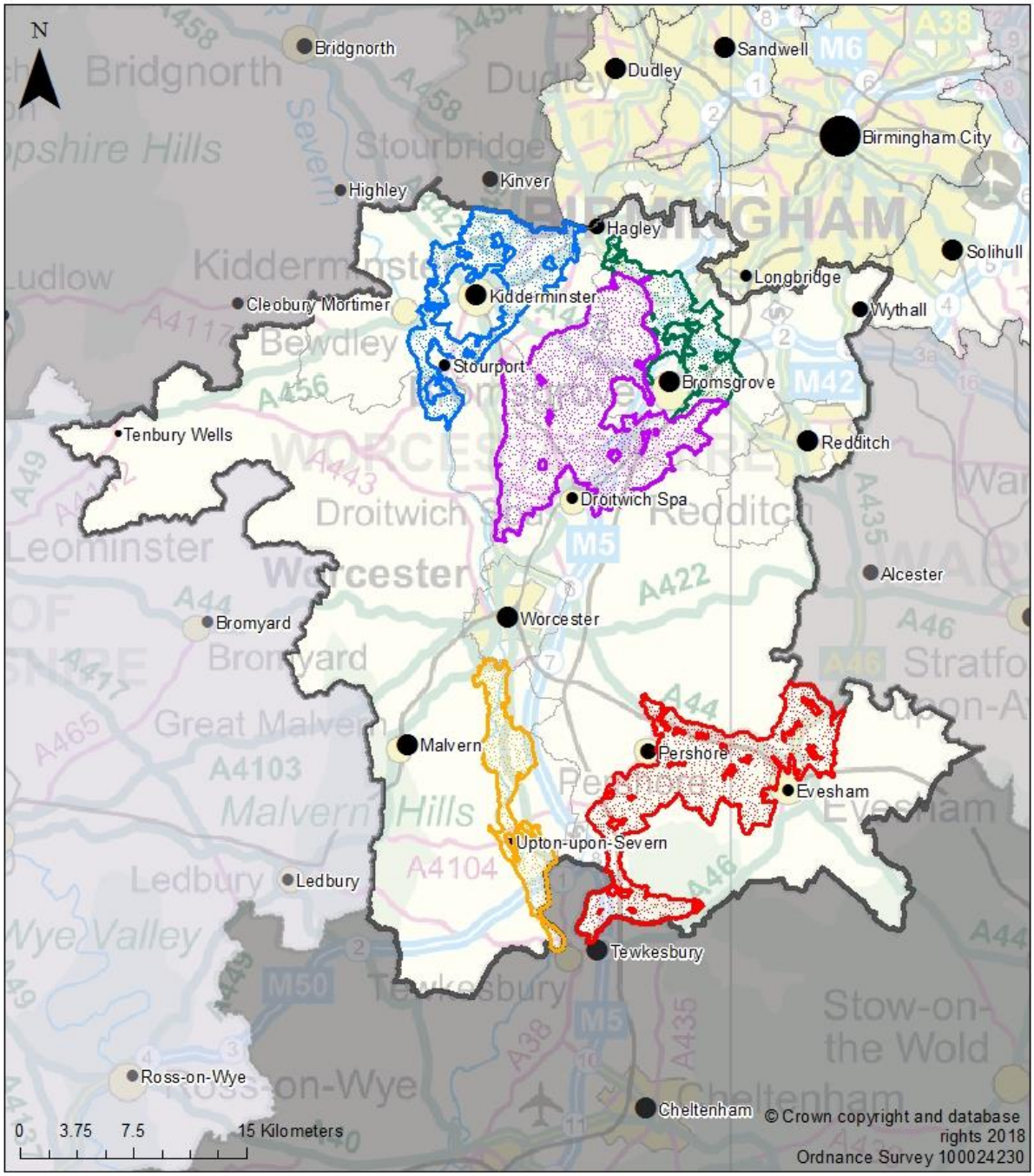
Table 1 (below) considers the Strategic Corridors and the key watercourses within the corridors.

Table 1: WMLP Potential Strategic Corridors and related watercourses

Strategic Corridor	Watercourses in relation to AOS within corridors
Avon and Carrant Brook Strategic Corridor	River Avon, River Isborne, Bourne Bk, Bow Bk, Badsey Bk
Lower Severn Strategic Corridor	River Severn, Careys Bk, Madresfield Bk, Pool Bk, Bushley Bk, Ripple Bk
North East Worcestershire Strategic Corridor	River Arrow, Battlefield Bk, Spadesbourne Bk,
North West Worcestershire Strategic Corridors	River Stour, Blakedown Bk, Staffordshire and Worcestershire Canal
Salwarpe Tributaries Strategic Corridor	River Salwarpe, Battlefield Bk,, Spadesbourne Bk, Hadley Bk, Elmbridge Bk
Outside of Strategic Corridors	None associated. None associated. None associated. None associated.

Note: Of the 5 strategic corridors:

- 2 are primarily terrace and glacial sand and gravel
- 2 are primarily solid sand but significant overlying terrace and glacial sand and gravel
- 1 is primarily clay, but includes some sand and gravel



Legend

Strategic corridors

- Avon and Carrant Brook Strategic Corridor
- Lower Severn Strategic Corridor
- North East Worcestershire Strategic Corridor
- North West Worcestershire Strategic Corridor
- Salwarpe Tributaries Strategic Corridor

NOTE: The strategic corridors can be viewed in more detail on the Policies Map (part of the interactive minerals mapping tool) at www.worcestershire.gov.uk/minerals.

Figure 2 Strategic Corridors

3.6 Data Gathering

This report is principally a desk-based study, using readily available existing information and datasets to enable Worcestershire County Council to apply the Sequential Test to the broad areas identified as options for minerals and waste development in the MLP and to identify whether the Exception Test may be required for specific sites (leading to the need for a Level 2 SFRA).

Under Section 14 of the NPPF, the risk of flooding from all sources must be considered as part of a Level 1 SFRA, including flooding from rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources.

Given the strategic nature of the MLP, this SFRA focuses on flooding from rivers, land and groundwater. Flooding from artificial sources and sewer flooding is acknowledged to be relevant for individual sites at application stage, but no appraisal of this type of flood risk is required for the MLP.

The best available data has been collected for use in this study. However, it is important to recognise that the SFRA is a 'living' document. As new information becomes available (such as improved river models) maps will be updated and the WMLP will need to be flexible to accommodate this to ensure that the best information is used to guide the site selection process for future developments.

The sources of information used to inform this assessment include:

- District Strategic Flood Risk Assessments (SFRAs)
- Catchment Flood Management Plans (CFMPs)
- Regional Flood Risk Appraisal (RFRA)
- Environment Agency Flood Map (covering river and tidal flooding)
- Locally agreed surface water and groundwater maps derived from a number of sources.
- Worcestershire Local Flood Risk Management Strategy (LFRMS)
- Worcestershire Surface Water Management Plan
- Catchment Based Management in Worcestershire – Technical Background Document.

The majority of local authorities within Worcestershire have either individually, or in partnership with adjacent authorities, produced SFRAs to support their proposed development allocations as part of their Local Development Framework (LDF) process. Level 1 SFRAs prepared by the Worcestershire Districts concentrate on mapping flood risk against proposed development, as such they are a good base upon which to build this countywide Level 1 Minerals SFRA. Within the Worcestershire County Council boundary, the following SFRAs have been produced

- Bromsgrove District Council Level 1 (2009), Level 2 (2012)
- Redditch Borough Council Level 1 (2009) & Level 2 (2012)
- South Worcestershire Development Plan (including Malvern Hills District Council, Worcester City Council, Wychavon District Council) Level 1 2009 & 2012 & Level 2 update 2014
- Wyre Forest District Council Level 1 (2007) & Level 2 (2010)

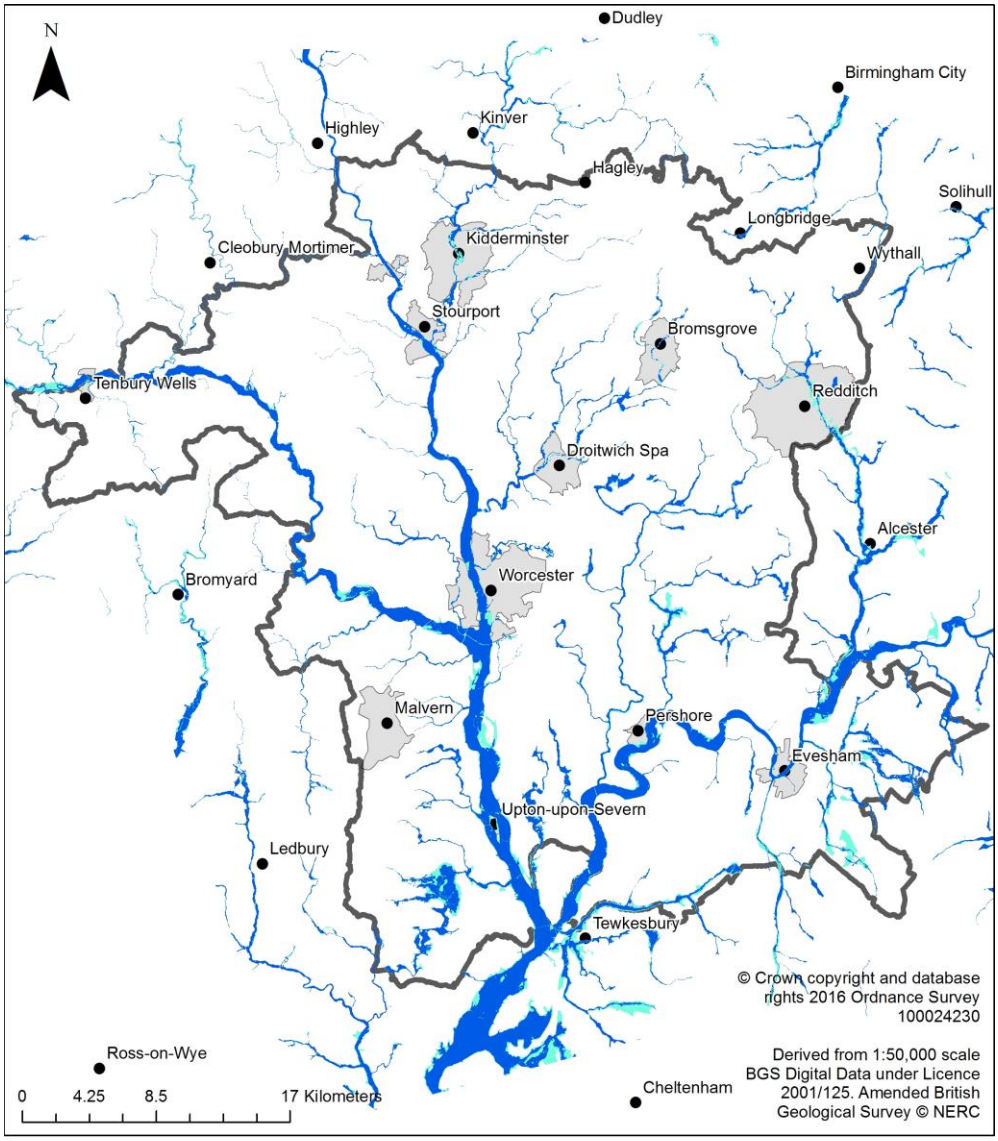


Figure 3 Map of Flood Zones 2 & 3 in Worcestershire

3.7 Stakeholder Consultation

Following consultation on the draft WMLP, it is envisaged that there will be a need for a further update of the Level 1 SFRA to inform the WMLP Sustainability Appraisal at which point further consultation will take place with stakeholders.

As advised by the Environment Agency the vital purpose is to demonstrate the application of the Sequential Test (ST). The NPPG sets out that Mineral Local Plans should 'take account' of flood risk when allocating land having regard to available Strategic Flood Risk Assessment (SFRA) data.

However, given that sand and gravel sites are classed as 'Water Compatible' and other mineral working processes as 'less vulnerable', and are therefore appropriate in areas at risk of flooding, the importance and need for a site specific SFRA is diminished. Indeed, there is not a requirement to apply the sequential test across the WMLP. To accord with the general aims of the NPPF and NPPG the WMLP this document undertakes an appraisal of the flood risk datasets that are available and summarises these for each site. The data that this report draws on includes

- EA Flood Map for Planning
- Updated Flood Map for Surface Water (UFMfSW)
- Worcestershire Local Flood Risk management Strategy
- Worcestershire Surface Water Management Plan
- LLFA anecdotal evidence/SWMPs/Surface Water flooding hotspots
- District council SFRAs
- River Basin Management Plans
- Catchment Flood Management Plans
- Emergency Plans

4.0 Assessment of Flood Risk in Worcestershire

4.1 Local Drainage Issues

There are several different types of flooding all of which occur in Worcestershire and need to be taken into account in developing the WMLP

- Flooding from rivers, "fluvial" - when the volume of water in a river exceeds its capacity, causing it to overflow onto low-lying adjacent land.
- Flooding from surface water - when heavy rainfall is unable to soak into the earth. This could be because the earth is fully saturated, or because the surface is impermeable.
- Flooding from groundwater - when the earth becomes completely saturated with water.
- Flooding from sewers - when the sewer system does not have enough capacity to take water entering the system from heavy rainfall or river or highway flooding.
- Flooding from reservoirs, canals and other artificial sources – due to potential failure or overtopping.

The winning and working of minerals can both worsen (if not properly managed) or improve flood risk and water quality. Surface water run-off from workings can, for example, lead to the pollution and eutrophication of water bodies or contribute to loss of protected habitats. Impediments to surface or groundwater flow or to the capacity of watercourses or the floodplain can all cause new, or worsen existing, flooding problems. The Minerals Local Plan will need to include policy criteria that ensure that these matters are properly addressed before and during operations and monitored in the aftercare stage following restoration.

There are however options during and after the course of mineral working operations and in the ways that sites are restored, which have the potential to mitigate the risk of flooding. Options include

- The creation of temporary and permanent flood storage capacity by restoring riparian corridors

- Creating flood retention or attenuation features or reservoirs. Such areas can be designed to hold floodwater, by storing runoff during the peak flow and releasing it at a controlled rate during and after the peak flow has passed.

- Strategic flood storage areas could be located upstream of urban areas so as to provide multiple flood risk management benefits within a catchment. One of the main advantages of flood storage areas is that flood attenuation generally extends downstream, so flood alleviation is not just a localised benefit. Flood storage areas associated with mineral workings could therefore be used as a high level strategic solution to reduce any increased runoff from new development in the upper end of the catchment mitigating the flood risk to existing communities downstream.

- Mineral workings and or restored sites can also create greater flow capacity by improving channels to reinstate more natural fluvial-floodplain processes. In addition, apart from their value to the sites themselves, any mineral workings that provide additional channel conveyance, flood storage or increases channel length, should have a net downstream benefit on flood risk.

NPPF paragraph 155[18] states that: *"inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future)."*

The most appropriate approach will vary according to site-specific circumstances and local priorities. In some cases flood mitigation may be strategically important and a restoration design approach, which maximises reduction of flood risk would be most suitable. This might involve detailed hydraulic design and engineered structures or by replicating natural landforms or processes.

In other circumstances improving freshwater biodiversity may be more important than flood reduction. Operational mineral workings and their restoration can facilitate these by providing

18 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/733637/National_Planning_Policy_Framework_web_accessible_version.pdf

river restoration schemes which promote natural fluvial and floodplain processes, improve habitat variability and provide additional flood storage. The Minerals Local Plan will need to include policies that enable all of the above and require proposals to demonstrate that they will secure the betterment of the water environment.

4.2 Severn River Basin Management Plan (2009, updated 2015)

The Environment Agency is expressly implementing the Water Framework Directive through the production of River Basin Management Plans (RBMP), for each of the River Basin Districts (RBD) in England and Wales. Worcestershire is part of the Severn River Basin District, the third largest in England and Wales. The Severn River Basin Management Plan, (Severn RBMP) covers Worcestershire. The Severn RBMP (2009) outlined the current state of the water environment and details actions to improve it across the Severn catchment. RBMPs must be reviewed and updated every 6 years and the 2009 plan was updated in 2015 and published in 2016[19]. As a regional application of the WFD, the Severn RBMP focuses on ecological conservation and improvement, water quality, resources and infrastructure and flooding. Section 3.2 of the plan requires that *"Local government to consider the impact on hydromorphology when preparing spatial plans and local flood risk management plans, decisions on development management, new buildings and infrastructure."* The MWLP will include policies that support the delivery of the RBMP.

To implement these actions the current Severn RBMP divides the Severn River Basin into 10 constituent catchments, for each of which there is a CFMP. These set out a preferred plan of action for sustainable flood risk management over the next 50 to 100 years. The issues in the Severn RBMP regarding water quality and quantity overlap those regarding flooding but for simplicity have been divided into flooding related issues and groundwater related issues, separately.

The objectives contained within the Severn CFMP aim to reduce the risk of flooding, through the use of generic actions. These include:

[19] Severn river basin district River basin management plan Updated: December 2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/501290/Severn_RBD_Part_1_river_basin_management_plan.pdf

- Increased attenuation
- Rural land use change
- Increased conveyance
- Localised protection
- Influence and informing (through combining with other policies, SuDS and better warnings).

Flood risks vary within different parts of a single river catchment and as a result different approaches are needed for different locations. CFMP divides the river catchment into a series of policy units each of which includes different priorities.

The Environment Agency has produced a 'Catchment Data Explorer' (CDE) tool.[20]This is a web application designed to enable users to explore information about catchments and the water bodies in them. The data is published in an open format designed for reuse by anyone. Users can view the data in the application and download it. The data is sourced from the Environment Agency's Catchment Planning System and the text summaries and photos are extracts taken from Catchment Summaries.

4.3 Severn Catchment Flood Management Plan (2009)

Evidence to date is that at least 167 sq.km (10%) of Worcestershire is at risk of flooding; approximately 11,100 (4.3%) addresses are at risk from fluvial flooding and approximately 20,000 (7.8%) from surface water flooding. The areas affected are not easily predictable however; as a result of surface water rather than fluvial flooding many of the floods in Worcestershire in 2007 took place outside of flood plains previously identified by flood mapping. The Environment Agency River Severn Catchment Flood Management Plan, December 2009[21] is based on a scenario that climate change will lead to a 20% increase in peak flows in all watercourses and a 30% increase in rainfall to 2115. This will increase the probability of large-scale flood events.

[20] Catchment Date Explorer http://environment.data.gov.uk/catchment-planning/
[21] River Severn Catchment Flood Management Plan (2009) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289103/River_Severn_Catchment_Management_Plan.pdf

Parts of Worcestershire are in four of the River Severn CFMP sub areas

- Lower Severn and Leadon catchment,
- Middle Severn Corridor,
- Telford, Black Country, Bromsgrove, Kidderminster and Coventry Cluster and
- Middle Avon Tributaries, Arrow and Alne, Redditch, Rugby and Teme (this sub area is in two parts in Worcestershire).

Each of these sub areas listed is covered by a broad policy, setting out the Environment Agency's priorities for the catchment (see Appendix 4). The Environment Agency's strategies encourage a 'natural processes approach' to managing flood risk, which includes managing the impact of physical modification in a beneficial way for the environment. Working with natural processes can include taking action to manage flood risk by protecting and restoring the natural function of catchments, rivers, floodplains and coasts. This could, for example, involve using farmland to store floodwater temporarily (flood storage areas), or reinstating wetlands to store floodwater away from high-risk areas.

The Severn River Basin District Consultation on the draft Flood Risk Management Plan[22] (October 2014) proposes a significant change in this approach. The consultation does not refer to the former categorisation of catchment areas into the 6 former zones, it sets out general objectives to improve flood risk both for the Severn catchment as a whole and the individual catchments within it. These are set out in table 2.

When designing flood management schemes, the Environment Agency seeks to identify where physical modification, along with other considerations such as water quality, can be mitigated by a single coordinated action. [23] The WMLP could contribute to some of these. The Environment

[22]Environment Agency: Severn River Basin District, Draft Flood Risk Management Plan (October 2014)
www.gov.uk/government/consultations/draft-flood-risk-management-plans and http://naturalresources.wales/media/1**373/severn-river-basin-district-**consultation-on-the-draft-flood-risk-management-plan.pdf

[23] Severn river basin district RBMP: 2015 https://www.gov.uk/government/collections/river-basin-management-plans-2015

Agency itself identifies the potential for flood alleviation from sustainable aggregate extraction. The WMLP's approach to co-ordinated green infrastructure accords with this. Examples which might be achievable in mineral works and restoration, include

- Removal or easement of barriers to fish migration
- Improvement to condition of channel/bed and/or banks/shoreline
- Improvement to condition of riparian zone and /or wetland habitats
- Dredging and silt management
- Manage pollution from waste water
- Reduce point source pollution pathways (i.e. control entry to the water environment)
- Mitigate/remediate point source impacts on receptor

The objectives in table 2[24] below have been sourced from the CFMPs that cover the Severn RBD in England. They set out the key factors that the Environment Agency will aim to tackle in this strategic area. The WMLP can only influence these to a very small extent, but they are valid considerations and will be taken into account in the development of and application of the WMLP.

[24] Environment Agency: Severn River Basin District, Draft Flood Risk Management Plan (October 2014)
http://naturalresources.wales/media/1373/severn-river-basin-district-consultation-on-the-draft-flood-risk-management-plan.pdf **Table 10.1**

Table 2 Objectives for the Severn River Basin District in England

OBJECTIVE CATEGORIES IN FRMP		OBJECTIVES TAKEN FROM CFRMP	WHAT CAN THE WMLP CONTRIBUTE
Economic	Agricultural economy	• Reduce or prevent an increase in the economic losses from flooding to agricultural land in the catchment. • Support the agricultural sector to manage flood risk and ongoing improvements in sustainable agriculture.	Opportunities for the protection, enhancement or creation of priority habitats and species. Improve the management of riparian corridors through the creation of buffer zones/corridors contributing to WFD. Opportunity for flood alleviation as part of wider catchment management.
	Commercial properties	• Reduce or prevent an increase in the economic damages from flooding to cities, towns and commercial property in the catchment	Opportunity for flood alleviation as part of wider catchment management.
	Leisure & tourism	None	Opportunities for the creation of water and natural environment based recreation and tourism.

OBJECTIVE CATEGORIES IN FRMP		OBJECTIVES TAKEN FROM CFRMP	WHAT CAN THE WMLP CONTRIBUTE
	Other	• Reduce the cost of flood damage for residential and commercial properties where it is economically viable to do so. • Ensure current and future investment in the catchment is proportional to flood risk.	Require consideration of safety and flooding issues on a site-by-site basis.
Environmental	Biodiversity	• Help maintain and enhance priority habitats and species in line with BAP targets. • Protect and where possible enhance internationally and nationally designated sites through appropriate flood risk management procedures.	Opportunities for the protection, enhancement or creation of priority habitats and species.
	Geology & soils	None	Opportunities to for the protection of geological features. Potential for future designation of sites following works.

OBJECTIVE CATEGORIES IN FRMP		OBJECTIVES TAKEN FROM CFRMP	WHAT CAN THE WMLP CONTRIBUTE
			Opportunity for projects to promote public awareness of geological importance.
	Geomorphology hydromorphology	• Protect and enhance, where possible, naturally functioning river and floodplains. • Encourage a more natural management of the river and its flood plain to help deliver WFD target of ecological status.	Opportunities to create flood alleviation areas including wetlands. Improve the management of riparian corridors through the creation of buffer zones.
	Historic Environment	• Sustain and protect sites of historic and cultural value from flooding.	Enhance the long-term quality of land and landscapes.
	Other	• Protect and enhance catchment landscape character.	Enhance the long-term quality of land and landscapes. Protect enhance and create habitats.

OBJECTIVE CATEGORIES IN FRMP		OBJECTIVES TAKEN FROM CFRMP	WHAT CAN THE WMLP CONTRIBUTE
Social	Life	• Reduce or prevent an increase in harm to life, as a result of flooding. • Reduce the likelihood of death or serious injury resulting from rapid inundation or deep and fast flowing water.	Require consideration of safety and flooding issues on a site-by-site basis.
	Other	• Improve community awareness and resilience to flooding.	Require consideration of safety and flooding issues on a site-by-site basis.

The Severn River Basin District Flood Risk Management Plan[25] (2016) also identifies proposals to address specific flooding problems, these are set out in Appendix 5; again only some can be influenced by the Minerals Local Plan. A summary of these is provided below[26]:

The Worcestershire Middle Severn Catchment

"A variety of flooding issues ranging from extended periods of elevated levels along the River Severn between Bewdley and Worcester. There are a number of watercourses that react quickly to rainfall in the catchment. These include the rapidly responding catchments of the Dick Brook (Astley Flooding from surface water /sewers occurs in many of the urban areas such as Kidderminster, Droitwich, Bromsgrove and Worcester and in isolated rural areas."

The WMLP could contribute to the following environmental benefits:

- Take opportunities to restore sustainable natural storage of floodwater on tributaries in their upstream areas, in order to offset increasing flood risk from trends including climate change.
- Work with natural processes wherever possible to achieve WFD objectives

Teme Catchment

"The upper catchment flood risk is mainly constrained to agricultural land and isolated properties. However, in larger events such as those experienced in 1947 and 2007 flooding to properties in urban areas such as Tenbury Wells occurs. In the lower parts of the catchment west of Worcester flood levels in the River Teme can combine with longer periods of flooding around it's confluence with the River Severn. The greatest impact on future flooding is considered to originate from changes in land use and farming practices in addition to climate change."

The MWLP will contribute to the following environmental benefits

[25] Severn River Basin District Flood Risk Management Plan 2015-2021 (2016) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/507832/LIT_10213_SEVERN_FRMP_PART_A.pdf

[26] River Severn Catchment Flood Management Plan https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289103/River_Severn_Catchment_Management_Plan.pdf

- Take opportunities to restore sustainable natural storage of floodwater on tributaries in their upstream areas, in order to offset increasing flood risk from trends including climate change.
- Create habitat through flood risk management activities, and specifically,

Warwickshire Avon Catchment

"The River Avon dominates this catchment, with the following tributaries being particularly important in Worcestershire, the River Stour, River Arrow, River Isbourne and Bow Brook. The catchment has a long and well-documented history of river flooding with larger events occurring in 1901, 1947, 1968, 1998 and most recently 2007. Each event has had its own characteristics and has affected different parts of the catchment.
Flooding from the Cotswold escarpment can be very rapid resulting in water levels rising quickly in such watercourses as the, River Stour, River Isbourne, and Badsey Brook. Downstream of Redditch the River Sowe and Bow Brook may also react quickly to intense rainfall events. Some smaller communities benefit from formal flood defences such as those at …. Sedgeberrow, Hinton on the Green, Pershore and North Littleton."

The MWLP will contribute to the following environmental benefits

- Take opportunities to restore sustainable natural storage of floodwater on tributaries in their upstream areas, in order to offset increasing flood risk from trends including climate change.

Severn Vale Catchment

"There is a well-documented history of fluvial flooding within the catchment, especially along the River Severn from Worcester to Gloucester. The most severe recent events occurred in July 2007 and 1947 when significant numbers of properties were affected on the River Seven and its tributaries between Worcester and Gloucester. The River Severn has floodplains of over 1 mile wide in the lower reaches. Road flooding causes access issues and travel disruption."

The Minerals Local Plan will contribute to the following environmental benefits:

- Take opportunities to restore sustainable natural storage of floodwater in the upstream area, in order to offset increasing flood risk from trends including climate change
- Improve water environment through flood risk management activities
- Improve hydro-morphology of rivers

- Create habitat through flood risk management activities

4.4 Environment Agency Flood Zone Maps

The extent of fluvial flooding is difficult to measure, and Environment Agency Flood Zone maps designate 4 flood zones according to their probability of flooding. The Environment Agency Flood Map for Planning shows flood plain areas that would naturally be affected by flooding from rivers (see Table 3). This mapping is used to prompt a more detailed assessment, should future development be under consideration in or adjacent to these areas. Whilst Flood Zone maps use coarse modelling techniques, and should only be the starting point of the appraisal of flood risk, they set the scene with regards to fluvial flood risks. Flood risk from smaller watercourses will be unknown in the absence of modelling as will surface water (SW) flood risks. In many places the results of flood mapping studies have superseded the previous outlines and have included detailed hydrological research, surveyed river cross sections, and more precise digital modelling.

Table 3: National Planning Policy Guidance Table 1 Flood Zones[27]

Flood Zone	Definition	Annual Exceedance Probability (AEP)

[27] DCLG NPPG Paragraph: 065 Reference ID: 7-065-20140306 Revision date: 06 03 2014

Flood Zone	Definition	Annual Exceedance Probability (AEP)
Zone 1 - Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map - all land outside Zones 2 and 3)	Less than 0.1% AEP
Zone 2 - Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)	1%-0.1% AEP
Zone 3a - High Probability	Land having a 1 in 100 or greater annual probability of river flooding: or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)	Greater than 1% AEP
Zone Floodplain 3b - The Functional	This Zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. Not separately distinguished from Zone 3a on the Flood Map.	5% AEP

The fact that a site is in Flood Zone 1 (FZ1) does not mean that it will not flood. However, only watercourses with a catchment area greater than 3km^2 have been modelled, therefore smaller watercourses may not be covered by the Environment Agency Flood Zone maps. As such, for any development site located adjacent to an unmapped watercourse within Flood Zone 1, it is recommended that an 8-metre development easement from the top of bank is applied (although with regard to sand and gravel workings this can be negotiated with the Environment Agency) and a site specific FRA is undertaken.

It should be noted that the Environment Agency is not the statutory consultee for ordinary watercourses and developers should refer to the LLFA. This has important implications for the WMLP because proposals adjacent to watercourses where Flood Zones have not been defined cannot be assessed against all aspects of the Sequential Test. They can however be considered against the findings of the Local Flood Risk Management Strategy (LFRMS) which shows areas of surface water flooding from ordinary watercourses, pluvial, drainage and groundwater sources in the county and with the Environment Agency's assessments of flooding from "main rivers". More significantly, these matters can also be addressed at the level of the FRA required for individual applications.

In addition the Environment Agency Flood Map does not show the potential impact of climate change or the functional floodplain, Flood Zone 3b. Given the uncertainty about the effect climate change will have on future flood zones, it is important that climate change is factored into flood risk assessments at the application stage.

4.5 Existing SFRAs

It is national Planning Policy that a Strategic Flood Risk Assessment (SFRA) should support a Local Plan. An SFRA is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future, taking account of the impacts of climate change and to assess the impact that changes or development in the area will have on flood risk. The findings of the SFRA should be used to ensure that flood risk is considered at a strategic level to inform land use planning.

SFRAs have been prepared for all six District Councils in Worcestershire at several scales and for different purposes. A summary of the Local Planning Authorities in Worcestershire's elements of the West Midlands Regional Flood Risk Appraisal Update (2009) is set out in Appendix 2.

Flood risk maps now cover the entire county (to varying scales). A summary of the District Councils' SFRAs for Worcestershire is included in Appendix 3. In summary they find that fluvial and surface water are significant sources of flooding within the county and that although the risk of groundwater flooding and sewer flooding are generally lower, they are locally important and should be considered as part of any site-specific flood risk assessment. Water Studies associated with the SFRAs addressed the potential impacts of climate change to varying levels. In essence these assessments conclude that as a result of the impact of future climate change, the risk in terms of fluvial flood risk in the county is set to increase, highlighting the importance of strategic flood attenuation measures and incorporating SUDS within new development.

The SFRAs

- Have helped inform and refine the County Council's flood mapping, from all sources across and from within the county
- Confirm the need to highlight climate change and its effects on flood risk through the proposed policies on sustainable design and use of resources and
- Will inform the evidence base for Sustainability Appraisal.

Three other matters are particularly important with regard to the City, Borough, District Councils' SFRAs and the WMLP: the first is that these SFRAs did not specifically address mineral resource. However, the SFRAs undertaken by the district are an important evidence base to support the WMLP. Further SFRA assessment at the county scale would not usefully illuminate the flooding categorisation for minerals resources. Government policy is that sand and gravel workings are water compatible development and therefore suitable for all Flood Zones.

Secondly the Council does not have detailed information on the extent, depth and method of working these sites it cannot undertake a Level 2 SFRA. However, this does not reduce in any way the need for Flood Risk Assessments, including Hydrogeological Impact Assessments (HIA) to be submitted with applications for planning permission for mineral extraction at these sites; some activities such as mineral processing are not water compatible and should not be undertaken in

the functional flood plain (Flood Zone 3b) and some working methods could affect groundwater and or the wider water environment. The WMLP will include policies to require such assessments at application stage, but it cannot make such assessments at this stage.

The third is a more technical point. The District Councils' SFRAs take into account the levels of flood defence present; in practice therefore the areas defined for flood risk zones 2 and 3 in them are often smaller than the corresponding Environment Agency flood risk mapping. When flood defences are taken into account in an SFRA a scenario is often incorporated, which models the result of a breach in the defences at weak points i.e. residual risk. Although the extent of overall flooding from a breach is likely to be often similar to the Environment Agency flood maps in the vicinity of the breach, differences exist in the nature of the hazard to life posed by breaches.

Flood defences generally fail from overtopping, where the height of a defence is insufficient to contain the water levels (i.e. the design event is exceeded), or as the result of structural failure. When a defence fails suddenly the level of risk to life may be extremely high if there are high flow levels close to the breach. This clearly needs to be taken into account in planning residential development where large numbers of people could be a risk. Mineral workings and associated development and facilities are non-residential and tend to employ very small numbers of people during limited parts of the day and are often restricted to the hours of daylight. As a result very low numbers of people tend to be on these sites for long with a resultant minimal risk.

The issue is further complicated by the absence of precise details of the areas, methods and depths of extraction for the submitted proposals for inclusion in the Plan, the Council's Sequential Test does not therefore consider breach scenarios. The site specific FRAs at application stage will be required to address these matters.

The WMLP will include policies to ensure that mineral developments do not worsen flooding. It will also be appropriate to consider Environment Agency 'policy areas' downstream of any minerals sites developed in the county. Flood alleviation measures upstream (in this county) may help to reduce the risk of flooding further downstream (in other Counties). For example, in

Worcestershire, the Lower Severn 'policy area' has an Environment Agency Policy 2[28] rating in areas of low to moderate flood risk plans may be reviewed so that they are proportionate to the risk; the Middle Avon 'policy area' has a Policy 3 rating where flood risk is generally being managed effectively and where the risk of flooding is not expected to increase significantly the approach to managing flood defences and other flood risk management actions will be reviewed. However, downstream the Cheltenham, Tewkesbury and North East Gloucester 'policy area' – located out of the county, downstream of both of these - has a Policy 5 rating *"Areas of moderate to high flood risk the Environment Agency can generally take further action to reduce flood risk where there are many people at high risk, or where changes in the environment have already increased risk. This will require additional appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options."*

The Council will liaise with the Environment Agency and adjoining Mineral and Local Planning Authorities to ensure that where possible the Plan can address matters such as cross boundary issues. Proposals have been submitted to both Gloucestershire and Worcestershire County Councils proposing sites adjoining the County boundary for inclusion in both counties' emerging Minerals Local Plans. Officers have met to discuss any issues for these sites, including but not limited to Flood risk.

4.6 Groundwater Flooding

Groundwater flooding occurs when water levels in the ground rise above surface elevations and cause spring resurgence. This type of flooding is dependent on the underlying geological strata and is most likely to occur in low-lying areas underlain by permeable rocks (aquifers) after prolonged rainfall.

[28] River Severn Catchment Flood Management Plan (2009) – Policies 2, 3 & 5 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289103/River_Severn_Catchment_Management_Plan.pdf

As part of the SFRA, an assessment of the risk of groundwater flooding needs to be considered; however, this is difficult to undertake at a strategic scale. This is due to the limited information available on flood risk from groundwater sources.

The Environment Agency has, however, developed a dataset, Areas Susceptible to Groundwater Flooding (AStGWF), which highlights 1 km grid areas with differing levels of risk. Due to the geology of the county, however, this form of flooding is considered relatively rare within the WMLP area. Review of District SFRAs and the emerging SWMP identify no sources of groundwater flooding. However, it should be noted that areas such as the Riddings Brook catchment and the low-lying areas of Wolverley are prone to saturation due to the high levels of the water table, which could potentially exacerbate surface flooding problems.

In most cases minerals workings excavate below the natural water table, which during periods of heavy rainfall may rise, and often operate a pumped system and can therefore impact on groundwater flow. These issues are most appropriately addressed in an FRA at the planning application stage for each site.

4.7 Surface Water Flooding

Overland flow and surface water flooding typically can take the form of runoff originating from agricultural/undeveloped land, or run off from developed urban land and often occur as a result of periods of short intense rainfall. This is affected by land use, land management, ground conditions, geology and time of year, in urban areas, this is due to development causing an increase in sealed surfaces, reducing permeability and both flows can quickly result in localised flooding.

The PPG states that an SFRA should identify areas at risk from surface water flooding and drainage issues, taking account of the surface water flood risk published by the Environment Agency as well as other available information.

4.8 Risk of Flooding from Surface Water

The Risk of Flooding from Surface Water (RoFSW), formerly known as the updated Flood Map for Surface Water (uFMfSW), has been undertaken by the Environment Agency. Mapping models surface water flood risk at a national scale and identifies those areas at risk of surface water flooding.

Risk of Flooding from Surface Water Maps includes the extent of flooding that could result from three different design rainfall events

- — High Probability – 3.3% AEP (1 in 30 chance of flooding in any one year)
- — Medium Probability – 1% AEP (1 in 100 chance of flooding in any one year); and,
- — Low Probability – 0.1% AEP (1 in 1000 change of flooding in any one year).

This dataset is also available of the Environment Agency website, and is referred to as 'Risk of Flooding from Surface Water'.

However, it should be noted that this national mapping does have its limitations. For example it is not suitable for identifying whether an individual property will flood and cannot be definitive but it does inform local flood risk management in the absence of better information and is supplemented by the Surface Water Management Plan for Worcestershire and Local Flood Risk Management Strategy for Worcestershire, which focus on "local flood risk" from surface run off, groundwater and "ordinary watercourses" (streams and ditches etc).

In addition the RoFSW does not include specific scenarios to determine the impact of climate change on the risk of surface water flooding. The updated climate change allowances, detailed in Section 2.17, will need to be assessed when taking into account potential effects of climate change on the risk of surface water flooding.

Importantly only watercourses with a catchment area greater than 3km^2 have been modelled, therefore smaller watercourses may not be covered by the Environment Agency Flood Zone maps. As such, for any development site located adjacent to an unmapped watercourse within Flood Zone 1, it is recommended that an 8-metre development easement from the top of bank is applied (although with regard to sand and gravel workings this can be negotiated with the Environment Agency) and a site specific FRA is undertaken.

4.9 Worcestershire Surface Water Management Plan

As discussed previously Worcestershire County Council has produced (2016) a SWMP for the county but it may be underpinned in future by more localised SWMPs where locally significant issues are identified, (e.g. for Bromsgrove Town Centre and Droitwich High Street). The SWMP details the location and extent of pluvial and groundwater flooding and where these interact with other sources, such as fluvial and sewer flooding. These locations have been mapped and contain information regarding event frequency, magnitude and thresholds. The SWMP uses the flooding information contained within SFRAs and Multi-Agency Flood Plans (MAFPs), and will in turn inform these documents when newer versions are produced. The Minerals Local Plan will include policies to ensure that wherever possible these plans are taken account of at the application stage.

As new technical information associated with flood risk management evolves and real events occur the WMLP Minerals Local Plan will need to include flexible policies or monitoring indicators to ensure that new information about flooding issues is taken into account.

4.10 Review of Historic Flood Event Records

There is a long history of flooding in Worcestershire and whilst media coverage focuses on the main river flooding in towns such as Bewdley, Worcester, Upton-upon-Severn and Evesham, the majority of flood risk is from surface water and the extensive network of smaller 'ordinary' watercourses.

The most significant events in living memory are those which occurred in June and July of 2007. Whereas previous events often struck one particular watercourse (in April 1998, the River Avon was particularly affected), in Summer 2007 there were a large number of incidents recorded throughout the county from a range of sources.[29] Major surface water flooding has occurred as

[29] Worcestershire Preliminary Flood Risk Assessment (2011) http://www.worcestershire.gov.uk/downloads/file/5199/preliminary_flood_risk_assessment_2011_pfra_for_worcestershire

recently as Winter 2014 and this is a stark reminder that flood risk remains a priority for Worcestershire and effectively managing it will be important to the county's future.

These events demonstrate the complexity and integrated nature of flooding in the county and expose the susceptibility to flood risk from many sources. Whilst the events in 2007 were exceptional, they gave insight into the scale of risk and demonstrate the need for strategic management of flood risk.

4.10a Catchment Based Management in Worcestershire (Technical Background Document) June 2018

This technical background document sets out the joint approach that has been followed by the Environment Agency and Worcestershire County Council. It outlines the local evidence on flood risk, water quality and river morphology pressures and future management opportunities that has been brought together by the partners.

In order to develop a comprehensive understanding of the water environment within Worcestershire, a number of local datasets including:

The Communities at Risk dataset

The Lead Local Flood Authority floodspot dataset

The Water Framework Directive (WFD)

These datasets have been overlain to catchment boundaries across Worcestershire, enabling a prioritisation based on each catchment's evidence of risk. The output of this work is a mapping tool for Worcestershire, which brings together an assessment of the datasets into a catchment based approach, enabling effective evidence based targeting of flood risk management infrastructure and Water Framework Directive measures.

In terms of flood risk, a count has been made of the number of receptors (residential properties, non-residential properties and key infrastructure) to identify where there are particular clusterings of known flood incidents or future modelled risk. Each catchment has therefore been prioritised as follows:

- LOW RISK – 1 to 49 receptors
- MEDIUM RISK – 50 to 250 receptors
- HIGH RISK – More than 250 receptors

It is intended that the mapping tool is a 'live' evidence base of catchment based data which will change over time as new evidence becomes available. As such, the tool captures and reflects the best available data at the time of publication and will be updated as and when significant chances to the source data occur.

The mapping tool will be used as a basis for encouraging proactive engagement between developers and both the County Council, as the Lead Local Flood Authority, and the Environment Agency, to identify and assist the appropriate delivery of multifunctional flood risk management infrastructure to achieve betterment.

The paper includes a series of guidelines that seek to recognise that the catchment boundaries represent a whole system of interlinked watercourses and flow pathways. Interventions, such as new development proposals, in a part of a catchment can therefore have direct impacts in other parts of the catchment and an integrated approach to managing water is therefore recommended.

Emphasis is placed on exploring how partnership working, particularly with the Environment Agency and the LLFA, can be used to deliver a set of integrated measures based on whole catchment risk and consider the full range of management opportunities that are available. This approach supports the NPPF, which clarifies that future Local Plans should have regard to the cumulative impacts of flood risk, rather than just the flood risk to or from individual development sites.

In addition to including a set of general guidelines, a detailed assessment has been undertaken for each proposed strategic corridor within the Minerals Local Plan.

The document establishes the general principle that all development has the potential for impact downstream and upstream of its location. The extent and magnitude of the impact upstream will depend on site and activity specific criteria. However, the impact on receptors situated outside the strategic corridor boundary will be largely limited by the direction of the flow and its position relative to the works being carried out. Similarly, the impact on surface water flood risk is likely to be limited to receptors located within or around close proximity to the location of the mineral development.

The paper includes a set of recommendations for all Strategic Corridors that

- All development consider downstream impact and mitigation
- All development which may constrain conveyance must consider impact upstream.
- All development which may affect multiple watercourses to consider sensitivities for potential impacts and mitigation opportunities at river confluences.
- All development to take account of the specific recommendations for the catchment they are located within, set out in the catchment specific guidelines below.

Report findings are summarised below:

Avon and Carrant Brook Strategic Corridor

The Avon and Carrant Brook Strategic Corridor intersects 11 catchments. In terms of flood risk, 5 of these catchments are classified within the mapping tool as being high risk, 2 are classified as medium risk and 4 are classified as low risk. The majority (72%) of the strategic corridor is within catchments with a high risk of flooding. The corridor is therefore considered to be sensitive in terms of existing flood risk.

The total number of floodspots inside the strategic corridor is sixty-eight and the total number of receptors is two hundred and sixty one.

Lower Severn Strategic Corridor

The Lower Severn Strategic Corridor intersects 10 catchments. In terms of the flood risk, 5 of these catchments are classified within the mapping tool as being high risk, 4 are classified as medium risk and 1 is classified as low risk. The majority (69%) of the strategic mineral corridor is within catchments with a high risk of flooding. The corridor is therefore considered to be sensitive in terms of existing flood risk.

The total number of floodspots inside the strategic corridor is twenty-one and the total number of receptors is forty-seven.

North East Worcestershire Strategic Corridor

The North East Worcestershire Strategic Corridor intersects 10 catchments. In terms of flood risk, 6 of these catchments are classified within the mapping tool as being high risk, 3 are classified as medium risk and 1 is classified as low risk. The majority (80%) of the strategic corridor is within catchments with a high risk of flooding. The corridor is therefore considered to be sensitive in terms of existing flood risk.

The total number of floodspots inside the strategic corridor is thirty-six and the total number of receptors is fifty-four.

North West Worcestershire Strategic Corridor

The North West Worcestershire Strategic Corridor intersects 25 catchments. In terms of flood risk, 10 of these catchments are classified as high risk, 7 are classified as medium risk and 8 are classified as low risk. However, the majority (66%) of the corridor is within catchments with a high risk of flooding.

The total number of floodspots inside the strategic corridor is twenty-eight and the total number of receptors is forty-six.

Salwarpe Tributaries Strategic Corridor

The Salwarpe Tributaries Strategic Corridor intersects 11 WFD catchments. In terms of flood risk, 4 of these catchments are classified as high risk, 3 are classified as medium risk and 4 are classified as low risk. In addition, there is a relatively even spread of flood risk across the corridor with 39% of its total area inside catchments with a low risk of flooding, 33% inside high risk and 28% inside medium risk catchments.

The total number of floodspots inside the strategic corridor is seventy-eight and the total number of receptors is one hundred and fourteen.

4.11 Flood Defences

Flood defences are structures, which affect flow in times of flooding and therefore prevent water from entering property. They generally fall into one of two categories; 'formal' or 'informal'.

A 'formal' flood defence is a structure, which has been specifically built to control floodwater, it is maintained by its owner or statutory undertaker so that it remains in the necessary condition to function. In accordance with the FWMA, the Environment Agency has powers to construct and maintain defences to help protect against flooding. WCC has similar powers on ordinary watercourses throughout the county.

An 'informal' defence is a structure that has not necessarily been built to control floodwater and is not maintained for this purpose. This includes road and rail embankments and other linear infrastructure (buildings and boundary walls), which may act as water retaining structures or create enclosures to form flood storage areas in addition to their primary function.

Should any changes be planned in the vicinity of road or railway crossings over rivers in the study area it would be necessary to assess the potential impact on flood risk to ensure that flooding is not made worse either upstream or downstream. The WMLP will include policies to ensure that smaller scale informal flood defences are identified as part of site specific FRAs and the residual risk of their failure assessed at the application stage.

There are a number of locations at risk of flooding that are currently protected by permanent defences within the county. Specific details about defences in each City, Borough, and District can

be found in their individual SFRA documents. However table 4 summarises some of the most notable defences.

It should be noted that flooding may still occur in defended areas if the defence is overtopped or breached, or if flooding occurs as a result of non-fluvial sources such as groundwater flooding or surface water flooding. Development behind defences should, therefore, be planned with due regard to the flood risk in the defended area.

Table 4 Strategic Scale Flood Defence Summary

District	Location	Defence Scheme
Redditch	Beoley	Earth Embankment defence
South Worcestershire	Pershore	Scheme consists of a flood relief channel and earth embankments to the south of the town and a flood wall built through community allotments.
South Worcestershire	Upton upon Severn	Scheme consists of an earth embankment, flood wall and floodgates across New Street. Additionally a flood wall was constructed in the Waterside area.
South Worcestershire	Powick	Scheme consists of two flood embankments, providing protection from a flood with a 1 in 75 chance of occurring in any one year.

District	Location	Defence Scheme
South Worcestershire	Badsey Brook	The scheme will include the construction of a flood storage area which will be able to hold up to 135,000 cubic metres of water upstream of Cheltenham Road in Broadway. Earth embankments and a control structure will also be constructed to limit the amount of water flowing down the brook during periods of high rainfall.
South Worcestershire	Kempsey	An 180m long earth embankment constructed downstream of the village to stop flooding from the River Severn. Additionally a large culvert and automated penstock allows Hatfield brook to flow freely into the River Severn in periods of low flow. Pumps are in place to discharge surface water and water from Hatfield Brook to the other side of the embankment when the penstock is closed. The scheme provides protection to a 1 in 100 chance of a flood occurring in one year.
South Worcestershire	Riddings Brook, Wribbenhall	Scheme consists of a 200m-earth bund.
South Worcestershire	Uckinghall	Scheme consists of an earth embankment, flood wall, pumping station, and highway alterations at Ferry

District	Location	Defence Scheme
		Lane including a floodgate.
South Worcestershire	Worcester City	Flood embankment and gate Hylton Rd.
Wyre Forest	Kidderminster	The scheme comprises a concrete culvert, which serves to limit the flow of the River Stour through a dam structure, causing flood water to back up on the Puxton Marshes.
Wyre Forest	Bewdley	The town of Bewdley is protected from flooding from the River Severn through a combination of walls through the town and the operation of temporary and demountable flood defences.

A number of flood alleviation schemes have been completed or further developed in 2017. Locations include

- Callow End
- Hagley
- Bewdley
- Broadway
- Kidderminster
- Feckenham
- Redditch
- Ripple

In addition a GIS-based 'Register of FRM Schemes' has been developed which includes all recent, current and forthcoming schemes in Worcestershire. This is the first time that information about schemes being led by all of the RMAs has been captured and made visible to them in one place.

4.12 Flooding from Canals & Reservoirs

In addition to the fluvial flood risk from watercourses, consideration is given to the risk of flooding arising from other sources including canals, particularly where they interact with Main Rivers or their tributaries. For example in 2007 the River Stour overtopped its banks and the floodwaters interacted with the Staffordshire and Worcestershire canal, filling all available freeboard[30] and rapidly conveying floodwaters downstream, resulting in flooding in Kidderminster. Bromsgrove District contains sections of two canals: the Worcester and Birmingham Canal which bisects the District from the northeast to the southwest; and the Stratford-on-Avon Canal of which approximately 700m cuts across the very northeastern corner of the District. Although there are no reports of flooding from the section of Stratford-upon- Avon canal, overtopping of the Worcester and Birmingham Canal has been blamed for flooding in the Stoke Prior area of Bromsgrove, most notably in 2007. In 2007 the River Salwarpe overtopped in to the Droitwich Canal, which impacted on flooding in Droitwich town centre.

Although the threat of flooding from the canals can be alleviated through the control of sluices, it is a source that should be considered for all potential development sites located in proximity to such waterways. There are no known incidents of reservoirs flooding.

4.13 Potential Impacts of Climate Change upon Flood Risk

Climate changes can affect local flood risk in several ways. Impacts will depend on local conditions and vulnerability. Wetter winters and more of this rain falling in wet spells may increase river flooding along the Severn and its tributaries. More intense rainfall causes more

[30] A height added to the predicted level of flood to take account of waves or turbulence and the uncertainty in estimating the probability of flooding.

surface runoff, increasing localised flooding and erosion. In turn, this may increase pressure on drains, sewers and water quality. Storm intensity in summer could increase even in drier summers, so we need to be prepared to react to unexpected short term localised storms.

There was consensus amongst climate model projections presented in the IPCC fourth assessment report for northern Europe (2007) suggesting that in winter high extremes of precipitation are very likely to increase in magnitude and frequency. These models project drier summers with increased chance of intense precipitation — intense heavy downpours interspersed with longer, relatively dry periods (Solomon et al., 2007)[31]

If emissions follow a medium future scenario the UKCP09 projected changes by the 2050s for the Severn River Basin District relative to the recent past are: Winter precipitation increases of around 12% (very likely to be between 2 and 26%); Precipitation on the wettest day in winter up by around 9% (very unlikely to be more than 22%); Peak river flows in a typical catchment likely to increase between 9 and 18%.

One of the purposes of Strategic Flood Risk Assessments is to take account of the effects of climate change on flood risk. The NPPF provides details on the degree of river flow increases, which need to be taken into account, when preparing planning documents. However, the effects of climate change are also likely to result in increased rainfall intensity, which will have a subsequent effect on the levels of Peak riverflows.

The NPPG suggests that rainfall intensity to be factored into modelling should be increased by the following amounts for modelling purposes

- 1990 to 2025 +5%
- 2025 to 2055 +10%
- 2055 to 2085 +20%
- 2085 to 2115 +30%

[31] IPCC Climate Change 2007: Impacts, Adaptation and Vulnerability https://www.ipcc.ch/report/ar4/wg2/

As result of the effects of climate change peak river flows are predicted to increase by the following percentages:

- 1990 to 2025 +10%
- 2025 to 2115 +20%

SFRAs prepared for the district authorities, have been calculated to take into account the development lifetime of the most vulnerable development type. For districts, this is generally housing, which has been calculated as having a development life of 100 years. Therefore, the time periods used in the climate change scenarios by the district authorities are also considered sufficient for the WMLP.

However, it is important to note that the Environment Agency's Flood Plain mapping does not take account of climate change issues. It is possible that such changes could alter the nature of flood events on the ground. Changes in the extent of inundation may be negligible in narrower floodplains, but could be dramatic in very flat areas.[32]

Changes in the depth of flooding under the same allowance could also reduce the return period of a given flood. This means that a site currently located within a lower risk zone (e.g. Zone 2) could in future be re-classified as lying within a higher risk zone (e.g. Zone 3a). This in turn could have implications for the type of development that is appropriate according to its vulnerability to flooding. It will therefore be important to recognise that the allowance needed for climate change is dependent on the life cycle of the development and that sensitivities for peak rainfall intensity and peak river flow will change over the life of the proposed development. Site specific FRAs at application stage will need to address these matters (see footnote below).

Note:

[32] Environment Agency, "Climate change allowances for planners" September 2013 v12

The Environment Agency has recently updated guidance on how climate change could affect flood risk to new development.[33] The main changes are to the peak river flow allowances which are provided for each river basin district rather than a single national allowance, and for the upper end of the range are significantly higher than previous the single national allowance. This is discussed further in section 2.17. Applicants will need to refer to the Environment Agency's advice at the application stage.

4.14 Possible Implications of mineral working for flooding

"Floods are natural phenomena which cannot be prevented. However, some human activities (such as increasing human settlements and economic assets in floodplains and the reduction of the natural water retention by land use) and climate change contribute to an increase in the likelihood and adverse impacts of flood events." [34]

Mineral operations within or close to floodplains are at risk of inundation during a flood event, with potential impacts including the erosion of stockpiles and waste tips. While fluvial flooding is the most likely source, quarries can also be affected by surface water (pluvial) flooding and by groundwater flooding if not properly managed. Surface water run-off from workings could, for example, lead to the pollution and eutrophication of water bodies or contribute to loss of protected habitats. Impediments to surface or groundwater flow or to the capacity of watercourses or the floodplain can all cause new, or worsen existing, flooding problems. The WMLP will include policies that ensure that these matters are properly addressed before and during operations and monitored in the aftercare stage following restoration.

Mineral extraction and related activities can also have significant benefits on flood risk over a wider area both during mineral working operations and in the approaches to site restoration. Significant possibilities include the creation of temporary and permanent flood storage capacity

[33] 'Flood risk assessments: climate change allowances' was published on gov.uk on 19 February 2016. https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

[34] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.

by restoring riparian corridors, creating flood retention or attenuation features or reservoirs. Such areas can be designed to hold floodwater, by storing runoff during the peak flow and releasing it at a controlled rate during and after the peak flow has passed.

These flood risk mitigation and environmental benefits are considered further in chapter 5 Sustainable Development.

5.0 Managing Flood Risk

5.1 Overview

Mineral extraction sites are unique in the sense that they can only be located where the mineral occurs. Therefore there is a much lesser degree of choice in locating mineral extraction sites than there is with other types of development. It is also sometimes difficult to avoid flood risk areas, particularly in the case of sand and gravel deposits, which are often found in abundance along river corridors.

The WMLP will assess mineral sites against a number of sustainability criteria. One of these criteria relates to flood risk, which aims to ensure that mineral sites are subject to the Sequential Approach and located in areas at lowest risk from flooding. Consideration should be given to alternative sites in a lower risk flood zone in preference to mineral sites in higher risk areas. In instances where mineral workings can be located in Flood Zone 3a and 3b such as sand and gravel extraction, it is important that the site is designed in such as way as to enable any processing, storage and office accommodation to be located outside the high risk Flood Zones where practicable.

5.2 Assessment of Risk (Flood Hazard)

National Planning Policy Guidance (NPPG) categorises development in terms of its compatibility with flooding (from lowest to highest compatibility) as:

- Essential Infrastructure
- Highly vulnerable
- More vulnerable
- Less vulnerable and
- Water compatible

And sets out where, in terms of flood risk, the different kinds of development are compatible. Flood risk vulnerability and flood zone "compatibility" are set out in Table 2 of the NPPG[35] and are summarised below.

[35] DCLG NPPG Paragraph: 067 Reference ID: 7-067-20140306 Revision date: 06 03 2014

Table 5 NPPG: Flood vulnerability and flood zone 'compatibility' (Table 3)

FLOOD ZONES		FLOOD RISK VULNERABILITY CLASSIFICATION			
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	☑	☑	☑	☑	☑
Zone 2	☑	Exception Test required	☑	☑	☑
Zone 3a	Exception Test required	☒	Exception Test required	☒	☒
Zone 3b *	Exception Test required	☒	☒	☒	☒

Key: ☑ Development is appropriate ☒ Development should not be permitted

NPPG includes the following notes to table 3

- *This table does not show the application of the Sequential Test which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;*
- *Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.*

In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- *Remain operational and safe for users in times of flood;*
- *Result in no net loss of floodplain storage;*
- *Not impede water flows and not increase flood risk elsewhere.*

Application of the sequential approach in the plan-making process, in particular application of the Sequential Test, will help ensure that development can be safely and sustainably delivered and

developers do not waste their time promoting proposals which are inappropriate on flood risk grounds.[36]

In summary, it is national policy that the overall aim should be to steer new development to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2, applying the Exception Test if required (see table below). Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required. The NPPG includes advice on how the Sequential and Exception tests should be applied.

Table 6 NPPG Flood Risk Vulnerability Classifications[37] assess mineral workings as falling into the following classifications:

Less Vulnerable

- Mineral working and processing (except for sand and gravel working).

Water-Compatible Development

- Sand and gravel working.

However, it should be noted that any subsequent development post operations and as part of restoration or aftercare plans may be considered to be more vulnerable.

5.3 National Planning Policy: Flood Risk Categories and the Sequential Test

[36] According to the information available, other forms of flooding should be treated consistently with river flooding in mapping probability and assessing vulnerability to apply the sequential approach across all flood zones."

[37] DCLG NPPG paragraph: 066 Reference ID: 7-066-20140306 Revision date: 06 03 2014

The NPPF [38] requires Local Plans to apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change. It requires:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk" (whether existing or future).

"Local Plans should be supported by Strategic Flood Risk Assessment and develop policies to manage flood risk from all sources they should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change." The NPPG paragraph 021 Diagram 2[39] illustrates the application of the Sequential Test in Local Plan preparation.

The aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. A sequential approach should be used in areas known to be at risk from any form of flooding.

"If it is not possible for development to be located in zones with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in national planning guidance". [40]

This policy is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher probability. The aim should be to locate development

[38] NPPF Paragraph 157 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf

[39] NPPG Paragraph 021 Diagram 2 Application of the Sequential Test for Local Plan preparation

[40] NPPF Paragraph 159 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf

out of medium and high flood probability areas (Flood Zones 2 and 3) of fluvial flooding and other areas affected by other sources of flooding where possible. Where this cannot be avoided, application of an Exception Test allows for the possibility of some development in flood risk areas taking place if flood risk is clearly outweighed by other sustainability drivers.

The Sequential Test is applied at all stages of the planning process, both between different Flood Zones and within a Flood Zone. All opportunities to locate new developments (except Water Compatible) in reasonably available areas of little or no flood risk should be explored, prior to any decision to locate them in areas of higher risk.

It is acknowledged within the NPPF that minerals have to be extracted where they are located and their operational workings 'should not increase flood risk elsewhere and need to be designed, worked and restored accordingly'. However, for this reason, sand and gravel extraction sites are classified as 'Water Compatible' development. All other minerals development are classified as 'less vulnerable' and only suitable in flood zones 1-3a.

Where sand and gravel workings are located within the floodplain, steps should be taken to apply a sequential approach within the site itself to ensure that ancillary and supporting infrastructure and buildings are located in areas of lowest flood risk to reduce the risk of being adversely affected by flooding or increasing flood risk elsewhere.

The WMLP should assess whether the requirement for the mineral could first be met from areas at no risk of flooding and, if not, that there is justification for the level of development that may ultimately need to take place in areas that are at risk of flooding.

If a location is recorded as having experienced repeated flooding from the same source this should be acknowledged within the Sequential Test.

5.4 National Planning Policy: Flood Risk Categories and the Exception Test

The NPPG states that the Exception test should only be applied as set out in NPPG diagram 3 and following the sequential test.[41]

Essentially, the two parts to the Test require proposed development to show:
"that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and

A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. Both elements of the test will have to be passed for development to be allocated or permitted"[42]

However, there is a potential conflict between satisfying the Sequential Test and delivering water quality betterment. The NPPG[43] states that in order to demonstrate that wider sustainability benefits to the community outweigh flood risk,

"Local planning authorities will need to consider what criteria they will use in this assessment, having regard to the objectives of their Local Plan's Sustainability Appraisal framework, and provide advice which will enable applicants to provide the evidence to demonstrate this part of the Exception Test is passed….

Waste and mineral planning authorities should apply the sequential approach to the allocation of sites for waste management and, ***where possible, mineral extraction and processing.*** *It should also be recognised that mineral deposits have to be worked where they are (and sand and gravel extraction is defined as 'water-compatible development' in table 2, acknowledging that these deposits are often in flood risk areas).*

[41] NPPG Paragraph 028 Applying the Exception Test in the preparation of a Local Plan http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/applying-the-exception-test-in-the-preparation-of-a-local-plan/#paragraph_028
[42] DCLG NPPG Paragraph: 067 Reference ID: 7-067-20140306 Revision date: 06 03
[43] DCLG NPPG paragraph: 037 Reference ID: 7-037-20140306 Revision date: 06 03 2014

However, mineral working should not increase flood risk elsewhere and needs to be designed, worked and restored accordingly.

Mineral workings can be large and may afford opportunities for applying the sequential approach at the site level. It may be possible to locate ancillary facilities such as processing plant and offices in areas at lowest flood risk. Sequential working and restoration can be designed to reduce flood risk by providing flood storage and attenuation.

This report must therefore establish if development is "flood zone compatible."

5.5 The Sequential and Exceptions Tests and the Minerals Local Plan

The Sequential and Exceptions tests are a key consideration for most types of development in that they allow the decision maker to employ a balancing exercise, weighing up wider sustainability benefits against flood risk constraints. In practice however minerals can only be worked where they exist and in Worcestershire many sand and gravel workings have been in Flood Zone 2 or 3 and are likely to be in the future. Sand and gravel workings are considered "water compatible" in national planning policy, subject to the proviso that when in Flood Zone 3b (the functional floodplain) they "*should be designed and constructed to:*

- *Remain operational and safe for users in times of flood;*
- *Result in no net loss of floodplain storage;*
- *Not impede water flows and not increase flood risk elsewhere."*

Even if the flood risk increases in a particular area, re-classifying the current zone to a higher risk e.g. from Zone 2 to Zone 3a, water compatible development such as sand and gravel workings would still be considered appropriate in the flood plain.

One of the aims of the emerging Minerals Local Plan is to improve both flood risk and water quality as part of wider green infrastructure aims; the WMLP will therefore include policies to require desirable, sustainable, benefits for the environment to be achieved. A Flood Risk Assessment (FRA) and a separate Hydrogeological Impact Assessments (HIA) where appropriate will nonetheless still be necessary as part of any application for planning permission for minerals

development on land susceptible to flooding and will need to assess impacts to and from the proposed development.

Apart from sand and gravel workings all other types of minerals working and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. The WMLP will also include policies to ensure that any such proposals will also be required to include an FRA with each application in line with national policy and legislation.

Policies in the WMLP will ensure that apart from sand and gravel workings, all other mineral workings, processing and associated development (such as buildings, fuel stores and parking areas) which are considered "less vulnerable" land uses are permitted in Flood Zones 1, 2 or 3 but not in Flood Zone 3b, the functional floodplain.

5.6 Applying the Sequential and Exceptions Tests to sites proposed for inclusion in the Minerals Local Plan

The Third Stage Consultation identified strategic corridors that were based around coherent landscapes, which contained clusters of key and significant sand and gravel resources or Mercia Mudstone clay resources. The precise boundaries were influenced by the components of green infrastructure, but primarily landscape character types.

The strategic corridors have been reviewed to take account of the key and significant aggregate resources and the Mercia Mudstone clay deposits, which have the potential to be suitable in planning terms, to ensure that they continue to represent significant clusters of mineral resources within coherent landscapes. To avoid conflict between the Minerals Local Plan and other parts of the Development Plan for the county, the strategic corridor boundaries have also been trimmed using settlement boundaries and site allocations the District and Borough Councils Development Plans.

In the Third Stage Consultation on the Minerals Local Plan, the five strategic corridors were given the status of Areas of Search. However, many comments received stated that these areas were

too broad to give confidence in where minerals development is likely to take place. The role of the strategic corridors has therefore been reviewed, and rather than having the status of areas of search in themselves, these will now provide the high-level direction for the location of development and the policy framework for the delivery of co-ordinated, landscape-scale green infrastructure benefits.

The individual resources namely

- Brick Clay,
- Solid Sand Sand & Gravel,
- Terrace Glacial Sand Gravel,
- Building Stone and;
- Silica Sand.

Which have the potential to be suitable in planning terms and which fall within the new strategic corridor boundaries have been identified as Areas of Search (AOS). Each AOS has been given a unique identifier and labeled 'mineral-specifically'. One hundred and sixty four individual AOS have been uniquely identified.

In practice it is likely that resources may be found in the same AOS and there will typically be some overlap e.g. Silica Sand is found within one of the two formations that make up Solid Sand. However, and for the purposes of the Sequential Test each AOS has been assessed individually.

Using the GIS layers provided by Worcestershire County Council the area in hectares was calculated for each AOS each area of search. Each AOS was then in turn overlaid with the following mapping layers:

- Flood Zone 1,Flood Zone 2, Flood Zone 3, Flood Zone 3b,
- Flood Risk Receptors from the LLFA and EA,
- WFD extents (using their respective values) and finally;
- Source Protection Zones.

The GIS was then used to run a query to analyse which of the aforesaid features fell within the extent of the each of the areas of search. The results were then recorded and a desktop analysis undertaken to inform the contents of this report.

However, many of the watercourses within the AOS do not have flood zones associated with them or do not have all flood zones defined. This does not mean that these watercourses do not flood, but that modelled data is not currently available. Given the strategic nature of this assessment

many of the AOS include watercourses where flood zones have not been defined and as a result cannot be assessed against all aspects of the Sequential Test using the existing data.

At this stage the LLFA and EA Flood Risk Receptors layer has been used to identify the risk of surface water flooding within each AOS. Given, the strategic nature of the assessment many of the AOS could include numerous un-modelled watercourses. These AOS may be at increased risk of surface water flooding and overland flows from adjacent higher ground. Surface water flooding and overland flow paths should therefore be taken into account in the development of the Minerals Allocation Plan.

5.7 Areas of Search

As mentioned previously individual resources have been identified as AOS for consideration in the development of the Minerals Local Plan.[44] The one hundred and sixty four AOS have each been identified and mapped at a necessarily strategic scale and range in size from 10 to 9,000 hectares (ha).

Given the strategic nature of these AOS it has been necessary to undertake a high level assessment of the flood risks and to sequentially test the AOS. The AOS have been divided by Strategic Corridor followed by AOS and the mineral resource identified.

The Sequential Test has been applied to all potential AOS drawing on the Environment Agency Flood Map (for rivers and the sea), Flood Map for Surface Water and Environment Agency and LLFA flood spots. Consideration has also been given to environmental constraints including the Water Framework Directive and Source Protection Zones.

However, the Environment Agency data does not distinguish between Zones 3a and 3b. Therefore the Minerals and Waste Planning Authority have taken the view in this SFRA that, as the primary purpose of a Level 1 SFRA is to inform the Sequential Test and to provide a relatively high- level

[44] Indication of the mineral type is based on information included with site proposal from landowner, operator or agent, or British Geological Survey maps where information was not provided with the submission.

overview of flood risk, the whole of Flood Zone 3 as depicted on Environment Agency mapping will be taken as and treated as the functional floodplain, Zone 3b.

If in future any part of the WMLP will be the subject of a Level 2 SFRA, or when at planning application a detailed Flood Risk Assessment is required, further advice and information will be sought from the Environment Agency, or specific modelling work will be required to provide information on where Zone 3b actually is.

The application of the Sequential Test will ensure that preference is given to areas at lowest flood risk, taking into account all other material planning considerations. The sequential approach will also need to be applied at the site level to ensure that more vulnerable uses are located in areas at lowest flood risk.

5.8 Sequential Test of the Submitted Sites proposed for inclusion in the Minerals Local Plan

All of the Areas of Search for sand or sand and gravel extraction are considered "water compatible" development, which can appropriately be located in the floodplain and other mineral workings are classed as 'Less Vulnerable'. However, The extraction of other minerals e.g. clay and building stone are not appropriate land uses within this zone and should not be permitted.

The NPPF acknowledges that minerals can only be worked where they occur and although sand and gravel extraction are classed as 'water compatible' the sequential approach to allocating sites for mineral extraction and processing should still be taken.

This does however have the possible advantage that, as discussed above, one of the aims of the emerging WMLP is to improve both flood alleviation and water quality, it might be helpful therefore to achieve the broad objectives of the Plan if some new mineral development in Worcestershire were to be in, or in significant conjunction with, Flood Zone 2 or 3 or land liable to flood/critical drainage areas.

The WMLP will therefore need to include policies to ensure that when applications for planning permission are made, flooding, surface and groundwater protection and water quality and quantity issues will be addressed on a site-by-site basis.

Table 6 Lower Severn Corridor Strategic Corridor

AOS TYPE	NUMBER OF AOS	FZ1*	FZ2	FZ3A	FZ3B	SUSCEPTIBLE TO SURFACE WATER FLOODING	IS DEVELOPMENT ACCEPTABLE
Brick Clay	•	4	4	4	4	☑	No - Minerals working for Brick Clay and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.
Solid Sand – Sand & Gravel (SSSG)	0	•	0	0	0	n/a	n/a
Terrace Glacial Sand & Gravel (TGSG)	14	14	13	13	14	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.

Building Stone	0	0	0	0	0	n/a	n/a
Silica Sand (WFSS)	0	0	0	0	0	• • •	n/a
Total number of AOS	18						

***Note:** Given the strategic scale of the AOS - Flood Zone 1 has been judged to be anywhere that falls outside of FZ 2 or 3 or 3b.

Table 7 North-West Worcestershire Strategic Corridor

AOS TYPE	NUMBER OF AOS	FZ1*	FZ2	FZ3A	FZ3B	SUSCEPTIBLE TO SURFACE WATER FLOODING	IS DEVELOPMENT ACCEPTABLE
Brick Clay	0	0	0	0	0	• • •	n/a
Solid Sand – Sand & Gravel (SSSG)	17	17	11	11	11	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Terrace Glacial Sand & Gravel	8	8	8	8	7	☑	Yes - Sand and gravel extraction is water compatible,

(TGSG)							so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Building Stone	4	4	4	4	4	☑	No - Minerals working for Building Stone and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.
Silica Sand (WFSS)	18	18	18	18	10	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase

							flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Total Number of AOS	47						

***Note:** Given the strategic scale of the AOS - Flood Zone 1 has been judged to be anywhere that falls outside of FZ 2 or 3 or 3b.

Table 8 North-East Worcestershire Corridor

AOS TYPE	NUMBER OF AOS	FZ1*	FZ2	FZ3A	FZ3B	SUSCEPTIBLE TO SURFACE WATER FLOODING	IS DEVELOPMENT ACCEPTABLE
Brick Clay	2	2	1	1	0	☑	Yes - Minerals working for Brick Clay and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test.
Solid Sand – Sand & Gravel (SSSG)	11	11	4	4	3	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not

							impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Terrace Glacial Sand & Terrace Glacial Gravel (TGSG)	17	17	17	17	17	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Building Stone	1	1	1	1	1	☑	No - Minerals working for Building Stone and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.

Silica Sand (WFSS)	23	23	23	23	23	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Total number of AOS	54						

***Note:** Given the strategic scale of the AOS - Flood Zone 1 has been judged to be anywhere that falls outside of FZ 2 or 3 or 3b.

Table 9 Salwarpe Tributaries Strategic Corridor

AOS TYPE	NUMBER OF AOS	FZ1*	FZ2	FZ3A	FZ3B	SUSCEPTIBLE TO SURFACE WATER FLOODING	IS DEVELOPMENT ACCEPTABLE
Brick Clay	3	3	3	3	3	☑	No - Minerals working for Brick Clay and processing are classed as 'less vulnerable'. This means that they and all

							associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.
Solid Sand – Sand & Gravel (SSSG)	0	0	0	0	0	• • •	n/a
Terrace Glacial Sand & Gravel (TGSG)	3	3	3	3	3	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Building Stone	4	4	4	4	4	☑	No - Minerals working for Building Stoneand processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.
Silica Sand (WFSS)	0	0	0	0	0	0	n/a

Total number of AOS	10	

***Note:** Given the strategic scale of the AOS - Flood Zone 1 has been judged to be anywhere that falls outside of FZ 2 or 3 or 3b.

Table 10 Avon & Carrant Brook Strategic Corridor

AOS TYPE	NUMBER OF AOS	FZ1*	FZ2	FZ3A	FZ3B	SUSCEPTIBLE TO SURFACE WATER FLOODING	IS DEVELOPMENT ACCEPTABLE
Brick Clay	3	3	3	3	3	☑	No - Minerals working for Brick Clay and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.
Solid Sand – Sand & Gravel (SSSG)	0	0	0	0	0	• • •	n/a
Terrace Glacial Sand & Gravel (TGSG)	28	28	28	28	16	☑	Yes - Sand and gravel extraction is water compatible, so suitable in flood risk terms for allocation in Draft Mineral Sites Plan. AOS in FZ3b will need to be 'designed and constructed to remain operational and safe for users in times of flood, result in no net loss of floodplain storage, not impede water flows and not increase flood risk elsewhere'. Surface Water Flooding is likely across all AOS and as

							such will require addressing in a site specific Flood Risk Assessment (FRA) submitted with any planning application.
Building Stone	0	0	0	0	0	• • •	No - Minerals working for Building Stone and processing are classed as 'less vulnerable'. This means that they and all associated processing elements should be acceptable in principle in all flood risk zones apart from Zone 3b "Functional Floodplain", subject to the Sequential and Exception Test. An exception test may be required.
Silica Sand (WFSS)	0	0	0	0	0	n/a	n/a
Total number of AOS	31						

The WMLP has identified a series of strategic corridors, which will form the focus for minerals development in the county. These have been developed using a green infrastructure approach, using landscape character as a base. The WMLP sets out the objectives for each of the strategic corridors, which where appropriate will include both fluvial and surface water flooding. This approach is set out through the policies in the Local Plan.

5.9 Minerals Local Plan and Flood Risk Issues

In summary, at this stage of the Plan's development:

119 of the submitted sites are in Flood Zone 2, 140 are in Flood Zone 3 and 124 are in Flood Zone 3b or are on land liable to flooding[45]

16 sites are in Flood Zone 3b and are considered non water compatible development (e.g. Brick Clay or Building Stone).

i) The Minerals Local Plan will not be able to identify enough sites to meet the predicted need for minerals over the life of the Plan. The Council cannot therefore exclude any of the sites proposed for inclusion in the Plan on the grounds that they are not in Flood Zone 1 and that other "*reasonably available sites appropriate for the proposed development in areas with a lower probability of flooding*" exist and

The Plan will include policies to assess the implications for all aspects of the water environment of proposals for the winning and working of minerals, including the need for an FRA to be submitted with every application for new mineral workings.

5.10 Residual Risk of Flooding

The risk from flooding can never be completely removed and the NPPG requires developers to demonstrate that development will be safe to satisfy the second part of the Exception Test. [46]

[45]In the sense that all or part of these sites is in Flood Zone 2 or 3 or on land identified by the County Council, in its role as Lead Local Flood Authority, as liable to surface water flooding.

With any flood defence there is the residual risk that failure could potentially occur in flood management infrastructure such as flood defences, or that an extreme weather event may exceed the imposed design standards. Should such an event occur it may result in rapid inundation of the local community behind the flood defence, and may pose a risk to life. Where residual risks remain, appropriate assessment of these risks and possible mitigation measures should be considered.

5.11 Flood Event Management

Emergency planning focuses on the response to and recovery from emergency incidents (including flooding). The Local Resilience Forum (including Emergency Services, Local Authorities, Environment Agency and Health Authorities) is responsible for working in partnership to plan for and respond to flooding emergencies. Local Authorities are responsible for leading the recovery from flooding incidents. Worcestershire County Council's Emergency Planning Team works with other agencies (including District/Borough Councils) to coordinate the preparation of Multi-Agency Flood Plans and a Local Authorities Recovery Plan to identify the response to and recovery from, flooding incidents.

The Civil Contingencies Act 2004 is of particular relevance to emergency planning for flooding. It formalises a number of duties on local authorities, the emergency services and other organisations involved (including the Environment Agency) in responding to any emergency.

The County Council is designated as a Category 1 Responder under the Civil Contingencies Act 2004. As such, the Council has defined responsibilities to assess risk, and respond appropriately in case of an emergency, including a major flooding event. Duties that fall on the County Council and District Authorities as Category 1 responders are

- Risk assessment
- Business Continuity Management
- Emergency Planning

[46] NPPG Paragraph 041 http://planningguidance.communities.gov.uk/blog/guidance/flood-risk-and-coastal-change/developers-to-demonstrate-that-development-will-be-safe-to-satisfy-the-second-part-of-the-exception-test/what-is-residual-risk/

- Maintaining public awareness and arrangements to warn, inform and advise the public.
- Provision of advice and assistance to the commercial sector and voluntary organisations.
- Co-operation and information sharing

The West Mercia Local Resilience Forum (WMLRF) is a multi-agency group comprising bodies such as local authorities, national and local health agencies, the three emergency services and the Environment Agency. It addresses through planning and risk management, the consequences of any emergency (including flooding) that may occur within the County.

5.12 Scope of FRAs required by the Minerals Local Plan

The WMLP will include policies requiring FRA and Hydrogeological Impact Assessments (HIA) for new minerals sites. The level of detail required will need to be proportionate to the degree of flood risk and appropriate to the scale, nature and location of the development.

Site specific FRAs will need to assess flooding from all sources at the site-specific level and offer mitigating options for the management of the risk, without increasing flood risk elsewhere and address how flood risk to others will be managed now and taking climate change into account. The FRAs will also need to cover issues of design layout and management of surface water. The onus is on the developer to provide this information in support of a planning application.

The scope of FRAs should be agreed with the Minerals Planning Authority in consultation with the Environment Agency, Lead Local Flood Authority, and any other relevant bodies, in advance of any submission. In most cases applicants will need to

- Include the start-up, operational and restoration phases of the proposal,
- Demonstrate the flood risk to the development itself from all sources of flooding, and how any flood risks to others will be managed,
- Ensure that that all related development issues are addressed, for example that there is sufficient space available outside the functional flood plain for operations such as stockpiling which would not increase flood risk on the site or elsewhere,
- Consider breach scenarios if appropriate,
- Include surface and groundwater mitigation measures for all stages of the operation and its restoration,

- Take appropriate climate change issues into account for the 1 in 100 year event over the lifetime of the development and
- Explore opportunities for betterment over the wider water environment.

Assessments will also need to consider other possible sources of flooding e.g. groundwater flooding, flooding from surface water runoff, reservoirs, canals and flooding from any associated leachate on site or within the wider area caused by disrupted drainage patterns.

The Environment Agency's Flood Zone mapping does not take account of climate change issues. It is possible that such changes could alter the nature of flood events on the ground. Changes in the extent of inundation may be negligible in narrower floodplains, but could be extensive in very flat areas. Changes in the depth of flooding under the same allowance could also reduce the return period of a given flood. This means that a site currently located within a lower risk zone (e.g. Zone 2) could in future be re-classified as lying within a higher risk zone (e.g. Zone 3a). This in turn could have implications for the type of development that is appropriate according to its vulnerability to flooding. It will therefore be important to recognise that the allowance needed for climate change is dependent on the life cycle of the development and that sensitivities for peak rainfall intensity and peak river flow will change over the life of the proposed development. This will be dependant upon the lifespan of the proposal e.g. operations in the short to medium and restoration in the longer term. The site-level FRAs should address these matters.

All of these matters can have implications for both water quality and quantity, for simplicity's sake these matters are dealt with separately in section 6.

6 Sustainable Development

6.1 Strategic Flood Risk Management

Mineral extraction and related activities can have significant impacts (including benefits) on flood risk over a wider area both during mineral working operations and in the approaches to site restoration. Significant possibilities include the creation of temporary and permanent flood storage capacity by restoring riparian corridors, creating flood retention or attenuation features or reservoirs.

Strategic flood storage areas could provide multiple flood risk management benefits within a catchment. One of the main advantages of flood storage areas is that flood attenuation generally extends downstream, so flood alleviation is not just a localised benefit. Flood storage areas associated with mineral workings could therefore be used as a high level strategic solution to mitigate the flood risk to existing communities.

Mineral workings and restored sites can also create greater flow capacity by improving channels to reinstate more natural fluvial-floodplain processes. Mineral workings that provide additional channel conveyance, flood storage or increases channel length, should have a net downstream benefit on flood risk and water quality.

The most appropriate approach to securing flood mitigation and restoration benefits will vary according to site-specific circumstances and local priorities. In some cases flood risk reduction may be strategically important and a restoration design approach, which maximises reduction of flood risk would be most suitable. This might involve detailed hydraulic design and engineered structures or by replicating natural landforms or processes. In other circumstances improving freshwater biodiversity may be more important than flood reduction. Operational mineral workings and their restoration may be able to facilitate these by providing river restoration schemes which promote natural fluvial and floodplain processes, improve habitat variability and provide additional flood storage. The WMLP will include policies that require proposals to demonstrate that they will secure the betterment of the water environment and enable the above where appropriate.

There are other, quite different, possible flood amelioration benefits from semi-natural habitats. Land that previously absorbed and slowly released rain and floodwater has often been replaced with intensive agricultural land-use and impermeable urban surfaces. As a consequence rain and flood water tend to be diverted into artificial or highly modified and constrained watercourses, which have limited capacity to cope with severe rainfall and flood events. In such cases surface run off is quicker, less controlled and more likely to cause flooding. The number of ponds, wetlands and historic flood meadows and water meadows, which previously helped manage this, have declined and their condition is likely to deteriorate further as a result of climate change. The loss of tree cover is also an important consideration. Water sinks into the soil under trees at 67 times the rate at which it sinks into the soil under grass.[47] The roots of the trees provide channels down which the water flows, deep into the ground. The soil there becomes a sponge, a reservoir that sucks up water and then releases it slowly. Site-specific matters, infiltration and subsoil characteristics, geology and groundwater flow routes will also all play a significant part.

Restored mineral workings may be able to replicate or re-instate some of these semi-natural habitats and features, some of which, such as wet woodland, are biodiversity action plan target habitats and can directly contribute to improved flood control.

Research by GWP consultants for Mineral Industry Research Organisation (April 2011)[48] concludes that any increase in floodplain storage implies a flood reduction benefit; low-level restoration of mineral workings to create flood storage is consequently a feasible and valid strategy and the WMLP will encourage this. There may also be opportunities to design sites restored as agricultural water storage reservoirs and could also contribute to flood storage capacity. The WMLP will include policies to enable these to be secured where appropriate.

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[47] The impact of rural land management changes on soil hydraulic properties and run-off processes: results from experimental plots in upland UK." M.R. Marshall, C.E. Ballard, Z.L. Frogbrook, I. Solloway, N. McIntyre, B. Reynolds and H. S. Wheatear. First published online 19 APR 2013 DOI: 10.1002/hyp.9826 Hydrological Processes, Vol 28 Issue 4 pages 2617-2629 15th February 2014.

[48] GWP consultants for Mineral Industry Research Organisation (April 2011) Restoring quarry voids for flood storage - Quantification of flood risk benefit and practical guidance for planning http://www.sustainableaggregates.com/library/docs/mist/l0006_ma_7_g_1_002b.pdf

6.2 Sustainable Drainage Systems (SuDS)

Sustainable drainage is an approach to control of surface water on developments in order to reduce flood risks to that location and other areas for example having open ponds that capture rainwater and allow it to slowly dissipate into the ground or using soakaways rather than connecting all roof water into a nearby sewer that may be overloaded. There are technically complex versions to this approach including underground storage and various ways to control or hold back water flow but in essence it is about reducing run off from new developments in particular and reducing flood risk to homes, businesses, roads and land.

To realise the greatest improvement, SuDS components should be used in combination, often referred to as the SuDS Management Train. The management train is a hierarchy consisting of three elements

- 'Source Control' within an individual site. Any surface water which cannot be wholly dealt with within the plot would drain to the second element;
- 'Local Control' which would service any need for collective drainage between sites. Any surface water which cannot be wholly dealt with through Local Control would drain to the third element; and
- 'Regional Control' which would service run-off from a large area of development.

The appropriate application of a SuDS scheme to a specific development will be heavily dependent upon the topography and geology of the site (and its surrounds). Careful assessment of the site characteristics must be considered to ensure the future sustainability of the adopted system, guidance on appropriate systems is provided by the Construction Industry Research and Information Association (CIRIA).

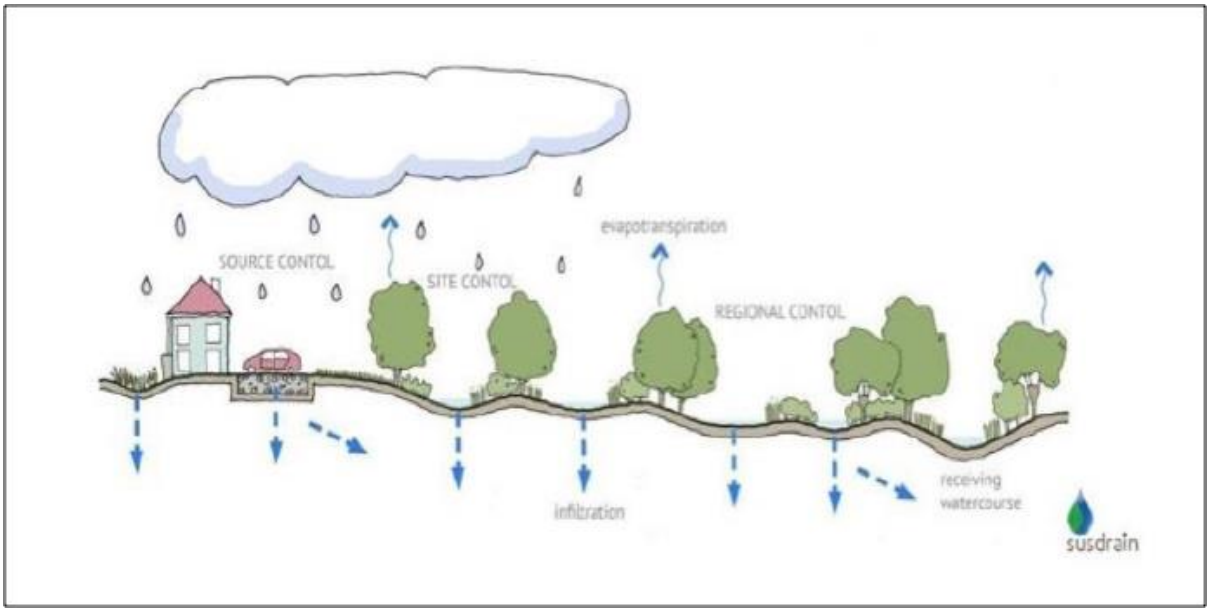

Figure 4 SuDS mimicking nature – Susdrain.

The application of a SuDS scheme to a specific development is heavily dependent upon the topography and geology of the site (and its surrounds). For example, areas overlaying clay geology are likely to be unsuitable for infiltration techniques including soakaways. Similarly, steep slopes are generally unsuitable for SuDS techniques that rely upon flow storage, e.g. ponds and wetlands. Careful consideration of the site characteristics is needed to ensure the future sustainability of the adopted drainage system. There are numerous different ways that SuDS can be incorporated into a development and the most commonly found components of a SuDS system are described in the following table:

Table 11 SuDS Typology

SuDS Type	Description
Pervious surfaces	Surfaces that allow inflow of rainwater into the underlying construction or soil.
Green roofs	Vegetated roofs that reduce the volume and rate off runoff and remove pollution
Filter Drain	Linear drains consisting of trenches filled with a permeable material, often with a perforated pipe in the base of the trench to assist drainage, to store and conduct water; they may also permit infiltration.
Filter strips	Vegetated areas of gently sloping ground designed to drain water evenly off impermeable areas and to filter out silt and other particulates.
Swales and wetlands	Shallow vegetated channels that conduct and retain water, and may also permit infiltration; the vegetation filters particulate matter.
Infiltration devices	Sub-surface structures to promote the infiltration of surface water to ground. They can be trenches, basins and soakaways.
Bio-retention areas	Vegetated areas designed to collect and treat water before discharge via a piped system or infiltration to the ground.

6.3 Water Quality

Water quality refers to the chemical, physical and ecological characteristics of water. The most common standards used to assess water quality relate to the health of ecosystems, safety of human contact and drinking water. Under the EU Water Framework Directive (WFD), water quality classifications are risk-based and focus on where there is likely to be a problem. They use a principle of 'one out, all out', which means that the poorest individual results determine the overall classification.

The WFD classification is based on over 30 measures, grouped into ecological status (including biology and elements such as phosphorus and pH) and chemical status ('priority substances'). The analysis of samples includes monitoring of levels of Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), ammonia, orthophosphate, suspended solids, temperature, conductivity and pH. The emphasis is on achieving good overall ecological status, not just on complying with water quality standards; fish, plant and amphibian and microorganism life are also monitored. The WFD covers estuaries, coastal waters, groundwater and lakes as well as rivers.

Water quality can be significantly affected by other aspects of the water environment, including simply the quantity of water available. Pollution incidents can be magnified by a lower flow level's ability to dilute and treat pollutants, reduced water volumes may be less able to absorb or remediate reductions in quality whatever the cause. It is very likely that future climate change will lead to hotter drier summers, a drop in water levels and reduced oxygenation. The same conditions that make water supplies scarce also have the effect of creating greater demand; crops will need more irrigation, livestock will need more water to stay cool and hydrated.

Water quality can also be adversely affected by flooding which can result in untreated water entering the water course or scour riverbanks and riparian land, increasing sediment levels, affecting natural morphology or requiring works to watercourses such as culverting or re-aligning watercourses.

6.4 Water Quality in Worcestershire[49]

Local level actions and decision making can help secure improvements to the water environment. This is widely known as the 'catchment-based approach' and has been adopted to deliver requirements under the WFD. It seeks to:

[49]Source of WFD Watercourses and status http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683.0&y=355134.0&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=wfd_rivers#x=384022&y=240252&lg=1,7,8,9,5,6,&scale=7

- deliver positive and sustained outcomes for the water environment by promoting a better understanding of the environment at a local level; and
- encourage local collaboration and more transparent decision-making when both planning and delivering activities to improve the water environment.

Water quality issues are important in Worcestershire; for **surface water**, the majority of the 600km of rivers and streams assessed in the county were found to be at medium to high risk of not meeting the WFD objectives in 2015[50]. For **groundwater**, large areas of Bromsgrove and Wyre Forest districts and small parts of Malvern Hills and Wychavon districts have poor groundwater quality; only a very small part of Redditch Boroughs groundwater is poor. Worcestershire has the highest levels of nitrate and phosphate pollutants in the West Midlands. Nitrate Vulnerable Zones cover large areas of the county and a number of Source Protection Zones have been designated in Worcestershire. The principal causes of this pollution are from diffuse (rather than point) sources from land management practices, notably abstractions, inappropriate watercourse management, pollution from pesticides, fertilisers, livestock management and high levels of siltation.

The naturalness of a watercourse may also affect the quality of the water environment. Water quality and quantity are part of this but the physical nature of the watercourse and the extent to which it has been artificially modified is central to this concept. Very few of Worcestershire's watercourses are considered to have "high naturalness". The restoration of mineral workings could be used to enhance, or restore, the naturalness of watercourses, e.g. by creating braided stream beds or adding meanders. The WMLP will encourage such works where appropriate.

The River Severn Catchment Abstraction Management Plan areas in the county are divided into four river catchments; a brief summary of each is set out in Appendix 4: Water Quality in Worcestershire. The WMLP will include policies to ensure that water quality issues are fully addressed when applications for mineral working are considered and that wherever possible water quality in its widest sense is enhanced by mineral development during and after sites are worked and restored.

[50] Environment Agency (2007) *Water for life and livelihoods, River basin planning: summary of significant water management issues. Severn River Basin District. ,*

6.5 Water Quantity and Supply

The Water Act 2003 brought all significant water abstraction under licensing control. Government policy development is still ongoing[51].

Abstractions from rivers and groundwaters for public water supply and to a lesser extent for industry and agriculture impact on river flows and groundwater levels. Many rivers and lakes have been subject to some form of physical modification, which has had negative impacts on habitats and wildlife.

The River Severn Basin Management Plan (2015)[52] expressly sets out the Environment Agency's concerns over maintaining the water resources available for people and the environment. This river basin district relies on groundwater for the majority of its public water supply but the aquifers also need to provide flow for rivers and wetlands. It is therefore essential to safeguard supplies and the environment by protecting groundwater from pollution, and managing the water resource.

6.6 Groundwater

The Environment Agency released a policy for the protection of groundwater "Groundwater Protection: Principles and Practice" (GP3) in November 2012, the Minerals Local Plan will have regard for this policy.

There are 40 groundwater bodies in the Severn River basin district. 25 per cent are identified in the Severn Catchment Management Plan (CMP) as having poor quantitive groundwater status and are not expected to improve during the first plan cycle to 2015, because it takes time for clean

[51]Climate Change Adaptation Committee report – Managing Climate Risks to Well Being and the Economy 2014.
http://www.theccc.org.uk/publication/managing-climate-risks-to-well-being-and-the-economy-asc-progress-report-2014/

[52] River Severn Basin Management Plan (2015)
https://www.gov.uk/government/collections/river-basin-management-plans-2015#severn-river-basin-district-rbmp-2015

recharge water to replenish the aquifers. The majority of the 25 per cent of groundwater bodies at poor quantitative status in the catchment are the principal aquifers used for drinking water and so are under the greatest abstraction pressure. Some groundwater bodies often take decades to recover from the effects of pollution. Concentration of pollutants can continue to rise for years after the pollution sources have been brought under control due to the time it takes for clean recharge water to reach the water table. The CMP identifies a range of actions to prevent deterioration and improve groundwater elements, as well as investigations to improve the confidence in groundwater classification.

Unsustainable abstraction from groundwater bodies can lower groundwater levels and affect dependent springs, base flow to streams and rivers or wetlands, or can induce the intrusion of poorer quality water from deeper aquifers. Reduced flow due to unsustainable abstraction has also been identified as a reason for not achieving good ecological status or potential in some rivers, lakes and estuaries.

Some key actions in the Severn River basin district relate to:

- Catchment Sensitive Farming or other advice led partnerships to address diffuse pollution;
- Designation and enforcement of Nitrate Vulnerable Zones;
- Pollution prevention activities to reduce diffuse pollution entering groundwater;
- Controls on abstraction of water from groundwater bodies; and
- Investigations to better understand the impact of the major groundwater abstractions in the river basin district.

There are Source Protection Zones (SPZ) in Worcestershire. Almost all of the North-West Worcestershire and all but small parts of the North-East Worcestershire Strategic Corridors proposed in the "Third Consultation" on the Minerals Local Plan overlie Groundwater Protection Zones. An assessment of which of the 164 AOS submitted for inclusion in the Plan are over Groundwater Protection Zones is included in Appendix 6. The Plan will include policies to ensure that the potential implications of mineral working on groundwater, particularly on SPZ are properly assessed when applications to work minerals are submitted. It will also include specific ground water related requirements for sites/corridors where possible.

Quarrying is an activity which can physically remove an aquifer and the usable groundwater resources contained within aquifers which may lead to impacts on the water environment as groundwater flows can alter, especially if watercourses derive base flows from this same source of groundwater or wetlands rely on this water for their existence. The natural baseline conditions can change significantly from quarrying activities, so assessments (EIA, quantitative Hydrogeological Impact Assessments) will need to be robust and where appropriate mitigation applied to reduce any risks to the water environment to a minimum to allow the development to take place (at the site specific stage). Only where Hydrological Impact Assessments are undertaken will the risk and indeed the appropriateness of development be clear, this will also impact on the quantum of won material.

It is the Environment Agency's advice that Hydrogeological Impact Assessments should be submitted as part of applications for planning permission to assess the potential effects of dewatering operations near to sensitive water resources receptors. The Environment Agency considers that groundwater level monitoring of such dewatering activities from onsite (and sometimes offsite) groundwater monitoring networks is vital to this understanding pre, during and post quarrying operations to provide an early warning should dewatering have a detrimental impact on water resources.

The role of the HIA is to identify any water features within a designated radius of the development site (via a water features survey) and then assess the full potential of any quantitative impacts and risks on the water environment which could take place from the activity of quarrying, notably from any dewatering pumping activities within excavations which has a zone of influence within the aquifer environment. We would recommend that an appropriately qualified hydrogeological consultant undertakes this specialist HIA assessment work which is provided in a lines of evidence approach to demonstrate any risks from the development proposal including the significance of the risk and whether it can be mitigated against to enable development.[53]

[53] The Environment Agency's summary guidance on assessing the impact of dewatering on water resources:
http://a0768b4a8a31e106d8b050dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/scho0407bmaf-e-e.pdf
And Hydrogeological impact appraisal for dewatering abstractions, PDF 204 pages, can be found at:

Alteration of groundwater flow and groundwater pathways must also be taken into account in addition to assessments of the reduction of aquifer storage. Impacts from these physical elements will affect other groundwater dependant environmental features (including surface water courses).

A few sites are located in sensitive hydraulic settings; being in Source Protection Zones (SPZs). This does not necessarily preclude mineral workings but it is a constraint that resultant Hydrological Impact Assessments will have to closely focus on. Environment Agency Groundwater Protection: Principles and Practice (GP3) policy provides guidance on the implications and limitations on SPZs.[54]

The quality of the rock/strata as an aquifer is hierarchical:

1) Principal
2) Secondary A
3) Secondary B
4) Secondary (undifferentiated)
5) Unproductive

However, it is not just dewatering that has an impact. Restoration and infilling in whole or in part using site won overburden materials or quarry waste, silt from washing plants, or imported material usually means the void is in-filled with materials of different permeability to that extracted (usually lower permeability). Below the water table this can cause a "dam" like feature in the aquifer impeding groundwater flow. Groundwater levels up-gradient can rise causing groundwater flooding or waterlogging, while those down-gradient can fall, affecting spring and stream flows. These impacts should be considered in site specific EIA or Hydrological Impact Assessments.

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https://www.gov.uk/government/publications/hydrogeological-impact-appraisal-for-dewatering-abstractions

[54]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/297347/LIT_7660_9a3742.pdf

In most applications for new extraction or extensions the Environment Agency also requires a long period of groundwater, surface water, and river and stream flow monitoring before consent in order to inform the Hydrological Impact Assessment and any predictive modelling work included in the Hydrological Impact Assessment. Sometimes this can be one or two years in order to establish a baseline through the seasons. Monitoring includes ground and surface water level monitoring, surface water flow measurement, and sampling and lab testing for water quality. As such long term monitoring plans with periodic monitoring reports submitted to the mineral planning authority or Environment Agency, regular reviews of actual against predicted and revisions of the Hydrological Impact Assessment are a feature of most planning permissions or environmental permits.

The Environment Agency recommends that an appropriately qualified hydrogeological consultant should undertake this specialist HIA assessment work which is provided in a lines of evidence approach to demonstrate any risks from the development proposal including the significance of the risk and whether it can be mitigated against to enable development.

The WMLP will ensure that adequate monitoring is put in place to enable effective resource management, pollution prevention and flood risk reduction over the lifetime of mineral workings. Mineral operations can have far reaching effects on water catchments and must be investigated and confirmed prior to any grant of planning permission. Site-specific impact boundaries rather than arbitrary defined distances may be a useful way to develop effective risk reduction strategies and mitigation measures.

6.7 Private Water Supplies

The planning system does not exist to protect the private interests of one person against the activities of another, although private interests may coincide with the public interest in some cases. It can be difficult to distinguish between public and private interests, but this may be necessary on occasion. The basic question is not whether owners and occupiers of neighbouring properties would experience financial or other loss from a particular development, but whether the proposal would unacceptably affect amenities and the existing use of land and buildings, which ought to be protected in the public interest. The WMLP will include policies to require hydrogeological monitoring where appropriate around application sites to assess the implications

of any proposals on private water supplies but these matters may ultimately be private, civil, matters for the parties to resolve, which are of very little material weight to the consideration of any specific proposal. Many operators will have experience of managing private water supplies or providing alternative supplies to those affected.

6.8 Water Levels and Flows in Worcestershire

Water levels and flows have to be taken into account as part of WFD assessments and therefore as part of the Minerals Local Plan. The quantity and natural flow of water systems directly affects their quality, biodiversity, the riparian landscape and the availability of supply for all kinds of users. Both shortages and flooding can create problems for all of these. Parts of the Severn catchment are underlain by Permo-Triassic sandstone and Jurassic limestone, which provide major aquifers to the Environment Agency Severn West area. These aquifers are used for domestic, agricultural and industrial purposes and are regionally significant for public water supply. The WMLP policies will ensure that the issues are properly assessed when applications for planning permission to work minerals are submitted.

The EA has low flow alleviation schemes for catchments known to be prone to low flows. In Worcestershire these include the Weir Brook, Blakedown Brook, Battlefield Brook, Hadley Brook, Bow Brook, Glynch Brook and River Teme. Most of these designations are as a result of excessive abstraction. Watercourses do however naturally respond to dry conditions and without sufficient rainfall will decline or even dry up entirely, examples can be seen on the River Teme, between Knighton and Leintwardine; although upstream of the Worcestershire boundary such reduced flows will affect the Teme within the county. None of these watercourses are within any of the sites submitted for inclusion in the Plan but the following are least partly within the Strategic Corridors proposed in the Plan:

Table 12 Strategic Corridors and tributaries with low flows

Strategic Corridor	Watercourse identified as having low flows
Avon and Carrant Brook Corridor	Bow Brook
North-East Worcestershire Corridor	Battlefield Brook
North-West Worcestershire Corridor	Blakedown Brook
Salwarpe Tributaries Corridor	Battlefield Brook

Mineral workings may provide an opportunity to enhance / regulate flows using water pumped out during dewatering or by using quarry voids for storage. Whilst none of these watercourses flows through or immediately adjoins any of the submitted sites there is a potential role for the WMLP to support the replenishment of these watercourses during operation and restoration of sites.

Worcestershire is currently a moderate area for water stress. The Catchment Abstraction Management Strategy (CAMS)[55] resource availability maps for Worcestershire demonstrate that most of the county has no water availability status, meaning that in theory no water is available for further licensing at low flows. Areas that are over abstracted, meaning existing abstraction is causing unacceptable environmental impacts at low flows, can be found in the north and centre of the county. A small area on the southern boundary of the County is over licensed, which means the current actual abstraction is resulting in 'No Water Available' at low flows and if all licences were used to their full allocation they could cause unacceptable damage to the environment during low flow periods. Water may still however be available for abstraction at high flows with appropriate restrictions. A very small area in the north east of the county has water available although restrictions may still apply. New water resources, treatment and distribution infrastructure will be required in future to serve projected housing growth rates.

[55] River Severn Corridor Abstraction Licensing Strategy https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291406/LIT_7848_c0b50e.pdf

Abstraction of water for public water supplies in Worcestershire[56] is already having detrimental impacts on biodiversity; lowland wet meadows in the county are already under serious threat. The unsustainable abstraction of groundwater has caused many problems in the North Worcestershire area and as a result a number of these water bodies are supported by compensatory water drawn from groundwater. Without this, some stream reaches would cease to flow and some pools would disappear in periods of low flow. Important wetland habitats in Redditch and Kidderminster have already been lost to development. The WMLP will ensure that these problems are not worsened. In most cases however water abstracted for use in mineral processing plants is returned to its source in almost identical quantities[57] to those abstracted. Once cleaned (often by discharging suspended material to a silt pond) water from mineral workings can be discharged to return to wherever is necessary. Both abstraction and discharges are controlled by Environment Agency licences or permits; the WMLP will include policies to ensure that, where appropriate within the concept of "development" the quality and quantity of recharged water is protected. This will ensure that the flows are maintained at current levels and where possible through storage contribute to improved flows.

There is a major drinking water extraction point on the river Severn in Worcestershire at Trimpley. Severn Trent Water Ltd (STWL) and South Staffordshire Water PLC (SSW) have identified sites on the river where they might need to apply for drought permits to increase abstraction during periods of low flow, including a site at Trimpley where a drought permit might be needed to maintain public water supply to Birmingham. The company's decision whether or not to apply for the permit will depend on water resource availability in the River Severn and Elan Valley reservoirs at the time and if their abstraction at Trimpley is restricted due to River Severn regulation. The WMLP will ensure that future mineral working does not compromise the flow of water to these water extractions or Trimpley reservoir and to include monitoring mechanisms to ensure that the implications of any changes[58] to these arrangements can be taken into account. None of the

[56] The Midlands Drought Plan (2012) http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_8460_d5a116.pdf

[57] There can be a minute loss of quantity where water is retained in damp processed material.

[58] Severn Trent Water's STWLs new water resource management plan, for example, envisages shutting down the use of aquifers in Bromsgrove and Malvern, the potential increase of

proposed Strategic Corridors or Specific Sites for development are within the area covered by the drought permit.

Issues are potentially wide scale however, not limited to the boundaries of any particular application. SSW for example has identified a site at Hampton Loade (Shropshire) where a drought permit might be needed to maintain public water supplies to their supply area. The company's decision whether or not to apply for the permit will depend on water resource availability at the time and if their abstraction at Hampton Loade is restricted due to River Severn regulation. Although the site is in Shropshire restrictions on water flows to supply this reservoir could adversely affect flows in Worcestershire.

The Environment Agency has stated that in undertaking its statutory duties they have to balance the competing interests of the river environment, water companies, agriculture, industry and navigation interests. During a severe drought, this balance would become increasingly more difficult to manage and that in this situation they will give priority to ensuring that essential public water supplies can be met, whilst working together with water companies to minimise the effects of any resulting environmental damage.[59]

The EA's Abstraction policies for the catchments in Worcestershire are summarised in more detail in Appendix 4 (Summary of Environment Agency Catchment Abstraction Management Plans for catchments in Worcestershire).

6.9 Summary: Possible implications of mineral working on water quality and quantity, adverse effects:

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abstraction at Trimpley, the possibility of re-applying for abstraction at Ombersley and the introduction of a pipeline to take flows from Trimpley to Malvern. All of which would be subject to OFWAT approval. http://www.severntrent.com/future/future-plans-and-strategy/water-resources-management-plan

[59] Environment Agency. Midlands Drought Plan 2012 page 214 (2012) http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_8460_d5a116.pdf

Mineral working has the potential to affect water quality and quantity both during operations and after restoration. The potential adverse effects on water quality and quantity are closely related, e.g. reductions in water quantity may directly affect its quality and changes in water quality may directly affect the quantity available for any particular use. The potential adverse effects on both quality and quantity are therefore addressed together in this section. The potential beneficial effects are similarly addressed together below. A balance needs to be maintained between meeting the need for minerals, ensuring no significant harm is caused to the environment and ensuring that waters are protected, particularly from pollution. The WMLP will consider how these effects and those set out below can be managed to ensure that any adverse effects are kept to acceptable levels and that any benefits can be maximised.

The major raw materials of the minerals industry often come from land that overlies or extends into principal and secondary aquifers; there are therefore potential conflicts of interest between the need to supply minerals and protect both water quality and quantity; drinking water supply, river flows and wetland ecosystems are particularly vulnerable to these effects.

Workings can physically disturb aquifers by removing the rock, which makes up the aquifer where groundwater is stored. They can also lower groundwater levels, affect groundwater quality or impede or intercept groundwater flow. Mining and quarrying activities often involve dewatering, sometimes for substantial periods of time over the lifetime of the quarry. Such dewatering can lead to the loss of water supply from wells and boreholes, the removal of natural groundwater discharges to ponds and streams and drying or deterioration of wetland ecosystems. The groundwater table may in some cases be permanently lowered, leading to irretrievable reduction or loss of spring and stream flows. All of these may require protection or for any loss to be mitigated.

Mineral workings can also cause problems by draining groundwater from an aquifer, diverting groundwater flows that support the wider environment, or by connecting what were originally separate aquifers. These types of issues can be subject to planning control. Water resources within groundwater Source Protection Zones defined by the Environment Agency for groundwater abstractions, notably public drinking water supplies, need particular protection. It is essential that water resources are appropriately protected from mineral workings and related developments so that the aquifers can operate sustainably as a water resource.

Whether water can be abstracted to supply mineral development or dewatered to enable mineral working depends on what water resources are available within a catchment and where abstraction for consumptive purposes is allowed. The EA has developed a classification system, which indicates:

- The relative balance between the environmental requirements for water and how much is licensed for abstraction;
- Whether water is available for further abstraction;
- And areas where abstraction may need to be reduced.

Mineral extraction can leave large void spaces, which can have significant effects on reducing not only the quantity but also the quality of groundwater. Restoration proposals need to have regard to this from the outset; back-filling voids in particular can have a detrimental effect on aquifers.

Any proposals to restore mineral voids using infilling could not only potentially pollute ground and surface waters but could also alter the ground profile of large areas and local drainage networks, potentially increasing flood risk elsewhere. In such cases an FRA including Hydrogeological Impact Assessments will need to be carried out (and the Sequential and Exception Test as appropriate) that will identify these issues and how they are to be addressed. It is national policy that developers should carry out an FRA when submitting planning applications for proposals in Flood Zones 2 and 3 and for sites in Flood Zone 1 over 1 HA.

There is also a risk that mineral workings can cause surface water pollution during the construction phase if appropriate management measures are not put in place.

During the operational phase other potential problems mineral workings could cause include

- Harm from hazardous substances, (oils and fuels) specific (metals) and non-hazardous pollutants including sediment to water quality,
- The physical modification of water bodies, (e.g. culverting watercourses for access or through delivering hard flood defences to mitigate flood risk, increasing sediment deposition or new outfalls for surface drainage). These can change the morphology of watercourses locally if not

carefully implemented and adversely affect the natural flow of watercourses and the habitats they provide,

- Building processing plant or storage areas on flood plains or river corridors reducing the ability of watercourses to cope with diffuse pollution and respond to flood events.

6.10 Summary: Possible implications of mineral working and restoration on water quality and quantity, beneficial effects.

As discussed above, water quality and quantity are often closely related and the potential beneficial effects on water quality and quantity are similarly addressed together in this section.

It is often possible to achieve multi-functional benefits at the same site which benefit both water quality and quantity, for example, river restoration, BAP habitat creation, flood attenuation and sustainable drainage (SUDS) can all significantly benefit water quality (through increased aeration and the biodiversity value of watercourses); physically changing, deculverting, restoring or re-profiling the morphology of watercourses as part of mineral workings or site restoration can benefit its quantity (through changing water flows, creating more natural conditions and new habitats and promoting flood risk management).

Mineral workings are often ideal sites for wetland and river restoration. Notable examples of new approaches to how these can be achieved are

- Encouraging mineral working within the flood plain of the Tame Valley in northern Warwickshire and southern Staffordshire, to enable both river restoration and enable additional mineral reserves to be worked which would otherwise have been sterilised and
- The "Slowing the Flow at Pickering"[60] project, a new approach to flood management to work with natural processes to help reduce the risk of flooding in a single river catchment. The project incorporated a range of elements (such as tree planting) all of which could be implemented as part of the restoration of a mineral working in a floodplain and demonstrates that the public benefits from this kind of approach well outweighed the costs.

[60] http://www.forestry.gov.uk/fr/INFD-7ZUCQY

- Nationally many species have directly benefited from more conventional mineral site restoration schemes; over 700 SSSIs have been designated on former mineral workings in England and recent research by the RSPB[61] indicates that mineral sites could meet 100% of the targets for nine out of 11 priority habitats in the UK Biodiversity Action Plan. The Mineral Products Association states that its members planted 17.64km of hedgerows in 2010 and, over the past 5 years have planted a million trees.

Other potential benefits include:

- Integrating sustainable drainage (SuDS) into new developments, to reduce flood risk, improve water quality by reducing levels of pollutants reaching watercourses (e.g. via filter strips) and provide biodiversity,
- Amenity benefits, which may include health, recreational and tourism gains,
- Adopting water efficiency measures as part of sustainable construction approaches in designing and constructing site buildings, reducing demands on local water resources,
- Integrating multi-functional green infrastructure into new developments,
- Creating new water storage areas which might link to horticultural or food production businesses,
- Cleaning up contaminated land from which pollutants previously seeped into groundwater and surface waters and
- Climate change adaptation benefits.

These improvements can enhance the attractiveness of an area, as well as contributing to local area and community regeneration.

Mineral workings are also one of the commonest ways of discovering new sites of geological and geomorphological importance. The latter in particular, can include water related features. Many such earth heritage features have been designated SSSIs or Sites of local Nature Conservation Importance (Local Geological Sites).

Potential climate change benefits include

- Reducing the causes of and impacts from flooding, e.g. by restoring sites to promote natural fluvial and floodplain processes

[61] http://www.rspb.org.uk/Images/natureaftermineralsreport2_tcm9-135675.pdf

- Improving habitat condition and variation and by creating habitats that are resilient to climate change and by linking existing sites and corridors to aid the dispersal of species and
- Improving water quality by increasing flow variation to aerate water and by slowing the flow of water to increase sedimentation.

The concept of Green Infrastructure recognises that any particular landscape can be multi-functional. The WMLP will include policies to ensure that site working and restoration maximises these functions but not all will be possible or of equal priority. The most appropriate approach will depend on site-specific circumstances and local priorities. A restoration design which maximises the reduction of flood risk might, in some circumstances be most effective through detailed hydraulic design and engineered structures, in other circumstances, improving freshwater biodiversity may be more important and a site restoration that promotes natural fluvial and floodplain processes, habitat variability and additional flood storage may be more desirable.[62]

6.11 Water quality and quantity considerations for mineral working in Worcestershire

Water quality and quantity are often closely related to flood management issues. The Environment Agency's **Severn River Basin District – river basin management plan 2015** combines elements of both, for each of the catchment Policy Units. It includes maps of current water status and specific key ecological actions relating to pollution reduction and sewerage management as well as abstraction. In Worcestershire the catchment policy units are

- Teme; (Malvern Hills District)
- Worcestershire Middle Severn; (Wyre Forest District, Worcester City, Bromsgrove District and Wychavon District)
- Severn Vale; (Malvern Hills District)
- Warwickshire Avon; (Wychavon, Redditch and Bromsgrove Districts)

The details are summarised in Appendix 5. Those potentially actionable by the WMLP include:

[62] GWP consultants for Mineral Industry Research Organisation (April 2011) Restoring quarry voids for flood storage - Quantification of flood risk benefit and practical guidance for planning http://www.sustainableaggregates.com/library/docs/mist/l0006_ma_7_g_1_002b.pdf

- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme,
- Encourage farmers and industry to build storage reservoirs to support or replace summer irrigation.

The updated Severn River Basin District Flood Risk Management Plan 2015-2021 sets out possible measures[63] to improve the catchments[64] in Worcestershire. The Strategic Corridors are within one or more of the following catchments:

- Severn Middle Worcestershire: Severn River Worcestershire and Stour River Tributaries Catchments, (North West Worcestershire Strategic Corridor - this Corridor also overlaps the Sandstone operational groundwater catchment)
- Severn Middle Worcestershire: Stour River Tributaries Catchment, and Salwarpe Catchment (North East Worcestershire Strategic Corridor - this Corridor also overlaps the Sandstone operational groundwater catchment, and Salwarpe Tributaries Strategic Corridor)
- Severn Vale: Severn River and Tributaries catchment (Lower Severn Strategic Corridor)
- Severn Vale: Malvern Hills and Bushley, Longdon, Marlbrook, Ripple Brook catchments (Malvern Hills Strategic Corridor)
- Avon Warwickshire: Avon Rural[65] and Avon Midlands West Catchments (Avon and Carrant Brook Strategic Corridor) (and Bredon Hill Corridor) and
- None of the Strategic Corridors are in the Teme; Lower Operational catchment.

In summary most of the proposals in the plan lie within the Environment Agency's remit and all are material planning considerations in the determination of applications

- Develop and implement nutrient management plans, for example on the Wye,
- Mitigate/remediate diffuse pollution impacts on the receptor.

[63] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/507832/LIT_10213_SEVERN_FRMP_PART_A.pdf

[64] http://environment.data.gov.uk/catchment-planning/RiverBasinDistrict/9

[65] NB, only a very small part of Worcestershire is in this catchment

- *Managing invasive non-native species*
- Early detection, monitoring and rapid response (to reduce the risk of establishment) and
- Mitigation, control and eradication (to reduce extent)

Where mineral sites are close to watercourses the WMLP could on a site by site and cumulatively contribute something to the following:

Improve modified physical habitats

- Improvements to condition of channel/bed and/or banks/shoreline (through appropriate site restoration) and
- Improvements to condition of riparian zone (through appropriate site restoration).

Improve the natural flow and level of water

- Water demand management (through restoring sites to create water storage) and
- Use alternative source/relocate abstraction or discharge points (through creating new discharges into watercourses) and

Manage pollution from rural areas

- Mitigate/remediate diffuse pollution impacts on the receptor (through creating swales/reedbeds between existing minor watercourses and larger ones).

There is potential for the restoration of future mineral workings in the catchments identified below and to contribute toward achieving some of the EA's proposed improvement

Table 13 MLP Strategic Corridors and their relationship with the Environment Agency's proposed catchments

MLP "Third Consultation" Proposed Strategic Corridor	WFD watercourses within MLP Strategic Corridor	EA updated RBMP Management catchment	EA updated RBMP Operational Catchments
North West Worcestershire Corridor	• Dakelow Bk - source to conf R Stour • R Stour (Worcs) - conf Smestow Bk to conf R Severn • Stourbridge Canal to River Severn • Blakedown Bk - source to con R Stour • Hoo Bk - source to conf R Stour • R Severn - conf R Worfe to conf R Stour • Gladder Bk - source to conf R Severn • R Severn - conf R Stour to conf River Teme (8 watercourses)	Severn Middle Worcestershire	Stour River and Tributaries. Some of the proposed MLP Strategic Corridor (small area around Stourport) is also in the River Severn Worcestershire Catchment.

MLP "Third Consultation" Proposed Strategic Corridor	WFD watercourses within MLP Strategic Corridor	EA updated RBMP Management catchment	EA updated RBMP Operational Catchments
North East Worcestershire Corridor	• Battlefield Bk - source to conf Spadesbourne Bk • R Arrow - source to Spernell HallFm, Studley • Spadesbourne Bk - source to conf Battlefield Bk (3 watercourses)	Worcestershire Middle Severn	River Salwarpe A small area northwest of Fairfield) is also in the Stour River and Tributaries catchment. The Stour River and Tributaries catchment in this area also includes part of the Sandstone Operational (groundwater) Catchment.
Lower Severn Corridor	• R Severn - conf R Teme to conf R Avon • Careys Bk - source to conf R Severn • Madresfield Bk - source to conf R Severn • Pool Bk - conf Mere Bk to conf R Severn • Bushley Bk - conf MarlBank Bk to conf R Severn	Severn Vale	Severn River and Tributaries Catchment.

MLP "Third Consultation" Proposed Strategic Corridor	WFD watercourses within MLP Strategic Corridor	EA updated RBMP Management catchment	EA updated RBMP Operational Catchments
	• Ripple Bk - source to conf R Severn (6 watercourses)		
Avon and Carrant Brook Corridor	• R Avon conf Workman Br, Evesham to conf R Severn • Bourne Bk - source to conf R Avon • Mary Bk - source to conf R Avon • Bow Bk - Shell to conf R Avon • Elmely Castle - source to conf R Avon • R Isborne - conf Laverton Bk to conf R Avon • R Avon -Tramway Br Stratford to	Avon Warwickshire	Avon Midlands West Catchment. Some of the corridor (a very small area, north east of Evesham) is in the Avon Rural catchment.

MLP "Third Consultation" Proposed Strategic Corridor	WFD watercourses within MLP Strategic Corridor	EA updated RBMP Management catchment	EA updated RBMP Operational Catchments
	Workman Br Evesham • Badsey Bk - conf Bretforton Bk to conf R Avon • Unnamed trib - source to con R Avon • Carrant Bk - conf Washbourne Bk to conf R Avon • Carrant BK - source to conf Washbourne Bk (11 watercourses)		
Salwarpe Tributaries Corridor	• Hadley Bk, source to conf R Salwarpe • Elmbridge Bk, source to conf R Salwarpe • Battlefield Bk, source to conf Spadesbourne Bk • Spadesbourne Bk source to conf Battlefield Bk • Salwarpe source to conf Elmbridge Bk	Worcestershire Middle Severn	Salwarpe Operational Catchment

MLP "Third Consultation" Proposed Strategic Corridor	WFD watercourses within MLP Strategic Corridor	EA updated RBMP Management catchment	EA updated RBMP Operational Catchments
	(5 watercourses)		

Many of the AOS include a water body defined as a watercourse in the terms of the Water Framework Directive (WFD) this is not to be unexpected at the strategic level of assessment. In practice current, operational and restored landforms will condition whether surface water connections exist between these sites and WFD designated watercourses. At present however the council does not have sufficient detail about if and how any mineral workings on these sites might influence or affect watercourses outside them. These matters will need to be addressed in site specific FRAs for every site. At this stage of the Plan development however the potential connection has been identified to draw attention to potential effects and the need to take account of them in the Plan.

All of these watercourses have been identified by the Environment Agency as having specific water quality or quantity issues. The WMLP will include policies to ensure that assessments are required of the potential effects of mineral working within these sites, which might affect the quality or quantity of all ground and surface waters before applications are determined. The WMLP will also ensure that the specific issues identified in connection with the watercourses are also addressed and where possible enhanced.

Table 14 - Summary of AOS with Watercourses WFD Status

Strategic Corridor	AOS Mineral Resource	Watercourse WFD Status			
		Good	Moderate	Poor	Bad
Lower Severn Corridor	Brick Clay	-	-	-	-
	Solid Sand /Sand &	-	-	-	-

	Gravel				
	Terrace Glacial Sand & Gravel	-	☑	☑	-
	Building Stone	-	-	-	-
	Silica Sand	-	-	-	-
North-West Worcestershire	Brick Clay	-	-	-	-
	Solid Sand /Sand & Gravel	☑	☑	☑	☑
	Terrace Glacial Sand & Gravel	☑	☑	☑	
	Building Stone	-	-	-	-
	Silica Sand	☑	☑	☑	
North-East Worcestershire	Brick Clay	-	-	-	-
	Solid Sand /Sand & Gravel	-	☑	☑	-
	Terrace Glacial Sand & Gravel	-	☑	-	-
	Building Stone	-	-	-	-
	Silica Sand	-	☑	-	-
Salwarpe Tributaries	Brick Clay	-	☑	☑	-
	Solid Sand /Sand & Gravel	-	-	-	-
	Terrace Glacial Sand & Gravel	-	-	☑	-
	Building Stone	-	-	☑	-
	Silica Sand	-	-	-	-
Avon & Carrant Brook	Brick Clay	-	☑	-	-
	Solid Sand Sand Gravel	-	-	-	-

	Terrace Glacial Sand & Gravel	-	☑	☑	-
	Building Stone	-	-	-	-
	Silica Sand	-	-	-	-

The WMLP will include policies that ensure that the issues relating to the water environment are properly addressed and that where possible these watercourses are enhanced to meet the Environment Agency's proposals above. These issues are predominantly related to the protection of surface water but the WMLP will also need to expressly protect groundwater.

6.11a Catchment Based Management in Worcestershire (Technical Background Document) 2018

The Catchment Based Management in Worcestershire (Technical Background Document) has been previously discussed (chapter 4) in relation to flood risk management.

In terms of water quality, consideration has been given to the WFD overall status, the risk of deterioration and the presence of EU Natura 2000 (N2K) designated sites or drinking water protected areas. Based on these considerations, the catchments have been ranked as follows

- LOW RISK- WFD good status or lower but the WFD objective has been met
- MEDIUM RISK- WFD status is less than good status and the WFD objective has not been met.
- HIGH RISK- WFD status is less than good status, there is a risk of or actual deterioration OR the catchment includes an at risk N2K water related site or Drinking Water Protected Area.

However, it is important to note that the assessment of risk differs and it is necessary to review both elements e.g. flood risk and WFD status independently in order to gain a complete picture of catchment risk and relevant management measures. For example, a catchment may be low risk in terms of flood risk but high risk for water quality or vice versa.

The aim is for the mapping tool to be used as the basis for encouraging proactive engagement between developers and both the County Council, as the Lead Local Flood Authority, and the Environment Agency, to identify and assist the appropriate delivery of multifunctional flood risk management infrastructure to achieve betterment.

A summary of the Strategic Corridors and WFD evidence is set out below

Avon and Carrant Brook Strategic Corridor

In terms of WFD 8 of watercourses in the corridor are considered as Medium priority as they are not meeting their 2026 objective of Good Ecological Status (GES), 1 watercourse currently meets GES and is therefore Low priority. Actions required for some watercourses to meet GES have been assessed as either not technically feasible or non-cost beneficial. In these cases an alternative objective has been set. The remaining 2 watercourses fall within this category and are considered as a Low priority as detailed in the Severn River Basin District Management Plan.

Lower Severn Strategic Corridor

In terms of WFD, 1 watercourse is considered to be a High priority as it designated as a Drinking Water Protected Area, 7 of watercourses in the corridor are considered as Medium priority as they are not meeting their 2026 objective of Good Ecological Status. Actions required for some watercourses to meet GES have been assesses as either not technically feasible or non-cost beneficial. In these cases an alternative objective has been set. The remaining 2 watercourses fall within this category and are considered as a Low priority as they are meeting this alternative objective as detailed in the Severn River Basin District Management Plan.

North East Worcestershire Strategic Corridor

The Water Framework Directive (WFD) requires all watercourses to meet Good Ecological Status (GES) by 2021. Currently 7 of watercourses in the corridor are considered as Medium priority, i.e. they are not meeting their 2026 objective. Actions required for some watercourses to meet GES have been assessed as either not technically feasible or non-cost beneficial. In these cases an alternative objective has been set. The remaining 3 watercourses fall within this category and are considered as Low priority as they are meeting this alternative objective, as detailed in the Severn River Basin District Management Plan.

North West Worcestershire Strategic Corridor

In terms of WFD, 1 watercourse is considered to be a High priority as it has deteriorated in WFD status. 6 of the watercourses in the corridor are considered as Medium priority as they are not meeting their 2026 objective of Good Ecological Status. Actions required for some watercourses to meet GES have been assessed as either technically feasible or non-cost beneficial. In these cases an alternative objective has been set. The remaining 1 watercourse falls within this category and are considered as a Low priority as they are meeting this alternative objective, as detailed in the Severn River Basin District Management Plan.

Salwarpe Tributaries Corridor

In terms of WFD, 1 watercourse is considered to be a High priority as it has deteriorated in WFD status. 9 of the watercourses in the corridor are considered as Medium priority as they are not meeting their 2026 objective of Good Ecological Status. Actions required for some watercourses to meet GES have been assessed as either not technically feasible or non- cost beneficial. In these cases an alternative objective has been set. The remaining watercourse falls within this category and is considered as a Low priority as it is meeting this alternative objective, as detailed in the Severn River Basin District Management Plan.

6.12 Groundwater issues and Source Protection Zones

Ninety-nine of the AOS overlie a Source Protection Zone almost all of which are located in the North-West Worcestershire and North-East Worcestershire Strategic Corridors. This does not necessarily preclude mineral workings but it is a constraint that resultant Hydrological Impact Assessments will have to closely focus on. Table 15 includes a summary of the strategic corridors and AOS that overlay the SPZ's.

Harmful effects on groundwater quality are also possible from flood storage created from mineral workings as well as the method of minerals extraction. Flood water retained in quarry voids may contain high pollutant loads, risking the degradation of water quality within aquifers through infiltration. It is however impossible to quantify risks to groundwater generically, the WMLP will include policies to ensure that the appropriate assessments are made on a site-by-site basis by the applicants. This will assist the mineral planning authority and the Environment Agency to assess where proposals which might cause such effects may be inadvisable, or where some monitoring should be undertaken before proceeding.

The WMLP will include generic policies to ensure that the issues relating to the Environment Agency's policies towards groundwater generally and source protection zones in particular, are properly addressed and that where possible these watercourses are enhanced to meet the Environment Agency's proposals above.

The WMLP will also ensure that the issues relating to mineral development also address the need to protect and enhance specific source protection zones. Ninety-eight of the 164 AOS overlie a defined source protection zone.

Table 15 - Summary of AOS Overlaying Source Protection Zones

Strategic Corridor	AOS Mineral Resource	Number of AOS overlaying a SPZ
Lower Severn	Brick Clay	0
	Solid Sand /Sand & Gravel	n/a
	Terrace Glacial Sand & Gravel	0

	Building Stone	n/a
	Silica Sand	n/a
North-West Worcestershire	Brick Clay	n/a
	Solid Sand /Sand & Gravel	16
	Terrace Glacial Sand & Gravel	8
	Building Stone	3
	Silica Sand	12
North-East Worcestershire	Brick Clay	2
	Solid Sand /Sand & Gravel	11
	Terrace Glacial Sand & Gravel	17
	Building Stone	1
	Silica Sand	23
Salwarpe Tributaries	Brick Clay	1
	Solid Sand /Sand & Gravel	n/a
	Terrace Glacial Sand & Gravel	0
	Building Stone	4
	Silica Sand	0
Avon & Carrant Brook Corridor	Brick Clay	0
	Solid Sand /Sand & Gravel	n/a

	Terrace Glacial Sand & Gravel	0
	Building Stone	n/a
	Silica Sand	n/a
		Total 99

7 Issues to be developed in the WMLP

The assessments made in this report are based on evidence from the SFRAs completed to date in the County, the Worcestershire Local Flood Risk Management Strategy and Worcestershire Surface Water Management Plan, the Environment Agency Flood Risk Maps and assessments of the quality and quantity of surface and groundwaters in the county. These are considered enough to identify the broad issues that need to be considered to inform the policies, the priorities for the Strategic Corridors and the potential allocation of specific sites in the "Third Consultation" for the Minerals Local Plan.

Because the Council has very little detail about the nature, depth and extent of the workings likely to be developed through the Plan, or how they might be restored, it is not able to assess their implications for the water environment generally and for flooding, quality and quantity of surface and groundwater in any detail. At this stage of the Plan's development it also seems likely that the Minerals Local Plan will not be able to allocate enough sites to meet the predicted need for minerals over the life of the Plan. It will therefore need to include policies to assess applications for sites as they come forward, including

- Any implications on nationally and internationally protected, sites, species and habitats,
- The likelihood, extent and implications of proposed mineral workings on the quality and quantity of ground and surface waters,
- The implications for flood risk both up and down stream of the site,
- Pollution issues on or off site, including any effects on the WFD status of some of watercourses,
- That the quality and quantity of surface and groundwater is properly assessed and protected,
- How site restorations could benefit flood alleviation and/or Water Framework Directive projects
- To include how the sequential and exception tests should be applied,
- To monitor the appropriateness and effectiveness of the Plan's policies as circumstances and other policies change,
- To maintain a balance between meeting the need for minerals and ensuring no unacceptable level of harm is caused to the wider environment,
- To ensure that all processing and associated development are not located within Flood Zone 3b,
- To support and implement the Local Flood Risk Management Strategy and Surface Water Management Plan

- To set out the circumstances where applicants will need to submit a site specific FRA and what it should contain,
- Clarify roles and responsibilities regarding the protection of Private Water Supplies and
- Set out how the plan will be flexible to accommodate changes in flood risk data.

The Plan will also need to ensure that, at the least, sites can be developed

- Safely with regard to flood risk and water management
- Without increasing flood risk on- or off-site,
- Take account of existing flood defences,
- Without creating pollution risk or harm to the quality and quantity of surface and groundwater
- Without causing unacceptable harm to amenity, water ecology, habitats, sites or species of acknowledged importance,
- To implement the Green Infrastructure Strategy for Worcestershire, so far as is possible, and
- To generate betterment for the water (and wider) environment in all its forms,
- So the Plan will include monitoring indicators to assess the appropriateness and effectiveness of policies in meeting its objectives.

The Council will discuss the principles and the precise wording of the text of these policies with the Environment Agency, Water Supply companies, Lead Local Flood Risk Authority, District, Borough and City Councils in and adjoining the County, Natural England and other stakeholders with interests in the water environment both through specific and, where appropriate, focused consultations.

Ends

Appendices

Appendix 1: Severn river basin district - river basin management plan (update 2015)

The Severn RBMP outlines the current state of the water environment and details **actions** to improve it by the next plan completion in 2021, including undertaking the following relating to water quality, resources and infrastructure and flooding

1. **Physical Modifications -** Taking action to address the impacts of physical modifications (for instance by using natural water retention measures such as wetland creation and coastal realignment) could help alleviate flooding slowing flows and making more space for water.
2. **Managing pollution from waste water -** Reducing the impact of pollution from waste water will provide many benefits and help support a wide range of water uses.
3. **Managing pollution from towns, cities and transport** - Benefits from action include improved flood resilience, climate change adaptation, increased biodiversity and social cohesion.
4. **Changes to natural flow and levels of water** - improving the way water resources are managed for a healthier water environment and secure supplies of water for people, businesses and agriculture. It will also provide more leisure opportunities and increase the amenity value of natural environments, leading to health benefits for people.
5. **Managing invasive non-native species** - to reduce the number of new species introduced and slow the spread of those that are already present.
6. **Manage pollution from rural areas** - Controlling this run-off will help reduce localised flooding, reducing sedimentation and reducing the amount of harmful chemicals entering water bodies.

Catchment partnerships have been established in the Severn river basin district to encourage local action to protect and enhance the water environment. The partnerships consist of a wide range of groups with an interest in the water environment. This includes, but is not limited to, local government, angling interests, wildlife organisations, water companies, land managers, business representatives and government agencies.

Partnerships have been established for the Teme catchment, Warwickshire Avon catchment and Worcestershire Middle Avon catchment.

Each catchment partnership is committed to working collaboratively to share evidence, develop common priorities and carry out work on the ground. Many partnerships are producing catchment plans that will detail local actions related to the measures in this plan.

Figure 5: Management catchments within the Severn River Basin District[66]

[66] Water for Life and Livelihoods - Part 1: Severn river basin district River Basin management plan. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/501290/Severn_RBD_Part_1_river_basin_management_plan.pdf

Appendix 2: Regional and Local Flood Risk Assessments and Indicators

The West Midlands Regional Flood Risk Assessment (RFRA)

The West Midlands RFRA was originally completed in September 2007 and was used to inform Phase Two of the (WMRSS). The study was updated and completed in February 2009. The assessment has been based on the Environment Agency's undefended flood map, as required, at the time, by PPS25. The RFRA provides a basis for further policy development and recommendations for sustainable flood risk policy options for the Phase three WMRSS revision options stage.

The flood risk assessment was concentrated in those areas proposed for housing development in Phase 2 of the WMRSS and particularly those areas set to have the most development, Worcester City, Redditch, Bromsgrove and Wychavon. The Worcestershire aspect included a summary of the impact on flood risk as a result of the Nathanial Lichfield and Partners Report. It estimated that approximately 10% of the county is at risk from flooding. The RSS has since been revoked but the evidence on which it is based remains material and each District Council SFRA includes the main findings from the RFRA each area.

RFRA summary of the Nathanial Lichfield and Partners Report

The RFRA identified that Worcester will have great difficulty in accommodating the currents RSS proposals as a result of flood risk. Increasing development is likely to increase flood risk on site and further downstream, with possible degradation to the natural environment.

Critical infrastructure (RFRA)

It was found that although Worcester has high proportion of land that fell into Flood Zone 3, for all of the authorities tested in the West Midlands it had the lowest percentage of critical infrastructure that fell in Flood Zones 2 and 3. Wychavon and Malvern Hills in contrast were

found to have a high percentage of critical infrastructure that fell in Flood Zones 2 and 3. Being rated 3 and 5 respectively out of the 12 authorities assessed.

Flood Risk indicators for Bromsgrove

In Bromsgrove it was felt that due to the area and portion on the Local Authority area that fell under flood zone 3 (with only 2% of the District located within Climate Change Flood Zone 3) that it was unlikely to be a limiting factor for development. Although this is just taking into account fluvial flooding and the impact from all source of flooding has to be considered. For example surface water flooding and canal overtopping within the District are likely to restrict the available developable area.

Flood Risk indicators for Redditch - Redditch (RFRA)

There is a relatively small area of the Borough within Flood Zone 3 the majority of the development should be located outside of fluvial flood risk areas and areas at risk of flooding from other sources.

Flood Risk indicators for Worcester City - Worcester City Council (RFRA)

The River Severn runs through Worcester and approximately 20% of the City is located within climate change Flood Zone 3. The assessment undertaken demonstrates a high flood risk in the area from all sources of flooding; this places significant constraint on development. The Severn CFMP highlights an existing risk of surface water flooding in the City and advises further action to ensure the level of risk does not increase in the future. It was recommended LPA undertakes a Surface Water Management Plan to take into account of the high level of surface water issues and other actions required to reduce the risk from such sources of flooding.

Flood Risk Indicators for Wychavon - Wychavon (RFRA)

The CFMP shows that the existing urban areas in the Wychavon District are at risk of flooding, however only 10% of the district is located in Climate Change Flood Zone 3. However there is a high risk of flooding from other sources. This will place a significant constraint on developable

land particularly in known high-risk areas such as Droitwich and Pershore. A Level 2 SFRA needs to be undertaken to ensure flood risk issues are clearly understood.

Appendix 3: The District Council SFRAs in Worcestershire

Wyre Forest

The Wyre Forest SFRA considered the development sites proposed in the Wyre Forest Core Strategy to see what flood zone they fell within (see appendix 3).

The impacts of climate change on potential development sites identified in Wyre Forest District were projected forward to 2087 through assessments of impacts on the existing Flood Zone 3, taking into account the impact of climate change on river flows. The majority of the development sites in the District proposed in the Wyre Forest Core Strategy are on brownfield sites and so it has been assumed that they are unlikely to contribute additional runoff. The SFRA concluded that Greenfield sites would need closer attention to the disposal of surface water.

Level 1

The key aims of the Level 1 SFRA are to broadly assess all sources of flooding and the other key flood risk considerations expected by PPS25[67] across the entire Council's area. The Level 1 SFRA has been prepared mindful of the current potential development sites proposed by Wyre Forest District Council. A number of these sites were identified in the Adopted Local Plan (Wyre Forest District Council, January 2004). Royal Haskoning completed level 1 in January 2008.

The findings of the Level 1 SFRA are given in the form of the report and 1 in 10,000 scale SFRA Flood Zone maps (as per Table D.1 of PPS25) covering the entire District. These maps provide the basis for the application of the Sequential Test.
Royal Haskoning reported that a sequential test must be undertaken by Wyre Forest District Council for all development sites and other sites in accordance with their report's findings when preparing the emerging LDF documents for the District. They went on to report that an update of the existing SFRA (including a review of developer guidance) would be needed to bring it more in line with PPS25 Level 2 SFRA standard incorporating the latest guidance and studies.

[67] References to PPS 25 in this section reflect the fact that when the District Council SFRAs were done, PPS 25 was still national policy. 25 is however still extant and relevant.

Level 2

The Level 2 SFRA report for the district builds upon the results of the Level 1 study and was published in February 2010. The level 2 SFRA used more detailed models to redefine the flood zones and identify areas of rapid inundation. The location, condition and responsibility of all flood defence structures have been identified and breach and overtopping analyses undertaken. Updated risk ratings have been given to those sites identified in the Level 1 report with detailed mapping and modeling of those within Flood Zone 3.

Following the completion of the Level 1 SFRA, the Council identified further potential development sites; these were examined in the Level 2 SFRA. A full assessment of the condition of all flood defences present in the Wyre Forest District can be found in the District Council SFRA Level 2. The Level 2 SFRA also provides an assessment on the likely impact to the development sites if there was a breach in the existing Dam and flood defence infrastructure or Dam overtopping. An assessment was also undertaken on the impact of pluvial flooding though it stressed that due to the lack of guidance available for pluvial flooding analysis, the hazard categories were based upon the same categories that they used to define fluvial flood hazard mapping.

The conclusions and recommendations of the Wyre Forest Level 2 SFRA's are;

- Flooding occurs mostly from the Severn and Stour, however minor watercourses, such as the tributary watercourses of Hoo Brook and Blakedown Brook to the east (both enmained in their downstream extents) and Drakelow/Hors Brook, and surface water flooding also pose a large problem.
- The assessment found that in Kidderminster the north, more urban areas appear to suffer with greater depths of pluvial flooding, than the south of Kidderminster
- Management of surface water runoff should use a combination of site specific and strategic SUDS measures, encouraging 'source control' where possible.
- The continued maintenance and upgrade of existing flood defences is key to flood risk mitigation in the area.
- The risk from defence overtopping and breaching must be mitigated for when planning new developments.

- Sites in Flood Zone 1 should reduce the overall level of flood risk in the area and beyond through the layout and form of the development and the appropriate application of SUDS.
- Sites in Flood Zone 2 should be safe and reduce flooding where possible through the use of SUDS.
- Sites in Flood Zone 3a and 3b should be safe with no net loss of flood storage and should reduce flood risk in the surrounding area. Existing developments should attempt to be relocate.
- All new developments must produce a site specific Flood Risk Assessment.

Bromsgrove District and Redditch Borough Strategic Flood Risk Assessment

Level 1 Report January 2009

Royal Haskoning produced this Level 1 report in close consultation with the Council and the Environment Agency (EA). Input to the SFRA was also provided by Severn Trent Water, British Waterways and the Highways Agency.

Level 1

Bromsgrove and Redditch commissioned Royal Haskoning to produce a joint level 1 SFRA and Water Cycle Strategy and this was completed in January 2009. An Addendum to the level 1 SFRA was also completed at the same time to include the sites identified as part of a study carried out by White Young Green.

The Level 1 SFRA has been prepared to take account of the current potential brownfield and greenfield development sites in the District and Borough Councils' emerging Core Strategies and has been approved by the Environment Agency.

Bromsgrove

Flooding in the District is dominated by rapid response flash flooding from the Main Rivers and ordinary watercourses. Due to its headwater location, lack of Main Rivers and small watercourses, Bromsgrove District has not suffered from severe fluvial flooding. However due to the number of watercourses present, there have been numerous occurrences of smaller-scale flooding, most notably flash flooding from rapid catchment response. In addition due to the topography, geology and the effect of development, the catchments have a rapid rainfall-runoff response and thus during rain storms the water levels within the watercourses increase rapidly. This increase in flow causes many of the watercourses to overtop during severe storms and cause rapid localised flooding.

Flooding within the District has been made worse by a lack of maintenance, infilling of the watercourses due to development and culvert collapse along the ordinary watercourse channels resulting in blockages that decreasing channel capacity. In addition rapid rainfall-runoff and overland flow is a common form of flooding in the District, due to the soil type i.e. clayey and loamy soils underlying most of the District, most notably to the east.

The majority of flooding from watercourses within Bromsgrove town has occurred along: Spadesbourne Brook; Sugar Brook and the River Salwarpe, with four main clusters located around Market Street and The Strand, Brook Road/Ford Road, between the Bowls Centre and the Supermarket, close to the A38 and the junction of Fish House Lane and Sugar Brook Lane. The council's mineral resource assessments show that there are no workable mineral resources in these areas.

There are multiple occurrences of sewer flooding within the District and canal flooding as a result of overtopping of the Worcester and Birmingham Canal. There are no reports of groundwater flooding within the District. The Bromsgrove Council Drainage Engineer has identified a number of Greenfield sites as being potentially problematic in terms of increased runoff downstream.

Redditch

As Redditch is located at the base of the incline up to the Birmingham plateau and is on relatively flat land, it suffers from rapid flash flooding as its numerous brooks and ordinary watercourses deliver storm water from the higher ground to the River Arrow. As the gradient suddenly reduces, the watercourses rapidly exceed their capacity and have a tendency to 'pool', flooding the surrounding area. This is most notable on the Batchley Brook, which flows into the northwestern corner of Redditch town.

Similarly to Bromsgrove District, multiple accounts of sewer flooding have been reported within the Borough, although limited to Redditch town, Astwood Bank and the village of Feckenham. The Bromsgrove District and Redditch Borough Water Cycle Strategy reports that sewers within Redditch are operating at capacity and are suffering from problems of storm water infiltration into the foul sewers, even though there is also an extensive network of storm water sewers within the town.

Redditch town suffers from urban runoff and underlying impermeable clayey substrata. The rapid response of the catchments, coupled with a lack of highway drains maintenance, also contributes to flooding of the road system and overloading of the sewers. As with Bromsgrove there are no reports of groundwater flooding.

Level 2

Bromsgrove and Redditch have commissioned a joint Level 2 SFRA and an updated Water Cycle Strategy to be undertaken by consultants MWH. This work has been postponed several times, the range of sites needing assessment has been refined, the methodology agreed and the survey is due for completion in 2011. Surveys of what is necessary have been progressively refined to limit the need for the assessment needed at Core Strategy level.

In Bromsgrove detailed modeling is proposed for the proposed development site(s) in Hagley. A precautionary approach, subject to FRA at application stage is proposed for the Whitford Road, Perryfields and Norton Farm sites. As the Saxon & Harris Business Park site in Stoke Prior has already had outline planning permission and only 1.8ha is left un-developed, the site is not going to be assessed in the SFRA. Survey work is in hand to assess what, if any, assessment will be necessary for the employment sites around Bromsgrove Business Park.

For Redditch the Environment Agency has accepted that no further assessment will be necessary at the Core Strategy level for the Arrow catchment and that it will be acceptable to require FRAs for individual sites at planning application stage.

South Worcestershire Development Plan area

South Worcestershire Development Plan, Level 1 and Level 2 SFRA, Final Report November 2009

Malvern Hills, Worcester City and Wychavon District Councils are working together to produce the South Worcestershire Development Plan (formerly the South Worcestershire Joint Core Strategy) and employed JBA Consulting to undertake an SFRA level 1, 2 and Water Cycle Strategy for all 3 areas. The SFRA were completed by November 2009 and the Water Cycle Study by September 2010. Both have been agreed with the Environment Agency.

The South Worcestershire SFRA covers an area of 1270km2 including Worcester, Evesham, Upton upon Severn, Droitwich Spa, Malvern, Pershore, Tenbury Wells and the surrounding villages in Wychavon and Malvern Hills districts, provides flood zone classifications for the identified SFRA study area and the information required to classify future allocations.

The main cause of flooding within these towns is from watercourses. This can be severe. Significant watercourses within the study area are the

- River Severn
- River Avon
- River Salwarpe
- Barbourne Brook and
- River Teme.

The SFRA involves a broad scale assessment of flood risk to identify sites at risk from flooding for the identified SFRA study area as well as the information required to classify future allocations. The Phase 2 SFRA and Water Cycle Study have both been accepted by the Environment Agency.

The conclusions and recommendations of the South Worcestershire SFRA are

- Surface water flooding is a high risk in many areas, especially Droitwich and Worcester. It is recommended that Surface Water Management Plans are produced for Droitwich, Pershore Malvern and Worcester City;
- For large scale developments, a strategic approach to SUDS for runoff attenuation and water quality improvement linking to the green infrastructure plan is required;
- Site specific Flood Risk Assessments will be required prior to such development to ensure flood risk is fully addressed, including the effects of climate change;
- Mitigation measures should be seen as a last resort to address flood risk, and only once risk has been minimised, by planning sequentially across a site;
- Developments should be safe up to a 1 in 1000-year event, with safe access and egress routes. The emergency services should be satisfied with evacuation and rescue capabilities if required.

The Environment Agency has agreed the SFRA and Water Cycle Study for South Worcestershire.

South Worcestershire Development Plan Revised SFRA

A revised Strategic Flood Risk Assessment (SFRA) was prepared by JBA in accordance with best practice and published in December 2012[68]. This informed Policy SWDP28 and site allocation policies in the SWDP Proposed Submission Document. The Environment Agency had expressed concern regarding flood risk on a limited number of proposed SWDP allocations. The SWC Councils have subsequently met with the EA and the SWDP now makes it explicit that no housing or other vulnerable uses will be permitted outside Flood Zone 1. For a few mixed use e.g. housing and leisure sites, land subject to Flood Zones 2 and 3 is included. The SWDP, however, makes it clear that housing will not be permitted in Flood Zone 2 or Flood Zone 3 and it can demonstrate that the capacity of these allocations allows for this. In effect, the SWC Councils have applied the sequential test in the aforementioned case. The revised SFRA provides sound advice to the 3 SWC Councils and developers on how to carry out the Sequential and Exception Tests. The SFRA also

[68] South Worcestershire Development Plan Infrastructure Delivery Plan Published November 2012 With updating up to 20th May 2013

sets out clear guidance for the design of sustainable drainage systems, which are required by policy SWDP 29.

The SFRA assessed the flood risk in the SWDP area as a whole and informed the SWC decisions about allocating sites for development. As a consequence of this work, some SWDP sites were deleted and a number of SWDP sites were carefully reviewed in Autumn 2012 as a direct consequence of this SFRA Update.

Key points from the County evidence base included that a number of flood defences schemes are already underway or recently completed in South Worcestershire. These have been led by the Environment Agency and supported by the County Council and the relevant Local Council. Based on the latest information from the Environment Agency in spring 2013, major schemes include:

- Pershore-complete.
- Upton-upon-Severn: New Street complete; Waterside complete.
- Powick; complete
- Kempsey; was completed in summer 2012 but encountered technical difficulties in the floods in November 2012, which are being addressed by the Environment Agency and all relevant partners.
- Riddings Brook: complete.
- Badsey Brook (Broadway, Childswickham, Murcot) Flood Alleviation Scheme: approved in principle but funding still to be finalised.
- Uckinghall: complete.
- There are other local flood defence/alleviation schemes e.g.; Barbourne Brook, Hylton Road, Worcester.

Other key points include

- There is an understanding of the areas prone to flooding in each District in South Worcestershire.
- The 2009 Baker Associates Study set out indicative costs for providing flood defences.
- The way in which Government funding is allocated to flood risk management schemes is changing.

- Particular importance is attached to the full use of Sustainable Drainage Systems (SuDS), which has informed Policy SWDP 29

Appendix 4: Summary of Environment Agency Catchment Abstraction Management Plans (for catchments in Worcestershire)

In Worcestershire the Severn Corridor CAMS extends the length of the county along the river Severn. The major tributaries such as the Stour, Teme and Avon are covered within separate CAMS assessments, although their tributary impacts are incorporated within the Severn Corridor resource assessment.

Hydrology: The Severn corridor catchment incorporates a large and diverse area where natural rainfall and catchment characteristics vary greatly from the source to the mouth. Along its course the hydrology is also heavily influenced by abstractions, discharges, water transfers, canal feeds and river regulation.

The River Severn Regulation system aims to ensure that a sufficient flow of water is maintained within the River Severn to satisfy the demands of the major abstractors and to meet environmental needs. This is achieved through controlled releases of water into the river upstream from Worcestershire (from Clywedog Reservoir, Lake Vyrnwy and the Shropshire Groundwater Scheme).

Geology and Hydrogeology: The Severn Corridor catchment is underlain by diverse geological strata, including the notable Permo-Triassic sandstone aquifers, which are highly productive and able to support large groundwater abstractions. Other aquifers within the catchment are classed as either secondary or poorly productive aquifers, which have limited potential for groundwater abstraction but nevertheless still provide important lower yielding private supplies.

Land Use: The largely rural catchment supports extensive areas of livestock and arable agriculture and forestry but also includes major urban centres, including Worcester.

Topography: The topography of the corridor is relatively even and flat in Worcestershire.

The Main Water Resource Pressures: for water within this catchment come from the agricultural sector, reflecting the largely rural character of the river corridor. There are only a few industrial

abstraction licences along the Severn Corridor and these are generally concentrated in small "pockets" of development. Pressure is placed on water quality due to the potential impacts from the use of fertilisers, general land management and sewage treatment discharges.

Water Availability in the River Severn CAMS in Worcestershire is Restricted.

The EA's abstraction policy for the River Severn downstream of Bewdley AP11, River Severn at Saxons Lode, AP12, River Severn at Deerhurst, AP13, River Severn at Hockcliffe is that: for these assessment points, there is restricted water available for licensing. For *new licences* on the River Severn downstream of Bewdley, this means

- There is no water available for unconstrained abstraction i.e. abstraction with no HOF condition.
- Water is available during periods of medium to high flows subject to a HOF condition.
- The HOF condition applied will state that abstraction must cease when flow in the River Severn falls below 1800 Ml/d as measured at the Environment Agency gauging station at Deerhurst.
- A time limit of 31 March 2022 will be imposed on the licence.
- The licence would obtain a presumption of renewal, subject to the renewal criteria and local considerations.

For existing licences

- Any existing licence that the holder applies to have formally varied to increase the volume abstracted will be subject to the same conditions as new licences on the increased part of the licence only.
- Licences due for renewal in this area will also be subject to the same conditions as new licences

Upstream of Bewdley, the River Severn is designated a Heavily Modified Water Body (HMWB) because of the impact of the River Severn regulation system, which influences its flow regime. The regulation system is designed to meet the water resource demands of abstractors on the river, while maintaining an acceptable flow for the purposes of fisheries, conservation, recreation, navigation, effluent dilution and other „in-river" uses. The legislation concerning the regulation system was established in 1963, when it was anticipated that the amount of water that people wanted to abstract from the river, principally for public water supply, could be greater than the

river could provide, particularly during dry years. The Clywedog Reservoir was constructed to maintain a statutory minimum flow of the River Severn and meet abstraction needs. The control point for river regulation is located at Bewdley. The maintained flow is now 850 Ml/d averaged over a 5 day period and a minimum of 650 Ml/d on any single day. During very dry summers the flow at Bewdley may fall below these values when river regulation reaches a prescribed maximum value.

The droughts of the 1970's confirmed that the available resources of the Clywedog Reservoir would be insufficient to fully meet the increased future demands for water from the River Severn and the Shropshire Groundwater Scheme (SGS) was developed to compensate low flows. A small proportion of the storage of Lake Vyrnwy (principally used to provide water supplies to Merseyside) is also used for river regulation.

The Environment Agency's policy for **Groundwater** in this catchment is to reduce the unacceptable impact of groundwater abstraction on surface water low flows and to encourage modification of existing water supply schemes to make better use of aquifer storage in conjunction with surface water. In principle, two types of scheme are acceptable

- Conjunctive use schemes: To encourage schemes with increased daily groundwater abstraction from the Permo-Triassic Sandstone during times of low surface flow,
- Increased surface water abstraction at times of high surface flow,
- Licence changes to reduce actual annual groundwater abstraction, to increase surface flows in the long term. These arrangements will only be considered for existing groundwater licences with relatively constant, high rates of actual abstraction, such as public water supplies and
- Surface to groundwater exchange licence schemes. We will consider exchanging surface water licences for groundwater licences where water resources are available and where there are benefits to the surface water environment.

In both cases, the EA will only consider schemes that achieve real improvements in surface water low-flow conditions. All schemes will be subject to environmental assessment.

New groundwater licence applications for abstraction from secondary aquifers will continue to be assessed on a case by case basis.

Existing groundwater licences, which are due for renewal in this area, will have a presumption of renewal, unless they were previously issued using resources allocated to the Shropshire Groundwater Scheme.

Water related Sites of Special scientific Interest in this catchment in Worcestershire are:

- Grimley Brick Pits
- Northwick Marsh
- Ashmoor Common
- Upton Ham
- Old River Severn Upper Lode
- Severn Ham Tewkesbury is in Gloucestershire but close enough to need to be considered as potentially affected by developments in Worcestershire.

The Severn Estuary and Walmore Common are significant Habitats and Birds Directive sites; both are SACs, SPAs and Ramsar sites. Both are near to the Severn Corridor CAMS. Although Walmore Common is a wetland basin near Minsterworth on the River Severn floodplain that drains into the River Severn it is not directly dependant on flows from the Severn Vale CAMS tributaries. The Severn Corridor CAMS Rivers are all tributaries of the River Severn, and the River Severn supplies the majority of flows to the Estuary. This means, in effect, that every tributary of the River Severn must be managed using appropriate flow restrictions to ensure an appropriate flow contribution to the Estuary. Any proposals within 20 km of the designated area of Walmore Common or affecting the tributaries of the River Severn will need assessment under the Habitats Regulations.

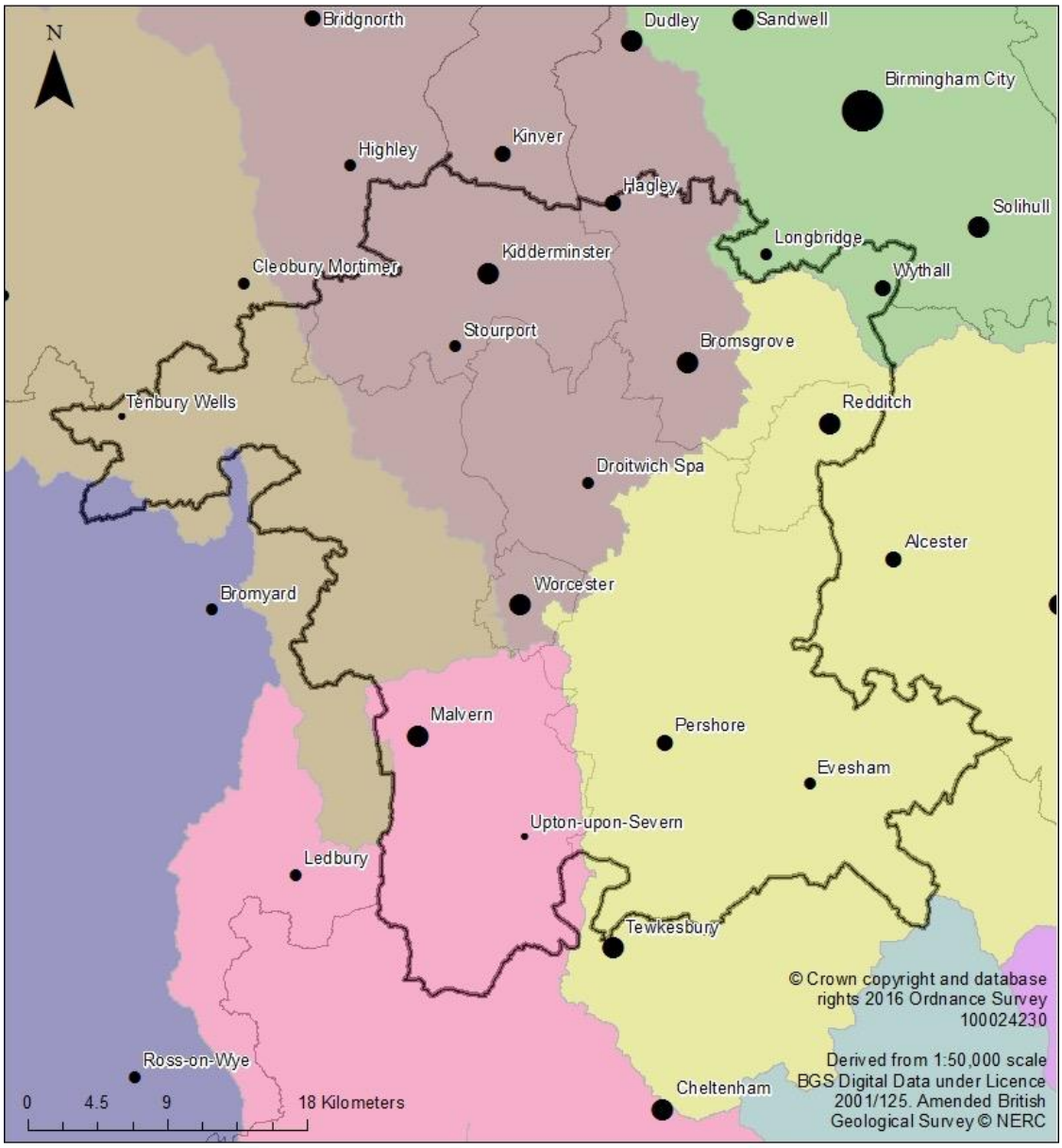

Figure 6 CAMS and relationship with Worcestershire

Middle Severn Corridor; Current EA Flooding Policy

The_Middle Severn Corridor_is an EA Policy Option 4 area[69]:

"Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change".

The EA's proposed actions to implement the preferred policy are:

- Ensure floodplains are not inappropriately developed. Follow the 'sequential approach' of PPS 25, and consider land-swapping opportunities.
- Encourage compatibility between urban open spaces, and their ability to make space for rivers to expand as flood flows occur. One example of a flood-compatible use is playing fields. Develop strategies to create 'blue corridors' by developing/redeveloping to link these flood-compatible spaces.
- Encourage rural and urban best practices in land-use and in land-management to restore more sustainable natural floodplains and to reduce run-off.
- Review how effective and sustainable each flood defence is. Review maintenance operations to ensure they are proportionate to flood risk. Focus efforts on protecting communities and making them more resilient to flooding. It should be noted that protecting large areas of agricultural land in the floodplain tends to increase flood risk for downstream communities.
- Develop a better understanding of flooding from surface water, from drainage systems, and from 'non-main' watercourses. Produce a strategy for operation and investment, integrating all these with main rivers.
- Raise awareness of flooding among the public and key partners, especially major operators of infrastructure, allowing them to be better prepared. Encourage them all to increase the resilience and resistance of vulnerable buildings, infrastructure and businesses.
- Maintain flood-warning systems and seek opportunities to improve effectiveness and coverage.
- Seek ecological improvements.

[69] Environment Agency RSCMP (Dec 2009) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289103/River_Severn_Catchment_Management_Plan.pdf

Worcestershire Middle Severn Catchment[70]: Water demand and supply

The Worcestershire Middle Severn CAMS area lies directly west of the West Midlands conurbation and covers parts of the counties of Shropshire, Staffordshire, Worcestershire and the West Midlands. Kidderminster, Bromsgrove and the outskirts of Worcester are within the CAMS.

The Worcestershire Middle Severn CAMS area includes numerous tributaries and several larger rivers such as the Stour, all of which eventually flow into the River Severn. The CAMS area is effectively divided in two by the River Severn, which is excluded from the Worcestershire Middle Severn CAMS itself and included in the Severn Corridor CAMS.

In Worcestershire the catchments of the River Salwarpe, River Stour, Battlefield Brook, Dick Brook and Hadley Brook are included in the CAMS area. These natural drainage boundaries comprise the boundary of the Worcestershire Middle Severn CAMS. A number of historic canals lie within the area including the Staffordshire and Worcestershire Canal and the Droitwich Canal.

The area contains significant quantities of groundwater contained in the Permo-Triassic Sandstone aquifer. The Permo-Triassic Sandstones are high yielding aquifers that support significant abstraction for public water supply, industry, agriculture and domestic use. Consequently the groundwater is very heavily abstracted, with most abstractions being made by historic licences. New groundwater licences have not been granted from the Permo-Triassic sandstone aquifer in this area for many years. The area also contains strata with more variable permeability where water is encountered in sufficient but lower quantities and these are capable of supporting locally important abstractions for both agricultural and domestic purposes.

The east of the CAMS is generally urban and the west rural, with the majority of the west given over to agricultural production. The main issue regarding water resources in this area is the historic over-abstraction of groundwater for public water supply and its accompanying environmental impact. There is also a high demand for water to irrigate agricultural land, and this

[70] Environment Agency Worcestershire Middle Severn Abstraction Licensing Strategy, (February 2013)http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_5356_35376b.pdf

has the potential to conflict with environmental needs as the peak demand for irrigation usually coincides with periods of low flows within watercourses. As water resources have become committed within this area, the abstraction of water at higher flows to fill storage reservoirs that can then be used as a source for summer irrigation has increased.
Pressure is also placed on water quality due to the potential impacts from the use of fertilisers, general land management and sewage treatment discharges.

Restricted surface water is available for licensing in most of the CAMS in Worcestershire. New mineral workings may need new surface water licences. The Minerals Local plan will need to ensure that any mineral development in the area does not compromise existing abstractions and is compatible with the EAs Abstraction Strategy for this area. The following could have important implications for mineral working in this catchment and its associated tributaries:

The EA's policy for **AP2, Dowles Brook at Oak Cottage** is that there is restricted water available for licensing. For *new surface water licences* on the Dowles Brook and associated tributaries this means:

- There is no water available for unconstrained abstraction i.e. abstraction with no HOF restriction.
- Water is only available during periods of medium to high flows subject to a HOF condition.
- The HOF condition applied will state that abstraction must cease when flow in the Dowles Brook falls below 3 Ml/d as measured at the Environment Agency gauging station at Oak Cottage.
- A time limit of 31 March 2026 will be imposed on the licence.
- The licence would obtain a presumption of renewal, subject to the renewal criteria and local considerations.

For *existing licences* on the Dowles Brook and associated tributaries, this means

- Any existing licence that the holder applies to have formally varied to increase the volume abstracted will be subject to the same conditions as new licences on the increased part of the licence only.

Licences due for renewal in this area will have a presumption of renewal, subject to the renewal criteria and local considerations. Renewals may be subject to minor changes including the addition of water efficiency conditions. The EA's policy is to endeavour to give six years notice if a licence will not be renewed or is to be renewed but on more restrictive terms.

The EA's abstraction policy for AP3, River Stour at Stourbridge, AP4, River Stour at Smestow, AP5, River Stour at Caunsal, AP6, River Stour at Callows Lane and AP7, River Stour at Stourport-On-Severn is that for these assessment points there is restricted water available for licensing. For *new surface water licences* on the River Stour and associated tributaries this means:

- There is no water available for unconstrained abstraction i.e. abstraction with no HOF restriction.
- Water is only available during periods of high flows subject to a HOF condition.
- The HOF condition applied will state that abstraction must cease when flow in the River Stour falls below 260 Ml/d as measured at the Environment Agency gauging station at Callows Lane.
- A time limit of 31 March 2026 will be imposed on the licence.
- The licence would obtain a presumption of renewal, subject to the renewal criteria and local considerations.

For *existing licences* on the River Stour and associated tributaries, this means

- Any existing licence which the holder applies to have formally varied to increase the volume abstracted will be subject to the same conditions as new licences on the increased part of the licence only.
- Licences due for renewal in this area will have a presumption of renewal, subject to the renewal criteria and local considerations. Renewals may be subject to minor changes including the addition of water efficiency conditions. We will endeavour to give six years notice if a licence will not be renewed or is to be renewed but on more restrictive terms.

The EA's abstraction policy for AP8, River Salwarpe at Avonscroft (Bromsgrove), AP9, Hadley Brook at Wards Bridge, and AP10, River Salwarpe at Harford Hill is that for these assessment points there is restricted water available for licensing. For *new surface water licences* on the River Salwarpe and associated tributaries this means

- There is no water available for unconstrained abstraction i.e. abstraction with no HOF restriction.
- Water is only available during periods of medium to high flows subject to a HOF condition.
- The HOF condition applied will state that abstraction must cease when flow in the River Salwarpe falls below 70 Ml/d as measured at the Environment Agency gauging station at Harford Hill.
- A time limit of 31 March 2026 will be imposed on the licence.
- The licence would obtain a presumption of renewal, subject to the renewal criteria and local considerations.

For existing licences on the River Salwarpe and associated tributaries, this means:

- Any existing licence which the holder applies to have formally varied to increase the volume abstracted will be subject to the same conditions as new licences on the increased part of the licence only.
- Licences due for renewal in this area will have a presumption of renewal, subject to the renewal criteria and local considerations. Renewals may be subject to minor changes including the addition of water efficiency conditions. We will endeavour to give six years notice if a licence will not be renewed or is to be renewed but on more restrictive terms.

The following Water related environmentally designated sites in this CAMS are Sites of Special Scientific Interest (SSSI) and so will also need to be taken account of in the Minerals Local Plan

- Illey Pastures
- Romsley Manor Farm
- Stourvale Marsh
- Hurcott & Podmore Pools
- Puxton Marsh
- Hartlebury Common & Hilditch Coppice
- Wilden Marsh & Meadows
- River Stour Flood Plain
- Feckenham Forest

- Shrawley Wood
- Upton Warren Pools
- Westward Great Pool
- Oakley Pool

There are water related Special Areas of Conservation at Fens Pool Dudley, which is designated for the Great Crested Newt and is upstream of Worcestershire and the Severn Estuary. The estuary receives the majority of its flow from the River Severn catchment. All of the rivers within the Worcestershire Middle Severn CAMS area are tributaries of the River Severn. This means that every tributary of the River Severn must be managed using appropriate flow restrictions to protect the environmental needs of the Estuary. In the Worcestershire Middle Severn CAMS the EA's policy is to manage this by ensuring that all new or upwardly varied surface water licences granted on the River Severn tributaries will have a local condition that is equal to or more restrictive than the HOF proposed for Deerhurst on the River Severn. This is a HOF of 1,800 Ml/d at Deerhurst Gauging station, and is the flow that is equalled or exceeded for 90% of the time.

For **Groundwater** all units within the Worcestershire Middle Severn area are closed to further consumptive abstraction as the existing levels of licensed abstraction currently exceed the long-term rate of recharge. The following reflect this:

Blakedown Brook Compensation Scheme (AP 6) Unsustainable groundwater abstraction from the Kidderminster groundwater unit has resulted in depletion of flows in the Blakedown Brook and the Hurcott and Podmore SSSI. To mitigate these impacts three boreholes are used to supplement low flows in this catchment and a water level management plan has been implemented at the SSSI. There is also a constant discharge pumped into the brook in the upper reaches near Hagley to supplement the flow.

Battlefield Brook Compensation Scheme (AP 10) Unsustainable groundwater abstraction from the Bromsgrove groundwater management unit has resulted in the depletion of flows along the Battlefield Brook. Two boreholes are currently operational to support flows in this catchment in the upper reaches and at Sanders Park in Bromsgrove.

Hadley Brook Compensation Scheme (AP 10) A borehole within the Ombersley groundwater unit is also used to supplement flows in three tributaries of the Hadley Brook, the Sytchampton, Woodfield and Yardings Farm Brooks, to mitigate the impacts of abstraction for public water supply.

- Worcestershire Middle Severn; (Wyre Forest, Worcester City, Bromsgrove and Wychavon): EA Proposals to improve Water Quality
- Improvement to discharges at a number of sewage treatment works
- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Projects on Wildlife Trust owned reserves to improve wetland and riparian habitat
- Wildlife Trust's 'Access to Nature' community involvement programme to improve habitat and raise awareness of Black Country rivers
- Green Futures initiative to provide co-ordinated advice to farmers on complying with agricultural and environmental regulations across the West Midlands

The Lower Severn Corridor and Leadon Catchment

The Lower Severn Corridor and Leadon Catchment is a Policy Option 2 area – Areas of low to moderate flood risk where we (the EA) can generally reduce existing flood risk management actions.
The EA's proposed actions to implement the preferred policy are to

- Encourage rural and urban best practices in land-use and in land-management to restore more sustainable natural floodplains and to reduce run-off.
- Raise awareness of flooding among the public and key partners, especially major operators of infrastructure, allowing them to be better prepared. Encourage them all to increase the resilience and resistance of vulnerable buildings, infrastructure and businesses.
- Ensure floodplains are not inappropriately developed. Follow the 'sequential approach' of PPS 25, and consider land-swapping opportunities.
- Review how effective and sustainable flood defences are. Ensure that maintenance operations are proportionate to flood risk. In the Severn Corridor there are raised defences in the Chelt

Basin that mainly protect agricultural land. These need to be reviewed to find out how effective they are and what impact they have downstream.

- Seek opportunities to improve watercourses where it would benefit fisheries (especially salmon.)
- Consider the impact of flood risk management activities on SSSIs, for example Malthouse Farm Meadows.

Severn Vale Catchment: Water demand and supply[71]

The EA Catchment abstraction strategy also refers to the Severn Vale catchment area, it begins immediately downstream of the confluence with the Teme at Worcester, and ends in the Severn Estuary at Lydney on the west bank and at the mouth of the River Frome on the east bank. It covers just less than 1,000 km2. Only two small areas, the Bushley Brook near Longdon and the Carey's Brook catchment near Malvern are in Worcestershire. Together these are part of the EA's WRMU 1of the CAMS. The area is predominantly rural and low-lying, with steeper topography at the margins formed by the Cotswold Hills, Forest of Dean and the Malvern Hills. It has high quality agricultural land in most of the catchment and arable land dominates the Leadon catchment in Worcestershire.

The majority of water supply abstraction in this CAMS in Worcestershire occurs from the Glynch Brook and Bromsberrow aquifers. These are almost completely outside of Worcestershire but their catchments do lie within the county boundary. The Glynch Brook is known to experience low flows during summer months and flows are augmented by compensation water from Severn Trent Water Ltd. The Environment Agency categorises both the Carey's Brook and Bushley Brook as having "No water available" at low flows. New mineral workings may need new surface water licences.

The Minerals Local plan will need to ensure that any mineral development in the area does not compromise existing abstractions and is compatible with the EAs Abstraction Strategy for this

[71] Environment Agency; Severn Vale Catchment Abstraction Strategy, January 2008 http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/gemi0108bnmp-e-e.pdf

area. This means that subject to an appropriate HOF condition as set out in table 5, in the Severn Vale catchment for new licences

- At low flows no new consumptive surface water licences will be granted;
- Surface water licences will be granted subject to HOF conditions of 55Ml/d at Wedderburn Bridge for WRMU 1.
- All new licences will be time-limited;
- New groundwater licence applications for minor aquifers will be assessed on a case-by-case basis. If they are within the groundwater exemption zone they will not require a licence until the Environment Agency has successfully applied to remove the
- Exemption under the Water Act 2003;
- All new licence applications in WRMU 1 will be examined on a case by case basis to ensure impacts are not directly affecting the development of either the Longdon and Elders field Marsh or the Teme and Severn Confluence Wetland Restoration Zones
- And for existing licences:
- There will be a presumption of renewal of time limited licences, subject to the renewal criteria, local conditions and HOF conditions;
- All abstraction licence applications will be subject to an assessment to take account of any local issues and be granted on a first-come-first-served basis.

Water supply in this unit is potentially affected by water related Sites of Special Scientific Interest (SSSIs) at Aileshurst Coppice, New Inn Meadow, Malvern Hills, Rye Street Meadows, Burley Dene Meadows, Malthouse Farm Meadows, Castlemorton Common and Micklefield Meadow.

The current and future restoration of Longdon and Eldersfield Marsh Wetland Restoration Zone in the catchment of Bushley Brook AP 2 requires adequate flows on the Bushley Brook to be maintained, so that water level can be restored in the marsh areas. Current marsh water levels are at a critically low level. Future plans may require further water than has been considered in this round of CAMS.

The Teme and Severn Confluence Wetland Restoration Zone is present in the catchment of Carey's Brook AP 1 and plans are in place to convert the fields east of Powick STW to wet grassland.

These issues need to be taken into account as the Minerals Local Plan is developed both so that the implications of any abstractions required by new mineral workings can be assessed and that the wetlands in this area can develop to their full potential without being adversely affected by new abstractions.

The Severn Estuary and Walmore Common are significant Habitats and Birds Directive sites; both are SACs, SPAs and Ramsar sites. Both are near to the Severn Vale CAMS. Although Walmore Common is a wetland basin near Minsterworth on the River Severn floodplain that drains into the River Severn it is not directly dependant on flows from the Severn Vale CAMS tributaries. The Severn Vale CAMS Rivers are all tributaries of the River Severn, and the River Severn supplies the majority of flows to the Estuary. This means, in effect, that every tributary of the River Severn must be managed using appropriate flow restrictions to ensure an appropriate flow contribution to the Estuary. Any proposals within 20 km of the designated area of Walmore Common or affecting the tributaries of the River Severn will need assessment under the Habitats Regulations.

The following SSSI's are within, or close to the parts of this CAMS in Worcestershire, are water related to some extent and so will also need to be taken account of in the Minerals Local Plan

- New Inn Meadow
- Aileshurst Coppice
- Malvern Hills
- Castlemorton Common
- Malthouse Farm Meadow
- Micklefield Meadow
- Rye Street Meadow
- Burley Dene Meadows

Severn Vale (Malvern Hills) EA Proposals to improve Water Quality

- Investigating the sources of metals and other pollutants and various actions to improve the management of water resources
- Improvement to discharges at a number of sewage treatment works and investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme

- Provision of advice to farmers under the England Catchment Sensitive Farming Delivery Initiative
- Salmon in Schools project to raise local awareness of the salmon lifecycle and habitat
- Pollution reduction campaigns on local industrial estates
- Actions to reduce the impact from pesticides including metaldehyde (slug pellets)

Middle Avon, Tributaries, Arrow and Alne, Redditch, Rugby and Teme: Current EA Flooding Policy

This are is a Policy Option 3 – Areas of low to moderate flood risk where we (the EA) are generally managing existing flood risk effectively.
The EA`s Proposed actions to implement the preferred policy are

- Encourage rural and urban best practices in land-use and in land-management to restore more sustainable natural floodplains and to reduce run-off
- Ensure that the run-off from all proposed development is minimised. For example, SuDS must be encouraged and targeted within planning approvals. Encourage the retro-fitting of SuDS where surface water flooding is already a problem.
- Raise awareness of flooding among the public and key partners, especially major operators of infrastructure, allowing them to be better prepared. Encourage them all to increase the resilience and resistance of vulnerable buildings, infrastructure and businesses.
- Maintain flood-warning systems and explore opportunities to improve their effectiveness and coverage.
- Ensure floodplains are not inappropriately developed. Follow the 'sequential approach' of PPS 25, and consider land-swapping opportunities.
- Encourage compatibility between urban open spaces and their ability to make space for rivers to expand as flood flows occur. One example of a flood compatible use is playing fields. Appraise strategies to create 'blue corridors' by developing/redeveloping to link these flood-compatible spaces.
- Develop better understanding of flooding from surface water, from drainage systems, and from 'non-main' watercourses. Produce a strategy for operation and investment, integrating these with main rivers.
- Support ecological improvements. Examples of this include Severn & Avon Wetlands Project; Natural England's three fluvial SSSIs; Cotswold AONB.

- Maintain flood-warning systems and look for opportunities to improve their effectiveness and coverage.

River Teme catchment downstream of Tenbury: Water demand and supply

The main demand for water in Teme catchment in Worcestershire comes from public water supply and agriculture, with very little industrial use. The River Teme has become an important source of water for irrigation in Worcestershire. [72]

The Environment Agency assessment points in Worcestershire AP4, Knightsford, AP5, Worcester, AP12, Rea, AP13, Sapey Brook, AP14, Leigh Brook, AP15, Laughern Brook all show that there is restricted water available for licensing. New mineral workings may need new surface water licences. The Minerals Local plan will need to ensure that any mineral development in the area does not compromise existing abstractions and is compatible with the EAs Abstraction Strategy for this area.

The following could have important implications for mineral working **downstream of the Tenbury** assessment point on the River Teme in this catchment and its associated tributaries:

- There is no water available for unconstrained abstraction i.e. abstraction with no HOF[73] restriction.
- Water is only available during periods of medium to high flows subject to a HOF condition.
- The HOF condition applied will state that abstraction must cease when flow in the river Teme falls below 226 Ml/d as measured at the Environment Agency gauging station at Tenbury.
- A time limit of 31 March 2025 will be imposed on the licence.
- The licence would obtain a presumption of renewal, subject to the renewal criteria and local considerations.

[72] Environment Agency Teme Abstraction Licensing Strategy page 7 http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7850_7f5c56.pdf

[73] Hands Off Flow: Environment Agency abbreviation for a condition attached to an abstraction licence which states that if flow (in the river) falls below the level specified on the licence, the abstractor will be required to reduce or stop the abstraction.

The Minerals Local Plan will take account of these restrictions.

A major consideration within this catchment for the Minerals Local plan must be the Downton Gorge and river Severn SACs and SSSIs. Any proposals within 20 km of the designated area of the gorge or affecting of the rivers within the Teme CAMS area are tributaries of the River Severn will need assessment under the Habitats Regulations.

The Environment Agency Teme Abstraction Licensing Strategy[74] states that this means that every tributary of 1.1. The River Severn must be managed using appropriate flow restrictions to protect the environmental needs of the Estuary. In the Teme CAMS they will manage this by ensuring that all new or upwardly varied surface water licences granted on the River Severn tributaries will have a local condition that is equal to or more restrictive than the HOF proposed for Deerhurst on the River Severn. This is a HOF of 1,800 Ml/d at Deerhurst Gauging station, and is the flow that is equalled or exceeded for 90% of the time. This could affect any abstractions related to mineral workings within the catchment. The Minerals Local Plan will need to be taken account of this restriction.

Groundwater considerations: There are no principal aquifers within the Teme CAMS area, and only parts of two secondary aquifer units. Consequently a large proportion of the Teme CAMS catchment falls within the area classed as 'exempt' whereby abstraction from groundwater does not require a licence. At present the Environment Agency has no control over such groundwater abstractions but this will change when certain parts of the 2003 Water Act are implemented. Nevertheless, where water-bearing rocks are present, small abstractions can be supported.

Secondary Aquifers: New groundwater licence applications for abstraction from secondary aquifers in this CAMS will continue to be assessed on a case-by-case basis.

[74] Environment Agency Teme Abstraction Licensing Strategy, February 2013 page 23 http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7850_7f5c56.pdf

Teme: (Malvern Hills) EA Water Quality proposals

- Improvements to discharges at several sewage treatment works
- Provision of advice to farmers under the England Catchment Sensitive Farming Delivery Initiative
- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Actions to reduce the impact from pesticides including metaldehyde (slug pellets)

Warwickshire Avon Catchment: Water Supply and Demand[75]

The EA Catchment Abstraction Strategy also refers to the Warwickshire Avon catchment. It covers some 2,900 square kilometres of central England. It includes most of Warwickshire and significant areas of Worcestershire, Gloucestershire and small parts of Oxfordshire, Leicestershire and Northamptonshire. The towns in this catchment in Worcestershire are Evesham, Redditch and Pershore. The River Avon is a major tributary of the River Severn. There are a number of important tributaries of the River Avon in Worcestershire including the Rivers Arrow and Isbourne and the Badsey and Bow Brooks, all of which support a significant number of abstractions. Apart from some more significant topographical features around the catchment boundary the majority of the catchment is low-lying.

The catchment has significant groundwater resources in Worcestershire stored in the principal and secondary aquifers around the Bromsgrove areas. The Great and Inferior Oolitic Limestone aquifers along the southwest edge of the area, including Bredon Hill and the Badsey areas in Worcestershire) are also a major resource. The Mercia Mudstone groups represent important geological strata in the Avon catchment in Worcestershire. Drift deposits represent the youngest deposits in the Avon catchment. Quaternary drifts formed of glacial deposits (sands/gravels and boulder clays) cap a high portion of the rocks in the northeastern part of the catchment in particular. Alluvial terraces of the River Avon constitute the most recent deposits of the geological

[75] Environment Agency Warwickshire Avon abstraction Licensing Strategy (February 2013) http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_2604_7a244e.pdf

sequence and generally follow river and stream channels. All of these formations include important aggregate resources in Worcestershire, several of which have been included in Areas of Search in the emerging Minerals local Plan.
The use of the River Avon for navigation is important in shaping its character. There are numerous weirs, which control water levels in much of the river enabling it to be used for recreational boating. The River Avon is navigable from Tewkesbury, through Worcestershire to Alveston, immediately upstream of Stratford.

Despite significant industrial activity, agriculture is an important part of the economy in this catchment in Worcestershire. Traditionally the main farming activities have been crop growing, grazing dairy and beef cattle with horticulture and market gardening, especially around Evesham. Fruit and vegetables produced in this area supply a significant proportion of supermarket demand across the country. These depend on abstracted water, the Minerals Local plan will need to ensure that any mineral development in the area does not compromise existing abstractions and is compatible with the EAs Abstraction Strategy for this area.

The Minerals Local plan will need to ensure that any mineral development in the area does not compromise existing abstractions and is compatible with the EA's Abstraction Strategy for this area. The following could have important implications for mineral working:

The EA's policy **for assessment points 6 and 10, the Avon catchment from Stareton to Evesham**, is that there is water available for licensing with a HOF of 409Ml/d at Evesham gauging station on the River Avon and a HOF of 1800Ml/d at Deerhurst gauging station on the River Severn.

This means that *for new licences*

All new consumptive or partially consumptive licences will be issued with this HOF;
Water is only available during periods of medium to high flows due to the HOF condition;
There is a time limit of 31 March 2025
and for existing licences

- There is no impact on existing licence holders.

- Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).

The EA's policy **for assessment points AP8 Broom (River Arrow)** is that there is water available for licensing with a HOF of 90Ml/d at Broom gauging station on the River Arrow and a HOF of 1800Ml/d at Deerhurst gauging station on the River Severn. This means that *for new licences*:

- All new consumptive or partially consumptive licences will be issued with this HOF;
- Water is only available during periods of medium to high flows due to the HOF condition;
- There is a time limit of 31 March 2025

and for existing licences

- There is no impact on existing licence holders.
- Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).

There have been low flow issues in the upper catchment around Batchley Brook, which make it non-compliant with WFD hydrological requirements. A borehole compensation release scheme is in operation to support levels in Hewell Park Lake SSSI and to ensure that the lake levels are maintained to agreed limits. The site is now in favourable condition, but the EA state that they will keep the Batchley Brook catchment closed to further abstraction. As such the Batchley Brook catchment will be closed to further abstraction.

The EA's abstraction policy for **assessment point AP9 Offenham (Badsey Brook)** is that

- Batchley Brook at the top of the River Arrow is non-compliant with WFD hydrology. There have been low flow issues in the upper catchment around Batchley Brook, which make it non-compliant with WFD hydrological requirements. A borehole compensation release scheme is in operation to support levels in Hewell Park Lake SSSI and to ensure that the lake levels are maintained to agreed limits. The site is now in favourable condition, but the EA state that they will keep the Batchley Brook catchment closed to further abstraction. As such the Batchley Brook catchment will be closed to further abstraction.

For assessment point 9, the Badsey Brook catchment, there is water available for licensing with a HOF of 15.5Ml/d at Offenham gauging station on the Badsey Brook and a HOF of 1800Ml/d at Deerhurst gauging station on the River Severn. This means that for new licences:
All new consumptive or partially consumptive licences will be is
Water is only available during periods of medium to high flows due to the HOF condition;
There is a time limit of 31 March 2025

and for existing licences

- There is no impact on existing licence holders.
- Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).

The EA's abstraction policy **for P11 Hinton (River Isbourne)** is that

- there is water available for licensing subject to a HOF of 38Ml/d at Hinton gauging station on the River Isbourne and a HOF of 1800Ml/d at Deerhurst gauging station on the River Severn.
- This means that for new licences: All new consumptive or partially consumptive licences will be issued with this HOF;
- Water is only available during periods of medium to high flows due to the HOF condition;
- There is a time limit of 31 March 2025

and for existing licences

There is no impact on existing licence holders.
Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).

The EA's abstraction policy for AP12 Wyre Piddle (Piddle Brook) is that

- There is water available for licensing subject to a HOF of 11Ml/d at Wyre Piddle gauging station on the Piddle Brook and a HOF of 1800Ml/d at Deerhurst gauging station on the River Severn.
- This means that *for new licences*:
- All new consumptive or partially consumptive licences will be issued with this HOF;
- Water is only available during periods of medium to high flows due to the HOF condition;
- There is a time limit of 31 March 2025

and for existing licences

- There is no impact on existing licence holders.
- Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).

The EA's abstraction policy for AP13 Besford Bridge (Bow Brook) is that

- there is water available for licensing subject to a HoF of 16Ml/d at Besford Bridge gauging station on the Bow Brook and a HOF of 1800Ml/d at Deerhurst gauging station on the River Severn.

This means that *for new licences*

- All new consumptive or partially consumptive licences will be issued with this HOF;
- Water is only available during periods of medium to high flows due to the HOF condition;
- There is a time limit of 31 March 2025

and for existing licences

- There is no impact on existing licence holders.
- Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).

The EA's abstraction policy **for AP14 Upper Pound (River Avon)** is that

- For the Avon catchment from Evesham to the Severn confluence, there is water available for licensing subject to a HoF of 1800Ml/d at Deerhurst gauging station on the River Severn.
- This means that for new licences:
- All new consumptive or partially consumptive licences will be issued with this HOF;
- Water is only available during periods of medium to high flows due to the HOF condition;

There is a time limit of 31 March 2025

and for existing licences

- There is no impact on existing licence holders.
- Time limited licences will be renewed subject to the fulfilment of the renewal criteria (justification of need, water efficiency and environmental sustainability).
- There are two SACs within the Warwickshire Avon catchment but as neither is water-dependent they have no impact on the licensing strategy.

The EA's abstraction policy for **Groundwater** in this catchment is that this area contains two principal aquifers – the Sherwood Sandstone and Jurassic Limestone.

Warwickshire Avon: (Wychavon, Redditch and Bromsgrove) EA Proposals to improve Water Quality

- Improvement to discharges at a number of sewage treatment works
- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Guidance and training in irrigation best practice, including benchmarking and Scheduling
- Pollution reduction campaigns on local industrial estates
- Encourage farmers and industry to build storage reservoirs to support or replace summer irrigation
- Voluntary Initiative educational and advice programme to reduce the impact of agricultural chemical use including metaldehyde (slug pellets) in the River Leam catchment
- Wildlife Trust projects to improve the ecological value of the rivers Avon, Stour and Sowe through partnerships with landowners, schools and the local community.

Telford, Black Country, Bromsgrove, Kidderminster and Coventry Cluster: Current EA Flooding Policy

This a Policy Option 5 – Areas of moderate to high flood risk where we (EA) can generally take further action to reduce flood risk.

The EA's Proposed actions to implement the preferred policy are

- Ensure floodplains are not inappropriately developed. Follow the 'sequential approach' of PPS 25 and consider land swapping opportunities.
- Encourage compatibility between urban open spaces and their ability to make space for rivers to expand as flood flows occur. One example of a flood-compatible use is playing fields. Develop strategies to create 'blue corridors' by developing/redeveloping to link these flood-compatible spaces.
- Raise awareness of flooding among the public and key partners, especially major operators of infrastructure, allowing them to be better prepared. Encourage them all to increase the resilience and resistance of vulnerable buildings, infrastructure and businesses.
- Develop better understanding of flooding from surface water, from drainage systems, and from 'non-main' watercourses. Produce a strategy for operation and investment, integrating all these with main rivers, Local authorities to develop Surface Water Management Plans for the Bromsgrove, Droitwich and Kidderminster areas. Apply lessons from Integrated Urban Drainage pilot schemes, for example Telford & Wrekin.
- Review how effective and sustainable each flood defence is. Review maintenance operations to ensure they are proportionate to flood risk. Manage fly-tipping [on floodplains and in channels.] Avoid excessive silt accumulation in artificial channels [Either by channel modifications or by de-silting.] Focus on bottlenecks.
- Maintain flood warning systems and explore opportunities to improve their effectiveness and coverage,
- Carry out an assessment of the scheme to canalise the River Salwarpe [around Droitwich etc] in terms of flood risk.

Appendix 5: Severn River Basin District Flood Risk Management Plan 2015-2021[76] (2016)

Includes the following conclusions and objectives with regard to improving flooding in the following catchments in Worcestershire, all of these will be material considerations but some, shown as an X in the table are not likely to be realised by the Minerals Local Plan.

Environment Agency Objectives

Where shaded green the following Objectives apply to these management catchments, where possible the WMLP will contribute to achieving the Objective.

[76] Severn River Basin District Flood Risk Management Plan 2015-2021 (2016) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/507832/LIT_10213_SEVERN_FRMP_PART_A.pdf

Table 16 Severn River Basin District Flood Risk Management Plan 2015-2021– Objectives and WMLP

Objective	Catchment Worcs Middle Severn	Teme	Warwickshire Avon	Severn Vale	WMLP
Social					
Reduce or prevent an increase in harm to life as a result of flooding.			Reduce risk to people		Can potentially contribute.
Reduce the likelihood of death or serious injury resulting from rapid inundation or deep and fast flowing water					Can potentially contribute.
Improve flood warning services on catchments that react rapidly to rainfall.					Sites not located in 'flashy' catchments.
Minimise community disruption by reducing impact of flooding by increasing preparedness through improved flood warning service and public awareness.			minimise community disruption prepare communities and build resilience		Not possible through WMLP
Locate development in areas at lowest risk of flooding			Consider flood risk in development plans		WMLP will contribute where possible.

Objective	Catchment				WMLP
	Worcs Middle Severn	Teme	Warwickshire Avon	Severn Vale	
Increased understanding and management of flood risk impacts					Not possible through WMLP.
Continue to work with utility providers to improve resilience of infrastructure services					Not possible through WMLP.
Continue to work with other bodies to improve resilience to the communication network and transport links					WMLP will contribute where possible.
Contribute to recreational amenity & cultural heritage conservation through managing flood risk					WMLP will contribute where possible.
Maintain existing assets that protect people			maintain existing assets that protect people where economically viable or find suitable alternatives by working in partnership with communities		Not possible through WMLP.

Objective	Catchment				WMLP
	Worcs Middle Severn	Teme	Warwickshire Avon	Severn Vale	
River, watercourse and defence maintenance					Not possible through WMLP.
Economic					
Reduce economic damage to commercial properties.			maintain existing assets that protect business		WMLP will contribute where possible.
Reduce flood risk to private properties.			reduce economic damage		WMLP will contribute where possible.
Reduce risk to agricultural land					WMLP will contribute where possible.
Support the agricultural sector to manage catchment flood risk and ongoing improvements in sustainable agriculture.					WMLP will contribute where possible.
Ensure current and future investment in the catchment is proportional to flood risk					Not possible through WMLP.

Objective	Catchment				WMLP
	Worcs Middle Severn	Teme	Warwickshire Avon	Severn Vale	
Support tourism by reducing flood risk and enhancing river corridors.					WMLP will contribute where possible.
Reduce risk of flooding to major infrastructure			reduce economic damage		WMLP will contribute where possible.
Contribute to integrated catchment water management &/or sustainable drainage approach					WMLP will contribute where possible.
Protect transport services					Not possible through WMLP.
Environmental;					
Take opportunities to restore sustainable natural storage of floodwater on tributaries in their upstream areas, in order to offset increasing flood risk from trends including climate change					WMLP will contribute where possible.

Objective	Catchment Worcs Middle Severn	Teme	Warwickshire Avon	Severn Vale	WMLP
Work with natural processes wherever possible to achieve WFD objectives					WMLP will contribute where possible.
Improve water environment through flood risk management activities			achieve WFD objectives through flood risk management		WMLP will contribute where possible.
Improve hydromorphology of rivers			achieve WFD objectives through flood risk management		WMLP will contribute where possible.
Minimise impacts of flooding on designated sites or areas of environmental interest			conservation areas		WMLP will contribute where possible.
Create habitat through flood risk management activities					WMLP will contribute where possible.
Achieve WFD Objectives through Flood Risk Management					WMLP will contribute where possible.
Protect designated heritage sites					WMLP will contribute where possible.

Appendix 5: Severn Catchment EA proposals to improve water quality, by catchment (Worcestershire only)

This is a compilation of the Water Quality issues, set out in the individual catchments above

Teme; (Malvern Hills)

- Improvements to discharges at several sewage treatment works
- Provision of advice to farmers under the England Catchment Sensitive Farming Delivery Initiative
- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Actions to reduce the impact from pesticides including metaldehyde (slug pellets)

Worcestershire Middle Severn; (Wyre Forest, Worcester City, Bromsgrove and Wychavon)

- Improvement to discharges at a number of sewage treatment works
- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Projects on Wildlife Trust owned reserves to improve wetland and riparian habitat
- Wildlife Trust's 'Access to Nature' community involvement programme to improve habitat and raise awareness of Black Country rivers
- Green Futures initiative to provide co-ordinated advice to farmers on complying with agricultural and environmental regulations across the West Midlands

Severn Vale; (Malvern Hills)

- Investigating the sources of metals and other pollutants and various actions to improve the management of water resources
- Improvement to discharges at a number of sewage treatment works and investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Provision of advice to farmers under the England Catchment Sensitive Farming Delivery Initiative
- Salmon in Schools project to raise local awareness of the salmon lifecycle and habitat
- Pollution reduction campaigns on local industrial estates
- Actions to reduce the impact from pesticides including metaldehyde (slug pellets)

Warwickshire Avon; (Wychavon, Redditch and Bromsgrove)

- Improvement to discharges at a number of sewage treatment works
- Investigations to assess the impacts of abstraction on the environment under the Restoring Sustainable Abstraction programme
- Guidance and training in irrigation best practice, including benchmarking and Scheduling
- Pollution reduction campaigns on local industrial estates
- Encourage farmers and industry to build storage reservoirs to support or replace summer irrigation
- Voluntary Initiative educational and advice programme to reduce the impact of agricultural chemical use including metaldehyde (slug pellets) in the River Leam catchment
- Wildlife Trust projects to improve the ecological value of the rivers Avon, Stour and Sowe through partnerships with landowners, schools and the local community.

The **Severn river basin district River basin management plan Updated: December 2015** divides the Severn basin into a number of operational catchments. The Corridors proposed in the Third Consultation on the Minerals Local Plan are within the following EA Management and Operational catchments and include the following Defra Countryside Stewardship target watercourses.

Table 17 MLP Strategic Corridors proposed EA catchments and Defra Countryside Stewardship target watercourse

MLP Strategic Corridor (Sand and gravel)	WFD watercourse within MLP Strategic Corridor	RBMP Management catchment.	EA Proposed Operational Catchments	Defra Countryside Stewardship Water priorities
North West Worcestershire Corridor	-R Stour (Worcs) - conf Smestow Bk to conf R Severn -Staffordshire & Worcester Canal, - Stourbridge Canal to River Severn -Blakedown Bk - source to conf R Stour -Hoo Bk - source to conf R Stour -R Severn - conf R Worfe to conf R Stour -Gladder Bk - source to conf R Severn -R Severn - conf R Stour to conf RIver Teme (8 watercourses)	Worcestershire Middle Severn	Stour River and Tributaries Partly overlaps with the Sandstone Operational catchment. Some of the corridor in River Severn Worcestershire (small area around Stourport).	Severn and Avon vales (NCA 106) (Phosphate, nitrate, sediment and pesticides in the Severn River and its tributaries and the River Severn in Worcestershire catchments)

MLP Strategic Corridor (Sand and gravel)	WFD watercourse within MLP Strategic Corridor	RBMP Management catchment.	EA Proposed Operational Catchments	Defra Countryside Stewardship Water priorities
North East Worcestershire Corridor	- Battlefield Bk - source to conf Spadesbourne Bk - R Arrow - source to Spernall Hall Fm, Studley - Spadesbourne Bk - source to conf Battlefield Bk (3 watercourses)	Worcestershire Middle Severn	River Salwarpe small area north-west of Fairfield as in the Stour River and Tributaries catchment. The Stour River and Tributaries catchment in this area includes part of the Sandstone Operational catchment	Severn and Avon Vales (NCA 106) (phosphate, nitrate, sediment and pesticides in the Salwarpe River, Severn River and its tributaries and the River Severn in Worcestershire catchments and flooding issues) Severn Vale upstream of Worcester including key tributaries: of River Salwarpe)
Lower Severn Corridor	- R Severn - conf R Teme to conf R Avon - Careys Bk - source to conf R Severn - Madresfield Bk - source to conf R Severn - Pool Bk - confluence	Severn Vale	Severn River and Tributaries	Malvern Hills (NCA 103) (surface water, drinking water sources from the River Severn in the catchment between the Teme and Avon) And Severn and Avon Vales (NA106) (phosphate, nitrate, sediment and pesticides in

MLP Strategic Corridor (Sand and gravel)	WFD watercourse within MLP Strategic Corridor	RBMP Management catchment.	EA Proposed Operational Catchments	Defra Countryside Stewardship Water priorities
	Mere Bk to conf R Severn - Bushley Bk - conf MarlBank Bk to conf R Severn - Ripple Bk - source to conf R Severn (6 watercourses)			Malvern Hills, Severn River and its tributaries and the River Severn in Worcestershire catchments) and (surface water, drinking water supplied in the catchment s to the River Severn between the Teme and Avon)
Avon and Carrant brook Corridor	-R Avon conf Workman Br, Evesham to conf R Severn - Bourne Bk - source to conf R Avon - Mary Bk - source to conf R Avon - Bow Bk - Shell to conf R Avon (Brist - Elmley Castle - source	Avon and Warwickshire	Avon and West Midlands Some of the corridor is in the Avon urban catchment (Avery small area, north east of Evesham).	Severn and Avon Vales (NCA 106) (phosphates and sediment in the Avon catchments) (flooding issues Avon Vale including key tributaries: Osbourne, Bow Brook, Badsey (including Bretforton, Littleton and Gate Inn Brooks), Merry Brook.

MLP Strategic Corridor (Sand and gravel)	WFD watercourse within MLP Strategic Corridor	RBMP Management catchment.	EA Proposed Operational Catchments	Defra Countryside Stewardship Water priorities
	to conf R Avon - R Isbourne - conf Laverton Bk to conf R Avon - R Avon- Tramway Br Stratford to Workman Br Evesham - Badsey Bk - conf Bretforton Bk to conf R Avon - Unnamed trib - source to conf Bretforton Bk - Harvington Bk - source to conf R Avon - Carrant Bk - source to conf Washbourne Bk - Carrant Bk - conf Washbourne Bk to conf			

MLP Strategic Corridor (Sand and gravel)	WFD watercourse within MLP Strategic Corridor	RBMP Management catchment.	EA Proposed Operational Catchments	Defra Countryside Stewardship Water priorities
	RIver Avon - Carrant Bk - conf Washbourne Bk to conf RIver Avon			
Malvern Hills Corridor	No WFD watercourses are designated in this corridor	Severn Vale	Malvern Hills catchment Some of the corridor is in the Bushley, Longdon, Marlbrook and Ripple Brook catchment. (The area south of Little Malvern).	Malvern Hills (NCA 103) Malvern Hills catchment) Malvern Hills (NCA 103) (Malvern Hills and Bushley, Longdon, Marlbank and Ripple Brook catchments)
Bredon Hill Corridor	- R Avon conf, Workman Br, Evesham to conf R Severn (1 watercourse)	Avon Warwickshire	Avon Midlands West catchment	Severn and Avon Vales (NCA 106) (phosphate and sediment in the Avon Catchments)

The **Severn River basin district River basin management plan Updated: December 2015** identifies the following measures to improve these catchments:

Table 18 Severn River basin district River basin management plan Updated: December 2015

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
Worcestershire Middle Severn: River Stour & tributaries	Removal or modification of engineering structure Improvement to condition of channel/bed and /or banks shoreline Improvement to condition of	Mitigate/remediate point source impacts on receptor	Reduce diffuse pollution pathways (i.e. control entry to the water environment)	Water demand management Control pattern/timing of abstraction Use alternative source/relocate abstraction or discharge	Reduce diffuse pollution at source Mitigate/remediate diffuse pollution impacts on the receptor	

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
	riparian zone.					
Worcestershire Middle Severn: Salwarpe Catchment	Removal or modification of engineering structure Improvement to condition of channel/bed and/or banks/shoreline Changes to operation and maintenance Vegetation management	Reduce diffuse pollution at source Mitigate/remediate point source impacts on receptor	Reduce diffuse pollution pathways (i.e. control entry to the water environment)	Control pattern/timing of abstraction	Reduce diffuse pollution at source Mitigate/remediate diffuse pollution impacts on the receptor	Early detection, monitoring and rapid response (to reduce the risk of establishment).

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
Worcestershire Middle Severn: Pt Sandstone operational catchment				• Control pattern/timing of abstraction • Use alternative source/relocate abstraction or discharge	• Reduce diffuse pollution at source	
Severn Vale: Malvern Hills	Removal or easement of barriers to fish migration Improvement to condition of riparian zone and /or wetland	Reduce diffuse pollution at source Reduce point source pollution pathways (i.e. control entry to the water environment)	Reduce diffuse pollution pathways (i.e. control entry to the water environment)		Reduce diffuse pollution at source	Early detection, monitoring and rapid response (to reduce the risk of establishment) Building awareness and understanding (to slow the

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
	habitats Changes to operation and maintenance	Reduce point source pollution at source				spread)
Severn Vale: Bushley, Longdon, Marlbrook and Ripple Brook catchment	Improvement to condition of channel/bed and/or banks/shoreline Improvement to condition of riparian zone and /or wetland habitats	Reduce diffuse pollution at source Reduce point source pollution pathways (i.e. control entry to the water environment) Mitigate/remediate point source impacts on receptor		Improvemento condition of channel/bed and/or banks/	Reduce diffuse pollution at source Reduce diffuse pollution pathways (i.e. control entry to water environment)	

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
		Reduce point source pollution at source				
Avon Warwickshire: Avon Midlands West	Removal or easement of barriers to fish migration Improvement to condition of riparian zone and /or wetland habitats Changes to operation and maintenance	Reduce diffuse pollution at source Reduce point source pollution pathways (i.e. control entry to the water environment) Reduce point source pollution at source	Reduce diffuse pollution pathways (i.e. control entry to the water environment)		Reduce diffuse pollution at source Reduce diffuse pollution pathways (i.e. control entry to water environment)	Early detection, monitoring and rapid response (to reduce the risk of establishment)

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
Avon Midlands West: Avon Rural Catchment	Removal or easement of barriers to fish migration Removal or modification of engineering structure Improvement to condition of channel/bed and/or banks/shoreline • Improvement to condition of riparian zone	Reduce diffuse pollution at source Reduce point source pollution pathways (i.e. control entry to the water environment) Mitigate/remediate point source impacts on receptor	Reduce diffuse pollution pathways (i.e. control entry to the water environment) Mitigate/remediate diffuse pollution impacts on the receptor	Control pattern/timing of abstraction	Reduce diffuse pollution at source	•Early detection, monitoring and rapid response (to reduce the risk of establishment)

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
	and /or wetland habitats					
Avon Midlands West: Avon Urban Catchment NB, only a very small part of Worcestershire is in this catchment	Removal or easement of barriers to fish migration Removal or modification of engineering structure Improvement to condition of channel/bed and/or banks/shoreline	Reduce diffuse pollution at source Mitigate/remediate point source impacts on receptor	Reduce diffuse pollution pathways (i.e. control entry to the water environment) Mitigate/remediate diffuse pollution impacts on the receptor	Control pattern/timing of abstraction Improvement to condition of channel/bed and/or banks/shoreline	Reduce diffuse pollution at source	Early detection, monitoring and rapid response (to reduce the risk of establishment)

Catchment	Improve modified physical habitats	Managing pollution from waste water	Manage pollution from towns, cities and transport	Improve the natural flow and level of water	Manage pollution from rural areas	Manage invasive non-native species
	Improvement to condition of riparian zone and /or wetland habitats Changes to operation and maintenance Vegetation management					

Appendix 6 Sequential test of Areas of Search

Table 19 below summaries the flood risk information for each site and the conclusion from the Sequential Test. Although sand and gravel sites are classed as 'water compatible', the allocation of sites should still follow the sequential approach and should consider the need to avoid flood risk from sources other than rivers and the sea. The sequential approach should also be applied at the site level to ensure that more vulnerable uses are located in areas at lowest flood risk.

Other types of mineral working (i.e. brick clay and building stone) and processing are considered less vulnerable and again do not require an Exception Test for Flood Zones 1-3a however they are not permitted in Flood Zone 3b. Given the strategic nature of this assessment and the requirement for mineral resources a more detailed analysis will be required including undertaking an Exception test, to enable the allocation of these resources within the MLP.

A 'RAG' rating has been devised to differentiate AOS according to the flood zone that intercepts it and to help identify which AOS may be more 'at risk' from flooding from a particular source to assist with the 'sequential test' process. This information will be used to inform the site selection and preferred areas of search process.

Flood Zones

Analysis has been made of the Flood Zones that intersect a given AOS and these have been recorded as follows

Flood Zone 1 (Green) any area that falls outside of Flood Zone 2, Flood Zone 3 or Flood Zone 3b is considered to be Flood Zone 1. However, at the time of writing flood zones are only mapped for watercourses with a catchment bigger than 3km2, meaning that smaller water courses are unmapped. As new evidence emerges the Flood Zone status may change.

Flood Zone 2 (Yellow), Flood Zone 3 (Amber) and Flood Zone 3b (Red).

Where no Flood Zone has been identified this has been left blank (White).

Given the strategic scale of the AOS it is possible that a large part of an AOS may fall within Flood Zone 1 (Green) and a small part of the AOS may be intersected by Flood Zone 3 (Red) from a neighbouring watercourse or Main River. In this case there may be no Flood Zone 2 or 3 identified and these have been left blank (White).

Surface water flooding

Given the strategic scale of the AOS there may be numerous watercourses present. Where flood risk receptors have been identified within an AOS the number has been recorded and the 'Risk of Surface Water Flooding' given an Amber status. Where no receptors have been identified a zero rating has been recorded and the 'Risk of Surface Water Flooding' given a green status.

However, green status does not imply that surface water flooding is not possible particularly as flood zones are currently only mapped for watercourses with a catchment bigger than 3km2.

The status of receptors and of watercourses may change overtime as new evidence emerges. The risk of surface water flooding should be modeled as part of a comprehensive Flood Risk Assessment to accompany any development application.

Water Framework Directive

Given the strategic scale of the AOS numerous WFD watercourses or catchments may intersect an AOS.

Where analysis has identified several watercourses with differing WFD status records intersecting an AOS the rating has been set at the lowest rating e.g. Good (Green)/Moderate (Yellow)/Poor (Amber)/Bad (Red).

Where no watercourse has been identified a zero record has been recorded and the column left coloured blank (white). WFD rating may change subject to further assessment and EA consultation at MLP or application stage.

Source Protection Zones

Where an AOS overlays a Source Protection Zone the status has been rated as amber. Where no Source Protection Zone is present the status has been recorded as green.

For confidence a 20 metre buffer has been applied to each AOS to identify any nearby Source Protection Zones and these should be taken into account in the preparation of Hydrological Impact Assessments.

Fluvial Flood Risk		
'RAG' Rating and Key to Table 18	Flood Zone	Risk of Flooding and is planning acceptable
	Flood Zone 3b	For mineral development not permitted in Flood Zone 3b e.g. brick clay and building stone.
	Flood Zone 3	Mineral development acceptable – subject to FRA
	Flood Zone 2	Mineral development acceptable – subject to FRA
	Flood Zone 1	Mineral development acceptable – subject to FRA
Surface Water Flood Risk		
	Medium Risk	Surface water flooding receptors identified. In addition un—modeled watercourses may be present – status may change. Unlikely to inhibit sand and gravel development.
	Low Risk	No surface water flooding receptors currently identified. However, un—modeled watercourses may be present – status may change.
Water Framework Directive	**WFD Status**	
	Good	Where there are several different status records across an AOS the rating has been set at the lowest rating e.g. Good (Green)/Moderate (Yellow)/Poor (Amber)/Bad (Red). The different ratings within an area of search have been identified to show the range that occurs. Rating may change subject to further

		assessment and EA consultation at MLP or application stage. The different ratings within the area of search to show the range
	Moderate	Where there are several different status records across an AOS the rating has been set at the lowest rating e.g. Good (Green)/Moderate (Yellow)/Poor (Amber)/Bad (Red). The different ratings within an area of search have been identified to show the range that occurs. Rating may change subject to further assessment and EA consultation at MLP or application stage.
	Poor	Where there are several different status records across an AOS the rating has been set at the lowest rating e.g. Good (Green)/Moderate (Yellow)/Poor (Amber)/Bad (Red). The different ratings within an area of search have been identified to show the range that occurs. Rating may change subject to further assessment and EA consultation at MLP or application stage.
	Bad	Where there are several different status records across an AOS the rating has been set at the lowest rating e.g. Good (Green)/Moderate (Yellow)/Poor (Amber)/Bad (Red). The different ratings within an area of search have been identified to show the range that occurs. Rating may change subject to further assessment and EA consultation at MLP or application stage.
Source Protection Zone		
	AOS overlays an SPZ	Or SPZ is buffered within 20m of AOS.
	AOS does not	

	overlay and SPZ	

Note

Mapping of fluvial water flood risk has been taken from the Environment Agency Flood Map and Historic Flood Map.

Mapping of surface water flood risk has been taken from the locally agreed surface water information informing Surface Water Management Plan for Worcestershire prepared by Worcestershire County Council identifying those areas where surface water flooding poses a risk to infrastructure, property, businesses and homes.

Source Protection Zones have been identified from information supplied by the Environment Agency.

Table 19 Sequential Test of AOS by Strategic Corridor

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection Zone (SPZ)	SPZ (within 20m)
Lower Severn (3280.61 Ha)	Clay	10	547					Development is appropriate		7	1	0	0	0
		11	655					Development is appropriate		12	0	0	0	0
		12	10					Development is appropriate		1	0	0	0	0
		13	136					Development is appropriate		2	3	0	0	0
	SSSG – N/A within this Corridor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	TGSG	61	71.53					Development is appropriate		0	0	M/P	0	0
		70	43.46					Development is appropriate		0	0	M	0	0
		69	128.47					Development		2	4	M	0	0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is appropriate						
		64	29.21					Development is appropriate		0	0	M	0	0
		63	9.32					Development is appropriate		0	0	0	0	0
		59	1.31					Development is appropriate		0	0	0	0	0
		60	203.28					Development is appropriate		7	0	M	0	0
		57	40.08					Development is appropriate		0	0	M	0	0
		58	39.45					Development is appropriate		0	0	M	0	0
		68	2.17					Development is appropriate		0	0	M	0	0
		65	28.25					Development is appropriate		0	0	M	0	0
		67	17.5					Development is appropriate		0	0	0	0	0
		66	503.76					Development		11	0	M	0	0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is appropriate						
		62	123.1					Development is appropriate		1	1	M/P	0	0
	Building Stone N/A within this corridor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	WFSS N/A within this corridor.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a-	n/a	n/a	n/a	n/a
North-West Worcs (5391.21ha)	Clay N/A within this corridor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	SSSG	13	6.94					Development is appropriate		0	0	M		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
		14	5.81					Development is appropriate		0	0	G/M/P	0	0
		15	1.68					Development is appropriate		0	0	G		0
		16	0.56					Development is appropriate		0	0	0		0
		17	1814.19					Development is appropriate		13	3	M/P		0
		1	292.52					Development is appropriate		0	0	G/M/P		0
		2	312.11					Development is appropriate		0	1	G/M/P		0
		3	228.38					Development is appropriate		4	4	G/M		0
		4	3.29					Development is appropriate		0	0	M		0
		5	10.85					Development is appropriate		0	0	G/M		0
		6	22.79					Development is appropriate		0	0	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection Zone (SPZ)	SPZ (within 20m)
		7	940.63					Development is appropriate		7	2	G/B/M		0
		8	0.11					Development is appropriate		0	0	M		0
		9	4.81					Development is appropriate		0	0	0		0
		10	73.3					Development is appropriate		1	0	G/B/M		0
		11	27.69					Development is appropriate		0	0	G/M		0
		12	144.04					Development is appropriate		0	0	0		0
	TGSG	3	25.31					Development is appropriate		0	0	G/M		0
		8	49.06					Development is appropriate		2	0	P		0
		1	10.35					Development is appropriate		0	0	P		0
		2	9.56					Development is appropriate		0	0	P		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection Zone (SPZ)	SPZ (within 20m)
		7	40.37					Development is appropriate		2	0	M		0
		4	19.99					Development is appropriate		1	1	P		0
		6	79.64					Development is appropriate		5	1	G		0
		5	1.25					Development is appropriate		0	0	P		0
	WFSS	1	1.64					Development is appropriate		0	0	0	0	0
		2	1.74					Development is appropriate		0	0	0	0	0
		10	1.68					Development is appropriate		1	0	G		0
		9	5.81					Development is appropriate		1	0	G/M		0
		8	6.94					Development is appropriate		3	0	G/M		0
		3	289.14					Development is appropriate		19	0	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
		5	3.29					Development is appropriate		1	1	0	0	0
		4	85.42					Development is appropriate		4	1	0	0	0
		6	10.86					Development is appropriate		0	0	G/M	0	0
		7	1000.43					Development is appropriate		9	2	G/M		0
		17	0.77					Development is appropriate		1	0	P		0
		16	7.92					Development is appropriate		0	0	P	0	0
		15	1.13					Development is appropriate		0	0	P		0
		13	2.78					Development is appropriate		0	1	P		0
		11	4.01					Development is appropriate		1	0	P/G		0
		18	518.2					Development is appropriate		2	2	P		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
		12	0.65					Development is appropriate		0	0	G		0
		14	505.66					Development is appropriate		0	0	P/G		0
	Building Stone	2						Development is not appropriate		1	0	0		0
		3						Development is not appropriate		0	0	0		0
		1						Development is not appropriate		1	0	0		0
		4						Development is not appropriate		0	0	0	0	0
		9						Development is not appropriate		0	0	B		0
North-East Worcs	Clay	3	42					Development is appropriate		1	1	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
(3347.13 ha)														
		5	64					Development is appropriate		0	0	0		0
	SSSG	18	18.03					Development is appropriate		0	0	0		0
		21	538.76					Development is appropriate		5	0	M/P		0
		22	3.03					Development is appropriate		8	0	0		0
		23	212.99					Development is appropriate		8	0	M		0
		30	192					Development is appropriate		4	0	M		0
		24	2.47					Development is appropriate		1	0	0		0
		25	219.53					Development is appropriate		6	0	0		0
		26	32.19					Development is appropriate		1	0	M		0
		27	24.51					Development		1	0	M		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is appropriate						
		28	181.88					Development is appropriate		8	0	M		0
		29	30.18					Development is appropriate		2	0	0		0
	TGSG	18	3.1					Development is appropriate		0	0	0		0
		17	11.31					Development is appropriate		0	0	0		0
		25	1.41					Development is appropriate		0	0	0		0
		24	14.63					Development is appropriate		1	0	0		0
		23	59.8					Development is appropriate		0	0	0		0
		15	2.18					Development is appropriate		0	0	0		0
		16	18.09					Development is appropriate		1	0	0		0
		14	1					Development		0	0	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is appropriate						
		13	9.56					Development is appropriate		0	0	M		0
		12	12.81					Development is appropriate		0	0	0		0
		9	100.99					Development is appropriate		2	0	M		0
		11	7.58					Development is appropriate		0	0	0		0
		10	2.57					Development is appropriate		0	0	0		0
		22	3.27					Development is appropriate		1	0	M		0
		21	27.16					Development is appropriate		2	0	M		0
		20	38.31					Development is appropriate		0	0	M		0
		19	0.99					Development is appropriate		0	0	0		0
	WFSS	40	5.35					Development		0	0	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is appropriate						
		39	16.11					Development is appropriate		0	0	0		0
		38	2.01					Development is appropriate		0	0	0		0
		37	1.9					Development is appropriate		0	0	0		0
		35	3.96					Development is appropriate		0	0	0		0
		34	0.02					Development is appropriate		0	0	0		0
		36	16.31					Development is appropriate		0	0	0		0
		41	168.69					Development is appropriate		1	0	0		0
		31	22.57					Development is appropriate		0	0	M		0
		30	5.08					Development is appropriate		0	0	0		0
		32	0.79					Development		0	0	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is appropriate						
		33	86.15					Development is appropriate		0	0	0		0
		28	27.11					Development is appropriate		0	0	0		0
		29	78.32					Development is appropriate		1	0	M		0
		27	3.9					Development is appropriate		0	0	0		0
		25	1.41					Development is appropriate		0	0	M		0
		26	58.25					Development is appropriate		3	0	0		0
		24	2.32					Development is appropriate		1	0	0		0
		23	133.84					Development is appropriate		2	0	M		0
		22	161.53					Development is appropriate		1	0	M		0
		21	21.32					Development		1	0	0		0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection Zone (SPZ)	SPZ (within 20m)
								is appropriate						
		20	4.14					Development is appropriate		0	0	0		0
		19	13.18					Development is appropriate		0	0	0		0
	Building Stone	6						Development is appropriate		0	0	0		
		11						Development is not appropriate		0	0	0		
		12						Development is not appropriate		1	0	0		
		13						Development is not appropriate		3	0	0		
Salwarpe Tributaries (12310.1 ha)	Clay	2						Development is appropriate		88	20	M/P	0	0
		1						Development		96	24	M/P		

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection Zone (SPZ)	SPZ (within 20m)
								is appropriate						
		10						Development is appropriate		2	1	P	0	
	SSSG N/A within this corridor.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	TGSG	28	44.98					Development is appropriate		1	2	P	0	0
		27	22.44					Development is appropriate		0	2	P	0	0
		30	9					Development is appropriate		1	1	P	0	0
	Building Stone	5						Development is not appropriate		0	0	0		
		4						Development is not appropriate		1	0	0		
		7						Development		1	0	P		

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
								is not appropriate						
		8						Development is not appropriate		0	0	0		
		10	734					Development is not appropriate		2	0	0		
Avon and Carrant Brook (9498.89)	Clay	8	73.59					Development is not appropriate		2	0	M	0	0
		7	228.17					Development is not appropriate		4	1	M	0	0
		9	315					Development is not appropriate		2	2	M	0	0
	SSSG N/A within this corridor.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
	TGSG	36	182.58					Development is appropriate		1	2	0	0	0
		34	236.92					Development is appropriate		5	0	0	0	0
		33	25.63					Development is appropriate		1	0	0	0	0
		30	12					Development is appropriate		0	0	0	0	0
		29	38.26					Development is appropriate		1	0	0	0	0
		31	117.93					Development is appropriate		0	1	MP	0	0
		32	210.91					Development is appropriate		9	0	MP	0	0
		43	530.80					Development is appropriate		6	1	M/P	0	0
		44	117.66					Development is appropriate		0	0	M	0	0
		39	312.38					Development is appropriate		6	1	M/P	0	0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
		49	94.16					Development is appropriate		1	0	M	0	0
		48	3.26					Development is appropriate		0	0	M	0	0
		47	10.47					Development is appropriate		0	0	M	0	0
		50	49.97					Development is appropriate		0	0	M	0	0
		54	76.36					Development is appropriate		2	0	M	0	0
		46	215.81					Development is appropriate		4	1	M	0	0
		53	219.84					Development is appropriate		6	0	M	0	0
		56	35.1					Development is appropriate		0	0	M	0	0
		55	53.02					Development is appropriate		0	0	M	0	0
		42	16.72					Development is appropriate		0	0	M/P	0	0

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	WFD status Bad, Good, Moderate or	Source Protection	SPZ (within 20m)
		40	16.38					Development is appropriate		0	0	M/P	0	0
		41	25.53					Development is appropriate		0	0	M/P	0	0
		52	13.9					Development is appropriate		0	0	M	0	0
		51	9.63					Development is appropriate		1	0	M	0	0
		38	24.47					Development is appropriate		2	0	0	0	0
		37	12.2					Development is appropriate		1	0	0	0	0
		45	27.04					Development is appropriate		0	0	M	0	0
		68	33.87					Development is appropriate		0	2	M	0	0
	Building Stone N/A within this	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Strategic Corridor	Area of Search Mineral	AoS Reference	AoS Ha	Flood Zone 1	Flood Zone 2	Flood Zone 3	Flood Zone	Outcome of Sequential Test	Risk of Surface Water Flooding	Flood Risk Receptors	Flood Risk Receptors	Moderate or Bad, Good,	WFD status	Protection	Source	SPZ (within 20m)
	corridor.															

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