Nottinghamshire Level 1 Minerals Strategic Flood Risk Assessment

Nottinghamshire County Council

March 2018

Quality information

Prepared by	Checked by	Approved by
Anne-Marie McLaughlin Graduate Consultant, Water	**Penelope Borton** Senior Consultant, Water	**Fay Bull** Regional Director, Water
Rachel Littley Graduate Consultant, Water Resources	**Katie Pearson** Associate, Water	
Tom Newman Graduate Consultant		

Revision History

Revision	Revision date	Details	Authorised	Name	Position
V1.0	29 March 2018	Final Draft Report	✔	Penelope Borton	Senior Consultant - Water

Prepared for:

Nottinghamshire County Council

Prepared by:

AECOM

AECOM
Royal Court
Basil Close
Chesterfield
Derbyshire
S41 7SL
UK

T: +44 (0) 1246 209221
aecom.com

This document has been prepared by AECOM Limited ("AECOM") for sole use of our client (the "Client") in accordance with generally accepted consultancy principles, the budget for fees and the terms of reference agreed between AECOM and the Client. Any information provided by third parties and referred to herein has not been checked or verified by AECOM, unless otherwise expressly stated in the document. No third party may rely upon this document without the prior and express written agreement of AECOM.

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- Is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations");
- Represents AECOM's professional judgement in light of the Limitations and industry standards for the preparation of similar reports;
- May be based on information provided to AECOM which has not been independently verified;
- Has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued;
- Must be read as a whole and sections thereof should not be read out of such context; and,
- Was prepared for the specific purposes described in the Report and the Agreement.

AECOM shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. AECOM accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

AECOM agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but AECOM makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

Except (1) as agreed to in writing by AECOM and Client; (2) as required by-law; or (3) to the extent used by governmental reviewing agencies for the purpose of obtaining permits or approvals, the Report and the Information may be used and relied upon only by Client.

AECOM accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of AECOM to use and rely upon the Report and the Information. Any injury, loss or damages arising from improper use of the Report shall be borne by the party making such use.

This Statement of Qualifications and Limitations is attached to and forms part of the Report and any use of the Report is subject to the terms hereof.

Table of Contents

Tables

Figures

1. Introduction

1.1 Background

The National Planning Policy Framework (NPPF) (2012)[1] sets out the requirement for Local Planning Authorities (LPAs) to complete a Strategic Flood Risk Assessment (SFRA) in support of Local Plans to aid in the planning process and decision making for flood risk.

A Level 1 Minerals and Waste Strategic Flood Risk Assessment (SFRA) was produced by URS/Scott Wilson (now AECOM) for Nottinghamshire County Council (NCC) and Nottingham City Council (NCiC) in 2011. A subsequent update by URS was completed in 2015 to include amendments to the proposed site allocations and ensure the assessment of flood risk aligned with the updated NPPF and accompanying Planning Practice Guidance (PPG) (2014)[2]. New and updated flood risk datasets were also available.

NCC is commencing preparation of the new Nottinghamshire Minerals Local Plan (following withdrawal of the previous plan). The new Minerals Local Plan will cover the planning period of 2016 to 2036 and will identify mineral demand, site specific allocations to meet this demand and the planning policies against which future minerals development will be assessed. Additionally, there have been updates to the PPG in regards to the assessment of flood risk in the context of climate change.

These changes must be addressed by a Level 1 SFRA. As such, AECOM Infrastructure and Environment Ltd. (AECOM) has been commissioned by NCC to produce an updated Level 1 Minerals SFRA.

The updated Level 1 Minerals SFRA will include the following updates to support the new Minerals Local Plan:

- A summary of national and local policy which remains relevant following the completion of the 2015 Level 1 Minerals SFRA update; policy released since the 2015 update and commentary on the policies which have since been superseded;
- A summary of the new climate guidance, released in February 2016[3], and provision of advice for the application of this guidance in the context of the SFRA;
- Updated methodologies for using the SFRA as a framework for applying the Sequential Test;
- A review and update of the GIS datasets previously used, including a summary of flood risk data provided by the Environment Agency and Lead Local Flood Authority (LLFA) for the purposes of the SFRA update;
- An update of mapping and reporting to reflect amendments to proposed Mineral Site Allocations and the identification of additional sites;
- Guidance to Nottinghamshire County Council on the use of the updated SFRA mapping in assessing site allocations;
- An update and review of flood risk across Nottinghamshire to account for recent flooding events and enhancements in data; and,
- An update of appendices to include additional sites and datasets where applicable.

1.2 Aims and Objectives

The aim of the study is to provide an up to date Level 1 Minerals SFRA to inform planning and development policies for NCC's new Minerals Local Plan in accordance with the NPPF and PPG. The SFRA will provide an evidence-based strategic level assessment of flood risk for the county to inform the delivery of mineral sites. The outcomes will feed into the longer-term new Minerals Local Plan and will be used to refine information on the areas that may flood, providing the basis for a sequential approach to development allocation and control.

Table 1-1 provides the planning context for NCC's Level 1 Minerals SFRA update.

1 Communities and Local Government (2012) The National Planning Policy Framework
https://www.gov.uk/government/publications/national-planning-policy-framework--2
2 Communities and Local Government (2014) National Planning Practice Guidance
http://planningguidance.planningportal.gov.uk/
3 Flood Risk Assessments: Climate Change Allowances
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Table 1-1: Planning Context for the SFRA: Relevant Past and Future Planning Documents

Planning Document	Date of Delivery	Context of SFRA
NCC and Nottingham Minerals and Waste Level 1 SFRA	April 2011	Historic assessment informs Level 1 Minerals SFRA Update for 2018.
NCC Minerals Level 1 SFRA Update	July 2015	Historic assessment informs Level 1 Minerals SFRA Update for 2018.
Call for Sites and Minerals Local Plan Issues and Options Consultation	14 January 2018	Call for Sites and Issues and Options Consultation will inform proposed Minerals Sites for assessment.
Nottinghamshire Minerals Level 1 SFRA Update (Draft)	March 2018	Draft Level 1 Minerals SFRA Update for 2018.
Sequential Test	To be confirmed	Sequential Test informed primarily by findings of the Minerals Level 1 SFRA Update.
Nottinghamshire Minerals Level 1 SFRA Update (Final)	Summer 2018	Final Level 1 Minerals SFRA Update for 2018 – Following Consultation and subsequent updates.
New Minerals Local Plan Submission Draft Consultation	Summer 2018	Flood risk considerations in the new Minerals Local Plan informed by the Nottinghamshire Minerals Level 1 SFRA Update.
Submission of new Minerals Local Plan	To be confirmed	As above.
Examination	To be confirmed	Independent examination by a Government Appointed inspector who will look at whether the new Minerals Local Plan is sound (taking into account any representations made at the submissions stage).
Adoption of Minerals Local Plan	2019	The new Minerals Local Plan will become adopted policy.

The aims of the Level 1 SFRA update will be met through achieving the following objectives:

- To provide an assessment of the impact of all potential sources of flooding in accordance with NPPF, including an assessment of any future impacts associated with climate change in the context of the new climate change guidance for planners;
- Identify planning policies for the management of local flooding issues;
- Provide information required to apply the Sequential Test for identification of land suitable for development, steering development towards areas of lowest flood risk, in line with the principles of the NPPF;
- To provide baseline data to inform the scope of the Sustainability Appraisal with regard to catchment-wide flooding issues which affect Nottinghamshire;
- Provide sufficient information to establish the detail required for site-specific Flood Risk Assessments;
- Provide recommendations of suitable mitigation measures including the objectives of Sustainable Drainage Systems (SuDS);
- Enable LPAs to use the SFRA as a basis for decision making at the planning application stage;
- Where necessary, provide technical assessments to demonstrate that development located in flood risk areas are appropriate and in line with the requirements of the Exception Test; and,
- Present sufficient information to inform each of the LPAs of acceptable flood risk in relation to emergency planning capability.

1.3 SFRA Structure

The NCC Level 1 Minerals SFRA report is set out as follows:

- **Section 1:** Introduction
- **Section 2:** Study Area
- **Section 3:** Policy Context
- **Section 4:** Level 1 Minerals SFRA Methodology
- **Section 5:** Strategic Assessment of Flood Risk
- **Section 6:** Flood Risk Management Measures
- **Section 7:** Sequential Test Guidance
- **Section 8:** Site-specific FRA Guidance
- **Section 9:** Sustainable Drainage Systems
- Appendices
  - **Appendix A:** County Mapping Overviews
  - **Appendix B:** 1:50,000 Scale County Insets – River Flooding
  - **Appendix C:** 1:50,000 Scale County Insets – Pluvial Flooding
  - **Appendix D:** 1:50,000 Scale County Insets – Other Potential Sources of Flooding and Historical Flooding
  - **Appendix E:** 1:50,000 Scale County Insets – Detailed Modelled Flood Outlines
  - **Appendix F:** Proposed Mineral Sites
  - **Appendix G:** Data Register
  - **Appendix H:** Site-specific Flood Risk Assessment Checklist (PPG)

2. Study Area

2.1 General Overview

The administrative areas within Nottinghamshire include Ashfield, Bassetlaw, Broxtowe, Gedling, Mansfield, Rushcliffe and Newark & Sherwood for the purposes of this study. Combined, the LPAs cover an approximate area of 2,081km^2. Nottinghamshire is situated within the East Midlands, bordering South Yorkshire to the north, Lincolnshire to the east, Derbyshire to the west and Leicestershire to the south. Nottingham City is a Unitary Authority and therefore does not come under the jurisdiction of NCC and is a separate LLFA.

A breakdown of the approximate areas for each individual LPA is given in Table 2-1.

Table 2-1: Approximate Areas for the Individual LPAs within Nottinghamshire

District/Borough	Approximate Area (km^2)
Ashfield	109
Bassetlaw	637
Broxtowe	80
Gedling	120
Mansfield	77
Newark and Sherwood	650
Rushcliffe	408

The study area is illustrated in Figure A-1 (Appendix A). The predominant land uses comprise arable farming and grazing, and urban land use. Nottingham is the only city within Nottinghamshire. Major towns include Mansfield and Newark. Other towns include Retford, Worksop, Southwell, Sutton-in-Ashfield, Kirkby-in Ashfield, Hucknall, Eastwood, Stapleford, Beeston and West Bridgford.

Nottinghamshire is in the rainfall shadow of the Pennines to the west, so receives relatively low rainfall at <600–800 mm annually (based upon averages recorded over the period of 1981 - 2010)[4].

2.2 Geology

Clays, sandstone and limestone form the predominant solid bedrock types within Nottinghamshire. Unconsolidated superficial deposits mainly consist of sands and gravel, alluvium and glacial till[5]. Contained within the solid and unconsolidated material is a mix of mineral resources, which have enabled the County to become one of the largest mineral producers in Great Britain.

The exposed bedrocks range from Upper Carboniferous to Lower Jurassic in age. The main structural trend is a shallow east-south-east dip which means the oldest rock formations are found in the west with the overlying younger rock formations being progressively exposed to the east[6].

Upper Carboniferous Coal Measures (mudstones, coals and sandstones) occur on the western border of Nottinghamshire. The overlying Permian age Magnesian Limestone forms a shallow escarpment running north from Nottingham through Mansfield and intermittently up to the Nottinghamshire village of Oldcotes.

Triassic sandstones of the Sherwood Sandstone Group outcrop through central and eastern Nottinghamshire. The porous nature of the Sherwood Sandstone gives rise to free-draining soils in this outcrop area, which includes Sherwood Forest. Much of the central and eastern part of Nottinghamshire is dominated by mudstones of the Triassic Mercia Mudstone Group. This is marked by an escarpment along the boundary with the Sherwood Sandstone which to the east gives rise to the relatively flat, undulating landscape through which the River Trent has cut its wide floodplain. Between Nottingham and Newark-on-Trent there is a very distinct trench. This is

4 UK climate: https://www.metoffice.gov.uk/public/weather/climate
5 English Heritage (2013) Strategic Stone Study – A Building Stone Atlas of Nottinghamshire
6 D.J. Harrison, P.J. Henney, D.G. Cameron, D.E. Highley, S.F. Hobbs, N.A. Spencer, S. Holloway, G.K. Lott, K.A. Linley and E.L. Bartlett (2002) Mineral Resource Information in Support of National, Regional and Local Planning

believed to have been created during the ice ages when the river's route to the Wash via the Ancaster Gap was blocked by ice in the Vale of Belvoir forcing it northwards.

The eastern border of Nottinghamshire is marked by a change to the thick blue clays (Lias) of the Lower Jurassic age. Areas of open water along the course of the River Trent represent former workings for gravel, huge quantities of which were deposited by the meandering nature of the river over the past 15,000 years. In the far south of Nottinghamshire a thick blanket of boulder clay forms an undulating landscape known as the 'Wolds'.

2.3 Current Minerals Extraction Situation

According to the NCC Minerals Local Plan Issues and Options Consultation Document (2017)[7], Nottinghamshire (excluding Nottingham City in this case) is rich in mineral resources which serve both local and wider needs. Nottinghamshire is the largest producer of sand and gravel in the East Midlands and one of the largest in Great Britain. Quarries within the county work the alluvial material found in the Trent and Idle Valleys with additional extraction from the Sherwood Sandstone.

Towards the south of the county between Newark and Kilvington, gypsum has been extensively mined. Other mineral resources working include brick clay, silica sand, building stone, aggregate limestone and oil to support locally important industries. In the future, there is potential to extract mineral resources that have not been previously worked which include dolomite located to the north west and coal bed methane and shale gas found across large parts of the county.

Since the UK recession in 2008, aggregate sales have continued to decline across Nottinghamshire despite the increase in sales recorded nationally, including the East Midlands. This is a result of investment steering towards existing quarries outside of the county instead of new sites available within Nottinghamshire.

2.3.1 Sand and Gravel

Nottinghamshire's sand and gravel production has generally mirrored national trends with annual production peaking at 3.6 million tonnes in 1988; however production trends began to fall to an annual average of 2.7 million tonnes between 1997 and 2001. This trend is believed to reflect a decline in construction/road activity, a greater use of secondary aggregates and a long-term national trend that has shifted from sand and gravel to crushed rock. Annual production in 2007 was at 2.7 million tonnes which dropped to 1.27 million tonnes in 2009. The drop in production was attributed to the recession and the temporary relocation of production at Finningley Quarry across the County boundary to Doncaster[8]. Although annual production steadily increased to 1.71 million tonnes in 2011, sand and gravel sales decreased to a low of 1.27 million tonnes in 2016[9].

Sand and gravel extractions have been concentrated in the Trent Valley near Nottingham, to the north of Newark and in the Idle Valley. There are currently nine out of eleven active[10] sand and gravel quarries in Nottinghamshire. The amount of active quarries replacing the worked out quarries has fallen. At the time of this report, a planning application for a quarry at Mill Farm has been submitted to NCC for determination which could provide 3.4 million tonnes of sand and gravel to serve the south Nottinghamshire area.

In 2009, approximately half of the sand and gravel produced (in addition to Sherwood Sandstone) was exported from Nottinghamshire. In 2014, the East Midlands Aggregate Working Party survey found 60% of the total amount extracted was exported[11] as there are limited resources outside of the county that produce high specification material to make high strength concrete. A large proportion of the sand and gravel from Idle Valley is exported to Rotherham and Doncaster to the north of the County.

The Local Aggregates Assessment (2017) sales data has indicated that Nottinghamshire will be expected to provide 32.3 million tonnes of aggregate over the next Plan period up to 2036 based on the average 10 year sale value of 1.7 million tonnes. Permitted reserves are currently at 17.5 million tonnes which creates a shortfall of 17.8 million tonnes. This reinforces the need for significant long-term reductions in the dependence on sand and gravel for meeting aggregate demand.

The output from the Idle Valley is limited in sand and gravel resources, with the number of active quarries falling from 8 to 5 since 2006. As a result, annual production has fallen from around 1.2 million tonnes to around 0.5

7 Nottinghamshire County Council (2017) Nottinghamshire Minerals Local Plan Issues and Options Consultation Document
8 Nottinghamshire County Council (2013) Nottinghamshire and Nottingham Local Aggregates Assessment
9 Nottinghamshire County Council (2017) Nottinghamshire and Nottingham Local Aggregates Assessment
10 One of the quarries is inactive whilst another is yet to be worked.
11 Department of Communities and Local Government (2014) Aggregate Minerals Survey

million tonnes in 2016. However, part of the reason for this decline is the delay in implementing the permitted quarry at Sturton Le Steeple. Finding sufficient, environmentally acceptable sites to continue production at current levels is likely to be a fundamental issue for the future[12].

2.3.2 Sherwood Sandstone

In Nottinghamshire, extraction of Sherwood Sandstone (covering nearly a quarter of the County) reached a peak in annual production of 1.15 million tonnes in 1992; however production reached lows of 0.32 million tonnes for each year in 2009 and 2010 from 0.55 million tonnes in 2005, with limited increases in the subsequent two years. Since 2010, sales have remained relatively stable between 0.32 million tonnes to 0.38 million tonnes, with 0.32 million tonnes recorded for 2016.

The new Minerals Local Plan is expected to provide an additional 3.3 million tonnes of Sherwood Sandstone to provide the 7.03 million tonnes required over the plan period until 2036 as indicated from the 10 year sales average figure from the Local Aggregates Assessment (2016). There are existing quarries being worked between Nottingham and Mansfield and north of Worksop. It is anticipated that the existing resources will be sufficient to meet the demand as an extension for the existing permitted site at Bestwood (East) quarry will secure an additional 1.4 million tonnes of sand over a 10 year period[13].

2.3.3 Limestone

Limestone is the only 'hard rock' of economic interest to be found in Nottinghamshire, with output being very low compared to the larger regional production. Production of aggregate limestone was dominated by one quarry immediately south-east of Nether Langwith which ceased to operate in 2009. The site has recently been given planning permission to reopen and enable working until 2035 to meet the demand for the majority of the plan period. In addition, small quantities of building stone are also produced at a quarry near Linby.

Sales of 'crushed rock' (including aggregate limestone) have recently declined, with the latest reported 10 year average at 0.005 million tonnes per year. However, between 2009 and 2016 there were no production sales of limestone[14]. The requirement over the 19 year plan period is 0.0095 million tonnes and the existing permitted resources indicate there is no expected shortfall now the Nether Langwith quarry has been reopened.

2.3.4 Brick Clay

As Nottinghamshire's brickworks produce facing bricks it is indicated that the demand will remain relatively stable, despite the national fall in production. The Minerals Local Plan Brick Clay Background Paper[15] states that only the Mercia Mudstone formation has been exploited for Brick Clay since the late 1970s. This is extracted at brick pits at Dorket Head near Arnold and Kirton near Ollerton which support associated modern brickworks that manufacture high quality facing bricks.

There is no national demand forecast for brick clay but it is reasonable to assume that demand will remain broadly similar to recent levels. Planning permission was granted for the western extension of the Kirton Brickworks at the end of 2017 which will provide clay reserves beyond 2036. Dorket Head has permitted reserves which are adequate until 2030 unless a small extension to the south of the site is allowed. However, further options to extend the existing clay pit will be unlikely. The maintenance of adequate clay reserves has been identified as an issue to address in the new Minerals Local Plan[16].

2.3.5 Gypsum

Nottinghamshire is one of the UK's largest gypsum producing areas. High quality mineral is extracted from a quarry at Balderton near Newark (Bantycock Quarry), with mill and cement grade minerals won from a drift mine at East Leake (Maebleagis Mine). These supply associated plasterboard and plaster works. The existing quarries have sufficient permitted reserves to last at least until 2026 at Marbleagis Mine and 2027 at Bantycock Quarry[17]. New reserves will need to be explored in the new Minerals Local Plan which will be influenced by the availability of specific grades of gypsums.

12 Nottinghamshire County Council (2017) Nottinghamshire and Nottingham Local Aggregates Assessment
13 Nottinghamshire County Council (2017) Nottinghamshire Minerals Local Plan Issues and Options Consultation Document
14 Nottinghamshire County Council (2017) Nottinghamshire and Nottingham Local Aggregates Assessment
15 Nottinghamshire County Council (2016) Nottinghamshire Minerals Local Plan Background Paper – Brick Clay
16 Nottinghamshire County Council (2017) Nottinghamshire and Nottingham Local Aggregates Assessment
17 Nottinghamshire County Council (2017) Nottinghamshire Minerals Local Plan Issues and Options Consultation Document

2.3.6 Coal

The exposed coalfield in the Erewash Valley has been worked extensively, mined by opencast methods but no opencast coal mining has occurred since 1999. Significant resources are known to remain and proposals to exploit this mineral in the future may occur. Nottinghamshire's 'deep mined' coal industry has collapsed over the last 30 years, falling from 29 collieries in 1980 to the last deep mine located at Thoresby Colliery closing in 2015.

A surface coal mine was granted planning permission, subject to the signing of a legal agreement, in 2013 at Shortwood Farm towards the west of the County[18]. This area is yet to be worked.

2.3.7 Hydrocarbons – Oil and Gas

As it is expected that three quarters of the UK's primary energy needs will be imported by 2020, there is a drive to establish hydrocarbon resources in Nottinghamshire, including unconventional methods, such as, coal bed methane and shale gas extraction[19]. Nottinghamshire produces a small percentage of the national oil production and there is no evidence to suggest that this may increase.

Mine gas, which represents a separate source to coal bed methane, exploits the build-up of methane gas which occurs following cessation of mine ventilation as a result of closure of a mine. Ten schemes were active in 2010 with four more proposed, however, it is unlikely that further mine gas schemes are to be proposed as a result of the lack of opportunities to exploit this gas.

There is potential to extract coal bed methane from the coal seam resources in the eastern half of the county. Proposals have been permitted for coal bed methane extraction but have not been developed. In addition, the shale deposits in the south and north areas of the County provide a potential shale gas resource. Although three exploration wells have been granted planning permission to the north, there have been no further applications submitted[20].

2.3.8 Other Minerals

Silica sand is a non-aggregate form of Sherwood Sandstone and prices for such minerals are higher than aggregate sands. The mineral has been extracted within Nottinghamshire for the past 150 years with currently one permitted quarry in existence at Two Oaks Farm in Ashfield. Silica sand reserves at this quarry are expected to last until 2053, exceeding the new Minerals Local Plan period to 2036.

Industrial Dolomite is predominantly utilised in the iron and steel industry, however no industrial dolomite is currently extracted within Nottinghamshire although suitable resources are situated in Holbeck, west of the county. There is potential to extend the existing Whitwell quarry in Derbyshire, considered an internationally important source for industrial dolomite, into this vicinity of Nottinghamshire before permitted reserves are expected to be worked by 2035[21].

Building stone is identified in the Minerals Local Plan Issues and Options Consultation as important for the purposes of repair of historic buildings and the development of new buildings in historic areas. The only building stone currently extracted is Bulwell Stone from the inactive Yellowstone Quarry, with reserves likely to last beyond the Plan period.

18 Nottinghamshire County Council (2016) Nottinghamshire Minerals Local Plan Background Paper – Minerals Safeguarding
19 Nottinghamshire County Council (2016) Nottinghamshire Minerals Local Plan Background Paper - Hydrocarbons
20 Nottinghamshire County Council (2017) Nottinghamshire Minerals Local Plan Issues and Options Consultation Document
21 Nottinghamshire County Council (2016) Nottinghamshire Minerals Local Plan Background Paper – Industrial Dolomite

3. Policy Context

Since the Level 1 Minerals SFRA update was completed in 2015, there have been further updates to national and local planning policy.

This section provides an updated summary of policy relevant to the 2018 SFRA Update.

3.1 Flood and Water Management Act

In response to the severe flooding across large parts of England and Wales in summer 2007, the Government commissioned Sir Michael Pitt to undertake a review of flood risk management. The Pitt Review – Learning Lessons from the 2007 floods and subsequent progress reviews outlined the need for changes in the way the UK is adapting to the increased risk of flooding and the role different organisations have to deliver this function.

The Flood and Water Management Act (FWMA) 2010, enacted by Government in response to the Pitt Review, designated Unitary Authorities and upper tier Local Authorities as Lead Local Flood Authorities (LLFAs). As LLFA for the Nottinghamshire administrative area, NCC has responsibilities to lead and coordinate local flood risk management. Local flood risk is defined as the risk of flooding from surface water run-off, groundwater and small ditches and watercourses (collectively known as ordinary watercourses). Nottingham City Council fulfils the role of LLFA for the Nottingham City administrative area.

The FWMA formalises the flood risk management roles and responsibilities for other organisations including the Environment Agency, water companies and highways authorities. The responsibility to lead and co-ordinate the management of tidal and (main river) fluvial flood risk remains that of the Environment Agency.

The FWMA initially gave LLFAs the role of Sustainable Drainage Systems Approval Body (SAB; Schedule 3) where the LLFA was due to be responsible for adopting and maintaining SuDS. However as detailed below, Schedule 3 has not been enacted and the use of SuDS in new development is instead enforced by LPAs through the planning system and not through the LLFA SABs.

3.2 Amendments to policy on Sustainable Drainage Systems

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 in December 2014 by DCLG on the proposal to make LLFAs the statutory consultees for planning applications with regards to surface water management, and the Government published its formal response in March 2015. The PPG was subsequently amended to reflect the new approach to implementation of SuDS in development.

The PPG was 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'.*

The proposed approach was to strengthen the planning system as a way of delivering SuDS rather than implement Schedule 3 of the FWMA, as written, which would have established a new SAB that would sit outside the existing planning system. This has been achieved principally by amending planning policy so that LPAs can give increased weight to the provision and maintenance of SuDS, alongside other material considerations, during the determination of a planning application.

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

LPAs within Nottinghamshire should consult NCC, as LLFA, on the management of surface water for major development. NCC, as the LLFA, is a statutory consultee for planning applications for major developments that have a drainage implication. As a statutory consultee, NCC will be under a duty to respond to the LPA and report

on their performance on providing a substantive response within deadlines set out in legislation. LPAs are required to:

- Satisfy themselves that the proposed minimum standards of operation are appropriate, and;
- Ensure, through use of planning conditions or planning obligations, that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

The PPG states that LPAs 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 watercourse;
- The relevant Highway Authority for an affected road;
- The Canal and Rivers Trust, if the drainage system may directly or indirectly involve the discharge of water into or under a waterway managed by them; and,
- 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 boards district.

The PPG contains the following information as to when the implementation of sustainable drainage systems may be inappropriate:

'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'.

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.

3.2.1 National SuDS Standards

A set of National Non-Statutory Technical Standards (NS) were published by Defra in March 2015[22] setting the requirements for the design, construction, maintenance and operation of SuDS. The NS are intended to be used alongside the NPPF and PPG.

The NS that are of chief concern in relation to the consideration of flood risk to and from development relating to runoff destinations, peak flow control and volume control are presented in Table 3-1:

Table 3-1: National SuDS Standards (2015)

Consideration	SuDS NS
Peak Flow Control	**S2** – 'For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must not exceed the peak greenfield runoff rate for the same event'.
	S3 – 'For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event'.
Volume Control	**S4** – 'Where reasonably practicable, for greenfield development, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event should never exceed the greenfield runoff volume for the same event'.
	S5 – 'Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to

22 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

	redevelopment for that event'.
	S6 – 'Where it is not reasonably practicable to constrain the volume of runoff to any drain, sewer or surface water body in accordance with S4 or S5 above, the runoff volume must be discharged at a rate that does not adversely affect flood risk'.
Flood Risk within the Development	**S7** – 'The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event'.
	S8 – 'The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development'.
	S9 – 'The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property'.

3.3 Amendments to Climate Change Guidance (2016)

The Environment Agency published updated climate change guidance for planners [23] in February 2016 to support NPPF, which supersede all previous allowances written in the NPPF and accompanying PPG. The 2016 guidance includes 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.

Specifically, this is supportive in terms of local planning when considering looking forward to future impacts from climate change on site specific allocations.

3.3.1 Fluvial Climate Change Allowances

Environment Agency guidance[23] provides clear advice for all parties involved in the planning process, by outlining how and when allowances should be applied for FRAs and SFRAs. For proposed developments in areas of fluvial flood risk, the flood risk vulnerability classification and flood zone considering the lifetime of a development are of particular importance to determine the correct climate change allowance (Table 3-4:). Additional information on allowances can be found within the Environment Agency guidance.

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).

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

Table 3-4: Assigning Appropriate Climate Change Allowance Categories (Fluvial)

	Vulnerability Classification				
	Water Compatible	Less Vulnerable	More Vulnerable	Highly Vulnerable	Essential Infrastructure
Flood Zone 2	NA	CA	Assess CA & HCA	Assess HCA & UEA	Assess HCA & UEA
Flood Zone 3a	CA	Assess CA & HCA	Assess HCA & UEA	X	UEA
Flood Zone 3b	CA	X	X	X	UEA

NA = No Allowance; CA = Central Allowance; HCA = Higher Central Allowance; UEA = Upper End Allowance; X = Development not permitted

Having determined a suitable allowance category, NCC can then confirm the corresponding percentages for increase in river flow that should be assessed, as listed under the Humber River Basin District (

Table 3-5).

Table 3-5: Assigning Appropriate Climate Change Percentages (Fluvial)

Humber River Basin District	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End Allowance	20%	30%	50%
Higher Central Allowance	15%	20%	30%
Central Allowance	10%	15%	20%

3.3.2 Pluvial Climate Change Allowances

For the anticipated changes in rainfall intensity, FRAs and SFRAs should assess both the central and upper end allowances to understand the range of impact and make suitable decisions to mitigate against pluvial flooding (Table 3-6). The allowances apply across England and are not river basin district dependent.

Table 3-6: Assigning Appropriate Climate Change Percentages (Pluvial)

	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End Allowance	10%	20%	40%
Central Allowance	5%	10%	20%

When assessing a range of allowances for peak river flow or rainfall intensity, the following must be considered:

- Likely depth, speed and extent of flooding for each of the assessed climate change allowances;
- Vulnerability of the proposed development types or land use allocations to flooding;
- 'Built in' resilience measures used, for example, raised floor levels; and,
- Capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach i.e. there may be instances where flood risk management measures may not be necessary now but will be required in the future.

3.4 National Strategy for Flood and Coastal Erosion Risk Management

In May 2011, in accordance with the FWMA, the Environment Agency published a National Strategy for Flood and Coastal Erosion Risk Management (FCERM) in England. This Strategy provides a framework for the work of all flood and coastal erosion risk management authorities (RMAs).

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 (LFRMS) by LLFAs, which in turn provide the framework to deliver local improvements needed to help communities manage local flood risk. It also aims to encourage more effective risk management by enabling people, communities and businesses and the public sector to work together to:

- Ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- Set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risks;
- Encourage innovative management of risks taking account of the needs of communities and the environment, and;
- Ensure that emergency responses to flood incidents are effective and that communities are able to respond properly to flood warnings.

3.5 Local Flood Risk Management Strategy

In December 2015, in accordance with the FWMA, NCC published their LFRMS[24]. The strategy outlines how NCC will manage sources of flooding from local sources and work with other authorities to address complex flood interactions now and in the future. The LFRMS was adopted in September 2016. NCIC also produced a LFRMS in 2015[25].

The LFRMS sets out local sources of flooding and priority flood risk locations that have been identified by comparing historic flood records and predicted flood outlines for fluvial and surface water sources; these, along with Surface Water Management Plans (SWMPs), should be reviewed during the production of site-specific Flood Risk Assessments (FRAs). An LFRMS can aid local planners in assessing site allocation details due to the nature of collating various data sets into a single document.

A Preliminary Flood Risk Assessment (PFRA) and Strategic Environmental Assessment (SEA) (including Water Framework Directive (WFD) review and Habitats Regulations Assessment (HRA)) have been carried out to inform the strategy.

3.6 Flood Risk Regulations

As well as the duties under the FWMA to prepare a LFRMS, NCC has legal obligations, under the EU Floods Directive[26], which was transposed into UK Law through the Flood Risk Regulations 2009 ('the Regulations'). As LLFA, NCC has to undertake and produce a Preliminary Flood Risk Assessment (PFRA), and also contribute to the Flood Risk Management Plan (FRMP) for the Humber River Basin District.

3.6.1 Preliminary Flood Risk Assessment

Under the Regulations, all LLFAs were required to prepare a PFRA report[27]. 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. NCC delivered its PFRA in 2011. The PFRA seeks 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

24 Nottinghamshire Local Flood Risk Management Strategy (LFRMS) http://www.nottinghamshire.gov.uk/planning-and-environment/flooding/the-councils-role
25 Nottingham City Council Local Flood Risk Management Strategy (LFRMS) http://committee.nottinghamcity.gov.uk/documents/s20314/Nottingham%20Local%20Flood%20Risk%20Management%20Strategy%20Appendix%20B.pdf
26 EU Floods Directive http://ec.europa.eu/environment/water/flood_risk/implem.htm?_sm_au_=iVVz2WB5T0tRQzqN
27 Nottinghamshire Preliminary Flood Risk Assessment (PRFA) (2011) http://site.nottinghamshire.gov.uk/enjoying/countryside/flooding/lead-local-flood-authority/pfra/

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. Analysis in the PFRA indicates that Nottingham and the surrounding area could possibly be considered as a Flood Risk Area. As part of the PFRA, NCC concluded that working jointly with NCIC through development of respective LFRMS would provide an effective and flexible approach to the flood risk identified.

3.6.2 Humber River Basin District Flood Risk Management Plan

The EU Floods Directive, transposed into UK Law through the Flood Risk Regulations, requires the Environment Agency to prepare FRMPs for all of England covering flooding from Main Rivers, the sea and reservoirs.

As such, the Humber River Basin District FRMP[28] was published in March 2016 and sets out the proposed measures to manage flood risk from all sources in the Humber River Basin District from 2015 to 2021 and beyond. This document draws on existing reports and plans which have been prepared in the past, and sets out how RMA's will work with communities to manage flood and coastal risk.

The Humber FRMP sits alongside the Humber River Basin Management Plan[29] which includes information on the following:

- Current state of the water environment;
- Pressures affecting the water environment;
- Environmental objectives for protecting and improving the waters;
- Programme of measures, actions needed to achieve the objectives; and,
- Progress since the 2009 plan.

3.7 National Planning Policy

3.7.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF)[30] was published in March 2012 together with accompanying Technical Guidance. The NPPF revoked most of the previous Planning Policy Statements (PPS) and Planning Policy Guidance, including PPS25: Development and Flood Risk Practice Guide[31].

The overall approach to flood risk is broadly summarised in NPPF Paragraph 103:

'When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- *Within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location, and*
- *Development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.'*

The NPPF consists of a framework within which LPAs and local people can produce local and neighbourhood plans that reflect the needs and priorities of their communities.

28 Humber River Basin District Flood Risk Management Plan (FRMP) https://www.gov.uk/government/publications/humber-river-basin-district-flood-risk-management-plan
29 Humber River Basin Management Plan (RBMP) https://www.gov.uk/government/collections/river-basin-management-plans-2015
30 Department for Communities and Local Government (DCLG) (March 2012) National Planning Policy Framework. https://www.gov.uk/guidance/national-planning-policy-framework
31 DCLG (2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide

The NPPF and supporting guidance require LPAs to undertake SFRAs and to use their findings, and those of other studies, to inform strategic land use planning, including the application of the Sequential Test which seeks to steer development towards areas of lowest flood risk prior to consideration of areas of greater risk.

The PPG states that: *'County level assessments may also be appropriate where minerals and waste issues can be considered at the same time'.* As the Minerals Planning Authority (MPA) for Nottinghamshire, it is therefore appropriate for NCC to deliver the Level 1 Minerals SFRA. In preparing the new Minerals Local Plan and to facilitate the sustainable use of materials, NCC should:

'set out environmental criteria, in line with the policies in [the NPPF], against which planning applications will be assessed so as to ensure that permitted operations do not have unacceptable adverse impacts on the natural and historic environment or human health, including from… flood risk, impacts on the flow and quantity of surface and groundwater and migration of contamination from the site; and take into account the cumulative effects of multiple impacts from individual sites and/or a number of sites in a locality'.

3.7.2 National Planning Practice Guidance

The Technical Guidance accompanying NPPF was since replaced by a series of Planning Practice Documents referred to as the Planning Practice Guidance (PPG)[32] on 6th March 2014. The PPG: Flood Risk and Coastal Change document[33] outlines how LPAs should use a SFRA to:

- Assess the flood risk to an area from all sources, both in the present day, and in the future. The impacts of climate change should be considered when assessing future flood risk;
- Determine the variations in risk from all sources of flooding across their areas, and also the risks to and from surrounding areas in the same flood catchment;
- Inform the sustainability appraisal of the Local Plan, so that flood risk is fully taken into account when considering allocation options and in the preparation of plan policies, including policies for flood risk management to ensure that flood risk is not increased;
- Apply the Sequential Test and, where necessary, the Exception Test when determining land use allocations;
- Identify the requirements for FRAs in particular locations, including those at risk from sources other than river and sea flooding;
- Determine the acceptability of flood risk in relation to emergency planning capability; and,
- Consider opportunities to reduce flood risk to existing communities and developments through better management of surface water, provision for conveyance and of storage for flood water.

SFRAs should be prepared in consultation with the Environment Agency, emergency response and drainage authority functions of LPAs, LLFAs and where appropriate Internal Drainage Boards (IDBs).

With regards to development of Minerals and Waste Local Plans, the PPG states that:

'Waste and mineral planning authorities need to take account of flood risk when allocating land for development. They should prepare their plan policies with regard to any available Strategic Flood Risk Assessments. The location of Mineral Safeguarding Areas and site allocations, in particular in relation to sand and gravel workings which are often located in functional floodplains, need to be identified. It is possible to explore benefits, such as restoring mineral working located in flood risk areas to increase flood water storage, which can also enhance the natural environment'.

3.8 Local Planning Policy

3.8.1 Nottinghamshire Minerals Local Plan Issues and Options Consultation

Between 20 November 2017 and 14 January 2018 an 'Issues and Options' consultation exercise ran for the new Minerals Local Plan to set out the main issues expected to arise during the plan period and to explore reasonable options to resolve them[34].

32 DCLG (March 2014) Planning Practice Guidance. https://www.gov.uk/government/collections/planning-practice-guidance
33 DCLG (March 2014) Planning Practice Guidance: Flood Risk and Coastal Change. https://www.gov.uk/guidance/flood-risk-and-coastal-change#Strategic-Flood-Risk-Assessment-section

The consultation document identified that almost all aspects of community well-being depend to one degree or another on minerals and that Nottinghamshire is a mineral rich County, with most of the County overlying at least one potential surface or underground resource. The document identifies that whilst mineral resources remain plentiful, permitted reserves are often limited and that finding sufficient new reserves to meet future demand will be a challenge over the next 15-20 years.

The overarching theme of the new Minerals Local Plan will be to promote sustainable development achieving the highest quality restoration possible through balancing economic benefit and mineral requirements against social and environmental constraints. Sustainability is a fundamental principle of the new Minerals Local Plan, with there being a driver to safeguard mineral resources from unnecessary sterilisation so that minerals remain available for extraction by future generations. It must be acknowledged that long-term environmental gains can be achieved through creating wildlife habitats out of worked quarries amongst various other approaches to restoration. To ensure sustainability, NCC must understand the current contextual factors associated with mineral extraction and how these are likely to change over the plan period. This will be facilitated through the development of a 'spatial portrait' of Nottinghamshire which sets out key environment, geological, geographic, social and economic influences across the County.

The plan will identify both a steady and adequate supply of minerals across the plan period with a range of development management policies which set out environmental and wider standards that all new mineral development proposals must comply with.

The draft vision of the plan is as follows:

'Minerals are a valuable natural resource and over the Plan period to 2036 will continue to be used as efficiently as possible across Nottinghamshire. This will include sustainable use of primarily minerals as well as the promotion of recycled and secondary aggregates.

Within geological constraints, mineral development will be concentrated in locations that offer the greatest level of accessibility to major markets and growth areas and to sustainable transport nodes to encourage sustainable patterns and modes of movement.

Nottinghamshire will continue to provide minerals to meets its share of local and national needs. Potential sites/quarries will be identified to support the economic, social and environmental benefits of sustainable growth. Mineral reserves will be identified and safeguarded against inappropriate development.

All mineral working will contribute towards a greener Nottinghamshire by ensuring that the County's diverse environmental and historic assets are protected, maintained and enhanced through appropriate working, restoration and after-use. This will result in improvements to the built and natural environment, and contribute to landscape-scale biodiversity delivery; and the re-connection of ecological networks.

The quality of life and health of those living, working in, or visiting Nottinghamshire will be protected'.

The key strategic issues have been identified as:

1. Improving the sustainability of minerals development

   Ensuring the primary minerals are worked in the most sustainable manner and the use of secondary and recycled aggregates is encouraged. Securing a spatial pattern of mineral development that efficiently delivers resources to markets within and outside Nottinghamshire.

2. Providing a steady and adequate supply of minerals

   Identifying a steady and adequate supply of minerals over the Plan period to assist in economic growth both locally and nationally.

3. Minimise impacts on communities

   Minimise the adverse impacts of Nottinghamshire's communities by protecting their quality of life and health from impacts such as traffic, visual impacts, noise and dust.

4. Biodiversity led restoration of worked out quarries

34 Nottinghamshire County Council, Nottinghamshire Minerals Local Plan (2017). Issues and Options Consultation 20 November 2017 – 14 January 2018.

Ensuring that all worked out quarries are restored to the highest standard and at the earliest opportunity through a biodiversity led approach and that the restoration proposals are addressed at an early stage of the application process.

5. Safeguarding of minerals from unnecessary sterilisation

To protect key mineral resources from the unnecessary sterilisation by other forms of development, and safeguard existing minerals infrastructure to ensure a steady and adequate supply in the future.

3.8.1.1 Development Management policies

Development Management policies facilitate more detailed criteria against which future planning applications will be assessed. The proposed policy topics include, as a minimum:

- Protecting local amenity
- Water resources and flood risk
- Agricultural land and soil quality
- Protection and enhancement of biodiversity and geodiversity
- Landscape character
- Historic environment
- Public access
- Cumulative impact
- Highways safety and vehicle movements/routeing
- Airfield safeguarding
- Planning obligations
- Restoration, afteruse and aftercare
- Minerals safeguarding and consultation areas
- Incidental mineral extraction
- Irrigation lagoons
- Borrow pits
- Associated industrial development
- Mineral exploration

3.8.2 Nottinghamshire Minerals Local Plan

The Nottinghamshire Minerals Local Plan[35] was adopted in December 2005, with a plan period which ended in 2014. The Minerals Local Plan provides a detailed set of minerals policies which can be used to test the acceptability of all minerals planning proposals within Nottinghamshire. The document also sets out key issues that were expected to arise over the plan period and potential options to meet them. Those which are relevant to flood risk and the water environment in Nottinghamshire are summarised below.

- **Policy M3.9** 'Flooding' – States that planning permission for minerals development will not be granted where there is an unacceptable impact on flood flows and flood storage capacity or on the integrity or function of flood defences and local land drainage systems unless conditions can be imposed to protect flood defences from both the temporary and permanent adverse effects of the development;
- **Policy M3.8** 'Water Environment' – States that planning permission for minerals development will only be granted where (a) surface water flows are not detrimentally altered; (b) groundwater levels, where critical, are not affected; and (c) there are no risks of polluting ground or surface waters. Unless engineering measures and/ or operational management systems can adequately mitigate such risks; and
- **Policy M9.1** 'Stockpiling of Dredgings' – Proposals for the stockpiling of river dredgings prior to their use as aggregate will be permitted subject to measures to protect the integrity of the floodplain.

3.9 The Water Framework Directive

The EU Water Framework Directive (WFD) (2000/60/EC) establishes a framework for the protection and improvement of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater.

The Directive requires the UK to classify the current condition of key waterbodies (giving a 'Status' or 'Potential') and sets objectives to either maintain their condition, or improve it where a waterbody is failing minimum targets.

35 Adopted Minerals Local Plan (2005) http://www.nottinghamshire.gov.uk/planning-and-environment/minerals-local-plan/adopted-minerals-local-plan

The chemical quality status attainable by a watercourse is either ‘Good’ or ‘Fail’ and the ecological quality status attainable ranges from ‘High’ to ‘Bad’. The target for all watercourses should be to achieve at least ‘Good’ chemical and ecological status. Any activities or developments that could cause deterioration within a nearby waterbody, or prevent the future ability of a waterbody to reach its target Status, must be mitigated so as to reduce the potential for harm and allow the aims of the WFD to be realised.

As well as ensuring that development does not result in deterioration in the Status of a waterbody, development can contribute towards attainment of WFD objectives, as well as other environmental benefits. Restoration of minerals sites may provide such opportunities within Nottinghamshire.

4. Level 1 SFRA Methodology

4.1 Overview

As outlined in Section 1, one of the objectives of the Level 1 SFRA update is to collect, collate and review available information relating to flooding in the Study Area. The information is then presented in a format to enable NCC to apply the NPPF Sequential Test to their preferred sites for future development and to identify potential development sites which require the application of the Exception Test through a Level 2 SFRA.

4.2 Tasks

The sequence of tasks undertaken in the preparation of the Level 1 SFRA was, in chronological order:

- Arrange an inception meeting with NCC to establish key objectives of the Level 1 SFRA; discuss available information and datasets; and, to identify relevant stakeholders;
- Liaise with stakeholders to request relevant datasets and information or to acquire data from online sources (as listed in Appendix G);
- Outline the new climate change guidance, released in February 2016, and provide advice for the application of this guidance in the context of the SFRA;
- Summarise national policy that has been released since the completion of the existing SFRAs;
- Interrogate received data and review against objectives of the SFRA to identify any gaps in the required information;
- Assess the risk of flooding from all sources, including flooding from rivers (fluvial), land (overland flow and surface water), groundwater, sewers and artificial sources;
- Produce strategic flood risk maps, GIS deliverables and a technical report to present available relevant information on flood sources and flood risk; and,
- Review received data against the SFRA objectives, providing data to provide a high level assessment of flood risk on proposed site allocations and future minerals applications.

The above tasks were completed between January 2018 and March 2018.

4.3 Stakeholder Consultation

In the preparation of this Level 1 SFRA update, the following stakeholders were contacted to provide data and information:

- Nottinghamshire County Council;
- Environment Agency;
- Severn Trent Water;
- Anglian Water;
- Isle of Axholme and North Nottinghamshire Water Level Management Board (IOANNWLMB);
- Trent Valley Internal Drainage Board;
- Doncaster East Internal Drainage Board;
- Upper Witham Internal Drainage Board;
- Highways England; and,
- Canals and Rivers Trust.

The Study Area falls within the Environment Agency's East Midlands Area of responsibility. The Environment Agency has discretionary powers under the Water Resources Act (1991)[36] for all Main Rivers and their associated flood defences within the Study Area.

NCC, as the LLFA for Nottinghamshire, is responsible under the FWMA for managing flood risk from local sources; groundwater, surface water and ordinary watercourses.

36 HMSO (1991) The Water Resources Act

Severn Trent Water (STW) is the statutory water supply and sewerage provider for the majority of the Study Area. However, Anglian Water (AWS) provide potable water distribution for a small area along the north eastern boundary of the Study Area.

The Canal and Rivers Trust (C&RT) is responsible for maintaining the inland navigable waterway network across the UK including the Nottingham, Erewash, Beeston, Grantham and Chesterfield canals located in the Study Area.

Nottinghamshire's administrative area includes watercourses that are administered by various IDBs. IDBs are statutory bodies under the Land Drainage Act 1991. Trent Valley IDB, Doncaster East IDB and Isle of Axholme and North Nottinghamshire Water Level Management Board IDB cover areas within the Nottinghamshire administrative boundary. The Water Management Consortium was formed to enable partnership working and share of resources which includes the Isle of Axholme and North Nottinghamshire Water Level Management Board, Lindsey Marsh Drainage Board and Trent Valley Internal Drainage Board. Upper Witham IDB covers a small section of the eastern boundary of Nottinghamshire.

Highways England has been contacted for evidence of historic flooding as statutory consultee in the planning system for Motorways and major A roads.

4.4 Data / Information Requested

During 2015, a number of Environment Agency datasets were published online as part of an **Open Government Licence (OGL)** initiative[37], it is now possible to view, review the availability, download and interrogate various GIS data free-of-charge. The data acquired through this channel included:

- Flood Map for Planning (Rivers and Sea) Flood Zone 2 (0.1% annual exceedance probability (AEP) event) and Flood Zone 3 (1% AEP event);
- Statutory EA Main Rivers;
- Risk of Flooding from Surface Water;
- Source Protection Zones; and
- Flood Warning Areas;
- Historical Flood Map;
- Areas Benefiting from Flood Defences;
- Spatial Flood Defences (including standardised attributes)

OS Open Data was used to collate the following datasets:

- 1:250,000 Scale Colour Raster
- OS VectorMap District

Canal and River Trust Open Data was used to collect the following data:

- Canal centreline

The remaining data required for the purposes of the NCC's Minerals Level 1 SFRA was acquired through engagement with relevant stakeholders, as detailed within **Appendix G**.

In addition to providing data, the Trent Valley Internal Drainage Board Water Management Consortium provided detailed feedback relating the following sites which are located in close vicinity to Board maintained watercourses:

37 Open Government Licence website: https://data.gov.uk

- PA07
- PA11
- PA12
- PA13
- PA14
- PA15
- PA16
- PA17
- PA18

4.5 Data Presentation

Using the GIS layers collected, ten Nottinghamshire-wide overview maps and four sets of thirteen detailed 1:50,000 scale map insets covering the whole of Nottinghamshire were produced as shown in Table 4-1 to visually assist NCC in their site allocation decision making process.

Table 4-1: SFRA Mapping Contents

	Contents	Appendix Figures
County Overviews	Study Area, Main Watercourses & Inset Index	A-1
	Environment Agency Flood Zones (Undefended)	A-2
	IDB Areas	A-3
	Groundwater Source Protection Zones	A-4
	Environment Agency Bedrock and Superficial Deposits Aquifer Designations	A-5 (a-b)
	Areas Susceptible to Groundwater Flooding	A-6
	Flood Warning Areas	A-7
	Existing (Active and Worked Out) and Potential Mineral Sites	A-8 (a-b)
1:50,000 Scale County Insets	Fluvial (River Flooding)	B1 to B13
	Pluvial (Surface Water Flooding)	C1 to C13
	Other Potential Sources of Flooding and Historical Flooding	D1 to D13
	Detailed Modelled Flood Outlines (Defended)	E1 to E13

4.5.1 Fluvial and Tidal Flood Data

The Guidance on Strategic Flood Risk Assessments requires LPAs to define all Flood Zones within their administrative boundary area including the functional floodplain[38]. Table 4-2 provides a definition for each Flood Zone as determined in the PPG for Flood Risk and Coastal Change.

Table 4-2: Flood Zones

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river and sea flooding – (Shown as 'clear' on the Flood Map – all land outside Zone 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual 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)
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)
Zone 3b Functional Floodplain	The zone comprises land where water has to flow or to be stored in times of flood. LPAs should identify in their SFRA areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency – (Not separately distinguished from Zone 3a on the Flood Map, unless detailed hydraulic modelling is available)

38 DEFRA and Environment Agency (2017) Local Planning Authorities: Strategic Flood Risk Assessment https://www.gov.uk/guidance/local-planning-authorities-strategic-flood-risk-assessment

The Environment Agency's Flood Zone Maps consist of a mixture of flood outlines derived through detailed numerical hydraulic modelling, where available and national broad-scale (coarse) modelled flood outlines. The Environment Agency updates their Flood Map on a quarterly basis to include the results of new flood mapping studies undertaken to improve and refine the Flood Zones.

These Flood Zone Maps define the extent of flooding ignoring the presence of defences and the fact that their presence cannot always be assured. The reason for this approach is to make an allowance for residual flood risk in the event of a failure or breach/overtopping of the flood defences. This conservative approach over time will reduce reliance on flood defences and raises the awareness of flood risk in defended areas to help ensure that it is managed appropriately as part of development proposals.

If a potential mineral site falls within an undefended Environment Agency Flood Zone 2 or Flood Zone 3, all available detailed modelled Flood Zones (GIS layers) should then be referred to.

A number of detailed hydraulic modelling studies have been undertaken along watercourses within the Study Area as part of the SFRAs (see Section 5 for additional information) or Environment Agency Strategic Flood Risk Mapping (SFRM) and Water and Environmental Management (WEM) framework studies. Table 4-3 details the availability of modelled outputs provided by the Environment Agency. All modelled outputs take account of the presence of flood defences.

However, the various defended scenario detailed modelled outlines provide an incomplete picture across Nottinghamshire. Consequently, the latest undefended Flood Zone 2 and Flood Zone 3 maps should be used to provide a basis for a consistent assessment of the risk of fluvial and, (in the case of the River Trent downstream of Cromwell Weir), tidal flooding against the potential minerals sites for the purposes of the Sequential Test. These are provided in Figure A-2 (Appendix A) and in the Fluvial Flooding map insets provided in Figures B1 to B13 (Appendix B). The Environment Agency regularly updates its flood zones following new modelling studies and therefore the Environment Agency website should also be consulted for the most up-to-date flood zone information[39]. The various defended scenario detailed modelled outlines are to be used to define the fluvial flood risk to proposed mineral sites, taking account of fluvial flood defences.

Flood Zone 3b is defined in the NPPF as land where water has to flow or be stored in times of flood. For the purposes of this Level 1 SFRA, Flood Zone 3b is identified as the 4% AEP event or 5% AEP event defended outline, utilising detailed model outputs where available. Where no detailed hydraulic modelled data is available for Flood Zone 3b, the Flood Zone 3a extent illustrated should be adopted as a conservative proxy for the functional floodplain until such a time that more detailed information is available, such as completion of a Level 2 SFRA, an Environment Agency study or a site-specific FRA, as recommended by the NPPF. Flood Zone 3b is mapped in Figures E1 to E13 (Appendix E).

Flood defences are structures which affect flow in times of flooding and therefore reduce the risk of 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. NCC has similar powers for ordinary watercourses within Nottinghamshire.

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.

Information on 'formal' raised flood defences was provided by the online dataset 'Spatial Flood Defences (including standardised attributes)'. The dataset lists major structures and flood defences maintained by the Environment Agency, providing information on the location, type, condition and standard of protection. Spatial Flood Defences are shown in Appendix B.

Raised defences may present a residual risk of flooding in the unlikely event of a major breach failure. The likelihood of this and potential locations where it could occur are dependent on the condition of the defences, maintenance regime and level of inspection/monitoring undertaken. The extent and impact of such an event is inevitably linked to the location at which the breach occurs and how long it is left to continue after the onset.

39 Environment Agency Flood Map for Planning
https://flood-map-for-planning.service.gov.uk/

A study of informal flood defences has not been made as part of this assessment. Part 1, Section 21 of the FWMA states that:

'(1) A lead local flood authority must establish and maintain:

a) A register of structures or features which, in the opinion of the authority, are likely to have a significant effect on flood risk in its area; and

b) A record of information about each of those structures or features, including information about ownership and state of repair.'

As a result, stakeholders seeking information in relation to flood defences should consult with NCC LLFA.

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. Smaller scale informal flood defences should be identified as part of site specific FRAs and the residual risk of their failure assessed.

The locations of 'formal' raised flood defences in the study area are presented in Figures B1- B13 (Appendix B), and Figures E1-E13 (Appendix E). The Flood Storage Areas GIS layer was downloaded through the open government licence website, however there were no assets identified within Nottinghamshire within this GIS layer.

The Environment Agency Areas Benefiting from Defences (ABDs) dataset shows areas benefitting from protection from flooding to a 1% AEP Standard of Protection (SoP) and is included in Figures E1-13 (Appendix E).

It should be noted that at the time of finalising this report (March 2018) the River Idle and River Torne are currently being modelled and new data is programmed to be available within the next few months.

Table 4-3: Detailed Modelled Flood Studies provided for use in the SFRA

Section of Watercourse	Study	Date
Baker Lane Brook	Baker Lane Brook SFRM, Halcrow	March 2009
Crocker Beck Dover Beck Crock Dumble	Nottingham Tributaries SFRM, JBA	January 2014
Day Brook River Leen	River Leen and Day Brook Model Update, Environment Agency	January 2017
Fairham Brook Nethergate Brook	Fairham Brook Flood Risk Mapping Study, Final Report, Environment Agency	September 2008
Greythorne Dyke	Greythorne Dyke SFRM, Capita Symonds	May 2008
Lowfield Drain Middle Beck	River Trent and Tributaries at Newark SFRM2, Halcrow	July 2011
River Erewash	River Erewash SFRM2 Study, Hyder,	2013
River Idle	River Idle Flood Risk Mapping Study, JBA	March 2005
River Maun	River Maun, Flood Risk Mapping, JBA	March 2017
River Meden	River Meden Flood Risk Mapping Strategy, JBA	June 2008
River Ryton	River Ryton SFRM Flood Risk Mapping Final Report, JBA	March 2008
River Smite	Flood Modelling of the River Smite, JBA	March 2012
River Soar	Lower Soar and Tributaries SFRM, JBA	January 2012
River Torne	Greater Nottingham SFRA, B&V	October 2010
River Trent	Greater Nottingham River Trent – SFRA 2010 and Climate Change Scenario, Environment Agency	2016

4.5.1.1 Climate Change

To ensure sustainable development now and in the future, the NPPF requires that the effects of climate change should be taken into account in an SFRA and that flood outlines delineating climate change should be presented. The Environment Agency's guidance on Flood Risk Assessments provides guidance on how to account for potential future climate change as discussed in Section 3.3[23].

Detailed modelled fluvial outlines for Flood Zone 3, including either a 20% or 25% increase in peak flows allowing for the effects of climate change have been presented in Appendix E for the defended scenarios, where available.

In the previous Level 1 SFRA update (2015), it was suggested to use Flood Zone 2 as a conservative proxy for where the 1 in 100 year event plus climate change allowance is not available within a detailed hydraulic model. The Environment Agency were contacted as part of this report to advise on the appropriate methods to assess climate change. As climate change allowances have increased since the previous SFRA update there are concerns that the flood extents will be larger than the flood outline for Flood Zone 2, particularly in regards to the Upper End value. **If the Flood Zone 3 plus climate change event outline is not available for the proposed site allocations then detailed modelling will need to be undertaken to determine the flood outline in a site-specific Flood Risk Assessment**. Section 3.3 can be used to identify the appropriate climate change allowance to use for a particular site.

Sites identified as being located alongside raised defences or within ABDs will require consideration of residual risk of flooding in the event of catastrophic failure of the defences (e.g. breach) as part of a Level 2 SFRA or a site specific FRA. The Environment Agency should be consulted to confirm existing availability of any such modelling, which may already have performed breach analyses.

Using proxy data to define Flood Zones presents a series of issues, limitations and uncertainties. This is especially true when Flood Zone 3a is used as a proxy for Flood Zone 3b. In urban areas, watercourses often flow in deep and canalised channels and through culverts or tunnels. However, broad-scale modelled outlines assume a 'bank-full' state prior to flooding and therefore large areas are shown to be flooded at both Flood Zone 3 and Flood Zone 2.

The level of confidence assigned to each Flood Zone is a result of the level of assumptions and limitations in the modelling approach when deriving that Flood Zone.

4.5.2 Flood Warnings

The Civil Contingencies Bill requires that the Environment Agency *'maintain arrangements to warn the public of emergencies'*. As a Category 1 responder, the Environment Agency has a duty to maintain arrangements to warn, inform, and advise the public in relation to particular emergencies.

NCC also has a duty under the Civil Contingencies Act (2004) to warn and inform the public and this is done mainly through the Communications Unit.

A GIS layer of areas benefiting from the Environment Agency Flood Warning system was obtained through the OGL. This information should be used by emergency planners in conjunction with the Flood Zone maps and flood defence information to assist in developing emergency plans for areas at risk of flooding within the study area.

Figure A-7 (Appendix A) defines the coverage of the Environment Agency's Flood Warning Areas within Nottinghamshire.

4.5.3 Flooding from Surface Water

4.5.3.1 Risk of Flooding from Surface Water Maps

The Risk of Flooding from Surface Water (RoFSW), formerly known as the updated Flood Map for Surface Water (uFMfSW), 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).

Overland flow and surface water flooding typically arise following periods of intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off the land and result in localised flooding.

The Environment Agency has undertaken modelling of surface water flood risk at a national scale and produced mapping identifying those areas at risk of surface water flooding during three events, 3.33% AEP, 1% AEP and 0.1% AEP. GIS layers of the RoFSW extents were obtained through the OGL.

The RoFSW is illustrated in Figures C1 to C13 (Appendix C), highlighting areas at risk of surface water flooding in the future, in relation to the proposed mineral sites. Historical flood data provided by Nottinghamshire County Council is included in Figures D1 to D13 (Appendix D).

The RoFSW does not include a specific scenario to determine the impact of climate change on the risk of surface water flooding. However, the updated climate change allowances, as detailed in Section 3.3, will need to be assessed when taking into account potential effects of climate change on the risk of surface water flooding.

4.5.4 Flooding from Groundwater

Groundwater flooding usually occurs in low lying areas underlain by permeable rock and aquifers that allow groundwater to rise to the surface through the permeable subsoil following long periods of wet weather.. Low lying areas may be more susceptible to groundwater flooding because the water table is usually at a much shallower depth and groundwater paths tend to travel from high to low ground.

Figure A-6 (Appendix A) presents the Environment Agency's dataset: Areas Susceptible to Groundwater Flooding (AStGWF), which indicates where groundwater may emerge due to certain geological and hydrogeological conditions. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. It does not take account of the chance of flooding from groundwater rebound.

The susceptible areas are represented by one of four area categories (listed below) showing the percentage of each $1km^2$ that is susceptible to groundwater emergence.

- < 25%
- >=25% <50%
- =50% <75%
- >= 75%

The data does not show where flooding is likely to occur, but instead should be used at a strategic level to indicate areas for further investigation. The data is relatively broad and susceptibility varies greatly throughout NCC.

4.5.5 Groundwater Source Protection Zones

Groundwater Source Protection Zone (GWSPZs) GIS layers were downloaded under the OGL to assist with the development of the SFRA. There are over 2,600 GWSPZs in England surrounding wells, boreholes and springs used for public drinking water supply[40]. These zones show the risk of contamination from any activities that might cause pollution in the area. Generally, the closer the contaminating activity, the greater the risk posed to the aquifer. The maps show three main zones (inner, outer and total catchment).

The zones are used in conjunction with the Environment Agency's Groundwater Protection Position Statements to set up pollution prevention measures in areas which are at a higher risk, and to monitor the activities of potential polluters nearby[41]. The shape and size of a zone depends on the condition of the ground, how the groundwater is removed, and other environmental factors. Groundwater source catchments are divided into three Source Protection Zones as follows:

- SPZ1 – Inner Protection Zone - Defined as a 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres;

40 Environment Agency (2017) Protect groundwater and prevent groundwater pollution https://www.gov.uk/government/publications/protect-groundwater-and-prevent-groundwater-pollution/protect-groundwater-and-prevent-groundwater-pollution
41 Environment Agency (2017) The Environment Agency's Approach to Groundwater Protection

- SPZ2 – Outer protection zone - Defined by a 400 day travel time from a point below the water table. This zone has a minimum radius of 250m or 500m around the source, depending on the size of the abstraction;
- SPZ3 – Total Catchment Zone - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

In confined aquifers, the source catchment may be displaced some distance from the source. For heavily exploited aquifers, the final Source Catchment Protection Zone can be defined as the whole aquifer recharge area where the ratio of groundwater abstraction to aquifer recharge (average recharge multiplied by outcrop area) is >0.75. There is still the need to define individual source protection areas to assist operators in catchment management.

The Environment Agency's GWSPZs have been presented as a thematic map in Figure A-5(a) (Appendix A).

4.5.6 Aquifer Designation

The Environment Agency provided information on Aquifer Designations through the 'What's in your backyard' function which is not compatible with the format of other GIS data acquired for the delivery of NCC's Minerals Level 1 SFRA. For the purposes of NCC's Minerals Level 1 SFRA, AECOM were granted permission to use the 2015 dataset for Bedrock and Superficial Deposits Aquifer Designations.

Groundwater is an important strategic resource with three-quarters of all the groundwater pumped from boreholes or taken from springs used for mains water supply. It directly supplies nearly a third of the drinking water in England and Wales. In some areas it is the only available drinking water resource. It also supplies nearly all those who do not have mains water.

The Environment Agency have prioritised GWSPZs where groundwater abstraction is intended for human consumption, public drinking water supplies, commercial potable supplies, groundwater abstractions used in commercial potable supplies, abstractions used in commercial food and drink production and other sources where additional protection is required for bespoke SPZs.

The widespread presence of groundwater means that any material spilt on or applied to the ground has the potential to reach the water table. Whether it will or not depends on the material involved and the ground conditions at that site. Pollutants introduced by people can overwhelm the natural capacity of the ground to deal with them.

If human activities do pollute groundwater, it is very difficult to return it to its original condition. Processes that take days or weeks in surface water systems may take decades to centuries in groundwater. This is because of the relatively slow rates of groundwater flow and the reduced microbiological activity below the soil zone (due to the general lack of oxygen and nutrients).

Protecting groundwater is therefore essential. The subsurface environment is inaccessible and complex and groundwater pollution can be very difficult to detect and may not become evident until a water supply or spring is affected. Pollutants may take months or years to migrate from the source to a receptor or to a point where they can be detected.

Aquifer designation relates to the importance of aquifers as groundwater resources such as drinking water supply, as well as for supporting surface water flow[40]. The use of infiltration techniques will be dependent on the ground and groundwater conditions. However, other SuDS techniques may be suitable even if groundwater conditions preclude infiltration.

The Environment Agency provides the following definitions for the Aquifer Designations:

- Principal aquifers provide drinking water or support rivers, lakes and wetlands.
- Secondary Aquifers are split into two groups:
  - Secondary 'A' aquifers comprise permeable layers that can support local water supplies, and may form an important source of river base flow.
  - Secondary 'B' aquifers are mainly lower permeability layers that may store and yield amounts of groundwater through characteristics like thin cracks (called fissures) and opening or eroded layers.

- Secondary 'undifferentiated' aquifers are aquifers where it is not possible to apply either a Secondary 'A' or 'B' definition because of the variable characteristics of the rock type. These have only minor value.

Factors that will influence the vulnerability of an aquifer to contamination include whether the aquifer is classed as confined or unconfined; the depth of the aquifer; whether a pathway exists to the aquifer i.e. if impermeable layers lie above an aquifer; and the soil vulnerability.

Some strata have a high leaching potential and have very little ability to slow or halt the progress of contaminants and transmit them readily to the underlying aquifer. Other strata have a low leaching potential and are therefore either impermeable or have a number of natural factors that can slow or stop the leaching of contaminants. Principal Aquifers with a high vulnerability tend to be those with a more permeable surface geology.

It is important to note that Aquifer Designation mapping is intended to be used at a strategic scale and further site-level investigation may be necessary.

The Environment Agency's Aquifer Maps have been presented as thematic maps in Figure A-5(a) and Figure A-5(b) (Appendix A).

4.5.7 Sewer Flooding

During heavy rainfall, flooding from the sewer system may occur if:

1. The rainfall event exceeds the capacity of the sewer system/drainage system:

Sewer systems are typically designed and constructed to accommodate rainfall events with a 3.3% AEP or less. Therefore, rainfall events with a return period of frequency greater than 3.3% AEP would be expected to result in surcharging of some of the sewer system. It is not economically viable to build sewers that could cope with every extreme rainfall event.

2. The system becomes blocked by debris or sediment:

Over time there is potential that road gullies and drains become blocked from fallen leaves, build-up of sediment and debris (e.g. litter).

3. The system surcharges due to high water levels in receiving watercourses:

Within the study area there is potential for river outlets to become submerged due to high river levels. When this happens, water is unable to discharge. Once storage capacity within the sewer system itself is exceeded, the water will overflow into streets and potentially into houses. Where the local area is served by 'combined' sewers i.e. containing both foul and storm water, if rainfall entering the sewer exceeds the capacity of the combined sewer and storm overflows are blocked by high water levels in receiving watercourses, surcharging and surface flooding may again occur but in this instance floodwaters will contain untreated sewage.

In order to fulfil statutory commitments set by OFWAT, water companies must maintain verifiable records of sewer flooding, which is achieved through hydraulic flood risk registers.

Areas at risk from sewer flooding have been determined through review of records from Severn Trent Water's hydraulic flood risk register (which replaces the DG5 register). Anglian Water Services confirmed that there are no records of historic sewer flooding incidents across Nottinghamshire.

The information provided by Severn Trent Water provides information of where properties have suffered internal or external flooding. Information relating to whether flooding has arisen from public, foul, combined of surface water sewers has not been provided. The hydraulic flood risk register does indicate areas or properties at risk of future flooding.

The flood risk register is a register of properties and areas at risk of internal and external sewer flooding due to hydraulic overloading/where flows exceed the capacity of the system. It does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages.

Properties may be added to the register following rainfall events, whilst risk will be reduced in some locations by capital investment which increases the capacity of the network. The hydraulic flood risk register is not a comprehensive 'at risk register'. At present it is principally a register of known flooding locations caused by overloading of the system.

Whilst a property or area remains on the register, it may benefit from a short-term measure to protect it from recurring flooding until a flood alleviation scheme is developed to provide more robust flood protection

It should be noted that records only appear on the hydraulic flood risk register where they have been reported to Severn Trent Water, and as such they may not include all instances of sewer flooding.

Severn Trent Water should be consulted for further information to support site-specific FRAs within Nottinghamshire.

Detailed maps provided in Figures D1 to D13 (Appendix D) identifies incidents of sewer flooding for Nottinghamshire.

4.5.8 Proposed Mineral Sites

4.5.8.1 Data Sources and Requirements

NCC has provided a GIS layer of 24 potential future minerals extraction sites put forward by the industry in response to a call for sites exercise. A number of these sites are currently unused allocations from the Adopted Minerals Local Plan (2005) which has since expired[42]. A summary of the sites is detailed below in Table 4-4.

Table 4-4: Proposed Site Allocations for New Minerals Local Plan

Proposed Allocation Site Reference	Site Name	Mineral Type	Area (Ha)	OSNGR Easting	OSNGR Northing	Operator	Extension/ New
PA01	Bantycock	Gypsum	188.1	480,883.92	348,260.35	British Gypsum	Extension
PA02	Barnby Moor	Sand and Gravel	10.18	466,183.68	385,800.77	Rotherham Sand and Gravel (very similar to the below – needs clarification)	New
PA03	Barnby Moor	Sand and Gravel	15.53	466,453.72	385,394.65	Hanson (subject to planning application)	New
PA04	Barton in Fabris (London Rock)	Sand and Gravel	88.39	453,133.29	333,787.06	London Rock (subject to planning application)	New
PA05	Barton in Fabris (West)	Sand and Gravel	38.07	457,932.14	331,922.74	Cemex	New
PA06	Bawtry Road	Sand and Gravel	3.838	467,461.79	395,012.72	Owner operator	Extension
PA07	Besthorpe East	Sand and Gravel	63.38	482,166.52	363.249.25	Tarmac	New
PA08	Bestwood II East	Sherwood Sandstone	5.374	457,289.97	352,471.22	Tarmac (subject to planning permission)	Extension
PA09	Bestwood II North	Sherwood Sandstone	2.993	457,241.19	352,679.69	Tarmac	Extension
PA10	Botany Bay	Sand and Gravel	100	467,575.86	383,139.39	Tarmac	New
PA11	Burridge Farm	Sand and Gravel	55.28	480,371.15	357,223.50	Tarmac	Extension
PA12	Coddington	Sand and Gravel	124.9	484,123.30	355,444.71	Hanson	New
PA13	Cromwell	Sand and Gravel	44.4	480,564.69	362,873.28	Cemex	New
	Cromwell		7.698	480,187.57	362,270.48		

42 Nottinghamshire County Council (2005) Nottinghamshire Minerals Local Plan

Proposed Allocation Site Reference	Site Name	Mineral Type	Area (Ha)	OSNGR Easting	OSNGR Northing	Operator	Extension/ New
	Triangle Carlton River Meadows		18.56	480,180.28	363,595.78		
PA14	East Leake	Sand and Gravel	44.66	456,844.93	325,384.02	Cemex	Extension
PA15	Great North Road (North)	Sand and Gravel	75.71	478,301.14	355,875.65	Tarmac	New
PA16	Great North Road (South)	Sand and Gravel	150.5	477,628.97	354,861.39	Tarmac	New
PA17	Langford south	Sand and Gravel	26.89	481,134.33	359,544.69	Tarmac (subject to planning application)	Extension
	Langford west		34.08	480,635.17	360,377.50		
PA18	Langford north	Sand and Gravel	122.7	481,370.72	361,649.83	Tarmac	Extension
PA19	Redhill	Sand and Gravel	27.7	449,257.11	329,681.70	No operator	New
PA20	Scrooby North	Sand and Gravel	13.45	465,429.20	389,895.66	Rotherham Sand and Gravel	New
PA21	Scrooby Thompson Land	Sand and Gravel	8.861	465,000.21	389,517.73	Rotherham Sand and Gravel	New
PA22	Scrooby Top Extension North	Sherwood Sandstone	26.01	465,000.21	389,571.73	Rotherham Sand and Gravel	Extension
PA23	Shelford	Sand and Gravel	239	465,499.79	342,415.82	Brett Aggregates	New
PA24	Woodborough Lane	Clay	18.322	460,710.94	347,049.74	Ibstock	Extension/ New

The potential future minerals sites have been included in all maps presented in Appendices A-E. When overlain with flood risk and historical flooding GIS layers, it is possible to determine which of the potential minerals sites are located in areas at risk of flooding and to what extent, to allow informed decisions regarding site allocation to be made. Existing sites are mapped within Figures A1 and A8 (Appendix A).

Flood risk information for the potential future minerals sites is presented in tabular form in Appendix F.

5. Flood Risk in Nottinghamshire

5.1 Introduction

This section describes the methodology used in the production of mapping deliverables for the project and the assessment of flood risk.

5.2 Requirements of the National Planning Policy Framework

The NPPF and the accompanying PPG requires SFRAs to present sufficient information on all flood sources to enable the LPAs and the MPA within the Study Area to apply the Sequential Test in their administrative areas. This information should be presented graphically where possible as a series of figures and/or maps. In addition, the assessment of probability should also account for the effects of climate change on a flood source for the lifetime of any development that is proposed.

5.3 Historical Flooding

There have been numerous historical flood events in Nottinghamshire. A GIS layer of the Environment Agency's Historic Flood Map (HFM) was obtained through the OGL to support this SFRA Update and is illustrated within Figures D1-D13 (Appendix D).

In 2015, based on reports from NCC Highways Management, numerous areas within NCC were affected by flooding from surface water and ordinary watercourses[24]. In addition, groundwater flooding was experienced in West Bridgford and Misterton. NCC has provided updated records of major historical flooding events across Nottinghamshire since the Nottinghamshire Minerals Level 1 SFRA (2010) and subsequent update in 2015.

In the LFRMS, NCC compiled a table with priority flood risk locations where recorded flood events from numerous sources were included. The majority of the recorded incidents were a result of flooding from surface water and ordinary watercourses with a few attributed to main river, groundwater or sewer flooding incidents (Table 5-1). *Additional records of historic flooding post-2015 have not been provided by NCC for the purposes of the Draft report.*

Table 5-1: Recorded flood incidents from multiple and/or combined sources between January 2012 and February 2015

Location	Recorded Incidents
Southwell	275
Hucknall	106
Lowdham	86
Calverton	47
Mansfield	40
Retford	34
East Bridgford	33
Carlton	32
Thurgarton	29
Newthorpe	28
Sutton-in-Ashfield	26
West Bridgford	23
Kimberley	22
Arnold	20
Ravenshead	18
Worksop	18

5.4 Fluvial Flooding

The predominant risk of flooding within Nottinghamshire is fluvial flooding from the overtopping of surface watercourses including rivers, streams and drainage channels (i.e. flows exceeding their bank-full capacity). The main watercourses within the SFRA Study Area are illustrated in Figure A-1 (Appendix A).

5.4.1 River Trent

The River Trent is the dominant catchment draining Nottinghamshire. Major tributaries join the River Trent from three main areas including;

- The Peak District (River Dove, River Derwent and River Erewash);
- South Midlands (River Sow, River Tame and River Soar); and,
- Lower catchment (River Torne and River Idle).

The River Trent bisects the Greater Nottingham administrative area, flowing in a north-easterly direction through all LPA administrative areas (except Ashfield and Mansfield) across a broad and low relief alluvial floodplain. The River Trent rises in the Staffordshire Moorlands and is joined by its major tributaries in the upper catchment before flowing northeast towards the Humber Estuary.

The Trent catchment is predominantly impervious with the catchment consisting largely of glacial clay and alluvium on top of Mercia Mudstone, with some sandstone and limestone being present[43]. The River Trent has little or no hydrological interaction with the underlying aquifer however the catchment through the study area comprises extensive terrace gravels and alluvium within the river valleys which maintain its base flow.

The Environment Agency's flood risk model confirmed that the River Trent is tidally influenced downstream from Cromwell Lock where the main towns within the vicinity include Newark and Gainsborough[44]. The new Climate Change Scenario (2016) model includes the new climate change allowances as listed in Table 3-3.

Following the 2000 flood event, the Environment Agency worked with partner organisations to study the flood risk over the entire length of the River Trent and its main tributaries. The Nottingham Left Bank Flood Alleviation Scheme (FAS) was subsequently developed by the Environment Agency[45].

The Nottingham Trent Left Bank FAS was designed to reduce the risk of flooding to 16,000 homes and businesses along a 27km stretch of the River Trent. The scheme, which was completed and fully operational in 2012 at a cost of £45 million, raised existing flood defences from Sawley to Colwick in order to provide a minimum 1 in 100 year Standard of Protection (SoP) along the left bank of the River Trent[46]. However, the River Trent Climate Change and Breach modelling (2016) identifies new areas at a residual risk of flooding.

The Nottinghamshire LFRMS (2016) includes case studies of other flood alleviation schemes that have been implemented in Nottinghamshire through partnership contributions[47].

5.4.2 River Soar

The River Soar is a major tributary of the River Trent flowing generally northwards through Leicestershire. It forms the south-western border of Rushcliffe where it is joined by Kingston Brook and continues towards its confluence with the River Trent at Trent Lock between Long Eaton and Ratcliffe-on-Soar.

The source of the river originates near Hinckley in Leicestershire proceeding to flow north east through Leicester where it is joined by the Grand Union Canal, River Sence, River Wreake and Rothley Brook upstream of the Greater Nottingham area.

The River Soar catchment is largely characterised by clay and alluvium, and is known to be rapidly responsive to rainfall events[48]. The predominant geology of the River Soar catchment is Mercia Mudstone with some sandstones in the west and Lias clays and limestone in the east. It has a moderate to low relief.

43 Natural England (2013) National Character Profile: Trent and Belvoir Dales
44 Environment Agency (2010) River Trent Catchment Flood Management Plan
45 East Midlands Council (2015) The Changing Nature of Flooding in the East Midlands
http://www.emcouncils.gov.uk/write/Item_9(a)_-_Changing_Nature_of_Flooding_FOR_WEB.v4.pdf
46 Environment Agency (2014) Nottingham Left Bank Flood Risk Management Scheme
https://www.gov.uk/government/publications/nottingham-left-bank-flood-risk-management-scheme/nottingham-left-bank-flood-risk-management-scheme
47 Nottinghamshire County Council (2016) Nottinghamshire Local Flood Risk Management Strategy.

The Trent Rivers Trust, the EA, farmers and other organisations have been working closely on a Natural Flood Management (NFM) project in Leicester to reduce the risk of flooding from surface and river sources within Leicester[49]. Recently, funding was secured for the implementation of the Soar NFM project to provide improvements to the River Soar and Grand Union Canal with the EA and Soar catchment partnership working together to deliver the project by 2021[50].

5.4.3 River Erewash

The River Erewash is a tributary of the River Trent comprising a moderate to low relief catchment which drains Carboniferous Coal Measures with Permian and Triassic bedrock on the east and southern extents. Approximately 30% of the catchment is urban, whilst the remaining area is characterised by arable and grazing land uses[51]. The river flows from north to south forming the border between Erewash and Broxtowe where it flows through Attenborough Lakes via breaches caused by mineral extraction before finally discharging into the River Trent.

More detailed modelling from the Greater Nottingham River Trent – SFRA 2010 and Climate Change Scenario (2016) has refined the Flood Zones along the River Erewash since previous SFRAs. These changes are also due to the construction of the 2012 Trent Left Bank FAS.

5.4.4 River Leen

The River Leen comprises a moderate to low relief catchment flowing from Newstead Abbey south through Gedling and Ashfield through the centre of Nottingham City towards its confluence with the River Trent near Lenton. It has a complicated base flow hydrology. The River Leen drains Magnesian Limestone in the west with Permian Mudstone and Sherwood Sandstone outcrops in the east, crossing the boundary between the two units several times before reaching the River Trent to the south-west of Nottingham. A significant fraction of the lower catchment is urban (approximately 50%). Other land uses include arable and grazing[52].

In the past, the Greater Nottingham area contained a large number of springs, many of which were located to the mudstone/sandstone boundary and drained into local river systems including the Rivers Leen and Trent. However, many tributaries of these rivers and related springs are believed to have now dried up.

There have been updates to the fluvial modelling of the River Leen and Day Brook (2017) since publication of the River Leen and Day Brook SFRA (2008) and the Greater Nottingham SFRA in 2010. The extent of the model has increased upstream through Bulwell, and the extent of the functional floodplain (5% AEP, Flood Zone 3b) has increased in the Old Basford area. The Flood Zone 3a (1% AEP) flood extent has increased in the Old Lenton area surrounding the hospital, in playing fields and industrial depots between Orston Drive and Triumph Road and within the marina north of The Mornings road. Flood Zone 2 (0.1 % AEP event) has reduced in the Castle Quay Close area and along Harrimans Lane south of the railway line, but reduced in the area of the University Park Tennis Centre. The new climate change allowance flood extents (20%, 30% and 50%) have been included in this model.

5.4.5 River Maun, River Meden and River Idle

The River Maun and River Meden form the upper catchment of the River Idle, originating in Ashfield. The River Meden flows generally north eastwards through Market Warsop. The River Maun also flows north eastwards through Ollerton before converging with the Meden at West Drayton in Bassetlaw. Continuing northwards through Retford as the River Idle, it is joined by the River Ryton west of Scafworth and redirects eastwards towards Misterton. The total catchment area is 896km^2

Downstream of Retford, the River Idle drains bedrock of Nottingham Castle Sandstone Formation and then Mercia Mudstone Group (Mudstone) downstream of its confluence with the River Ryton and the small settlement of Misson. The underlying bedrock formations are classified by the Environment Agency as Principal and Secondary B Aquifers respectively. Downstream of Retford, the River Idle has well defined floodplains.

48 Environment Agency (2014) The Soar Management Catchment
49 Trent Rivers Trust (2013) Soar Natural Flood Management
50 Environment Agency (2017) Leicester Integrated Flood Risk Management Strategy Strategic Environmental Assessment (SEA) Environmental Report
51 Centre for Ecology and Hydrology (2012) National River Flow Archive. Erewash at Sandiacre. http://www.ceh.ac.uk/data/nrfa/data/station.html?28027
52 Centre for Ecology and Hydrology (2012) National River Flow Archive. Leen at Triumph Road, Nottingham. http://www.ceh.ac.uk/data/nrfa/data/station.html?28035

The Isle of Axholme Flood Risk Management Strategy (2012)[53] states that there are significant lengths of minor embankments along the River Idle. The embankments have been designed to overtop during flood events with a low return period with the intention of inundating adjacent washland areas.

At its downstream end, the River Idle discharges into the River Trent at the West Stockwith Pumping Station.

A review of the NRFA database[54] highlighted that the catchment is comprised predominantly of low relief, but more moderate relief in the headwaters. Its tributaries rise on Magnesian Limestone and then traverse an outcrop of Sherwood Sandstone. The lower reaches are underlain by alluvium and Mercia Mudstone. Approximately 15% of the catchment is urban; therefore the land use is predominantly rural, inclusive of arable farming.

The River Maun and River Meden are not currently defended by any formal flood defences. A significant tributary of the River Idle is the Retford Beck joining the right bank from the east. The lower reaches of the Retford Beck are heavily culverted and are considerably under capacity to convey resulting flows, causing frequent flooding at culvert entrances.

The Mansfield SFRA (2016)[55] identifies that there have been minor, localised updates on the Flood Zones 2 and 3 for the River Meden but not for the River Maun within the administrative boundary.

The Bassetlaw District Council SFRA (2009) states the River Idle has very few formal defences as it flows through Retford. Previously, the channel has been widened to now contain much of the 1 in 20 year (5% AEP) flows within bank. There are very few features along the River Idle banks to prevent a 1 in 100 year (1% AEP) flood spilling out of bank onto the adjacent land. Culverts present along the River Idle cause some backing up of flood water to occur due to the culverts under Albert Road and Bridgegate.

5.4.6 River Ryton

The River Ryton enters Bassetlaw from the west and flows eastwards through Worksop before redirecting northwards through Blyth and Bircotes to its confluence with the River Idle.

A review of the NRFA database[56] highlighted that the catchment is comprised of moderate and low relief. The headwaters drain part of the Magnesian Limestone outcrop; with the bulk underlain by Permian Marl and Sherwood Sandstone with little Superficial Drift deposits. Apart from Worksop, the catchment is wholly rural and is characterised by mainly arable farming.

The Bassetlaw SFRA (2009) states that in Worksop, the River Ryton has few maintained formal defences. The river passes through culverts in the town centre which are too small to carry a 1 in 100 year (1% AEP) flood event, resulting in water backing up and flooding out of bank onto the surrounding land.

5.4.7 River Smite

The River Smite flows north eastwards through eastern Rushcliffe in proximity to the settlements of Barnstone, Aslockton and Flawborough. The river is joined by the River Whipling east of Aslockton and is a tributary of the River Devon flowing northwards immediately north east of the study area boundary.

5.4.8 Small Watercourses

In addition to these major watercourses, there is an extensive system of streams and smaller watercourses including:

53 Isle of Axholme Flood Risk Management Strategy
https://www.shiregroup-idbs.gov.uk/wp-content/uploads/2016/12/IoA-Strategy-Appraisal-Report.pdf
54 Centre for Ecology and Hydrology (2012) National River Flow Archive. Idle at Mattersey.
http://www.ceh.ac.uk/data/nrfa/data/station.html?28015
55 Mansfield District Council (2016) Local Plan Consultation Draft Addendum to the Strategic Flood Risk Assessment.
56 Centre for Ecology and Hydrology (2012) National River Flow Archive. Ryton at Blyth.
http://nrfa.ceh.ac.uk/data/station/info?28091

- River Greet
- Lambley Dumble
- Mill Dame Dyke
- River Torne
- Day Brook
- Lowfield Drain
- Nut Brook
- River Whipling
- Slough Dyke
- Ock Brook
- Kingston Brook
- Middle Beck
- Golden Brook
- Fairham Brook
- Woodborough Brook
- Laneham Beck
- Nethergate Brook
- Tinkers Leen
- Saundby Beck
- Dover Beck
- Retford Beck
- Cocker Beck
- Ouse Dyke
- Tottle Brook
- Greythorne Dyke
- Crock Dumble
- Robins Wood Dyke
- Lees Brook
- Baker Lane Brook
- Oldcoates Dyke
- Adbolton Brook
- Polser Brook
- Gamston Brook
- Carlton Beck
- Beauvale Brook
- River Poulter
- Grassthorpe Beck
- Boundary Brook

5.4.9 Local SFRAs

5.4.9.1 Ashfield District Council SFRA

Ashfield District Council completed a Level 1 SFRA[57] in February 2009. Flood risk for the district of Ashfield is considered to be low however some specific locations require further investigation including the valley of Cuttail Brook, the valley below Sutton Lawn Dam, Mill Lane in Huthwaite and land to the north of Ashlands Road.

5.4.9.2 Bassetlaw District Council SFRA

In July 2009 JBA Consulting Ltd. completed a Level 1 and Level 2 SFRA[58] for Bassetlaw District Council. Bassetlaw District Council is mainly at risk of flooding from fluvial sources. The main rivers in the district that pose a risk are the River Ryton which has few maintained formal defences, the River Idle which has few formal flood defences and the lower reaches of Retford Beck which are culverted and are already restricted in their capacity to carry catchment flows.

5.4.9.3 Mansfield District Council SFRA

RPS Group undertook a Level 1 SFRA[59] in June 2008 for Mansfield District Council. The SFRA concluded that the administrative area was generally at low risk from flooding. An addendum to the SFRA was originally produced in 2014 with updates being made in 2016 to reflect changes to national guidance. The addendum concludes that flood risk from rivers remains low.

5.4.9.4 Newark and Sherwood District Council SFRA

In July 2009 WSP produced a Level 1 SFRA[60] for Newark and Sherwood District Council. In June 2010 WSP produced a Level 2 assessment[61] which focussed on three strategic sites which are centred on Newark's Growth Point. The key finding for the Level 2 SFRA was that the majority of the land fell within areas of low fluvial flood risk; other sources of flooding also posed a low risk. A second phase Level 2 SFRA[62] was delivered in 2012 by WSP. A review[63] of the SFRA was delivered in 2016 by WYG Engineering Limited. The review makes revisions to the SFRA to align with updated national guidance, other key policy documents published by risk authorities and updated flood risk data.

57 Ashfield District Council (2009) Ashfield Level 1 Strategic Flood Risk Assessment
58 JBA Consulting (2009) Bassetlaw Strategic Flood Risk Assessment
59 RPS Group (2008) Mansfield Level 1 Strategic Flood Risk Assessment
60 WSP (2009) Newark and Sherwood Level 1 Strategic Flood Risk Assessment
61 WSP (2010) Newark and Sherwood Level 2 Part 1 Strategic Flood Risk Assessment
62 WSP (2012) Newark and Sherwood Level 2 Part 2 Strategic Flood Risk Assessment
63 WYG Engineering Limited (2016) Newark and Sherwood District Council SFRA Review 2016

5.4.9.5 Greater Nottingham SFRA

The Greater Nottingham SFRA[64] was completed by Black and Veatch in 2008. The urban area of Nottingham extends beyond the administrative boundaries of Nottingham City Council, and includes taking in several surrounding towns and villages. The SFRA states that within the urban extent there are 20,000 properties at risk of flooding on the right and left bank of the River Trent from a 1 in 100 year event. In a 1 in 100 year event the existing flood defences in Sawley, Attenborough, Rylands, Nottingham City Centre, Colwick and Burton Joyce overtop into Sawley, Long Eaton, Attenborough, Dunkirk, Rylands, Nottingham City centre, Colwick, Netherfield and Burton Joyce. For the less frequent 1 in 1000 year event, more extensive flooding of urban areas including West Bridgford, Wilford and Barton-in-Fabis (which is presently protected for the 1 in 100 year event) is modelled.

An addendum to the SFRA[65] was developed in 2017 by AECOM. The addendum to the SFRA outlines new national guidance and reviews new flood risk data provided by the Environment Agency. Additional and improved hydraulic modelling demonstrates a reduction in flood risk across LPAs where the new Trent Left Bank FAS defences have been constructed. Table 5-2 provides information as to the flood risk areas identified from the Greater Nottingham SFRA addendum.

Table 5-2: Flood risk areas identified from the Greater Nottingham Addendum SFRA and SFRAs from Individual Councils

District/Borough	SFRA and Addendum Comments
Broxtowe Borough Council	The SFRA concludes that River Trent flooding would likely impact Beeston, Toton, Stapleford and Rylands areas. Some limited locations adjacent to Boundary and Beauvale Brooks (previously modelled by using the Hydrologic Engineering Center's River Analysis System (HECRAS)) are at risk of flooding in a 1 in 100 year (1% AEP) event. These locations include around the cricket pitch and upstream of Mansfield Road (Boundary Brook), and at Devonshire Drive and Roehampton Drive (Beauvale Brook). Flooding along Beauvale Brook is affected by the flap valve under the River Erewash defences The addendum states that there have been significant reductions in residual flood risk across the Attenborough, Chilwell and Beeston Rylands areas of Broxtowe Borough due to the construction of the Trent Left Bank FAS. Along the River Erewash, the most recent modelled results (SFRM2, 2013) show more detailed outlines for Flood Zone 2 and 3 than in the 2010 Greater Nottingham SFRA, although there are no major reaches where any large areas has moved into a higher/lower risk band. The uFMfSW illustrates the greatest pluvial flooding risk along the lower elevations of the Ordinary Watercourse and Main River valleys. Where obstructions in the floodplain are present (for example road embankments, bridges, canals and railways), there is a high proportion of impermeable land use and/or ground levels flatten out, a greater extent of ponding is exhibited. The AStGWF map illustrates areas with the greatest susceptibility to groundwater emergence along the River Trent corridor, followed by areas along the corridor of the River Erewash.
Erewash Borough Council	The 2012 Trent Left Bank FAS has reduced the area at risk of flooding in Erewash Borough, particularly in Long Eaton within the Sawley and Trent Meadows areas. Along the River Erewash, more detailed modelling has refined the Flood Zones since previous SFRAs. Updated modelling along the River Derwent (SFRM2, 2011) shows that some properties in Draycott have moved out of Flood Zone 2. These updates are solely due to updated modelling and not as a result of flood defences. Updated modelling along Ock Brook (SFRM, 2012) shows a reduction in the extent of Flood Zone 3 but a greater Flood Zone 2 extent. Again, these updates are solely due to updated modelling approach and not as a result of any new flood defences. The uFMfSW illustrates the greatest pluvial flooding risk along the lower elevations of the Ordinary Watercourse and Main River valleys. Where obstructions in the floodplain are present (for example road embankments, bridges, canals and railways), there is a high proportion of impermeable land use and/or ground levels flatten out, a greater extent of ponding is exhibited. The AStGWF map illustrates areas with the greatest susceptibility to groundwater emergence along the River Derwent and River Trent corridors, followed by areas along the corridor of the River Erewash.
Gedling Borough Council	Ouse Dyke modelling revealed a small number of properties at risk from the Day Brook. The 2012 Trent Left Bank FAS has reduced the area at risk of flooding in Gedling Borough, particularly in the Colwick and Netherfield areas. Detailed modelling as part of the Nottingham Tributaries SFRM2 (2014) study of the Crock Dumble and the Dover Beck has provided more detailed outlines in the Woodborough and Burton Joyce areas. The uFMfSW illustrates the greatest pluvial flooding risk along the lower elevations of the Ordinary Watercourse and Main River valleys. Where obstructions in the floodplain are present (for example road embankments, bridges, canals and railways), there is a high proportion of

64 Black and Veatch (2008) Greater Nottingham Level 1 Strategic Flood Risk Assessment
65 AECOM (2017) Greater Nottingham Strategic Flood Risk Assessment Addendum

District/Borough	SFRA and Addendum Comments
	impermeable land use and/or ground levels flatten out, a greater extent of ponding is exhibited. The AStGWF map illustrates areas with the greatest susceptibility to groundwater emergence along the River Trent corridor, followed by areas along the corridor of the headwaters of the River Leen and Baker Lane Brook.
Nottingham City Council	Fairham and Nethergate Brooks were modelled by Flood Modeller which showed four properties and Fairham Community College at risk from a 1 in 100 year (1% AEP) flood event; with more properties affected in a 1 in 1000 year (0.1% AEP) flood event. The 2012 Trent Left Bank FAS has reduced the area at risk of flooding in Nottingham City, particularly in the Beeston Rylands, Nottingham University, Lenton, Queens Drive and Meadows areas. There have also been updates to the fluvial modelling of the River Leen and Day Brook since publication of the River Leen and Day Brook SFRA (2008) and the Greater Nottingham SFRA in 2010. The extent of the model has increased upstream through Bulwell, and the extent of the functional floodplain (5% AEP, Flood Zone 3b) has increased in the Old Basford area. The Flood Zone 3a (1% AEP, 1 in 100 year) flood extent has increased in the Old Lenton area surrounding the hospital, in playing fields and industrial depots between Orston Drive and Triumph Road and within the marina north of The Mornings road. Flood Zone 2 (0.1% AEP event) has reduced in the Castle Quay Close area and along Harrimans Lane south of the railway line, but reduced in the area of the University Park Tennis Centre. The uFMfSW illustrates the greatest pluvial flooding risk along the lower elevations of the Ordinary Watercourse and Main River valleys. Where obstructions in the floodplain are present (for example road embankments, bridges, canals and railways), there is a high proportion of impermeable land use and/or ground levels flatten out, a greater extent of ponding is exhibited. This occurs widely in Nottingham within the predominantly urban floodplains comprising shallower topography and a high proportion of impermeable land use. The AStGWF map illustrates areas with the greatest susceptibility to groundwater emergence along the River Trent corridor, followed by areas along the corridor of Tottle Brook.
Rushcliffe Borough Council	Fairham Brook was modelled by Flood Modeller which showed that the 1 in 100 year (1% AEP) flood event is likely to affect many properties in Wilford and Clifton Boulevard. Grantham Canal and Adbolton, Gamston and Polser Brooks are likely to cause additional flooding behind the River Trent defences. The uFMfSW illustrates the greatest pluvial flooding risk along the lower elevations of the Ordinary Watercourse and Main River valleys. Where obstructions in the floodplain are present (for example road embankments, bridges, canals and railways), there is a high proportion of impermeable land use and/or ground levels flatten out, a greater extent of ponding is exhibited. This occurs widely in Rushcliffe within the predominantly rural floodplains comprising shallower topography. The AStGWF map illustrates areas with the greatest susceptibility to groundwater emergence along the River Soar and River Trent corridors, followed by areas along the corridor of the River Smite.

5.4.9.6 River Leen and Day Brook SFRA

Black and Veatch were also commissioned by the Environment Agency, NCIC and Nottingham Regeneration Limited to carry out a SFRA of the River Leen and Day Brook[66]. This was completed in 2008.

The SFRA identified that major overtopping of the flood defences occurs at Bulwell, Basford, Bobbers Mill, Radford and Sherwood. Overtopping was shown to affect major transport infrastructure such as the railway line, tram line and arterial roads in the north and west of Nottingham City. Generally, the River Leen channel and flood defences are considered to provide around a 1 in 25 year (4% AEP) SoP although flooding commences at a 1 in 5 year (20% AEP) flood event in parts of Bulwell, Basford and Sherwood.

5.5 Surface Water Flooding

During periods of prolonged rainfall events and sudden intense downpours, overland flow generated from adjacent higher ground may flow across land and ‘pond’ in low-lying areas without draining into watercourses, surface water drainage systems or the ground. Intense rainfall that is unable to infiltrate into the ground or enter drainage systems can quickly run overland and result in local flooding.

Surface water (otherwise known as ‘pluvial’ flooding) is frequently experienced, can be destructive in nature and is possibly a more serious problem than suggested by historic records. The River Trent Catchment Flood Management Plan established that 20% of flood events were a result of surface water or sewer flooding.

66 Black and Veatch (2008) River Leen and Day Brook Strategic Flood Risk Assessment

Surface water flooding does not need a watercourse in close proximity to occur and is exacerbated by areas of highly impermeable hard standing such as tarmac, or low permeability soils and geology (such as clay). In developed areas, this flood water can be polluted with domestic sewage where foul sewers surcharge and overflow.

As a result, minerals development, inclusive of stockpiles and ancillary buildings, could lead to more frequent surface water flooding and could cause significant disruption to the site and surrounding land. However, any problems encountered from pluvial flooding are more likely to inconvenience the operator and are unlikely to be significant in assessing the suitability of sites.

In recent years, a significant amount of the flooding in Nottinghamshire has been attributed to surface water in areas such as Southwell, Hucknall etc. See section 5.3 for additional information.

Information of the RoFSW dataset can be found in Section 4.5.3.

5.6 Groundwater Flooding

Groundwater flooding occurs where groundwater levels rise above ground surface levels. The local geology is an important factor when assessing the risk of groundwater flooding. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers), usually associated with chalk, sandstone and limestone catchments that allow groundwater to rise to the surface through permeable subsoil following long periods of wet weather.

High water tables may result in standing water on low lying ground that is unable to reach a ditch or watercourse and is unable to percolate through the ground due to seasonally high perched groundwater levels.

Minerals workings in most cases excavate below the natural water table, which during periods of heavy rainfall, may rise. Mineral workings often operate a pumped drainage system and can therefore interfere with groundwater flow. These issues would be most appropriately addressed in a site specific FRA at the planning application stage.

Industrial flooding can also occur when pumping ceases and groundwater returns to its natural level, for example in former mineral workings and urban areas where industrial water abstraction is reduced from its former rate. Some of this flooding may also be contaminated.

The Environment Agency's AStGWF map is presented in Figure A-6 (Appendix A), more information on the AtGWF dataset can be found in Section 4.5.4.

5.7 Sewer Flooding

Sewer flooding generally results in localised short-term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure; however this is not included in Severn Trent Water's flooding records.

Maps provided in Appendix D illustrate sewer flooding incidents for Nottinghamshire, as provided by Severn Trent Water. No sewer flooding incidents have been recorded within, or within 100m of, any of the potential mineral sites. For additional information on the format of the hydraulic flood risk register provided by Severn Trent Water see Section 4.5.7.

Sewer and surface water flooding are likely to become more frequent and widespread as a result of urbanisation and climate change, further reinforcing the importance of integrated SuDS.

5.8 Artificial Sources – Canals and Reservoirs

Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure. The latter can happen suddenly resulting in rapidly flowing, deep water that can cause significant threat to life and major property damage. The Nottingham, Beeston, Erewash, Grantham and Chesterfield canals are all situated within the Study Area as illustrated in Figure A-1 (Appendix A).

A number of overtopping and breach events have previously occurred along the Chesterfield Canal, as well as the Grantham and Erewash Canals. No historic breach or overtopping events have been recorded in proximity to

the Proposed Mineral Sites. There are four canals within the NCC boundary which include the Nottingham and Beeston Canal; the Grantham Canal; the Erewash Canal and the Chesterfield Canal.

The southern section of the Nottingham Canal is now part of the River Trent Navigation, and the northern section is a designated nature reserve. The downstream section of the canal remains in use as part of the Beeston and Nottingham Canal.

The Grantham Canal stretches from Grantham to West Bridgford via 18 locks where it joins the River Trent. It was previously used as a water supply for agriculture and as such most of the channel remains in water. Since the 1970s, the Grantham Canal Society has been working towards its restoration, and two stretches are now navigable to small vessels.

The Erewash Canal starts from the River Trent at Trentlock and proceeds through Long Eaton. After passing Long Eaton, the canal runs roughly parallel to the River Erewash, alongside the towns of Sandiacre and Ilkeston, crossing the River Erewash near Eastwood. The canal ceases at the Langley Mill (Great Northern) basin, where it joins the Nottingham Canal and the Cromford Canal (both now in a state of abandonment)

The Chesterfield Canal runs 74km from the River Trent at West Stockwith in Nottinghamshire through Worksop to Chesterfield, Derbyshire. The canal comprises 65 locks and two tunnels, of which one at Norwood collapsed at the start of the 20th century. As commercial traffic ceased, the lower reaches were retained and remain popular with pleasure boats. Much of the rest of the canal has been restored.

Flood risk posed by the canals is un-quantified at present. However, it is widely acknowledged that canals may present potential flood risks. Canals are considered to be controlled water bodies so flood risk is deemed to be minimal unless overtopped in storm conditions. There is, however, a residual risk of structural failure. The C&RT is not a flood defence body, although they do manage some critical flood defence structures including the Beeston, Sawley and Cranfleet flood gates.

In general, the canal system is hydraulically closed down at relatively low river levels prior to the issuing of a flood alert from the Environment Agency. This is to protect the canal corridors from higher than average river levels which would overtop the banks, and to protect craft from venturing onto rivers at dangerous flows. The system however is dependent on the levels of associated Environment Agency flood defences. Overtopping or breach of river defences into the canal corridor could result in transfer of flood waters to other vulnerable areas, for example problems at Beeston could lead to flooding in Nottingham itself.

Canals generally work at relatively stable water levels with the various lock by-passes, and waste weirs passing and controlling excess feeds without leading to overtopping of the banks.

The main causes of flooding are likely to be vandalism and a failure of a canal embankment. This has been known to happen occasionally but the impact is not considered to be as extensive as a failure of a reservoir dam as studies have shown that maximum discharges are limited to the volume held within the canal cross section between two locks. This risk is managed by the C&RT.

For potential mineral sites located adjacent to a canal, a detailed site specific FRA should be undertaken to determine the risk of overtopping. For those located adjacent to raised canal embankments, the detailed site specific FRA should determine the residual risks from breaching or overtopping as a result of water level control infrastructure failure. If the development proposals are of a significant scale, consideration should be given to undertaking a Level 2 SFRA study for that area to determine these residual risks.

The C&RT provided records of breach and overtopping events associated with the canals they operate within Nottinghamshire. These have been presented in Figure E1-13 (Appendix E).

5.8.1 Flooding from Reservoirs

The Environment Agency's Risk of Flooding from Reservoirs Mapping identifies areas that could be flooded if a large reservoir were to fail and release the water it holds. The Environment Agency website should be consulted for further information on risk from reservoirs[67].

67 Environment Agency's Risk of Flooding from Reservoirs Mapping
https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

Reservoirs in the UK have an extremely good safety record. The Environment Agency is the regulatory authority for the Reservoirs Act 1975 in England and Wales. All large reservoirs must be inspected and supervised by reservoir panel engineers on an annual basis.

5.8.2 Infrastructure Failure

Flooding may result from the failure of engineering installations such as flood defences, land drainage pumping stations, sluice gates, floodgates and weirs. Hard defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement and toe protection or the failure of ground anchors. Such deterioration is often difficult to detect, meaning that should a failure occur, it is often sudden and unexpected. Failure is more likely when a structure is under maximum stress, such as extreme fluvial flooding events.

The Environment Agency's Areas Benefitting from Flood Defences dataset is presented in Appendix B. Areas benefitting from the protection of flood defences are at residual risk from flooding in the event of a breach of the defences.

5.9 Proposed Capital Works (FCERM Programmes)

Local authorities, internal drainage boards and the Environment Agency are working together to develop schemes to reduce the risks of flooding between April 2015 and March 2021. The proposed Flood and Coastal Erosion Risk Management (FCERM) projects currently in development across the Nottinghamshire area are included in Table 5-3[68].

This information is provided to enable NCC to take a proactive, holistic approach to flood risk management, with the potential opportunity for alignment of schemes with development. Projects listed below are subject to determining a cost beneficial solution and sourcing sufficient funding. For those programmed FCERM projects that have not yet secured full funding contributions, the opportunity for partnership working with developers could facilitate future development in these areas.

Table 5-3: FCERM programme of Works within NCC and NCIC

Project Name	Local Authority	Risk Management Authority	Estimate Earliest Construction Date
Isle of Axholme, West Stockwith Pumping Station Improvements	Bassetlaw	Environment Agency	By April 2019
Heckdyke, 3 Bridges and 4 Bridges Pumping Station Refurbishment, Nottinghamshire	Bassetlaw	Isle of Axholme and North Nottinghamshire Water Level Management Board	Beyond 2021
Retford Beck, Grove Lane and Blackstope Lane Flood Mitigation Scheme, Retford, Nottinghamshire	Bassetlaw	Bassetlaw District Council	Beyond 2021
Smeath Lane Culvert Replacement Scheme, Clarborough, Nottinghamshire	Bassetlaw	Bassetlaw District Council	By April 2021
Cocker Beck Flood Alleviation Scheme, Lowdham, Nottinghamshire	Newark and Sherwood	Environment Agency	By April 2019
Gunthorpe, River Trent Flood Defence Scheme, Nottinghamshire	Newark and Sherwood	Environment Agency	By April 2021
Lowfield Drain, Lowfield Pumping Station Refurbishment, Nottinghamshire	Newark and Sherwood	Trent Valley IDB	By April 2019
Southwell Flood Alleviation Scheme, Nottinghamshire	Newark and Sherwood	Nottinghamshire County Council	By April 2019
Nottingham Trent Left Bank Flood Alleviation Scheme	Nottingham	Environment Agency	By April 2019
Day Brook Flood Alleviation Scheme, Old Basford, Nottingham	Nottingham	Environment Agency	By April 2021

68 Programme of Flood and Coastal Erosion Risk Management Schemes
https://www.gov.uk/government/publications/programme-of-flood-and-coastal-erosion-risk-management-schemes

Project Name	Local Authority	Risk Management Authority	Estimate Earliest Construction Date
Mapperley Park Surface Water Management Scheme, Nottingham	Nottingham	Nottingham City Council	By April 2021
Tottle Brook Flood Alleviation Scheme, Nottingham	Nottingham	Nottingham City Council	Beyond 2021

5.10 Existing Flood Risk Management in Nottinghamshire

The Environment Agency Spatial Defences dataset identifies a significant number of flood defences throughout the study area, which are classified as fluvial defences. These include major flood defence assets along the River Trent. The River Trent defences in Nottinghamshire consist of a range of methods of protection including embankments, walls and culverts with varying SoPs.

5.11 Flood Warning Areas

Ensuring people in areas of flood risk are aware of potential flooding is key to ensuring they are prepared, facilitating the protection of property and evacuation where necessary. The Environment Agency operates a free flood warning service for many areas at risk of fluvial and tidal flooding, issuing flood warnings to homes and businesses when flooding to properties is expected. The service currently consists of three stages as outlined in Table 5-4. Further information on Flood Warnings in force and Flood Alert Areas can be found from the Flood Warning Information Service on the gov.uk website[69].

Table 5-4: Environment Agency Flood Warning Codes

Code	What it Means?	When it is used?	What to do?
	**Flood Alert:** Flooding is possible. Be prepared.	Two hours to two days in advance of flooding.	• Be prepared to act on your flood plan • Prepare a flood kit of essential items • Monitor local water levels and the flood forecast on the Flood Warning Information Service website
	**Flood Warning:** Flooding is expected. Immediate action required.	Half an hour to one day in advance of flooding.	• Move family, pets and valuables to a safe place. • Turn off gas, electricity and water supplies if safe to do so. • Put flood protection equipment in place.
	**Severe Flood Warning:** Severe flooding. Danger to life.	When flooding poses a significant threat to life.	• Stay in a safe place with a means of escape. • Be ready should you need to evacuate from your home. • Co-operate with the emergency services. • Call 999 if you are in immediate danger.

For Nottinghamshire, the EA's Flood Warning Areas are located predominantly along the River Trent through Beeston, Nottingham City and West Bridgford, and progress further downstream through the less densely populated Trent Valley, past Newark, throughout the wider flatter floodplain towards the confluence with the River Idle. Smaller Flood Warning Areas are located along the River Erewash, on the western border of the County at Selston through to Stapleford, until it comes into confluence with the River Trent. Further areas include the River Lean and Day Brook within Nottingham City Council's administrative boundary.

The Flood Warning Information Service is available for the River Maun at Mansfield and where the river flows through the Sherwood Forest National Nature Reserve. A parcel of land is covered for flood warning before the

69 Flood Warning Information Service
https://flood-warning-information.service.gov.uk/warnings

River Maun comes into confluence with the Idle alongside the River Meden and Poulter at Markham Moor. Pockets of Flood Warning Areas also exist where the River Idle flows through Retford and in Worksop and Blyth where the River Ryton comes into confluence with the River Idle in the northern part of the county.

The Environment Agency's Flood Warning Areas within the Nottinghamshire Study Area are presented in Figure A-7 (Appendix A).

5.12 Emergency Planning and Flood Risk

LPAs are classified as Category 1 responders in the context of the Civil Contingency Act 2004. As such their responsibilities include risk assessment, emergency planning and warning and informing the public. Emergency Plans are in place in Nottinghamshire. The LPAs work closely with other Category 1 Responders, such as the Emergency Services, to minimise the impact of flooding.

When dealing with flood risk the multi-agency approach is as follows:

- **Preparation** – raising flood awareness, ensuring no inappropriate use of the floodplain, ensuring emergency access and egress routes are available, protecting vital infrastructure, ensuring adequate flood resilience measures are employed;
- **Response** – The emergency services would be responsible for rescue operations with LPAs taking responsibility for providing safe refuge and short term accommodation; and,
- **Recovery** – A LPA led Recovery Working Group co-ordinates efforts to provide support to the community providing longer term temporary accommodation where appropriate.

NCC has a Flood Response Plan in place, produced by the Local Resilience Forum. The Flood Response Plan can be viewed via NCC's website[70].

5.13 Potential Future Minerals Sites and Flood Risk

Appendix F presents flood risk information relating to NCC's potential future minerals sites in tabular format, with flood risk in relation to the sites also discussed below.

Stockpiles and ancillary buildings can reduce the storage capacity of the floodplain. In addition, they could alter the natural flow of the flood water by blocking flow paths and increasing flood risk to adjacent land. Typically in floodplain quarries, sand and gravel extracted in spring and summer months is sold directly, resulting in small stockpiles. However, stockpiles are often increased in late summer and autumn to provide sales during the winter months when pumps are switched off and excavation is inhibited.

This leads to a larger potential impact in the winter months. In order to mitigate this, the sequential approach should be applied on a site level to ensure that stockpiles and ancillary offices are located in areas at lowest flood risk to avoid being adversely affected by flooding or increasing flood risk elsewhere. Site specific FRAs submitted at the application stage can ensure that sites are designed, worked and restored accordingly.

Flood risk information contained within this Level 1 SFRA Update will form the evidence base to carry out the Sequential Test for the potential minerals sites. The Sequential Test is a simple decision-making tool designed to ensure that sites at little or no risk of flooding are developed in preference to sites at higher risk. Section 7 of this SFRA update provides further detail on the application of the Sequential Test.

Whilst the Sequential Test has not yet been completed by NCC, based on existing and potential locations available at the time of writing, the following comments can be made regarding the need for an Exception Test or potential Level 2 SFRA.

The potential Sherwood Sandstone and Clay extraction sites classified as 'less vulnerable' developments in the NPPF (see Table 7-1) are located within Flood Zone 1 (<=0.1% AEP event) and are therefore considered compatible with the respective 'low risk' of fluvial flooding location. NCC will therefore not be required to apply the Exception Test to these particular sites and it is not expected that a Level 2 SFRA study will need to be undertaken.

70 Nottinghamshire County Council Emergency Plans
http://www.nottinghamshire.gov.uk/planning-and-environment/emergencies-and-disruption/council-emergency-plans

A large proportion of the potential Sand and Gravel sites, are located in the valley of the Trent and its tributaries (Appendix A-2). 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 plus climate change. Therefore, these sites are considered to be at a medium to high risk of fluvial flooding. The Bantycock gypsum site is also included in Flood Zone 2 and 3.

Sand and gravel sites are often located on low lying ground characteristic of lowland meandering floodplain deposits where there may be limited surface water drainage due to the water table being close to the ground surface. Therefore, these may be at increased risk of surface water and groundwater flooding resulting in standing water and overland flow from adjacent higher ground. The majority of the sand and gravel sites are located along the River Trent where areas have a susceptibility of over 50% for groundwater flooding. Overland flow paths should therefore be taken into account in spatial planning for mineral developments.

Such sand and gravel workings are classified as ‘water compatible’ development and it is not expected that an Exception Test will need to be undertaken for such sites. However, a Level 2 SFRA may be required to determine the areas within these flood zones that pose the least hazard (resulting from a combination of flood depth and velocity), within which to suitably locate the buildings and stockpiles.

The potential minerals sites are generally located in rural areas remote from settlements and scattered housing, therefore, sewer flooding is not thought to be a significant issue with regard to flood risk at potential minerals sites. There have been no canal breaches or over toppings within the vicinity of the potential sites.

6. Flood Risk Management Measures

6.1 Overview

All new and future minerals development should consider and integrate flood risk management within the planning stage, including a robust and comprehensive application of the requirements of both the NPPF and PPG, with the use of sustainable flood risk management measures being encouraged where practicable. This Chapter of the SFRA describes how flood risk management can be applied within Nottinghamshire.

Both local planning authorities and developers should seek to identify flood risk management opportunities (such as safeguarding land) to reduce both the causes and impacts of flooding (through use of SuDS or green infrastructure for example).

Flood risk both to and from the proposed development site(s) must be considered. Through assessing flood risk early on within the planning process, the risk of subsequent, significant additional costs being incurred are reduced. The broad approach of assessing, avoiding, managing and mitigating flood risk should be followed.

Sustainable flood risk management promotes a catchment based approach. Defra state that *'a better coordinated action is desirable at the catchment level by all those who use water or influence land management and that this requires greater engagement and delivery by stakeholders at the catchment as well as local level, supported by the Environment Agency and other organisations'*[71]. A catchment-based approach to flooding uses natural processes and systems to slow down and store water.

Once mineral sites have become redundant, opportunities exist for floodplain creation and restoration. In addition to flood risk management, a range of opportunities to deliver other social and/or environmental benefits may exist at disused mineral sites, such as biodiversity improvements and opportunities to improve water quality to meet Water Framework Directive (WFD) objectives.

6.2 Residual Risk

Section 8.6 provides the following information in regards to residual risk:

- Definitions and examples of residual risk;
- Elements that should be considered within a flood risk assessment as part of an evaluation of residual risk; and,
- Measures to manage residual risk.

6.3 Emergency Planning

NCC as LPA should use this SFRA to determine the acceptability of flood risk in relation to emergency planning capability. A key consideration for any new development is whether adequate flood warning systems and procedures are in place to ensure that occupants of the site are able to act upon the warnings and are equipped to take steps to remain safe in the event of a flood.

For sand and gravel workings, the PPG states that any essential ancillary sleeping or residential accommodation for staff required by the workings will only be permitted in areas of flood risk subject to a specific warning and evacuation plan.

6.4 Sustainable Flood Risk Management

Traditional flood risk management measures have typically used hard engineering, such as building flood walls, embankments and large concrete bridges and culverts. Similarly, rivers have been straightened and floodplains drained to allow for farming and urban development. The result of this activity is that rivers flow faster and over smaller, more restricted areas than they would under natural conditions. Subsequently, the flow of water can become restricted, increasing flood risk in other areas of the catchment, which is likely to be further exacerbated

71 Defra (2013). Catchment Based Approach: Improving the quality of our water environment - A policy framework to encourage the wider adoption of an integrated Catchment Based Approach to improving the quality of our water environment. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/204231/pb13934-water-environment-catchment-based-approach.pdf [Last Accessed: 19 February 2018].

by climate change. As a result, more sustainable approaches to flood risk management are required. The Humber FRMP[72] states that where new and/or improved defences are justified, they will *'work with natural process to achieve a more sustainable solution that will provide a better more robust standard of protection in the future'.*

The FRMP also states that *'Flood risk and coastal erosion management activities require careful planning to ensure that appropriate, sustainable, options are selected and that they are implemented properly. Actions should be planned effectively, for the long-term, and provide a clear picture of what will be done to manage risk and provide multiple benefits'.*

A number of social, economic and environmental objectives have been identified for the Humber river basin district as follows:

- **SOC1:** Understanding Flood Risk and Working in Partnership
- **SOC2:** Community Preparedness and Resilience
- **SOC3:** Reduce Community Disruption
- **SOC4:** Flood Risk and Development – Working in partnership to understand the pressure for economic growth and economic sustainability throughout the river basin.
- **SOC5:** Reduce Risk to People
- **ECON1:** Reduce Economic Damage
- **ECON2:** Maintenance of Main River and Existing Assets
- **ECON3:** Transport Services – Minimise the risk of flooding to key transport links within the river basin.
- **ECON4**: Flood Risk to Agricultural Land – Consideration of the value of agricultural land and the damages that can occur as a result of flooding.
- **ECON5:** Tourism – Ensure flood risk management activities do not adversely affect tourism.
- **ENVI1:** Water Framework Directive – Working with Catchment based approach (CaBA) partnerships to achieve WFD objectives.
- **ENVI2:** Designated Nature Conversation Sites – Minimise negative impacts of flooding to designated nature conservation sites.
- **ENVI3:** Designated Heritage Sites – Minimise the negative impacts of flooding to heritage assets and landscape value.

The overarching theme of the new Minerals Local Plan will be to promote sustainable development achieving the highest quality restoration possible through balancing economic benefit and mineral requirements against social and environmental constraints.

Section 3.8.1 of this report identifies how NCC intends to integrate sustainability across the development and delivery of the new Minerals Local Plan.

6.5 Restoration and Aftercare of Minerals Sites

Restoration of mineral sites can be designed to reduce flood risk by providing flood storage and attenuation once extraction of minerals has ceased.

Responsibility for the restoration and aftercare of mineral sites lies with the minerals operator. The most appropriate form of site restoration to facilitate different potential after uses should be addressed in NCC's new Local Minerals Plan which should include policies to ensure that worked land is reclaimed at the earliest opportunity. Restoration and aftercare should be of high-quality, being addressed on a site-by-site basis informed and guided by discussions between the mineral operator and MPA. The MPA can facilitate sound restoration and aftercare proposals though the imposition of suitable planning conditions and, where necessary, through planning

72 Humber River Basin District Flood Risk Management Plan
https://www.gov.uk/government/publications/humber-river-basin-district-flood-risk-management-plan

obligations. In order to explore all potential restoration options, collaborative working between the site operator, and relevant flood risk, wildlife and environmental organisations is strongly encouraged.

Restoration of minerals sites is likely to be most effective at a strategic (county) scale. Restoration may need to be undertaken in phases so that disruption is minimised locally.

Restoration and aftercare will comprise the following five stages:

1. Stripping of soils and soil-making materials and either their storage or their direct replacement (i.e. restoration) on another part of the site;
2. Storage and replacement of overburden;
3. Achieving the landscape and landform objectives for the site, including filling operations if required, following mineral extraction;
4. Restoration, including soil placement, relief of compaction and provision of surface features; and,
5. Aftercare.

Sand and gravel extraction in a floodplain is likely to create a void that can be used to provide potential flood storage, generally reducing flow and water levels in the vicinity of the extraction. Opportunities may also exist to re-position old flood defences in order to reconnect the floodplain, offering multiple benefits, whilst ensuring that flood risk is not increased to receptors. Water filled mineral extraction sites are valuable stopping off points for migrating wildfowl. Where marginal vegetation is present they can also provide nesting sites and a good habitat for invertebrates.

There are various possible land-uses once restoration and aftercare of land is complete including:

- Creation of new habitats and biodiversity;
- Use for agriculture;
- Forestry;
- Recreational activities;
- Waste management, including waste storage; and,
- The built environment, such as residential, industrial and retail where appropriate.

Once potential restoration options have been considered, a site specific FRA will be required to provide an adequate assessment of flood risk.

7. NPPF Sequential Test Guidance

7.1 Overview

The PPG requires each MPA to provide a steady and adequate supply of minerals through preparation of an annual Local Aggregates Assessment. A Local Aggregate Assessment contains three core elements:

- A forecast of aggregate demand based on both the rolling average of 10 year sales data and other relevant local information;
- An analysis of all aggregate supply options, as indicated by landbanks, mineral plan allocations and capacity data. This should be informed by planning information and other relevant local information; and,
- An assessment of the balance between demand and supply, and the economic and environmental opportunities and constraints that might influence the situation.

Minimum landbanks of permitted reserves are also required to be maintained and include a minimum landbank of 7 years for sand and gravel and Sherwood Sandstone (per mineral) and 10 years for crushed rock[73].

A sequential approach to site selection ensures that as far as reasonably practicable, sites are located where the risk of flooding (from all sources[74]) is lowest. This approach considers climate change alongside the vulnerability of future uses of sites. In plan making, this involves applying the Sequential Test to local plans.

The PPG states that LPAs should undertake a SFRA to fully understand the flood risk in an area to inform the preparation of Local Plans. The NPPF facilitates stringent testing to ensure that people and properties are protected from flooding and that development is steered towards low flood vulnerability areas by applying the Sequential Test and where necessary the Exception Test (see Section 7.4). Development should be direct to Flood Zone 1 wherever possible, and then sequentially to Flood Zones 2 and 3.

The PPG states that: *'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'*** *acknowledging that these deposits are often in flood risk areas). However, mineral working should not increase flood risk elsewhere and needs to be designed, worked and restored accordingly'.*

NCC must demonstrate that it has considered a range of possible sites in conjunction with the flood zone information from the SFRA and the Environment Agency and has applied the Sequential Test in the mineral site allocation process.

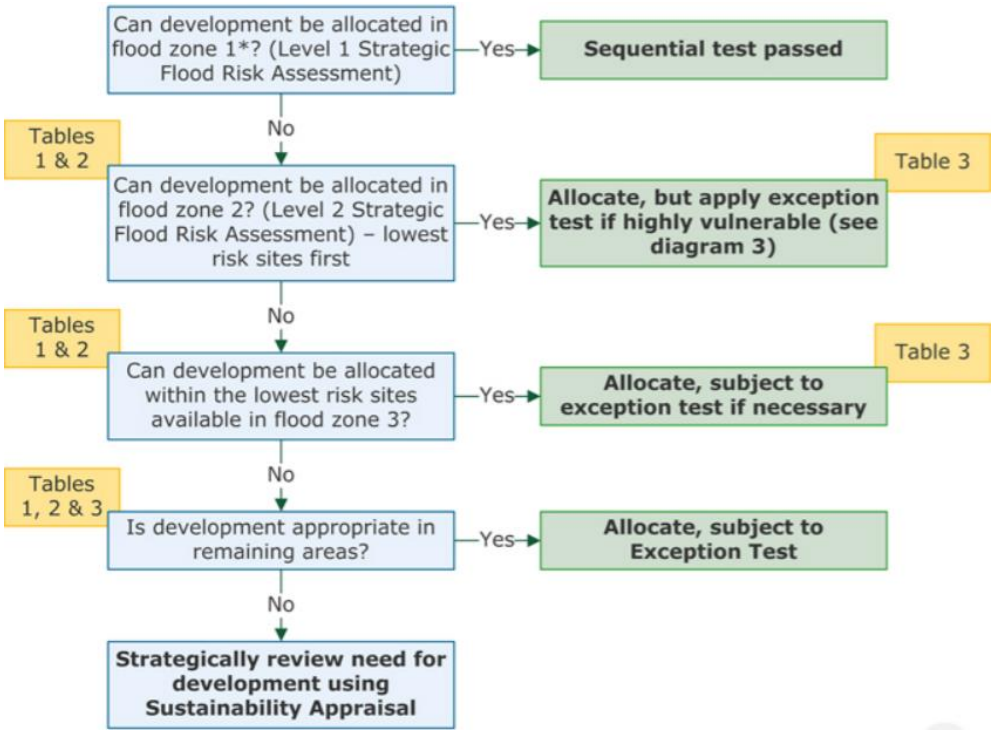
The PPG states that mineral extraction sites often cover large areas, thereby offering the potential to apply the sequential approach at the site level. Such an approach may allow ancillary buildings and supporting infrastructure to be located within areas of a site at lowest risk of flooding, in order to reduce the risk of being adversely affected by flooding or increasing flood risk elsewhere.

It should be noted that essential ancillary sleeping or residential accommodation for staff required by all Water Compatible development (including sand and gravel workings) are subject to a specific flood warning and evacuation plan. NCC 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 a strong justification for the level of development that may ultimately need to take place in areas that are at risk of flooding.

A flow diagram for the application of the Sequential Test from the PPG is provided in Figure 7-1.

73 Nottinghamshire County Council (2017) Nottinghamshire Minerals Local Plan Issues and Options Consultation Document
74 Sources of flooding to consider include: fluvial, tidal, pluvial, groundwater, sewers and drains and manmade or artificial sources.

Figure 7-1: Application of Sequential Test for Plan-Making (Tables 1-3 referenced within this figure can be found within the PPG)



Application of the Sequential test requires:

- An understanding of the flood zones in the study area; and,
- An understanding of the vulnerability classifications of the proposed developments.

A summary of each Flood Zone with an accompanying definition (Table 1 of the PPG) can be found in Table 4-2. Table 7-1 provides a summary of the vulnerability classifications for mineral sites (based on Table 2 of the PPG). Table 7-2 demonstrates which types of mineral development site are appropriate within each flood zone and where the Exception Test is required.

Table 7-1: Summary of Vulnerability Classifications for Mineral Sites

Development Type	Vulnerability Classification
Minerals working and processing (except for sand and gravel working). Including Sherwood Sandstone, Limestone, Clay and Gypsum.	Less Vulnerable
Sand and gravel working. Essential Ancillary sleeping or residential accommodation for staff required by this use, subject to a specific flood warning and evacuation plan.	Water Compatible

Table 7-2: Flood Zone and Flood Risk Vulnerability Classification Compatibility

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	Exception Test Required	✓	✓	✓
Flood Zone 3a†	Exception Test Required †	✗	Exception Test Required	✓	✓
Flood Zone 3b*	Exception Test Required*	✗	✗	✗	✓*

✓= Development is appropriate
✗= Development should not be permitted
*= 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; and,
- Not impede water flows and not increase flood risk elsewhere.

†= In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

Tables 7-1 and 7-2 demonstrate that mineral developments are classified as either Water Compatible or Less Vulnerable development and as such as permitted within Flood Zone 1, Flood Zone 2 and Flood Zone 3a, subject to satisfaction of the Sequential Test. Table 7-3 confirms that the Exception Test is not usually applicable to minerals development sites due to their vulnerability classification; however any essential ancillary sleeping or residential accommodation for staff required by Water Compatible development, such as sand and gravel workings, are subject to a specific flood warning and evacuation plan.

Any proposed development on a windfall site will by definition differ to a site allocated in the new Minerals Local Plan that has been sequentially tested. Therefore, the Sequential Test will need to be applied at the planning application stage and should be subject to the same consideration of flood risk as other development sites.

Where a flood source other than tidal and fluvial is identified, the ability of a site to pass the Sequential Test is not affected. However, a site specific flood risk assessment should be completed to assess the full impacts of flooding to the site from all flood sources. For example, a site may be located in Flood Zone 1 yet is at risk of surface water or ground water flooding; in this instance the site would pass the Sequential Test but a site specific flood risk assessment would be required to fully investigate flood risk from all sources.

The maps presented in Appendix A-E are designed to assist NCC in determining the flood risk classification for each site and in completing the Sequential Test. This will aid the determination of the most suitable type of land use at each site based upon vulnerability classification and flood risk.

The spatial strategy for minerals development is primarily driven by geology as minerals can only be worked where they naturally occur. This has implications when carrying out the Sequential Test in accordance with the NPPF (steering development to lowest flood risk) as reasonable alternative sites may not always be available. This is particularly the case with deposits of sand and gravel as many of the deposits are located within natural river floodplains which are often inundated during flood events, and therefore not ‘preferred’ in accordance with the Sequential Test.

7.2 Using the SFRA Maps, Data and GIS Layers

Table 7-3 highlights which GIS layers and SFRA data should be used in carrying out the Sequential Test. The table poses some example questions which provide some guidance in where to look within the SFRA for the information.

Table 7-3: Sequential Test Key - A Guide to using the SFRA GIS Layers

Category	GIS Layer & Figure	Example Questions
Development Vulnerability	Not applicable refer to Table 2 in PPG/Table 7-2 of this SFRA	Question 1 - Is the proposed development defined as 'More Vulnerable' according to Table 2 of PPG/Table 7-2 of this SFRA?
		Question 2 - Is the proposed development defined as 'Less Vulnerable' according to Table 2 of PPG/ Table 7-2 of this SFRA?
		Question 3 - Is the proposed development defined as 'Water Compatible development' according to Table 2 of PPG/ Table 7-2 of this SFRA?
Flood Zone Classification	Environment Agency main river maps. Appendix A1 & B of this SFRA	Question 4 - Is the site located near a watercourse?
	SFRA fluvial FZ2, FZ3a & FZ3b layers. Appendix A2, B & E (detailed hydraulic modelling outputs).	Question 5 – Through consultation of the Environment Agency's Flood Zone maps/SFRA mapping, is the development site located in Flood Zone 1?
		Question 6 - Through consultation of the Environment Agency's Flood Zone maps/SFRA mapping, is the development site located in Flood Zone 2?
		Question 7 - Through consultation of the Environment Agency's Flood Zone maps/SFRA mapping, is the development site located in Flood Zone 3a?
		Question 8 - Through consultation of the Environment Agency's Flood Zone map/SFRA mapping, is the development site located in Flood Zone 3b?
		Question 9 - Can the development be located in Flood Zone 1?
		Question 10 - Can the development be located in Flood Zone 2?
		Question 11 - Can the development be located in Flood Zone 3a?
Other Flood Sources	SFRA fluvial FZ3 outlines plus climate change Appendix E	Question 12 – Is the site impacted by the effects of climate change
	Sewer Flood Layer & Historical Flood Outlines Appendix D	Question 13 - Is the site in an area potentially at risk from sewer flooding?
	RoFSW, historical Flood Outlines, groundwater vulnerability maps	Question 14 - Is the site in an area potentially at risk from overland flow flooding?
		Question 15 - Is the site located in an area of rising

	Appendix A-6, C & D	groundwater levels?
		Question 16 - Does the site have a history of flooding from any other source?
Flood Risk Management	Spatial Defence Layer, Flood Warning Layer, Areas Benefiting from Flood Defences Layer Appendix A-7, & B	Question 17 - Does the site benefit from flood risk management measures?
		Question 18 - Can the development be relocated to an area benefiting from flood risk management measures or of lower flood risk?

7.3 How to apply the Sequential Test where there are gaps in data

Some watercourses within the study area do not have flood zones associated with them and/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. As a result, allocations adjacent to watercourses where flood zones have not been defined cannot be assessed against all aspects of the Sequential Test using the existing data.

To overcome these gaps in the data and to enable NCC to proceed with the application of the Sequential Test, the following criteria should be considered:

- For watercourses where no flood zones have been defined:
  - For application of the Sequential Test, the site should be considered as lying within Flood Zone 3a until proven otherwise.
  - If a site is within 8m of a watercourse and promoted for development, further investigation should be undertaken to determine the suitability of the site for the proposed development.
  - If, following further investigation, the site is found to lie within Flood Zone 3b the development may not be appropriate against the policies presented in the NPPF;
- For watercourses where Flood Zone 3b (functional floodplain) has not been defined:
  - If a proposed development site is located in Flood Zone 3a, there is a possibility it may also fall within Flood Zone 3b. Further investigation should be undertaken to define Flood Zone 3b for the local watercourse(s).
  - According to the NPPF, when applying the Sequential Test the site should be considered as lying within Flood Zone 3b until proven otherwise.
  - If, following further investigation, the site is found to lie within Flood Zone 3b the development may not be appropriate against the polices presented in the NPPF;
- For watercourses where the effect of climate change on flood zones has not been defined:
  - For any development located in or adjacent to a flood zone boundary, there is a possibility that when considering the effects of climate change the site may be at greater flood risk. For example if a site is clearly identified to be located in Flood Zone 2 (present day), when the effects of climate change are considered the site may be found to lie within Flood Zone 3.
  - For application of the Sequential Test for sites located in Flood Zone 3 or at the boundary of Flood Zone 2 and 3, where the effects of climate change are not defined, the sites can be considered to lie within the higher risk flood zone. However, the effects of climate change should be investigated further as part of a site specific FRA.
  - If following further investigation the site is found to lie within a different flood zone, the Sequential Test should be re-applied to determine if the proposed development is appropriate.

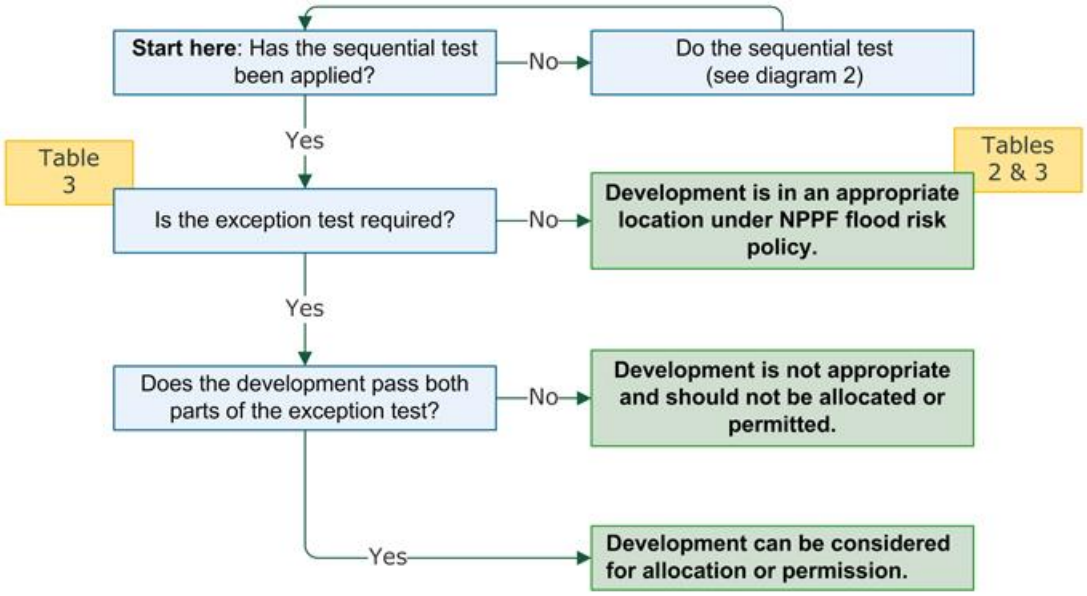
7.4 The Exception Test

The Exception Test is a method developed to ensure that flood risk to people and property will be managed in a satisfactory way. The Exception Test allows necessary development to go ahead in situations wherein suitable sites at a lower risk of flooding are not available. There are two elements to the Exception Test which require the proposed development to demonstrate that it will provide sustainability benefits to local communities which outweigh flood risks and that the development will be 'safe for its lifetime' without increasing flood risk elsewhere, with a preference to reduce flood risk overall, considering climate change. Both elements of the test will need to be passed in order for the development to be allocated.

Whilst it is acknowledged that the Exception Test is not usually applicable to minerals development sites due to their vulnerability classification, a final decision on whether the Exception Test is required should be taken following application of the Sequential Test.

A flow diagram for the application of the Exception Test from the PPG is provided in Figure 7-2.

Figure 7-2: Guidance on the Application of the Exception Test (Tables 2&3 referenced within this figure can be found within the PPG)



7.5 What is a Level 2 SFRA?

Where a Level 1 SFRA shows that land outside of flood risk areas cannot appropriately and adequately accommodate all necessary development, a Level 2 assessment may be required. A Level 2 SFRA provides the information necessary for the application of the Exception test where appropriate and should consider the detailed nature of the flood characteristics within the flood zone including:

- Flood probability;
- Flood depth;
- Flood velocity;
- Rate of onset of flooding; and,
- Duration of flood.

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 modelling may be required to define flood risk as part of a site-specific FRA. Where sites require detailed flood risk modelling, this may be delivered within a Level 2 SFRA, or as part of the planning application process.

8. Site Specific Flood Risk Assessment Guidance

8.1 Introduction

This Level 1 Minerals SFRA for NCC provides a high level assessment of the flood risk posed to the area. However, this document has a strategic scope and it is therefore essential that site-specific flood risk assessments are also developed for individual development proposals and that where appropriate, suitable mitigation measures are incorporated.

This section of the Level 1 Minerals SFRA for NCC presents recommendations and guidance for site-specific flood risk assessments prepared for submission with planning applications for mineral sites in Nottinghamshire to the LPA. Site-specific flood risk assessments are carried out by (or on behalf of) a developer to assess flood risk both to and from a development site. The assessment must demonstrate to the LPA how flood risk will be managed (with regard to the determined vulnerability classification) both now and across the lifetime of the development, with there being a requirement for climate change to be considered.

8.2 When is a Flood Risk Assessment required?

A site-specific flood risk assessment is required in the following circumstances:

- In flood zone 2 or 3 including minor development and change of use;
- For proposals of more than 1 hectare (ha) in flood zone 1;
- For proposals of less than 1 ha in flood zone 1, including a change of use in development type to a more vulnerable class, where they could be affected by sources of flooding other than rivers and the sea (for example surface water drains, reservoirs); and,
- In an area within flood zone 1 which has critical drainage problems as notified by the Environment Agency

The PPG states that *'Site-specific flood risk assessment should always be proportionate to the degree of flood risk and make optimum use of information already available, including information in a SFRA for the area'.*

All of the proposed mineral sites for Nottinghamshire considered within this SFRA are greater than 1 hectare in site area and would therefore require a site-specific FRA[75].

Guidance provides information on:

- When to complete a flood risk assessment as part of a planning application;
- How to complete a flood risk assessment; and,
- How a flood risk assessment is processed.

8.3 Scope of a Site-Specific Flood Risk Assessment

The PPG states that the objectives of a site-specific FRA are to establish:

- Whether a proposed development is likely to be affected by current or future flooding from any source;
- Whether it will increase flood risk elsewhere;
- Whether the measures proposed to deal with these effects and risks are appropriate;
- The evidence for the LPA to apply (if necessary) the Sequential Test, and;
- Whether the development will be safe and pass the Exception Test, if applicable.

The PPG provides a site-specific flood risk assessment Checklist which is designed to assist applicants/developers in preparing a site-specific flood risk assessment. The Checklist is reproduced in Appendix H.

75 Flood Risk Assessment for Planning Applications (February 2017). https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications

It is the responsibility of applicants to consider the flood risk to a site as early as possible. Applicants should refer to the SFRA at the start of the pre-application stage, or if this is not carried out, as the earliest stage in the preparation of development proposals and a planning application.

A site-specific flood risk assessment should demonstrate that the development does not increase the risk of flooding to third parties from all sources and that the proposals are compliant with local planning policy. Where possible, the development should aid to reduce flood risk overall, and the site specific FRA should demonstrate where this is the case.

8.4 Sequential Approach within Development Sites

Site-specific flood risk assessments should utilise the Sequential Approach as detailed within Section 7 of this SFRA. Flood risk should be considered at an early stage in deciding the layout and design of a site to provide an opportunity to reduce flood risk within the development. The application of a sequential approach to development sites enables the most vulnerable elements of a development to be located in the areas of lowest risk. Should development pressure create a need to develop more vulnerable land uses within the site in higher flood risk areas, appropriate mitigation measures should be incorporated that are proportionate to the flood risk and would not increase the risk of flooding to surrounding areas. Structures located in areas with a high flood risk must be flood resilient.

8.5 Surface Water Management

The site-specific flood risk assessment will need to show how surface water runoff generated by the development will be managed. The NPPF and PPG require LPAs and developers to reduce the cause and impacts of flooding through the layout and form of development including the use of SuDS.

SuDS are designed to control surface water run off close to where water falls within the catchment and to mimic natural drainage. SuDS provide wider benefits including opportunities to:

- Reduce the causes and impacts of flooding;
- Remove pollutants from urban run-off at source; and,
- Combine water management with green space with benefits for amenity, recreation and wildlife.

Additional information on SuDS is provided in Section 9 of this SFRA.

Sustainable drainage systems may not be practicable for some forms of development, including mineral extraction.

The NPPF states that flood risk should not be increased elsewhere as a result of development and therefore surface water runoff leaving the site should not increase from existing rates. The PPG states that this should be applicable over the lifetime of a development, allowing for climate change, through use of the Environment Agency's Climate Change Allowances[76].

8.6 Residual Risk

The PPG defines 'residual risk' as *'risks remaining after applying the sequential approach to the location of development and taking mitigation actions'.* Examples of residual risks include:

- The failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;
- Failure of a reservoir, or;
- A severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.

76 Environment Agency (February 2016) Flood risk assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The NPPF states that residual risk(s) of flooding should be identified as part of a FRA, alongside identification as to how residual risk(s) will be safely managed and will not expose people to hazardous flooding from any source. This SFRA provides a starting point for obtaining information on residual risk (see locations of spatial defences in Appendix B).

The following elements should be considered within a Flood Risk Assessment and as part of an assessment of residual risk:

- The design of any flood defence infrastructure;
- Access and egress;
- Operation and maintenance;
- Design of development to manage and reduce flood risk wherever possible;
- Resident awareness;
- Flood warning and evacuation procedures (see also advice on when flood warning and evacuation plans are needed); and,
- Any funding arrangements necessary for implementing the measures.

As with all aspects of development and flood risk, this is best considered early in the development process so that measures to manage residual risk can be incorporated into site layout to make the best use of the developable land.

Measures to manage residual flood risk include:

- Developer contributions towards publically-funded flood alleviation schemes;
- Flood resilience and resistance measures;
- Flood warning and evacuation plans; and,
- Designing new SuDS taking account of storm events which exceed the design standard.

8.7 Summary

To achieve the aims of the NPPF with regard to site-specific FRAs, NCC should:

- Ensure that the Sequential Test is undertaken for all occasions, including for windfall sites which are promoted for development within NCC's administrative area;
- Have regard to the vulnerability classification of developments and local emergency planning issues when determining suitable locations for minerals development sites;
- Have regard to the cumulative impact of development on flood risk. In Flood Zone 2 and Flood Zone 3, the mapped/known risk of flooding comes from either fluvial or tidal sources. In these areas, the impact of minor development on flooding by causing flood levels to rise is usually small. In some instances however, the cumulative effect of many minor developments in the same area can have a significant impact and must therefore be considered. It should be noted that minerals sites typically cover a large area and therefore the cumulative impact may be considerable;
- Ensure the management of residual risks after the sequential approach has been utilised;
- Determine decisions for windfall development through the application of the Sequential Test. Where this is not practical, NCC should balance the flood risk at an individual site. Consideration should be given to: the type of development proposed (including the proposed mineral to be extracted); emergency planning; and, the contribution that the development would make to the wider sustainability of the area before determining a decision;
- Consider flood risk as one of a number of policies that in parallel can provide mechanisms to deliver sustainable developments with multiple benefits;

- Encourage a reduction in the cause and impacts of flooding through the layout and form of development including the use of SuDS; and,
- Engage with developers and local regulators throughout the development process to develop and instigate initiatives for the reduction of flood risk.

9. Sustainable Drainage Systems

An overview of SuDS and why they should be used is included below. Dewatering and pumping during mineral extraction will require the use of appropriate SuDS techniques to ensure that the risk of flooding in the surrounding area is not increased and where possible is reduced. The construction of any ancillary buildings and paved areas as part of the mineral sites will also need to comply with the requirements for surface water management and be addressed as part of the site-specific FRA.

Site promoters should consult with the Environment Agency, LPAs and the Lead Local Flood Authority (LLFA) at NCC about their proposals for surface water management and site drainage through the use of SuDS to ensure that they are adopting the most effective methods for their site. Recently, Defra published the Non-Statutory Technical Standards for SuDS, providing guidance on design, construction, maintenance and operation[22] (see Section 3.2.1).

NCC, as LLFA for Nottinghamshire, is a statutory consultee for major development planning applications that have a drainage implication. NCC's LFRMS (2016) promotes the use of SuDS as a measurable output to ensure flood risk management is integrated into proposals during the planning process. As outlined in the FWMA, NCC will be under a duty to respond to the LPA and report on their performance on providing a substantive response within deadlines set out in legislation.

9.1 What are SuDS?

SuDS are typically softer engineering solutions inspired by natural drainage processes such as ponds and swales which manage water as close to its source as possible. This is achieved by harvesting, infiltrating, slowing, storing, conveying and treating runoff on site. Wherever possible, a SuDS technique should meet the four goals identified below with the preferred system contributing significantly to each objective.

Where possible SuDS solutions for a site should seek to:

1. Reduce surface water flood risk;
2. Pollution prevention to improve water quality;
3. Provide amenity value; and,
4. Create biodiversity.

Whilst SuDS are used to reduce surface water flood risk, there are numerous benefits that can be delivered through effective surface water management. Often a successful SuDS solution will utilise a combination of techniques, providing flood risk, pollution and landscape/wildlife benefits. SuDS management techniques used in a series of connected components are considered the best solution to meet the above objectives.

In addition, SuDS can be employed on a strategic scale, for example with a number of sites contributing to large scale jointly funded and managed schemes. It should be noted that each development site must offset its own increase in runoff and attenuation cannot be 'traded' between developments.

SuDS techniques can be used to reduce the rate and volume and improve the water quality of surface water discharges from sites to the receiving environment (i.e. natural watercourse or public sewer etc.), which is of particular importance for mineral sites. As part of any SuDS scheme, consideration should be given to the long-term maintenance of the SuDS to ensure that it remains functional for the lifetime of the development

Guidance on SuDS designs, operation and maintenance can be found in the SuDS Manual, CIRIA C753, released in 2015[77]. This information is reproduced in Table 9-1 of this document and outlines a variety of SuDS options, detailing their components and associated benefits.

77 CIRIA (2015) The SuDS Manual.

Table 9-1: SuDS component delivery of design criteria

Component Type	Description	Collection Mechanism	Peak runoff rate	Small events (interceptions)	Large Events	Water Quality	Amenity	Biodiversity
Rainwater harvesting systems	Systems that collect runoff from the roof of a building or other paved surface for use	P		●	●		●	
Green roofs	Planted soil layers on the roof of buildings that slow and store runoff	S	○	●		●	●	●
Infiltration systems	Systems that collect and store runoff, allowing it to infiltrate into the ground	P	●	●	●	●	●	●
Proprietary treatment systems	Subsurface structures designed to provide treatment of runoff	P				●		
Filter strips	Grass strips that promote sedimentation and filtration as runoff is conveyed over the surface	L		●		●	○	○
Filter drains	Shallow stone-filled trenches that provide attenuation, conveyance and treatment of runoff	L	●	○		●	○	○
Swales	Vegetated channels (sometimes planted) used to convey and treat runoff	L	●	●	●	●	●	●
Bioretention systems	Shallow landscaped depressions that allow runoff to pond temporarily on the surface, before filtering through vegetation and underlying soils	P	●	●	●	●	●	●
Trees	Trees within soil-filled tree pits, tree planters or structural soils used to collect, store and treat runoff	P	●	●		●	●	●
Pervious pavements	Structural paving through which runoff can soak and subsequently be stored in the sub-base beneath, and/or allowed to infiltrate into the ground below	S	●	●	●	●	○	○
Attenuation storage tanks	Large, below-ground voided spaces used to temporarily store runoff before infiltration, controlled release or use	P	●					
Detention basins	Vegetated depressions that store and treat runoff	P	●	●		●	●	●
Ponds and wetlands	Permanent pools of water used to facilitate treatment of runoff – runoff can also be stored in an attenuation zone above the pool	P	●			●	●	●

Key: **P** – Point, **L** – Lateral, **S** – Surface, ● – Likely valuable contribution to delivery of design criteria, ○ – Some potential contribution to delivery of design criteria, if specifically included in the design

Source: CIRIA (2015) C753 The SuDS Manual

9.2 Why use SuDS?

Traditionally, built developments have utilised piped drainage systems to manage storm water and convey surface water run-off away from developed areas as quickly as possible. Typically, these systems connect to the public sewer system for treatment and/or disposal to local watercourses. Whilst this approach rapidly transfers storm water from developed areas, the alteration of natural drainage processes can potentially impact on downstream areas by increasing flood risk, reduction in water quality, loss of water resource and detriment to

wildlife. Therefore, receiving watercourses have greater sensitivity to rainfall intensity, volume and catchment land uses post development.

Certain measures can be taken to protect more sensitive areas by reducing or prohibiting infiltration. In marginal areas where polluted water may have an impact on the groundwater, runoff can pass through one or more treatment stages depending on the potential level of pollution and hydro-geological conditions. If all infiltration was prohibited it is likely that a SuDS attenuation system would still represent an improved system over a traditional piped system enabling an improvement to the quality of the surface water runoff.

Current planning policy outlines that runoff rates post development must not exceed the existing (pre-development) rates. In addition, opportunities should be sought to achieve Greenfield runoff rates.

9.3 The SuDS Hierarchy

In regards to the discharge of surface water, the following destinations must be considered in order of preference:

1. Discharge into the ground;
2. Discharge to a surface water body;
3. Discharge to a surface water sewer; and,
4. Discharge to a combined sewer.

9.4 Infiltration SuDS

The underlying ground conditions of a development site will often determine the type of SuDS approach to be used at development sites. Infiltration measures include the use of permeable surfaces and other systems that are generally located below ground. In the design of any drainage system and SuDS approach, consideration should be given to site-specific characteristics and where possible be based on primary data from site investigations.

Infiltration SuDS rely on discharges to ground, where ground conditions are suitable. Therefore, infiltration SuDS are reliant on the local ground conditions (i.e. permeability of soils and geology, the groundwater table depth and the importance of underlying aquifers as a potable resource) for their successful operation. BGS have created a dataset to identify the suitability of ground conditions in Great Britain where the compatibility for infiltration SuDS are categorised using the suitability classifications, as listed in Table 9-2[78].

Table 9-2: Description of Suitability Classifications

Classification	Description
Highly compatible for infiltration SuDS	Suitable for free-draining SuDS
Probably compatible for infiltration SuDS	The subsurface is probably suitable for infiltration SuDS, but the design of the system may be influenced by the ground conditions
Opportunities for bespoke infiltration SuDS	The subsurface is potentially suitable for infiltration SuDS, but the design will be highly influenced by the ground conditions
Very significant constraints	There is a very significant potential for one or more hazards associated with infiltration

Various infiltration SuDS techniques are available for directing the surface water run-off to ground. Development pressures and maximisation of the developable area may reduce the area available for infiltration systems but this should not be a limiting factor for the use of SuDS.

If a sufficient area required for infiltration is not available, a combined approach with attenuation could be used to manage surface water runoff. Attenuation storage may be provided in the sub-base of a permeable surface, within the chamber of a soakaway or as a pond/water feature.

78 BGS (2013) Suitability of the subsurface for infiltration SuDS in Great Britain

Appendix A County Mapping Overviews

Flood Warning/Alert Areas

The Environment Agency provide a free flood warning service for many areas at risk of flooding from rivers and the sea. In some parts of England the Environment Agency may be able to provide warnings when flooding from groundwater is possible. The Environment Agency free flood warning service can provide advance notice of flooding and can provide time to prepare. Flood Warnings are issued to homes and businesses in specific areas when flooding is expected. Upon receipt of a flood warning, occupants should take immediate action. Flood Alerts are issued to homes and businesses in larger areas when flooding is possible. Upon receipt of a flood warning, occupants should be prepared for flooding and to take action.

AStGWF

1. This map illustrates the Environment Agency's Areas Susceptible to Groundwater Flooding (AStGWF) dataset. The Environment Agency states that it shows “the proportion of each 1 km grid square where geological and hydrogeological conditions suggest that groundwater might emerge.it does not show the likelihood of groundwater flooding occurring”.
2. Absence of values for any grid square means that no part of that square is identified as being susceptible to groundwater emergence.
3. It should be noted that flood risk from other sources is not shown.

Appendix B 1:50,000 Scale County Insets – River Flooding

Flood Zones

Main Rivers are designated by Defra on a 'Main River Map'. The Environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only. However, overall responsibility for maintenance lies with the riparian owner.

The Environment Agency Flood Map for Planning (Rivers and Sea) is available on the Environment Agency website (www.gov.uk/government/organisations/environment-agency) and displays the risk of flooding based on probability.

Flood Zone 1: Land assessed, ignoring the presence of flood defences, as having a less than 0.1% annual probability of fluvial or tidal flooding.

Flood Zone 2: Land assessed, ignoring the presence of flood defences, as having between a 1% and 0.1% annual probability of fluvial flooding or between a 0.5% and 0.1% annual probability of tidal flooding in any year.

Flood Zone 3: Land assessed, ignoring the presence of flood defences, as having a 1% or greater annual probability of fluvial flooding or a 0.5% or greater annual probability of tidal flooding in any year.

Appendix C 1:50,000 Scale County Insets – Pluvial Flooding

RoFSW

1. This map illustrates the predicted likelihood of surface water flooding as defined by the Environment Agency's Risk of Flooding from Surface Water (RoFSW) Map data, which may be subject to further analysis in the future. Further information is provided on the Environment Agency website (www.gov.uk/government/organisations/environment-agency).
2. The Risk from Surface Water Flooding is divided into categories:-High: each year, the chance of flooding is greater than 1 in 30 (3.3%). Medium: each year, the chance of flooding is between 1 in 100 (1%) and 1 in 30 (3.3%). Low: each year, the chance of flooding is between 1 in 1000 (0.1%) and 1 in 100 (1%). Very Low: each year, the chance of flooding is less than 1 in 1000 (0.1%).
3. The potential impact of surface water flooding can vary according to the depth of the water, and its velocity (speed and direction that it is flowing in).
4. Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. This type of flooding can be difficult to predict as it is hard to forecast exactly where or how much rain will fall in any storm.
5. This map is intended to provide a strategic overview of surface water flood risk and should not be used to assess flood risk for individual properties.

Appendix D 1:50,000 Scale County Insets – Other Potential Sources of Flooding and Historical Flooding

Appendix E 1:50,000 Scale County Insets – Detailed Modelled Flood Outlines

Appendix F Potential Minerals Sites

Proposed Allocation Site Reference	Name	Mineral Type	Area (Ha)	Easting	Northing	EA Flood Zone 1	EA Flood Zone 2	EA Flood Zone 3	Flood Zone 3B	Flood Zone 3 + CC	Areas Benefitting from Flood Defences	Flood Warning Areas	RoFSW (1 in 30 year)	RoFSW (1 in 100 year)	RoFSW (1 in 1000 year)	STW Historical Sewer Flooding	EA Historic Flood Map	AStGWF (<25%)	AStGWF (25-50%)	AStGWF (50-75%)	AStGWF (>75%)	Main River Within site
PA01	Bantycock	Gypsum	188.1	480,883	348,260	✓	✓	✓					✓	✓	✓				✓			
PA02	Barnby Moor	Sand and Gravel	10.18	466,183	385,800	✓	✓	✓					✓	✓	✓		✓	✓			✓	
PA03	Barnby Moor	Sand and Gravel	15.53	466,453	385,394	✓	✓	✓					✓	✓	✓		✓			✓	✓	
PA04	Barton in Fabris (London Rock)	Sand and Gravel	88.39	453,133	333,787	✓	✓	✓	✓	✓	✓	034FWFTRTHRMPTN	✓	✓	✓		✓	✓		✓	✓	
PA05	Barton in Fabris (West)	Sand and Gravel	38.07	457,932	331,922		✓	✓	✓	✓		034FWFTRTHRMPTN					✓		✓	✓	✓	
PA06	Bawtry Road	Sand and Gravel	3.838	467,461	395,012		✓	✓									✓	✓		✓	✓	
PA07	Besthorpe East	Sand and Gravel	63.38	482,166	363.249		✓	✓				034FWBTRCOLLHAM 034FWBTRBESTHRP	✓	✓	✓		✓			✓	✓	
PA08	Bestwood II East	Sherwood Sandstone	5.374	457,289	352,471	✓									✓							
PA09	Bestwood II North	Sherwood Sandstone	2.993	457,241	352,679	✓												✓				
PA10	Botany Bay	Sand and Gravel	100	467,575	383,139	✓							✓	✓	✓		✓	✓		✓	✓	
PA11	Burridge Farm	Sand and Gravel	55.28	480,371	357,223		✓	✓				034FWFTRNTHMUSKHM	✓	✓	✓		✓				✓	
PA12	Coddington	Sand and Gravel	124.9	484,123	355,444		✓	✓					✓	✓	✓		✓			✓	✓	
PA13	Cromwell	Sand and Gravel	44.4	480,564	362,873		✓	✓				034FWBTRCROMWELL	✓	✓	✓		✓	✓			✓	
	Cromwell Triangle		7.698	480,187	362,270																	
	Carlton River Meadows		18.56	480,180	363,595							034FWBTRCARLTON										
PA14	East Leake	Sand and Gravel	44.66	456,844	325,384	✓							✓	✓	✓				✓			
PA15	Great North Road (North)	Sand and Gravel	75.71	478,301	355,875		✓	✓	✓	✓		034FWFTRSUGARNWK	✓	✓	✓		✓				✓	
PA16	Great North Road (South)	Sand and Gravel	150.5	477,628	354,861		✓	✓	✓	✓		034FWFTRSUGARNWK	✓	✓	✓		✓				✓	
PA17	Langford south	Sand and Gravel	26.89	481,134	359,544		✓	✓	✓	✓		034FWFTRHOLME		✓	✓		✓	✓			✓	
	Langford west		34.08	480,635	360,377																	
PA18	Langford north	Sand and Gravel	122.7	481,370	361,649		✓	✓	✓	✓		034FWBTRCOLLHAM 034FWFTRHOLME	✓	✓	✓		✓				✓	

Proposed Allocation Site Reference	Name	Mineral Type	Area (Ha)	Easting	Northing	EA Flood Zone 1	EA Flood Zone 2	EA Flood Zone 3	Flood Zone 3B	Flood Zone 3 + CC	Areas Benefitting from Flood Defences	Flood Warning Areas	RoFSW (1 in 30 year)	RoFSW (1 in 100 year)	RoFSW (1 in 1000 year)	STW Historical Sewer Flooding	EA Historic Flood Map	AStGWF (<25%)	AStGWF (25-50%)	AStGWF (50-75%)	AStGWF (>75%)	Main River Within site
PA19	Redhill	Sand and Gravel	27.7	449,257	329,681		✓	✓	✓	✓		034FWFSOREDKEG	✓	✓	✓		✓				✓	✓ (Adjacent to site)
PA20	Scrooby North	Sand and Gravel	13.45	465,429	389,895	✓							✓	✓	✓		✓	✓				
PA21	Scrooby Thompson Land	Sand and Gravel	8.861	465,000	389,517	✓							✓	✓	✓		✓	✓				
PA22	Scrooby Top Extension North	Sherwood Sandstone	26.01	465,000	389,571	✓											✓	✓			✓	✓ (Adjacent to site)
PA23	Shelford	Sand and Gravel	239	465,499	342,415		✓	✓	✓	✓		034FWFTRSHLFDMNR	✓	✓	✓		✓	✓	✓	✓	✓	
PA24	Woodborough Lane	Clay	18.322	460,710	347,049	✓									✓			✓				

Appendix G Data Register

Dataset	Source	Format	Description
Existing Mineral Sites	Nottinghamshire County Council	GIS Layer	Existing minerals sites located within Nottinghamshire
Proposed Mineral Site Allocations	Nottinghamshire County Council	GIS Layer	Potential sites for future mineral extraction
District Boundaries	Ordnance Survey Open Data	GIS Layer	A GIS layer of the administrative boundaries within Nottinghamshire
Canal Centrelines	Canal and River Trust Open Data	GIS Layer	A GIS layer of the canal network within Nottinghamshire
Flood Map for Planning (Rivers and Sea) Flood Zones 2 and 3	Data.gov.uk	GIS Layer	A quick and easy reference that can be used as an indication of the probability of flooding from Main Rivers. The original Flood Map was broad scale national mapping typically using JFLOW modelling software that is generally thought to have inaccuracies. This is regularly updated with the result of new modelling studies.
EA Detailed Fluvial Model Outputs	Environment Agency	GIS Layer	Outlines of the flood extents derived from detailed fluvial/tidal flood modelling. The extents are provided for defended scenarios and have been used to help define Flood Zone 3b and Flood Zone 3a accounting for the effects of climate change
EA Statutory Main Rivers	Data.gov.uk	GIS Layer	Identification of the river network including Main Rivers within Nottinghamshire
EA Detailed River Network	Permission to use previous 2015 data by NCC	GIS Layer	Identification of the river network including Main Rivers and Ordinary Watercourses within Nottinghamshire
EA Flood Warning Areas	Data.gov.uk	GIS Layer	A GIS layer of the existing Flood Warning Areas within Nottinghamshire. In such areas alerts are provided to members of the public, businesses and other stakeholders for flood events of different severity
EA Historical Flood Map	Data.gov.uk	GIS Layer	A single GIS layer showing the extent of fluvial historic flood events created using best available information at time of publication. However, some of the data is based on circumstantial and subjective evidence. There is not always available metadata, e.g. date of flood event.
EA Spatial Defences	Data.gov.uk	GIS Layer	A record of raised flood defences within Nottinghamshire
EA Areas Benefitting from Defences	Data.gov.uk	GIS Layer	A GIS dataset showing areas benefitting from protection from flooding to a 1% AEP (1 in 100 year) Standard of Protection (SoP). Such areas are at residual risk from fluvial and/or tidal flooding
Internal Drainage Board Boundaries	Water Management Consortium Upper Witham IDB	GIS Layer	GIS layers of Internal Drainage Board administrative boundaries
Internal Drainage Board Watercourses	Water Management Consortium Upper Witham IDB	GIS Layer	GIS layers of Internal Drainage Board maintained watercourses
EA Risk of Flooding from Surface Water	Data.gov.uk	GIS Layer	Provides an indication of the broad areas likely to be at risk of surface water flooding, i.e. areas where surface water would be expected to flow or pond. This dataset does not show the susceptibility of individual properties to surface water flooding.
EA Groundwater Source Protection Zones	Permission to use previous 2015 data by NCC	GIS Layer	A GIS layer showing the risk of contamination from any activity in an area that may result in pollution.
EA Bedrock and Superficial	Permission to use	GIS Layer	A GIS layer that shows aquifer designations for

Dataset	Source	Format	Description
Deposits Aquifer Designation	previous 2015 data by NCC		bedrock aquifers. The designations identify the potential of the geological strata to provide water that can be abstracted and have been defined through the assessment of the underlying geology.
EA Areas Susceptible to Groundwater Flooding	Permission to use previous 2015 data by NCC	GIS Layer	Strategic-scale mapping indicating areas where groundwater emergence may occur
Highways England Flood Events	Highways England	GIS Layer	Records of flood events along the Highways Agency road network
Highways England Flood Hotspots	Highways England	GIS Layer	A GIS layer of area identified as being prone to flooding
Canal and River Trust Breach Events	Canal and River Trust	GIS Layer	Historic records of canal breach events held by the Canal and River Trust
Canal and River Trust Overtopping Events	Canal and River Trust	GIS Layer	Historic records of canal overtopping events held by the Canal and River Trust
Sewer Flooding Records	Severn Trent Water	GIS Layer	Historic records of foul, surface water and combined (foul + surface water) sewer flooding as a result of insufficient hydraulic capacity in the sewer network.

Appendix H: Site-specific Flood Risk Assessment Checklist (PPG)

The PPG should be reviewed to access supporting information and guidance relating to each element of the checklist below.

1: Development Site and Location

a)	Where is the development site located? (e.g. postal address or national grid reference)	☐
b)	What is the current use of the site (e.g. undeveloped land, housing, shops, offices)	☐
c)	Which Flood Zone (for river or sea flooding) is the site within? (ie Flood Zone 1, Flood Zone 2, Flood Zone 3).	☐

2: Development Proposals

a)	What are the development proposal(s) for this site? Will this involve a change of use of the site and, if so, what will that change be?	☐
b)	In terms of vulnerability to flooding, what is the vulnerability classification of the proposed development?	☐
c)	What is the expected or estimated lifetime of the proposed development likely to be? (e.g. less than 20 years, 20-50 years, 50-100 years?)	☐

3: Sequential Test

a)	What other locations with a lower risk of flooding have you considered for the proposed development?	☐
b)	If you have not considered any other locations, what are the reasons for this?	☐
c)	Explain why you consider the development cannot reasonably be located within an area with the lowest probability of flooding (flood zone 1); and, if your chosen site is within flood zone 3, explain why you consider the development cannot reasonably be located in flood zone 2.	☐
d)	As well as flood risk from rivers or the sea, have you taken account of the risk from any other sources of flooding in selecting the location for the development?	☐

4: Climate Change

a)	How is flood risk at the site likely to be affected by climate change?	☐

5: Site-specific Flood Risk

a)	What is/ are the main source(s) of flood risk to the site? (e.g. tidal/sea, fluvial or rivers, surface water, groundwater, other?).	☐
b)	What is the probability of the site flooding, taking account of the maps of flood risk available from the Environment Agency, the local planning authority's Strategic Flood Risk Assessment and any further flood risk information?	☐
c)	Are you aware of any other sources of flooding that may affect the site?	☐
d)	What is the expected depth and level for the design flood?	☐

e)	Are properties expected to flood internally in the design flood and to what depth?	
f)	How will the development be made safe from flooding and the impacts of climate change, for its lifetime?	
g)	How will you ensure that the development and any measures to protect the site from flooding will not cause any increase in flood risk off-site and elsewhere? Have you taken into account the impacts of climate change, over the expected lifetime of the development?	
h)	Are there any opportunities offered by the development to reduce the causes and impacts of flooding?	

6: Surface water management

a)	What are the existing surface water drainage arrangements for the site?	
b)	If known, what (approximately) are the existing rates and volumes of surface water run-off generated by the site?	
c)	What are the proposals for managing and discharging surface water from the site, including any measures for restricting discharge rates?	
d)	How will you prevent run-off from the completed development causing an impact elsewhere?	
e)	Where applicable, what are the plans for the ongoing operation and/or maintenance of the surface water drainage systems?	

7: Occupants and users of the development

a)	Will the development proposals increase the overall number of occupants and/or people using the building or land, compared with the current use?	
b)	Will the proposals change the nature or times of occupation or use, such that it may affect the degree of flood risk to these people?	
c)	Where appropriate, are you able to demonstrate how the occupants and users that may be more vulnerable to the impact of flooding (e.g. residents who will sleep in the building; people with health or mobility issues etc.) will be located primarily in the parts of the building and site that are at lowest risk of flooding? If not, are there any overriding reasons why this approach is not being followed?	

8: Exception Test

a)	Would the proposed development provide wider sustainability benefits to the community? If so, could these benefits be considered to outweigh the flood risk to and from the proposed development?	
b)	How can it be demonstrated that the proposed development will remain safe over its lifetime without increasing flood risk elsewhere?	
c)	Will it be possible to for the development to reduce flood risk overall (e.g. through the provision of improved drainage)?	

9: Residual Risk

a)	What flood related risks will remain after the flood risk management and mitigation measures have been implemented?	
b)	How, and by whom, will these risks be managed over the lifetime of the development?	

10: Flood risk assessment credentials

a)	Who has undertaken the flood risk assessment?	
b)	When was the flood risk assessment completed?	

aecom.com