

Appraisal Framework Module 15. Operational Risk: Ground Infrastructure Heathrow Airport Extended Northern Runway

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Executive Summary

Heathrow Airport operates today within risk parameters that are not excessive or unusual for an airport of its type. It appears to have adequate provision of utility infrastructure and procedures to be able to respond to extreme weather conditions that can affect the capacity and safety of airport operations. The airport, like other busy airports in the UK is sufficiently resilient to events that affect it alone and which have wider implications for the airport and airspace system.

The Heathrow Airport Northern Runway Extension scheme appears unlikely to change the likelihood or severity of the key risks that could impact the operations of the airport. The proposed in-line runway could present an incremental risk at times of low visibility operation that will need to be mitigated by appropriate operational procedures.

Although expansion of the airport would increase the numbers of passengers and staff that would be affected by any incidents impacting operations, the proposed extended runway and additional terminal capacity would also enhance the airport's ability to provide resilience (and recovery) in the event of some risks.

It should be noted that any expansion of a major airport is likely to put additional pressure on airspace in the event of a major disruption that delays or diverts landings. This is the inevitable consequence of intensification of airspace utilisation in a certain area, although technology improvements and continued refinement of operational procedures can mitigate this over time.

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1 Introduction and Methodology

1.1 Purpose and Structure

This document presents a strategic level assessment of operational risks at Heathrow Airport, the impacts of the Heathrow Airport Northern Runway Extension scheme (hereafter “the scheme”), and the capability of the airport to prevent, absorb, adapt to, and recover from disruptive events.

The analysis was undertaken against the Operational Risk module of the Airports Commission’s Appraisal Framework (April 2014).

1.2 Module 15: Operational Risk

The Operational Risk module is an assessment of the inherent risk to airport operations resulting from a number of identified disruptive events. The key measure is the extent to which the proposed scheme improves or worsens the airport’s ability to prevent, absorb, adapt to, and recover from such events, and the additional mitigation measures needed. Beyond airport operations, the Operational Risk assessment looks at how the proposal and accompanying mitigations may affect the impact of disruptive events on surrounding areas and industries.

The key disruptive events that are considered are:

- *flooding;*
- *birdstrike risk;*
- *power outages;*
- *reduced fuel supplies;*
- *terrorism attacks;*
- *extreme weather events (including volcanic ash); and*
- *adaptability to climate change.*

This report does not directly consider risks relating to adaptability to climate change, which primarily relate to flooding (as discussed in Section 2.2), and reference should be made to the Jacobs report covering climate change.

The assessment also considers the full range of risks listed in the National Risk Register¹ and examines those that could have a specific impact on the airport beyond the general disruption they may cause at a national or regional level.

1.3 Methodology

Each of the risks identified in the Operational Risk module were considered at a strategic level according to:

- *the type of impact on airport operations;*
- *the ability of the airport to mitigate or reduce the probability of the risk;*
- *the scope of any measures that could reduce or mitigate the risk including measures proposed by the scheme promoter.*

¹ National Risk Register of Civil Emergencies, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/211867/NationalRiskRegister2013_amended.pdf

1.3.1 National Risk Register

The National Risk Register, 2013, has been reviewed and the highest level risks have been screened to identify:

- *relevance to airport operations; and*
- *the ability of the airport to mitigate or reduce the probability of the risk.*

The identified risks that are relevant to airport operations, and for which an airport specific response would be expected, were subject to the same assessment as the risks identified in Section 1.2.

Table 1-1 lists the key top level risks from the National Risk Register that have been reviewed for their relevance. It identifies whether the risk has specific airport impacts and whether it would be expected for the airport to have addressed the risk and made due provision. These risks are considered further in Section 2.

Additional Risks	Relevance to Airport	Airport Specific Response Required
Pandemic influenza	Yes	Yes
Coastal flooding	No	No
Catastrophic terrorist attacks	Yes	Yes
Severe effusive (gas-rich) volcanic eruptions abroad	Yes	No
Severe wildfires	Yes	No
Major transport accidents	Yes	Yes
Major industrial accidents	Yes	Yes
Other infectious diseases	Yes	Yes
Inland flooding	Yes	Yes
Animal diseases	Yes	Yes
Drought	Yes	Yes
Public disorder	Yes	Yes
Severe space weather	Yes	No
Low temperatures and snow	Yes	Yes
Heatwaves	Yes	Yes
Storms and gales	Yes	Yes
Disruptive industrial action	Yes	Yes

Table 1-1 National Risk Register Assessment

2 Risk Assessment

2.1 Introduction

Airports, like any major infrastructure facility, are at risk from major events that disrupt their ability to operate. These may be categorised into four groups:

- *criminal or human-led disruption (e.g. terrorism, civil disorder, industrial dispute);*
- *accidents (transport and industrial);*
- *interrupted utility supplies (including fuel); and*
- *extreme weather, including the effects of weather such as flooding.*

By their nature, airports concentrate people and activities that are inherently risky, and it is not feasible to eliminate all such risks. However, it is possible to take steps to reduce exposure, to mitigate impacts of exposure and to facilitate response and recovery to minimise disruption and avoid harm to people and property. Airports have long been recognised as critical sites that are at risk from terrorism, and take extensive security measures to prevent this. However, airports share with other major transport and other facilities, such as ports, hospitals and universities the risk of interruptions to key utilities or human-led disruption due to industrial disputes or any wider disorder. These are not airport specific issues.

In general terms, a larger airport with more flights and more passengers and cargo will mean that disruptive events are likely to affect a greater number of people than had the airport not been expanded. However, expansion of an airport may not increase the probability of most of these events, and indeed the additional capacity may enable the airport to accommodate aircraft, passengers and baggage that may be delayed or redirected due to a specific unplanned event.

Beyond the impact at the airport, the airport's additional capacity and forecast growth results in a greater number of aircraft (and passengers and their bags) in the system, but without additional capacity elsewhere in the system. Consequently, should the expanded airport be unavailable, the system may have to accommodate a greater displaced demand within current capacity constraints. This will require careful management to ensure that events that require delays or redirection of incoming flights can be handled safely and as efficiently as possible.

The following sections discuss each of the risks set out in Section 1.

2.2 Flooding

This section summarises the assessments discussed at greater length within the separate Water and Flood Risk reports to which reference should be made.

Heathrow Airport lies between the floodplain of the River Colne to the west and the River Crane to the east, with man-made watercourses to the south (Longford River and the Duke of Northumberland's River). There are no records of fluvial flooding at the airport although there is a long history of flooding along the River Colne to the west of Heathrow and the River Crane to the east of Heathrow. Heathrow is considered to be largely free of flood risk, with surface flooding risk of around 1 in 1000 (per year), and only a few peripheral sites seen to be at risk of large floods, such as a serious breach of one of the reservoirs to the south-west.

The Heathrow Airport Northern Runway Extension scheme would extend westwards onto the floodplains of the River Colne, Wraysbury River and the Colne Brook.

The scheme will cause loss of floodplain storage, culverting several major watercourses and significantly modify groundwater flow paths that may risk groundwater flood risk. It may also shift the risk of reservoir breach. Effective mitigation measures should be taken to address the various risk of increased flooding from the scheme.

A flood mitigation strategy should be developed to manage fluvial flooding, the risk of raising groundwater levels, and the impacts of the scheme on neighbouring land. It is expected that this will be developed in the detailed design phase to address the risks to flooding at and adjacent to the site, as identified in the Module 9. Water and Flood Risk: Flood Risk Assessment report.

2.3 Birdstrike Risk

Birdstrike presents a risk to airline operations primarily from ingestion of birds into turbofan engines, which could at worst, result in engine shutdown. Although modern aircraft are designed to fly with one engine non-operational, it is during take-offs and landings, when operations are at their most critical, that birdstrike presents the greatest risk. Airlines and airports both manage the risk of birdstrike by following procedures contained in ICAO and CAA guidance.

Heathrow lies in a semi-urban environment, comprised of a mix of residential buildings with gardens and light industrial buildings, hotels and car parks. These are interspersed with agricultural land and grassed areas, including sports fields and grazing pasture. This supports a range of common birds including pigeons, starlings, gulls and finches.

However, Heathrow is also in the vicinity of several very large water supply reservoirs and a complex of flooded mineral extractions in the Thames and Colne Valleys to the south and west of the airport. This means that bird numbers are augmented by large numbers of gulls that roost on reservoirs in winter, and waterfowl that occupy reservoirs and gravel pits year round. Despite the presence of such birds, it appears that the birdstrike rate per 10,000 aircraft movements is low at Heathrow, compared to other UK airports and major airports around the world. Although Heathrow Airport Limited (HAL) is required to have a birdstrike risk management plan, which is periodically audited by CAA, risks from outside the airport property can be difficult for the airport to manage or influence. Adjacent landowners are not obliged to allow access to disperse birds, or manage their properties to deter birds. It is key to any airport development that it does not introduce features to attract more birds that pose a risk of birdstrike or change the behaviour of existing birds so as to increase the risk (e.g. by increasing the likelihood of flying across active airspace).

The proposed runway extension will mean that the western threshold of the northern runway will be significantly closer to the complex of reservoirs and gravel pits to the west of the airport than at present. The main birdstrike risk to aircraft at Heathrow is due to the very large winter gull roosts that occur at these locations. It is possible that gulls will access these roost sites at altitudes above that for aircraft and may soar above roost sites at such altitudes. Gulls also fly between the larger reservoirs. It is likely that the scheme will result in a significantly elevated birdstrike risk from gulls, which would need to be mitigated by dispersal of the roosts from these sites,

and/or from feeding sites that attract birds to adopt flightlines across the active airspace at heights that generate that risk.

During the detailed design phase, a full assessment of the heights and flightlines of gulls that fly over the reservoirs should be undertaken to determine likely collision risk and the appropriate mitigation measures if this is proven necessary.

The scheme includes environmental mitigation measures to provide around 26ha of lakes and ponds, the location of which could also have a significant impact on the birdstrike risk at the airport. In the detailed design phase, consideration should be made to locate such mitigation measures far enough away from the airport so that the impact on birdstrike risk is appropriately minimised.

2.4 Utility Outages

2.4.1 Electricity

Electricity is a critical utility for the airport. Outages could cause disruption to passenger, baggage and aircraft handling functions and could require closure of areas of affected terminals or potentially the entire airport. Even a brief interruption to electricity supplies could have a long-lasting impact as systems can take time to recover.

Beyond the management of supply and grid services, which lie outside the airport's control, the responsibility for managing electricity supply risk lies with the airport and businesses operating from the airport. While some services can be temporarily supported with generator or battery backups, the key weakness is the main transmission line connections to the airport.

Heathrow is equipped with on-site generation and appears to have resilient electricity supplies that are compliant with regulations and standards. Its new energy centre is a biomass heat and power plant that enables both the T5 and T2 terminal complexes to be heated and powered from the plant, and also to feed the local power grid to support demand from other users.

It is not unreasonable to assume that the expansion of the airport would be accompanied with additional provision of resilient supplies and back-up generation or uninterruptible power supplies to serve the additional facilities. These additions could potentially enhance the resilience of existing facilities.

While the expansion of Heathrow would increase the number of passengers and aircraft affected by any power outage, its current provision of on-site generation and other measures to ensure resilient supply appear to be adequate to enable the expanded airport to withstand and recover from interruptions to supply.

2.4.2 Gas

Gas is used at airports primarily for heating, hot water, and for kitchen facilities. Interruption of gas supply is likely to have a greater impact during periods of cold weather. However, it is unlikely to have a critical impact on primary airport operations, but rather create discomfort and inconvenience (i.e. with less effective heating and reduced catering available in terminals).

Heathrow's Energy Centre provides heating for T5 and T2 complexes and has scope for expansion, significantly reducing the dependence of the airport on grid gas

supply and enabling the main terminals to be heated in the event of interruption to gas supply. If there were disruption to external gas supplies, the key impact may be one of discomfort and inconvenience (i.e. poorer quality heating and hot water in some locations, reduced catering availability at food outlets) rather than critical interference with operations.

2.4.3 Water

Disruption to water supplies primarily affects sanitation, and secondarily the supply of water to aircraft, kitchens and ancillary facilities. As a minimum, this may interrupt and delay some operations, such as refilling aircraft water tanks; at worst it may result in restrictions on toilet block availability and require provision of temporary sanitation facilities. Depending on the reason for the disruption to supply, it may be possible to supply some water by tanker (for aircraft) and it is noted that a proportion of catering water needs could be met by providing water in bottled form.

A number of planned mitigations are included in the scheme to manage the demand for water as a result of development of the scheme. These include rainwater harvesting and grey-water capture and recycling back into the non-potable water system, reducing demands for potable water.

It is expected that due to water efficiency and recycling measures the airport will use less water as an airport after the implementation of the scheme than at present.

Given these measures it would appear that the airport's vulnerability to interrupted water supply could be mitigated by on-site reuse and recycling, and that expansion of the airport may not increase that vulnerability.

The airport is ultimately dependent upon the water supply company managing the risk to supply, including the impacts of drought and other demands on water. However, it could work with businesses at the airport that would be seriously impacted by a disruption in water supply, to develop appropriate mitigation strategies, including prioritisation of demand and provision for alternative supply.

Heathrow does not appear to be disproportionately exposed compared to any other airport to issues with the supply or contamination of water. It appears that the expansion of the airport may not increase the exposure of the airport to risk of water supply disruption. In addition, the usage of water at the airport is unlikely to grow in proportion to passenger numbers, as efficiency of water use continues to improve incrementally and the airport may become self-sufficient to an extent through rainwater harvesting.

2.4.4 Waste Water

Interruption to waste water facilities (unrelated to water supply disruption) has a direct effect on sanitation and is likely to impact as a minimum on passenger comfort (as toilets may be closed to manage demand) and at a maximum would limit airport operations for public health reasons. Limited alternative provision can be made for terminal waste water, although aircraft waste water might be handled by tankers if necessary.

The scheme proposes to reduce the airport's water demand through harvesting rainwater from the terminals and satellite buildings as well as using treated water from wetland and water recovered from the de-icing run-off. This will also serve to

reduce the volume of run-off requiring attenuation storage and subsequent treatment.

The scheme also includes construction of a sewage treatment plant to treat all of the airport's blackwater. This could reduce the airport's requirement for other supplies of potable and non-potable water, and would significantly add to the airport's resilience to disruptions to external waste water treatment services.

2.4.5 Telecommunications

Telecommunications services are supplied to the airport by fixed lines, mobile networks and satellite communications to a wide variety of users involved in airport operations and ancillary services. Interruption to such services may as a minimum result in some inconvenience or slow operation for some airport services, and at worst is likely to result in significant reductions in the capacity of the airport to process passengers and aircraft.

Unlike other utilities, telecommunications services are subject to competitive service delivery, in some cases involving parallel competing infrastructure. Redundancy of critical systems could therefore be achieved by having in place arrangements to use alternative suppliers' infrastructure as a back-up in the event of primary telecommunications system failure.

Beyond loss of electricity supply to a network (which telecommunications network operators mitigate by having their own backup systems for transmission), the key risk is around physical disruption to a cable or transmission/reception equipment. Critical systems affected by such an outage, such as ATC and emergency services, have resilience built into their communications networks on a national rather than airport specific basis. Unlike other fixed infrastructure, telecommunications networks can be partially replicated using mobile technologies, which should be capable of supporting some of the services that would otherwise be disrupted by network disruption. Expansion of the airport appears unlikely to adversely affect the risk of disruption to telecommunications services, particularly if the progressive expansion of competition in such infrastructure continues.

2.5 Reduced Fuel Supplies

Risks from disrupted fuel supplies may arise from either local disruption to pipeline connections, or from network or wider systemic shortages that have a regional or national impact on the ability to meet demand for oil based fuels. The ability to manage disruptions of supply at a national level is limited and not within the capacity of the airport to reasonably address. However, disrupted fuel supplies can have a significant effect in airport operations, primarily by limiting the options for airlines to refuel at the airport.

If distribution to the airport is disrupted due to a supply network constraint, onsite storage may provide a limited time to enable alternatives to be established. Various operational measures can be taken to mitigate the impacts of disruption, such as requiring short-haul flights to be fuelled at their destinations, and utilising road tankers to provide temporary supply.

Provision of additional pipelines and onsite storage are the primary means to mitigate this risk. The scheme proposes doubling onsite storage at the midfield site from 6 to 12 tanks, and establishing a new site for fuel storage to the south of the airfield to support 9 more tanks. Taking into account the proposed increased airport

capacity, this would provide a significant improvement in the ability of the airport to manage fuel supply disruption.

2.6 Terrorism Attacks

Terrorism attacks present a danger of death, injury, property damage and disruption to passengers and staff, and are one of the key priorities for airport security and for national security and policing authorities in managing wider terrorism threats to the UK. Construction works can present a potential security vulnerability which may be mitigated by introducing background security checks for construction workers, physical screening of personnel and vehicles, and relocating perimeter fencing so that works take place outside the restricted zone.

The scheme intends to incorporate best practice and the latest standards in design for security. Security vulnerabilities and mitigations are managed through the Airport Security Plan, which is developed and maintained in collaboration with stakeholders. The airport is required to comply with international and national regulations governing physical and procedural security measures.

While it is reasonable to assume that expansion at Heathrow could increase the attractiveness of the airport as a target of interest to terrorists (the M25 tunnel may also do this, although there are already tunnels on the M25, and road tunnels to the Heathrow Central Terminal Area), there are no aspects of the proposal that would indicate greater security vulnerabilities or prevent security risks from being adequately mitigated to a level required for compliance with regulations.

2.7 Extreme Weather

2.7.1 Volcanic Eruption

The primary impact of volcanic eruption on airports is the risk that volcanic ash can have on aircraft safety. Such ash has been a clear danger to aviation in the past, specifically with the 1982 incident involving a British Airways Boeing 747 that lost engine power from ash over Indonesia due to the eruption of Mt Galunggung. More recently, the eruption of volcanoes in Iceland (Mt Eyjafjallajökull and Mt Grimsvotn) caused severe disruption to flights across Europe, including the grounding of all flights at many UK airports, as aviation safety authorities sought to avoid the risk of catastrophe from large volumes of airborne ash.

A repeat of such an incident that would affect UK aviation cannot be managed directly by any airport, as it is primarily a matter of airspace management. However, the indirect impact of disruption may be to delay or cancel some or all flights, or require diversion of flights from some airports to others. Airports that may remain open may have to handle far more flights than usual, while those that are to close must manage stranded passengers and daily new arrivals of passengers by surface transport seeking to board flights that may or may not depart.

The key consequence from expanding the airport will be to increase the scale of the impact due to a greater number of flights and passengers that would be affected by such an eruption. It is expected that the airport would work closely with CAA and NATS as part of a co-ordinated UK and European response to such an event.

2.7.2 Snow

The snowfall experienced in the winter of 2010 highlighted the vulnerability of the UK's airports to adverse weather and led to significant flight delays and cancellations.

Snow clearance and aircraft de-icing have a consequential impact on airline schedules, while reduced runway friction conditions can increase aircraft braking distances and therefore require greater aircraft separation. Heathrow's runways are capacity constrained throughout the day and therefore the airport does not have the requisite spare capacity to accommodate snow events. The addition of a third runway would increase the resilience of the airport during those times until it reaches capacity itself.

Heathrow has made significant recent investments in snow clearing equipment and has developed a winter resilience plan. With the deployment of additional resources in proportion to the scale of the expanded area and operation, a three-runway Heathrow would likely be at least as resilient to snow as today.

2.7.3 Wind

Wind can affect airport operations by disrupting flights, interfering with ground operations and blowing debris or objects that can cause injury or property damage around the airfield. Analysis of ten years of historical wind rose data for Heathrow has found very few instances of high wind speeds or cross-wind that would cause disruption to operations at Heathrow. The use of time based separation for arriving aircraft can mitigate delays during severe crosswinds. Furthermore, the airport has procedures to respond to high winds to protect the airfield from debris and loose objects.

2.7.4 Fog

The presence of fog in the vicinity of an airport can have a significant impact on operations as low visibility procedures must be implemented, requiring the separation between aircraft both approaching and taxiing on the ground to be increased. This reduces the capacity of the airport.

The ability for an airport to continue operations during periods of fog depends on the standard of the instrument landing system (ILS) equipment, and the approach and surface movement ground radar. CAT IIIa ILS equipment can accommodate operations down to a runway visual range (RVR) of 200m. CAT IIIb operations can accommodate an RVR of between 75 and 200m. Below 75m RVR, i.e., very dense fog, airports are likely to be forced to close.

Analysis of hourly fog events at Heathrow over the period 2004-2013 found that fog at or below the 200m threshold was recorded on 260 occasions (0.3% of total annual hours). 21 hours of fog were below the 75m visibility threshold over the ten year period. There were two instances of fog lasting more than ten hours over the ten year period. Between 40 and 50% of fog events lasted one hour or less.

Heathrow is exposed to radiation fog rather than coastal fog and therefore instances are more likely to occur in the early morning during winter months, with November and December accounting for the majority of instances.

The scale of impact of fog depends to a great degree on how busy the airport is at the time, its spare runway capacity and, to a slightly lesser extent, its spare taxiway capacity.

The proposed in-line runway presents a new incremental risk to operations in low visibility conditions. Given that the in-line runway concept is unique and unprecedented, there is a risk that aircraft in low visibility conditions could misidentify runway lighting. Operational procedures will need to be developed to mitigate this risk.

Heathrow's exposure to fog can be considered low, but during periods of reduced visibility requiring CAT IIIa/b operations, the airport's resilience would be improved beyond current levels with addition of a third runway, until such time as that runway itself reaches capacity.

2.7.5 Storms

Storms (excluding snow and strong winds) are disruptive to airport operations due to low visibility, and the combined impact of heavy rainfall and winds, and as such reduce operations limiting the capacity of the airport and in some cases force temporary closure. Excluding flooding (which is discussed at Section 2.2), the primary impact is temporary disruption of flights and ground activity due to torrential rain. The probability and impact of such events does not change with the expansion of the airport and given the prevailing weather conditions at this location, is unlikely to be on a scale or severity to require additional mitigation measures.

2.8 Pandemic Influenza and Other Infectious Diseases

Pandemic influenza and other infectious diseases could have widespread national and local impacts. The National Risk Register considers that there is a high probability of an influenza pandemic occurring, and though it is not possible to forecast its impact or timing, modelling suggests that in the UK up to one half of the population may experience symptoms and potentially hundreds of thousands of deaths would occur. Widespread social and economic disruption would result, with significant threats to the continuity of essential services.

Airports are large employers and the impact on staff absenteeism resulting from pandemic diseases could cause disruption to operations.

The airport could also be expected to play a role in maintaining the UK's border controls against pandemic flu and other infectious diseases, with government agencies potentially implementing stricter controls to monitor inbound and outbound passengers.

Airport expansion would be likely to increase the vulnerability of the airport operation to pandemics, both as a result of a larger number of people travelling through the airport potentially spreading communicable diseases, and since the unavailability of some staff in specialist roles (e.g., ATC, those requiring security clearance) could have an impact on a greater number of passengers and aircraft movements. As the capacity of the airport grows, its ability to accommodate passenger health screening or other border controls as required by the government in extremis would also increase. Consideration should be given to the preparation of detailed contingency plans and rehearsals for these and other similar scenarios.

2.9 Major Transport Accidents

Airports inherently have significant exposure to major transport accidents given their operations and rail and road connections being critical to their operations. Major transport accidents, as defined in the National Risk Register, are those that require a national response. Such accidents are extremely rare.

It is very unlikely that any rail or road accident that would directly affect Heathrow Airport would be within the definition of a major transport accident, as this would likely require a catastrophic multiple vehicle incident that would disable a critical part of a network. Nevertheless, there is a risk of less serious transport accidents interfering with the efficient operation of the airport.

The primary risk to the airport of a major surface transport network accident is to limit access to the airport for passengers, staff and cargo. A major accident on either the mainline or underground railway lines to Heathrow would be disruptive to passengers and staff, and create delays and overcrowding on alternative networks and services, but would not be likely to critically impact the operations of the airport. Similarly, closure of the M25 or M4 would be disruptive, but be extremely unlikely to prevent continued operation of the airport.

There are several significant railway and highway tunnels located under the airfield. Whilst closure of any of the railway links is likely to create significant delays for some passengers, complete closure of the central terminal area (CTA) road tunnel is likely to have a critical impact on the ability of that part of the airport to remain open. However, it is proposed that a new southern access road tunnel be built to connect the CTA, which would significantly improve the resilience of this part of the airport.

The proposed new runway will place part of the M25 in tunnel. This presents a new incremental risk that an event (for example, a major fire) in the M25 tunnel could disrupt operations on this runway, as well as impeding access for staff and passengers to the airport.

It is reasonable to expect the airport to have contingency plans in place if a serious traffic accident were to close one of the key access routes to the airfield or airport buildings, and the layout would appear to enable alternative routes to be available in such event.

2.10 Major Industrial Accidents

Industrial accidents can take many forms and their impact can range from being contained within a very local area to having more far-reaching effects. The National Risk Register cites examples such as a fire in a telephone exchange leading to a loss of telephone communication with emergency services, and the Buncefield Oil Storage Terminal fire which led to the local area being evacuated, long-term disruption to operations, and reduced fuel supply to Heathrow, which at the time received half its daily fuel supplies from Buncefield. Other industrial accident risks include contamination of food or water supplies, or the release of toxic or radioactive substances.

Within the framework of an all-hazards risk assessment, many of the consequences of industrial accidents are shared with other risks such as disruption to fuel, electricity and telephone supplies, for which mitigation plans are in place.

At this stage it would not appear that an expanded Heathrow airport would be at a significantly greater risk from major industrial accidents than present day, though a greater number of passengers could be affected.

2.11 Drought

The direct effects of drought are likely to be limited, due to the airport not being dependent on rain water for essential facilities. However, the indirect effect of drought is to affect water supplies for the airport, which are essential for sanitation, cleaning, catering, aircraft supply and other purposes. The scheme would not change the risk to the airport, but it would increase demand for water as additional flights, passengers and terminal capacity requires.

Water companies are required to have drought plans. Provision for additional resilience in the event of disruption of water supplies is described in sub-section 2.3.3.

2.12 Public Disorder

Public disorder can manifest itself in rioting, looting, vandalism, violence and arson. Such events are unpredictable and there are no known instances of public disorder that have caused disruption to operations at a UK airport.

However, there have been instances of trespass and unlawful protests that have caused disruption at UK airports. It is reasonable to assume that expansion of any UK airport will attract opposition from climate change and other environmental groups, and that this poses a risk to airport operations. The greatest risk would appear to be in the period prior to and during construction.

Heathrow Airport's policing is funded by the airport under a police services agreement. While it is reasonable to assume that the risk of public disorder is considered as part of the airport's Multi-Agency Threat and Risk Assessment process, it is likely that this would need to be revisited and updated in the event of the airport proceeding with runway expansion.

2.13 Disruptive Industrial Action

The risk of industrial action disrupting airport operations is primarily managed by the various employers and the respective trade unions that have a diverse range of relationships and roles across the airport. Given that many of these relationships do not involve the airport company itself (and in some cases the disruption arises from industrial action at other sites and sometimes in other countries), there is little that can be done by the airport to mitigate such risks, as they are driven by commercial and industrial interests of the parties concerned, and affected by legislation and relationships between parties.

As with any changes to the scale or nature of business operations, there will be a residual risk of industrial dispute arising from the expansion of airport operations. It is expected that this will be managed by employers and trade unions respectively as part of any negotiations involving expansion or changes in employment activity at the airport.

2.14 Multiple Disruptive Events

Airport operations are susceptible to many types of events and the risk exists that multiple events may occur simultaneously. Certain events such as storms and flooding could prevent the airport from responding according to its contingency plans, for example as a result of staff being unable to access the airport, or due to concurrent disruption to other services such as utility supplies. While there are potentially many combinations of events, many of them share similar mitigation strategies. Airports hold contracts with a diverse range of suppliers, many of which would have in place their own measures to ensure operational resilience. The occurrence of multiple events could put strain upon the airport's ability to co-ordinate its response. However, the airport's contingency plans can be expected to anticipate various types and scales of events to which the airport would have to respond by deploying its own resources and those of its contractors in order to minimise operational disruption.

Airport operations are vulnerable to a wide range of risks, including weather, interruption to fuel supplies, major incidents (e.g. industrial or transport related) and disruptive human activity (e.g. terrorism, crime, public disorder).

Types of operational risk that affect the airport include those that have national impacts on aviation and other industries and those that specifically impact the airport.

Many of these specific risks are primarily managed and mitigated by third parties, such as utility companies, whose expansion and contingency plans have not been assessed within this appraisal.

Some of the risks can be managed and mitigated by the airport, such as energy and fuel supplies, while certain mitigations will require cooperation from the wide range of businesses operating from the airport.

Airlines, ground support companies, surface transport operators and their suppliers all bear some responsibility for managing risks, although the key risks to be managed by the airport are those that have wide infrastructural impacts.

The scheme will introduce a new incremental risk by placing part of the M25 in a tunnel under the extended runway, although this is not expected to put the airport at greater risk than the existing tunnels under the northern runway.

A mitigation strategy will be required to address the birdstrike risk given the presence of some roosting sites near the site of the new runway.

The proposed in-line runway will introduce a new incremental risk at times of low visibility operations that will need to be addressed during detailed design and by appropriate operational procedures.

The proposed expansion of the airport does not change the probability or impacts of risks overall, but it will increase the numbers of people exposed given higher passenger and staff numbers.

However, the headroom in capacity afforded by the extended northern runway and additional terminal capacity will improve the resilience towards and recovery from risks such as fog and snow, until such time as demand grows to fill that capacity during peak times of operation.