



# **Investment Decision Pack**

## **NGET\_A10.05\_Extreme Weather**

### **December 2019**

As a part of the NGET Business Plan Submission

**nationalgrid**

Engineering Justification Paper Extreme Weather			
<b>Name of Scheme</b>	Protection from the threat of Extreme Weather		
<b>Primary Investment Driver</b>	To improve network resilience and continue to implement the requirements of industry guidance on flooding within Engineering Technical Report 138 'Resilience to Flooding of Grid and Primary Substations'		
<b>Reference</b>	A10.05 - Extreme Weather		
<b>Outputs</b>	<ul style="list-style-type: none"> <li>- Flood mitigation measures on sites identified through approved methodology [REDACTED]</li> <li>- Monitoring and intervention measures to manage the increasing exposure to tower foundations from water driven geohazards such as erosion and subsidence on approximately [REDACTED]</li> <li>- Research and development of a long-term climate change strategy to identify key future adaptation trigger and review points for asset design changes.</li> </ul>		
<b>Cost</b>	£59.81m		
<b>Delivery Year(s)</b>	RIIO-T2		
<b>Reporting Table</b>	C2.24		
<b>Outputs included in RIIO T1 Business Plan</b>	No		
<b>Spend Apportionment</b>	<b>T1</b>	<b>T2</b>	<b>T3</b>
	£124.57m	£59.81m	£1.54m

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## 1. Executive Summary

This engineering justification paper justifies T2 expenditure of £59.81m in protecting the network and end consumers from the threat of extreme weather.

Our stakeholders have told us that protecting the network from external threats is important to them. One of the greatest challenges facing business's and society both now and in the future is ensuring that they are resilient to climate change, this is especially true of critical utilities with ageing sites and assets. The reliance on having a constant secure energy supply, is perhaps the underpinning element in ensuring that all other critical infrastructure both functions and can recover quickly from climatic incidents. One of the key threats that we currently mitigate against is the threat of damage or disruption caused by extreme weather events particularly flooding and water driven and amplified hazards.

Weather related risks that we aim to mitigate or resolve within T2 can be summarised as;

1. Surface water flood risk against our assets and sites
2. Erosion risk to tower foundations and land surrounding tower foundations
3. Longer-term climate change risk to our assets

The majority of expenditure within T2 focuses on complying with the guidance within Engineering Technical Report (ETR) 138 'Resilience to flooding of Grid and Primary Substations' which is recognised as best practice for ensuring the energy sector is resilient to flooding. We have received clear direction from the Department for Business, Energy and Industrial Strategy (BEIS) to implement the latest guidance within ETR138 before the end of the T2 period. The latest guidance ensures protection from surface water level flooding. Following initial assessment of flood risk on our sites, we are planning to implement solutions on approximately [REDACTED]

Damage to our assets is increasingly becoming a concern because of erosion. Based on a historic trend, we expect an average year on year increase of 1 to 2 instances per year to result up to approximately 22 instances of repairing flood related erosion and subsidence issues per year by the end of RIIO T2 given some outliers. In T2 we will be taking a proactive approach to the management of asset interventions due to erosion. Our T2 plans are based on forecast costs for this increasing trend of required interventions as well as research and assessments on how to proactively manage these assets and protect them from the threat of erosion.

We will be undertaking research to outline and support the development of a long-term strategy for adapting our assets and systems to future climate projections. Identifying key 'triggers' and planned assessment points with target dates for key strategy plans to be in place and any potential design standards change.

All of our T2 expenditure is in response to formal guidance or changing threats against our assets. The works outlined within this paper provide benefits to end consumers throughout T2 and beyond by protecting assets from risk of damage and potential disruption of power supply.

A forecast profile of our T2 expenditure is as follows;

	CAPEX/OPEX	2021/22	2022/23	2023/24	2024/25	2025/26
WEATHER RESILIENCE	CAPEX	£4.30M	£8.76M	£14.28M	£16.15M	£16.33M
	OPEX	£0.0M	£0.0M	£0.0M	£0.0M	£0.0M

All options for delivery of flood defences will be considered when determining site specific solutions, for which offsite or environmental solutions may be a possibility and likely to drive further value for money for consumers.

## 2. Introduction

This section provides an introduction to the threat of extreme weather and the existing or emerging categories which require attention to address. The specific threats considered within this Justification Report are;

- Flooding
- Erosion
- Climate change

### 2.1 Flooding

Flooding on an electricity transmission substation could cause damage to assets and result in the loss of electricity supply to thousands of consumers. We must protect these sites and the need of consumers by ensuring that recommended flood defences are implemented, relevant to the specific flood risk at that site. These defences could include measures such as permanent walls, removable barriers (that could be utilised at several sites) or environmental solutions like ponds to divert water. The specific solution implemented entirely depends on the flood risk at that site and the result of cost benefit analysis for that solution. We engage with DNO's where appropriate and environment agencies to ensure we're delivering the most appropriate flood defence solutions relevant to the risk and impact on consumers.

#### 2.1.1 Engineering Technical Report 138 'Resilience to Flooding of Grid and Primary Substations'

ETR138 was developed in partnership with BEIS, Ofgem, TOs and DNOs and provides a systematic approach to ensuring the resilience of grid and primary substations against the risk of flooding. BEIS, Ofgem, TOs and DNOs are all signatories to the flood resilience requirements set out in ETR138. The principles and resilience levels set out in ETR138 are recognised as best practice by the Government's National Flood Resilience Review carried out in 2016. We use the principles set out in ETR138 to help determine what flood defence investments are required on our sites. The approach outlined within ETR138 for companies to follow is summarised below;

- a) identify all substations within flood zones using best available current data from Environment Agency/Scottish Environment Protection Agency/Natural Resource Wales or specialist flood risk/hydrological consultants. In order that companies apply a consistent approach to flood risk modelling it is recommended that the modelling be The Environment Agency (EA), Natural Resources Wales or Scottish Environment Protection Agency (SEPA) sourced.
- b) Establish the flood risk for each substation to identify predicted flood depth and other key factors to establish which substations are 'at risk' i.e. where the predicted depth of flooding is likely to cause damage to key parts of the substation resulting in the loss of supplies to customers.
- c) For each substation that is 'at risk' of flooding, identify the flood impact for that site including societal impact. It is accepted within ETR138 that all National Grid and Transmission sites would be a high societal impact.
- d) Establish if the site is or will be protected by a flood protection scheme sponsored by the appropriate public authority or whether any other action is planned by another body – e.g. action by Local Authority to relieve a flood threat, including long-term maintenance plans.
- e) If the site is to remain unprotected by another organisation, establish the most appropriate options for protecting the site with estimated costs. In establishing the most appropriate protection solutions, network owners should consider their individual approaches to managing flood risk e.g.
  - Provision of permanent or temporary barriers (subject to the criticality and deployability)
  - Protecting all the site or only key areas
  - Providing an appropriate level of network interconnection
  - Commissioning a replacement substation in an alternative location
- f) Propose an appropriate solution based on the level of flood risk to be considered and a cost/benefit analysis. (CBA section 6.)

## 2.2 Erosion

Our assets have increasingly been exposed to weather related issues such as sea level rises, changes to rainfall patterns and secondary impacts from flooding. These issues can cause damage to our assets and surrounding supporting land. More specifically, we have seen an increase in instances of tower foundation repair required due to the effects of erosion. This has ranged from minor to major interventions typically between £10k-£150k. In rare cases, costs have been up to £8m to make safe, demolition of old tower, replacement with a temporary tower and construction of an island. Figure 1 below shows the impact that erosion can have on tower foundations.

**Figure 1: Visual example of the impact of erosion on towers**



## 2.3 Climate change

## 2.3 Climate Change

A failure to adapt to climate change is one of the greatest global risks facing businesses today. However, whilst a possible cause of increased rainfall resulting in a need to protect our assets from flooding and erosion, it is currently not clear what long term requirements there will be to mitigate the impact of climate change.

Our assets are designed to operate anywhere in the world within a wide range of weather scenarios across all seasons. It is currently not understood how network and business systems would cope with major shifts in 'normal' weather conditions.

We are seeking to understand what future climatic impacts, scenarios or combinations we should design and build into a future resilient system. A crucial element of this is understand at which points a future system is at greater risk than currently from extreme weather events and what future hazards we should design to cope with. Our work on addressing flood events and erosion helps to ensure a network resilient to extreme weather within the T2 period, however we want to conduct further research into climate change to understand what a resilient network in the future will look like. Research topics will include;

- What impact would a prolonged drought or sustained high temperature period have?
- What impact would changes in seasonal 'norms' have on our outage and maintenance programs and could be look at extending the traditional outage season?
- What impact will Atlantic low pressure storm systems have with hurricane force winds and sea surges?
- What 'unknown' future risks could there be?



### 3. Background Information

This section details our current approach to protection from extreme weather and outlines lessons learnt that will help us efficiently deliver flood protection investments in the future, both in the remainder of RIIO-T1 and in RIIO-T2. Within T1 our investment focused on protecting the network from river and tidal flooding, in line with the recommendations made by ETR138.

#### 3.1 Flexibility in RIIO-T1

The risk of flooding can change and varies significantly from site to site. Within RIIO T1 we needed to take a flexible approach to implementing flood defences due to changing requirements and individual site solutions being necessary. Flood defence is not a ‘one size fits all’ solution and needs to be managed on a site by site basis. Therefore, it was challenging to outline the site-specific works required within our T1 business plans for an eight-year period, especially with flood risk likely to change within that time.

#### 3.2 RIIO-T1 requirements and allowances

We based our T1 proposals on the best information that was available at the time. Within our proposals we identified 102 sites at risk of flooding. These were identified by using flood plain data available at the time. After carrying out more detailed investigations, modelling and analysing the highest risk sites, we established that a high percentage of these sites would not require works (or would require minimal investment) despite being shown as located in flood risk areas. Due to the nature of the work, many of the detailed requirements for the sites cannot be determined through desktop exercises and will only become known when we physically investigate sites and develop individual solutions within the pre-works development stage.

Our RIIO T1 allowances were based on an expectation of carrying out works on between 45 and 55 sites (of the 102 identified at risk) to address river and tidal flood risk as advised by ETR138 guidance at the time. It was not possible to establish a unit cost due to the solution variance at each site.

The actual number of sites we currently plan on investing in in RIIO T1 is 49, which is within the range originally predicted.

Our RIIO T1 allowances also covered investigation into further risks of extreme weather. This has been used to develop our plans to protect against surface water flooding, erosion and climate change in T2.

#### 3.3 Delivery to date

##### 3.3.1 Delivery

At the start of the T1 period, we estimated that 45 to 55 sites would require works for flood mitigation within T1. **To date works have either been completed or are in progress on 37 sites at a cost of £70.7m.** 12 more sites are scheduled to begin works in 2019, 2020 and 2021, to complete works on a total of **49 sites in T1 at a forecast cost of £124.6m.**

We have delivered these works efficiently through conducting more detailed analysis of the sites at flood risk to optimise the flood resilience levels. Where the depth of flood water is relatively low, we targeted the flood resilience measures around equipment critical to the operation of the site minimising costs while maintaining system reliability.

In response to changing threats in the T1 period, we have also started to investigate the climate change impact against our assets. Working with the British Geological Society we undertook an assessment to identify sites and assets within a flood risk area with a heightened risk of erosion. A weighted scoring mechanism has identified that 1278 towers are within high or very high risk areas. The table below shows the result of this assessment with the number towers and their risk score.

Total towers	Low (1-7 score)	Medium (8-12 score)	High (13-15 score)	Ver high (>15 score)
21887	8303	4536	882	396

While most notable incidents that occurred in the T1 period were on towers in the 'high' and 'very high' categories, we also have had similar incidents on towers in lower risk categories these tend to be where human factors have played a part in causing an issue. The monitoring and investigative works will see a rise in the development of schemes to react to situations as follows;

- Tower and cable exposure to erosion and foundation destabilisation
- Increased monitoring of assets at risk
- Increased repair and 'make safe' actions
- Movement of sites and assets due to changes in shoreline management plans and retreat from flood and sea defences.

### 3.3.2 Deferred sites

Within T1, we reviewed the need for investment at our lower risk sites by using climate change and sea level rise information available. This highlighted that a number of sites did not require 'hard' defences such as steel, concrete and pumps (which typically have lifespans of 30-80 years) as a need would be unlikely to materialise within T1 or T2. If these defences were implemented within the T1 period, the assets and infrastructure could be 30%-50% through their asset life by the time they were required. With the additional future maintenance costs of these assets, it would not have been in consumer's interest to invest in these within RIIO T1.

As a result, **investment at sites was deferred** to ensure defences are constructed closer to when risks may develop. At an average spend on [REDACTED] per site, this equated to a deferral of approximately [REDACTED] for later review and possible investment in RIIO T3 and beyond and will equate to approximately [REDACTED] saved in asset depreciation.

Removable barriers can be used in the interim until firm investment drivers have been confirmed. Additional barriers and equipment were purchased in 2015 which allows for increased multiple site protection. These assets will continue to be used within RIIO T2. Some sites will require minor adaptation measures to ensure that the removable barriers work effectively, these works will be completed within the T1 period, however will deliver a more cost-efficient solution.

### 3.3.3 Benefits to consumers

By following the guidance included within ETR138, the flood protection introduced within RIIO T1 has delivered and continue to deliver the following benefits to consumers;

- Ensures overall resilience of network to threats, focusing on protection of specific sites against the threat of flooding. This reduces the likelihood of consumers being affected by a flooding incident on the Electricity Transmission system.
- Reduces the likelihood of consumers having loss of electricity supply as a result of flooding on substations.

The photos below illustrate the benefit of flood defences in protecting our assets from the risk of river and tidal flooding within the T1 period. The photos show a before and after investment view of our Walham substation.



**Figure 2: Walham substation flood defences**

We are proposing to deliver similar defences to those in the T1 period, and therefore have reviewed our lessons learnt within T1 to apply them to our planned investment for RIIO T2.

- We will make sure to continue to work with not just our sector partners, but also other non-energy partners in developing alternate integrated flood mitigation solutions such as natural solutions like creating a pond to divert water. This helps to reduce our risk exposure and drive further efficiencies and potentially expand National Grids natural capita value. This includes coordinating works with the all the Environment Agencies.
- We will continue our approach of only investing in flood mitigation measures on sites where there is an immediate risk. This saves on asset depreciation on our flood mitigation assets. To support this approach, we will extend the use of our removable barrier systems.
- We will also continue our approach of coordinating works with our other major site development works, such as those taking place to enhance integrated security solutions on sites as part of the Physical Security Upgrade Programme (PSUP). For sites with multiple projects taking place at the same time, we have awarded the works to a single contractor. This reduces project management costs and increases efficiency during the construction phase.
- Where possible we have utilised above ground exposed sheet piles as an alternative to concrete walls. This has had significant advantages due to its reduced carbon footprint and faster construction durations.
- We have experienced delays obtaining approval from the Environment Agency on a few sites which has delayed some projects significantly. This was due to the third-party impacts created by our flood resilience works diverting water elsewhere. Early engagement with the EA to agree on methodology on future projects will minimise delays implementing our projects.

## 4. T2 Proposals

This section outlines the need for investment within T2, our approach to how we have developed our business plans and an overview of our proposals.

### 4.1 Need for works

#### 4.1.1 Surface level flood risk

Since the start of the T1 period, the threat of extreme weather has changed. The threat of flooding has increased (through increased frequency of events and types of flooding) and more information has become available on risks of flooding. These have resulted in ETR138 guidance being updated to minimise the risk against key infrastructure.

Since the first version of ETR138 was published, further information on surface level flooding has become available with the publication of various Environment Agencies surface water risk assessments. The second version of ETR138 was published in January 2016 and includes recommendations on the management of these flood risks. This new guidance resulted in a complete review of all previously discounted sites within T1. We reviewed all sites that were not previously identified as being at risk of flooding using the Environment Agencies tidal and fluvial flood data that was available at the start of the T1 period.

The National Flood Resilience Review in 2016 prompted a further update to the ETR138 guidance which recognises that the electricity industry is leading the way with proactive flood risk management and that the 1:1000-year target resilience level should be applied for all critical local infrastructure supplying 10,000 customers or more.

This latest updated was expected to drive further significant flood resilience investment across the network prior to the end of the T2 period. Works completed within the T1 period automatically protect our sites from surface level flooding, however there is a need to address this risk on additional sites which were originally considered not at risk.

BEIS have requested that TOs and DNOs implement this latest guidance by the end of their relevant price control period, for National Grid, by the end of T2 [REDACTED]. We continue to use the guidance outlined within ETR138 to determine appropriate investments for protection from flooding within the T2 period.

#### 4.1.2 Erosion

Throughout the T1 period, there have been growing instances of erosion causing issues for our assets, which then requires intervention to fix. As a result, we have responded by completing further repairs within T1 than originally planned to maintain asset safety and proactively manage erosion issues surrounding our towers and cable routes. The result of erosion not being addressed could potentially result in damage to and failure of our assets, which would be timely and costly to fix and could potentially impact the electricity supply to thousands of consumers.

Based on our experience, early intervention costs to manage erosion prove more efficient than 'make safe' and rectifying action costs. Because of this, we aim to invest further in the proactive management of erosion risks within T2.

#### 4.1.3 Climate change

As mentioned previously, failure to adapt to climate change is seen as one of the greatest global risks facing businesses today. Like we have done in the past with the threat of flooding and erosion, we must conduct further research into how this threat is likely to impact our assets. By doing so, we will be able to ensure system and asset climate change adaptation factors into the whole asset life of our assets. We manage our risks through design standards and therefore need to develop a long-term strategy of when to review and amend design standards for our assets.

## 4.2 Approach

On flood protection, we use the guidance outlined in the Engineering Technical Report 138 'Resilience to Flooding of Grid and Primary Substations' to ensure we're only delivering required works and providing value for money to consumers. We engage with other TOs and DNOs to develop site-specific solutions and through the ETR138 task group for consistency. These stakeholders also follow the guidance within ETR138 to ensure a whole system approach to flood resilience.

Our T2 plans are based on known information and assumptions based on previous experience, as site specific requirements are yet to be determined.

### 4.2.1 Site specific flood resilience measures

Following the process outlined in paragraph 2.1.1, we have identified [REDACTED] potentially at risk of flooding in our initial assessment against ETR138 guidance. Based on experience gained from the RIIO T1 investment program, we estimate that approximately [REDACTED] will require mitigation measures. These sites are different to those that received investment within RIIO T1. Our T1 investments protected sites and assets from tidal and river flooding and also automatically protected from surface level flooding. The proposed new sites are additional to those protected within T1.

We are also able to increase our resilience to flooding by how we approach works and by considering alternate methods to mitigating risk. In some cases, we can effectively protect our sites by investing in off-site Environmental Agency led works and by default remove the risk without the need for investment directly on our sites. For example, in T1, we had a risk of tidal flooding identified in Dungeness which needed to be addressed. By working with the Environmental Agency, we identified an alternate off site solution which involved contributing approximately £0.2m to their tidal defence measures effectively reducing the risk of flooding on our site and removing the need for additional flood protection on site. This will save approximately £3m which would have been required to build hard defences on site.

Our T2 investments include development of a strategy demonstrating a flexible approach of when and how to invest in adaptation measures. This will be critical to ensuring the network is resilient to the threat of extreme weather in the future. It will help us determine most appropriate and efficient timescales for investment which will deliver further value for money for consumers.

## 4.3 Our T2 proposals

### 4.3.1 Flood protection

Our T2 investments to continue to protect our sites from flooding. We will focus on ensuring site protection from surface level flooding as advised in the latest iteration of ETR138. After initial assessment of flood risk and learning from work completed in T1, our **T2 plan aims to protect an estimated [REDACTED]** from surface level flooding.

### 4.3.2 Erosion

Our tower flood and erosion costs are based on an estimated increase in the number of interventions which we are undertaking to repair and reinstate assets and infrastructure following erosion or flood damage. Damage to cables is increasingly becoming a concern because of erosion. Typically, we are currently dealing with 6 to 10 interventions a year at an average cost of £10k and £150k. Based on a historic trend, we expect an average year on year increase of 1 to 2 instances per year to result up to approximately 22 instances of repairing flood related erosion and subsidence issues per year by the end of RIIO T2 given some outliers. **Our forecast T2 costs for our erosion works are based on average previous scheme costs and undertaking studies and works on approximately [REDACTED] over T2.**

Our T2 plans are based on forecast costs for this increasing trend of required interventions as well as research and assessments on how to proactively manage these assets and protect them from the threat of erosion.

### 4.3.3 Climate change

We will be undertaking research to outline and support the development of a long-term strategy for adapting our assets and systems to future climate projections. Identifying key ‘triggers’ and planned assessment points with target dates for key strategy plans to be in place and any potential design standards change.

## 5. Optioneering

### 5.1 Sites requiring works

To determine the works required on sites we follow the ETR138 systematic approach outlined above in 2.1.1.

The first step of this approach is to identify all substations within a flood plain for surface level flooding using current data from the Environment Agencies or specialist flood risk/hydrological consultants. We have completed this stage and identified 180 sites at risk of surface level flooding. As mentioned previously, based on previous experience we do not consider that works will be required on all [redacted] sites. We have estimated that approximately [redacted] will require flood mitigation measures to be introduced, this is based on our previous experience implementing flood defences within RIIO T1.

Each site and solution is unique therefore we expect the spend per site to vary depending on several factors i.e. flood depth, soil type, topography and number of individual assets affected on site. The following bandings have been applied to give as an estimate of the total cost;

- [redacted] site protection at a cost of [redacted] which gives a range of [redacted] total spend
- [redacted] requiring localised protection sites at [redacted]

The costs associated with these bandings are based on actual costs of T1 sites. We have taken Individual itemised costs of parts of larger scheme solutions to represent likely costs for smaller site costs. For example, on large T1 sites we have extrapolated buildings, individual asset protection costs, drainage uprating, offsite ditch establishment and typical similar large and small civil works and used this as a basis of our estimations. This methodology also builds on the experiences gained in assessing and undertaking the works on the T1 sites and applying our engineering judgment on realistic situations.

### 5.2 Site Specific Operational Requirements

As part of the pre-works exercise (to be completed within RIIO T1) we are assessing individual sites identified as being at risk of flooding against latest Environmental Agency data to determine site specific flood mitigation solutions required. We are taking the approach of delivering appropriate requirements for each site in line with the latest version of ETR138 and supporting data to deliver value for money to end consumers. BEIS have outlined their request for network companies to implement these changes by the end of RIIO T2. Considering this and the increasing occurrence of extreme weather events, we see it as prudent to follow the advice and implement upgrades to flood resilience at sites where required.

Site specific solutions are also developed in conjunction with local Environment Agency representatives to help efficiently deliver with known planning requirements and identify opportunities for coordinating works and developing alternate solutions. From the sites at risk we have carried out further assessment works to identify likely solutions from the top [redacted] most likely to require works investigated so far, we have identified potential high-level options please note a site may have multiple single or combination of options as outlined in our assumptions in the table below.

Full or partial perimeter protection	Site Drainage uprating	Individual asset protection	Building protection	External natural solution
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

We have reviewed the top [redacted] and selected an initial [redacted] which reflect a broad cross section of the types and size of sites both substations and cable sites as well representing as broad a spread of the likely types of solutions we will be implementing. This initial [redacted] sites will form the first year of T2’s workload we are targeting to have these sites to a developed costed solution by the end of 2020 in preparation for beginning works April 2021. Until we have these firm costings, we will continue to base our T2 costs as outlined in section 5.1.

### 5.3 Options considered

When protecting assets from surface level flooding, there are limited options in terms of mitigation strategies. With river and tidal flooding in T1, it was possible to use alternative solutions such as removable barriers which could be moved and overall provided an efficient alternative option as can provide a solution for several sites. We have utilised this option to drive efficiencies within the T1 period. Unlike river and tidal flooding, surface level flooding cannot be predicted as easily and generally happens within a short space of time. Therefore, portable solutions, such as removable barriers, are not as practical, and effective solutions need to be implemented on site ready for an incident. This view is supported by EA guidance which advises where and when specific defences should be used. Unlike river and tidal flooding, the surface water risk is unlikely to decrease over time. The frequency and intensity is increasing and projected to increase over time. Therefore, once the risk has been identified, deferral is unlikely to be viable option, however is considered as part of the options assessment.

In terms of determining the level of investment needed, we also consider whether a) the works are required at all and b) what the cost and benefit of implementing flood protection at all sites to provide a long-term solution. We have outlined below the pros and cons of these options;

Option	Cost	Pros/Cons
Do nothing	£0m to invest (Could be significant resulting cost from incidents. Cost to repair sites following previous flooding incidents have ranged from £1.5m - £3m. We would also have additional costs relating to generators being unable to connect to the network)	Pros – No initial outlay Cons – would be non-compliant and would result in an unacceptable level of network risk. Potential damage to site and loss of supply resulting in cost to recover, reputational damage and non-compliance. Surface water risks do not allow enough time for demountable barrier system to be mobilised and deployed
Defer all works until T3	£0m to invest (Could be significant resulting cost from incidents. Cost to repair sites following previous flooding incidents have ranged from £1.5m - £3m. We would also have additional costs relating to generators being unable to connect to the network) Costs to carry out works likely to increase offering no incentive to delay.	Pros – No initial outlay Where possibly we will continue to coordinate works extending the period into T3 for some sites may offer more opportunities. Cons – would be non-compliant and would result in an unacceptable level of network risk. Potential damage to site and loss of supply resulting in cost to recover, reputational damage and non-compliance. Surface water risks do not allow enough time for demountable barrier system to be mobilised and deployed.
Ensure flood resilience compliance in line with ETR138 v3 to	£49.8m	Pros – Resilience levels or sites in line with ETR138 recommendations. Complies with government expectations on flood resilience



sites which have immediate risk		Manages risk at a level that is affordable to consumers. Cons – Increased investment requires continued costs for consumer
Flood resilience to high standard for likely flood risk scenarios in 2080	£227m	Pros – Site would be resilient now and well into the future Cons – Potential for overinvestment in defences not required. Wasted investment in lost asset value Increase asset maintenance and replacement costs in future. Significant increase in T2 consumer bill impact.

In terms of tower erosion works, each scenario encountered is different, however they all follow the same scheme assessment route within our scheme development process. This process ensures that we are investing in the most economical solution at the right time taking all factors into consideration.

## 6. Detailed Analysis & CBA

The key driver of these investments is the updated ETR138 and the request from BEIS that we implement required changes to reflect this updated guidance and therefore as mentioned above we consider the option to ‘do nothing’ to be unacceptable in managing risk.

In line with our internal procedures, Cost Benefit Analysis will be completed on a site by site basis in the pre-works phase to be completed within RIIO-T1. This will enable us to determine the cost and benefit of implementing different solutions at each site identified to be at risk of flooding to meet specific site requirements. This will generally be based on site criticality and number of consumers impacted in the event of loss of electricity supply. Under ETR138 guidance, all our sites are considered critical to the security of supply and taken as having the highest societal impact. This view of criticality is based on operating voltage (anything above 132kV is considered as critical) and the potential for a societal impact of 10,000 customers or more.

Where possible we will base our prioritisation on likelihood (frequency) of flooding risk and where practicable be prioritising work within RIIO T2 based on site criticality. We will be looking at this from a whole system point of view, working downstream to understand the impact on the DNOs and identify which sites are most critical for protection from flooding. We will coordinate works with any planned outages and maintenance. We will then aim to complete the works required on these sites first. We also submit our progress against our flooding risk to sites twice yearly to BEIS to review.

Our research and development investments in RIIO T2 into erosion and effects of climate change are not driven by formal requirements but by stakeholder views and business need. Our stakeholders have asked us to ensure we deliver a network that is resilient to threats both today and in the future. We have a good understanding of the extreme weather threats that we face today, and how to best protect our network from these threats and there is formal guidance in place to follow. We do not yet have a strong understanding or strategy for how we manage new emerging threats of extreme weather and when the optimum time for investment, to deliver value for money to end consumers, will be. Our RIIO T2 investments in this area, will help us understand future threats from erosion and other climate change related threats and help us prepare to mitigate these in the future delivering a resilient network in the long-term.



## 7. Key Assumptions, Risk and Contingency

We provide detail below of the key assumptions, risks and opportunities in delivering our T2 weather resilience plans.

### 7.1 Assumptions

Due to having not yet assessed detailed site-specific requirements for RIIO T2, we have two key assumptions in determining forecast costs and sites required for our request for allowances.

- Our T2 costs have been forecast using information available of actual costs for implementing flood defences in RIIO T1. We have taken cost elements of larger schemes and solutions of similar size and scope of works to produce estimated costs. Section 5.1 of this document provides an overview of the bandings applied in the estimate. Our ongoing desk top investigations into the at-risk sites continue to support our expectations of volumes and scope of works.

- As demonstrated in RIIO T1, we have assumed that a large proportion of the [REDACTED] identified will not require works due to perceived flood risk being low or despite the site having water on it no impacts to supply would be expected. We have applied our learning from the amount of required investment in T1 to determine the expected number of sites requiring works in T2 the number of sites we expect to undertake works is 100 sites.

### 7.2 Risks

- We base our assessment of sites on the Environment Agency's data which is recognised as the best available data representing the 1:1000 flood profile on which we base our assessment. This data is continuously reviewed by the Environment Agency and can change at any time. All our assumptions are based on projections and models validated by the Environment Agency. Our view is that the best available data on which to base our climate change adaptation assessments is UKCP18 (UK Climate Projections 2018). There is a risk that we may need to change our plans based on updates to external data or information. This could include changes to the Environment Agency climate change data or guidance within ETR138.

### 7.3 Opportunities

- We will aim wherever possible to coordinate flood resilience works with planned maintenance outages to ensure efficiencies. However due to this, full benefit of implementation of flood mitigation measures may not be realised until planned maintenance works are complete.

- Due to the level of expected investment at each site being potentially very different, we will aim to use the most efficient delivery mechanism possible for each site. For example, if a site only requires a small amount of investment, we may deliver it through our Electricity Transmission minor civils framework, whereas larger scale investment could be delivered via our Capital Delivery department.

- Lightning storms have the potential to cause damage, latent damage, flashovers and transient interruptions to the electricity transmission network, for example; damage to insulators, bushings and cables. The effects of lightning can be minimised by including both shielding measures and suppression devices into electricity networks. The existing design standards of overhead lines and substations take account of frequency of lightning storms i.e. 1 event / 100km / annum. At present, there is no data published in UKCP09 or UKCP18 to indicate an increase in the severity or frequency of lightning storms. Therefore, unless a future update of UKCP indicates an increase in intensity or frequency, there is no potential climate change impact to National Grid Electricity Transmission assets from lightning storms and hence adaptation measures are not required at this stage. However, recognising that the risks may have a knock-on impact beyond National Grid, we will work closely with our customers and stakeholders to ensure greater UK resilience.

## 7.4 Uncertainty within RIIO-T2

As is the nature with external threats generally, we expect that either the threat or requirements to mitigate the threat will change within RIIO-T2. As it is not possible to accurately predict the scale or detail of change within RIIO-T2, we consider the most appropriate way to manage this is by including a re-opener mechanism within the price control.

We will manage the risk that a change in threat or requirements may have on our network by being flexible with our plans, and regularly meet with the EA and BEIS to review whether the latest guidance is appropriate considering the threat of extreme weather.

ETR138 is updated on an ad-hoc basis when there are major changes to threat or policy. For example, this could be as a result of a major flood event, a Government review or updated data becoming available. This creates some uncertainty within RIIO T2 as best practice guidance may change and require response to implement further weather related enhancements.

Whilst Ofgem have not included weather resilience as an area of uncertainty within RIIO T2<sup>1</sup>, we are proposing that a re-opener mechanism be included within RIIO T2 to take account for changes required to our programme of work because of change in threat and requirements/guidance.

## 8. Conclusion

In summary, in response to changes in threat and updated guidance, it is essential that we widen the scope of our existing flood protection on the electricity transmission network, proactively respond to increased instances of erosion issues and prepare for the future by considering the impact of climate change on our assets.

We will be delivering;

- Solutions to protect our assets and sites from the threat of surface level flooding on approximately [REDACTED]
- Proactive management of tower foundation repairs as a result of increased instances of erosion. We expect to undertake works at **approximately [REDACTED] locations in T2.**
- A long-term strategy on how to incorporate climate change action into the

In summary, we are proposing to maintain our resilience to extreme weather by making required enhancements to site protection to flooding in line with industry guidance. We will be proactively mitigating the threat of erosion against our assets, ensuring that issues are dealt with efficiently, minimising cost and risk to consumers. We are also understanding and proactively planning for our future requirements to protect from other threats of extreme weather.

Our RIIO T2 investments will protect the network from the present threat of surface level flooding on our sites and deliver a strategy for how we manage future threats and maintain a resilient network in the long-term.

### 8.1 Preferred options and outputs

In summary, the outputs that we will deliver within RIIO T2 are;

- Specific site solutions to ensure resilience against surface level flooding on an estimated [REDACTED] sites. - **£49.8m**
- Research, pre-works assessments and scheme development for Erosion and other flood related natural hazards on approximately [REDACTED] towers. - **£8m**

<sup>1</sup> Within the RIIO T2 sector specific methodology decision <https://www.ofgem.gov.uk/publications-and-updates/riio-2-sector-specific-methodology-decision>

- A long-term strategy of when to review and amend design standards for our assets to reflect threats posed by climate change. - **£2m**

For our flood mitigation measures, we aim to build on the significant investment we made in RIIO T1, to bring the resilience of our sites in line with latest guidance on flood protection. This will ensure continued resilience from flooding, helping to protect consumers from any impact of a flooding event on an electricity transmission site.

Our works associated with managing the increasing threat from erosion and other weather related threats will allow for proactive monitoring and prediction of hazards and drives efficient investment only when appropriate in the future.

Developing a long-term strategy for climate change will ensure we manage the challenges and risks posed by over or under investment in future resilience of our assets. It will also ensure that we maintain our current, medium and long-term commitments and meet our stakeholders’ aspirational levels of system resilience.

**8.2 Costs**

Our forecast costs for our flooding investments are based on actual RIIO T1 costs for similar sized sites. We have used costs from similar engineering solutions to estimate our cable sites works.

Our tower flood and erosion costs are based on a steady increase in the number of interventions which we are undertaking to repair and reinstate assets and infrastructure following erosion or flood damage. Damage to cables is increasingly becoming a concern because of erosion.

High level costs for the proposed investments are below, with further detail provided within the data table.

	CAPEX/OPEX	2021/22	2022/23	2023/24	2024/25	2025/26
WEATHER RESILIENCE	CAPEX	£4.30M	£8.76M	£14.28M	£16.15M	£16.33M
	OPEX	£0.0M	£0.0M	£0.0M	£0.0M	£0.0M

**9. Outputs included in RIIO T1 Plans**

We expect that a few sites will fall into RIIO T2 delivery having commenced in 2020/21. These investments are starting later than originally planned as we have decided to coordinate works with other major site developments (to enhance Physical Security) or with the Environment Agency off site defence schemes to help deliver more cost-efficient solutions.

We will also be delivering [REDACTED] for protection against river and tidal flooding as to coordinate works with other major project investments. For clarification, the costs for these works **are not included within our justification or T2 data tables.**