Re-opener Report

MSIP– Extreme Weather

31/01/2022

nationalgrid

Contents

Executive summary

This reopener report justifies T2 expenditure of £3.92m in protecting 33 sites across the network and removing the threat of pluvial flooding to end consumers.

Our stakeholders have told us that protecting the network from external threats is important to them. One of the greatest challenges facing businesses 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. During our T2 engagement, stakeholders told us that their most important priority was reliability of the electricity network and therefore it is crucial that our critical infrastructure both continues to function and can recover quickly from climatic incidents.

The recommendations in the National Infrastructure Commission's (NIC) report titled "Anticipate, React, Recover: Resilient Infrastructure Systems" detail that HM Government should develop a "framework for resilience which should deliver infrastructure that is resilient to a range of future challenges". On 15th September 2021, HM Government formally and publicly responded to this report and agreed with the statement above. As a result of the NIC's recommendations, Engineering Technical Report 138 (ETR138) was developed in partnership with BEIS, Ofgem, TOs and DNOs and provides a systematic approach to ensuring the resilience of the 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. We use the principles set out in ETR138 to help determine what pluvial flood defence investments are required on our sites.

As part of the RIIO-T2 final determinations Ofgem expressed a preference for all survey works to be completed up-front, prior to submitting funding requests. Therefore, National Grid changed its delivery approach from the proposal in Supplementary Evidence NGET_A10.05 to a focussed effort to produce flood risk assessments, outline designs and cost estimates, which are based on T1 delivered scheme costs, across our sites identified to be at risk of pluvial flooding. During the bilateral meeting with Ofgem on 17th August 2021, it was agreed that National Grid would provide a first submission in January 2022, to cover the funding for those sites for which cost estimates are available. A further MSIP reopener in January 2023 will then be used to request additional funding once the remaining site surveys had been completed. This split reopener would enable work to continue at pace, preventing any delays to the programme. Ahead of the January 2023 submission, we will return to evaluate our sites and assess in more detail to determine whether any form of climate change defence (not limited to pluvial flooding) would be required.

The initial high-level review of the Environment Agency / Natural Resources Wales flood maps carried out at the end of the T1 period delivered the expectation that from the 180 identified 'at risk' sites, 135 sites were likely to require some form of risk mitigation, with 100 of these sites requiring physical defences and accompanying Flood Action Plans, and 35 of these sites requiring Flood Action Plans only. Following flood risk assessments and surveys carried out on 84 sites, it is expected that 59 sites require physical interventions. For 33 sites out of the 59, which form this MSIP re-opener, cost estimates have been produced.

Following RIIO-T2 final determinations, Ofgem allowed baseline funding of £15.2m to deliver flood reinforcements for 12 sites which had cost estimates and to allow for additional surveys and risk assessments for the remaining sites considered at risk of flooding.

National Grid requires further funding to deliver 33 additional projects in years 2 and 3 of the T2 period, to the value of £3.92m (2018/2019 price base). This sum represents only the Capex cost with the expectation that an Opex escalator will be added to the total funding.

It is in the consumer`s best interest that funding is provided up-front as opposed to delivering the funding after all sites are tendered (expected late 2023). This will ensure National Grid delivers the required pluvial flood reinforcement within the T2 period. Furthermore, it will allow National Grid to flex the programme and exploit opportunities to align works, increase the scope of flood protection options and realise efficiencies, such as corelating works with planned maintenance and project works with specific example from T1 flood mitigation project at Seabank substation, which has been delayed to coordinate with the Hinkley Point connection, with an estimated saving of £800k (cost reduction from the entire flood scheme).

We are requesting for an additional 20% contingency on contractor works to cover for the key project risks. This valuation takes into consideration cost of similar unexpected events related to flood reinforcements projects delivered in T1 and early T2 period. The contingency also takes into account the reduced investment cost for each site and the high-cost impact of unforeseen events which could double the initial cost of investment. During project delivery, unexpected cost increase can occur due to a number of reasons such as COVID impact, resource availability, planning delays, third party interface delays, foundation works due to underground obstructions or ground contamination. Additional cost will be incurred during contractor works with possible changes to scope of work, site access issues, delays to site working methods following safety rules application, tendering and awarding work on sites more than 3 months in advance of the planned delivery date, due to a significant material cost uncertainty of a distant start date. Moreover the 20% contingency also includes the RPE adjustment (based on Consumer Prices Index Including Owner Occupiers' Housing Costs) for works delivered in the T2 period under this reopener.

There is a significant cost difference between the 12 baseline sites (~£0.74m/site) and the 33 which form part of this re-opener (~£0.15m/site). This is due to the type of flood reinforcements required which have changed from whole site protection to localised and minor flood reinforcements.

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Summary Table

Table 1. Summary table

Name of scheme	Extreme Weather
Primary driver	Pluvial flooding
Scheme reference / mechanism of category	MSIP
Output references/type	Flood defences
Cost	£3.92m
Delivery year	2022-2024
Reporting table	6.17 and 4.3
Outputs included in previous RIIO Business plan	£115m flood investments delivered in T1

Introduction

This document is the formal MSIP submission to Ofgem by NGET for the Flood defence works during the RIIO T2. This is submitted under the MSIP re-opener provided for in Special Condition 3.14 of the NGET Transmission Licence.

This submission is made in accordance with the 'RIIO-2 Re-opener Guidance and Applications Requirements' published by Ofgem in February 2021. The contents of the submission have also been informed by engagement between NGET and Ofgem with the aim of ensuring that this submission enables the Authority to make a positive timely decision on funding.

As a result of RIIO T2 Final Determination, it was confirmed that of the £47.2m (revised amount September 2020) funding requested in Investment Decision Pack NGET_A10.05_Extreme Weather (Extreme Weather IDP) for flooding defences, partial funding of £15.2m has been allowed to deliver pluvial flood defences at 12 sites, and to survey the remaining sites to be delivered in T2. For context, a pluvial, or surface water flood occurs when an extreme rainfall event creates a flood independent of an overflowing water body.

We must implement the guidance in Energy Networks' Associations Engineering Technical Report 138 (ETR138) to protect our network against surface water flooding by the end of the RIIO-T2 period, as required by BEIS. Failure to invest in flood defences at the right level at the right time could result in devastating consequences for our customers, stakeholders, and the end consumer.

National Grid ensures the application of ETR 138 via the Flood Mitigation Policy PS(T) 095, and the Flood Defences Technical Standard TS 2.10.13. The former defines the target levels for flood defence and resilience that should be applied to National Grid's existing transmission substations. The latter details National Grid's technical and procedural requirements for flood resilience of new and existing operational electricity substations.

Following site surveys carried out since the beginning of the T2 period, National Grid has to-date delivered cost estimates for flood defences at 33 sites, over and above the 12 baseline sites. The scope of this MSIP re-opener therefore covers the funding for these 33 sites. If successful, this means we will have funding for 45 of the expected 59 within the T2 period. National Grid will request additional flood protection funding for the remaining sites via a January 2023 MSIP re-opener, as agreed in the bilateral meeting with Ofgem on 17th August 2021.

All the sites covered by this re-opener will require flood defences at a localised level, as opposed to full site protection. This results in a lower cost per site in comparison to RIIO T1 reinforcements which focused on rivers and sea flooding, and in comparison to the 12 T2 baseline sites, which did include some full site protection at locations such as Newhouse. The total investment needed is estimated at £3.92m. This expenditure does not include operational and project management costs which are covered by the Opex escalator mechanism, applied by Ofgem post successful funding approval.

Demonstration of the Needs Case

The strategic context

The Electricity Safety, Quality & Continuity Regulations[1] (ESQCR) 3 (1) (b) state that "Generators, distributors and meter operators shall ensure that their equipment is so constructed, installed, protected (both electrically and mechanically), used and maintained as to prevent danger, interference with or interruption of supply, so far as is reasonably practicable". However, ESQCR does not provide specific guidance on the acceptable level of flood risk. The Energy Networks Association's ETR138 seeks to address this gap and provides a common approach to assessing flood risk and installing appropriate mitigation. Three versions of ETR 138 have been published to date: first in 2009, second in 2016 and the current one in 2018.

The 2nd version of ETR138 stated that:

"As a general principle Network Owners will target the completion of agreed protection to grid and primary substations as follows:

Transmission sites:

- Flooding from rivers and the sea – by the end of RIIO-T1 in 2021
- Flooding from surface water – by the end of RIIO-T1 in 2021"

Recognising that this guidance was published in January 2016, when funding had already been agreed for the RIIO-T1 period, NGET has been required by BEIS to mitigate against the risk of pluvial flooding by the end of RIIO-T2 . The ministerial agreement of ETR138 is detailed in Annex 1.

This requirement is echoed by our stakeholders. Our Business Plan is underpinned by the largest public engagement exercise we have ever conducted. Through this exercise:

- Our stakeholders asked us to maintain levels of reliability at an affordable cost.
- We adopted a tougher T2 target for Energy Not Supplied (a measurement of network reliability) weighing more heavily on recent performance.
- We committed to maintaining a consistent level of network reliability between T1 and T2.

Furthermore, the National Infrastructure Commission (NIC) published Anticipate, React, Recover: Resilient Infrastructure Systems in May 2020, which outlines a framework for resilience.

To draw the three primary recommendations together, the NIC suggests HM Government develops a "framework for resilience should deliver infrastructure that is resilient to a range of future challenges". On 15th September 2021, HM Government formally and publicly responded to this report and agreed with the statement above.

Figure 1 details the extract from the NIC report which National Grid is following.

[1] https://www.legislation.gov.uk/uksi/2002/2665/contents/made

Figure 1: Extract from Anticipate, React, Recover: Resilient Infrastructure Systems

To deliver resilient infrastructure, a framework for resilience is required that:

- better anticipates future shocks and stresses by facing up to uncomfortable truths
- improves actions to resist, absorb and recover from shocks and stresses by testing for vulnerabilities and addressing them
- values resilience properly
- drives adaptation before it is too late.

Much of what is needed is already in place, but improvements can still be made:

- government should publish a full set of resilience standards every five years, following advice from regulators, alongside an assessment of any changes needed to deliver them
- infrastructure operators should carry out regular and proportionate stress tests, overseen by regulators, to ensure their systems and services can meet government's resilience standards, and take actions to address any vulnerabilities
- infrastructure operators should develop and maintain long term resilience strategies, and regulators should ensure their determinations in future price reviews are consistent with meeting resilience standards in the short and long term.

Our proposals are designed to ensure that we can maintain a network that is resilient to weather related risks now and into the future and are in line with the recommendations in the NIC report, an extract of which is included in Figure 1 above.

Climate change

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.

National Grid ET continues to proactively monitor for any new climate risks, in order to remain ahead of any climate change impacts which would affect the network. The majority of NGET assets are above ground (7, 212 km of overhead electricity lines) and so are exposed to the elements and subject to the climate change parameters such as:

- Flooding and heavy rain fall (including saturated ground conditions)
- Snow and ice
- Increases in temperature, heat waves and drought conditions
- Coastal erosion from sea level rise
- River erosion
- Storm events and high winds

In the last two years alone, there have been a high number of storms across Europe and the UK which caused flooding that negatively impacted people in those regions. The below list outlines some of those impacts:

- 24th to 25th July 2021: thunderstorms cause chaos in Western Europe as storms floods in UK, Germany France Belgium and Switzerland. Roads flooded in London.

- 11th July 2021 extreme rainfall causes flooding in eastern England: Peterborough and Cambridgeshire was the worst affected.
- Jan 2021 Storm Christoph prompts evacuations with flooding in North Wales and North West.
- December 2020 extreme rainfall causes flash flooding in Wales and South West.
- November 2020 Extreme rainfall causes river flooding in Yorkshire and the North West.
- 25th August 2020: flash flooding in UK and France after Storm Francis.
- 13th August 2020: storms cause flooding and landslides in UK France and Italy.
- February 2020: Storm Dennis causes flooding in England and South Wales

Since the first version of ETR138 was published, further information on pluvial 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 as well as the pluvial risk data which was not available at the start of the T1 period. As a result, we have identified additional sites at risk from all forms of flooding (including pluvial) such as cable sealing ends and tunnel heads.

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 significant local communities (SLCs) comprising of at least 10,000 customers/connections. All National Grid sites are SLCs.

This latest update of ETR 138 delivered in June 2018 calls for the development of longer-term plans for permanently improving the resilience of service provision to SLCs and is driving for further significant flood resilience investment across the network, prior to the end of the T2 period. As a conclusion, the current version of ETR138 expanded on the flood risk to require resilience on all National Grid sites. Works completed within the T1 period automatically protect our sites from pluvial flooding, however there is a need to address 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 (see Annex 1). We continue to use the guidance outlined within ETR138 to determine appropriate investments for protection from flooding within the T2 period.

Benefits to consumers

By following the guidance included within ETR138, the flood protection introduced within RIIO T1 has delivered and continues 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 a loss of electricity supply due to flooding on substations. The photos below illustrate a view of our Walham substation during two flooding events, before and after the flood defences were built. Although major energy supply loss was avoided during the 2007 flooding event, this was due to the emergency instalment of a demountable barrier system borrowed from the Environment Agency then rapidly replaced by a

constructed barrier system installed by the Army and National Grid. National Grid flood defences were in place and ready to be used in 2009. Similar levels to 2007 flooding have occurred twice since then at Walham. Should the site have been forced to switch out, it is likely that significant impacts and supply constraints would have resulted in supply losses in the area and South Wales. More examples of flood works delivered in T1 via NGET minor schemes delivery unit can be seen in Annex 2, section E.

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 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, drive further efficiencies and potentially expand National Grid's natural capital value. This involves coordinating works with 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 [redacted] on sites as part of the [redacted] fFor 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.

Background information 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.

A detailed explanation of T1 delivery, including the deferred and delayed sites, is presented in Annex 2.

Table 2 provides an overview of the T1 spent vs allowance for flood defences. All costs are related to 2020/2021 price base.

Table 2. RIIO – T1 Actuals vs Allowance (£m)

RIIO-T1 Actuals	RIIO-T1 Allowance	RIIO-T1 Actuals vs Allowance	Forecast for RIIO-T1 delayed sites	RIIO-T1 Actuals + Delayed forecast
115	151	-36	50	165

T1 the RRP was recorded cumulative for all flood works. Delivered sites were not reported individually as they formed part of 1/100 or 1/200 flood schemes.

In the T1 RRP 4.3 we detailed that we spent £36m less than the RIIO-T1 allowance of £151m, this is mainly driven by the works delayed into RIIO-T2 and the 3 deferred.

Although there is a £36m variance to the RIIO-T1 allowance which is mainly driven by the 13 delayed RIIO-T1 sites, we are currently forecasting costs of ~£50m in RIIO-T2 to complete the delayed works. These costs are separate from any RIIO-T2 funded sites, and we shall not ask for any further funding to complete the works. There is a £4.4 m difference from RRP 2021 flooding data. The cost difference is due to updated cost forecast, closer completion date and better cost understanding.

We list the RIIO-T1 delayed sites with justifications to why delivery will now be completed in RIIO-T2 in Annex 2, section D.

Options and option costs

When protecting assets from pluvial 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 this could provide a solution for several sites. We have utilised this option to drive efficiencies within the T1 period.

Unlike river and tidal flooding, pluvial 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 evidence of recent times shows the frequency and intensity of pluvial flooding is increasing, and it is projected to continue to increase over time. Therefore, once the risk has been identified, deferral of a permanent solution is unlikely to be viable option however, is considered as part of the options assessment. Pluvial water risks are primarily driven by short duration extreme rainfall events such those that occur during thunderstorms. Future climate change projections show a continued increase in storms both as winter North Atlantic low-pressure systems and summer deluge events. The increased frequency increases the likelihood that an extreme rainfall event occurring when rivers and drainage systems are already saturated and amplifying the impacts of a surface water event.

Out of the 180 sites initially identified at risk of pluvial flooding (after performing a high-level review of the Environment Agency / Natural Resources Wales flood maps and following the flood risk assessment methodology detailed in the next chapter), this re-opener focuses on mitigating the flood risk identified on 33 sites (for which we have delivered cost estimates). A detailed chart of T2 works and progress is presented in the chapter: Project delivery and monitoring.

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.

Table 3. Delivery options

Option	Option Cost	Option Cost Pros/Cons
1.No investment. Potential significant cost from flooding events.	£0m to invest Estimated cost to repair the 33 sites is £[redacted] and estimated cost of lost load is £[redacted] (see Annex 5). Annex 3 provides specific examples of damage caused by flooding to HV substations. Additional costs could be borne 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 network risk. Potential damage to site and loss of supply resulting in cost to recover, reputational damage and non compliance. Surface water risks do no allow enough time for demountable barrier system to be mobilised and deployed.
2.Defer all works until T3 Potential significant cost from flooding events in T2.	£0m to invest in T2 The estimated cost to repair sites and replace equipment ranges from £[redacted] - £[redacted] (see Annex 5). Additional costs could be borne relating to generators being unable to connect to the network Costs to carry out works in T3 only likely to increase, offering no incentive to delay. As seen with the T1 to T2 increased costs, the	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

Option	Option Cost	Option Cost Pros/Cons
	construction of flood defences is unlikely to go down.	risks do not allow enough time for demountable barrier system to be mobilised and deployed. Opportunity: We are undertaking innovation works to develop and streamline our flood risk monitoring process. See Annex 4 for details. However, while this will give us greater awareness and increase our resilience to tidal, fluvial and erosion it would not be an effective defence against pluvial flooding (it will only give us increased warning).
3.Ensure flood resilience compliance in line with ETR138 2018 to sites which have immediate risk	3.1. £3.92m, to invest in localised protection at 33 sites (not including Opex escalator of 17%) 3.2. ~£100m, to invest in full site protection at 33 sites	Pros – Resilience levels or sites in line with ETR138 recommendations. Complies with government expectations on flood resilience Manages risk at a level that is affordable to consumers. Cons – Increased investment requires continued costs for consumer
4.Flood resilience to high standard for likely flood risk scenarios in 2080	4.1. £36m (considering investing on 180 sites in T2 at an average price/ site of £0.2m – localised protection) 4.2. £540m (full site protection for 180 sites at an average price of £3m/site)	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. Increased asset maintenance and replacement costs in the future. Significant increase in T2 consumer bill impact.

Taking into consideration Table 3, we have discarded Option 1and 2 as it would not ensure compliance with ETR138 and it would be against NIC and HM Government recommendations.

Also, we have eliminated Option 4, as it would deliver overinvestment and will increase the consumer bill.

Option 3 can be split in 4 major cost options depending on the type of flood defence:

3.1. Localised protection - Individual building and items such as marshalling kiosks and cabinets are protected separately. In some cases, even on large sites there may be a single cabinet or building at risk. Alternatively, where many items require protection, due to cost increase, a whole perimeter protection becomes the most cost-effective solution.

3.2. Full site protection – Where either there are multiple assets to protect, or the depth of water becomes such that individual protection or building protection becomes untenable, a perimeter defence is used around site. The solution can be delivered via constructed walls inside or outside the fence or on the fence line. This type of solution can also contribute to the increased flood duration as water cannot escape the site fast enough. This option tends to be the most expensive (average price RIIO T1 is £3.2m), however it is sometimes the only option in cases where a groundwater cut off is required.

3.3. Off-site protection:

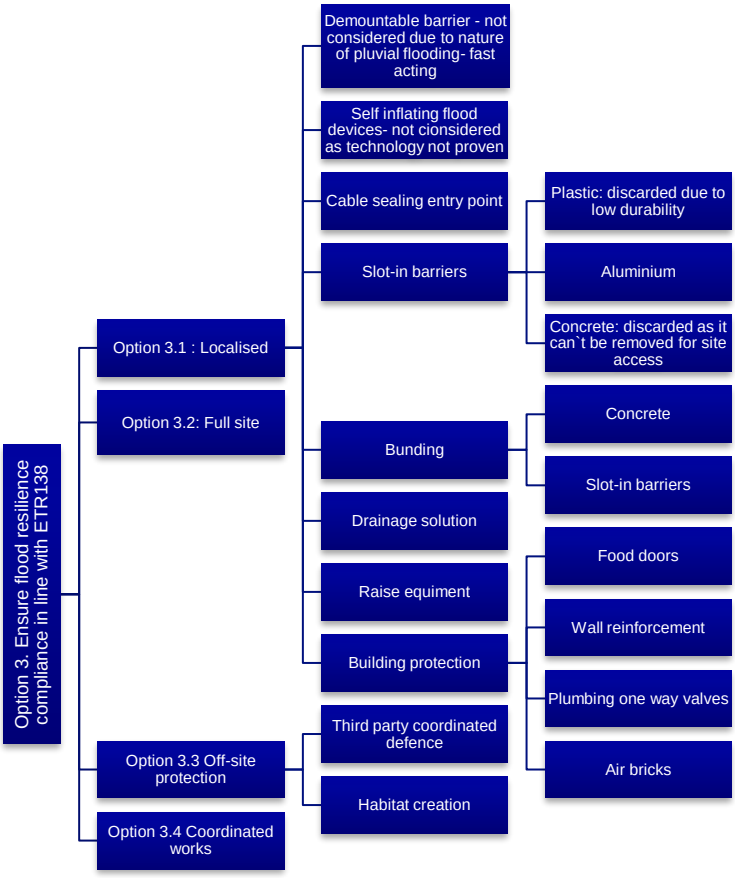
3.3.a - As part of the assessment works it can be identified that a co-ordinated defence with a local stakeholder may be an option, however experience gained from the T1 works has shown that there is an unwillingness to work to the level of flood defence we require as per ETR138. We have looked at catchment wide solutions however these types of solutions carry with them a higher degree of uncertainty in the level of defence offered and are usually unsuitable.

3.3.b - Green solution is comprised of options around creating flood storage areas on unused land the benefits include the potential habitats these may create however as with the previous option the uncertainties of levels of defence are a factor. This option also requires suitable spare land be available adjacent to the site and if not, the land purchase price often excludes this as a viable option. There are cases where changes to the drainage ditches around a site can manage the risk effectively. Where possible this is our preferred option, however it is unusual if no other works are required such as building or individual asset protection. Cost to deliver this option in RIIO T1 was £XXXXXXX at Botley Wood (18/19 price base), but no additional land needed to be acquired by National Grid.

3.4. Co-ordinated works - Where possible we endeavour to carryout works with any other suitable on-site schemes such as HS2,

As previously mentioned, the flood defences considered are site specific, each site having customised flood protection delivered based on the site topology and flood data. In most cases, the proposal developed by the design consultant provides most cost-effective viable flood defence option for each site. In some situations, due to the possibility of co-ordinated works, alternative options will be considered.

Figure 3. Summarised Option 3 - ETR 138 compliance



A more detailed explanation of the solutions considered for pluvial flood protection is presented in Table 4.

Table 4. Solutions flood protection T2

Flood protection type	Description/ when is it used
Building protection	Installation of flood proof doors or drop in panels, sealing of cable entry points below ground and water level, treating air bricks either through raising or one way flow system, waterproofing the brick work up to the flood depth, one way systems for sinks and toilets. It can be fitted to protect against maximum 900mm of water.
Flood wall around site	For situations where building protection cannot be fitted (water level > 900 mm) or structural reinforcement is required or multiple equipment in the compound need to be protected. Once more than two or three separate buildings need to be protected and multiple individual items around a site, costs begin to rise to the stage where larger area protection becomes more efficient.
Slot-in barriers	Slot in barriers are used as a semi-permanent option to protect isolated equipment or in an area where a permanent wall would limit the access around site. The barriers can be removed for access or maintenance. These barriers can be constructed from plastic, aluminium or concrete. Due to access being required, the concrete solution cannot be chosen (not demountable) and plastic is not a durable material, leaving aluminium as the preferred option.
Bunding	Bunding, also called a bund (flood) wall, is a constructed retaining wall around an equipment or parts of a substation designed to the protect property from flooding. The solution could also be delivered using temporary bunds (slot-in barriers).
Flood door protection	A door with inbuilt flood protection required for building protection.
Raising equipment	Raising a specific electrical equipment off the ground and placing them above flood level (see Annex 2 section E – Port Ham example)
Seal trenches	Sealing trenches tend to accompany building protection and isolated plant items and allow for cable removal. The installation can be done via expanding foam or silicone type resins.
Drainage solution	Drainage ditches around site allow flood water to escape and reduce impact of flooding. Includes pumping station and drainage channel.

To evaluate the consequence of not delivering the flood defences (do nothing option), two aspects have been considered, the cost of lost load and the cost of equipment replacement and building repairs.

The cost of lost load has been calculated using the following data:

- Electricity Ten Year Statement data, Appendix G - FES nodal demand, Winter Peak 2025/2026[2].
- Similar time of disconnection from previous flooding events on National Grid sites. E.g.: 25th June 2007 Neepsend substation lost 38MW (~half site demand) for more than 72 hours.
- Value of Lost Load £/MWh is £[redacted] per MWh in 18/19 prices based on Ofgem`s Final Determination document[3]

[2] https://www.nationalgrideso.com/document/227546/download

[3] https://www.ofgem.gov.uk/sites/default/files/docs/2021/02/final_determinations_et_annex_revised.pdf

- 132 kV interconnection for possible demand transfer. Depending on the demand transfer capability (full demand transfer, partial or no demand transfer) between the different grid supply points, the ENS can be in the range 0£ to millions of £.
- Source of site shutdown from flood site surveys can be related to loss of protection, LVAC or batteries.

The total cost of repair/replacement takes into consideration:

- Cost of building repairs, using previous tender costs (e.g.- Thorpe Marsh 2007 increased by the cumulative price change of 39.299% from 07/08 to 18/19 price base)
- Additional mobilisation costs (10% of equipment cost) – not included in Table 5
- The following assumption have been considered for the cost of equipment replacement (Table 5):

Table 5. Cost of equipment replacement/ repairs (2018/2019 price base)

Subject	Cost (£k	Basis of Price
Building	xxx	Based upon previous historical
Marshalling Kiosk	xxxxxx	Replacing kiosk and re-wiring. Multi-cores in troughs assumed to be not replaced
Relay room	xxxxxxx	Assume no damage to relay room. Work is limited to replacing relay panels
Compressor	xxxxxxx	Replacing equipment only
Diesel	xxxxxxx	Replacing generator and cable sets - unit assumed to 250-499kVA
Batteries	xxxxx	Supply and installation single battery, single charger, fuse box and associated distribution cabling. Per 5 Bays.
MVAC	xxxxxxx	Replacing panels only
LVAC	xxxxxxx	Replacing panels only
Telecoms Room	xxxxxx	Replacing equipment only
Static Var Compensator	xxxxxxx	Replacing Statcom +225/-x MVAr - 400kV
Circuit Breaker	xxxxxx	Replacing 400kV AIS units only
Super Grid Transformer	xxxxxxx	Replacing transformer on a like for like basis. Costs used are typical for 400/275kV unit
Shunt Reactor	xxxxxxx	Replacing reactor on a like for like basis. Costs used are typical for 200MVAr unit

Annex 5 describes the optioneering analysis for ETR138 compliance and it`s based on the options presented in Figure 3, the costs from Table 5 and the cost of lost load. For 3 of the 33 sites two options (A & B) for localised protections have been considered. However, due to cost or safety reasons, only one options is viable.

One detailed exercise for flood cost option was carried out for Bustleholm flood works. Bustleholm is a T1 delayed site delivered in T2 which requires a complex whole site protection, thus allowing for multiple solutions to be considered. The detailed cost options considered are presented in Annex 6.

Methodology for selection of the preferred option

Cost benefit

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 (CBA) will be completed in the pre works phase. 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 with a single site failure. The CBA carried out for this re-opener is detailed in Annex 7.

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 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 pluvial flooding threats that we face today, and how to best protect our network from these threats and there is formal guidance in place to follow.

Risk modelling

National Grid applies ETR138 using a risk-based methodology as well as a cost/benefit assessment for each site.

The following key areas have been covered for the RIIO T2 assessment:

- The impact of flooding on the GB Electricity Supply System and risks for society

- Available flood risk information and its use.

- National flood defences and planning requirements.

- Systematic approach to Flood Risk Assessment and the identification of appropriate protection including.

    i. Conducting Flood Risk Assessments for each Substation;

    ii. Identification of the flooding impact for each particular site and individual assets;

    iii. Establishing if a site will be protected by a National flood protection scheme;

    iv. Where necessary, identifying the most appropriate flood protection system for each site.

- Levels of acceptable flood risk and implications for investment including a Cost/Benefit assessment that considers societal risk. For sites with more than 10,000 unrecoverable connections (all National Grid sites), resilience against a 1/1000 flood event has been considered be the target level of resilience.

- Work programmes for implementation of substation flooding resilience which will be dependent on the availability of necessary funding.

Following the key areas above and using the Flood Risk Assessment Methodology described later in this paper, out of 180 initially identified as being at risk of pluvial flooding at the beginning of T2, 135 sites were identified to require mitigation in the form of hard defences or flood defence plans, with 100 expected to require hard defences.

We have carried out 84 site surveys by January 2022, 3 sites have pending surveys, and 5 at risk but require more detailed flood modelling and data to provide a definite result. Out of the 84 sites, 59 have been identified as requiring flood defences (including the aforementioned sites with ongoing investigations).

The risk of doing nothing and not investing in the sites identified at pluvial flooding risk has a significant societal impact.

Flooding can affect overhead lines and cable routes through surface and near surface flows causing erosion issues which may lead to operational issues. However, substations and other site compounds can be particularly vulnerable if water reaches certain critical depths and, the impact of substation flooding on National Grid sites can be particularly severe if power flow is lost and limits the re-configuration options of the network, potentially leaving more than 10,000 customers unsupplied, if DNOs are also unable to reconfigure.

National Grid ET has an Energy Not Supplied (ENS) incentive scheme under RIIO T2 covering the period from April 2021 to March 2026. This is detailed in Transmission Licence – Special Condition 4.2, which states that we must have in place and maintain a reliability incentive methodology statement agreed with the Authority, and that we must use reasonable endeavours to prevent incentivised loss of supply events and to restore supplies quickly and efficiently after an event. Although the maximum financial loss for National Grid which could occur due to ENS is capped at £31.331m, the risk so society is greater as the cost of lost load can add up to £[redacted] as detailed in Annex 5. National Grid ET is aiming to reduce the risk of unsupplied energy by protecting the assets against flooding.

Experience of flooding incidents underlines the particularly severe impact on society of a combination of flooding and loss of electricity supplies to a large community, especially if this also affects other critical infrastructure such as water, gas, sewage or telecommunications.

Flood risk assessment methodology

Reference documents

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. 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 the 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) Investigate options for flood protection. Following the flood impact assessment, if it is decided that flood protection is necessary, there are a number of options that can be deployed. Network Operators will make their own individual assessments for any of their substations requiring protection in order to decide what type of protection will be provided to mitigate the flood risk. These assessments and their associated costs will be factored into Network Operator's' investment plans as appropriate.

e) Propose an appropriate solution based on the level of flood risk to be considered and a cost/benefit analysis.

2. Flood Mitigation Policy PS(T)095

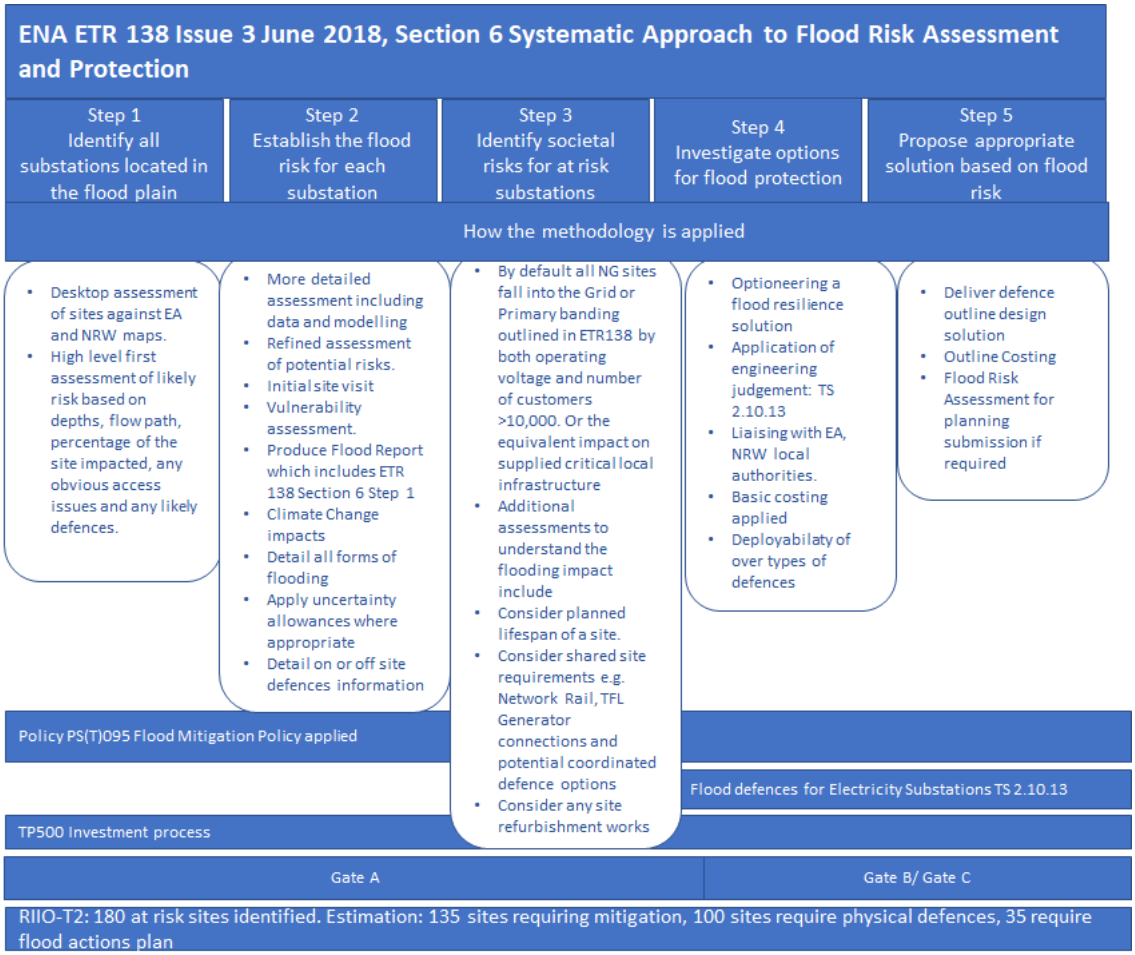
This document defines National Grid's declared target levels for flood defence / resilience that should be applied to existing transmission substations, all new build electricity transmission substations and at legacy substations subjected to an expansion or a major refurbishment programme. National Grid's Flood Mitigation Policy incorporates the guidance from ETR138 to target a 1/1000 year resilience level for all new and existing substations, National Flood Resilience Review 2016 (as defined in UKCP18 (UK Climate Projections 2018)) and the uncertainties surrounding climate change. To account for data errors and uncertainties in modelling, the flood depth is increased by 300mm, based on current advice provided by the EA/NRW/SEPA and as specified in ETR138. A copy of PS(T)095 can be found in Annex 8.

3. Flood Defences Technical Standard TS 2.10.13

This document details National Grid's technical and procedural requirements for flood resilience of new and existing operational electricity substations. This specification expands upon the requirements outlined in National Grid Policy Statement PS(T)095 – 'Flood Mitigation Policy'. National Grid's requirement for flood modelling and risk assessment is presented. This will be used to assess the need for flood mitigation measures at particular sites. A copy of TS 2.10.13 can be found in Annex 9.

Methodology

Figure 4: High-level summary flood risk assessment process



This approach applies the guidance in ETR138 to meet our stakeholders' expectations and achieve the required balance between ensuring our network is resilient to weather-related shocks and delivering value for the end consumer.

Key Assumptions

Due to having not yet assessed all 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 actual cost information available for implementing flood defences in RIIO T1. We have taken cost elements of larger schemes and solutions of similar size and scope to produce estimated costs. 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 180 sites 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 were expecting to undertake construction works is 100 sites. We expect on several the 180 sites a flood action plan would be required where investigations show that water on site would not impact the supply but still impact the site.

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. 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 allowance data or guidance within ETR138. The EA are undertaking a review of the National Flood and Coastal Erosion Strategy for release in 2024, If there are any significant changes, this may result in an update to ETR138.

Opportunities

- We will aim wherever possible to coordinate flood resilience works with planned maintenance outages to ensure efficiencies. However due to this, the 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, we have changed the delivery mechanism from RIIO T1 – large investments delivered via our Capital Delivery department to Electricity Transmission minor civils framework managed by National Grid regional Engineers, as most sites only require a small amount of investment.

Applied methodology for RIIO-T2

Following a high-level review of the Environment Agency / Natural Resources Wales flood maps, as per the methodology used in RIIO-T1 and summarised in Figure 4, 180 sites were initially identified at risk of pluvial flooding. These sites are separate from the 52 sites that are being protected in T1. Annex 10 provides the comprehensive list of the 180 sites.

The previous T1 schemes had primarily focused on electricity substations, and not all sites in the system which may cause supply issues or support the reconfiguration of the network. Accurate pluvial flooding risk data was only available from 2016 in an accurate and consistent format on which we could base an assessment. The bulk of the sites considered for T2 flood defence works are not substations, but associated sites such as cable sealing end compounds, tunnel head house compounds, cable cooling stations and alike. Where substations are now being considered, it is generally as a result of pluvial risk and / or where further changes in the EA's data have increased the risk

Of the many sites identified as being within or near EA designated flood zones, desk top studies were undertaken, and this has assessed out a large number of sites as being shown to be not at risk. Of the remainder, some initial 180 locations were identified for more detailed desk top analysis, which included a high level risk calculator and assigned a score to each site.

We have reviewed the EA / NRW flood map data for the 180 sites, in conjunction with the Flood Risk Assessments (where available), satellite images and existing site knowledge, and have carried out a desktop exercise to make an initial assessment of the risk of pluvial flooding. Two sites are shown in Figure 5 as an example. This assessment details the return period banding of 100 which means Kent Gateway Tunnel is at pluvial flooding risk and has 1/100 chance of occurrence in any year.

Figure 5: Example of initial assessment of pluvial flooding risk

Site	Surface water Flood Risk Banding				Works likely to proceed	Site Specific Protection Designed	Protection Implemented	Nature of defences
	Return Period Banding	Risk to Site	Risk to Private Access Road	Risk to Public Road Network Access				
Kent Gateway Tunnel (Cable Site)	100	M	L	N	Likely	Start of RIIO T2	RIIO T2	Subject to detailed flood risk assesment/CBA
Kilburn Grange Park (Cable Site)	>1000	N	N	N	Unlikley	Start of RIIO T2	RIIO T2	Subject to detailed flood risk assesment/CBA

The 180 sites were then used to identify the top approximately 100 at risk sites, and further modelling determined the predicted flood depth and potential impact at each site. A further desktop assessment was then carried out for the 180 sites, taking the Flood Risk Assessments (where available), satellite images and existing site knowledge into account, resulting in an initial assessment of the risk of pluvial flooding. A summary of this desktop assessment is included in Figure 6 and shows that of the 180 sites initially identified at risk of pluvial flooding, we expected 100 sites to require mitigation. The 100 sites were determined based on the highest risk score determined by a high-level risk banding exercise carried on several factors (e.g.: EA data, historical flooding, known site changes). Annex 11 provides a detailed view of flood risk for NG sites which was used to determine the 100 sites at risk.

Figure 6: Summary of initial desktop assessment

Sites identified as unlikely to require mitigation	45
Sites identified as likely to require mitigation	135
Expected number of sites requiring mitigation following detailed assessment	100

The expectation was that 135 sites were likely to require some form of risk mitigation, with 100 of these sites requiring physical defences and accompanying Flood Action Plans, and 35 of these sites requiring Flood Action Plans only.

Site visits were undertaken to verify the assumptions made during the desk top studies and assess the impact of the predicted flood levels and consequently identify the specific assets at risk and the level of protection required. This includes likely flow paths of surface water.

From the original sample list of 100, many have been determined to not require hard defences due to the actual level of risk but may still require site action plans. This means fewer sites than initially anticipated will require hard constructed defence works. Ahead of the January 2023 submission, we will return to evaluate the remaining sites from the original list of 180 ‘at risk’ sites, that were not included in the current list of 100 ‘highest risk’ sites), and assess in more detail to determine whether any form of defence would in actual fact be required. In this way we may be able to identify more sites requiring defences and thus more closely approach our estimate of 100 sites defended. While some sites may not require hard defences, they may still require a site flood action plan in line with ISO14001 standard and ISO14090 guidelines.

Factors considered in the solution options are similar to those considered in T1: Whole site protection, protection of only part of the site, building or individual asset protection. However, due to the nature of surface water from an extreme rainfall event only demountable defences which are in place all the time and only removed for access and maintenance are suitable. At worst case, whole site protection is required (Newhouse is the only site to date where this has been identified as the required solution), but usually it is partial site or individual asset protection.

Site longevity has also been considered, and locations expected to be decommissioned in the reasonably near future have been discounted.

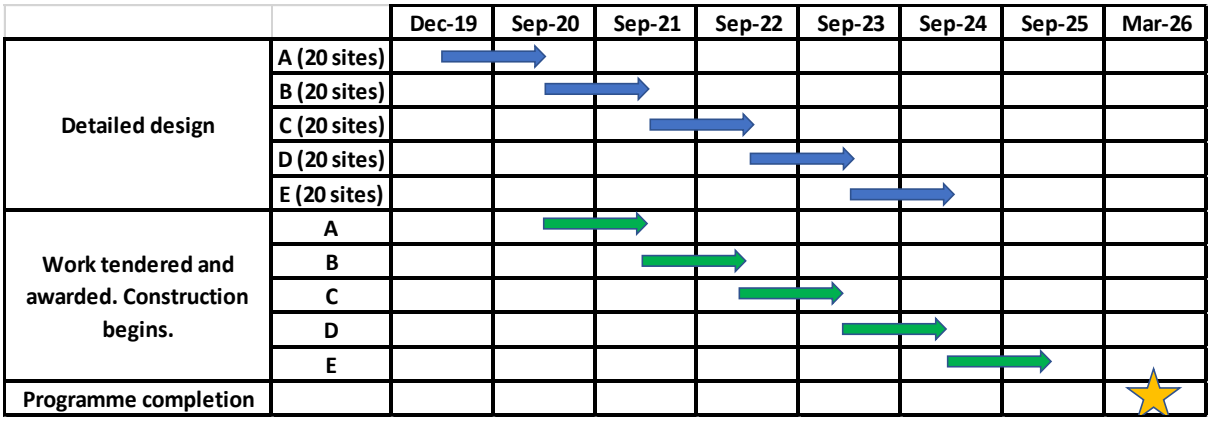
The output from the site visits and investigations creates an outline solution, which is used for cost estimation purposes, and then used to prepare detailed design drawings for construction.

The latest data from the January 2022 site surveys shows that only 59 sites have been identified to-date that require physical defences.

Original Approach

In order to mitigate against the risk of pluvial flooding by the end of the RIIO-T2 period, as required by BEIS, we originally planned a rolling programme of works, as shown in Supplementary Evidence NGET_A10.05 and included as Figure 7 below for completeness.

Figure 7: Initial programme of works



The expectation was that ~25-30 sites would be surveyed each year, with 20 progressing to detailed design.

This would have allowed us to carry out the Flood Risk Assessments and subsequent detailed designs for one tranche of sites, whilst simultaneously tendering and awarding work for another tranche of sites.

Revised Approach

The outcome of the Final Determinations has required a change in approach. Therefore, the rolling programme of works has been replaced with a focus on cost estimates for all sites requiring physical defences as soon as possible.

During the bilateral meeting between Ofgem and National Grid on 17th August 2021, it was agreed for National Grid to deliver a split reopener. This was to enable all cost estimates to be submitted (in line with the level of detail provided in the T2 paper) for ~40 sites (including baseline) in Jan 2022, and the remaining cost estimates in Jan 2023, therefore enabling work to continue at pace and preventing any delays to the programme. A comprehensive view of the RIIO- T2 status by January 2022 is presented in Table 6.

Table 6. RIIO T2 flood defence

Sites identified at risk T2	Sites identified to require mitigation	Site visits by December 2021	Sites requiring flood defences following outline design	Sites at risk, defence TBC pending assessment	Cost estimates
180	135	84	51	8	33 (excluding baseline)

Cost Assessment

Original Costing Approach

Due to the original approach of following a rolling programme of works, site specific cost estimates were not available when Investment Decision Pack NGET_A10.05_Extreme Weather (IDP) was submitted in December 2019. We therefore carried out an exercise to estimate the total cost to install flood mitigation at approximately 100 sites, based on an initial view of the range of potential solutions required and average costs of works of a similar scale delivered during RIIO-T1.

Recognising that cost estimates were only available for 9 sites when Supplementary Evidence NGET_A10.05 was submitted in September 2020, we applied another approach to demonstrate the required level of funding for pluvial flood mitigation. This approach was based on Table 6.16.1 “criticality substations” from our annual RRP submission. This methodology generated a total cost estimate of £47.16m, compared to £49.8m requested in the IDP.

Finally, during a bilateral meeting with Ofgem on 30th September 2020, we submitted initial cost estimates for a further 3 sites and estimated the cost of completing site surveys to be £xxxxx per site. During this bilateral meeting we also requested funding to deliver a further 28 sites in Years 1 and 2, based on the average cost of the 9 “final” and 3 “initial” cost estimates, but this additional funding was denied.

Agreed Costing Approach

Following Ofgem’s Final Determinations, we understand that funding will only be awarded where cost estimates have been produced following completion of a site survey and outline design. As discussed in the Methodology section for RIIO T2 section detailing the revised approach, we are therefore working to complete site surveys and produce cost estimates as soon as possible. The progress of works can be seen in Table 6.

Cost Assurance Deep Dives

Following agreement to continue to submit a January 2022 reopener investment request to Ofgem, based on a site flood mitigation survey, an outline design and estimated costs, we have agreed this cost assurance approach to compare the original estimated costs to the resulting tendered costs and to illustrate how representative they are of the cost to deliver the mitigations across all of the T2 sites. These example sites are Newhouse and Brelston Green and are the 2 sites included in the 12, T2 baseline sites which have undergone a tendering process.

Figure 8 contains a high-level breakdown of the costs associated with Brelston Green and Newhouse. A further deep dive into the detail underneath these figures can be found in the cost models in Annex 12 section A, which cover all direct costs relevant to the 2 sites. Project management costs are based on third party estimates using established cost frameworks as well as internal NG rates. Between the 2 sites the indirect cost element is 15% which would be comfortably covered by the Opex escalator.

As part of NGET’s baseline allowance for flood defence, Ofgem funded £xxx per site, for site investigation and design works, which have subsequently been carried out on both sites. Due to the size and complexity of the 2 sites compared to the other simpler sites in the baseline, we have seen higher costs than the ‘per site' funding, which was to be expected. Contractor work costs are the contract award values which have been received from the winning tender. The factor which has contributed to a smaller actual cost for contracted works compared to what was estimated as part of the baseline submission is related to cost uncertainty. The original estimates were based on estimate of work volumes using the flood risk assessments and site construction drawings (see Annex 13). However, this work was estimated to an outline design level and not sent to tender at that time, therefore the cost has been subject to change. The site drawing identified all the flood reinforcements needed at the site based on the flood level. However, to cost up the design recommendations, T1 costs (from delivered schemes) were used, and additional contingency cost was added on top. This is in line with the variance of cost received for these 2 sites during the tendering process, as the 5 contractors provided a 23% difference in cost from the cheapest to the most expensive tender.

Based on historic schemes we would expect the project costs to outturn higher than the tendered prices, under the compensation event process, to cater for unforeseen changes in scope or events outside the control of the project. We have already encountered several unexpected events at Newhouse which have increased the cost above the scope covered in the tendered works, and more are expected for which an estimated contingency has

been included. These changes have been driven by third parties as well as scope changes due to progression of the site's detailed designs. More details regarding these unexpected costs are included within the cost models under Annex 12 section A. Risk accounts for further unavoidable and unexpected costs covering events such as third party driven program delays, further site works outside of the tender scope, as well as rises in commodities prices throughout delivery.

Overall, the 2 sites will be expected to be delivered under the original estimates and thus allowances received as part of the baseline funding. NGET's organisational re-design, unlocking efficiencies through project delivery, is one of a few contributing factors for this. Another includes a reduction in the scope of works following design survey completion. As mentioned, these original estimates were based on limited detail prior to site design surveys being carried out. Finally, these 2 sites are the largest and most complex within the 12 baseline sites NGET received funding for, therefore, there is the greatest likelihood of variability between estimates and actuals. This size of variance been estimates to actuals is not proportionately correlated to the rest of the baseline flood defence portfolio.

For our T2 costing submission, site estimates will have a higher degree of accuracy, due to better knowledge of the scope of works needed at each site with outline designs being conducted. Coupled with this, the cost estimates for January 2022 reopener sites have been based, where available, on T1 delivered works. As a result, we expect less deviation from the estimated costs for the 33 sites (detailed in Table 9) as is expected to be delivered on par with estimated costs.

Figure 8. Detailed costs for Brelston Green and Newhouse flood defences works

	Direct Costs				Indirects		
£k (20/21 prices)	Site Investigations & Design Surveys	Contractor Works Costs	Unexpected Events	Risk	Project Management	Total	Allowance
Brelston Green							
Newhouse							

Note: Allowance has been out turned using Ofgem's October financial parameters for comparability.

Costing details

In the Extreme Weather supplementary documentation for NGET_A10.05 from October 2021, National Grid provided an estimated cost for RIIO T2 Year 1 and 2 flood defence works of £xxx, which covered the survey cost for Year 3-5 for each site, estimated at £xxxxx per site. The revised cost estimation, following site surveys and outline designs is £xxx for Years 1, 2 and 3 of the T2 period.

NGET_A10.05 included estimated costs for the first 12 sites requiring mitigation during the RIIO-T2 period. A summary of these costs, which has been taken from NGET_A10.05 is included in Table 7 below.

Table 7: Cost estimates from NGET_A10.05

	Site	Level of protection	Estimated cost (£m)
Initial 9 sites from NGET_A10.05	Brelston Green	Localised	xxxx
	Chessington	Localised	xxxx
	Chesterfield	Localised	xxxx
	Groeslon	Localised	xxxx
	Kent Gateway	Localised	xxxx
	Knaresborough	Localised	xxxx
	Newhouse	Full site	xxxx
	Sheffield City	Localised	xxxx

	Wern	Localised	xxxx
	Total	**-**	xxxx
Additional 3 sites from NGET_A10.05	Fleet	Localised	xxxx
	Kearsley	Localised	xxxx
	Winn Road	Localised	xxxx
	Total	**-**	xxxx

All flood works cost components are detailed in Table 8 below. The cost components for flood reinforcements for each site includes: contractor works including contingencies. The costs which are covered by the Opex escalator and thus no funding is required: NGET operations staff costs, project management and CDM consultants. Funding is not required for site investigations and design consultants as this is included in the baseline cost. The key project risks are detailed in Annex 14.

Table 8. Cost components for flood works

Included costs

Contractor works can include:

1. Preliminaries costs
2. Sheet piled flood defence wall & top beam
3. Mass concrete flood defence wall
4. Pumping stations & electrical connections
5. Flood gates
6. Civil works for slot-in & pivot barriers
7. Slot-in & pivot barriers
8. Steel flood doors
9. Seal building trench entries & split duct services
10. Fill wall cavities in buildings
11. Raise the heights of bund/retaining walls
12. Re-profiling of site stone surfacing
13. Kerb profiling to re-direct flood water
14. Fencing works
15. Miscellaneous drainage works

Contingency:

20%

Explanation in Annex 14 – Key Risks

Costs not included

NGET Operations:

1. Facilitate & support initial site survey
2. Review PC's Rams
3. Issue Safety Documents if required
4. Monitor Safety from the System through construction stage
5. Witness commissioning and accept new flood control equipment

Project Management & CDM Consultants:

1. Arrange & manage site investigations
2. Prepare cost estimates for outline designs
3. Prepare Tender documents, including Pre-Tender SHEQ Plan
4. Support Tender process with NG
5. Tender assessment and recommendations
6. Facilitate and chair Inaugural, weekly & monthly meetings with the PC.
7. Sensible monitoring of PC site activities, including programme, RAMS, progress, safety and design issues
8. Agree & Certify monthly valuations

9. Commissioning with NG as Client
10. Agree Final Account
11. Support the preparation of the H&S File
12. Issue Completion Certificate

Site Investigations:

1. Initial site survey by Design Consultant
2. Topographical surveys
3. Ground Penetrating Radar surveys
4. CCTV drainage surveys
5. Ecology & Habitat surveys
6. Borehole & trial pit investigations
7. Laboratory testing
8. Utility searches
9. Consents & Wayleave

Design Consultants:

1. Desktop review & flood modelling
2. Design Flood Report
3. Site survey to determine plant & equipment at risk
4. Flood Risk Assessment
5. Outline design proposals
6. Final designs, drawings & specifications
7. Technical support through tender & construction stages
8. As Built drawings & support with H&S File

Table 9 provides a detailed view of the 33 cost estimates delivered in the period July 2021 - January 2022. The outline designs which detail the preferred flood solution are presented in Annex 15. Using the outline designs, the cost associated with the contractor works was estimated and the results are presented in Annex 16. Table 9 costs are in line with Annex 16. The RPE indexation for the delivery period is calculated at 9% of total cost and forms part of the 20% contingency.

Table 9. Cost estimates 33 sites (price base 2018/2019)

Site #	Phase	Cost Element	RIIO-T2 2023 £k Forecast	RIIO-T2 2024 £k Forecast	RIIO-T2 2025 £k Forecast	RIIO-T2 2026 £k Forecast	RIIO-T2 Total £k Forecast
1	2022-26	Beacon Road Cooling Station	xxxxx				xxxx
2	2022-26	Berkswell	xxxxx				xxxx
3	2022-26	Birkenhead	xxxxx				xxxx
4	2022-26	Bolney	xxxxx				xxxx
5	2022-26	Bramford	xxxxx				xxxx
6	2022-26	Bushbury	xxxxx				xxxx
7	2022-26	Capenhurst	xxxxx				xxxx
8	2022-26	Cellarhead	xxxxx				xxxx
9	2022-26	Clapham Cooling Station	xxxxx				xxxx
10	2022-26	Clilfynydd	xxxxx				xxxx
11	2022-26	Didcot	xxxxx				xxxx
12	2022-26	Exeter	xxxxx				xxxx

13	2022-26	Feckenham		xxxx		xxxx
14	2022-26	Fiddlers Ferry		xxxx		xxxx
15	2022-26	Fourtstones (Harker)		xxxx		xxxx
16	2022-26	Grangetown		xxxx		xxxx
17	2022-26	Hurst		xxxx		xxxx
18	2022-26	Hutton		xxxx		xxxx
19	2022-26	Kitwell	xxxx			xxxx
20	2022-26	Lister Drive		xxxx		xxxx
21	2022-26	Lovedean		xxxx		xxxx
22	2022-26	Macclesfield	xxxx			xxxx
23	2022-26	Millhill	xxxx			xxxx
24	2022-26	Nechells		xxxx		xxxx
25	2022-26	Norton		xxxx		xxxx
26	2022-26	Offerton		xxxx		xxxx
27	2022-26	Oldbury		xxxx		xxxx
28	2022-26	St Johns Wood		xxxx		xxxx
29	2022-26	Taunton		xxxx		xxxx
30	2022-26	Tinsley Park		xxxx		xxxx
31	2022-26	West Burton	xxxx			xxxx
32	2022-26	Willesden		xxxx		xxxx
33	2022-26	Willington		xxxx		xxxx
-	**-**	**Total**	**2,117.42**	**2,120.96**		**3,920.53**

*The flood works will be done by an existing National Grid scheme, which already has work planned at Bushbury.

Project delivery and monitoring

Delivery of delayed T1 works in T2

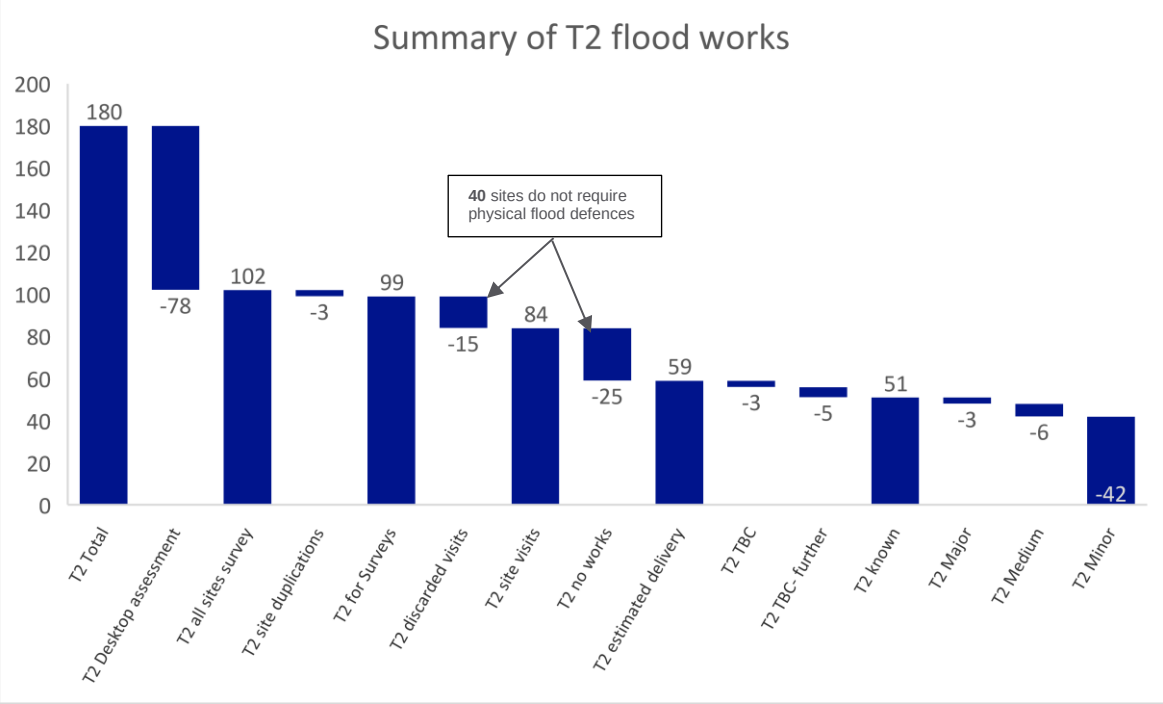
From the 52 sites initially identified as requiring works during the T1 regulatory period, following additional flood risk assessment carried out based on updated flooding data, 3 sites have been identified as not requiring works (not at risk of flooding), 3 have no immediate flood risk and have been deferred. 12 of the major investment works are still yet to be delivered with 1 of them being an EA scheme, as detailed in Annex 2, section D. From the delayed sites, only 3 are at the design stage, with the remaining being in delivery and being progressed via the capital delivery framework. The 3 sites which are at the design stage will be delivered via the minor civil framework. However, as we have more than 15 contractors across the country, these works not interfere with the T2 plan.

T2 Pluvial Flood Defence Projects

Out of the 180 sites initially considered at flood risk, 59 sites are expected to be delivered within the T2 period. The prioritisation of works to be delivered will be based on the results of the flood risk banding as per Annex 11, which shows the sites with the highest risk of pluvial flooding.

A summarised plan for T2 flood defence projects is presented in Figure 9.

Figure 9. T2 flood defence works summary



As of January 2022:

- From the **180** sites considered at flood risk,
- It was established at desktop assessment stage that **78** sites do not required flood defences, but might still require flood plans (e.g.: if access road to site floods, but site is not at flood risk).
- The total number of discrete sites to be assessed: **99** (102 initial sites, however among the original list there are works at the same location, e.g.: Greystone A and Greystone B).
- **40** sites do not require flood defences to protect electrical equipment, but might still require flood plans (not a security of supply issue, but site may be at safety risk due to flooding).
    - 15 sites (included in the 40 above) did not require site surveys, having been discounted prior to survey for various reasons such as site redundancy, closure, or sale.
- **59** sites are expected to require flood defences out of which:
    - 3 sites will be confirmed (TBC) following survey results (Heysham, Penwortham & Crayford). The site visits are planned by early of February for Heysham and Penwortham, while for

Crayford substation no site visit has been arranged at the moment due to construction works which are ongoing at the site.

- 5 sites require further information before the need for flood defences can be determined (responses to queries, site-specific flood modelling, etc.).These sites are: Trawsfynydd, Greystones, Wilton, Eggborough and Elstree.
- 2 sites are currently under construction at Brelston Green and Newhouse with major works scope underway started November 2021.
- 6 other sites are currently undergoing tender processes (namely Chesterfield, Knaresborough, Sheffield City, Chessington, Kent Gateway and Winn Road). Site works are expected to commence in March 2022. Works at these sites have an expected duration of 6-8 weeks for these considered being categorised as minor works with an estimated duration of 4-5 months in total.
- 42 flood reinforcements projects, out of 51 sites, are considered minor works, as they consist in defending the building perimeter or specific equipment. Duration (as specified above): 6 to 8 weeks/ site.
- The 6 medium flood projects namely Bolney, Chickerell, East Claydon, Feckenham, Macclesfield and West Burton comprise of protecting the building perimeter together with specific site electrical equipment. Duration: 16 weeks/ site
- The 3 major flood works at Brelston Green, Fleet and Newhouse will be delivered as part of this project. These works consist of flood walls around the perimeter of the site or many of the site equipment protected individually. Duration: 26-52 weeks/ site.

Annex 10 provides the comprehensive list of the 180 sites categorised by type of work.

Delivery programme

The revised approach for the delivery programme is detailed in Table 10.

Table 10. T2 flood defence work plan

	T2 Flood defence plan					
T2 delivery period	2021-2022	2022-2023	2023-2024	2024-2025	2025-2026	T2 close: March 2026
Type of works	84 site surveys	Finalise site surveys	Tender, contract award and works delivered			
	45 outline designs	Detail design for all sites				
Flood defences to be delivered	8	14-17	14-17	14-17	4-10	Total: 59 sites

The programme will be based on delivering 14-17 sites per year in the first 3 years, leaving maximum 10 sites remaining for the 4th year. At an average duration of 2 months, this requires 3 sites to be in delivery concurrently. Since the sites are spread over the whole country, and the Minor Civils Framework contains ~15 contractors, the plan will be delivered by the end of T2 regulatory period.

Outline designs have been concluded on all except the last 3 sites yet to be surveyed, and the 5 sites with outstanding queries. In the event any of these require more extensive works, the project will be commenced early in the program to avoid any likelihood of over-run.

Outline designs will now be converted into detailed designs and tendered in an ongoing manner. The delivery model will follow the Electricity Transmission Operations T1 delivered flood scheme approach, whereby detailed design is prepared pre-tender, and a contract is let to a build only contractor. The estimated costs have been

derived from historic costs obtained from the Electricity Transmission Operations T1 delivered schemes, and in T2 the same contractor base, the Minor Civils Framework, will be used.

As per the RIIO T1 regulatory period, the delivery of the flood defence works will be tracked via the RRP. However, Table 6.17 detailing the flood mitigations has been incorporated in Table 4.3. In this manner, flood schemes costs based on flood risk assessment and mitigation status will be reported together.

During project delivery, we expect cost increases due to project management costs incurred by contractor services. The mitigation of this risk is delivered by the Opex escalator of 17% which covers all costs associated with operational staff and project management.

Additional project risks, detailed in Annex 14 are associated with: ground contamination (e.g.: asbestos), underground services/obstructions, COVID impact, resource unavailability, planning delays or third-party interface delays. These will be covered by contractor works contingency of 20%.

Opportunity: following organisational changes, National Grid has streamlined it`s operating model to enable more efficient delivery of works through regional areas. We are allocating many of the Project Management works to our internal regional teams, thus reducing the overall project costs.

Glossary of terms

Term	Description
Pluvial	Source of flooding where an extreme rainfall event creates a flood independent of an overflowing water body
Fluvial	Source of flooding where water levels in rivers rise and overtop their banks
Tidal	Relating to or affected by tides
EA	Environmental Agency
NRW	Natural Resources Wales
1/100	This refers to a flood level or peak that has a one in a hundred, or 1% chance of being equalled or exceeded in any year
1/200	A flood that has a 0.5% chance of happening in any given year
1/1000	A flood that has a 0.1% chance of happening in any given year
Energy Networks Association (ENA)	Represents the interests of its member companies who operate the national and regional networks for energy to transport gas and electricity into the UK homes and businesses.
Engineering Technical Report (ETR138)	ENA technical report which provides guidance on flood risk assessments
Electricity Safety Quality and Continuity Regulations (ESQCR)	Statutory instruments which support the Electricity A

Annexes

Annex 1. Ministerial Agreement of ETR 138

OFFICIAL – SENSITIVE

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David Smith
CEO, ENA
By email

CC:
Electricity Network Operators
Peter Bingham, Ofgem
Garth Graham, Chair of Electricity Task Group

14 June 2018

Dear David,

MINISTERIAL AGREEMENT OF REVISION TO ENGINEERING TECHNICAL REPORT (ETR) 138

I am writing to inform you that ministers have considered the Network Operators' proposed changes to the ETR138 document for flood defence of substations and have endorsed and agreed with the proposals to increase standards.

As you are aware the modifications came as a result of conclusions from the Ministerial National Flooding Risk Review, these modifications included:

- A revision to the design guidelines to set that primary substations with over 10,000 connections should be defended against 1/1000-year flood events.
- As already agreed, it is expected that Electricity Network Operators with fewer sites will implement the revised standards in the current price control period (ends 31 March 2023), whereas organisations with more sites will look to revise standards in both this and the next price control period.

I am aware that under ENA leadership, that the standard itself is already being updated; work to progress the implementation of these changes by Network Operators should be reported back to Sam Wright in my team in BEIS in line with current 6 monthly reporting. Ofgem will of course, continue to monitor through their normal regulatory channels. The Electricity Task Group can also act as a useful forum for discussion of collective issues; I have asked Sam to raise this at the next meeting.

I would like to thank you for your teams' input and patience in getting this submission submitted. If you have any further questions on this, please feel free to contact Sam directly (samuel.wright@beis.gov.uk).

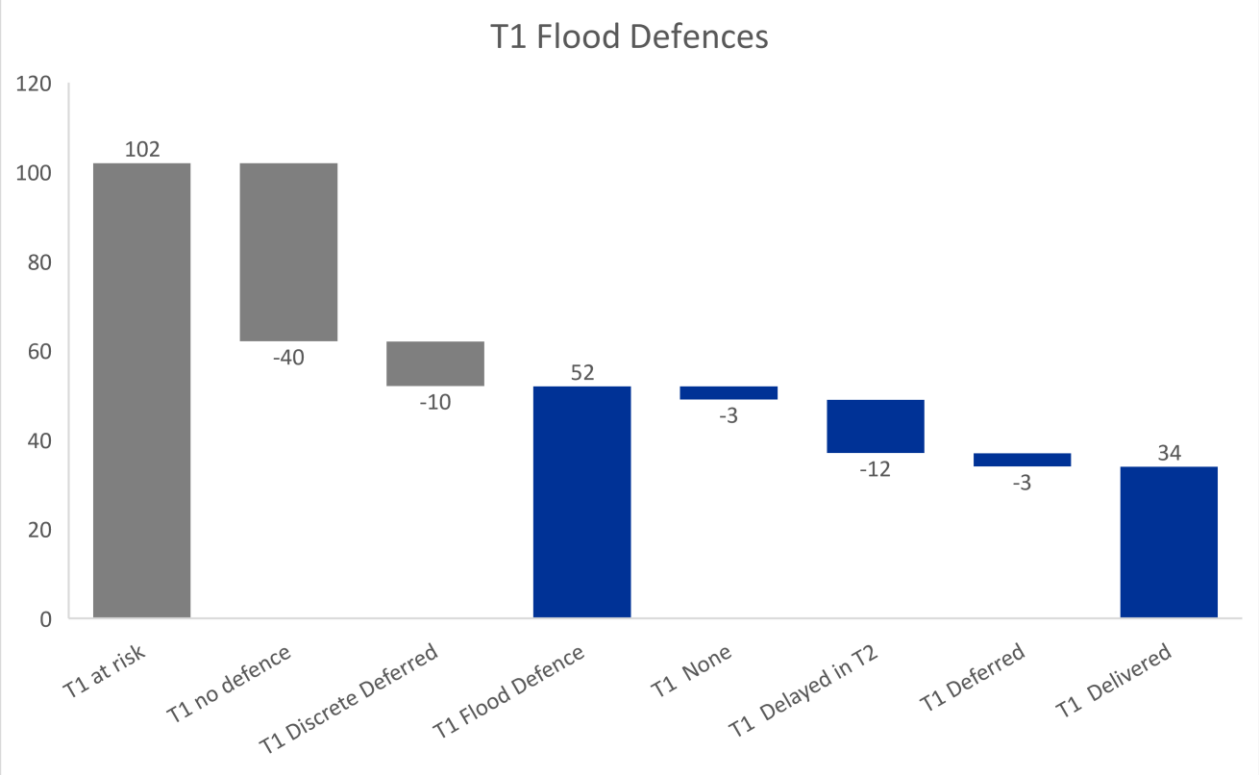
Yours faithfully,

Mark Prouse
Deputy Director, Energy Resilience & Emergency Response

Annex 2. RIIO T1 works

A. Overview of the delivery of T1 sites

A summary of T1 work plan is presented in the figure below.



As detailed in the NGET_A10.05 (section 3.2) supplementary evidence paper, our RIIO-T1 submission initially identified 102 sites (only substation sites) at risk of fluvial and coastal flooding using EA and Natural Resources Wales (NRW) mapping data, which defines the risk level (1/100, 1/200 and 1/1000 year event) for each area. Our proposals did not include pluvial flood mitigation as accurate data was not available at the time. However, as part of the review into the flooding works in 2016, it was confirmed that all T1 site works to mitigate fluvial and coastal flooding also provided protection against pluvial flooding. All subsequent site analyses have included an assessment of pluvial risk.

As the flood risk assessment is a continuous process based on site visits and EA data, the full T1 status of works and the revised list of deferred sites (January 2022 review) is presented in section B of this Annex.

From the 102 sites originally identified as at-risk:

- **40 sites were identified through Flood Risk Assessments as not requiring protection**. National Grid followed the recommendation of ETR138 and appointed external contractors to carry out Flood Risk Assessments for the 102 sites originally identified at risk. The EA / NRW maps identify the risk on a large scale (usually 1:10,000) and are therefore not completely representative of the risk to a local area and don't usually include predicted flooding depths. ETR138 states that the provision of robust flood depth data is essential for the proper assessment of flood risk to substations and the identification of appropriate protection. It therefore recommends employing specialist contractors to carry out modelling of flood depths across a substation site to identify areas at risk of flooding and understand the level of protection required. The Flood Risk Assessments concluded that an initial 52 out of the 102 sites would require protection in RIIO-T1. Although in the supplementary evidence we estimated that 49 sites would require flood

protection, as the delivery mechanism during T1 period consisted of a rolling programme, carrying out detailed design followed by work delivery, the initial estimated number changed to 52 following detailed design carried out by our contractors.

- **A further 10 were deferred**. As part of the T1 2018 analysis, using the flood risk assessment methodology detailed later in this paper, these sites were identified as requiring flood defences in the future as the flooding risk would not materialise until 2050 and beyond. Site visits and flood risk assessment were carried out and detailed design was produced which identified that in accordance with ETR138, minimum or no reinforcement was required at this time. As presented in paragraph 3.3.3 in Annex 10.05 - Engineering Justification Paper on Extreme Weather- the strategy for deferral takes into consideration analysis carried out using climate change and sea level rise information available. This highlighted that the 11 discrete deferred 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.
  12 sites were initially categorised as deferred, however 2 (Penn and Walpole) were subsequently considered as no works required following update EA data. For the avoidance of doubt, the 10 discrete deferred sites should not be confused with sites that formed part of the T1 flood defence programme. A detailed explanation of reinforcement needed for the deferred sites is presented in section C of this annex.

- **This left the 52 sites identified as requiring protection in RIIO-T1.** Of these,
  - **3 sites were subsequently identified as not requiring works** (not at risk of flooding)
  - **3 had no immediate flood risk and have been deferred.**
    For 2 of the deferred sites: South Manchester and Kingsnorth minor works have been delivered in T1 but we have deferred major investment. The flood risk assessment did not identify a current 1 in 1000 flooding risk. However, flood defences would be required within 20 to 30 years with increased climate change allowances. As previously outlined, investing now in hard permanent defences would have resulted in half the defence design life being lost until the defences were required. To ensure the best economic solution in the consumer`s interest, we facilitated works to allow the full use of the demountable barrier system. These defences cost ~£[redacted] and are comprised of installing an impermeable path on the barrier route. The cost savings produced by delivering intermediate flood defence is estimated to be ~£[redacted]. This solution was considered during site option development for all other sites, however due to response and deployment constraints was ruled out, given the risk was too high in many cases.
    In the case of Blyth substation, the site was initially identified at risk of flood from tidal events. The works were deferred due to the power station land recently (in 2021) been redeveloped and raised which cuts off this flow path to our sites. Consequently, there is no current 1/1000 flood risk, but we expect by 2050 the risk will increase.
- **12 are delayed into T2**: works could not be delivered in T1 due to COVID-19 delays, co-ordinated works or scope of works changes. At the start of the T2 period, 14 sites were delayed from T1, however 2 have been completed since. A detailed explanation of the delayed flood works is presented in section D of this annex.

B. T2 status of works

T2=52 sites, 14 sites delayed

No	Scheme Name / Sites	Completion	Status
1	Carrington 400/132kV	Not required following assessment	Works Cancelled
2	Beddington 400kV	Not required following detailed assessment	Works Cancelled
3	Hartlepool	Not required following detailed assessment	Works Cancelled
4	Wincobank	2018	Delivered
5	Botley Wood	2014	Delivered
6	Burwell	2016	Delivered
7	Canterbury North	2015	Delivered
8	Ferrybridge A	2015	Delivered
9	Neepsend	2014	Delivered
10	Thorpe Marsh	2015	Delivered
11	Walham Substation Flood Protection	2013	Delivered
12	Whitson QBs	2016	Delivered
13	Wimbledon	2013	Delivered
14	Saltend North	2021	Delivered
15	Aberthaw	2017	Delivered
16	Brimsdown	2021	Delivered
17	Humber Refinery 400kV	2017	Delivered
18	Imperial Park 400kV	2015	Delivered
19	Iver	2020	Delivered
20	South Humberbank 400kV	2016	Delivered
21	Stella South 132kV	2014	Delivered
22	Stella West 400kV	2020	Delivered
23	Uskmouth 275kV	2014	Delivered
24	West Weybridge 400 & 275	2021	Delivered
25	Brereton (Rugeley)	2020	Delivered
26	Cardiff East	2018	Delivered

No	Scheme Name / Sites	Completion	Status
27	Drakelow	2020	Delivered
28	Ferrybridge B	2021	Delivered
29	Melksham	2018	Delivered
30-31	Stalybridge (2 sites)	2021	Delivered
32	Tremorfa	2018	Delivered
33	Upper Boat	2018	Delivered
34	Watford South*	2017	Delivered
35	West Weybridge 132	2021	Delivered
36	Dungeness	T2	Delayed into T2; Minor works delivered in T1 by NGET and major works coordinating with EA coastal scheme
37	Bustleholm	T2	Delayed into T2
38	Padiham 400kV	T2	Delayed into T2
39	Pembroke	T2	Delayed into T2
40	Keadby	T2	Delayed into T2
41	Seabank	T2	Delayed into T2
42	Sellindge	T2	Delayed into T2
43	Ninfield	T2	Delayed into T2
44	Frodsham	T2	Delayed into T2
45	Laleham	T2	Delayed into T2
46	Elland	T2	Delayed into T2
47	Waltham Cross	T2	Delayed into T2
48	Tottenham	T2	Delayed into T2
49	Ferrybridge C	T2	Delayed into T2
50	South Manchester	To Be Determined (TBD)	Deferred, Minor works delivered in T1 - deferred major investment
51	Kingsnorth	TBD	Deferred, Minor works delivered in T1 - deferred major investment
52	Blyth	TBD	Deferred

	No	Scheme Name / Sites	Completion	Status
Discrete deferred sites	1	Bridgwater	TBD	Deferred
	2	Carrington 400kV and 132kV	TBD	Deferred
	3	Drax and Camblesforth	TBD	Deferred
	4	Grain	TBD	Deferred
	5	Kemsley	TBD	Deferred
	6	Staythorpe	TBD	Deferred- Minor works delivered in T1 - deferred major investment
	7	Fawley	TBD	Deferred
	8	Hartlepool	TBD	Deferred
	9	Saltholme	TBD	Deferred
	10	Hackney	TBD	Deferred
	11	Penn	Following EA data changes in 2018, it was determined no works are needed following detailed assessment	Works Cancelled
	12	Walpole	Following EA data changes in 2018, it was determined no works are needed following detailed assessment	Works Cancelled

C. Deferred sites RIIO T1

No.	Site and voltage level (kV)	Nature of defences	Reason for deferral	Works done so far
1	Blyth 66 and 275	Demountable	Deferred due to redevelopment of area to the North of site which will raise the ground level and reduce Tidal flooding risk. Sea level rise will gradually increase the risk to the state where defences may be required but after 2040.	Produced detailed design

2	Bridgwater 275	Demountable	Construction of new tidal barrage by the local authority and the EA will mitigate much of the risk the current proposal is for works to begin by2025	Flood risk assessment
3	Camblesforth 66 and Drax 400	Demountable	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Produced detailed design
4	Carrington 132	Demountable	Construction of new PowerStation prevents water coming from the canal/river changes in flow models review by 2035	Produced detailed design
5	Fawley 400	Under Review	Current modelling show site will not flood during a 1 in 1000 surge this risk will increase and a review into the sustainability of this and the tunnel heads by 2030 will be necessary we are reviewing the tunnel heads risks as part of the T2 works covering ‘other’ sites.	Flood risk assessment
6	Grain 400	Under Review	Current modelling show site will not flood during a 1 in 1000 surge this risk will increase and a review into the sustainability of this and the tunnel heads by 2030 will be necessary	Flood risk assessment
7	Hackney 400	Assessment shows that defences are not required at this time	Current EA model shows flooding from a 1 in 1000 event will not impact the site review by 2035	Flood risk assessment
8	Hartlepool 275	Assessment shows that defences are not required at this time	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Flood risk assessment
9	Kemsley 400	Assessment shows that defences are not required at this time	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Produced detailed design

10	Kingsnorth 400	Demountable	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Minor investment delivered: interim defence in accordance with ETR138
11	Saltholme 275	Assessment shows that defences are not required at this time	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Flood risk assessment
12	South Manchester 275	Demountable	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Minor investment delivered: interim defence in accordance with ETR138
13	Staythorpe 400	Demountable	Detailed modelling shows that at current levels the site will not flood during a 1 in 1000 year event. Sea level Rise will gradually increase the risk. Defences options should be reviewed by 2035	Minor investment delivered: interim defence in accordance with ETR138

D. RIIO T1 delayed sites status of works

Site Name	RIIO-T2 Forecast (£m)	Reason for delay	Delivery status
Bustleholm	xxx	Due to a rescope of works at Bustleholm, changing to full flood defence and covering the protection of the DNO Substation, the completion of the flood defence works is now due to commence in 2021/22.	In design
Padiham 400kV	x	The site was initially on hold due to the EA flood defence review which looked at the needs case to defend the site. EA have now confirmed their flood defence proposals won't protect or increase the risk to our site, which now means we are required to install flood defenses. This review has resulted in a delay in delivery pushing the site into RIIO-T2. Subsequent design and scope of work.	In design

Site Name	RIIO-T2 Forecast (£m)	Reason for delay	Delivery status
Pembroke	xxx	Bundled with xxxxxxxxxxxxxxxxxxxxxxx to achieve cost efficiencies xxxxx which will be delivered within RIIO-T2. Estimated completion: February 2022	In delivery
Keadby	xxx	Bundled with xxxxxxxxxxxxxxxxxxxxxxx to achieve cost efficiencies xxxxx which will be delivered within RIIO-T2.	Complete
Seabank	xxx	Delayed into RIIO-T2 to tie into the works delivered at the site under the Hinkley Project. Estimated completion: March 2024.	In delivery
Sellindge	xxx	Concerns from the EA on the third-party impacts of installing a flood defence at Sellindge have now been resolved. Due to the delays in obtaining EA consent, along with multiple works ongoing at Sellindge (including xxxx and refurbishment projects), a revised milestone date of 2021/22 has been agreed.	In design
Ninfield	xxx	Ninfield has been delayed into RIIO-T2 due to the NEMO interconnector project whereby SAP resource in the region has been reallocated. This has led to a delay in the flood defence works at Ninfield.	Complete
Frodsham 400kV	xxx	Site access was delayed due to site specific management hazard zone. Flooding works bundled with Customer connection works. Estimated delivery: 29/06/22.	In delivery
Laleham	xxx	Due to the impacts of COVID-19 on the capital programme and supplier's works are now due to start within 2021/22. First Site Access date 05/09/2022, estimated completion: July 2023.	In delivery
Elland	xxx	Due to the impacts of COVID-19 on the capital programme and supplier's works have an estimated completion of September 2022.	In delivery
Waltham Cross	xxx	Due to the impacts of COVID-19 on the capital programme and supplier's works are now due to start within 2021/22. First Site Access date: 03/05/2022. Estimated completion: September 2023.	In Delivery
Tottenham	xxx	Due to the impacts of COVID-19 on the capital programme and supplier's works are now due to start within 2021/22. Fist site access: 04/10/2021 Estimated completion: May 2022.	In Delivery
Ferrybridge C	xxx	Works commenced Nov 2019 and minimal delays due to COVID-19. Delay experienced March 2021 due to Peregrine Falcons on site. Recommenced Works September 2021. Major works Complete November 2021. Pending minor works. Estimated completion May 2022	In delivery
Dungeness	xxx	Environmental Agency scheme is ongoing to do the works along the whole coast. National Grid had consultations on the level of resilience and is estimated to contribute with £xxxxx. As yet, no formal request for the contribution has been requested.	In delivery
TOTAL*	xxxx**	-	-

*Costs include Opex requirements
** 4.4 m£ difference from RRP 2021. Cost difference is due to updated cost forecast, closer completion date and better cost understanding

E. T1 Flood Schemes Delivered by ET Operations Minor Schemes unit

Site	Type of protection	Cost	Delivery year	Example
Neepsend	Whole site protection	£xxxxx	2013	
Thorpe Marsh	Whole site protection	£xxxxx	2014	
Burwell	Whole site protection	£xxxxx	2014	

Site	Type of protection	Cost	Delivery year	Example
Canterbury North	Whole site protection	£xxxxx	2014	
Ferrybridge A	Protection of two transformer marshalling kiosks and the control building	£xxxxx	2014	
Whitson	Protection of two Quad Booster marshalling kiosks	£xxxxx	2015	Not available
Botley Wood	Improvement of drainage ditches around site to allow flood water to escape and reduce impact of flooding	£xxxxx	2012	
Wimbledon	Time limited protection during the London Olympics and	£xxxxx	2012	Not available

Site	Type of protection	Cost	Delivery year	Example
	prior to site redevelopment			
Drakelow	Isolated protection of 3 dispersed relay rooms, the LVAC supplies building and various pumping chambers	£xxxxx	2019	
Brereton	Isolated protection of equipment and the control building	£xxxxx	2019	Not available
Port Ham	Raising cable monitoring cabinets above flood level	£xxxxx	2021	
Watford South	Accommodation works to allow temporary barrier use, plus protection to supplies transformers	£xxxxx	2019	

Annex 3. Flood consequences on High Voltage Substations.

Flood%20consequen
ces%20HV%20transm

Annex 4. Innovation project plan on automated weather alerts

Automated Weather
Alerts.docx

Annex 5.

A. T2 Flood protection options for 33 sites to ensure ETR 138 compliance (correlation with Figure 3)

No	Site	Option 3.1.A Localised Protection - A	Option 3.1.B Localised Protection - B	Option 3.2 Full Site Protection	Option 3.3a Off Site Protection With Third Party	Option 3.3b Off Site Protection Green Solution Habitat Creation	Option 3.4 Coordinating With other site works	Solution Chosen	Reason	Details of preferred option	If no reinforcements	
											Cost of Lost Load (m£)	Cost of Repair (m£)
1	Willington East 400 & 132	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection of 132kV relay rooms and isolated cabinets	xxxxx	xxxxx
2	Feckenham	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection: Compressor room, Diesel room, Shunt reactor building, SGT7 supplier pillar cabinet, SGt9 supplier pillar	xxxxx	xxxxx
3	Macclesfield 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection and isolated assets – MK01 for SGT1, MK 2 for SGT2; compressor /battery room; relay room	xxxxx	xxxxx
4	Fiddlers Ferry	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Two isolated kiosks and main relay room and LVAC building	xxxxx	xxxxx
5	Offerton 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Isolated asset protection around 2 marshalling kiosks (for SGTs) slot in barriers to allow for easy maintenance and access	xxxxx	xxxxx
6	Grangetown 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Minor building and isolated asset protection: relay Room, mess Room, MK01, MK02 (for SGT1 &SGT2)	xxxxx	xxxxx
7	Oldbury 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection to main control building and possibly 2 shunt reactor buildings	xxxxx	xxxxx

No	Site	Option 3.1.A Localised Protection - A	Option 3.1.B Localised Protection - B	Option 3.2 Full Site Protection	Option 3.3a Off Site Protection With Third Party	Option 3.3b Off Site Protection Green Solution Habitat Creation	Option 3.4 Coordinating With other site works	Solution Chosen	Reason	Details of preferred option	If no reinforcements Cost of Lost Load (m£)	Cost of Repair (m£)
8	Berkswell 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Potentially with HS2 TBC	3.1, 3.4TBC	Cost savings	Main Control building housing battery & LVAC	xxxxx	xxxxx
9	Bushbury 275	Preferred	Raising specific equipment off ground	Un-necessary	Unavailable	Unavailable	Included in NG works	3.4	Cost savings	S/Grid T3 Shunt Reactor	xxxxx	xxxxx
10	Didcot Spares Complex	Preferred	Raising equipment	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Safety	STORES BUILDING protection up to 500mm height Building protection preferred over raising internal storage due to safety concerns	xxxxx	xxxxx
11	Hutton 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection to relay room including wall protection.	xxxxx	xxxxx
12	Hurst 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Control building to have MVAC room protected against any water ingress. Compressor room requires flood protection in the Auxiliary Plant Building. 2No. rooms in the Cooling station building require flood protection.	xxxxx	xxxxx
13	Mill Hill 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	SGT 2A Reactor Building, Terminal Cabinet Base Extension, SGT 2B Terminal Cabinet Base Extension Building and isolated cabinet protection with drop in panels for easy access and maintenance.	xxxxx	xxxxx
14	Exeter 400	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection to main control building. Auxiliary Plant building Synchronised Compensator No4	xxxxx	xxxxx

No	Site	Option 3.1.A Localised Protection - A	Option 3.1.B Localised Protection - B	Option 3.2 Full Site Protection	Option 3.3a Off Site Protection With Third Party	Option 3.3b Off Site Protection Green Solution Habitat Creation	Option 3.4 Coordinating With other site works	Solution Chosen	Reason	Details of preferred option	If no reinforcements	
											Cost of Lost Load (m£)	Cost of Repair (m£)
										building and main super grid control cabinet		
15	Tinsley Park	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Isolated protection to 4 marshalling kiosks for the SGTs	xxxxx	xxxxx
16	Norton 400	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Isolated asset protection and sealing of control building cable entry points	xxxxx	xxxxx
17	Bolney 400	Preferred	Raise Grid Transformer 1	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Safety-height restrictions	Control building, relay rooms: X310, Reactor No 2, X 305 Ninfield 2, X 550 Static Comp 5, Bus Section Relay Room. MVAC ROOM, COMPRESSOR HOUSE, GRID TRANSFORMER NO 1-base extension and slot in barriers	xxxxx	xxxxx
18	Kitwell 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	CONTROL BUILDING, COMPRESSOR ROOM, 4 NO MK BASE EXTENSIONS (SGT 1, SGT 2, SGT 3, SGT 4)	xxxxx	xxxxx
19	West Burton	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	13 No RELAY ROOMS, ELECTRICAL ROOM, RELAY ROOMS, COMPRESSOR ROOM, LVAC ROOM	xxxxx	xxxxx
20	Willesden	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection and protection to tunnel vent shafts	xxxxx	xxxxx
21	Bramford 400	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	CONTROL BUILDING, SGT 3 Cable Cabinet Base Extension, EARTH Cabinet Base Extension, GIS EAST and GIS WEST BUILDINGs (2 no) , Protection to roller shutter	xxxxx	xxxxx

No	Site	Option 3.1.A Localised Protection - A	Option 3.1.B Localised Protection - B	Option 3.2 Full Site Protection	Option 3.3a Off Site Protection With Third Party	Option 3.3b Off Site Protection Green Solution Habitat Creation	Option 3.4 Coordinating With other site works	Solution Chosen	Reason	Details of preferred option	If no reinforcements	
											Cost of Lost Load (m£)	Cost of Repair (m£)
22	Cilfynydd 400	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	2 buildings and an isolated cabinet to be protected	xxxxx	xxxxx
23	Birkenhead 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	The relay room building to be provided with flood building protection	xxxxx	xxxxx
24	Lister Drive 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	2 MK cabinets to be protected, one next to series reactor, on next to transformer building	xxxxx	xxxxx
25	Lovedean 400	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	1 cabinet to be protected	xxxxx	xxxxx
26	Nechells 275	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	1 Marshalling kiosk to be protected with drop in panels to ease maintenance and easy access	xxxxx	xxxxx
27	Beacon Rd Cooling Station	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Cooling station buildimg protection	xxxxx	xxxxx
28	St Johns Wood	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection to tunnel access and 2 marshalling kiosks	xxxxx	xxxxx
29	Cellarhead	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	SGT 10 relay building, SVC 5 building, SVC 6 building, main entrance, control building, entrance door protection	xxxxx	xxxxx
30	Clapham Cooling Station	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection	xxxxx	xxxxx
31	Capenhurst	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	SGT 1A transformer building, SGT 5A transformer building, INCE B2 building,	xxxxx	xxxxx

No	Site	Option 3.1.A Localised Protection - A	Option 3.1.B Localised Protection - B	Option 3.2 Full Site Protection	Option 3.3a Off Site Protection With Third Party	Option 3.3b Off Site Protection Green Solution Habitat Creation	Option 3.4 Coordinating With other site works	Solution Chosen	Reason	Details of preferred option	If no reinforcements	
											Cost of Lost Load (m£)	Cost of Repair (m£)
										Compressor Cabinet Base Extension, 5 No SGT Cabinet Base Extensions		
32	Taunton	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	2 cabinets to be defended with slot in barriers	xxxxx	xxxxx
33	Fourstones	Preferred	Unavailable	Un-necessary	Unavailable	Unavailable	Unavailable	3.1	Cost savings	Building protection to main control buildings	xxxxx	xxxxx
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	xxxxx	xxxxxx

The detailed calculations related to the results presented above are detailed in the spreadsheet below.

B. Cost details

Costs%20if%20no%20reinforcements%20

Annex 6. Cost options for Bustleholm flood defence works, 20/21 price base

In case of Bustleholm flood defence, the construction requirements are listed below:

- Access to flood wall works is generally external to HV compound.
- Temporary access road from near main gate, around west end of 132kV substation to full length of southern boundary. This is separate from and additional to the temporary piling platform constructed immediately adjacent to line of piling, and required for the piling operation.
- Remote controlled CCTV camera systems along the various lines of Temporary Security Fencing. Due to security issues experienced in the area on previous projects provision is also made for out of hours site security personnel based on site.
- The drainage and building flood protection proposals remain the same for both options and are based on advance outline information provided by the Designers.

Option	**Option 1: Continuous flood wall to south, west, north west and northern boundaries of 13kV and 275kV Substations.**	**Option 2: Separate Flood Walls to North and South boundaries of 132kV and 275kV Substations.**
Details	Temporary Works, including security, temporary external roadway to works areas, temporary security fence. £[redacted] Flood Wall: -Piled wall with concrete capping, and in situ reinforced concrete bridging panels over HV cable crossings: £[redacted] - In situ fibre reinforced concrete wall: £[redacted] - Flood Gates and concrete thresholds and buttresses: £[redacted] Fencing Works: £[redacted] Drainage Works: £[redacted] Building Protection Works: £[redacted] Road Alterations: £[redacted] Preliminaries (pre main works such as site clearance, excavations movement of existing equipment, setting up of site office, setting out of work areas) £[redacted]	Temporary Works, including security, temporary external roadway to works areas, temporary security fence: £[redacted] Flood Wall: -Piled wall with concrete capping, and in situ reinforced concrete bridging panels over HV cable crossings: £[redacted] - In situ fibre reinforced concrete wall: £[redacted] - Flood Gates and concrete thresholds and buttresses: £[redacted] Fencing Works: £[redacted] Drainage Works: £[redacted] Building Protection Works: £[redacted] Road Alterations: £[redacted] Preliminaries: £[redacted]
Total	£[redacted] - No Opex included	£[redacted] - No Opex included

For option 1 a temporary security fence is to be erected outside the whole working area to enable the existing security palisade to be removed to permit the piling operation and in situ flood wall construction where on the line of the new wall. Temporary demarcation of the HV compound will be required on the inside of the floodwall construction line.

For option 2, a temporary security fence is to be erected outside the line of works on the southern boundary area to enable the existing security palisade to be removed to permit the piling operation on this line. Temporary demarcation of the HV compound will be required on the inside of the floodwall construction line. Provision for a gateman to control access to the southern boundary line of works has been allowed for. Local lengths of temporary security fence have been allowed for to the existing northern 275kV substation boundary where the flood wall is to be constructed on its existing line.

Option 2 provides the required level of protection with less material and less costs needed. The site plan is attached below.

Busteholm FLOOD_DEFENCE_OV

Annex 7. Cost Benefit Analysis

CBA 7.zip

Annex 8. Flood Mitigation Policy PS(T)095

PS_T_095.pdf

Annex 9. Flood Defences Technical Standard TS 2.10.13

Technical Specification.pdf

Annex 10. Sites identified at risk of pluvial flooding RIIO T2

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
1	Abham	No	N/A
2	Acton Lane	No	N/A
3	Alverdiscott	No	N/A
4	Andrews Road (Cable Site)	No	N/A
5	Aust	No	N/A
6	Avery Hill (Cable Site)	Yes	None
7	Bakers Gap (Cable Site)	No	N/A
8	Baring Street (Cable Site)	No	N/A
9	Beachley (Cable Site)	No	N/A
10	Beacon Road (Cable Site)	Yes	Minor
11	Berkswell	Yes	Minor
12	Birkenhead	Yes	Minor
13	Bold	Yes	None
14	Bolney	Yes	Medium
15	Bradford West	No	N/A
16	Bradwell	No	N/A
17	Bramford	Yes	Minor
18	Brelston Green CSE	Yes	Major
19	Brynrfail (Cable Site)	Yes	None
20	Burntwood Lane (Cable Site)	No	N/A
21	Bushbury	Yes	Minor
22	Bushey	No	N/A
23	Capenhurst	Yes	Minor
24	Carpenters Road (Cable Site)	Yes	None
25	Cellarhead	Yes	Minor
26	Centennial Park (Cable Site)	No	N/A
27	Chessington	Yes	Minor

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
28	Chesterfield	Yes	Minor
29	Chetney Marsh (Cable Site)	No	N/A
30	Chickerell	Yes	Medium
31	Chilling (Cable Site)	Yes	None
32	Cilfynydd	Yes	Minor
33	City Road	No	N/A
34	City Road Lock Valve (Cable Site)	No	N/A
35	Clapham (Cable Site)	Yes	Minor
36	Coreys Mill	Yes	None
37	Cowbridge	Yes	None
38	Crayford CSE	Yes	TBC
39	Cricklewood Sidings (Cable Site)	No	N/A
40	Culham	No	N/A
41	Culham Jet	Yes	None
42	Daines	Yes	None
43	Dartford Tunnel (Cable Site)	Yes	Minor
44	Didcot National Spares	Yes	Minor
45	Dunford Bridge	No	N/A
46	East Claydon	Yes	Medium
47	Eggborough	Yes	TBC- further information
48	Elstree	Yes	TBC- further information
49	Eltham	No	N/A
50	Eltham Palace Road (Cable Site)	Yes	None
51	Epsom Road (Cable Site)	Yes	None
52	Exeter	Yes	Minor
53	Feckenham	Yes	Medium
54	Fellows Road (Cable Site)	Yes	None
55	Ferrybridge 2C	No	N/A

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
56	Ferrybridge West 400kV CSE	No	N/A
57	Ffestiniog	Yes	None
58	Fiddlers Ferry	Yes	Minor
59	Fleet	Yes	Major
60	Footscray Lane (Cable Site)	No	N/A
61	Fourstones	Yes	Minor
62	Garth CSE	No	N/A
63	Grange	No	N/A
64	Grangetown	Yes	Minor
65	Grendon	Yes	None
66	Greystones	Yes	TBC- further information
67	Greystones A	Yes	TBC- further information
68	Greystones B	Yes	TBC- further information
69	Grimsby West	Yes	None
70	Groeslon (Cable Site)	Yes	None
71	Groveway (Cable Site)	No	N/A
72	Hendon	Yes	Minor
73	Hendon Head House (Cable Site)	Yes	None
74	Heysham	Yes	TBC
75	High Marnham	Yes	None
76	Horshoe Point (Cable Site)	No	N/A
77	Hurst	Yes	Minor
78	Hutton	Yes	Minor
79	INCE 132KV CABLE TO TOWER	No	N/A
80	Indian Queens	No	N/A
81	Kearsley	Yes	Minor
82	Kensal Green	No	N/A
83	Kent Gateway Tunnel (Cable Site)	Yes	Minor

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
84	Kilburn Grange Park (Cable Site)	No	N/A
85	King Henrys Road (Cable Site)	No	N/A
86	Kitwell	Yes	Minor
87	Knaresborough	Yes	Minor
88	Ladbroke grove (Cable Site)	No	N/A
89	Lakeside (Cable Site)	No	N/A
90	Landulph	Yes	None
91	Langage	No	N/A
92	Lee Valley Tunnel	No	N/A
93	Leicester Refub Centre	Yes	None
94	Leighton Buzzard	Yes	None
95	Lister Drive	Yes	Minor
96	Llanwern	No	N/A
97	Lodge Road	Yes	None
98	Long Buckby	Yes	None
99	Lovedean	Yes	Minor
100	Lower Bottom Lock Pumping Station (Cable Site)	No	N/A
101	Macclesfield	Yes	Medium
102	Maiden Lane Pumping Station (Cables Site)	No	N/A
103	Mannington	No	N/A
104	Margam	No	N/A
105	Marylebone	No	N/A
106	Meaford	No	N/A
107	Medway Tunnel East	No	N/A
108	Medway Tunnel West	No	N/A
109	Mill Hill	Yes	Minor
110	Mouldsford Down	Yes	None

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
111	Nechells	No	Minor
112	Newark	Yes	None
113	Newby (Cable Site)	Yes	None
114	Newhouse (Cable Site)	Yes	Major
115	North Fleet West	No	N/A
116	North Hyde	Yes	None
117	Norton	Yes	Minor
118	Nursling	No	N/A
119	Offerton	Yes	Minor
120	Oldbury	Yes	Minor
121	Osbaldwick	Yes	None
122	Oxenholme	No	N/A
123	Penisarwaun (Cable Site)	Yes	None
124	Penrhos	Yes	None
125	Penwortham	No	TBC
126	Poppleton	Yes	None
127	Port Ham	No	N/A
128	Prince Edwin Street (Cable Site)	No	N/A
129	Rayleigh Main	Yes	None
130	Rotherham Reporting Centre	No	N/A
131	Rowdown	Yes	None
132	Rugeley	Yes	None
133	Severn Tunnel (Cable Site)	No	N/A
134	Sheffield City	Yes	Minor
135	Shrewsbury	Yes	None
136	Sidcup Road (Cable Site)	No	N/A
137	Skelton Grange	Yes	None
138	Spennymoor	Yes	Minor

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
139	St Johns Wood	Yes	Minor
140	St Johns Wood Pumping Station (Cables Site)	No	N/A
141	St Marylebone	No	N/A
142	Stocksbridge	Yes	None
143	Sundon	Yes	Minor
144	Taunton	Yes	Minor
145	Thurrock (Cable Site)	No	Minor
146	Tilbury Tunnel	No	N/A
147	Tinsley Park	Yes	Minor
148	Trafalgar Avenue (Cable Site)	No	N/A
149	Trawfynydd	Yes	TBC- further information
150	Ty-Mawr(Cable Site)	Yes	None
151	Upper Bottom (Cable Site)	No	N/A
152	Waddon (Cable Site)	No	N/A
153	Walford (Cable Site)	Yes	None
154	Wandsworth Common (Cable Site)	No	N/A
155	Warley	No	N/A
156	Weaver Junction	No	N/A
157	Wells Way (Cable Site)	No	N/A
158	Wern (Cable Site)	Yes	None
159	West Boldon	Yes	None
160	West Burton	Yes	Medium
161	Whitegate	Yes	Minor
162	Wick Lane (Cables Site)	No	N/A
163	Willenhall	No	N/A
164	Willesden	Yes	Minor
165	Willington	Yes	Minor
166	Wilton	Yes	TBC- further information

Number	Site	Site expected to require mitigation following detailed assessment	Size of flood defence project determined via site investigation
167	Winn Road (Cable Site)	Yes	Minor
168	Wood head (Cable Site)	No	N/A
169	Wood Lane (CSE)	No	N/A
170	Wymondley (Main)	Yes	None
171	Axminster	No	N/A
172	Camblesforth (Drax)	No	N/A
173	Dinorwig	No	N/A
174	Hackney (Cable Site)	No	N/A
175	Hambleton Tee	No	N/A
176	Hemsworth (Cable Site)	No	N/A
177	John Williams Close (Cable Site)	No	N/A
178	Southampton Bridge Pumping Station (Cable Site)	No	N/A
179	Turnham Road (Cable Site)	No	N/A
180	Skelton Grange B	Yes	None

Annex 11. Flood risk data RIIO T2

Master site flood risk April 2019 - WS Edit -

Annex 12.

A. Cost assurance deep dives Newhouse and Brelston Green

Newhouse%20Cost%20Model.xlsx

Brelston%20Green%20Cost%20Model.xlsx

Newhouse%20and%20Brelston%20Green,

B. Cost assurance deep dives 8 baseline sites

Flood%20T2%20Schedue%20T2%20Sites

Annex 13. Brelston Green and Newhouse Flood Reinforcements construction drawings

Newhouse For Construction Drawing

Brelston Green For Construction Drawing

Annex 14. Key Risks

Analysing the flood works delivered to date, the impact caused by the risks detailed in the table below is as follows:

- 9.3% (£14m) cost increase for T1 sites due to various reasons (details in Annex 2.D)

- 3% (£20k) increase at Brelston Green due to re-design

-7%(£169k) increase at Newhouse due to 3rd party interface works

The estimated contingency for the 33 sites which form this re-opener is **20%** due to low-cost investment for each site (average at £150k/site) and high impact causes (e.g.: redesign and 3rd party delays could cost more than the initial flood works, as per the Newhouse example, or T1 sites).

Cause	Description	Impact	Probability	Mitigation / controls
Covid -19	Work delays due to COVID-19 issues in supply chain or Resource unavailability	Delay in work delivery. Compensation Event claims from main works contractor.	30%	Covid -19 regular testing in place for all operational staff
Lack of ground condition information	Sites requiring foundation works, due to ground contamination or underground obstructions	Additional design & construction works.	20%	Contractors to check on-line and site drainage records and site plans

Outage cancellation post-contract award due to resource constraints and/or more critical works arising.	The planned outage(s) may be cancelled. Operational restrictions may be imposed.	Delay to work delivery. Compensation Event claims from main works contractor.	20%	All outages and resources booked and monitored as part of the Transmission Network System outage/resource plan
Design changes driven by reduced site details	Some of estimates are based only on annotations on a marked-up drawing without any site specific detailing	Design changes are implemented incurring additional costs.	20%	Not available due to changed approach with focus on producing cost estimates
Further changes required to proposed Scope of Works	Following involvement of NG site staff and Team Leader, as they may not have been involved in the original site surveys and in many cases have changed personnel.	Additional costs due to changed scope of works and delay to work delivery.	20%	Early engagement of contractors with ET operational staff for site visits
Tendering and awarding work on sites more than 3 months in advance of the planned delivery date.	Significant material cost uncertainty due to distant start date of works	Additional costs	50%	Not available due to changed approach with focus on producing cost estimates
Third party interface delays	Delays created by EA or DNOs agreement on works	Delays, cost increase and out of sequence working.	20%	Early liaison with EA and DNOs
Site access not available when required due to operational, security or other restrictions.	Site is not available as planned.	Delay to installation works and potential mitigation strategy.	20%	Continuous liaison with the ET Operations team to confirm any restrictions early
Exclusion zones (RMHz/OESBs) - Close proximity to exclusion zones.	Probable Exclusion Zones imposing restriction or no access to work area.	Schedule delay associated with working around restrictions.	40%	Close monitoring of OESB published and close liaison with the ET Operations team to confirm any restrictions early

Annex 15. Outline designs for 33 sites

outline designs.zip

Annex 16. Cost components flood reinforcements T2

Flood Schedue Reopener 33 sites.xlsx

Annex 17. Ofgem Guidance Checklist[4]

Guidance Reference	Guidance Name	Reference Notes
2.2-2.3	Assurance Requirements	See assurance letter appended to this submission pack
2.4-2.6	Publication & Redaction	Submission to be published here before the 5th February: https://www.nationalgrid.com/uk/electricity-transmission/about-us/business-plan
3.1-3.2	Readability, structure & detail	Throughout this document, detail has been provided to offer Ofgem sufficient information to assess the application. The executive summary has been written to summarise the request in a short self-contained format.
3.3	Tables that maps out the relevant reopener requirements	Ofgem Guidance Checklist within the annexes of the reopener document
3.6	Gas Distribution	N/A
3.8-3.11	Demonstration of needs case	See pages 7-10 of this reopener document
3.12	Optioneering	Generic optioneering information is included in this document on pages 11-16
3.13-3.16	Preferred option description including delivery plan	Preferred option details are included in each individual site CBA (Annex 7) and delivery plans are outlined in pages 29-31.
3.17	Stakeholder Engagement	This is included on page 6 in The Strategic Context section
3.19-3.22	Detailed cost information	• Included in executive summary and cost assessment section of the main reopener document (pages 24-28) and in Annex 16. • Within the separate CBAs
4.3	Glossary of terms References and annexes	See page 32 of this document

[4] Re-opener Guidance and Application Requirements Document (ofgem.gov.uk)